

STATUS OF INTRODUCED MOUNTAIN GOATS
IN THE EAGLES NEST WILDERNESS AREA,
COLORADO

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ABSTRACT

Mountain goats (Oreamnos americanus) were studied in the Eagles Nest Wilderness Area in Summit and Eagle Counties, Colorado, from June 8, 1977, to August 2, 1977, to determine population size, sex and age ratios, distribution, habitat utilization, mineral lick behavior, mortality, and interactions with predators, recreationists, and indigenous bighorn sheep (Ovis canadensis).

The minimum to maximum population of goats inhabiting the area was 77-110 goats. Sex and age ratios were 48 kids: 100 older animals, 57 kids and 18 yearlings: 100 adults, and 125 kids: 100 nannies. Summer distribution extended as far west as the West slope of Mt. Powell, as far north as the northern slope of Dora Mountain, and as far south and east as Slate Creek. This encompasses about 62.4 square kilometers within the Wilderness boundary.

Northern aspects were used in 56 per cent of the non-lick

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observations (n=50). Goats were observed within 0.4 kilometers of water in 80 per cent of the sightings. Observations of goats ranged in elevation from 3,414 meters to 3,840 meters. Grasses, sedges, and forbs comprised the vegetation type in 77 per cent of the accounts.

Mountain goats used mineral licks extensively. Soil analyses from two licks indicated that sodium was probably the attracting mineral while phosphorus was quite low. The dominance hierarchy at licks was, in decreasing order, nannies with kids, nannies, billies, and yearlings of either sex. Based on population estimates since introduction in 1966, the mountain goat population appears to be increasing exponentially.

INTRODUCTION

The Colorado Division of Wildlife introduced the Rocky Mountain goat (Oreamnos americanus) into Colorado in 1948 (Rutherford 1972). Since then, herds have been established in several areas of the state for consumptive and nonconsumptive use. Three male and five female mountain goats from South Dakota were transplanted into the Eagles Nest Welderness Area (then called the Gore Range-Eagles Nest Primitive Area) on June 13, 1968. This introduction was based on the migration of two billies into the range from either the Mt. Evans or Collegiate Range herds. Their persistence in the range indicated that the habitat was suitable for mountain goats. In 1970, one male and two females from British Columbia were released. The male was later found dead and another male from British Columbia was transplanted in

1971. During the summer of 1972, the Division of Wildlife released one male and four females from the Mt. Shavano herd in Colorado.

Bruce McCloskey, of the Colorado Division of Wildlife, sighted 53 different goats during a helicopter survey in 1976. The population was estimated at 75 mountain goats. Prior to the helicopter survey and this study, little was known about the dynamics and habitat utilization of this herd. There was some concern about the possibility of competition between the goats and bighorn sheep (Ovis canadensis) which have historically inhabited the Gore Range.

The Gore Range-Eagles Nest Primitive Area was designated the Eagles Nest Wilderness Area on July 12, 1976, and is managed under the Wilderness Act of September 3, 1964. Under the proposed management plan, non-indigenous species like the mountain goat may be allowed to maintain an equilibrium with carrying capacity provided that they are not detrimental to native species or the wilderness resource (USDA Forest Service, 1977).

The Colorado Division of Wildlife (1974) identified five problems in mountain goat management in the state:

1. There are not enough mountain goats to satisfy the demand for sport hunting.
2. Areas which should have mountain goats do not.
3. Existing mountain goat populations are not being maintained at proper levels.
4. Mountain goats may compete with bighorn sheep where they occur together.

5. Surplus mountain goats are not being harvested.

The demand for harvesting mountain goats exceeds the present supply. In 1976, 438 people applied for 48 licenses to harvest mountain goats in Colorado. This study area will be opened for mountain goat for the first time. Four permits will be issued for rifle hunting during the period from August 26 to October 9, 1978.

The primary objectives of this study were to (1) obtain minimum and maximum mountain goat population estimates, (2) estimate sex and age ratios for the population, (3) determine the summer goat distribution, (4) delineate habitat types frequented by goats, and (5) record information on mortality, mineral lick behavior, and interactions with predators, bighorn sheep, and recreationists. Data obtained during this study will assist both agencies in future management decisions.

This study was a cooperative project between the Dillon Ranger District of Arapaho National Forest, the Colorado Division of Wildlife, and the Department of Zoology and Physiology at the University of Wyoming. Support was provided by the Forest Service and the Division of Wildlife. We are grateful to personnel of both agencies, particularly Bruce McCloskey of the Colorado Division of Wildlife and Dennis Havig of the U.S. Forest Service for providing advice and logistical support. We also wish to thank Robert Keiss of the Colorado Division of Wildlife for the analysis of soil samples.

