

MOUNTAIN GOAT STATUS, BLACK HILLS, SOUTH DAKOTA

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Abstract: An apparent decline in population of Rocky Mountain Goats (Oreamnos americanus) within the Black Hills, South Dakota dictated a baseline study to determine population numbers, dynamics and habitat use. From 1983 through 1987, 48 marked and/or radio-collared mountain goats were monitored. Home range for adult males averaged 29 km². Adult female home range averaged 5 km². Use of granite outcroppings demonstrated seasonal preference ranging from 99% use during winter to 74% during fall. Time spent off granite outcroppings was primarily feeding in open slopes, meadows, clear-cuts, and riparian areas. Age specific natality representing 41 female goat-years productivity varied from 0% for 2-year-olds to 68% for 5-or-more-year-olds. Documented kid production remained stable during 1983, 1984, 1985, but increased 30% during 1986. During study duration, yearly mortality estimates were 14% for 1+ year-old adults. Known kid mortality ranged from 40% to 20% for the same time period. Population estimates indicated a stable to slightly increasing population. Findings suggest highly fluctuating reproductive rates and annual kid mortality, mandating conservative harvest strategies.

A small population of Rocky Mountain Goats (Oreamnos americanus) exists within the Black Hills of South Dakota. However, they are not indigenous to the state. In 1924, Custer State Park obtained 6 animals from Alberta, Canada. The first night, 2 escaped a holding enclosure, and by 1929, all remaining goats had escaped (Richardson 1971). By the late 1940's an estimated population of 300-400 goats inhabited granite outcroppings around Harney Peak (Hanson 1949), an area approximately 12 km (10 mi) northwest of Custer State Park.

Population numbers remained stable from the 1940's through early 1970's (Cruse 1959, Richardson 1971). Occupied range was 13,000 ha (32,000 ac) with a primary range of 800 ha (2,000 ac). Richardson (1971) reported kid/adult ratios ranging from 23/100 in 1950 to 39/100 in 1967. He felt annual mortality was low for all age classes.

Richardson and Blankenship (1967) reported overutilization of available forage on primary goat range within the Black Hills by late 1960's. Overutilization of available forage by mountain goats is difficult to assess since no preference is shown for a particular plant species; one must consider all plants within their habitat (Chadwick 1983). However, lack of logging or thinning since 1956 (Theron Schenck, Forest Biologist, United States Forest Service, Custer, pers. comm.)

and/or natural fire have allowed pine encroachment into areas that would normally provide mountain goats with needed forage. At present canopy closure within the area averages 70% (Edward Johnson, Silviculturist, United States Forest Service, Custer, pers. comm.) and is expected to increase in future years, therefore, decreasing present available forage.

Human-mountain goat interactions have increased substantially since periods of stable population numbers. In December, 1980, the area surrounding Harney Peak was designated the Black Elk Wilderness Area which included most of the primary range of mountain goats. Currently, there are approximately 18 km (11 mi) of trails within the wilderness area, and an additional 41 km (25 mi) of trails in surrounding Norbeck Wildlife Preserve.

Hunting seasons with limited permits were initiated in 1967. No licenses were issued in 1972, 1974, 1975, 1982, 1983 and 1984. Hunter success averaged over 90% with a harvest of 134 billies and 102 nannies. Most of the harvest occurred on historic primary range. However, harvest from 1976 through 1981 indicated more pressure on secondary range (Fig. 1). This may have been due to population declines on primary range. In addition, from 1960 through 1968, 43 animals were removed from the population for transplanting to other states.

Prior to 1980, management surveys were limited to yearly population count from horseback. During 1980 and 1981, hunter input indicated a substantial decline in goat numbers may have occurred. Organized surveys in 1981 and 1982 using simultaneous ground and air observations confirmed the decline.

Severity and time of decline are unknown due to the absence of baseline data. The last comprehensive population study was conducted by Richardson (1971). Speculation on causes of the decline were numerous: increased natural mortality, overutilization of available habitat, human-mountain goat interactions, and/or overharvest of population.

Richardson (1971) reported low annual mortality during periods of a stable mountain goat population. However, several authors have indicated that winter mortality may affect overall population levels. Majority of annual mortality for all age groups occurs during winter months (Casebier et al. 1950). Nichols (1980) reported 42% kid mortality and 27% yearling mortality during winter in Alaska. Anderson (1940) reported a 20-80% kid mortality depending on winter conditions in Washington state. In Colordao, Adam and Bailey (1982) felt that reproductive success of mountain goats was negatively correlated with depths of spring snow. Highly fluctuating reproductive and mortality rates have been reported for mountain goats in coastal "ecotypes" in both Alaska and Canada (Smith 1984, Hebert and Smith 1986).

Joslin (1980, 1982) felt that uncontrolled and intensive activities in mountain goat range had detrimental affects in Montana. She recommended elimination of human interference in mountain goat winter, nursery and breeding areas. However, Bergman (1984) indicated human and mountain goat interactions had no observable effects on mountain goat

