



Ecology of mountain goats in the Absaroka Range, south-central Montana  
by Nathan Crane Lentz Varley

A thesis submitted 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 3 year field study of mountain goat ecology was conducted in the Absaroka Range of south-central Montana. Mountain goats were introduced to the Absarokas in 1956 by the state of Montana. The population increased after introduction then declined in the early 1970's. A compensatory response followed the decline and the population level remained stable through the 1980's. Population trend counts in 1993-95 are more than double any previous count. From the initial introduction site, the population has expanded its distribution southward and eastward within the Absaroka-Beartooth Wilderness. In the last 20 years, goats have become established in the northeast corner of Yellowstone National Park in northwest Wyoming. Sporadic sightings occurred in the interior regions of the park during the study. Density of goats within 4 units of the 300 km<sup>2</sup> study area varied. Population composition in the study units appeared to be related to different rates of population growth depending on period of subpopulation residency. Preferred habitats were typically wet, rocky areas with patchy, succulent vegetation. Cliff ledge habitats were used intensively for feeding and bedding. Goats most often fed within or nearby steep escape terrain. Fall diet of goats predominantly included graminoids (76%) and forbs (20%). Forage taxa in representative habitats contributed to fall food habits in proportion to their estimated abundance. Fall diet of native bighorn sheep was similar to mountain goats; however, bighorn sheep preferred moderately dry, open meadows with abundant vegetation throughout much of the summer and early fall. Differences in habitat selection and feeding behavior enabled the species to avoid direct competition in feeding areas during summer and fall.

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IN THE ABSAROKA RANGE, SOUTH-CENTRAL MONTANA**

by

**Nathan Crane Lentz Varley**

**A thesis submitted in partial fulfillment  
of the requirements for the degree**

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APPROVAL

of a thesis submitted by

Nathan Crane Lentz Varley

This thesis has been read by each member of the graduate committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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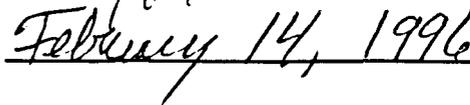
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## ABSTRACT

A 3 year field study of mountain goat ecology was conducted in the Absaroka Range of south-central Montana. Mountain goats were introduced to the Absarokas in 1956 by the state of Montana. The population increased after introduction then declined in the early 1970's. A compensatory response followed the decline and the population level remained stable through the 1980's. Population trend counts in 1993-95 are more than double any previous count. From the initial introduction site, the population has expanded its distribution southward and eastward within the Absaroka-Beartooth Wilderness. In the last 20 years, goats have become established in the northeast corner of Yellowstone National Park in northwest Wyoming. Sporadic sightings occurred in the interior regions of the park during the study. Density of goats within 4 units of the 300 km<sup>2</sup> study area varied. Population composition in the study units appeared to be related to different rates of population growth depending on period of subpopulation residency. Preferred habitats were typically wet, rocky areas with patchy, succulent vegetation. Cliff ledge habitats were used intensively for feeding and bedding. Goats most often fed within or nearby steep escape terrain. Fall diet of goats predominantly included graminoids (76%) and forbs (20%). Forage taxa in representative habitats contributed to fall food habits in proportion to their estimated abundance. Fall diet of native bighorn sheep was similar to mountain goats; however, bighorn sheep preferred moderately dry, open meadows with abundant vegetation throughout much of the summer and early fall. Differences in habitat selection and feeding behavior enabled the species to avoid direct competition in feeding areas during summer and fall.

## INTRODUCTION

Mountain goats (*Oreamnos americanus*) were historically distributed in the coastal range from Alaska to northern Washington and in the Rocky Mountains from northern Canada to northern Montana and central Idaho. Through introductions by state wildlife agencies, their distribution has been successfully expanded into vacant habitats in their historic range, as well as in habitat outside their historic range in the western United States (Johnson 1977, Wigal and Coggins 1982).

Mountain goats were released into the Absaroka Range of south-central Montana in 1956 (5 goats), 1957 (10 goats), and 1958 (8 goats) by the Montana Fish and Game Department to provide for recreational opportunities including hunting (Montana Fish and Game 1976). These goats originated from native herds on the Continental Divide in southwest Montana and were released in two drainages, Pine Creek and Deep Creek, in the northern Absarokas (Swenson 1985). Two transplants in adjacent mountain ranges may have also contributed to the success of the Absaroka population. In 1945 and 1946, 9 goats were released at Woodbine Camp in the Stillwater Canyon of the nearby Beartooth Mountains, but these goats were believed to have not fared well (Stoneberg and Foss 1977). Between 1942 and 1956, 39 goats were released in the East Rosebud and Rock Creek drainages of the eastern Beartooths (Stoneberg and Foss 1977). No significant barriers to movements between the Absaroka and Beartooth ranges exist; thus, these introductions may have contributed to the Absaroka population.

The Absaroka population has grown in number and expanded its distribution, mainly to the south and east. Recent survey counts by Montana Fish, Wildlife and Parks (MFWP) have exceeded 250 individuals with some group sizes of 60+ (MFWP 1993, 1994, 1995). Harvest quotas have been increased since hunting began in 1964, particularly in recent years, as a response to increasing numbers. Expanded from one original district, current distribution of mountain goats in the Absarokas includes 3 hunting districts.

Sightings of mountain goats in the Absaroka Range in Wyoming and Yellowstone National Park represent pioneering individuals at the frontier of mountain goat colonization (Laundre' 1990). Wyoming Fish and Game has a mandate for wildlife management similar to Montana but mountain goats were not actively introduced to Wyoming. Instead, goats have expanded into the Wyoming Absarokas and Beartooths from introduced populations in Montana. Officials from Wyoming and Yellowstone have expressed concerns over possible competition between goats and native Rocky Mountain bighorn sheep (*Ovis canadensis*) herds.

Yellowstone Park officials are also concerned with the ecological consequences of mountain goat colonization. Evidence that mountain goats were a member of the Yellowstone fauna during historic time is lacking, and therefore, they may be considered exotic by the National Park Service (NPS 1991). Exotic species may have serious impacts on native communities (Berger 1991). For example, mountain goats introduced to Olympic National Park have altered native vegetation communities and affected endemic plants (Pfitsch et al. 1983, Pfitsch and Bliss 1985, Schreiner 1994). Thus, the ecological consequences of mountain goats in Yellowstone is an important management issue.

The agencies involved in management of the mountain goat in the Absaroka Range have different mandates and objectives, but have the same need for information.

This study was intended to provide baseline ecological information on the population of mountain goats in the Absaroka Range and to help determine if the population is compatible with the native community ecologically and compatible with the management objectives of the agencies involved.

The objectives of the research were to collect and analyze several sets of data related to the status and general ecology of mountain goats in the Absaroka Range. Goat population trend has been monitored by MFWP from 1966 to 1995. This data was analyzed for indications of density dependence and compared with climate data to detect associations between climate and population trends. Current population distribution, density of subpopulations, group sizes, and age composition data were gathered and compared within the 300 km<sup>2</sup> study area. Goat feeding sites were described by habitat, aspect, slope, elevation, and distance to escape terrain. Feeding site data were compared to detect changes in use through 5 summer and early fall periods. Parturition sites and winter-use sites were described. Feeding site descriptions of bighorn sheep and goats were compared to assess potential competition between the two species. Feeding behavior of sheep and goats were described and contrasted, and the diets of mountain goats and bighorn sheep were compared to assess similarity.

## STUDY AREA

The study area was located primarily in the northern Absaroka Range of southwest Montana (Figure 1). The area included an estimated 300 km<sup>2</sup> of alpine habitats extending from timberline, around 2,550 m, to 3,313 m on Amphitheater Mountain. The range is characterized by narrow, abrupt ridges separated by forested drainages. It lacks large, flat plateaus as found in the adjacent Beartooth Mountains. Steep cliffs and scree slopes are most common on northern and eastern exposures. Gradually sloping northern and western aspects accumulate more soil and support turf vegetative communities. Dry, southern slopes typically have shallow soils and are sparsely vegetated. Parent material in the Absarokas is primarily the Eocene Absaroka Volcanic Supergroup (Decker 1990). The igneous bedrock is of two primary types: volcanic breccia and lava flows.

The temperate climate of the study area was characterized by long, cold winters and short, cool summers. Altitude and aspect play a major role in determining local climate regimes. Temperature declines and precipitation increases with elevation; north and east aspects tended to be cooler and wetter than south and west aspects. Mean temperatures varied by month between -8° C and -20° C in the winter and 7° C and 15° C in summer. Yearly precipitation accumulations average between 80 cm and 150 cm depending upon elevation and topography.

The subalpine forests of the Absarokas primarily consists of subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*), and Engelman spruce (*Picea engelmannii*). Common understory vegetation includes grouse whortleberry (*Vaccinium scoparium*),

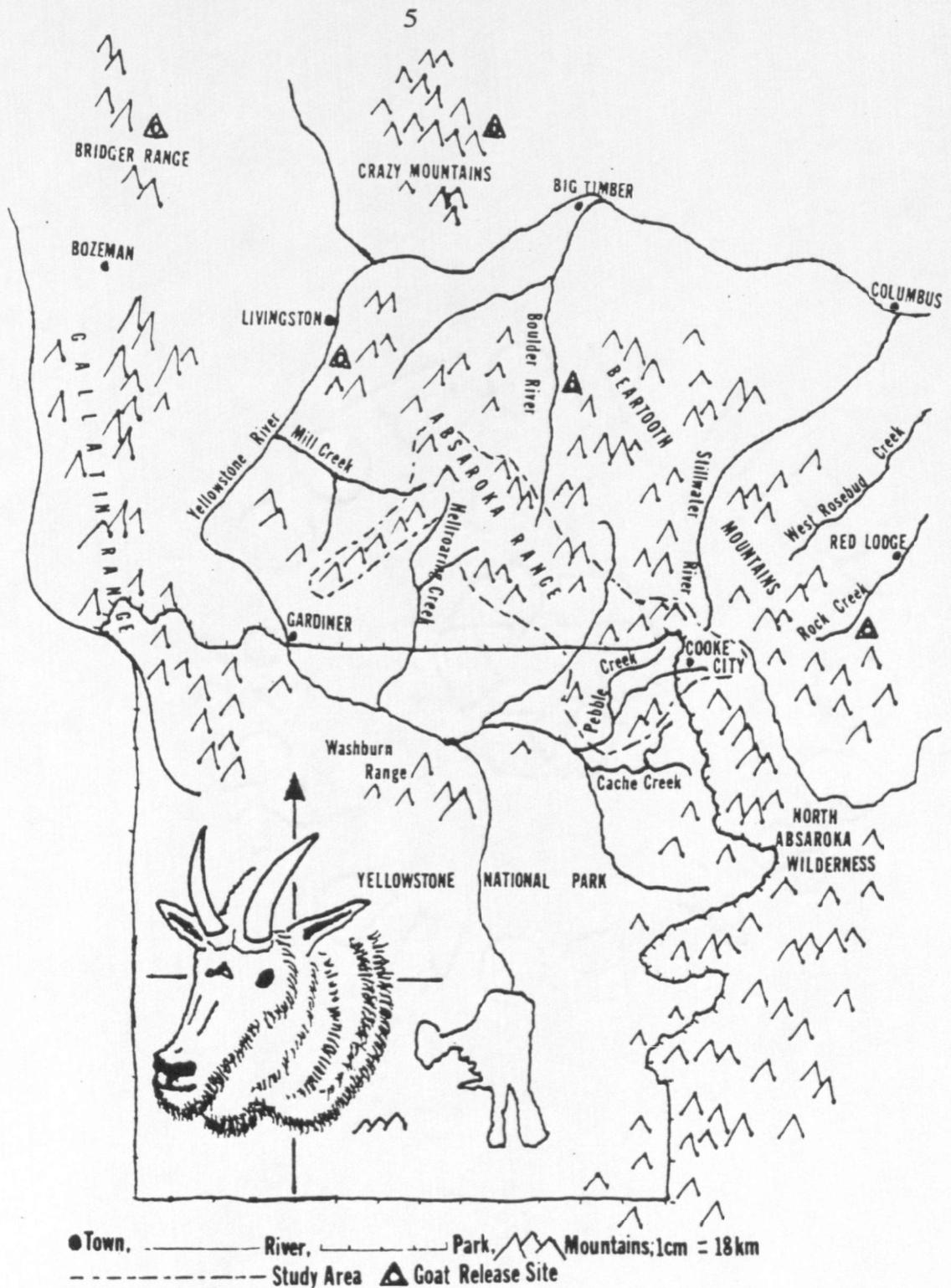


Figure 1. Study area in the Absaroka Mountain Range in south-central Montana and northwest Wyoming.

*Arnica* spp., and sedges (*Carex* spp.). Sedges, bluegrasses (*Poa* spp.), tufted hairgrass (*Deschampsia cespitosa*), bluebells (*Mertensia* spp.), and chickweed (*Cerastrium arvense*) are abundant in subalpine and alpine meadows. Wet, shaded areas are sparsely vegetated with mosses (*Polytrichum* spp.), bluegrasses, and rushes (*Juncus* spp.). Stonecrop (*Sedum lanceolata*), sky pilot (*Polemonium viscosum*), and moss campion (*Silene acaulis*) were common in loose rocky areas.

Potential mountain goat predators observed in the study area included coyotes (*Canis latrans*), golden eagles (*Aquila chrysaetos*), and black bears (*Ursus americanus*). Mountain lions (*Felis concolor*) and grizzly bears (*Ursus horribilis*) are known to occupy the area. Gray wolves (*Canis lupus*) were reintroduced to Yellowstone Park in 1995 and on May 5 were known to have preyed upon a mountain goat in the study area (Smith and Phillips, in press). Rocky Mountain elk (*Cervus elaphus canadensis*), moose (*Alces alces*), and mule deer (*Odocoileus hemionus*) are other ungulates that were observed along with mountain goats and bighorn sheep.

Hunters have legally harvested mountain goats in the Absarokas under a limited license system since 1964. In 1994, 42 goat permits were available by special drawing from three hunting districts. Four permits were issued in the North Absaroka district (H.D. 330), north of the study area and closest to the introduction site. Eighteen permits were issued for the South Absaroka district (H. D. 323) which includes the Mill Creek unit and the Clover Basin and Crow Mountain subunits of the Hellroaring unit. Twenty goat licenses were issued for the Hellroaring-Slough Creek district (H.D. 329) which was created in 1986 to include expanding goat populations to the south and east. The Middle Ridge and Iron Mountain subunits are in this hunting district as are adjacent mountain areas to the east and southeast. In 1995, total license numbers in the 3 districts were increased by 10: (330) = 4, (323) = 28, (329) = 20.

Wyoming Fish and Game does not issue licenses for the harvest of mountain goats in the Absaroka Range in Wyoming. The only part of the study area to fall within the jurisdiction of Wyoming Fish and Game was the eastern section of the Amphitheater-Abiathar subunit where goats were not found in abundance.

With the exception of those few in Yellowstone Park and Wyoming, mountain goats occur almost entirely within the Absaroka-Beartooth Wilderness Area of the Gallatin National Forest. The study area extended from The Pyramid at the headwaters of the Boulder River and Mill Creek, southeasterly along the crest of the mountain chain to Amphitheater Mountain, south of Cooke City, Montana. The area includes the Mount Wallace ridgeline extending from Crow Mountain southwest to Monitor Peak, and the mountains in and around northeastern Yellowstone Park including Wolverine Peak, Cutoff Mountain, and The Thunderer.

The study area was divided into four units associated with major drainages: Mill Creek, Hellroaring Creek, Pebble Creek, and Cache Creek (Figure 2). The Mill and Hellroaring Creek units were entirely within the Absaroka-Beartooth Wilderness of the Gallatin National Forest (Figure 3). The Pebble Creek unit included the northeast corner of Yellowstone Park, and also extended into the Gallatin National Forest north of Cooke City, Montana (Figure 4). The Cache Creek unit was south of Soda Butte Creek and north of Cache Creek in Yellowstone Park and extended east into the North Absaroka Wilderness of the Shoshone National Forest, Wyoming.

Study units were further divided into smaller subunits that were surveyed for mountain goats. The goat habitats associated with particular peaks and/or ridges represented a subunit. Mountain goat movement was assumed to occur among subunits, and to a lesser extent, among units.

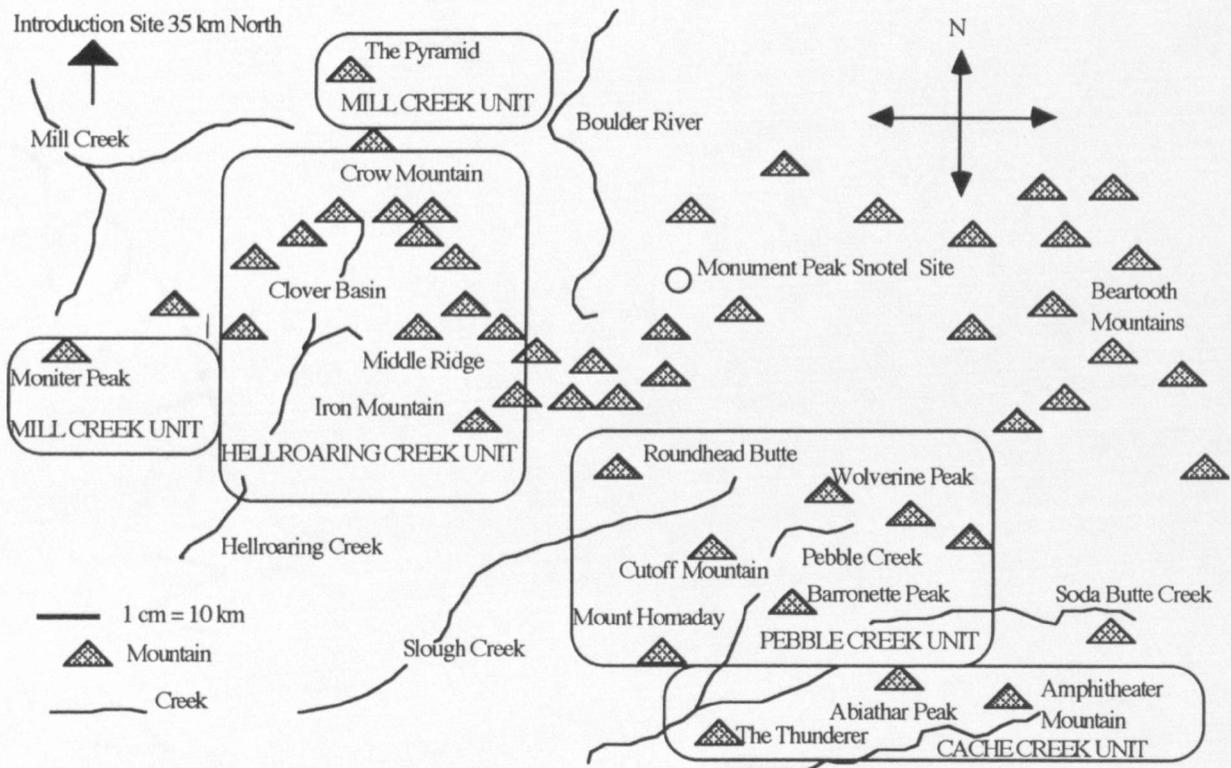


Figure 2. The subunits of the Mill Creek, Hellroaring Creek, Pebble Creek, and Cache Creek units of the Absaroka Range study area.

The Mill Creek unit consisted of 2 relatively isolated mountain peaks at the headwaters of Mill Creek: (1) The Pyramid and (2) Monitor Peak (Figure 3). The summit areas and associated alpine ridgelines to the north and south of both peaks constituted the 2 subunits of the Mill unit .

The Hellroaring Creek unit consisted of the ridge system separating Hellroaring Creek from the Boulder River and Mill Creek (Figure 3). Four subunits were surveyed: (1) Middle Ridge, (2) Crow Mountain, and (3) Iron Mountain, and (4) Clover Basin. Middle Ridge included Middle Ridge, the headwaters of Copper Creek, the headwaters of Sheep Creek, and the peaks around Elk Lake. The Crow Mountain subunit included the summit and ridges of Crow Mountain, north to Bridge Lake and south to Bridge Point. The Iron Mountain subunit consisted of the summit area of Iron Mountain and the ridgeline extending northeast to its junction with the Boulder River divide. Clover Basin included Clover, Silver, and North Fork Basins; Mount Wallace; and the headwaters of Grizzly Creek. The subunits of the Hellroaring Creek unit were often junctions of several mountain ridges; they had high habitat diversity and continuity relative to other subunits.