THE STUDY AREA

The study area is defined by the boundaries of the Eagles Nest Wilderness Area which contains the high peaks of the Gore Range. The Wilderness is located approximately 8 km. (5 miles) northeast of Vail, in Summit and Eagle Counties, Colorado (Figure 1). It encompasses 542 square km. (133,915 acres).

The range was formed by a Precambrian uplift of granite and gneisses and is characterized by a series of knife-edged peaks and ridges separated by deep glacial valleys (Tweto et al., 1970). Cirques, moraines, rock glaciers, and other glacial features dominate the topography. Maximum relief at the summit of Mt. Powell, 4,125 m. (13,534 ft.), to the Piney River, 2,393 m. (7,850 ft.), is approximately 1,737 m. (5,700 ft.). Annual precipitation varies from 51 cm. (20 in.) to over 102 cm. (40 in.) at higher elevations (mostly as snow) (U.S.D.A., Forest Service, 1977). Approximately one third (180 km.² or 44,640 acres) of the wilderness area is alpine tundra, craggy peaks, talus and boulder fields. This comprises the most suitable habitat for mountain goats.

Vegetation of the area varies with elevation. Dense stands of engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa) dominate the subalpine zone. Lodgepole pine (Pinus contorta) and aspen (Populus tremuloides) also occur. Treeline occurs at about 3,505 m (11,500 ft.). Above timberline, the spruce-fir become dwarfed and give rise to alpine vegetation such as bluegrasses (Poa spp.), tufted hairgrass (Deschampsia caespitosa), spiked trisetum (Trisetum spicatum), kobresia

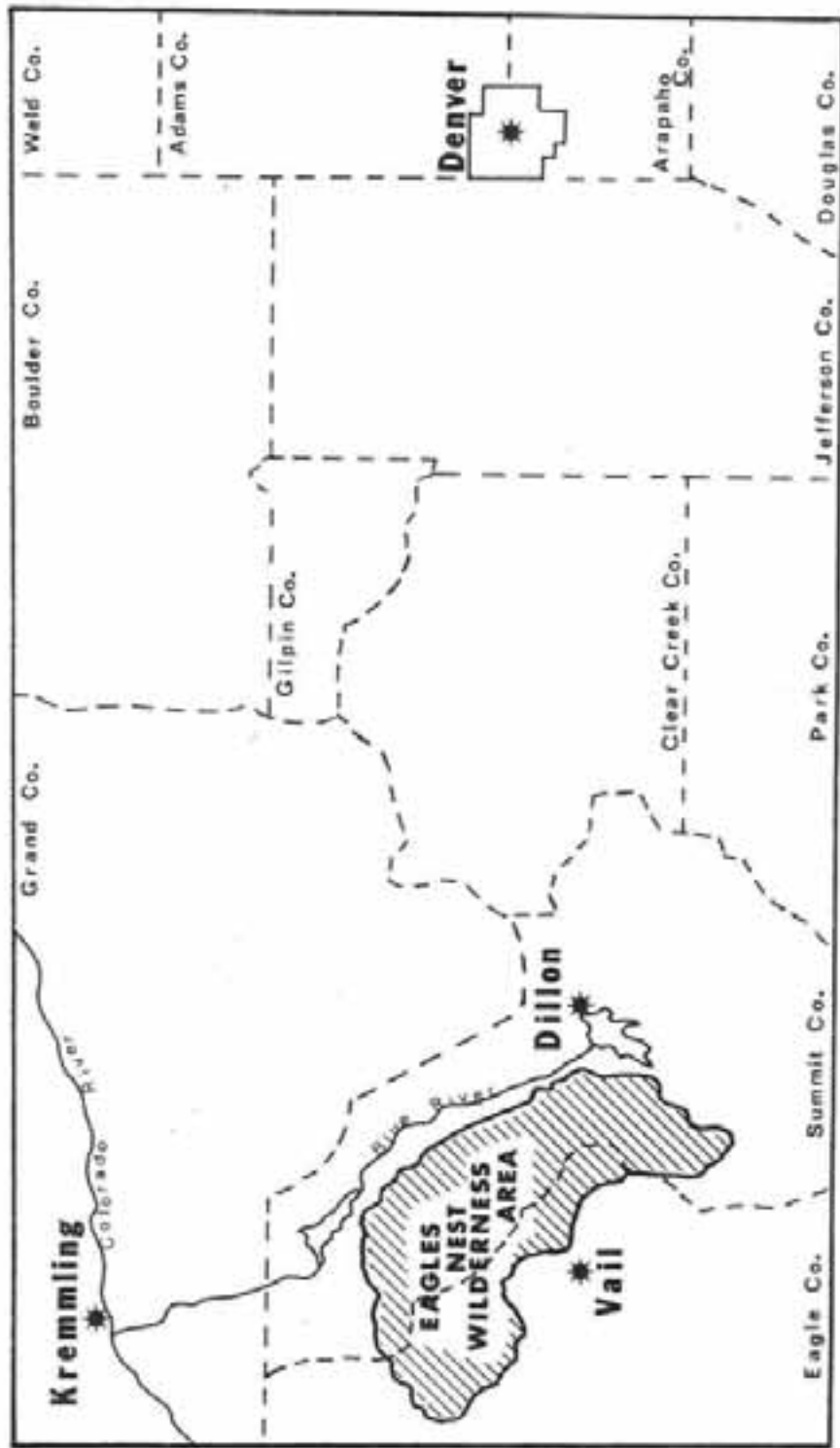


Figure 1. Map showing the location of the Eagles Nest Wilderness Study Area in relation to Denver, Colorado.