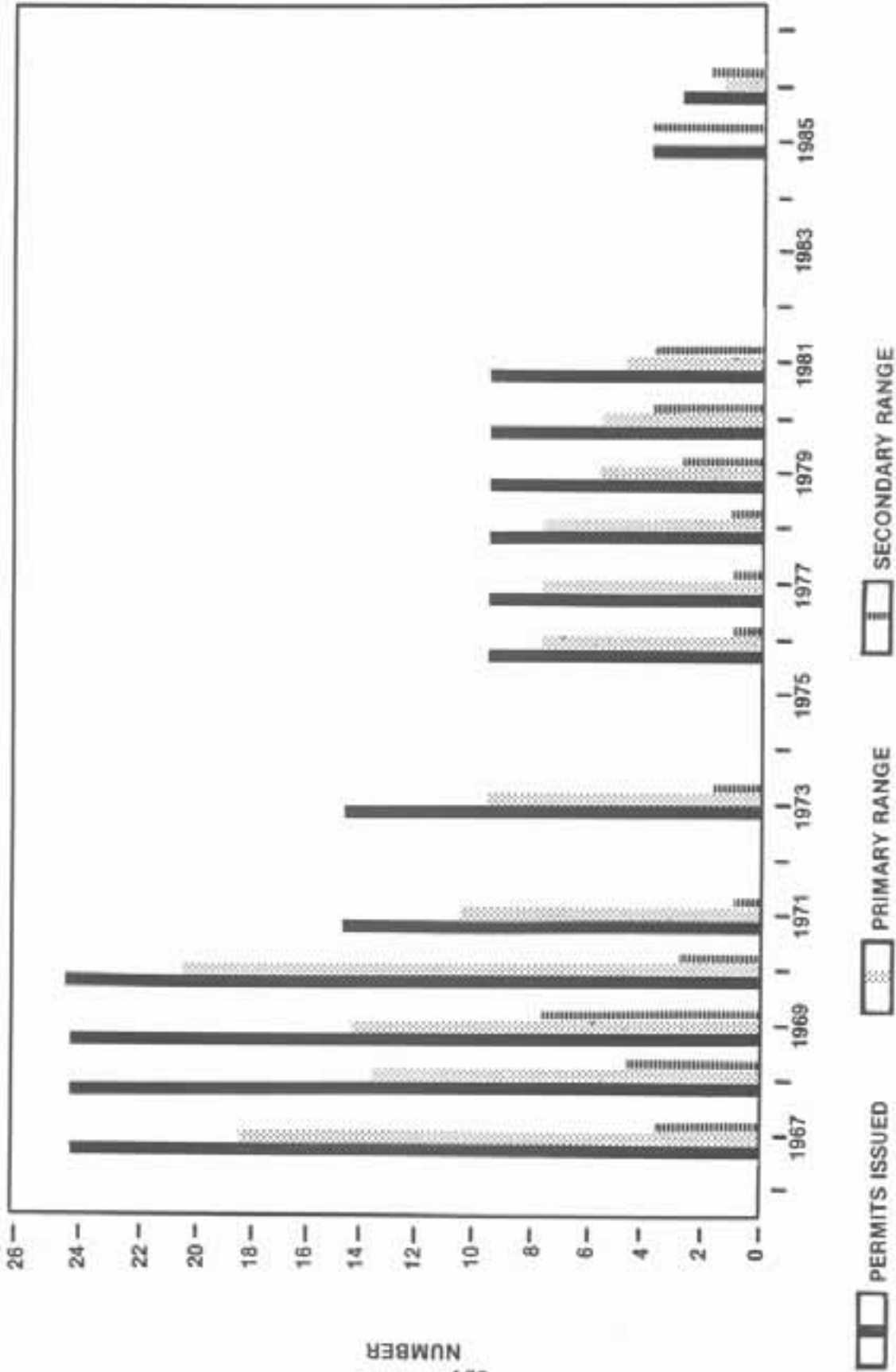


Figure 1. Mountain goat harvest, 1967-1986

populations. Yet, apparent decline in Black Hills mountain goats coincided with increased human activity in the primary range.

Coinciding with increased human activity, removal for transplant programs coupled with hunter harvest in primary range from 1967 through 1978 may indicate that overharvest occurred. This in turn could have caused subsequent overharvest during the 1980's even though license numbers were reduced. Kuck (1977) reported overharvesting may have caused declines in mountain goat populations of Idaho and hunting should be considered an added mortality factor with no compensating increases in reproduction or in forage utilization. Both Kuck (1977) and Chadwick (1983) felt mountain goats were self-regulating and that standard reasoning for harvesting animals did not hold true. Adams and Bailey (1982) determined that a population could be harvested if harvest level was below 7.5% of the population. Mountain goat females learn home range from their mother (Chadwick 1983). If a nannie is harvested in a particular area, then the process of passing that home range on to future female offspring is eliminated. Furthermore, Nichols (Lyman Nichols, Wildlife Biologist, Alaska Dept. Fish and Game pers. comm.) believed that if a nannie was harvested in fall, her kid may not survive the winter. However, Swenson (1986) felt that reproduction of a Montana population was density dependant and that an increase in harvest may increase kid production.

Whatever the cause(s) of decline in mountain goat numbers in the Black Hills, proper management dictated that baseline data be collected. Population dynamics were virtual unknowns. Mortality estimates, reproductive rates, and habitat use needed to be determined before proper management of the species could be accomplished. The objectives of this study were to determine population numbers, dynamics and habitat use of Rocky Mountain goats in the Black Hills, South Dakota.

STUDY AREA

The study area encompassed the Black Elk Wilderness and immediate surrounding areas consisting of approximately 13,000 ha (32,000 ac) within the Black Hills National Forest (Fig. 2). Elevations within the area range from 1,515 m (5,000 ft) to 2,195 m (7,242 ft).

The Black Elk Wilderness is characterized by numerous granite outcroppings rising from Ponderosa pine (Pinus ponderosa) forests with occasional open ridges and meadows. Geomorphic features of the granite outcroppings are comprised of a variety of caves, crevasses, and horizontal shelves. Vegetation types found on the granite outcroppings are primarily Ponderosa pine associations: 1) Ponderosa-bearberry (A. uva-ursi), 2) Ponderosa-grass, forbs, and 3) Ponderosa-browse, grass.