Five subunits in or near Yellowstone Park's northeast corner north of Soda Butte Creek comprised the Pebble Creek unit: (1) Wolverine Peak (2) Cutoff Mountain (3) Barronette Peak, (4) Mount Hornaday, and (5) Roundhead Butte (Figure 4). The Wolverine Peak subunit consisted of peaks and ridges adjoining Wolverine Peak including Sunset Peak, Miller Mountain, Mineral Mountain, and Meridian Peak. A ridgeline (called Wolverine Ridge) extending west from Wolverine Peak and south of Wolverine Creek was also surveyed. The relatively isolated Mount Abundance north of Wolverine Peak was also included in this subunit. The ridgeline north of Bliss Pass to the summit of Cutoff Mountain and the ridgeline extending east from Cutoff's summit to Wolverine ridge at the headwaters of Lost and Pebble Creeks composed the Cutoff

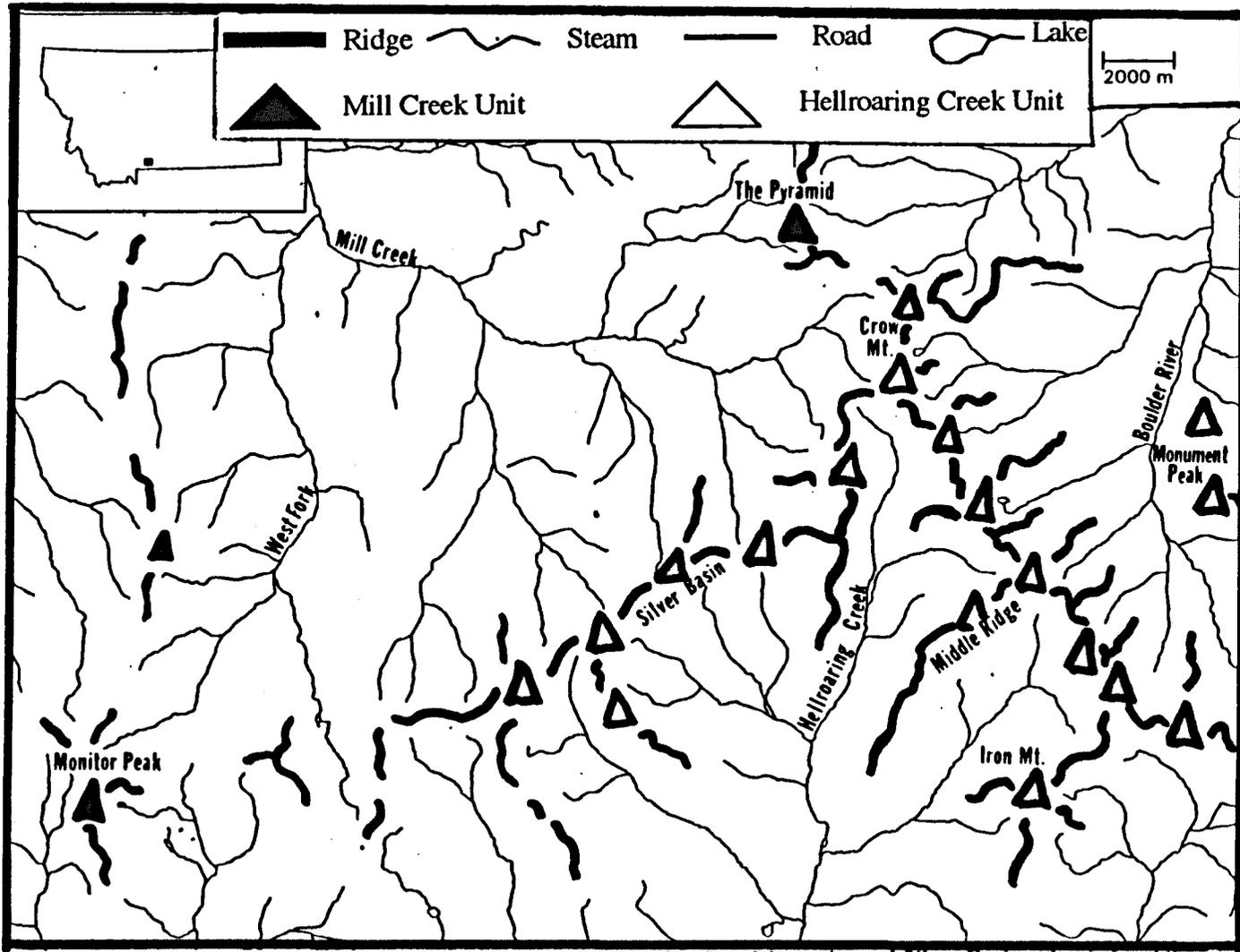


Figure 3. The Hellroaring Creek unit (Crow Mountain, Middle Ridge, Iron Mountain, and Silver Basin subunits) and the Mill Creek unit (The Pyramid and Monitor Peak subunits) of the study area in south-central Montana.

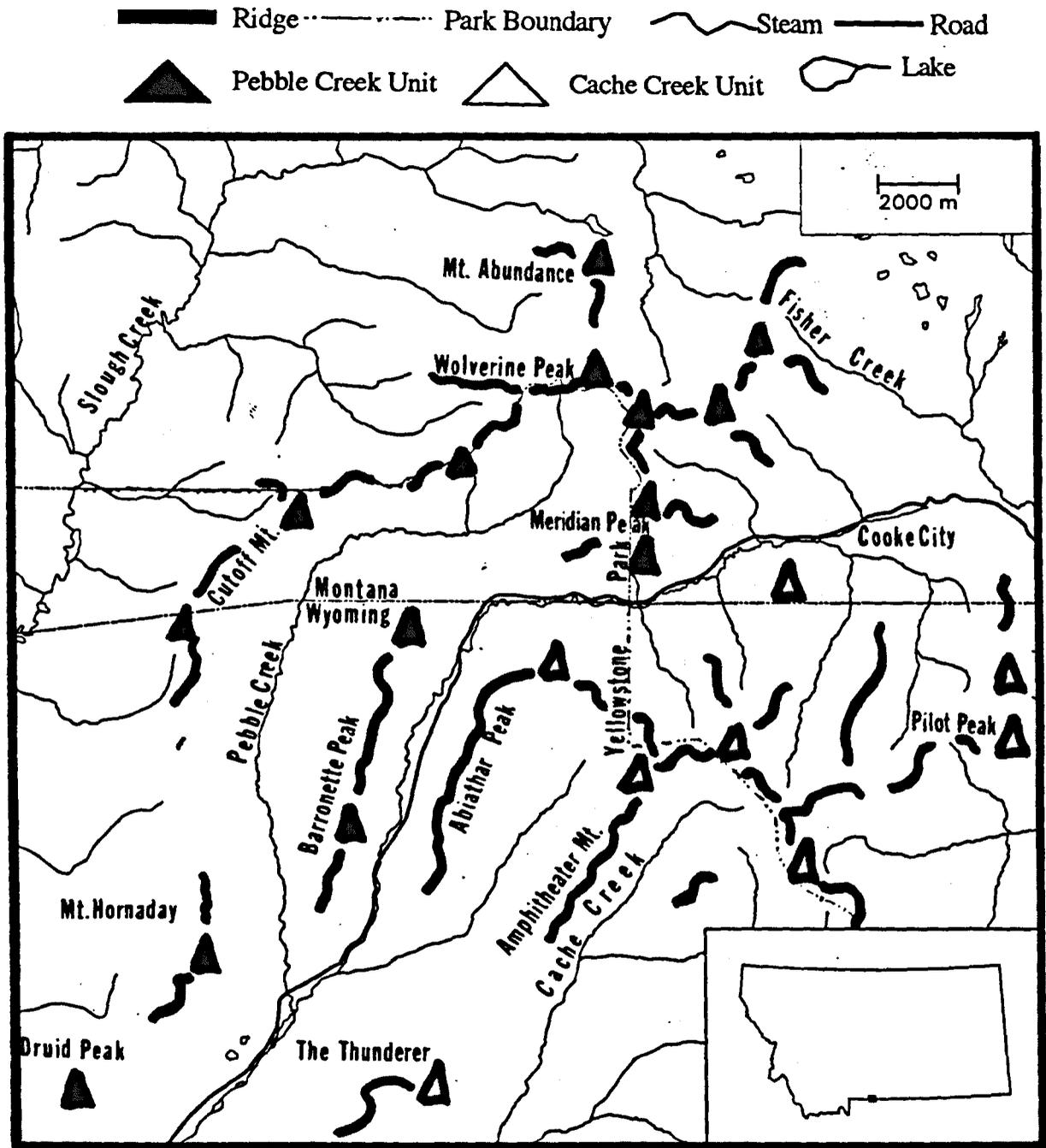


Figure 4. The Pebble Creek (Wolverine Peak, Cutoff Mountain, Mount Hornaday, and Barronette Peak subunits) and the Cache Creek unit (Amphitheater-Abiathar and The Thunderer subunits) of the study area in Yellowstone National Park and adjacent lands, south-central Montana and northwest Wyoming.

subunit. Mount Hornaday, Barronette Peak, and Roundhead Butte were isolated mountain areas in the Pebble Creek unit.

The Cache Creek unit was south of Soda Butte Creek and north of Cache Creek in the Park (Figure 4). It also includes the ridge system immediately adjacent to the park boundary east of Amphitheater Mountain in the North Absaroka Wilderness of Wyoming. It contained two subunits: (1) Amphitheater-Abiathar and (2) The Thunderer. The steep, rugged ridges associated with Amphitheater Mountain and Abiathar Peak were surveyed. The ridgeline extending east from Amphitheater Mountain to the headwaters of Republic Creek was also included. The forested ridgeline extending west from Amphitheater Mountain ends in an isolated linear ridge called The Thunderer.

## METHODS

### Population Trend and Distribution

#### Aerial surveys

Aerial survey counts were used to assess population trend and distribution of mountain goats in the Absaroka Range. Nineteen aerial counts were conducted by MFWP from 1966 to 1995 using fixed-wing aircraft (MFWP 1995). Counts were conducted in late August, September, or early October. The number and location of all mountain goats were recorded, and a reproductive success ratio [the number of kids (age 0-6 months) per 100 older goats observed] was generated from each count. Adult sex could not be determined from aerial observations. The size of the area surveyed increased to coincide with the expanding distribution of the population. Current areas surveyed include the Mill and Hellroaring Creek units, as well as areas outside the study area including the northern extension of the range just south of Livingston, Montana, and the upper Slough Creek drainage north of Yellowstone Park. Portions of the Pebble Creek unit in and around Yellowstone Park were surveyed in 1993. I performed aerial surveys of the Pebble and Cache units of the study area in June, 1991, and November, 1992.

#### Visitor reports

Visitor reports of mountain goats in Yellowstone Park were collected at visitor centers and ranger stations and compiled for information on distribution and dispersal into the park. The validity of visitor reports was assessed from report form descriptions

of mountain goats and habitat; as well as, visitor experience with mountain goats and other wildlife (see Appendix G).

### Climatic Indices

Climatic trends have been suggested as being a factor in mountain goat population growth (Bailey 1991). Reproductive success was negatively correlated with snow depth during late gestation for mountain goats in the Absarokas (Swenson 1985) and in the Sawatch Range of Colorado (Adams and Bailey 1982). Climate data from 1965-1993 were collected from weather stations on Monument Peak east of the Hellroaring Creek unit. Data from weather stations at the Northeast Entrance of Yellowstone Park and Fisher Creek, east of the Pebble Creek unit, were used to estimate missing data from the Monument Peak data set. May 1 snowpack in both depth (cm) and snow water equivalency (cm), temperature ( $^{\circ}\text{C}$ ), and June and July precipitation (cm) were compiled from snowcourse and automated Snotell sites. The effect of winter temperature severity on mountain goats was estimated using a temperature-metabolic relationship described by Krog and Monson (1954) in which base metabolism for a mountain goat increases exponentially as temperature dropped below  $-20^{\circ}\text{C}$ . The metabolic demands of daily temperature at 6 a.m. for the winter months (October of the previous year through April) were accumulated for an estimate of winter temperature severity. Severity indices ranging from -4 for the most severe, to +4 for the mildest conditions were generated from a normal probability function of the temperature data from 1965 to 1993 (Farnes 1990).

Simple linear regression analysis was used to examine the association of population growth with climatic indices. Reproductive success (kids/100 older goats) from MFWP trend counts was the dependent variable in all regressions. Independent

variables included May 1 snowpack of the current year and the previous year, temperature severity of the year and June and July precipitation the previous year.

### Density and Composition

Ground surveys were conducted from mid-May through mid-October, 1991-1993, to estimate the density of subpopulations in different units and subunits of the study area. Only the Pebble and Cache Creek units were surveyed in 1991; all units were surveyed in 1992 and 1993. In 1994, three surveys were made in July in the Pebble Creek unit. Surveys originated from basecamps close to goat habitats. Peak and ridgeline routes in subunits between 3 and 10 km long were searched for goats with the aid of 7X binoculars and a 20X-60X spotting scope. Counts of mountain goats were made during each survey. Each count constituted 1 day of survey effort. While surveying a subunit, sightings of goats in other subunits would frequently occur; thus, a total count of goats, or unit count, was kept to account for all sightings each day. Density estimates for subunits were derived from daily counts and subunit area where  $SD = SA / DC$ . SD is the subunit density estimate, SA is the subunit area ( $\text{km}^2$ ) estimated from U. S. Geological Survey 7.5" topographical maps, and DC is the daily count (number of goats) for the subunit. Unit density estimates were calculated as the mean of subunit density estimates for that unit. Size and composition of groups encountered were recorded; classifications of age and sex followed Smith (1988).

## Resource Use

### Habitat Use

For observations of feeding mountain goats, feeding site characteristics, time spent in each site, and distance traveled were recorded. Habitats were described based on terrain, vegetation, and soil characteristics within a 25-meter radius of the subject animal. Classifications are similar to those made by Pallister (1974), Stewart (1975), and Martin (1985) for Absaroka summer range. In addition to habitat description, 4 physical characteristics of feeding sites were recorded from U.S.G.S. 7.5" topographic maps: slope, aspect, elevation, and distance to escape terrain (defined as the estimated distance (m) to steep terrain ( $> 25^\circ$  slope)).

Plant specimens from alpine and subalpine habitats were collected, and a list of species and genera identified in the study area was compiled. Vegetation characteristics in three habitats used frequently by feeding mountain goats were measured. Percent canopy cover and plant frequency were estimated for plant species in 20 X 50 centimeter plots spaced at 1-meter intervals along 29 20-meter line transects (Daubenmire 1959). Transect sites were not selected randomly but on the basis of accessibility and safety. Transects were placed in three habitats: 6 in ledge, 12 in rocky scree, and 11 in turf. Three of 11 turf transects were in turf-scree habitat but were combined with turf because of the similarity in species composition and frequency in the two habitats. Transects in ledge habitat were difficult and were discontinued after 1992 for safety reasons.

Feeding site description data were grouped into five 30-day periods: (1) May 15 - June 15, (2) June 16 - July 15, (3) July 16 - August 15, (4) August 16 - September 15, (5) September 16 - October 15. Parturition habitats were located and described. Seven

surveys were made in November, 1994 in the Hellroaring Creek unit to search for goat wintering areas.

### Diet

In 1992, 22 goat hunters were issued licenses within the study area (hunting districts 323 and 329) were asked to provide one-quart rumen samples from their harvested animal. Rumen analysis (Korschgen 1980) was used to determine fall diet. No adjustments for differential digestibility were made.

Mean percent canopy cover and mean frequency of the plant taxa in rumen samples were compared using Spearman's rank-correlation. The diet of mountain goats from this study and bighorn sheep derived from Martin (1985) for the Absarokas were compared using the Kulczynski's similarity index (SI) described by Oosting (1956) and Jarman (1971):

$$SI = \{ \sum (2w) \div \sum (a + b) \} \times 100$$

where  $w$  is the lesser percentage of a forage category in the two diets and  $a + b$  is the sum of the percentages of the forage category in the two diets.

### Bighorn Sheep

Observations of feeding bighorn sheep were recorded in the same manner as mountain goats. Interspecific interactions were recorded when the species were observed within ~20 meters of each other. Each interaction was classified according to 4 categories based on whether either species prevented use of a resource by the other: sheep-dominated, goat-dominated, neutral (mutual tolerance), or ambiguous (not clearly ascertained).

## RESULTS

### Population Trend

The Absaroka mountain goat population has been monitored since 1966 (Table 1). An initial period of rapid growth in the late 1950's and 1960's was followed by a population decrease in the early 1970's which was attributed primarily to harvest (Swenson 1985, Figure 5). A population rebound that followed in the late 1970's was considered to be a compensatory response to the population reduction after harvest was reduced (Swenson 1985, 1986). Counts stabilized around 100 goats through the 1980's with wide fluctuation in reproductive success. Based on similar count methods and areas surveyed in the 1980's, counts in 1993-95 more than doubled (247-284) any previous count, suggesting a substantial and rapid population increase. The most recent survey conducted in fall of 1995 resulted in 269 goats counted with 35 kids/100 older goats. Reproductive success ratios were negatively correlated with number of older adults from 1966-1991 suggesting density dependence ( $r = -0.79$ ,  $p < 0.01$ ); adding the higher counts from 1993, 1994 and 1995 weakened the association ( $r = -0.46$ ,  $p = 0.08$ ).

Table 1. Absaroka goat population trend counts, composition, and harvest from Montana Fish, Wildlife and Parks; and climate data from Monument Peak snowcourse, 1966-1994.

Year	Mountain Goat Trend			Climatic Indices		
	n	kids / 100 older goats	harvest	snow depth/ SWE (cm) <sup>a</sup>	temperature severity <sup>b</sup>	J & J pcp. (cm) <sup>c</sup>
1966	48	60		150 / 38.94	2.5	14.85
1967	56			245 / 67.76	-3.3	20.28
1968				195 / 58.08	-1.9	20.41
1969	86	46		180 / 49.72	0.0	24.54
1970				218 / 58.96	-2.0	15.48
1971			21	258 / 76.56	-3.8	11.72
1972	91	28	14	218 / 62.26	-2.6	14.41
1973			13	198 / 44.22	1.4	14.02
1974	69	33	18	233 / 68.20	-3.4	19.32
1975			14	253 / 66.88	-3.2	18.66
1976			19	250 / 78.82	-3.6	16.62
1977	60	50	08	120 / 28.16	3.7	22.50
1978	60	43	09	193 / 49.72	0.0	11.25
1979			12	180 / 49.06	0.7	10.50
1980			12	150 / 40.04	2.3	13.25
1981	98	36	08	135 / 34.10	3.3	14.75
1982	107	21	05	220 / 61.82	-2.5	14.75
1983	96	22	12	163 / 43.56	1.6	15.00
1984			29	192 / 46.20	0.9	12.50
1985	96	28	11	145 / 37.84	2.7	14.00
1986			14	198 / 57.20	-1.7	14.00
1987			24	118 / 25.30	4.0	16.00
1988	116	11	14	148 / 36.96	2.9	03.50
1989	88	40	15	170 / 43.78	1.5	10.25
1990	96	25	19	158 / 48.40	0.4	06.75
1991	112	38	16	217 / 53.90	-1.1	04.75
1992			17	135 / 41.14	2.1	17.65
1993	247	28	22	- / 47.74	-2.1	23.75
1994	284	43	28			

<sup>a</sup> Snowpack on May 1: depth (cm) / snow-water equivalency (cm); (-) indicates no data available.

<sup>b</sup> Index for winter temperature, from - 4, most severe, to 4, most mild, based on 30-year mean.

<sup>c</sup> Total precipitation (cm) from June and July.

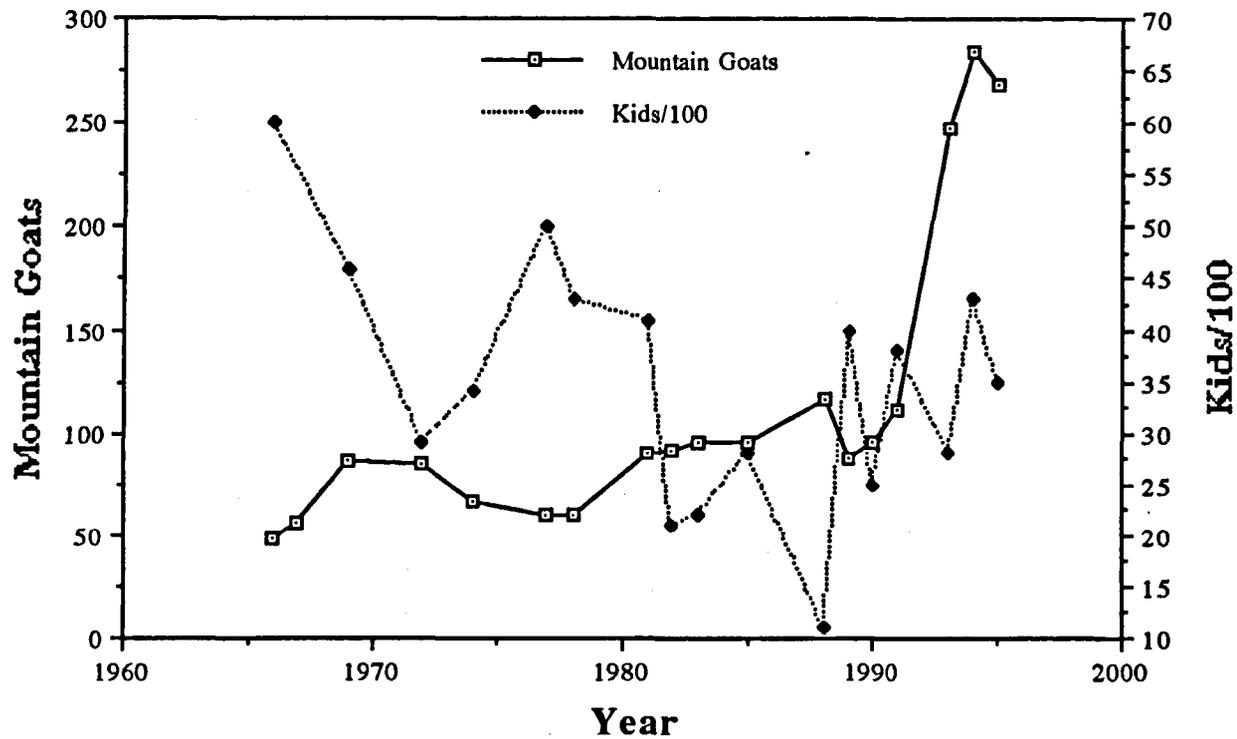


Figure 5. Mountain goat trend counts and reproductive ratios (kids / 100 older goats) from the Absaroka Range from Montana Fish, Wildlife and Parks aerial surveys, 1966-1995.