(Kobresia spp.), sedges (Carex spp.), and forbs such as alpine avens (Geum rossii), clovers (Trifolium dasyphyllum, T. nanum, T. parryi), green-leaved chiming bells (Mertensia viridis), mountain dryad (Dryas octopetala), and cinquefoil (Potentilla spp.). Willow (Salix spp.) and shrubby cinquefoil (Potentilla fruticosa) are the major shrubs in the alpine.

Three mineral licks occur on Dora Mountain where salt blocks were placed by Division of Wildlife personnel (Figure 2). The northeast licks, numbered one through three, northwest and southwest licks are designated by their positions on the mountain. None of the original salt is present aside from what has leached into the soil. Goats used these licks extensively and much of our research centered around them.

METHODS AND MATERIALS

From June 8 to August 9, 1977, approximately five days and four nights per week were spent in the field. We backpacked into most areas and established base camps. Over 384 km. (240 miles) were covered on foot.

Three flights were made over the area during the study. We flew on June 9 for orientation and preliminary observations using a Division of Wildlife single-engine plane. A Hughes 500C helicopter was used for census and classification flights on July 25 and 26.

Direct observations were aided by the use of 7 x 35 binoculars and a 20X spotting scope. Forms were used in the field to record observations of both mountain goats and bighorn sheep.