METHODS

Forty-eight mountain goats were captured and released during 1983 and 1984. Nineteen adult females, 9 adult males, 4 yearling females, 7 yearling males, 2 female kids, and 7 male kids were marked with livestock ear tags and/or fitted with radio-collars. Capture was accomplished with clover traps baited with salt or with the use of a hand held net gun from

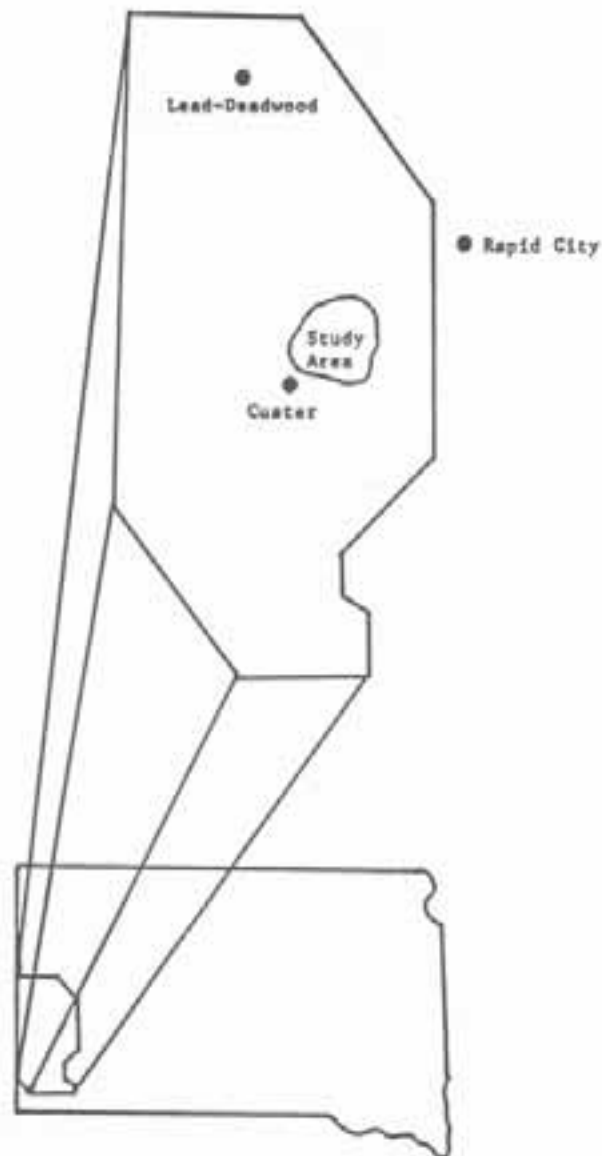


Figure 2. Mountain goat study area, Black Hills, South Dakota.

the ground. Animals were captured at five different locations covering the entire mountain goat habitat.

Daily/seasonal movement and home range were determined from 1,052 radio locations and 658 observation of marked animals. Preferred habitat was determined using 1,128 observations of marked and unmarked animals. Population dynamics were calculated using 658 observation of marked mountain goats. Population estimates employing mark-recapture methodology (Standard Lincoln index) were calculated using 1,598 observations. Study was conducted from January 1983, through November, 1986. Data collection was conducted on the ground and occurred year-round averaging three days per week.

RESULTS

Home Range

Marked differences in home range size between adult billies and nannie groups or single nannies was documented. The largest adult billy home range was approximately 29 km² (11 mi²) whereas single nannies or nannie/kid groups averaged 5 km² (2 mi²). Adult billy home range expanded during successive years. In contrast, nannies and nannie/kid groups did not increase home range during study duration and demonstrated a fidelity to their home range. Seven nannie group areas were identified and mapped within the mountain goat range. Each area was used by a combination of all nannie/nannie groups established within that area, and was usually separated from another by an expanse of ponderosa forest with a lack of major granite outcroppings. Entire home range was utilized by both sexes throughout the year with no discernible seasonal movement except for brief periods during weather extremes.