Climatic Effects

No relationship between reproductive success (kids / 100 older adults) and spring (May 1) snow depth was detected from 1966 through 1992 ( $r = 0.19$ ,  $p = 0.51$ ,  $n = 14$ ; Table 2), as there was from 1966 through 1983 (Swenson 1985, 1986). May 1 snow water equivalency (SWE) readings from the automated Snotell site and May 1 snow depth readings from the snowcourse at Monument Peak were not similar ( $r = -0.313$ ). No association between SWE and reproductive success was found ( $r = 0.25$ ) suggesting depth may be a more significant factor than SWE in determining forage availability.

A weak positive association between reproductive success and May 1 SWE of the previous year was found ( $r = 0.45$ ,  $p < 0.1$ ; Table 2). Prebreeding forage conditions, determined by prebreeding snowpack, may influence reproductive success (Stevens 1983). No associations with winter temperature severity and June and July precipitation (current and previous year) were found.

Table 2. Linear regression of climatic variables with reproductive ratios, kids/100 older adults, from Montana Fish, Wildlife and Parks trend counts 1966-1994.

Independent Variable	r	R <sup>2</sup>	F-test	p-value
June and July Precipitation	0.43	0.19	2.954	0.109
June and July Prec. (Previous Year)	0.10	0.01	0.136	0.718
May 1 SWE	0.25	0.06	0.839	0.376
May 1 SWE (Previous Year)	0.45	0.20	3.230	0.095
Temperature Severity	0.22	0.05	0.690	0.421

## Population Distribution

### Distribution

Aerial surveys confirmed mountain goats occurred in all 4 units of the study area. MFWP trend counts indicate goat populations have increased in the Mill and Hellroaring Creek units since 1964. In the fall of 1993, the MFWP surveyed the Wolverine Peak and Cutoff Mountain subunits of the Pebble unit for the first time (MFWP 1993); 22 goats were counted during the survey of this area (note: this count was separate from the 1993 trend count). Fifteen goats were sighted in northeast Yellowstone Park on June 16, 1991, during an aerial survey I completed. A single adult was located on a southern cliff-face of Abiathar Peak in the Cache Creek unit during the same survey.

### Gender-selected Distribution

The general distribution of adult males (billies) and females (nannies) within subunits was found to be different during ground surveys (Figure 6). Billies tended to select peripheral or isolated habitats. For example, when goats were found near the end of a ridgeline or on a peak isolated from other alpine areas by forests, these goats were most often billies. Numerous billies and very few nannies were sighted on Mount Abundance (Figure 4), a small alpine area on the periphery of an extensive ridgeline and isolated by forests. Fewer billies than nannies were sighted during the surveys--billies may have been underrepresented in ground survey results because only the most continuous habitats were surveyed while outlying pockets of habitat were typically not surveyed.

In contrast, nannies were often found in the more continuous habitat complexes where several ridges or peaks were in close proximity. Large maternity groups were

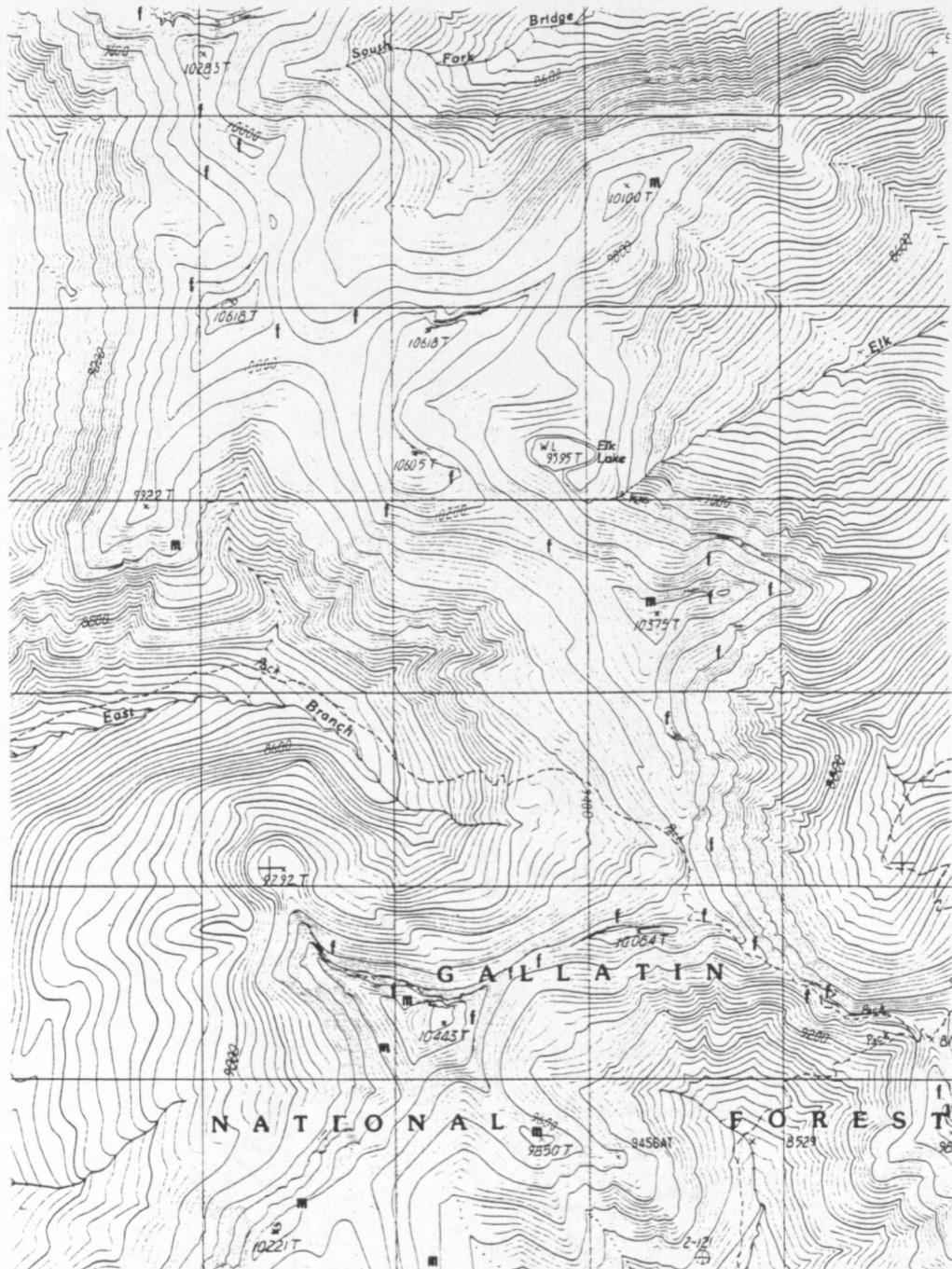


Figure 6. Distribution of adult males (m) and adult female (f) mountain goats in the Middle Ridge subunit of the Hellroaring Creek unit, Absaroka Range, 1992.

often sighted at or near the junctions of 2 to 3 extensive ridgelines such as Wolverine Peak and Iron Mountain. Elsewhere, nannies are reported to consistently occupy the "best" available habitats within their ranges (Chadwick 1977).

### Yellowstone Park Visitor Reports

Reports of mountain goats in Yellowstone Park began as early as 1965, were rare in the 1970's, and increased slowly through the 1980's (Laundre' 1990). Visitor sightings in 1991-95 occurred in a variety of locations in and adjacent to Yellowstone (Table 3). Sightings occurred primarily along roads and in high visitor-use areas such as the Mount Washburn-Dunraven Pass area and the Grand Canyon of the Yellowstone River. Many of the goat sightings near roads were reported multiple times. Thirty-four of 43 sightings between 1991 and 1995 were of one or two individuals. These may simply be "probe movements" (Stevens 1983), in which lone adults or subadults wander from populated areas in search of other populations. Individuals may remain for a period of time, sometimes up to one year (Stevens 1983), before moving on. Some sightings of what seemed to be the same individuals continued for up to a week. Sightings occurring before this study indicate mountain goats have made these movements into the Park sporadically for 20 years (See Appendix E for reports prior to 1991).

One area where several sightings had been made was investigated. In October, 1992, two surveys of Sepulcher Mountain near Mammoth Hot Springs were conducted. On the first survey one adult and one 3-year-old billy were sighted on the north-slope cliffs near the summit. These two matched the description of those sighted in the Gardner River Canyon in late August, and if they were the same individuals, it can be concluded that these pioneering individuals lingered in the vicinity for 5 weeks or more. Goats were found on Sepulcher Mountain in 1992, 1994, and 1995, including nannies with kids. Sepulcher Mountain is an extension of the mountains of the northwest corner of the park

Table 3. Date, composition, and location of visitor reported sightings of mountain goats in and adjacent to Yellowstone National Park, 1992-1995.

Date	Group Composition <sup>a</sup>	Location Description
05-17-91	2? <sup>b</sup> -0-0	South side of Black Mountain <sup>c</sup>
05-24-91	1-0-0-0	The Thunderer
05-24-91	2?-0-0	Tower Falls area
06-09-91	1-0-0-0	North slope of Mount Washburn
06-27-91	0-2-0-1	Electric Peak
07-20-91	10?-0-0	East Slope of Snowslide Mountain <sup>c</sup>
08-19-91	1?-0-0	Guitar Lake <sup>c</sup>
08-20-91	0-2-0-0	Near Gallatin Highway
09-23-91	1?-0-0	Grebe Lake Trailhead, Norris-Canyon Road
02-04-92	1?-0-0	West side of Garnet Hill
05-17-92	1?-0-0	Elk Creek, east of Floating Island Lake
05-30-92	2-0-0-0	Mount Hornaday, Cliffs on south side
06-17-92	1?-0-0	Fossil Forest Cliffs in Lamar Valley
06-19-92	1?-0-0	Mount Washburn
07-03-92	2?-0-0	Mount Washburn
07-03-92	1?-0-0	Mount Washburn near Dunraven Pass
07-08-92	1?-0-0	Mount Washburn near Dunraven Pass
08-01-92	1-0-0-0	Seven-mile Hole, Grand Canyon of the Yellowstone
08-16-92	1-0-0-0	Mount Washburn summit
08-25-92	1?-0-0	Northeast slope of Sepulcher Mountain
08-28-92	2-0-0-0	Gardner River Canyon
08-29-92	2-0-0-0	Gardner River Canyon
09-16-92	2?-0-0	East side of Dome Mountain, Gallatins Mountains <sup>c</sup>
09-22-92	2?-0-0	Sepulcher Mountain, North face
06-02-93	1?-0-0	The Thunderer, near Pebble Creek Campground
06-06-93	5?-3-0-3	East side of Yellowstone River near Tower Falls
06-15-93	0-2-0-2	East side of Yellowstone River near Tower Falls
06-26-93	1?-0-0	Bliss Pass
08-03-93	0-1-0-1	Meridian Peak
06-20-94	0-1-0-1	Sepulcher Mountain
07-07-94	0-6-0-2	Ramshorn Peak, Tom Miner Basin <sup>c</sup>
07-16-94	0-3-0-1	North side of Sheep Mountain, Tom Miner Basin <sup>c</sup>
07-22-94	0-1-0-1	Sepulcher Mountain
07-27-94	0-1-0-1	Sepulcher Mountain
07-29-94	2?-0-0	Dunraven Pass

Table 3. (Concluded)

08-06-94	0-1-0-1	Sepulcher Mountain
08-14-94	1-1-0-0	Tom Miner Creek <sup>c</sup>
09-17-94	1-0-0-0	Southeast side of Mount Washburn
10-10-94	1-0-0-0	Bunsen Peak
05-30-95	2?-0-0	Druid Peak
06-02-95	2?-0-0	Druid Peak
06-08-95	2?-0-0	Barronette Peak
06-11-95	0-1-0-1	Tower Falls
06-15-95	2?-0-0	Yellowstone canyon by Tower Falls
06-15-95	1?-0-0	East side of Mount Hornaday
06-17-95	1?-0-0	Yellowstone canyon north of Tower Falls
07-24-95	0-1-0-0	Sepulcher Mountain
08-07-95	1-0-0-0	Northeast ridge of Mount Washburn
09-07-95	0-2-0-1	North of Bighorn Pass
09-12-95	3?-0-1	North slope of Sepulcher Mountain

<sup>a</sup> Numer of adult males-adult females-yearlings-kids

<sup>b</sup> Number of adults of unknown sex

<sup>c</sup> Adjacent to the park

where a herd seems to have established itself. Larger groups occurred in the Gallatin Mountains inside and adjacent to the northwest park boundary including Electric Peak, Sheep Mountain, and Ramshorn Peak.

Goats were observed in the Yellowstone River canyon near Tower Falls in June, 1993 and 1995. The group did not remain in this highly visible area for more than about a week during both years. The steep canyon walls being used by goats are adjacent to Specimen Ridge, a long, rolling extension of the Absarokas to the east. Goats returned to this area presumably by the same route during two years in which spring plant growth came late to alpine areas due to heavy snowpack.

#### Population Density

Ground surveys of the study area produced 102 daily counts of 13 different subunits (See Appendix B for dates and locations of surveys). Density estimates, counts and group sizes in the subunits and units varied (Table 4). In the case of the Hellroaring unit, goat densities were comparable to other introduced populations (Table 5).

No goats were sighted during 4 surveys of the Cache Creek unit. Density estimates for the other 3 units varied between 0.2 goats / km<sup>2</sup> in the Pebble Creek unit in 1991 to 5.1 goats / km<sup>2</sup> in the Hellroaring Creek unit in 1993 (Table 4). 1991-93 counts and group sizes were greater in the Hellroaring Creek unit than in the Pebble Creek unit ( $t = -3.71$ ,  $p = 0.001$ ;  $t = 39.5$ ,  $p < 0.0001$ , respectively) and the Mill Creek unit ( $t = -3.54$ ,  $p = 0.002$ ;  $t = -22.6$ ,  $p < 0.0001$ , respectively). The largest counts and group sizes occurred in the subunits of the Hellroaring unit during both years surveyed. The largest unit count of the study, 101, occurred in the Hellroaring unit on September 29, 1993. Large groups were spotted in the Clover Basin, Crow Mountain, Middle Ridge, and Iron Mountain subunits on that day. In 1993, Iron Mountain, where the largest group, 43, was observed,

Table 4. Density, daily unduplicated counts, and group sizes of mountain goats observed during ground surveys of 11 subunits in the Pebble, Hellroaring, and Mill units of the Absaroka study area, 1991-1993.

Year	Subunit and Area (km <sup>2</sup> )	Density <sup>a</sup>			Daily Unduplicated Count			Group Size		
		Goats / km <sup>2</sup>	n	Mean	Range	n	Mean	Range		
1991	Wolverine Peak	11.8	0.9	7	3.1	0-11	5	5	1-11	
	Cutoff Mountain	6.8	0.0	1	0	0	0	0	0	
	Barronette Peak	4.5	0.0	2	0	0	0	0	0	
	Mount Hornaday	1.3	0.0	1	0	0	0	0	0	
	PEBBLE UNIT	24.4	0.2	11	2.0	0-11	5	5	1-11	
1992	Wolverine Peak	11.8	4.1	12	9.9	0-49	25	3.6	1-10	
	Cutoff Mountain	6.8	0.7	3	1.7	0-5	1	5.0	5	
	Mount Hornaday	1.3	0.0	1	0	0	0	0	0	
	PEBBLE UNIT	19.9	1.6	14	8.4	0-49	36	3.5	1-10	
	Middle Ridge	8.3	6.0	7	27.5	12-50	26	9.0	1-29	
	Crow Mountain	9.7	3.7	4	18.7	2-36	11	7.5	1-33	
	Iron Mountain	6.9	2.6	3	8.0	1-18	3	8.0	1-18	
	HELLROARING	24.9	4.1	13	20.8	2-61	40	8.5	1-33	
	The Pyramid	7.0	1.4	3	4.3	0-10	4	3.3	1-7	
	Monitor Peak	5.9	0.3	3	0.7	0-2	1	2	2	
	MILL UNIT	12.9	0.8	6	2.5	0-10	5	3.0	1-7	
	1993	Wolverine Peak	11.8	1.7	22	14.9	0-20	46	3.1	1-10
		Cutoff Mountain	6.8	0.9	3	3.3	2-6	4	2.5	1-6
Roundhead Butte		4.7	2.3	1	11	11	1	11	11	
PEBBLE UNIT		18.6	1.6	21	6.8	0-32	50	3.0	1-10	
Crow Mountain		9.7	3.9	6	23.7	5-38	10	14.2	1-37	
Iron Mountain		6.9	6.8	3	21.7	0-47	2	32.5	22-43	
Clover Basin		9.3	4.6	9	12.3	0-43	13	6.4	1-24	
HELLROARING		25.9	5.1	18	17.7	0-101	25	11.6	1-43	
The Pyramid		8.0	2.5	6	14.8	6-20	23	3.2	1-11	
MILL UNIT		8.0	2.5	6	14.8	6-20	23	3.2	1-11	

<sup>a</sup> Subunit Density = (Maximum daily unduplicated count) X (area); Unit Density = Mean Subunit Density.

Table 5. Location, origin, density and reference for selected mountain goat populations.

Location	Origin	Goats/km <sup>2</sup>	Reference
Snake River Range, Idaho	introduced	4.3 - 20.8	Hayden 1989
Olympic National Park, Washington	introduced	14.0	Stevens 1983
Kodiak Island, Alaska	introduced	7.2	Hjeljord 1973
Kenai Peninsula, Alaska	native	2.4	Hjeljord 1973
Yoho National Park, Alberta	native	0.6 - 3.1	McCrary et al. 1977
Glacier National Park, Montana	native	2.8 - 15.4	Chadwick 1974, Singer and Doherty 1985
Knight Inlet / Wakeman Sound, British Columbia	native	0.2 - 2.1	Hebert and Turnbull 1977
Absarokas, Pebble Creek unit	introduced	0.2 - 1.6	Present Study
Absarokas, Hellroaring Creek unit	introduced	4.1 - 5.1	Present Study
Absarokas, Mill Creek unit	introduced	0.8 - 2.5	Present Study

had the highest density estimate, 6.8 goats / km<sup>2</sup>, for a subunit. Large groups of 20-40 were seen in the Middle Ridge, Crow Mountain, and Clover Basin subunits on almost a daily basis. A 1994 MFWP trend survey located the largest recorded group size of 67 goats (MFWP 1994).

Density estimates for the Mill Creek unit were less than for the Hellroaring Creek unit; group sizes were also smaller in the Mill Creek unit than in the Hellroaring Creek unit. The Pyramid was surveyed in 1992 and 1993. The largest daily unduplicated counts were 10 and 20 and the largest group sizes were 7 and 11 in 1992 and 1993, respectively. Only 2 goats were located in the Monitor subunit during a 1992 survey.

Counts and group sizes for the Pebble Creek unit were less than for the Hellroaring Creek unit but not different from the Mill Creek unit ( $t = 1.2$ ,  $p = 0.2640$ ;  $t = 1.32$ ,  $p = 0.191$ ). Groups were concentrated in the Wolverine Peak subunit. Groups of 6-11 were most consistently seen on Wolverine Peak, Wolverine's long west ridge, Sunset Peak, and Mineral Mountain. Individuals and groups of 2-5 were found consistently on

Meridian Peak, Miller Mountain and Mount Abundance. The largest count for the Wolverine Peak subunit was 49, seen during a 1992 survey of Mineral Mountain, Sunset Peak, and Wolverine Peak. The largest group seen was 11 in 1991.

Only small groups ( $\leq 6$ ) and single individuals were found in 7 surveys of the Cutoff Mountain subunit. Goats were sighted on the east slope of the mountain in the Pebble Creek drainage in 1993, on the eastern slope by Bliss Pass in 1992, and on the ridgeline continuous with Wolverine Peak to the east during both years. No goats were found in 1991.