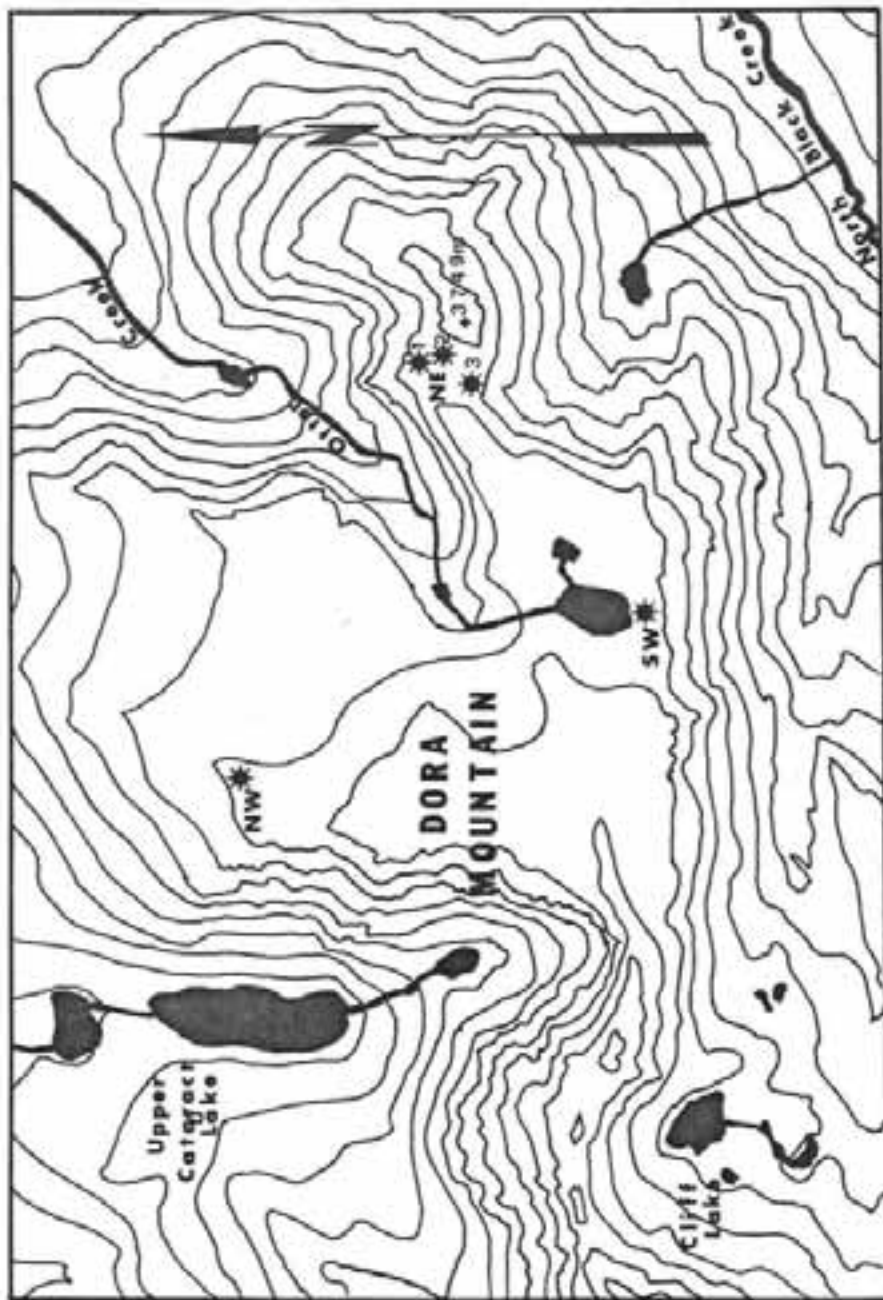


Figure 2. Map of the Dora Mountain area, Eagles Nest Wilderness, Arapaho National Forest, Summit County, Colorado. Asterisks indicate the locations of mineral licks used by mountain goats during the summer of 1977. Contour intervals are 61 m (200 ft.).

Observer, date, weather conditions, species, and time of day were noted. Codes were devised to facilitate recording information on location, elevation, vegetation, relative plant density, slope, substrate, aspect, proximity to water, classification by sex and age, and activity. Results were tabularized to determine the frequencies of occurrence.

Mountain goats were classified as adult males, adult females, yearlings, kids, unknown adults, and unknown subadults. Adults were considered to be animals two years old or older, while yearlings were considered to be animals between one and two years of age. Kids were considered as goats less than one year old. Unknown subadults were assumed to be less than two years old. Unknown adults, unknown sub-adults, yearlings, and kids were not classified by sex. Sex and age ratios were determined as kids: 100 older animals, kids and yearlings: 100 adults, and kids: 100 nannies. Sex determination followed criteria from Hibbs(1967).

We determined the estimate for the minimum population size as the highest number of goats observed without duplication. A maximum population estimate was based on observational data and accounted for the largest percentage of the population believed to have been overlooked. Locations of goats sighted were plotted on maps and recorded to quarter sections. The summer goat distribution was determined from the plotted goat locations.

Soil samples from all licks on Dora Mountain, as well as five meters away from licks, were collected for analysis of mineral composition. Twenty-four predator scats were gathered for determining whether or not mountain goats were consumed. Twenty-three fecal pellet samples were collected for determination of

endoparasites or food habits. All samples were taken to the Colorado Division of Wildlife Research Laboratory in Ft. Collins, Colorado, for analyses.

Additional notes and comments were recorded in a field notebook.

RESULTS AND DISCUSSION

Population Size

during the study, we classified 657 mountain goats from 93 observations including duplicate sightings. Approximately seven goats were seen per observation. Our highest one-day count without duplication was 44 goats. Our minimum population estimate was 77 which included 25 kids, 8 yearlings, 20 nannies, 8 billies, and 16 unknown adults. The maximum population size was estimated at 110 assuming 30 per cent of the population was overlooked. Based upon transplants (Rutherford, 1972) and population estimates for 1972 (Sandfort, 1973), 1976 (Bruce McCloskey, WCO, Colorado Division of Wildlife, Kremmling; personal communication), and 1977 (this study), the Gore Range goat population appears to be growing exponentially (Figure 3). The rate of increase for this herd is estimated at 30 per cent.

Sex and Age Ratios

Due to the difficulty of sexing goats, particularly at a distance, we feel our kid: older animal ratio of 48 : 100 to be the most reliable. Our kid and yearling : adult ratio was 57 and 18 : 100 which may be slightly biased by inadvertently class-