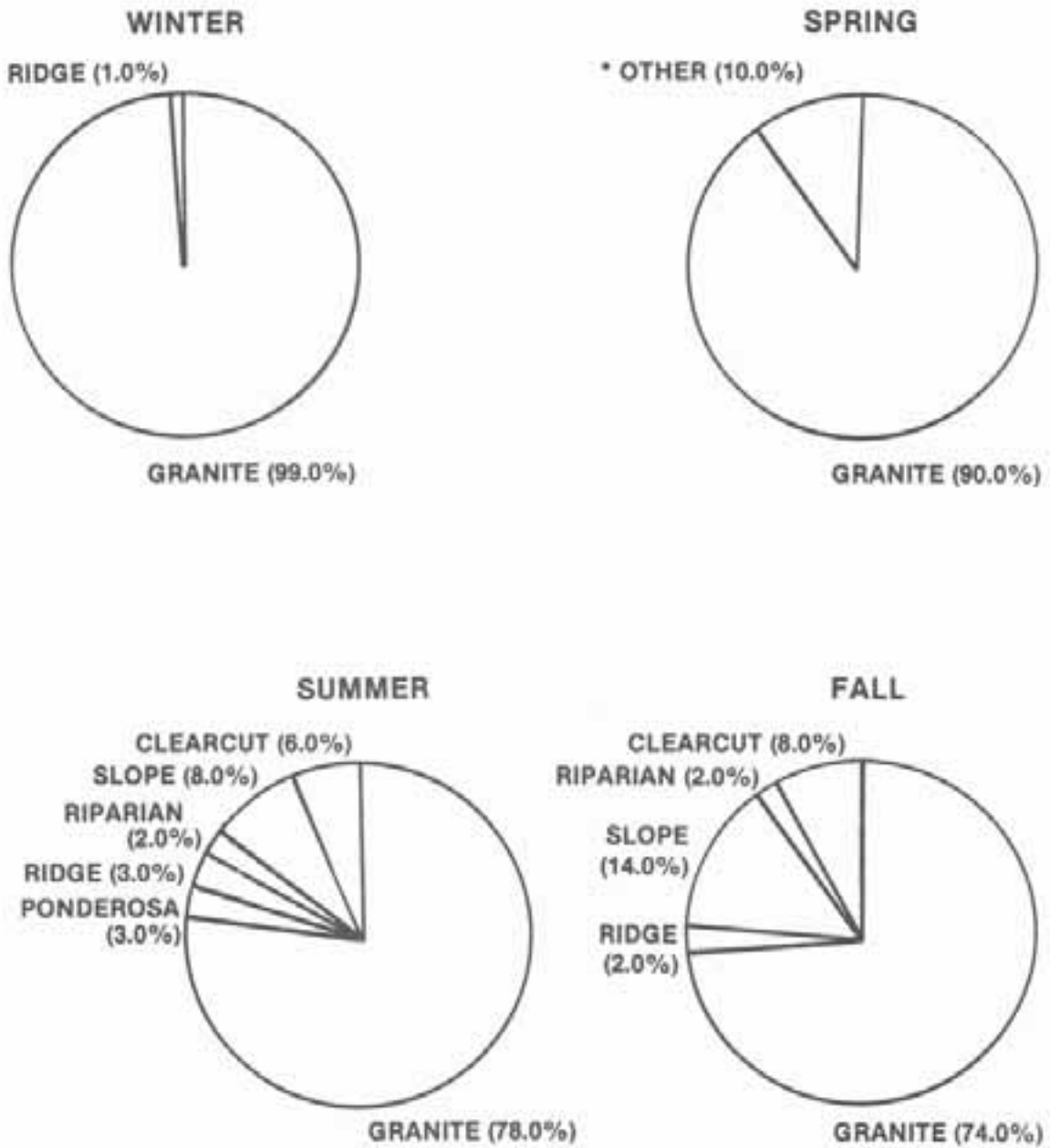
During kidding season (May-June), movement for parturient nannies ceased. Activity was closely associated with kidding areas which were large granite outcroppings. Sufficient soil formation had occurred on the outcroppings for some forage production on flat areas and crevasses. Forage present included trees, shrubs, grasses, forbs, and lichens. There were also shallow depressions on granite surfaces near or on the summit that captured and held water. Most outcroppings provided south-facing aspects for loafing in early morning hours and shade on north faces or crevices during heat of day. These outcroppings provided kidding nannies with all life requirements (Rice and Benzon 1985).

Kidding sites were mapped for radio-collared nannies in 1985 and 1986. During 1985, 6 radio-collared nannies gave birth. Three of these gave birth the following year in 1986. Of these, only one returned to the same granite outcropping used in 1985. Sample size was small, however, this may indicate that mountain goats do not have traditional kidding sites that are used in consecutive years.

Habitat Use

Habitat use by mountain goats was primarily associated with the many granite outcroppings within home range. Seasonal preference for outcropping use vary with 99% use during winter, 90% during spring, 78% during summer and 74% during fall (Fig. 3).

Use of granite outcroppings during winter (99%) and spring (90%), clearly demonstrated the dependance of mountain goats on the various ecotypes within the outcroppings. Ponderosa-bearberry ecotype was the most utilized for forage during winter (43%). However, during other seasons Ponderosa-grass and forbs was the most consistently preferred ecotype for foraging: 24% in spring; 23% in summer; and 34% in fall. Due to limited amount of forage on the outcroppings, and probably over-utilization during winter and spring, mountain goats increased use of other habitat types for foraging in summer and fall. During fall mountain goats spent the largest percent of time foraging in habitats other than outcroppings (26%). It was assumed that it is during the fall season that



* slope (1%), clearcut (2%), ponderosa (2%), Riparian (2%), ridge (3%)

Figure 3. Mountain goat habitat, use by season, 1983-1986

mountain goats must store enough body fat to survive the rigors of winter months on the granite outcroppings.

Off-granite feeding patterns were still associated with outcroppings but distance traveled varied with season. During spring, goats foraged within 50 meters of a granite outcropping 69% of the time and within 50-100 meters the remaining 31%. Summer feeding observations varied from 65% within 50 meters; 28% from 50-100 meters; and 7% greater than 100 meters. Fall feeding patterns had the largest disassociation with granite outcroppings during intense feeding periods with 49% within 50 meters; 32% from 50-100 meters; and 19% greater than 100 meters. Summer and fall habitat use observations clearly showed the need for forage within close proximity of granite outcroppings. Foraging was primarily spent in open slopes, meadows, or clearcuts (Fig. 3).

Slope preference.--Habitat use on granite outcroppings also showed seasonal slope exposure preference (Fig. 4). North facing slopes were used during spring (6%), summer (9%), and fall (3%) for thermal cover and foraging; no use was observed during winter, probably due to temperature and snow depth. Combined summit and south facing slope use during winter (67%), spring (60%), and fall (68%) was for snow-free foraging areas and loafing. Lower summer use (39%) was probably due to avoidance of intense mid day heat. Largest percent of time spent on granite during summer was west aspect (34%). Percent of time goats spent on top of exposed granite averaged 32% throughout the year.

Population Dynamics

Reproduction.--Reproductive history was documented for 23 marked female mountain goats in 1985 and 1986 (Table 1). It must be noted that observations were conducted during entire summer season and a nannie could have produced a kid that died prior to observation. Therefore, reported reproductive rates are minimal and based on a small sample size.