No goats were found during 2 surveys of Barronette Peak in 1991 and 2 surveys in 1994 although signs of previous occurrence including hair, scat, and tracks were found. No sign of goats was found on Mount Hornaday during surveys in 1990, 1991, and 1992. Both of these subunits are island-like in that they are isolated from the Wolverine and Cutoff subunits by forested ridges or valleys.

Only 3 goat sightings occurred in the Cache Creek unit during the study. In addition to the single individual sighted during the 1991 aerial survey, 3 goats including 1 kid were observed feeding on a ridge-top east of Amphitheater Mountain in the North Absaroka Wilderness of Wyoming. These goats were located with a spotting scope from Mineral Mountain in the Pebble unit 5 miles away. A Yellowstone Park visitor reported the third sighting, a single adult seen on The Thunderer on June 6, 1993 (Table 3).

No mountain goats were seen while surveying the Cache Creek unit on the ground during all 3 years. The Thunderer was surveyed in 1990, 1991, 1992, and 1994; while it appeared to have suitable goat habitat, no goats were found. No goat sightings were made in 1992 (2 surveys) and 1993 (1 survey) of the Amphitheater-Abiathar subunit which was the the most rugged subunit surveyed in the entire study area. The jagged ridges lacked diversity and slopes were consistently too steep to have the terraces associated with ledge habitat.

### Population Composition

Nannies comprised the largest proportion of the mountain goats observed (Table 6). They often occurred in large groups with yearlings and kids of both sexes during all periods. These groups were encountered more frequently than billies. Billies were encountered singly or in smaller groups (2-5).

The highest kids /100 older goats ratio was associated with the Pebble Creek unit. Nearly a third of all goats observed in this unit were kids in 1991 and 1993. The proportion of nannies with kids was greater in the Pebble unit than in the high density Hellroaring unit in 1992 and 1993. In 1993, a reproductive success ratio of 48 kids/100 older goats was recorded in the Pebble Creek unit versus 24 kids/100 older goats for the Hellroaring Creek unit. During the study, 8 cases of nannies with twins were observed in the Pebble Creek unit versus no cases in the Hellroaring Creek unit.

Table 6. Population composition of mountain goats observed in three units of the Absaroka study area, 1991-1993.

Year	Study Unit	n	Classifications <sup>a</sup>					Age ratio <sup>b</sup>		Twins <sup>c</sup>
			Male	Female	Yearling	Kid	Uncl.	Yearlings	Kids	
1991	Pebble	25	3 (12) <sup>d</sup>	12 (48)	2 (8)	8 (32)	0 (0)	9	47	3
1992	Pebble	179	14 (8)	68 (38)	45 (25)	40 (22)	12 (7)	33	29	0
	Mill	15	1 (7)	4 (27)	5 (33)	3 (20)	2 (13)	50	25	0
	Hellroaring	252	24 (12)	111 (44)	35 (14)	47 (19)	29 (11)	16	23	0
	Totals	446	42 (10)	183 (41)	85 (19)	90 (20)	43 (10)	24	25	0
1993	Pebble	157	24 (15)	53 (34)	13 (8)	51 (32)	16 (10)	9	48	5
	Mill	74	13 (18)	30 (40)	9 (12)	22 (30)	0 (0)	14	42	1
	Hellroaring	323	38 (12)	143 (44)	27 (8)	62 (19)	53 (16)	9	24	0
	Totals	554	75 (14)	226 (41)	49 (9)	135 (24)	69 (12)	10	32	6

<sup>a</sup> Classifications include adult males (2+ years), adult females (2+ years), yearlings (1 year), kids (0 year), and unclassified.

<sup>b</sup> Number per 100 other classification.

<sup>c</sup> Number of cases of females with twins observed.

<sup>d</sup> Number observed, (percent of total).

## Mountain Goat Resource Use

### Feeding Sites

Goats fed individually or in small groups (mean group size =  $5.6 \pm 8$  (SE), 1-47) in rocky, broken habitats. While feeding, goats often traveled substantial distances before arriving at bedding sites. They typically traversed a variety of habitats using isolated patches of resources and pausing no more than a few minutes to graze any particular site. A mean of  $2.9 \pm 1.9$  habitats were used per hour of uninterrupted feeding. Goats primarily fed on young, succulent vegetation growing in wet areas. Late snow melt allows some vegetation to be in early growth stages throughout the summer.

Seven mountain goat habitats were described (See Appendix A). Goats fed in all habitats at least once during the 5 periods observed (Figures 7-11). All aspects were used as goats pursued the emergence of vegetation that followed receding snow (Table7).

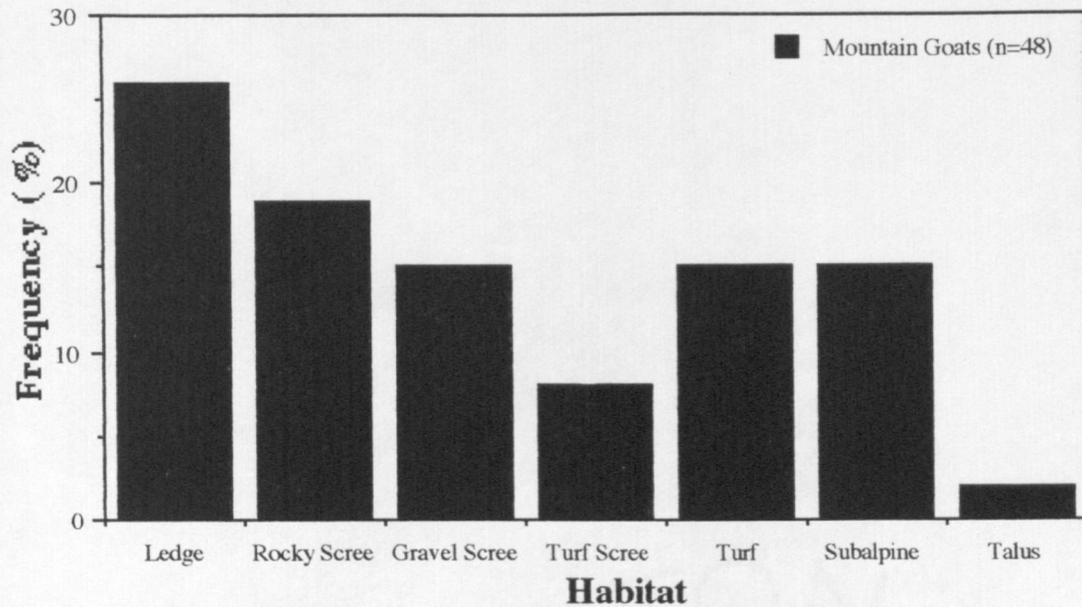


Figure 7. Habitat use by mountain goats in the Absaroka Range, May 15 - June 15, 1991-1993 (n = number of observations).

Table 7. Summer use of aspect by feeding mountain goats and bighorn sheep in the Absaroka Range, 1991-1993.

	n	N	NE	E	NW	W	SW	SE	S
<b>May-June</b>									
Goats	48	5(10) <sup>a</sup>	2(4)	2(4)	5(10)	6(13)	8(16)	9(18)	11(23)
<b>June-July</b>									
Goats	40	8(21)	3(7)	3(7)	6(15)	5(13)	5(13)	4(11)	6(15)
Sheep	36	2(7)	0(0)	0(0)	1(2)	8(27)	9(32)	2(7)	7(25)
<b>July-Aug.</b>									
Goats	73	19(26)	10(14)	15(20)	9(13)	8(11)	5(7)	4(5)	3(4)
Sheep	36	1(2)	1(2)	0(0)	2(5)	8(22)	7(19)	3(10)	14(40)
<b>Aug.-Sept.</b>									
Goats	68	23(34)	11(16)	16(23)	11(16)	4(6)	1(2)	0(0)	2(4)
Sheep	28	3(12)	1(3)	1(3)	4(13)	10(35)	3(12)	1(3)	5(19)
<b>Sept.-Oct.</b>									
Goats	62	15(24)	11(18)	12(20)	15(24)	7(12)	0(0)	1(2)	0(0)
Sheep	29	2(5)	0(0)	0(0)	1(2)	8(27)	9(32)	2(7)	7(25)

<sup>a</sup> Number of observations (percent of total).

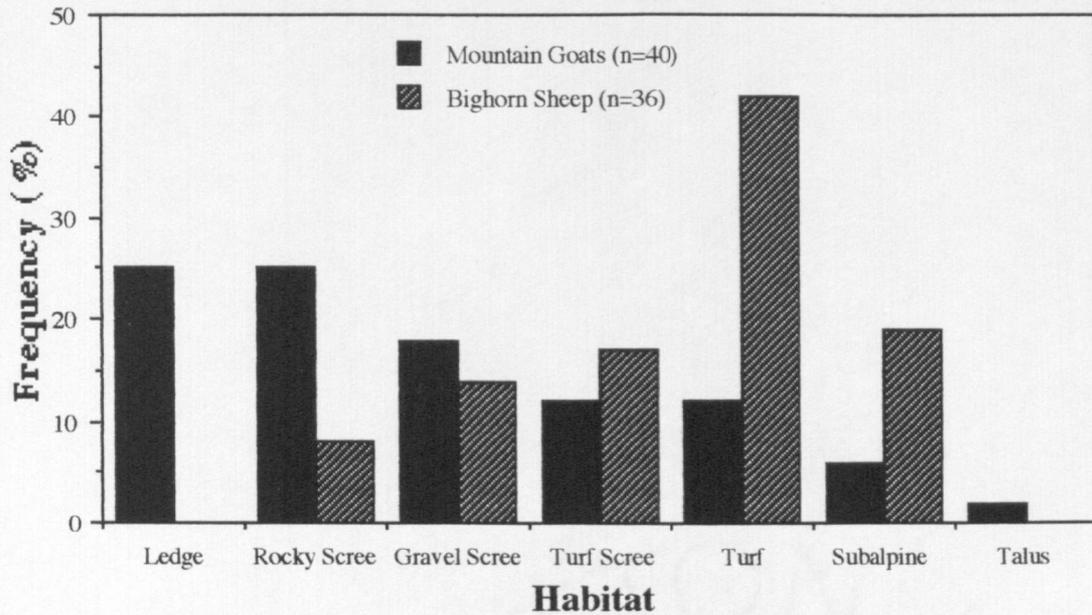


Figure 8. Habitat use by mountain goats and bighorn sheep in the Absaroka Range, June 16-July 15, 1991-1993 (n = number of observations).

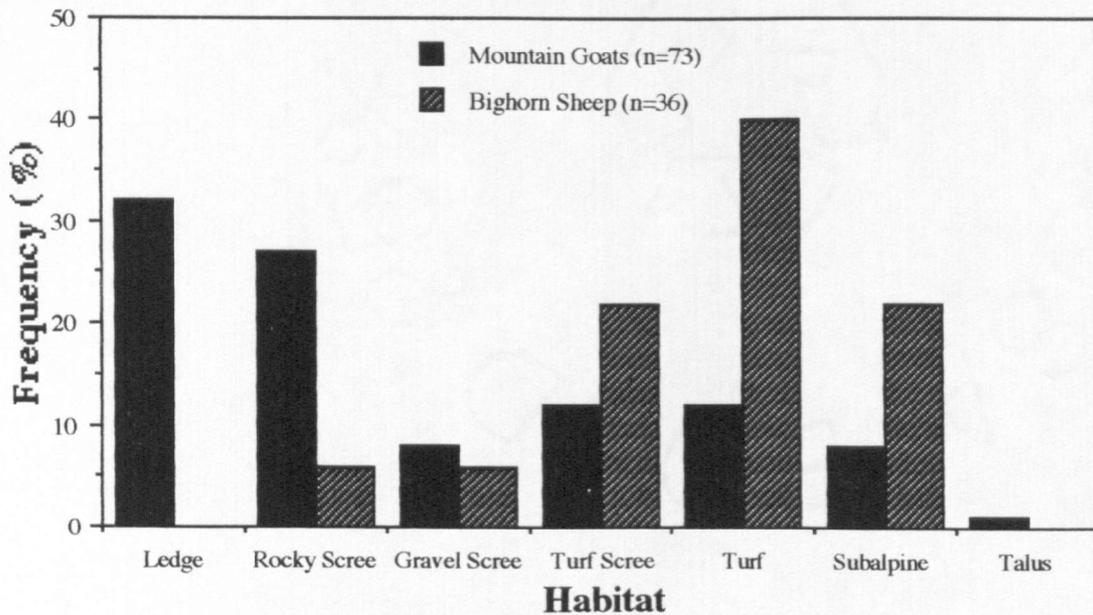


Figure 9. Habitat use by mountain goats and bighorn sheep in the Absaroka Range, July 16- August 15, 1991-1993 (n = number of observations).

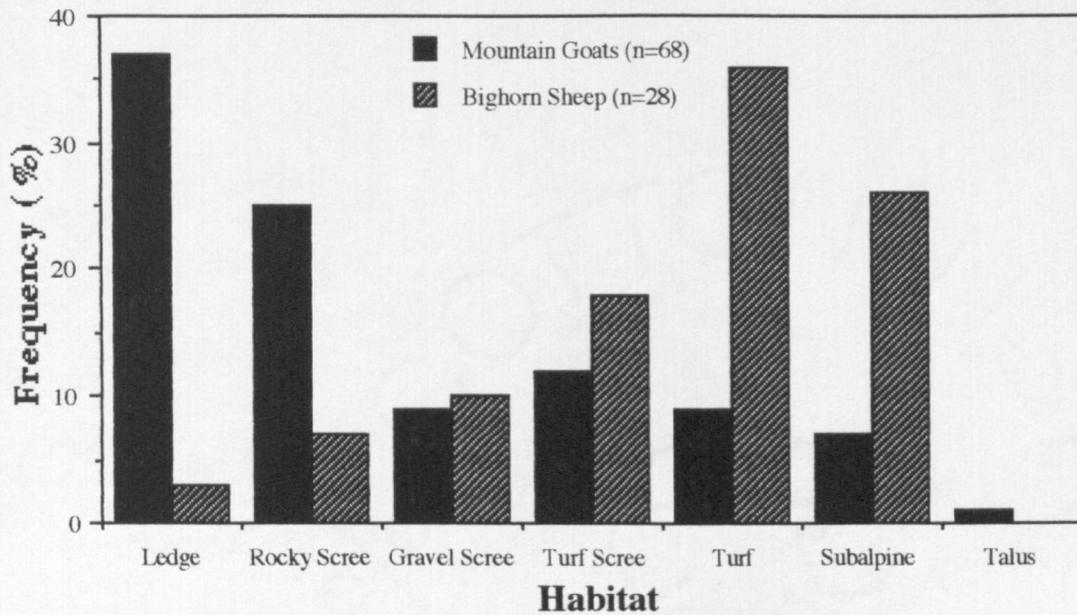


Figure 10. Habitat use by mountain goats and bighorn sheep in the Absaroka Range, August 16-September 15, 1991-1993 (n = number of observations).

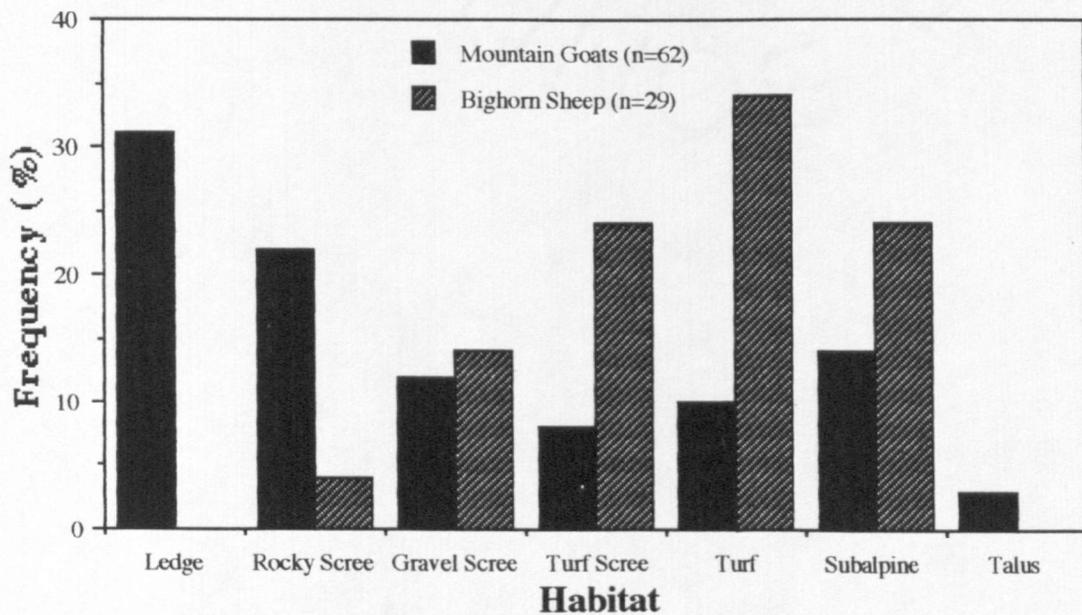


Figure 11. Habitat use by mountain goats and bighorn sheep in the Absaroka Range, September 16-October 15, 1991-1993 (n = number of observations).

In the spring, the first snow-free habitats on south aspects were used. Gradually goats moved to feeding sites on the western aspects in early summer. May 15-June 15 habitat and aspect use were different from June 16-July 15 at  $p < 0.01$ . In mid-summer ledges and rocky scree were used more extensively on north and east aspects where melting snow was harbored on steep, shaded slopes. June 16- July 15 habitat and aspect use were different from July 16-August 15 at  $p < 0.02$  as more ledge on northern aspects and less gravel scree on west and south aspects were used. July 16-August 15 habitat use did not differ from August 16-September 15 habitat use ( $X^2 = 2.09$ ,  $p = 0.9113$ ) but aspect use was different for late summer ( $p < 0.0001$ ). August 16-September 15 habitat use also did not vary from September 16-October 15 habitat use ( $X^2 = 9.259$ ,  $p = 0.1598$ ) while aspect use did differ for the period ( $p < 0.0001$ ). Goats used a greater variety of aspects but not habitats during late summer and early fall.

Ledge and rocky scree habitats were most consistently sought throughout the growing season. Ledge habitats were used most frequently during all 5 periods. Well-used ledge habitats were characteristically steep ( $35-50^\circ$ ), providing security, yet had more moderately sloping terraces or shelves interspersed where soil accumulated and vegetation developed. Large snowfields were common in and often up-slope from these areas.

Slopes with vertical or near vertical rock faces were avoided. Habitats adjoining these slopes seemed to be avoided as well--the rock faces acting as barriers to movement between habitats. For example, no goat observations were made near the summit area of Cutoff Mountain, for example, which is extensively bordered by near-vertical slopes. Amphitheater Mountain and Abiathar Peak had the most near-vertical slopes in the study area, a possible factor involved with low counts. The north faces of Iron Mountain, Middle Ridge, and Crow Mountain all had near-vertical slopes on a smaller scale than those just mentioned which were minor barriers to travel between surrounding habitats.

Certain specific ledge areas were used intensively. They served as centers for herd activity and kid-rearing, and were called "nursery areas". Feeding, bedding, and social interactions were observed in nursery areas. Goats were found in nursery areas almost daily. Four observations of goats bedding at dusk were in nursery areas. Nursery areas centered around ledge habitat but also were closely associated with a variety of other habitats. This diversity of habitats in close proximity enabled nursery groups to find forage and security with little daily movement.

Locations clearly used as nursery areas included Wolverine Peak's long west ridge, Bridge Point at the headwaters of Hellroaring Creek, the northeast face of Mount Wallace, the headwater cliffs of Sheep Creek and Copper Creek, and the north and east faces of The Pyramid.

Scree slopes (rocky, gravel, and turf types) were used often during persistent feeding events. Rocky scree was common near ledges and in avalanche chutes between terraced ledge areas. Goats commonly fed across rocky scree slopes in the course of traveling between major ledge areas.

Turf and turf scree areas were used briefly in early summer when young vegetation emerged on west and north aspects. Large groups fed in open turf meadows but, unlike sheep, tended to keep moving rather than concentrate their feeding on these sites.

Goats used subalpine habitats during all periods. Subalpine use may be underrepresented due to the difficulty of detecting goats in habitats with trees. Most subalpine sites were grassy turfs or screes in and among narrow strips of subalpine fir and whitebark pine. Goats seemed to avoid low elevation habitats where escape terrain diminished with increasing tree cover. One adult billy did, however, venture about 300m from escape terrain to forage on abundant wildflowers growing among a strip of conifers that burned in 1988.

Groups and individuals typically fed on steep slopes during all periods (Figure 12), either in or near escape terrain. Forty-six percent of all observations of feeding mountain goats were in escape terrain (Figure 13). Mean slope and mean elevation of feeding habitats was 33 degrees (11-54) and 3562 (2925-3836) meters, respectively.

### Parturition Sites

Three observations were made of nannies with new-born kids. During a survey of The Pyramid on June 8, 1992 a nanny with a kid that appeared wet and red-colored was sighted on a ledge in rocky terrain estimated to be between 40-45°. Although observed from 400-500m away, the nanny moved her kid, wobbly but able, beyond view after detecting humans. Later that day, another nanny was sighted in similar terrain with a recently born kid. Three other nannies and 3 yearlings were bedded or feeding nearby. On June 20, 1992, another new-born kid was sighted on Middle Ridge. Three billies came upon the nanny shortly after she gave birth. The nanny responded with threatening gestures, which eventually turned away the curious billies.