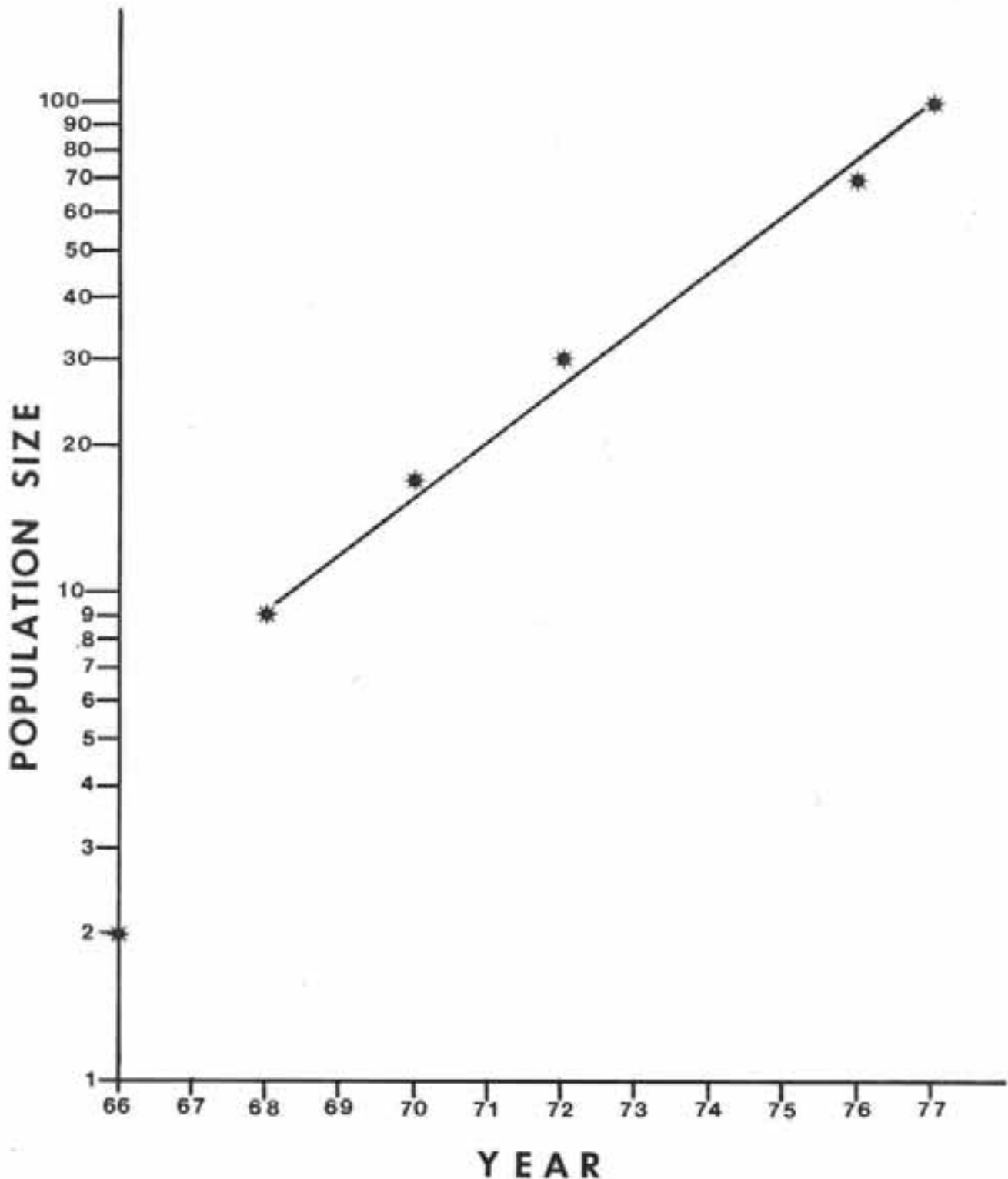


Figure 3. Graph showing the exponential growth of the mountain goat population in the Eagles Nest Wilderness Area, Colorado, based on population estimates from 1966 through 1977 (semi-logarithmic plot). In 1966, two billies were reported to occur in the area and were not believed to have contributed to the population growth prior to transplants which began in 1968.

ifying some yearlings as adults. We feel our calculated kid : nanny ratio of 125 : 100 under-represents nannies in the population based on the probable number classified as unknown adults. However, this value is within the range of values determined from other studies. Hibbs (1965) reported 150 kids : 100 nannies from the Collegiate Range in Colorado in 1963. Kid production in the Gore Range appeared to be high in 1977, possibly due to an unseasonably mild winter and lack of spring storms. Bailey *et al.*, (1977) found a negative correlation between age ratios and snow depth. Brandborg (1955) found kid production to vary with winter conditions undergone by pregnant females prior to parturition, and indicated that rainy weather may lower kid survivorship during their first weeks of life.

Distribution

The 1977 summer distribution of mountain goats in the Gore Range is similar to that reported for 1976 (Bruce McCloskey, Wildlife Conservation Officer, Kremmling; personal communication). The goat distribution extends North to Dora Mountain, West to Mt. Powell, and South and East to the South Fork of the Slate Creek drainage (Figure 4). The occurrence of goats in Slate Creek appears to be an extension of their range. Prior to 1976, mountain goats were not known to occur there (Rutherford 1972). The Gore Range goat population seems to be staying in the same general area in which the releases occurred. The mineral licks on Dora Mountain may be holding the goats in the area. The southeastern extension of the goat range may have resulted from the