Age specific natality for 1985 and 1986 resulted in a sharp difference between age of first parturition for Black Hills nannies. The initial year's data indicated that first parturition was 4 years of age (Rice and Benzon 1985, Benzon and Rice 1986). During 1986, 2 of 3 marked 3-year-old nannies were documented to give birth (Table 1). Richardson (1971) documented frequent reproduction by 2-year-old nannies of the same population in the late 1960's. Chadwick (1983) reported that goats introduced into areas of unutilized forage had first parturition at 2 years but stabilization of populations resulted in reproduction at 3 years. Smith (1984) found 38% reproduction for 2-year-old nannies, 64% for 3-year-olds, 60% for 4-year-olds, and 100% for 5-or-more-year-old nannies in a mountain goat population in "coastal ecotype". Joslin (1980) felt stable populations exhibited first parturition at 3 years of age. Nichols (1982) reported first parturition at 4 years of age for a population without minor fluctuations. Combined age specific natality for marked Black Hills nannies during 1985 and 1986 representing 41 female goat-years' productivity, resulted in 0% reproduction for 2-year-olds, 25% for 3-year-olds, 78% for 4-year-olds, and 68% for 5-or-more-year old nannies (Table 2).

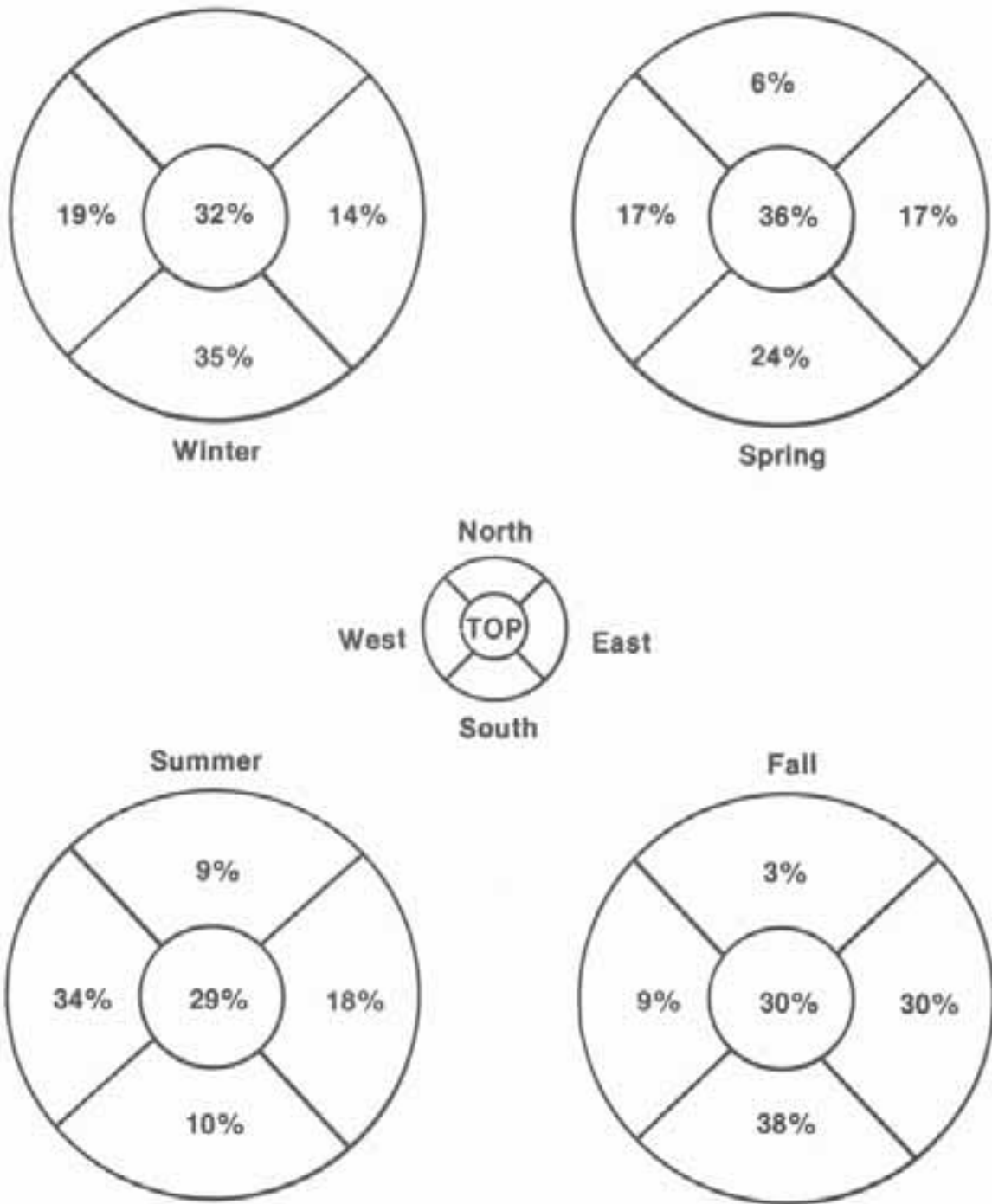


Figure 4. Mountain goat slope preference on granite outcropping by season, 1983-1986

Table 1. Reproductive history of mountain goats in the Black Hills.