No kids were encountered during surveys in late May and no new-born kids were encountered after the third week in June. Births appeared to occur primarily during the first 3 weeks in June.

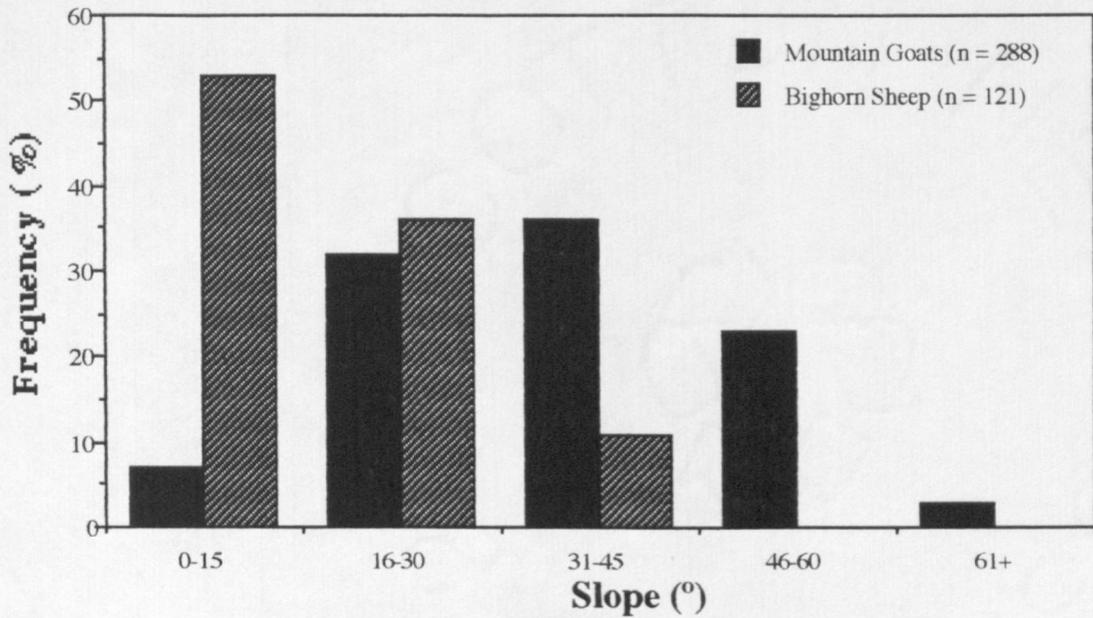


Figure 12. Use of slope by feeding mountain goats and bighorn sheep in the Absaroka Range, May 15-October 15, 1991-1993 (n = number of observations).

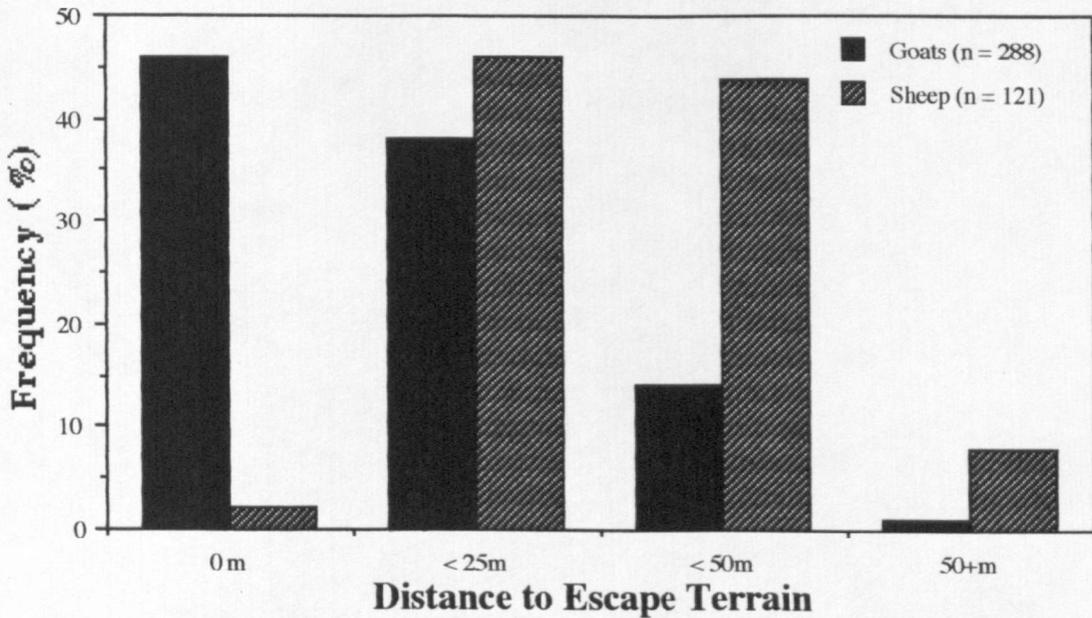


Figure 13. Association with escape terrain by feeding mountain goats and bighorn sheep in the Absaroka Range, May 15-October 15, 1991-1993 (n = number of observations).

### Winter-use Sites

Information on the location of mountain goat winter range in the Absarokas is limited. No mountain goats were sighted during an aerial survey of the Pebble, Cache, and Hellroaring unit on November 9th, 1991, but low-lying clouds obstructed lower elevations. On May 2, 1995 under late winter conditions (heavy snowpack) 3 goats were observed at low elevation (~2500m) at forested sites south of Barronette Peak in the Pebble Creek unit during MFWP bighorn sheep helicopter surveys (T. Lemke, pers. comm., 1995)

Six ground surveys made in November 1994 revealed a shift in goat distribution to lower elevation (~2500 m) wintering areas adjacent to the summer range. No goats or sign were found during 3 November surveys of alpine summer range in the Hellroaring unit. Individuals and small groups (2-5) were located during 3 late-November surveys of steep, forested rock outcrops of the Boulder River canyon.

Goats show strong affinity for local sites in the winter (Hjeljord 1973, Kuck 1977). Alpine areas with accumulations of goat fecal pellets were found on windblown ridgelines and isolated rock outcrops during the summer surveys. These pellets likely accumulated during winter when goat movement was restricted. Windblown ridges, steep ledges and south-facing rock outcrops where pellet accumulations were found fit the descriptions of goat wintering areas given in other reports (Brandborg 1955, Lentfer 1955, Hjeljord 1973, Hebert and Turnbull 1977).

The remains of 2 mountain goats were located. One was in a thick stand of Krumholtz (stunted subalpine fir and whitebark pine) near Elk Lake in the Middle Ridge subunit. Dense stands of trees may serve as thermal cover during periods of extreme low temperature or deep snow. The other was a kid found on a wind-swept turf meadow near the summit of Cutoff Mountain.

## Diet

Seven of 15 successful hunters (47%) returned rumen samples. Analysis of the samples indicated predominant use of graminoid species (76%) in the fall (Table 8). Important graminoids included sedges (*Carex* spp. ), rushes (*Juncus* spp. ), bluegrasses (*Poa* spp.), sheep fescue (*Festuca ovina*), tufted hairgrass (*Deschampsia caespitosa*), and two wheatgrasses (*Agropyron scribneri*, *A. spicatum*).

Forbs were second in importance (20%). Major forb species included arctic sandwort (*Arenaria obtusiloba* ), field chickweed (*Cerastrium arvense* ), lupine (*Lupinus argenteus* ), bluebells (*Mertensia ciliata* and *M. alpina* ), and lance-leaf stonecrop (*Sedum lanceolata* ).

A combination of browse and lichens made up the remaining portion of the diet. The lichen species *Umbilicaria krascheninnikovii* (Savicz) Zahlbr., *U. virginis* Schaerer, and *Rhizoplaca melanophthalma* (DC. in Lam. & DC.) Leuck. and Poelt comprised 2.5% of the diet. These species made up about one quarter of the identifiable volume of 1 rumen sample collected near Boulder Pass in the Absarokas (see Appendix C). Lichens were also present in trace amounts (<1 ml) in 4 of the other 6 samples. Bryophytes, mostly mosses, were found in trace amounts. One rumen sample was found to have liverwort (*Marchantia polymorpha*) thalli, archegonial heads, and antheridial heads. Bryophyte use may have been due to accidental ingestion rather than to actual selection.

Table 8. Canopy cover and frequency estimates of vegetative taxa in three habitats and fall diets for mountain goats and bighorn sheep.

Taxa	Habitat Types				Fall Diets	
	Ledge n = 6	Rocky Scree n = 12	Turf n = 11	Mountain Goat n = 7	Bighorn Sheep <sup>a</sup> n = 17	
GRAMINOIDS	30.0 (94) <sup>b</sup>	26.0 (88)	26.0 (98)	75.6 (75.5) <sup>c</sup>	74 (17) <sup>d</sup>	
<i>Agropyron spp.</i>	0.1 (2)	2.2 (68)	0.2 (4)	5.3 (7)	-	-
<i>Agrostis scabra</i>	-	-	0.3 (4)	tr. <sup>e</sup> tr.	-	-
<i>Alopecurus alpinus</i>	-	-	0.2 (4)	-	-	-
<i>Bromus spp.</i>	-	-	-	-	1	(2)
<i>Carex spp.</i>	9.9 (94)	8.5 (54)	4.0 (24)	20.1 (19)	51	(17)
<i>Deschampsia caespitosa</i>	2.1 (43)	0.4 (24)	7.3 (82)	6.1 (6)	6	(14)
<i>Elymus spp.</i>	-	0.1 (04)	0.4 (5)	1.6 (1.5)	-	-
<i>Festuca ovina</i>	2.1 (36)	2.4 (48)	2.5 (33)	8.4 (7)	11	(15)
<i>Juncus spp.</i>	7.3 (62)	7.0 (85)	1.9 (18)	15.2 (15)	2	(6)
<i>Koeleria cristata</i>	0.1 (2)	0.4 (8)	1.4 (16)	1.0 (1)	-	-
<i>Luzula spp.</i>	1.5 (60)	1.0 (13)	1.1 (5)	6.5 (6)	1	(1)
<i>Oryzopsis spp.</i>	-	-	-	-	1	(3)
<i>Phleum alpinum</i>	-	0.7 (08)	0.8 (10)	-	-	-
<i>Poa spp.</i>	6.6 (97)	2.9 (81)	5.3 (85)	10.4 (11)	2	(8)
<i>Trisetum spicatum</i>	0.7 (22)	1.1 (32)	1.1 (7)	2.5 (2)	-	-
FORBS	22.0 (91)	37.0 (90)	59.0 (100)	19.6 (22)	16	(15)
<i>Achillea millefolium</i>	0.5 (12)	0.9 (16)	2.2 (26)	tr. tr.	-	-
<i>Androsace spp.</i>	-	-	0.8 (32)	-	-	-
<i>Antennaria spp.</i>	0.8 (36)	1.3 (07)	0.3 (4)	1.7 (1.3)	-	-
<i>Areneria obtusiloba</i>	0.8 (30)	1.5 (55)	6.4 (53)	1.7 (1.6)	-	-
<i>Arnica spp.</i>	0.3 (14)	3.1 (17)	1.1 (13)	1.1 (1.7)	-	-
<i>Artemisia spp.</i>	1.4 (18)	0.8 (12)	0.5 (8)	tr. tr.	1	(2)
<i>Astragalus spp.</i>	1.2 (40)	3.5 (51)	5.4 (37)	tr. tr.	2	(3)
<i>Castilleja spp.</i>	-	-	1.5 (12)	-	-	-
<i>Cerastrium arvense</i>	0.7 (21)	1.4 (28)	3.2 (41)	1.5 (1.6)	-	-
<i>Cirsium foliosum</i>	1.5 (48)	1.5 (40)	0.4 (5)	tr. tr.	-	-
<i>Draba spp.</i>	-	0.1 (2)	-	-	-	-
<i>Descurainia spp.</i>	-	-	-	-	2	(4)
<i>Epilobium augustifolium</i>	-	-	0.5 (12)	-	-	-
<i>Erigeron spp.</i>	2.5 (62)	1.7 (38)	3.2 (43)	tr. tr.	1	(4)
<i>Lupinus argenteus</i>	0.1 (4)	0.8 (8)	2.6 (16)	3.1 (4)	5	(4)
<i>Mertensia alpina</i>	0.1 (4)	0.4 (6)	4.3 (20)	1.8 (1.7)	-	-
<i>Phlox multiflora</i>	0.2 (8)	0.2 (4)	7.8 (58)	tr. tr.	-	-

Table 8. (Concluded)

<i>Plantago spp.</i>	-	-	-	-	0.4 (19)	-	-	1	(1)
<i>Polemonium pulcherum</i>	0.4 (20)		0.2 (12)		0.8 (06)	-	-	-	-
<i>Polemonium viscosum</i>	1.4 (32)		3.2 (41)		-	-	-	-	-
<i>Polygonum bistortis</i>	0.1 (2)		0.1 (1)		1.9 (31)	tr.	tr.	-	-
<i>Potentilla spp.</i>	1.2 (19)		1.1 (39)		8.2 (57)	tr.	tr.	1	(2)
<i>Ranunculus spp.</i>	0.1 (14)		0.5 (14)		0.1 (1)	-	-	-	-
<i>Rumex spp.</i>	0.1 (2)		0.1 (1)		-	tr.	tr.	-	-
<i>Saxifraga spp.</i>	5.4 (76)		4.5 (32)		0.9 (26)	tr.	tr.	-	-
<i>Sedum lanceolata</i>	2.1 (42)		4.4 (62)		3.8 (37)	4.3 (5.4)		-	-
<i>Senecio spp.</i>	0.8 (18)		1.3 (20)		-	1.3 (1.3)		-	-
<i>Sibbaldia procumbens</i>	-	-	-	-	-	-	-	4	(7)
<i>Silene acualis</i>	-	-	2.2 (38)		2.2 (17)	tr.	tr.	-	-
<i>Smelowowskia calcyna</i>	0.5 (38)		0.7 (13)		0.2 (2)	-	-	-	-
<i>Taraxacum spp.</i>	-	-	0.2 (4)		0.4 (6)	-	-	-	-
<i>Trifolium haydenii</i>	1.2 (20)		1.4 (40)		1.5 (16)	1.1 (1.5)		-	-
BROWSE	0.3 (5)		1.1 (15)		1.0 (5)	0.4 (0.5)		10	(10)
<i>Pinus spp.</i>	0.3 (5)		0.8 (8)		0.2 (1)	tr.	tr.	1	(2)
<i>Rosa spp.</i>	-	-	0.2 (5)		-	-	-	1	(4)
<i>Rubus spp.</i>	-	-	-	-	-	-	-	1	(2)
<i>Salix spp.</i>	-	-	0.1 (2)		0.8 (4)	0.1 (0.5)		5	(8)
<i>Shepherdia canadensis</i>	-	-	-	-	-	-	-	2	(2)
<i>Vaccinium scoparium</i>	-	-	-	-	-	0.1 (0.5)		-	-
MOSS	16.0 (92)		5.0 (87)		3.0 (44)	tr.	tr.	-	-
LICHEN	5.0 (88)		3.0 (73)		1.0 (10)	2.3 (2.5)		-	-
ROCK AND SOIL	22.0 (100)		29.0 (100)		11.0 (85)	-	-	-	-

<sup>a</sup> From Martin (1985).

<sup>b</sup> Percent canopy coverage (frequency of occurrence).

<sup>c</sup> Percent of diet (mean percent volume).

<sup>d</sup> Percent of diet (constancy of samples).

<sup>e</sup> Trace amount, less than 1 ml or 1%.

### Vegetation

One hundred fifty-five species from 100 genera were identified on the study area (see Appendix D for listing). Identification and nomenclature followed Despain (1975) and Dorn (1984). Specimens were collected from all alpine habitats and subalpine forests and meadows. Representative specimens of most taxa were pressed and brought to the herbarium at Montana State University, Bozeman, for verification and storage.

Spearman's rank-correlation between canopy cover estimates from vegetation transects and mean frequency in rumen samples for individual plant taxa was 0.45 ( $p < 0.05$ ) suggesting forage selection was proportional to abundance. Spearman's rank-correlation between graminoid species canopy coverage and mean percent occurrence of those species in rumen samples was 0.83 ( $p < 0.01$ ) suggesting graminoid use in the fall diet is proportional to abundance. No discernible association between use of forb taxa and their availability was detected using the rank-correlation test statistic ( $R_s = -0.09$ ,  $p < 0.8$ ).

### Mineral Use

Mountain goats have been known to congregate at specific sites to consume minerals (Hebert and Turnbull 1977, Thompson 1981); however, no mineral licks were located in the study area.

### Bighorn Sheep Observations

#### Composition

Five bighorn sheep herds migrate to summer ranges in the study area from winter ranges in the Beartooth Mountains and Yellowstone Park (Table 9). Sheep arrive on the Absaroka summer range in mid-June having already lambled in transitional ranges

(Stewart 1975, Martin 1985). Groups of ewes, lambs, and juveniles were frequently observed; only 4 observations of adult rams (3-year-old or older) were made during the study. Rams use habitats separate from ewe-juvenile bands on the Absaroka summer range (Oldemeyer et al. 1971).

**Table 9. Ranges associated with five bighorn sheep herds using the Absaroka study area.**

Winter Range	Summer Range	Reference
Stillwater Canyon	Lake Plateau, Boulder River	Pallister 1974
Rock Creek	Pilot and Index Peaks	Martin 1985
West Rosebud Creek	W. Rosebud, Wolverine Peak and adjacent mountains	Pallister 1974, Stewart 1975
Soda Butte Creek	Amphitheater Mountain, Abiathar and Barronette Peaks	Woolf et al. 1970, Oldemeyer et al. 1971
Druid Peak	Cutoff Mountain, Mount Hornaday, and Barronette Peak	Woolf et al. 1970, Oldemeyer et al. 1971

Sixty-three observations of bighorn sheep groups were made in the Pebble and Cache Creek units; primarily large groups of ewes with lambs (Table 10). Sheep were primarily found near Wolverine Peak and Mineral Mountain. The alpine meadows of Wolverine's west ridge, Mineral's east ridge, and the saddle between Sunset Peak and Miller Mountain were used extensively. This herd was believed to winter in the West Rosebud drainage of the Beartooth Mountains (Pallister 1974, Stewart 1975).

Sheep were found in the cirque on the western side of Amphitheater Mountain and on the summit meadow of Abiathar Peak. These sheep likely winter in the Soda Butte drainage (Woolf et al. 1970, Oldemeyer et al. 1971). Groups were also encountered in the subalpine meadows near Bliss Pass and in the alpine meadows near the summit of Cutoff Mountain. These sheep likely winter in Lamar valley and around Druid Peak (Woolf et al. 1970, Oldemeyer et al. 1971). Sixteen rams were observed in the summit

meadow of The Thunderer in 1994. This congregation may be from various herds in the region.

Table 10. Group sizes and age ratios from 126 observations of bighorn sheep in the Pebble and Cache Creek units, Absaroka Range, 1991-1993.

Year	n	Group Sizes		Lambs / 100 Ewes
		Mean	Range	
1991	28	14.5 ± 12.5	2-42	38
1992	36	13.5 ± 9.7	5-29	45
1993	62	9.0 ± 4.0	4-16	65

### Feeding Sites

From mid-June through September, sheep fed in groups in open alpine and timberline meadows. By late September, smaller groups fed in timberline meadows and in patches of sparsely vegetated gravel scree. Bighorn sheep and mountain goats were observed using proportionally different aspects ( $p < 0.0001$ , Table 7) and habitats ( $p < 0.0001$ , Figures 8-11) during all 5 periods.

The average slope of sheep feeding sites was 24 degrees (6-39) as compared to 33 degrees (11-54) for goats. Sheep tended to feed on more moderately sloping terrain than did mountain goats ( $p < 0.0001$ , Figure 12). Distance to escape terrain was greater for feeding sheep than goats ( $p < 0.0001$ , Figure 13). The mean elevation of sheep feeding sites was 3429 meters (2960-3868), 133 meters lower than for goats ( $t = 4.34$ ,  $p < 0.001$ ).

In contrast to goats, sheep tended to concentrate feeding on 1 site per feeding bout. Mean number of habitats per hour of uninterrupted feeding was  $1.5 \pm 0.7$  and lower than for goats ( $t = 3.29$ ,  $p < 0.01$ ). Sheep herds intensively grazed 1 site and directional movements were not observed to the same extent as with goats.

## Diet

Martin (1985) determined fall diet for sheep on Absaroka summer range by microhistological analysis of fecal droppings (Table 8). Sheep consumed grasses predominantly (74%) while forbs were second in importance (16%). Sheep also used browse (10%), mainly willow (*Salix* spp.). Overlap of forage taxa in the diets of sheep and goats (Table 8) using Kulczynski's similarity index (Oosting 1956, Jarman 1971) averaged 30% .