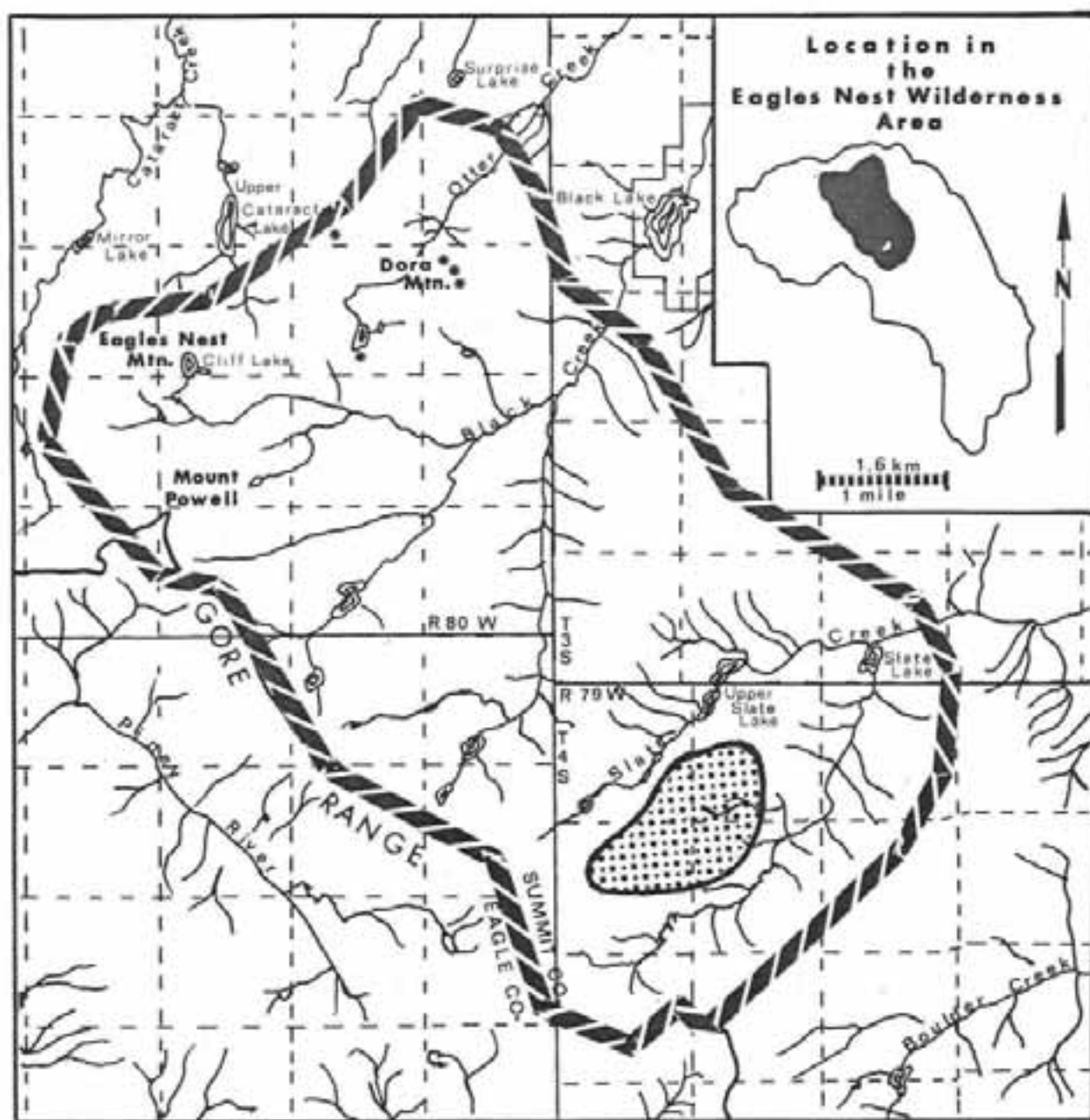


Figure 4. Summer 1977 distribution of mountain goats (broad line) and big-horn sheep (stippled area) in the Eagles Nest Wilderness Area, Colorado. Asterisks on Dora Mountain represent mineral lick localities.

use of salt blocks placed in Slate Creek. Goats have been reported to use these blocks (Dennis Havig, Range Conservationist, Arapaho National Forest; personal communication). Brandborg (1955) reported mountain goats traveling up to 24 km. (15 miles) to use licks. The 1977 goat distribution in the Eagles Nest Wilderness Area encompassed 62 km.² (24 sq. miles). Ninety-nine per cent of our mountain goat observations occurred on the Summit County side of the range. Bighorn sheep were observed within this distribution in the Slate Creek drainage (Figure 4).

Habitat Utilization

Mountain goats were observed using northern aspects in 56 per cent of the non-lick sightings. Observations at licks on Dora Mountain were excluded since these occurred on a flat summit with no particular aspect, and the influence of these licks biased the utilization of this area. North and north-east aspects accounted for 30 and 20 per cent of the observations, respectively. Eastern exposures were used in 42 per cent of the observations, while southern aspects received 26 per cent of the use. Western exposures received only 26 per cent of the use by goats. Low amounts of snowfall during the 1976-1977 winter may have accounted for an earlier use of northern aspects. Smith (1976) reported that the annual per cent utilization of southern aspects appeared to be dependent on snow depth.