Area	Number	Age	1985		1986	
			Kid Observed	Age	Kid Observed	Age
Rushmore	BK#1	6	yes	7	yes	
	BK#4	4	yes	5	yes	
	BK#6	3	no	4	yes	
	BK#7	6	yes	7	yes	
	BK#8	6	yes	7	no	
	BK#9	3	no	4	no	
Bear Bulch	R#1	9	yes	10	yes	
	R#2	2	no	3	no	
	R#4	2	no	3	yes	
	R#5	6	yes	7	yes	
	R#6	4	yes	5	no	
Cathedral Spires	B#1	4	no	5	no	
	B#2	2	no	3	yes	
	B#6	6	no	7	yes	
Needles	G#4	6	unknown	7	no	
	G#6	4	yes	5	yes	
	G#8	3	no	4	yes	
	G#9	9	yes	Dead		
	G#13	3	no	4	yes	
	G#15	1	unknown	2	no	
	G#18	4	yes	5	unknown	
	G#20	3	no	4	unknown	
	G#21	8	unknown	9	no	

Table 2. Age specific natality for marked female mountain goats, 1985-1986.

Age Size	% Natality ^a	Sample
	1985	
1	Unknown	1
2	0	3
3	0	5
4	80	5
5+	86	7
	1986	
1	0	0
2	0	1
3	67	3
4	75	4
5+b	58	12
	<u>Combined 1985 and 1986</u>	
1	Unknown	1
2	0	4
3	25	8
3	78	9
5+b	68	19

^a Based on observations during summer months

^b Oldest female giving birth was 10 years of age

Documented kid production for both marked and unmarked goats the over entire range remained stable during 1983, 1984 and 1985, however, an increase of approximately 30% was recorded for 1986 (Fig. 5). This increase may be due to an increased number of nannies maturing to reproductive age, plus documented parturition of 3-year-olds.

Samples from trapped goats during 1983 showed 22% of population was kids. Winter census counts indicated 20% of the population was kids. In 1984, 14% of all animals trapped were kids while census counts determined 20% was kids. Census counts for 1985 recorded 28% kids, and 24% in 1986. Disparity between documented kid production and results of census counts was attributed to low observability of mountain goats due to high canopy closure within mountain goat range.

Mortality rates.--Mortality rates were estimated using 3 different samples: 1) age at capture, 2) observations of marked animals, and 3) census counts. Time specific life tables calculated for combined sex, yearling + age classes for 1983 was 24% annual Qx; 1984 captures resulted in a 33% yearling + annual mortality. Combined age structures for both years resulted in a 28% annual yearling + mortality. This was based on capture results, which may not reflect true population age structures

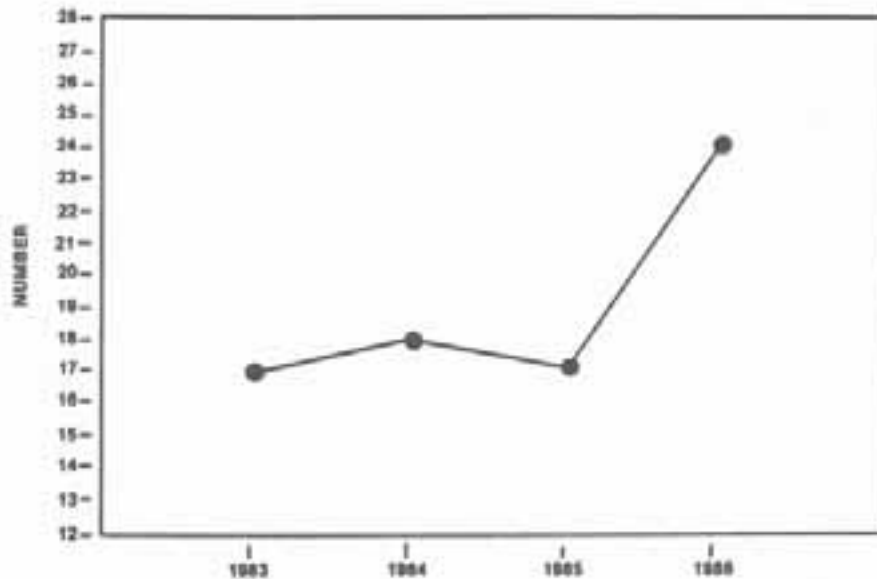


Figure 5. Documented mountain goat kid production, 1983-1986

(Rice and Benzon 1985). It must be emphasized that time specific life table methodology assumes an age stable, stationary population. It was suspected that mountain goat numbers were slightly increasing, therefore, mortality rates would be overestimated using this methodology.

Observations of the 26 mountain goats marked in 1983 indicated a 23% mortality rate over a 3 year period (average of 8% per year). Mountain goats marked in 1984 had a 40% mortality rate over a 2 year period for 20% average annual mortality. The 2 groups combined had 14% annual mortality. These estimates are based on several assumption: 1) an animal not observed during the period of January to October, 1986, was dead, 2) all age classes and sexes of mountain goats are equally observable, and 3) mortality rates were equal between years; therefore, estimates would be maximum mortality. During the study period, January, 1983 through November, 1986, one marked nannie was found dead. An additional 2 marked nannies were found dead after study was concluded.

Kid mortality was estimated using 2 methods: 1) ground census counts, and 2) radio telemetry of kid-bearing nannies. Census counts of kid/adult ratios during November through May were compared to yearling/adult ratios from June through October for 1984 and 1985 kid populations. Data indicated a 66% annual kid mortality for 1984 and 10% for 1985. Radio-telemetry results showed 40% kid mortality during 1984, 33% during 1985, and 20% during 1986 (Fig. 6). Kid mortality for kid-bearing radio-collared nannies occurred during mid-summer and early fall and kid/adult census counts were conducted during winter and spring. Again the high degree of variability between census and telemetry methodology may be due to limited observability due to canopy cover.