## Mineral Use

Bighorn sheep were not observed using mineral licks. Martin (1985) did not observe sheep using mineral licks on the Absarokas summer range. The alkaline rock types of the Absarokas are characterized by relatively high potassium and sodium content (Decker 1990); therefore, mineral sources may be abundantly dispersed throughout the range, rather than concentrated in particular sites. Forage growing in the volcanic soils may also provide abundant minerals. Observations of goats and sheep using mineral licks in the Absarokas were reported to the author by visitors to Wolverine Peak and Druid Peak.

## Interspecific Interactions

Only 6 observations of goat-sheep interactions were made. Five of these interactions were neutral. The sixth concerned a group of 11 sheep feeding within 20m of 7 bedded goats. When I appeared, 10 sheep fled leaving 1 adult ewe and the goats who appeared unconcerned. Attempting to escape to ledge areas, the ewe was blocked by the bedded goats. The ewe was forced to approach to within 10m of the observer in order to reach an alternate escape route. While goats prevented use of the escape route, this observation was influenced by the observer.

## DISCUSSION

The demographics of mountain goat populations are poorly understood (Houston and Stevens 1988, Bailey 1991). Certainly the Absaroka mountain goat population presents a complex case of population growth and the factors involved. From 23 individuals introduced in the late 1950's, it has grown to at least 275 individuals in 1995. The population as a whole appeared to stabilize during the 1980's around 100, but distribution was slowly shifting. Colonization of unexploited habitats in the Absarokas to the south and east may account for much of the growth witnessed in the last 10 years. Factors influencing mountain goat population growth may interact complexly and with threshold relationships (Houston and Stevens 1988); thus, several other factors are likely involved.

The series of mild winters in the 1980's and early 1990's may have been a determining factor in juvenile survival, as it was in other ungulate populations in the region which also experienced significant growth during the 1980's (Mack and Singer 1993). The extensive wildfires of 1988 removed many subalpine forests and possibly improved habitat and forage conditions for goats. Goats were observed feeding in recently burned areas on 14 occasions. At least 3 nursery areas, Wolverine Ridge, Copper Creek, and Sheep Creek, included burned areas.

Mountain goat densities in the Absarokas seemed to be related to a number of factors which included (1) the quality and quantity of habitat, (2) the connectivity of subunits, and (3) the duration of subpopulation establishment. Mountain goat habitat in

the Absarokas appears to have certain notable qualities. One quality is the presence of ledges. Ledges were often central to a network of diverse habitats that were used consistently. Goats with kids and juveniles intensively used these habitat networks, or nursery habitats. Two characteristics of the volcanic parent material in the Absarokas may contribute to the suitability of goat habitat in the range. The breccia bedrock readily erodes on outcrops and steep slopes and is deposited downslope to produce a relatively productive mountain soil. The summer range for mountain goats appears to principally be in ledge and scree habitats which have less-developed soils but enough soil to produce forage for the population. Secondly, the structural conformation of the lava flow parent material provides desirable ledge habitats. The proportion of the population that inhabited areas with these characteristics was low in the 1960's but rose sharply through the 1980's. Now the volcanic crags of the Absarokas appear to be some of the most productive goat habitat in the region. Hebert and Turnbull (1977) found higher goat densities associated with the tufts and breccias of the Silverthorne (volcanic) formation compared to other areas of British Columbia.

The alpine habitats of mountain goats are essentially island-like in distribution. Although movements between islands of goat habitat occur, lack of alpine connectivity may be limiting density and colonization in subunits. Lack of habitat linking goat-use areas may limit use of suitable, but isolated, areas (Hayden 1989). More peripheral or isolated subunits tended to support lower densities. Subunits such as Monitor Peak and The Pyramid are examples; both The Pyramid and Monitor Peak subunits had suitable goat habitat but were geographically isolated from the continuous mountain chains of the Hellroaring Creek unit by 10-20 km of forested areas and/or patchy, marginal habitats. The 1992 density estimates for The Pyramid and Monitor Peak were 1.4 and 0.3 goats / km<sup>2</sup>, respectively.

Analysis of density and reproduction in subpopulations within the study units suggests the demographics of subpopulations vary widely so that information on any one subpopulation may be misleading if extrapolated to the entire population. Density, reproductive success, and cases of twins varied among subpopulations in different study units (Figure 14 and 15). The variation in the units may partially be explained using the ungulate population growth model developed by Riney (1955) and Caughley (1970) in which growth indicators vary among subpopulations depending on the duration of establishment after introduction. The model predicts an irruptive growth phase in which a newly established population responds to abundant resources with high productivity. The population increases to well above the long-term carrying capacity ( $K$ ) of the range characterized by high density and low productivity. As a consequence of high population levels, resources are scarce and the population declines well below  $K$ . The post-decline stage of growth is characterized by a population fluctuating near  $K$  in a density-dependent manner.

No evidence of subpopulation establishment was found in the Cache Creek unit. Whether this is due to insufficient colonization time or resource deficiency is unclear. Considering the close proximity of the Amphitheater-Abiathar subunit to the populous Wolverine subunit, an explanation for the subunit's low counts may be resource deficiency rather than insufficient colonization time. The Amphitheater-Abiathar subunit was characterized by multiple near-vertical slopes and few ledge habitats. It did not appear to have nursery areas like those found in other subunits. In contrast, The Thunderer appeared to have extensive ledge habitat and potential nursery areas; however, its isolation from other alpine areas and distance from established herds may be the more proximal factor limiting colonization.

The time required to establish herds in currently unoccupied but suitable areas is difficult to estimate. Goats colonizing the Olympic mountain range progressed at an

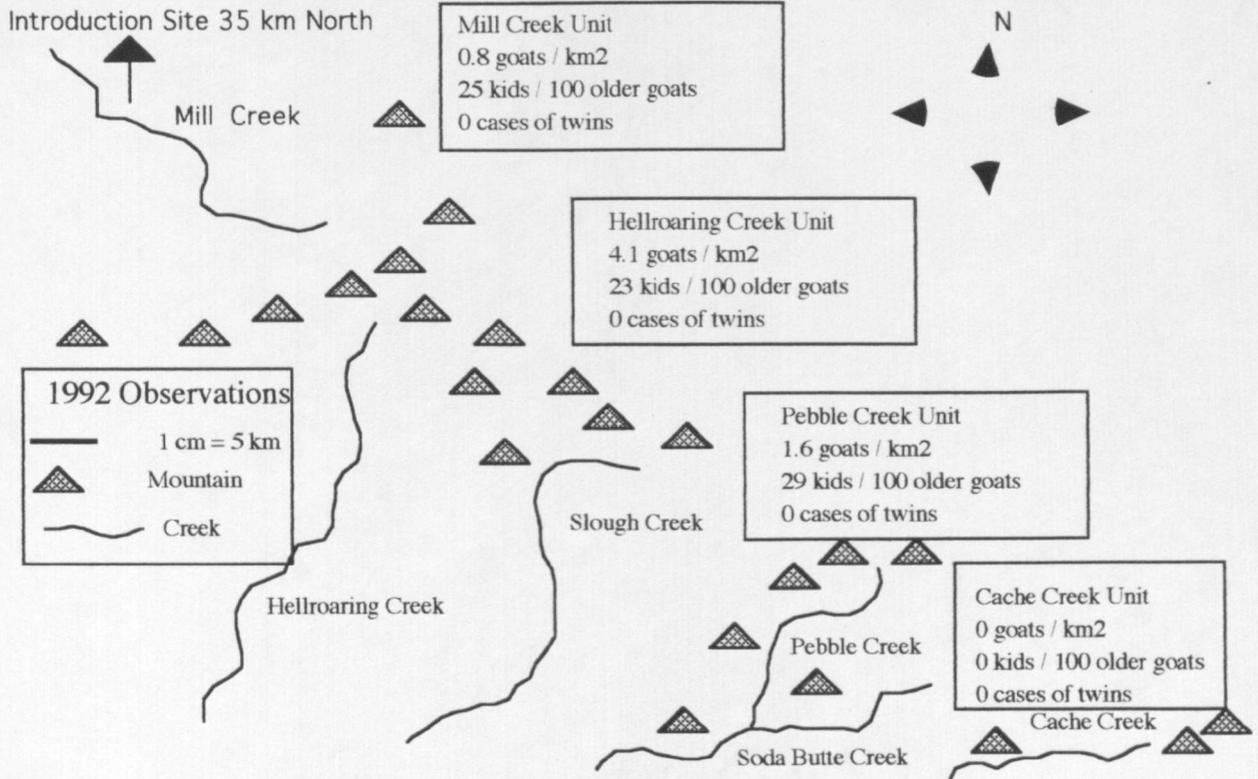


Figure 14. Density, reproductive success, and cases of twins observations from the 4 units of the Absaroka Range study area, 1992.

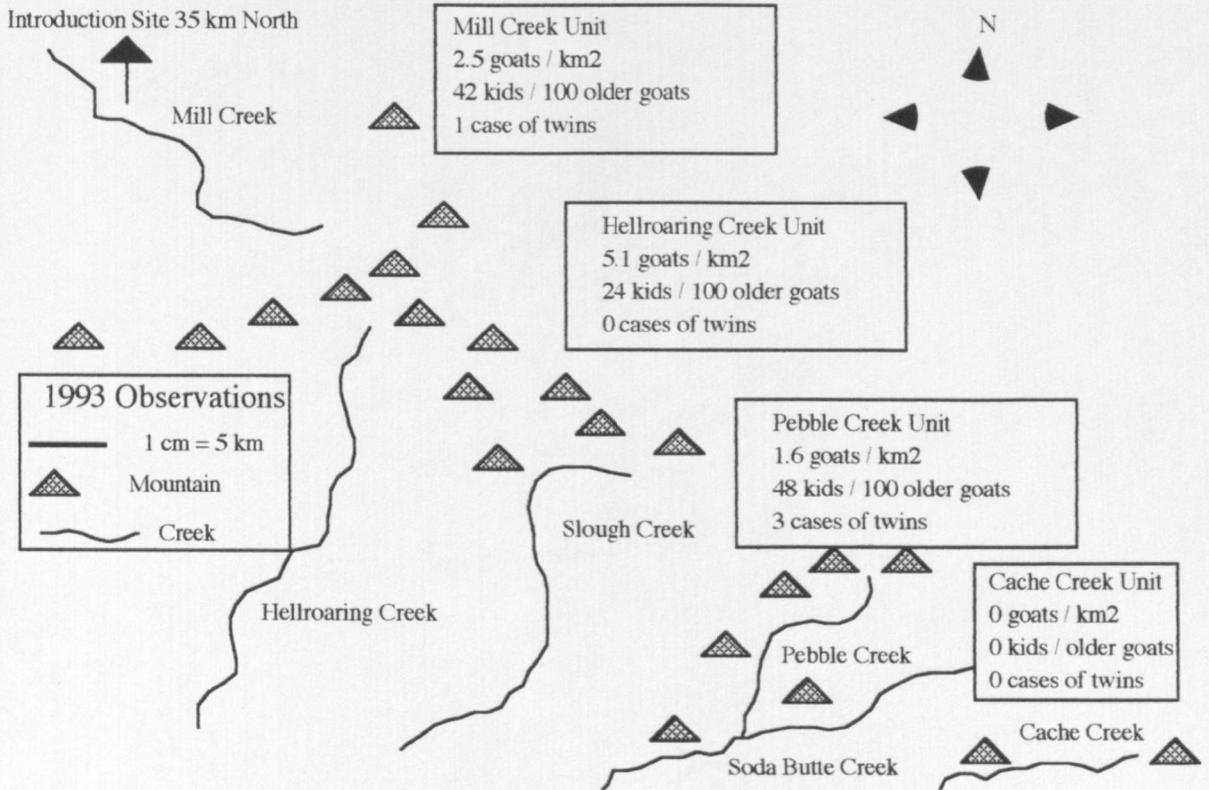


Figure 15. Density, reproductive success, and cases of twins observations from the 4 units of the Absaroka Range study area, 1993.

estimated rate of 3-6 km/year (Houston et al. 1994b). On June 26, 1966, an adult mountain goat sighted on Meridian Peak represented the first recorded sighting in the Pebble Creek unit (Laundre' 1990). In the same year, the first goats were harvested from a growing population in the Hellroaring and Mill Creek units. While the herds in these units grew, occasional sightings continued in the Pebble Creek unit through the 1970's and 1980's. Current distribution and abundance data indicate a viable herd is now established in the Pebble Creek unit, 35-40 years after the initial introductions took place. Mountain goats are considered to be relatively poor dispersers (Stevens 1983). Goats may have reached the Pebble Creek unit within 10 years, but took 3 times longer to establish a resident herd. This supports the supposition that goats are slow to establish herds in vacant ranges, but that individuals will travel great distances from established herds (Chadwick 1974). The Pebble Creek unit is approximately 100 km south of the Absaroka and 85 km west of the Beartooth introduction sites.

The Pebble Creek unit subpopulation is likely in an early irruptive stage of population growth characterized by low density and high productivity. The rapid growth indicators found in the Pebble Creek subpopulation may be a response to abundant resources occurring in the unexploited habitats of the unit. The number of cases of twins in the Pebble Creek unit indicate high productivity which is common in recently established populations (Lentfer 1955, Hayden 1984, Festa-Bianchet et al. 1994).

Goats in the Hellroaring unit have been established 20-30 years longer than in the Pebble Creek unit, and at current levels, density and group sizes are high relative to the other units. No cases of twins were observed, a sign of high density (Houston and Stevens 1988). These indicators suggest the herd may be at or nearing peak densities of irruptive growth and may forewarn a density-dependent decline similar to that reported in other introduced populations (Foss 1962, Bailey 1991). The Hellroaring Creek unit density is similar to the densities given for other introduced populations in Table 4.

The goats in the northern portion of the Absaroka Range are not as productive or numerous as those in the study area (MFWP 1993, 1994, 1995). The subpopulation there may be in the post-decline stage of population growth meaning the ecological carrying capacity threshold was reached in this area, within 40 km of the introduction site. In general, the north end of the Absarokas does not possess the conducive topography and variety of goat habitats that are found in the study area (Lemke, pers comm., 1995). This may have contributed to low productivity as well.

Density dependence has been inferred in introduced populations (Adams and Bailey 1982, Houston and Stevens 1988), but has not been inferred in native populations (Hebert and Turnbull 1977, Kuck 1977). Trend data from aerial surveys in the Absarokas appear to indicate density dependence prior to the 1993-95 counts (Figure 4). A density dependent response was reported in the Absaroka mountain goat population (Swenson 1985). Swenson documented compensatory reproduction to changes in population size during the 1970's, but cautioned maximum reproductive response to harvest may only be expected when goat populations are in the initial increase phase of growth. Introduced goat populations have experienced peaks in population growth followed by a population reduction and variable or poor growth (Foss 1972, Adams and Bailey 1982, Hayden 1989). Goats introduced in the Sawatch Range of Colorado experienced a density-dependent decrease 25 years after release (Adams and Bailey 1982), while an introduced goat population in the Palisades Mountains of Idaho peaked in less than 20 years (Hayden 1989). Peaks in population growth appear to be related to the ecological carrying capacity of the range. The Absaroka population, particularly the Hellroaring Creek unit subpopulation, does not seem to have reached its ecological carrying capacity ~40 years after introduction. It is difficult to predict at what density this population will begin to exhibit indications of resource limitation.

One of several factors related to the ecological carrying capacity for mountain goats may be the extent and relative isolation of the particular mountain range the population inhabits. Mountain goats in the Crazy Mountains north of the Absarokas (Figure 1) reached high densities and experienced a dramatic decline about 15 years after introduction (Foss 1962). This was likely a result of exceeding the long-term carrying capacity of the winter range. Unlike the Absarokas, the Crazy Mountains are a small area isolated by cultivated river valleys. The isolation of the Crazy Mountains may limit dispersal leading to crowded conditions on the winter range. The Absarokas are an extensive range located among several adjacent ranges. Emigration to abundant and as yet unexploited areas in the Absarokas, Beartooth, and Gallatin mountains may mitigate population effects at or near ecological carrying capacity. Goats dispersing to new areas alleviate crowding on winter ranges that leads to over-grazing and subsequent population declines.

The effects of spring snow depth on reproductive success have been suggested in the literature (Thompson 1981, Swenson 1985, 1986; Bailey 1991). A negative association was present from 1966-1983 in the Absaroka herd (Swenson 1985), but was not in the analysis of 1966-1992 data. Adams and Bailey (1982) found a negative correlation between snow depth during gestation and reproductive success in an introduced herd in Colorado from 1966-1979. However, the correlation did not persist after the population stopped increasing and stabilized (Bailey 1991). The Absaroka population still appears to be increasing though the effects of climate on reproduction remain unclear. Subpopulations that have slowed in growth may now be a greater proportion of the population at this time, so spring snow depth is no longer a major factor in reproduction, similar to a situation that was documented in a Colorado population (Bailey 1991). The weak positive association between reproduction and spring snow

pack of the previous year may indicate a heavy snowpack results in productive forage conditions that, in turn, lead to better reproductive success.

Mountain goat diets vary throughout North America depending on local vegetation and climate (Chadwick 1974). Diets tend to be season- and site-specific (Adams and Bailey 1983). The diet data presented here support the supposition made by Geist (1971) that, in order to survive in its narrow niche, the mountain goat utilizes a wide variety of forage items. When available, young plant tissue is preferred (Hjeljord 1973).

Seasonal changes in aspect, elevation, and habitat use in response to early plant growth have been reported in other mountain goat studies (Hjeljord 1973, Smith 1976, Adams 1981). In this study, goats consistently used wet sites with young vegetation. By closely following receding snows and subsequent plant growth, goats used these sites in all habitats and on all aspects. During 1993, these sites were available throughout the entire observation period because heavy snowpack persisted on steep northern and eastern aspects well into September. The persistence and availability of green forage depends on summer precipitation and snowpack from the previous winter. Variation in these climatic factors may influence reproductive success as suggested earlier.

Fall diets of the Absaroka mountain goats were similar to those reported for the Rocky Mountains of Montana and in Colorado (Casebeer 1948, Hibbs 1967, Johnson et al. 1978, Thompson 1981). Diets were most similar to those reported from adjacent mountain ranges. Saunders (1955) reported use of grasses (75%) and forbs (20%) in the fall diet of goats in the Crazy Mountains. Mountain goats in the Beartooth Range, adjacent to the Absarokas, use forbs (60%) and grasses (40%) in the summer (Pallister 1974). In the Absarokas, significant use of forbs was observed in the summer, suggesting goats respond to the availability of ephemeral forbs, and that forbs may constitute a high proportion of the diet in the summer when most available. Goats in the Spanish Peaks,

Montana, used forbs (78%) predominantly in the summer and switched to grasses (90%) in the winter (Peck 1972).

Lichens have been reported as an important food item in some areas (Harmon 1944, Brandborg 1955, Saunders 1955). In all likelihood, the amount of lichens consumed by mountain goats in the Absarokas increases in the winter relative to summer and fall. Lichens are available to mountain goats in mid-winter because they grow on bare rock made snow-free by wind or steep inclines. This vertical component of mountain goat feeding sites may be important, particularly during winters with deep snow (Chadwick 1974). Elsewhere, lichens, moss and conifers are important foods during periods of deep and/or heavy snow (Fox and Smith 1988).

Substantial changes in the vegetation communities would occur assuming the Riney-Caughley model of population growth in the case of the Absaroka mountain goat population. The basis for population irruption and subsequent decline in the model is the modification of vegetation resulting from the establishment of ungulates in formerly unexploited habitat. Very few studies have reported the nature and extent of these changes, particularly for alpine ungulates. The establishment of exotic Himalayan thar in New Zealand incurred changes in mountain vegetation documented by Caughley (1970). Another case involved changes resulting from mountain goat introductions in Olympic National Park, Washington. Mountain goats altered vegetation communities through grazing, wallowing and trampling (Olmsted 1979, Pfitsch et al. 1983, Schreiner 1994).

Changes in the Absaroka vegetation community resulting from mountain goats were difficult to identify and document in areas where herds have been established and are difficult to predict for uncolonized areas. Notable goat-caused changes observed during this study included trails, day beds, and ruderal species invasion in certain well-traveled areas. These changes seemed minor and were not widespread. Extensive wallows and trampling were not found.

The alpine vegetation in the Absarokas has coevolved with herbivory pressure; it has adaptations resulting from use by at least 3 ungulate species: bighorn sheep, elk and mule deer. The effects of an additional ungulate in the Yellowstone system may not be as severe as documented in the Olympic Mountain Range system. The Olympic Range vegetation coevolved with fewer alpine and subalpine herbivores. For example, bighorn sheep, pika (*Ochotona princeps*), and golden-mantled ground squirrels (*Spermophilus lateralis*) are absent in the Olympics but present in the Absarokas. Other differences in a number of major aspects between the two ecosystems make extrapolation from these cases tenuous. The Olympics receive high rainfall (100-400cm, annually, depending on elevation, topography, etc.) compared to the Absarokas (80-150 cm annually). Due to the relative isolation of the Olympic range, a unique biota is present that has 35 endemic plant and animal forms, including 14 vascular plant taxa (Houston and Schreiner 1994, Houston et al. 1994 a). Although not studied to the same extent as the Olympic plant community, the Absaroka plant community is not particularly unique nor does it have any documented endemic plant taxa (Laundre' 1990).