Goats were observed within 0.4 km. ($\frac{1}{4}$ mile) of water in 80 per cent of our observations. Twenty-six per cent were within

100 m of water. It would be difficult for goats to get further from water, due to the topography of the range.

Mountain goats used slopes ranging from 0 to 80 degrees. Thirty-seven per cent of the observations occurred on slopes of 0 to 10 degrees, reflecting the flatness of Dora Mountain. Slopes of 50-60 degrees received 15 per cent of the use, while slopes greater than 60 degrees were used in 15.5 per cent of our sightings. Mountain goats were seen using cliffs 28 per cent of the time, surface-exposed rock (fellfields) in 29 per cent, and boulderfields in 34 per cent of the observations.

Mountain goats utilized herbaceous (graminoid-forb) areas most frequently, comprising 77 per cent of our observations. Sixty-two per cent of the sightings were in high density herbaceous vegetation. Willow and spruce-fir types each occurred in only 5.4 per cent of the observations (Table 1).

During the summer of 1977, goats occurred at elevations ranging from 3,414 m. (11,200 ft) to 3,841 m. (12,600 ft), a vertical span of 428 m. (1,400 ft). Fifty-eight per cent of our goat observations occurred from 3,658 m. (12,000 ft.) to 3,719 m. (12,200 ft).

Mortality

No mortalities were observed during the study. Various bones were found in parts of the study area but were felt to be from cervids or domestic stock. Analysis of 24 predator scats has not been completed.

TABLE 1. Per cent of Observations of Mountain Goats on Particular Vegetation Types in the Gore Range, Colorado, During Summer 1977.

Vegetation Type	Density	Number of Observations	Per Cent of Observations
Graminoid-forb (herbaceous)	High	58	62.4
	Medium	8	8.6
	Low	6	6.5
	Combined	72	77.4
Krummholz (dwarfed spruce- fir)	High	2	2.2
	Medium	8	8.6
	Low	2	2.2
	Combined	12	12.9
Barren	---	7	7.5
Willow	High	2	2.2
	Medium	3	3.2
	Low	0	0
	Combined	5	5.4
Spruce-fir	High	0	0
	Medium	2	2.2
	Low	3	3.2
	Combined		5.4

We observed only two interactions between predators and goats during the study, neither of which resulted in injury or death. On June 11, a golden eagle (Aquila chrysaetos) made a low pass over five goats near the northeast number three lick on

Dora Mountain. The goats ran down toward the Black Creek drainage. A coyote (Canis latrans) chased a group of five yearlings from the same lick on June 22. Three of the yearlings returned to the lick within 15 minutes after the encounter. In both instances, goats ran south-southwest toward an 80 degree slope near rock cover. In Idaho, Brandborg (1955) felt coyotes and eagles were relatively unimportant predators on mountain goats while cougars (Felis concolor) and bobcats (Lynx rufus) may have been important in more remote ranges. This is due to their ability to negotiate the same terrain as goats. Both mountain lions and bobcats are known to exist in the study area. Free-roaming dogs (Canis familiaris) from Vail and other surrounding areas might contribute to goat predation in the Gore Range.

Other potential sources of mortality such as parasites, disease, snowlides, and accidents were not investigated. Brandborg (1955) speculated that snow-slides probably accounted for more accidental deaths than any other natural cause. As mentioned previously, conditions related to winter severity influence kid production and survivorship. The hazards imposed by precipitous terrain characteristic of mountain goat habitats probably also contribute to mortality.

Salt Lick Behaviour

The Colorado Division of Wildlife placed three salt blocks on Dora Mountain to hold goats in that area (Bruce McCloskey, personal communication). Only the salt that has leached into the soil remains. In addition, a local rancher was reported to

have dropped salt blocks from a plane in 1976, one of which shattered on impact (Dennis Havig, personal communication). The number of goats utilizing these licks increased through mid-July with a gradual decline noticed in late July and early August. Additionally, the licks receiving the highest use changed from the northeast licks in June through mid-July to the southwest lick from mid-July on. The southwest lick appeared to be wetter than the northwest licks after mid-July. Singer (1975) found water seeping into licks was a major factor determining late summer use.

At these licks the goats had dug down into the mineral soil. One of these licks measured 178 cm. (70 lin.) by 217 cm. (85.4 in.) wide by 48 cm. (17.4 in.) deep. Two other licks measured 308 cm. (121.3 in.) by 3.8 cm. (125.2 in.) by 42 cm. (16.5 in.) deep and 408 cm. (160.6 in.) by 181 cm. (71.3 in.) by 44 cm. (17.3 in.) deep. Goats have trampled the vegetation around these licks. Trails occur along the southeast rim of Dora Mountain above Black Creek, between licks and along slopes.