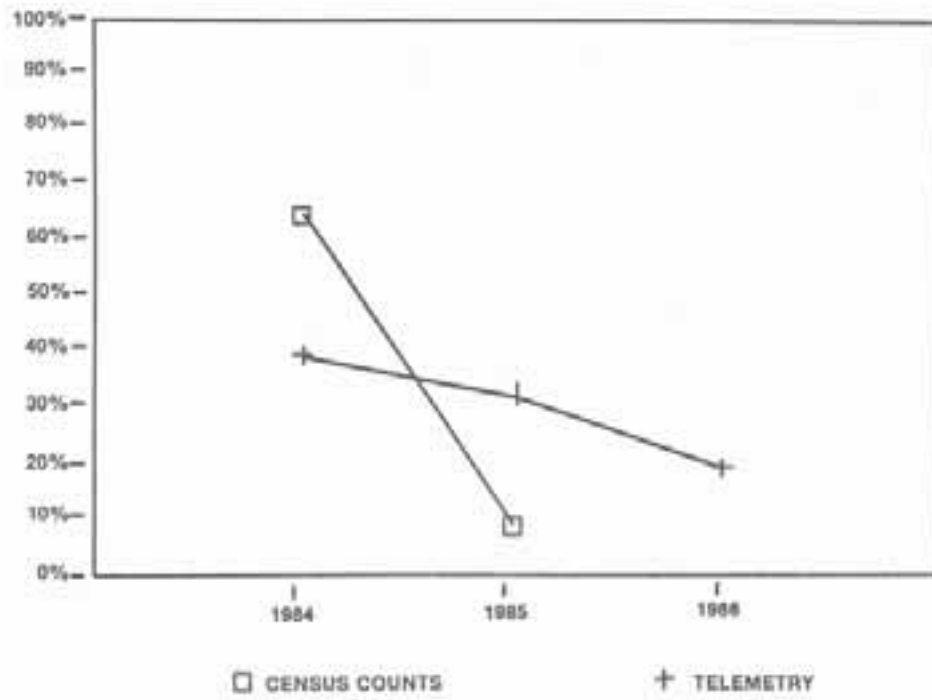
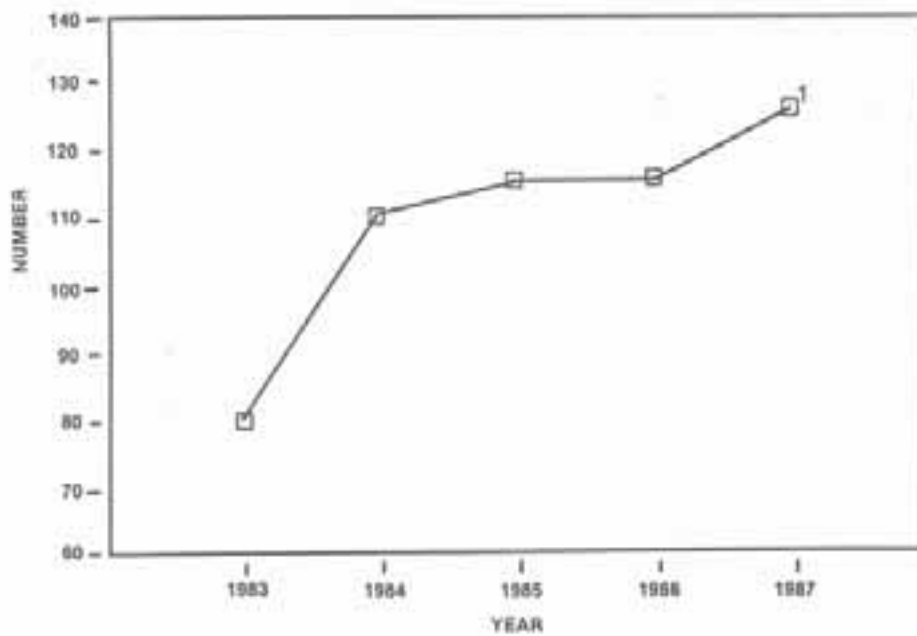


Figure 6. Mountain goat kid mortality, 1984-1986



¹ 1987 estimate is based on annual mortality for 1986 population.

Figure 7. Mountain goat pre-kidding population estimates, 1983-1987

Population Estimates

Estimates placed the mountain goat pre-kidding population at 80 animals in 1983 and 110 in 1984. These estimates were calculated from observations of separate groups of unmarked animals and were subject to a high degree of variability.

Subsequent population estimates were determined by using mark-recapture methodology (i.e., observation of a marked and/or unmarked animal).

Calculations resulted in an estimated pre-kidding population of 115 (SE=+20) in both 1985 and 1986. After the 1986 kidding season, population estimates were 150 (SE=+22) animals. Estimated kid mortality of 20%, and yearling + mortality of 14%, placed pre-kidding 1987 population estimates at 125 (Fig. 7).

CONCLUSION AND MANAGEMENT RECOMMENDATIONS

Movement and Preferred Habitat Use

Marked differences in home range size between adult billies and nannie/nannie groups were documented. While billies increased their home range during successive years, nannie/nannie groups demonstrated fidelity to a specific area. Management of the herd should focus on the 7 nannie/nannie group areas identified. Habitat improvement in any 1 of the 7 areas would definitely increase forage production for that specific group of nannies, however, this would not impact the entire herd as a whole. Habitat use results clearly demonstrated a need for habitat improvement either by clear-cutting or fire, however, improvements should be made within each nannie group area to benefit the entire herd.

Observation of marked animals showed nannie kids establish home ranges within the same nannie group area as their parents. Therefore, density of mountain goats for each nannie group area was different and could fluctuate according to habitat improvement, reproductive success, and natural or hunting mortality. Nannie harvest should be evaluated for specific areas of kill, and harvest recommendations should reflect the loss of reproductive nannies either by lowering permits issued, or recommending that hunters avoid that specific area.