The sheep diet described by Martin (1985) is similar to that found for mountain goats in this study. Dailey et al. (1984) found forage taxa overlap averaged 59% for summer range compared with 30% found in this study. Summer diet similarity has been found for goats and sheep in other studies (Adams et al. 1982). The greatest divergence in diet composition and quality occurs during winter (Dailey et al. 1984).

The diet of both sheep and goats primarily consisted of common graminoids, particularly sedges (*Carex* spp.), rushes (*Juncus* spp.), and bluegrasses (*Poa* spp.). The 5 forage taxa with the highest mean canopy cover composed greater than half of both species' diets suggesting both ungulates are generalists and feed on the most abundant forage available. The use of uncommon forage taxa was not detected in either species' diet.

With few exceptions, sheep and goats foraged on different forbs. Sheep used more browse and less lichen than goats. Dissimilarities in the 2 diets may reflect feeding site selection differences. For instance, goats fed on rushes (*Juncus* spp.) that were abundant in wet, shaded areas such as ledges and steep avalanche chutes. Also, sheep often browsed willow which grew along drainages in gently sloping meadows.

Summer feeding site selection and feeding behaviors for the 2 species were dissimilar. Mountain goats fed on steep, sparsely vegetated sites during all observation periods. Feeding sites were often rocky and closely associated with melting snow. Generally, goats fed in groups of less than 10 and traveled substantial distances before stopping. Chadwick (1974) described this behavior as "trail feeding" and noted it was more prevalent in summer and did not vary until winter when snow prevented long movements and restricted feeding to particular sites.

By contrast, bighorn sheep groups concentrated feeding in open, moderately sloping, alpine or timberline meadows. Habitat use was similar to that found in previous studies of bighorn sheep in the Absarokas (Stewart 1975, Martin 1985). While sheep were observed in ledge habitats, they rarely were feeding in these sites. Sheep are attracted by the relatively high biomass of turf communities (Shannon et al. 1975), and they rely on group size and the visual radius of their feeding sites to detect predators (Adams et al. 1982). Goats rely less on conspecifics for predator detection (Adams et al. 1982).

Houston et al. (1994b) state "The ability to persist in small groups organized along dominance hierarchies permits mountain goats to successfully exploit isolated, small pockets of resources." This ability is a factor in avoiding competition with sheep and is consistent with the observations made in the Absarokas with one exception. Large groups (20-40) observed in the Hellroaring Creek unit primarily from August to October made use of expansive, continuous habitats such as turf meadows rather than isolated

patches. The behavior of these groups was indicative of the feeding behavior described for bighorn sheep. No sheep were located in the Hellroaring Creek unit, so no conflicts were observed; however, goat herds reaching high densities and feeding in large groups could lead to more habitat overlap and conflict with sheep herds in sheep-use areas. The effect would be short-term if the goat density was temporarily high at the peak of irruptive growth as presumed in the Riney-Caughley growth model (see Adams et al. 1982).

Overall, sheep tended to use moderately dry sites where vegetation was more abundant and mature compared to that selected by goats. Goats and sheep used some of the same feeding sites on southern and western slopes but goats would precede sheep by 2-6 weeks, when vegetation was in earlier growth stages.

Competition would occur if the two species were utilizing some environmental resource in short supply; however, feeding behavior and site selection differences minimized this possibility during the growing season. Native mountain goats clearly coexist with wild sheep elsewhere, and the contrasting patterns described here are indicative of niche divergence that would be expected given the 2 species' extensively overlapping distribution and evolutionary history in North America.

The potential for competition between sympatric sheep and goats would be greater during winter when resources are more limited (Adams et al. 1982). Mountain goats currently do not occupy sheep winter ranges in Yellowstone Park. However, wintering areas for the goat population in the Beartooth Mountains overlap with those for some sheep herds that migrate from Absaroka summer range. Investigating the relationship between the 2 species on this winter range would be valuable in further addressing the question of competition between native bighorn sheep and introduced mountain goats.

## MANAGEMENT IMPLICATIONS

### Montana Fish, Wildlife and Parks

Harvest does not appear to be adversely affecting the population. Goat populations can be sensitive to harvest (Kuck 1977, Hebert and Turnbull 1977, Swenson 1985); however, this population exhibits no signs of overharvest such as declining numbers and low reproduction. Rather, counts are at record highs for the population and reproduction has not declined, suggesting the current increasing harvest quotas are not having a detrimental effect on growth. Increased harvest on the high density subpopulations in hunting districts 323 and 329 may slow and prolong growth and/or lessen future density-dependent population decreases.

The Montana portions of the Pebble Creek unit outside of Yellowstone Park support resident herds that are not being hunted. Based on increasing goat numbers (MFWP 1993, 1994, 1995), MFWP has recommended a new goat hunting district (316) that will include portions of the Pebble Creek unit as well as unhunted goat habitat north of the unit and east to the Stillwater River. Another new goat hunting district (314) is recommended for the Gallatin Range north of Yellowstone Park's northwestern boundary. Goat hunting in both areas is likely to begin in 1996.

Wyoming Game and Fish

The Absaroka Range of Wyoming will support a large population of mountain goats based on the amount of goat habitat available. The mountains of the North Absaroka Wilderness and Washakie Wilderness of northwest Wyoming are topographically similar to the Hellroaring Creek unit mountains and may be expected to support relatively high goat densities (~4-6 goats/km<sup>2</sup>) after colonization. Competition with bighorn sheep on the summer range would not be expected to be significant; however, the issue should be evaluated on a herd by herd basis on winter ranges. The sheep herds that winter on high elevation ridges would be more at risk of competition with goats than those wintering at low elevation sites like the sagebrush grasslands of the South Fork of the Shoshone River.

National Park Service, Yellowstone Park

The Absaroka and Gallatin Mountains seem to be the only areas that will likely support substantial, long-term mountain goat populations in the Park (Laundre' 1990). Currently, goats occupy portions of the Absarokas in the northeast corner and the Gallatins in the northwest corner of Yellowstone. No significant barriers to further colonization in either range exist. Goats will continue expanding their distribution in the Absarokas of Wyoming along and within the eastern boundary of the Park. The mountains in the Park generally consist of a solitary ridge or peaks isolated from other mountains by forested divides or valleys. They are topographically similar to the low goat density subunits of the Mill and Pebble Creek units. In contrast to the adjacent mountains of the North Absaroka and Washakie Wildernesses, long-term densities in these areas may be expected to be low (~0.5-2 goats/km<sup>2</sup>).

In addition to the Absarokas and Gallatins, goat colonization may occur to a lesser extent in more interior regions of Yellowstone Park. Mountain goats have been known to inhabit subalpine areas such as the Sapphire Range of western Montana (Rideout 1977) as long as the terrain is structurally suitable (i.e. steep and rocky). Smaller mountain complexes with steep river canyons nearby are potential goat habitats because short migrations, or seasonal shifts, from mountains into adjacent canyons have been reported in other goat studies (McCrorry et al. 1977). Some goats of the Spanish Peaks descend to winter in the Beartrap Canyon of the Madison River (Peck 1972), and goats in the Wyoming Beartooths descend into the Clark's Fork Canyon--an elevational migration of ~2100 meters (Haynes 1992). The close proximity of the Grand Canyon of the Yellowstone River to the Washburn Range and the Gardner River Canyon to the Gallatins presents the opportunity for a similar situation. Colonization of habitats in the interior of the park such as the Washburn Range and Red Mountains is possible, although the long-term densities may be expected to be significantly lower than for the peripheral mountain ranges due to the isolation of these habitats.

For the National Park Service, colonization of Yellowstone Park by mountain goats involves both ecological and philosophical issues. This study provides information for the ecological issues; however, the Park may decide the issue is not one to be settled on ecological grounds. That is, if mountain goats have non-native species status, then in keeping with park policy, they may be eradicated, controlled, or otherwise managed on the basis of classification (NPS 1991). But if the issue focuses more on ecology than philosophy, then additional information is needed to develop a better understanding of (1) the extent to which vegetation in the park will be changed by mountain goats, (2) the potential dispersal into park areas by goats, and (3) the long-term densities that might be expected subsequent to colonization.

To explore these issues, Yellowstone managers may wish to follow the example set in the Olympic case by investigating use of specific, sensitive plant taxa (Pike 1981), using exclosures for controlled experiments (Pfitsch and Bliss 1985, Schreiner 1994), and establishing numerous long-term photopoints for monitoring (Schreiner and Burger 1994, Laundre' 1990). Visitor reports seem to be adequate for tracking dispersal into interior park regions such as the Washburn Range but they are not for remote regions like the Absarokas and Gallatins where more colonization is occurring. Monitoring the established herds in these areas, particularly the Pebble Creek unit, should offer an indication of how much population fluctuation will occur in the short-term, and the resulting long-term population density that can be expected for areas of future colonization.

Absaroka mountain goats have crossed boundaries between differing management agency philosophies. Recognizing that the agencies involved have differing goals and mandates, ultimately, a management scheme that tries to satisfy all agencies' objectives would be the ideal. As with other cases of Greater Yellowstone ungulates and boundaries, mountain goat management has the potential to be a divisive public issue; therefore, ideas and plans should be considered in a public process involving all agencies and user groups (hunters, naturalists, etc.). Public involvement and interagency cooperation is critical to this management process. Integrated strategies reached through mutual understanding will likely have the best results in this complicated issue.

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**APPENDICES**

## APPENDIX A

Habitat Descriptions

Seven habitats in the alpine and subalpine zones of the study area were described based on terrain features, soil development, and vegetation for the purpose of this study.

Ledge

Ledge habitats were common on north and east aspects of mountain peaks and ridges. Ledge habitats were short, moderately-sloping shelves between vertical bedrock faces. Avalanche chutes of rocky scree vertically intersected ledges and fields of talus often accumulated at the base of steep ledge areas. The slopes typically ranged between 30 and 60 degrees.

Winter snowpack, particularly large cornices at the top of cliffs, melted slowly throughout the summer and kept the ledges moist. Continuous runoff accelerated soil development on the ledges and supported patchy vegetation communities.

Sedges (*Carex* spp.), rushes (*Juncus* spp.), bluegrasses (*Poa* spp.), and saxifrage (*Saxifragas* spp.) were common amongst mats of mosses (*Polytrichium* spp.). Lichens of various species were abundant on rocks and soil.

### Talus

Talus consisted of large rocks and boulders that accumulated at the base of steep slopes. Very little soil or vegetation was found in these types. Shrubs such as willows (*Salix* spp.) and currants (*Ribes* spp.) emerged through crevices. Talus slopes were found on all aspects but were uncommon in the study area because the volcanic parent material broke down into mainly cobbles and fines.

### Rocky Scree

Steep slopes with unconsolidated cobbles, gravel, and fines were common on all mountain aspects. There was very little soil development associated with this type due to constant erosion. Slopes varied between 20 and 60 degrees.

The rocks hosted an array of crustose lichens while sheep fescue (*Festuca ovina*), rushes, and sedges were common in the cracks between the rocks. Forbs such as stonecrop (*Sedum lanceolata*), sky pilot (*Polemonium viscosum*), and moss campion (*Silene acaulis*) clung to islands of soil in the debris.

### Gravel Scree

Dry slopes with shallow soils occurred mainly on southerly aspects and ridge-tops. Unconsolidated gravels and fines formed the top layer of these scree slopes. Slopes were generally flat to moderate for these areas, 0-25 degrees. Spreading wheatgrass (*Agropyron scribneri*), yarrow (*Achillea millefolium*), buckwheat (*Eriogonum ovifolium*), milkvetch (*Atragulus* spp.) and phacelia (*Phacelia* spp.) were common in dirt scree communities.

### Turf

Meadows with inceptisol soils and continuous vegetative cover were common on western aspects and northern aspects. This type commonly had moderate (<20 degrees) slopes and supported the most diverse and plentiful plant communities. Tufted hairgrass (*Deschampsia caespitosa*), sedges, phlox (*Phlox multiflora*), chickweed (*Cerastrium arvense*), sandwort (*Arenaria obtusiloba*), bluebells (*Mertensia alpina*), and cinquefoil (*Potentilla quinquefolia*) were abundant.

### Turf Scree

These habitats were similar to both rocky scree and turf communities and were found on western and northern aspects primarily. The slopes were steeper than turf communities and contained less rocky debris than rocky scree. The sedges, tufted hairgrass, and sheep fescue were common growing in patchy turf islands primarily composed of moss, saxifrage, sandwort, and moss campion.

### Subalpine

Areas occurring below timberline (~2550m) on all aspects were grouped into the subalpine category. Areas which were within or among continuous overstory tree cover were considered subalpine. An additional description such as meadows and forested outcrop was often added to the record for better detail. The dominant tree species included subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*) and engelmann spruce (*Picea engelmannii*).

## APPENDIX B

Table 11. Date, period, unit, subunit, and location of all ground surveys of the Absaroka study area, 1991-1993.

Date	Period <sup>a</sup>	Unit, Subunit	Areas surveyed
07/21/91	3	Pebble, Wolverine Peak	Wolverine Peak, Sunset Peak
07/22/91	3	Pebble, Wolverine Peak	Wolverine Peak, Wolverine Pass, Lost Peak
07/23/91	3	Pebble, Wolverine Peak	Meridian Peak, Mineral Mountain, Sheep Creek Pass
08/14/91	3	Pebble, Barronette Peak	North Barronette Ridge
08/15/91	3	Pebble, Cutoff Mountain	Cutoff Mountain, Bliss Pass
08/24/91	4	Pebble, Barronette Peak	Barronette Peak,
08/25/91	4	Cache, The Thunderer	The Thunderer
09/02/91	4	Pebble, Mount Hornaday	Mount Hornaday
05/23/92	1	Pebble, Wolverine Peak	Meridian Peak, Mineral Mountain
05/24/92	1	Pebble, Cutoff Mountain	Lost Peak
06/08/92	1	Mill, The Pyramid	The Pyramid
06/09/92	1	Mill, The Pyramid	The Pyramid, North Crow Mountain
06/10/92	1	Mill, The Pyramid	The Pyramid
06/23/92	2	Hellroaring, Middle Ridge	Middle Ridge, Sheep Creek, Copper Creek
06/24/92	2	Hellroaring, Middle Ridge and Crow Mountain	Copper Creek, Elk Lake, Bridge Point
06/26/92	2	Hellroaring, Middle Ridge and Iron Mountain	Middle Ridge, Sheep Creek, Iron Mountain
06/27/92	2	Hellroaring, Middle Ridge	Middle Ridge, Copper Creek, Elk Lake
06/29/92	2	Hellroaring, Middle Ridge and Iron Mountain	Middle Ridge, Iron Mountain

Table 11. Continued

06/30/92	2	Hellroaring, Iron Mountain	Iron Mountain
07/08/92	2	Mill, Monitor Peak	Monitor Peak
07/09/92	2	Mill, Monitor Peak	Monitor Peak
07/14/92	2	Pebble, Wolverine Peak	Wolverine Peak, Sunset Peak, Miller Mountain
07/16/92	3	Pebble, Wolverine Peak	Mount Abundance
07/17/92	3	Pebble, Wolverine Peak	Mineral Mountain, Meridian Peak, Sheep Creek Pass
07/19/92	3	Pebble, Wolverine Peak and Cutoff Mountain	Wolverine Peak, Wolverine Ridge, Lost Peak
08/05/92	3	Pebble, Cutoff Mountain	Cutoff Mountain, Bliss pass
08/12/92	3	Pebble, Mount Hornaday	Mount Hornaday
08/19/92	4	Hellroaring, Crow Mountain	Crow Mountain, Bridge Point
08/21/92	4	Hellroaring, Crow Mountain	North Crow summit, Crow Mountain
09/04/92	4	Cache, Amphitheater-Abiathar	Abiathar Peak
09/11/92	4	Cache, Amphitheater-Abiathar	Amphitheater Mountain, Guitar Lake
09/12/92	4	Cache, Amphitheater-Abiathar	Republic Ridge, Woody Ridge
10/12/92	5	Pebble, Wolverine Peak	Wolverine Peak
06/07/93	1	Pebble, Cutoff Mountain	Lost Peak
06/08/93	1	Pebble, Cutoff Mountain	Cutoff Mountain, Bliss pass
06/09/93	1	Pebble, Wolverine Peak	Meridian Peak, Mineral Mountain
07/05/93	2	Hellroaring, Clover Basin	Grizzly Creek, east of Thompson Lake
07/08/93	2	Hellroaring, Clover Basin	Mount Wallace, Clover Basin, Silver Basin
07/09/93	2	Hellroaring, Clover Basin	Clover Basin, Silver Basin
07/23/93	3	Pebble, Wolverine Peak	Wolverine Peak, Sunset Peak, Miller Mountain
07/24/93	3	Pebble, Wolverine Peak	Mount Abundance

Table 11. Concluded

07/25/93	3	Pebble, Wolverine Peak and Cutoff Mountain	Wolverine Ridge, Lost Peak
07/27/93	3	Pebble, Wolverine Peak	Roundhead Butte
08/02/93	3	Pebble, Wolverine Peak	Wolverine Peak, Mount Abundance
08/05/93	3	Pebble, Wolverine Peak	Wolverine Peak, Wolverine Ridge
08/12/93	3	Mill, The Pyramid	The Pyramid
08/14/93	3	Mill, The Pyramid	The Pyramid
08/15/93	3	Mill and Hellroaring, The Pyramid	The Pyramid, North Crow Mountain
08/17/93	4	Mill, The Pyramid	The Pyramid
08/28/93	4	Hellroaring, Crow Mountain	Crow Mountain, Bridge Lake
08/30/93	4	Hellroaring, Crow Mountain	Crow Mountain, Lambert Creek
09/01/93	4	Hellroaring, Crow Mountain	Crow Mountain, South Fork of Bridge Creek, Bridge Point
09/03/93	4	Hellroaring, Middle Ridge and Iron Mountain	Bridge Point, Middle Ridge, Iron Mountain
09/28/93	5	Hellroaring, Clover Basin	Silver Basin, Clover Basin, North Fork Basin
09/29/93	5	Hellroaring, Clover Basin	Silver Basin, Clover Basin
10/04/93	5	Pebble, Wolverine Peak	Wolverine Peak, Sunset Peak, Sheep Creek Pass
10/06/93	5	Pebble, Wolverine Peak	Wolverine Peak, Sunset Peak, Miller Mountain
10/07/93	5	Pebble, Wolverine Peak	Wolverine Peak, Mount Abundance, Wolverine Ridge

<sup>a</sup> Periods: (1) May 15-June 15, (2) June 16-July 15, (3) July 16-August 15, (4) August 16-September 15, (5) September 16-October 15.

APPENDIX C

Table 12. Contents of seven mountain goat rumen samples collected in Fall, 1992.