The results of two soil samples from different licks show that both were low in phosphorus (0.01 % and 0.03 %) while sodium was believed to be the attracting element (0.45 ppm and 0.7 ppm) (Robert Keiss, Colorado Division of Wildlife, personal communication.) Stockstad *et al.*, (1953) found sodium compounds were preferred by ruminants from mineral cafeteria and soil impregnation tests. Because of the affinity of goats to lick, these licks provided an ideal place to observe behavior.

Particular parts of the licks were used by more dominant

animals. Subdominants often had to wait until the dominant animals had left the licks in order to use them. The social hierarchy at licks was found to be nannies with kids, nannies, billies, and yearlings in order of decreasing dominance. This differs with other reports where yearlings were ranked above billies (Hibbs et al., 1969) and where billies ranked highest (Singer, 1975).

Vocalizations were most frequently heard from kids separated from nannies. Bleats by adults of both sexes were heard at the licks. One nanny bleated while apparently searching for her kid which she later joined. One goat was observed flicking its tongue in and out while making a bleat-like sound. This tongue motion may have been due to excitement (Geist, 1964).

Mounting attempts were observed by goats of all age classes including kids. Rush-threats and horn-threats as described by Geist (1964) were the main types of agonistic behavior exhibited by goats at the licks.

In the licks, goats were observed eating and pawing the soil. We could hear the abrasive sounds of animals chewing the soil from over 30 m. (100 ft.) away. Although fecal pellet samples have not been analyzed, some of the pellets appeared to be composed entirely of inorganic soil. Only one observation was made of a goat drinking from open water.

There are three main dustbathing areas on Dora Mountain. These erosion sites appear to have been started as marmot (Marmota flaviventris) dens. Mountain goats were observed rolling and laying in these sites. These animals would lay upright in the

soil, kicking dirt on their sides with their forelegs. This behavior is believed to relieve irritations under their long, dense pelage including that from ectoparasites (Brandborg, 1955; Geist, 1971). Goats were also observed scratching their heads and necks with their hindlimbs. They seemed to be quite adept at this, and not clumsy as reported by Geist (1971).

Reaction to Recreationists

We observed few encounters between recreationists and mountain goats. Where people were observed on Dora Mountain above Upper Cataract lake, no goats were sighted although hair and pellet groups were found in that area. On one occasion a couple backpacking on Dora Mountain visited the lick by the lake. One of them said he got to within 21.3 m. (70 ft.) of the goats at this lick before they flushed. That evening, none of the goats had returned to any of the licks. This couple had camped on the north ridge of Dora Mountain above the head of Otter Creek Canyon. Prior to their departure over the north side of the mountain, eight goats were spotted 150 m. (164 yds.) east of their camp on the north ridge behind a boulder field. As the people left, the goats moved southwest toward the head of the drainage near where the two had camped.

On occasion, goats came within 4.6 m. (15 ft.) of the authors out of curiosity. Tail erection (Brandborg, 1955) was commonly observed when we approached too closely to the goats.

Interaction with Bighorn Sheep

No interactions between bighorn sheep and mountain goats were observed, although both species occurred in the Slate Creek drainage. On July 25, 1977, six mountain goats and one bighorn ram were spotted in this drainage from the helicopter. The next day, 16 bighorn sheep, including five lambs, were seen there. This area has been used as winter range by the sheep (Bear and Jones 1973). According to Bear and Jones (1973), the bighorn population in the Gore Range has declined since 1947 but has appeared to be stable since 1970. Mountain goats were considered to be too few in number (about 10) to offer much competition. Figure 4 shows the known 1977 summer distributions of mountain goats and bighorn sheep in the Gore Range. Sheep may also occur in other drainages but were not observed elsewhere during this study. Obviously further study is needed.

CONCLUSIONS AND RECOMMENDATIONS

Further research on mountain goats in the Eagles Nest Wilderness Area is needed. If the population is indeed growing exponentially, it would be necessary to determine the carrying capacity of the habitat and to predict at what population density the population will stabilize. Continued study may reveal whether or not the licks continue to hold the goats in their present distribution or whether the goats expand into surrounding suitable habitat. The effects of harvesting on population growth, distribution, and age ratios should be observed. Whether or not harvesting is compensatory or additional as observed by Kuck (1976)

in Idaho remains to be seen for this herd. Winter distribution and habitat utilization should be assessed as well as the effects of snow depth and persistence on kid production and survival. In addition to continued mountain goat inventories, comprehensive information on the seasonal distribution and habitat utilization of the bighorn sheep in the Gore Range is necessary for evaluating the effects of goats on sheep habitat. This goat herd might be an acceptable population on which to develop and test computer-simulated population models useful in the management of this species.

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