Human activity within a specific nannie group area could also impact that specific group. During kidding season (May - June), nannies select large granite outcropping and generally remain there for 2-to-3 weeks after giving birth. This is a critical period for newborn kids, and human activity could cause nannies to leave the outcropping increasing the likelihood of kid mortality. Since nannies did not demonstrate traditional kidding site behavior, then any granite outcropping should be considered a possible kidding site and recreational use plans should avoid major outcroppings.

Population Dynamics

Increase in estimated population numbers of 80 in 1983 to 125 by

1987 may reflect both documented decrease in kid mortality and increase in kid production during 1986. Adult mortality appeared to be stable (14%) over the study duration suggesting kid production and survivorship as the crucial factor determining population trend. Determining annual kid mortality would prove too costly for management purposes, leaving kid production as the most reliable method of determining herd status.

Stable kid production during 1983, 1984, and 1985 with an increase of 30% during 1986, combined with a lower age at first parturition during 1986 suggests a possible fluctuating reproductive rate for Black Hills mountain goats, at least for certain years. As with mountain goats in "coastal ecotypes", reproductive rates could decrease and/or kid mortality could increase causing a decline in population numbers in a specific group or as a whole. Management practices should consider that kid production may fluctuate effecting overall population numbers.

Future Management

Data for the period of decline in Black Hills mountain goat numbers was too limited to accurately assess the factor or factors that caused the decline. The three factors of possible overharvest, increased recreational activities, and loss of habitat could have all singularly caused mountain goat numbers to decline. However, a combination of all three would assuredly have a negative impact on mountain goats and are the suspected cause of the decline in mountain goat numbers. Future management should emphasize habitat improvement, input into recreational use plans, and conservative harvest strategy. Additional research should be directed toward mountain goat/human interactions and possible effects.

LITERATURE CITED

- Adams, L. G. and J. A. Bailey. 1982. Population dynamics of mountain goats in the Sawatch Range, Colorado. *J. Wildl. Manage.* 46:1003-1009.
- Anderson, N. W. 1940. Mountain goat study. Washington Dept. of Game, Seattle. *Biol. Bull. No. 2.* 21 pp.
- Benzon, T. A. and L. A. Rice. 1986. Rocky Mountain Goat population in the Black Hills, South Dakota. S. D. Dept. Game, Fish and Parks, Pierre. *Pittman-Robertson Progr. Rpt.* 25 pp.
- Bergman, C. 1984. The mt. goat forments trouble in a fragile paradise. *Smithsonian*, August, 103-109.
- Casebier, R. L., M. J. Rognurd and S. Bradborg. 1950. Rocky Mountain Goat in Montana. Montana Fish and Game Commission, Wildlife Restoration Division, Helena. *Pittman-Robertson Fed. Aid Proj. Bull. No. 5,* 107 pp.
- Chadwick, D. H. 1983. A Beast the color of winter, *Sierra Club Book,* 208 pp.
- Cruse, J. 1959. The mountain goat in the Black Hills National Forest.

- Black Hills National Forest Supervisor's Office, Custer, South Dakota. 5 pp.
- Hanson, W. O. 1949. Survey and management of the mountain goat in South Dakota. Unpubl. Pittman-Robertson Rept., S. D. Game, Fish and Parks, Pierre. 5 pp.
- Hebert, D. and T. Smith. 1986. Mountain goat management in British Columbia. Bienn. Symp. North. Wild Sheep and Goat Council., 5:48-59.
- Joslin, G. 1980. Mountain goat habitat management plan for the Cabinet Mountains, Montana. Ecological Services Division, Montana Dept. Fish, Wildlife and Parks, Helena. 122 pp.
- _____. 1982. Montana mountain goat investigations along the east front of the Rocky Mountains Lewis and Clark National Forest. Montana Dept. Fish, Wildlife and Parks, Helena. Progr. Rpt., 69 pp.
- Kuck, L. 1977. The impacts of hunting on Idaho's Pahsimeroi mountain goat herd. Pp. 114-125 in W. M. Samuel and W. G. MacGregor (Eds.), Proc. First International Mountain Goat Symp., Kalispell, Mt. 243 pp.
- Nichols, L. 1980. Mountain goat management technique studies. Alaska Dept. of Fish and Game, Juneau. Final Rpt. 51 pp.
- _____. 1982. Mountain goat movements study, Vol. II. Alaska Dept. of Fish and Game, Juneau. Prog. Rpt. 22 pp.
- Rice, L. A. and T. A. Benzon. 1985. Rocky Mountain Goat population status in the Black Hills, South Dakota. S.D. Dept. Game, Fish and Parks, Pierre. Pittman-Robertson Progr. Rpt. 46 pp.
- Richardson, A. H. 1971. The Rocky Mountain Goat in the Black Hills, South Dakota, S.D. Dept. of Game, Fish and Parks, Pierre. Bull. No. 2. 24 pp.
- Richardson, A. J. and J. Blankenship. 1967. The Rocky Mountain Goat in the Black Hills. Unpubl. Black Hills National Forest Supervisor's Office, Custer. 4 pp.
- Smith, C. A. 1984. Evaluation and management implications of long-term trends in coastal mountain goat populations in southeast Alaska. Bienn. Symp. North. Wild Sheep and Goat Council., 4:395-424.
- Swenson, J. E. 1986. Reproductive response of the Absaroka mountain goat population to an experimental reduction. Bienn. Symp. North. Wild Sheep and Goat Council., 5:71-75.