TAXA	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Total
	80/ 110 <sup>a</sup>	68/ 130	78.5/ 156	74/ 189	106.5 /188	90/ 208	205/ 311	702/ 1292
GRAMINOIDS	64.5/80 <sup>b</sup>	60/88	61.5/ 78.5	34.5/ 46	69/64	69/ 75.5	186.5/91	545/ 77.5
<i>Agropyron spp.</i>	tr. <sup>c</sup>	14/20	7/9	tr.	5/5	5/5.5	6/3	37/ 5
<i>Agrostis scabra</i>	1.5/2	-	-	-	2/2	tr.	-	3.5/ 0.5
<i>Carex spp.</i>	13/16	14.5/21	16/20	7.5/10	18.5/ 17	21/23	50.5/ 25	141/ 20
<i>Deschampsia spp.</i>	4/5	8/12	5/6	2/3	5/5	2/2	17/8	43/6
<i>Elymus spp.</i>	2.5/3	tr.	3.5/4	-	2/2	3.5/4	tr.	11.5/ 2
<i>Festuca ovina</i>	tr.	tr.	4/5	5/7	6.5/ 6	11.5/13	32/16	59/ 8.5
<i>Juncus spp.</i>	27.5/34	8.5/ 13	11.5/15	9.5/12	7.5/7	4/4	38/ 18.5	106.5/ 15
<i>Koeleria cristata</i>	-	-	tr.	-	3/3	4/4	tr.	7/1
<i>Luzula spp.</i>	tr.	3/4	5/6	7/9	3/3	9/10	19/9	46/ 6.5
<i>Poa spp.</i>	16/20	12/18	7.5/10	3.5/5	9/8	7/8	18/9	73/ 10
<i>Trisetum spicatum</i>	-	tr.	2/2.5	tr.	7.5/ 7	2/2	6/3	17.5/ 2.5
FORBS	15.5/19	8/ 11	13.5/18	37.5/51	24.5/23	20.5/ 23	18.5/10	138/ 20
<i>Achillea millefolium</i>	1.0/ 1	tr.	-	tr.	-	-	-	-
<i>Antennaria spp.</i>	tr.	tr.	4.5/6	1/1	tr.	tr.	3.5/2	9/ 1
<i>Areneria obtusiloba</i>	-	-	1/1	1.5/2	8/7	tr.	1.5/1	12/2
<i>Arnica spp.</i>	3.5/4	2.5/4	2.5/3	-	1/1	tr.	tr.	8/2
<i>Artemisia spp.</i>	-	-	-	-	tr.	-	tr.	-
<i>Astragalus spp.</i>	-	-	tr.	-	1/1	-	3/1.5	3/0.5
<i>Cerastrium arvense</i>	tr.	1/1	tr.	3/4	4.5/4	2/2	tr.	10.5/ 1.5
<i>Erigeron spp.</i>	tr.	tr.	-	tr.	tr.	tr.	-	tr.
<i>Lupinus argenteus</i>	tr.	1/1	tr.	8/11	1/1	11/12	1/1	22/3
<i>Mertensia spp.</i>	6.5/8	-	3/4	tr.	-	tr.	3.5/2	13/2
<i>Phlox spp.</i>	-	-	tr.	1/1	-	-	-	1/0.5
<i>Polemolium spp.</i>	-	-	-	-	tr.	-	tr.	tr.
<i>Polygonum bistortis</i>	tr.	-	tr.	tr.	-	-	-	tr.
<i>Potentilla spp.</i>	tr.	tr.	-	3.5/5	-	tr.	tr.	3.5/ 0.5
<i>Rumex spp.</i>	1.5/2	-	-	-	-	tr.	-	1.5/ 0.5
<i>Saxifraga bronchialis</i>	tr.	-	tr.	tr.	4/4	-	-	4/0.5

Table 12. Concluded

<i>Sedum lanceolata</i>	tr.	tr.	3.5/5	18/24	1/1	6/7	2/1	30.5/ 4
<i>Senecio spp.</i>	3.0/4	-	-	tr.	1/1	1.5/2	4/2	9.5/1
<i>Trifolium haydenii</i>	-	3.5/5	tr.	1.5/2	3/3	tr.	tr.	8/1
SHRUBS	tr.	tr.	tr.	tr.	1/1	2/2	tr.	3/0.5
<i>Abies lasiocarp</i>	-	-	tr.	-	-	-	-	tr.
<i>Phyllodoce spp.</i>	-	-	-	tr.	-	-	-	tr.
<i>Picea engelmannii</i>	-	-	tr.	tr.	tr.	-	-	tr.
<i>Pinus albicaulis</i>	tr.	tr.	tr.	-	tr.	tr.	tr.	tr.
<i>Ribes aureum</i>	tr.	-	-	-	tr.	tr.	-	tr.
<i>Salix spp.</i>	tr.	-	tr.	-	tr.	1/1	-	1/0.5
<i>Vaccinium scoparium</i>	tr.	-	-	tr.	tr.	1/1	-	1/0.5
NONVASCULAR plants	tr.	tr.	1.5/2	tr.	16/15	tr.	tr.	17.5/ 2.5
Moss	tr.	tr.	tr.	tr.	tr.	tr.	tr.	tr.
Lichens	-	tr.	-	tr.	16/15	tr.	tr.	16/2
<i>Marchantia spp.</i>	-	-	1.5/2	-	-	-	-	1.5/ 0.5

<sup>a</sup> Total identifiable volume/ total volume per sample, in milliliters.

<sup>b</sup> Volume in milliliters/percent of total.

<sup>c</sup> Trace amount, less than 1 ml or 0.5%.

Table 13. Date, district, location, sex, age and volume of rumen samples taken from the harvest of seven mountain goats in the Absaroka Range, 1992.

Sample	Date	Hunting District	Location Description	Sex	Age	Volume, ml
1	9-17	323	Wallace Pass	F	3	110
2	9-29	329	Baboon Mountain	M	5	130
3	10-1	329	Roundhead Butte	M	3	156
4	9-15	329	S. Fork Sheep Creek	F	5	189
5	10-6	329	Shepherd Peak	M	8	188
6	9-17	323	Mt. Wallace	M	4	208
7	9-15	329	Iron Mountain	F	5	311

## APPENDIX E

Table 14. Graminoids, forbs, and shrubs identified in mountain goat habitats of the Absaroka Range, south-central Montana (\* indicates common species).

Genus and/or Species	Common Name
<b>GRAMINOIDS</b>	
<i>Agropyron scribneri</i> Vasey.	Spreading wheatgrass*
<i>A. spicatum</i> (Pursh) Scribner and Smith	Bluebunch wheatgrass*
<i>Agrostis humilis</i> Vasey.	Alpine bentgrass
<i>A. scabra</i> Willd.	Rough bentgrass
<i>Alopecurus alpinus</i> J. E. Smith	Alpine foxtail
<i>Bromus ciliatus</i> L.	Fringed brome
<i>Carex</i> spp.	Sedges*
<i>C. geyeri</i> Boott	Elk sedge
<i>C. phaeocephala</i> Piper	Mountain hare sedge
<i>C. praticola</i> Rydb.	Meadow sedge*
<i>Deschampsia atropurpurea</i> (Wahl.) Scheele	Mountain hairgrass
<i>D. caespitosa</i> (L.) Beauv.	Tufted hairgrass*
<i>Elymus glaucus</i> Buck.	Western rye-grass
<i>Festuca idahoensis</i> Elmer.	Idaho fescue
<i>F. ovina</i> L.	Sheep fescue*
<i>Juncus</i> spp.	Rushes*
<i>J. drummondii</i> E. Meyer	Drummond's rush
<i>J. parryi</i> Engelm.	Parry's rush
<i>J. regelii</i> Buch.	Regel's rush
<i>Koeleria cristata</i> Pers.	Koeler's junegrass
<i>Luzula parviflora</i> (Ehrh.) Desv.	Small-flowered woodrush
<i>L. spicata</i> (L.) DC.	Spiked woodrush*
<i>Oryzopsis hymenoides</i> (R. & S.) Ricker	Indian ricegrass
<i>Phleum alpinum</i> L.	Alpine timothy*
<i>Poa</i> spp.	Bluegrasses*
<i>P. alpina</i> L.	Alpine bluegrass*

Table 14. continued

<i>P. grayana</i> Vasey.	Gray's bluegrass
<i>P. juncifolia</i> Scribner.	Big bluegrass
<i>P. lettermanii</i> Vasey.	Letterman's bluegrass
<i>P. nevadensis</i> Vasey.	Nevada bluegrass
<i>P. rupicola</i> Nash.	Timberline bluegrass
<i>Trisetum spicatum</i> (L.) Richt.	Spike trisetum
FORBS	
<i>Achillea millefolium</i> L.	Yarrow*
<i>Androsace septentrionalis</i> L.	Fairey's candelabra*
<i>Anemone multifida</i> Poir.	Wind flower anemone
<i>Antennaria alpina</i> (L.) Gaertn.	Alpine pussy-toes
<i>A. corymbosa</i> E. Nels.	Flat-topped pussy-toes
<i>A. lanata</i> (Hook.) Greene	Woolly pussy-toes*
<i>Aquilegia flavenscens</i> Wats.	Yellow columbine
<i>Arabis lyalli</i> Wats.	Lyall's rockcress*
<i>Arenaria congesta</i> Nutt.	Ballhead sandwort*
<i>A. obtusiloba</i> (Rydb.)	Fern arctic sandwort
<i>Arnica cordifolia</i> Hook.	Heart-leaf arnica
<i>A. diversifolius</i> Greene	Sticky arnica*
<i>A. latifolia</i> Bong.	Mountain arnica
<i>A. longifolia</i> D.C. Eat.	Seep-spring arnica
<i>A. rydbergii</i> Greene	Rydberg's arnica
<i>Artemisia michauxiana</i> Bess	Michaux mugwort
<i>A. campestris</i> L.	Boreal sagewort*
<i>A. scopulorum</i> Gray	Alpine sagebrush
<i>Aster alpigenus</i> (T. & G.) Gray	Alpine aster*
<i>Astragalus alpinus</i> L.	Alpine milkvetch*
<i>A. kentrophyta</i> Gray	Mat milkvetch
<i>Caltha leptosepala</i> D.C.	Elkslip, marshmarigold*
<i>Campanula rotundifolia</i> L.	Harebell
<i>Castilleja cusickii</i> Greenm.	Cusick's paintbrush
<i>C. pulchella</i> Rydb.	Showy paintbrush*
<i>C. rhexifolia</i> Rydb.	Rhexia-leaved paintbrush
<i>Cerastrium arvense</i> L.	Field chickweed*
<i>Chrysopsis villosa</i> (Purs.) Nutt.	Hairy golden aster
<i>Cirsium foliosum</i> (Hook.) D.C.	Leafy thistle

Table 14. continued

<i>C. scariosum</i> Nutt.	Evert's thistle
<i>Delphinium glaucum</i> Wats.	Pale larkspur
<i>Claytonia lanceolata</i> Pursh	Springbeauty
<i>Dodecatheon conjugens</i> Greene	Slimpod shootingstar
<i>Draba crassifolia</i> R. Grah.	Thickleaved draba
<i>D. densifolia</i> Nutt.	Nuttall's draba
<i>D. oligosperma</i> Hook.	Few-seeded draba
<i>Dryas octopetala</i> L.	White dryad
<i>Epilobium alpinum</i> L.	Willow herb
<i>E. augustifolium</i> L.	Fireweed
<i>E. glaberrimum</i> Barbey	Smooth willow herb
<i>Erigeron compositus</i> Pursh	Cutleaf daisy*
<i>E. rydbergii</i> Crunq.	Rydberg's daisy
<i>E. simplex</i> Greene	Alpine daisy
<i>Eriogonum ovalifolium</i> Nutt.	Cushion buckwheat*
<i>Eritrichium nanum</i> (Vill.) Schrad.	Alpine forget-me-not
<i>Fragaria vesca</i> L.	Woods strawberry
<i>F. virginiana</i> Duchesne	Wild strawberry
<i>Gentiana algida</i> Pall.	Whitish gentian
<i>G. calycosa</i> Griseb.	Mountain Bog Gentian
<i>Geum triflorum</i> Pursh	Prairie smoke
<i>Haplopappus acaulis</i> (Nutt.) Gray	Stemless goldenweed
<i>Heracleum lanatum</i> Michx.	Cow-parsnip
<i>Hieracium gracile</i> Hook.	Slender hawkweed
<i>Ivesia gordonii</i> Hook.	Gordon's Ivesia
<i>Lewisia pygmaea</i> (Gray) Robins	Alpinelewisia
<i>Linnaea borealis</i> L.	Twin flower
<i>Lupinus argenteus</i> Pursh	Silvery lupine*
<i>Mertensia alpina</i> (Torr.) G. Don	Broad-leafed bluebells
<i>Mimulus tilingii</i> Regel	Monkey flower
<i>Musineon divaricatum</i> (Pursh) Nutt.	Leafy musineon
<i>Myosotis sylvatica</i> Hoffm.	Woods forget-me-not*
<i>Oxyria digyna</i> (L.) Hill	Mountain sorrel*
<i>Oxytropis sericea</i> Nutt.	Silky crazyweed
<i>O. campestris</i> (L.) DC	Slender crazyweed
<i>Pedicularis bracteosa</i> Benth.	Bracted louswort
<i>P. groenlandica</i> Retz.	Elephant's head

Table 14. continued

<i>P. parryi</i> Gray	Parry's louswort*
<i>Penstemon montanus</i> Greene	Mountain beardtongue
<i>P. procerus</i> Dougl.	Small-flowered penstemon
<i>Phacelia hastata</i> Dougl.	Silverleaf phacelia
<i>P. Sericia</i> (Grah.) Gray	Silky phacelia*
<i>Phlox multiflora</i> A. Nels.	Many-flowered phlox
<i>P. pulvinata</i> (Wherry) Cronq	Cushion phlox
<i>Polemonium pulcherrimum</i> Hook.	Jacob's ladder*
<i>P. viscosum</i> Nutt.	Sky Pilot
<i>Polygonum bistortoides</i> Pursh	Western bistort
<i>Polygonum viviparum</i> L.	Alpine bistort*
<i>Potentilla diversifolia</i> Lehm.	Vari-leaf cinquefolia
<i>P. ovina</i> Macern	Sheep cinquefoil
<i>P. quinquefolia</i> Rydb.	Five-leaved cinquefoil
<i>Ranunculus eschscholtzii</i> Schlecht.	Subalpine buttercup
<i>Saxifraga arguta</i> D. Don	Brook saxifrage
<i>S. bronchialis</i> L.	Yellowdot saxifrage*
<i>S. oppositifolia</i> L.	Purple saxifrage*
<i>S. rhomboidea</i> Greene	Diamondleaf saxifrage
<i>Sedum leanceolata</i> Torr.	Lanceleaved stonecrop*
<i>S. roseum</i> (L.) Scop.	King's crown
<i>Senecio crassulus</i> Gray	Thick-leaved groundsel
<i>S. fremontii</i> T. & G.	Dwarf mountain butterweed
<i>S. fuscatus</i> Hayek	Twice hairy groundsel
<i>S. lugens</i> Richardson	Black-tipped butterweed
<i>S. triangularis</i> Hook.	Arrowleaf groundsel*
<i>Sibbaldia procumbens</i> L.	Creeping sibbaldia
<i>Silene acaulis</i> L.	Moss campion*
<i>Smelowskia calycina</i> (Steph.) C. A. Mey.	Alpine smelowskia*
<i>Solidago multiradiata</i> Ait.	Northern goldenrod*
<i>Spirea splendens</i> Baumann ex Koch	Subalpine spirea
<i>Spraguea umbellata</i> Torr.	Pussypaws
<i>Taraxacum lyratum</i> (Ledeb.) DC.	Alpine dandelion
<i>Thalictrum occidentals</i> Gray	Western meadow rue
<i>Tofieldia glutinosa</i> Michx.	Sticky tofieldia
<i>Townsendia parryi</i> Eat.	Parry's townsendia
<i>Trifolium haydennii</i> Porter	Hayden's clover*

Table 14. concluded

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<i>T. nanum</i> Torrey	Dwarf clover
<i>T. parryi</i> Gray	Parry's clover
<i>Trollius laxus</i> Salisb.	Globeflower
<i>Veronica wormskjoldii</i> Roem. & Schult	American alpine speedwell
<i>Viola nuttallii</i> Pursh	Nuttall's violet
<i>Zygadenus elegans</i> Pursh	Alpine death camas

## SHRUBS

<i>Amelanchier alnifolia</i> Nutt.	Western serviceberry
<i>Abies lasiocarpa</i> (Hook.) Nutt	Subalpine fir*
<i>Alnus incana</i> (L.) Moench	Thinleafed alder
<i>Arctostaphylos uva-ursi</i> (L.) Spreng.	Kinnikinnik
<i>Mahonia repens</i> (Lindl.) G. Don.	Creeping Oregon grape
<i>Phyllodoce empetriformis</i> (Sw.) D. Don	Pink mountain heath*
<i>Picea engelmannii</i> Parry	Engelman spruce
<i>Pinus albicaulis</i> Engelm.	Whitebark pine*
<i>P. contorta</i> Dougl.	Lodgepole pine
<i>Ribes montigenum</i> McCatchie	Alpine prickly current
<i>Rosa woodsii</i> Lindl.	Wood's rose
<i>Salix arctica</i> Pall.	Arctic willow
<i>S. reticulata</i> L.	Net-veined willow
<i>S. rotundifolia</i> Trautv.	Round-leafed willow
<i>S. glauca</i> L.	Gray leaf willow
<i>Vaccinium scoparium</i> Leiberg	Grouse whortleberry

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\* Common in Mountain Goat Habitats

## APPENDIX F

Table 15. Date, composition, and location of visitor reported sightings of mountain goats in and adjacent to Yellowstone National Park, 1965-1990.

Date	Sex <sup>a</sup>	Location
07-20-65	0 <sup>b</sup>	Bighorn Peak, Gallatin Mountains
06-29-66	0	Meridian Peak, Absaroka Mountains
07-02-69	0	Bighorn Peak, Gallatin Mountains
07-15-69	0	Sepulcher Mountain, Gallatin Mountains
10-01-71	1	Wolverine- Cutoff ridge, Absaroka Mountains
09-06-78	1	Bliss Pass, Absaroka Mountains
09-05-82	0	Wolverine-Meridian ridge, Absaroka Mountains
09-10-82	0	Wolverine Peak, Absaroka Mountains
09-10-82	0	Sunset Peak, Absaroka Mountains
09-08-83	2	Wolverine Peak, Absaroka Mountains
09-08-83	0	Wolverine Peak, Absaroka Mountains
07-16-84	1	Barronette Peak, Absaroka Mountains
06-15-84	0	Specimen Creek, Gallatin Mountains
08-15-85	0	Sunset Peak, Absaroka Mountains
08-20-85	0	Sheep Mountain, Absaroka Mountains
10-19-85	0	Wolverine- Cutoff ridge, Absaroka Mountains
08-01-86	2	Bliss Pass, Absaroka Mountains
07-31-86	0	Bliss Pass, Absaroka Mountains
08-11-86	0	Cutoff Mountain, Absaroka Mountains
09-16-86	0	Wolverine Peak, Absaroka Mountains
08-31-87	0	Dome Mountain, Gallatin Mountains <sup>c</sup>
09-04-87	0	Dome Mountain, Gallatin Mountains <sup>c</sup>
10-22-87	0	Electric Peak, Gallatin Mountains
06-17-88	0	Yellowstone River Canyon, near Hellroaring Creek
06-22-88	0	Wolverine Peak, Absaroka Mountains
06-23-88	0	Mount Abundance, Absaroka Mountains

Table 15. Concluded

07-11-88	0	Mount Washburn, Washburn Range
07-11-88	0	Mount Holmes, Gallatin Mountains
10-27-88	0	Wolverine Peak, Absaroka Mountains
05-01-89	0	Tower Falls, Washburn Range
06-01-89	0	Hellroaring Creek Trailhead
06-14-89	0	Mount Hornaday, Absaroka Mountains
06-26-89	0	Gardner River Canyon
06-29-89	0	Bannock Peak, Gallatin Mountains
06-30-89	0	Mount Holmes, Gallatin Mountains
07-15-89	2	Mount Holmes, Gallatin Mountains
08-08-89	0	Cutoff Mountain, Absaroka Mountains
08-29-89	1	Gallatin River Canyon
09-08-89	0	Cutoff Mountain, Absaroka Mountains
09-22-89	0	Cutoff Mountain, Absaroka Mountains
09-28-89	0	Cutoff Mountain, Absaroka Mountains
10-15-89	0	Berly Spring
06-19-90	2	Meridian Peak, Absaroka Mountains
05-30-90	2	Deep Creek, Washburn Range
06-11-90	0	Yankee Jim Canyon <sup>c</sup>
09-14-90	0	Gallatin River Canyon

<sup>a</sup> Group size and age composition unavailable

<sup>b</sup> Sex: 0 = unknown; 1 = male; 2 = female; 3 = male and female

<sup>c</sup> Adjacent to the park

**RARE ANIMAL OBSERVATION FORM  
YELLOWSTONE NATIONAL PARK**

YELL 95  
Revised

Please fill out all appropriate information and turn into Bear Management Office or phone 307-344-2162.

Species \_\_\_\_\_ Time \_\_\_\_\_ a.m. p.m. (circle one)  
Observation Date \_\_\_\_/\_\_\_\_/\_\_\_\_ Number of Animals \_\_\_\_\_ Sex: M \_\_\_ F \_\_\_ Unknown \_\_\_

Observer Name \_\_\_\_\_ Phone ( ) \_\_\_\_\_ Visitor \_\_\_ Employee \_\_\_  
Address \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Have you seen this species before? Yes \_\_\_ No \_\_\_ Where? \_\_\_\_\_  
(Indicate experience with this species)

*Describe the Animal (Characteristics unique to this species)* \_\_\_\_\_

Color \_\_\_\_\_ Ears \_\_\_\_\_  
Weight \_\_\_\_\_ Shoulder height \_\_\_\_\_ Horns/Antlers (circle one) Describe \_\_\_\_\_  
Length \_\_\_\_\_ Tail position: Up \_\_\_ Down \_\_\_ Straight out \_\_\_ Curled \_\_\_  
Tags or radio collar (color, placement) \_\_\_\_\_

*Describe Behavior of the Animal* \_\_\_\_\_

How long did you observe the animal? \_\_\_\_\_ Distance from animal \_\_\_\_\_  
Optical aid used: None \_\_\_ Binoculars \_\_\_ Spotting scope \_\_\_ Other \_\_\_\_\_ Power of optics \_\_\_\_\_  
Photos taken? \_\_\_\_\_ May we make or have copies? Yes \_\_\_ No \_\_\_

*Exact Location* \_\_\_\_\_

Drainage \_\_\_\_\_ UTM \_\_\_\_\_ E \_\_\_\_\_ N Elevation \_\_\_\_\_

*Describe Surrounding Area (i.e. meadow, marsh, forest)* \_\_\_\_\_

Describe vegetation near animal \_\_\_\_\_

Describe animal size in relation to vegetation or other animals \_\_\_\_\_

Describe weather conditions (foggy, sunny, etc.) \_\_\_\_\_

Figure 16. Rare animal observation form for visitor reports of mountain goats in and around Yellowstone National Park, provided by U.S. National Park Service.

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