

LONGEVITY OF AMERICAN MOUNTAIN GOATS

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*Abstract:* Remains of 12 mountain goats were found in Montana's Bitterroot Mountains from 1973-1975. The mean age (10.8 years) of the 9 remains which could be aged and sexed was significantly ( $P < 0.001$ ) greater than the mean age (6.0 years) of 123 harvested goats. Ages of male and female goats were not significantly different in the harvest ( $P = 0.17$ ) nor among natural mortalities ( $P > 0.9$ ). Age-specific horn breakage, an indication of accidental injury rate, was correlated ( $P < 0.01$ ) with age. However, 70% of all horn breakage had occurred by 3.5 years-of-age. Natural longevity of adults is likely dependent upon rate of wear and loss of teeth. Regulations which favor harvest of males and recruitment of juveniles to breeding age could improve management of hunted goat populations.

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Longevity, particularly of females, is an important determinant of productivity in species with late sexual maturation, such as the mountain goat. Low fecundity and high juvenile mortality of mountain goats underscore the importance of long life spans of animals reaching adulthood. Some factors affecting productivity, such as birth rates (Brandborg 1955: 101-109, Hall and Bibaud 1978, Taber and Stevens 1980, Youds et al. 1980) and recruitment rates (Rideout 1974, Hebert and Turnbull 1977, Hall and Bibaud 1978, Chadwick 1983:110-114) have been reported. However, longevity of mountain goats is not well documented. This paper provides information on longevity of a hunted mountain goat population native to western Montana.

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METHODS

During an investigation of mountain goat ecology in Montana's Bitterroot Mountains (Smith 1976), ages of mountain goat remains found on winter ranges were recorded. Horn annuli and horn morphology were used respectively to determine age and sex (Brandborg 1955). Age and sex of 123 mountain goats harvested in western Montana from 1973-1978 were likewise determined in the field or at taxidermy shops. Horn breakage observed on the harvested goats was recorded. Broken horns were compared to unbroken horns and when  $> 4$  mm were missing, a horn was considered broken.

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## RESULTS AND DISCUSSION

### Natural Longevity

Remains of 12 goats were found on winter ranges in 1974 and 1975. For 9 of the 12 remains, age and sex were established. This is the largest sample of natural mortalities of adult goats for which age and sex have been reported. Mean age was 10.8 years (SE = 0.87) and ranged from 6.5-15.5 years for 7 males and 8.5-13.5 years for 2 females. The mean age of the males ( $\bar{x}$  = 10.79, SE = 1.02) was not significantly different ( $t$  = 0.09,  $P$  > 0.9) than the females ( $\bar{x}$  = 11.0, SE = 2.51). Maximum ages reported elsewhere include a 13-year-old male from Idaho (Brandborg 1955), a 10-year-old female from Washington (Johnson 1983:20), 10-year-old males and females from Alaska (Nichols 1980), and 12-year-old female from Olympic National Park (Taber and Stevens 1980). Cowan and McCrory (1970) reported an 18-year-old female and a 14-year-old male from among 165 goat skulls in museum collections. They observed that the average age of the oldest individual from four geographic areas of the species' distribution was 10 years.

### Harvested Goats

From 1955-1974, hunters harvested 85 females (N = 335) for every 100 males (N = 396) taken in the Bitterroot Mountains, resulting in a post-season sex ratio of 87 adult males:100 adult females (Smith 1976). Selective harvest of males apparently affected the adult sex ratio of the population.

Females tend to outlive males in most polygamous North American ungulates (Flook 1970, Geist 1971:280, McQuivey 1978, Meagher 1978:125, Gavin et al. 1984) as was reported in an unharvested mountain goat population (Taber and Stevens 1980). Mean age of the 83 males harvested in western Montana ( $\bar{x}$  = 5.7 years, SE = 0.34) was less but not significantly so ( $t$  = 1.41,  $df$  = 121,  $P$  = 0.17) than that of the 40 harvested females ( $\bar{x}$  = 6.6 years, SE = 0.54). This suggests a similar age structure in the sexes since hunter selection of older animals from one or the other sex is unlikely given similar growth rates of adult male and female horns and the difficulty in distinguishing relative ages of goats observed in the field on the basis of horn size or other physical characteristics once adulthood is reached (Smith 1986).

Hunting apparently removed goats from the populations at an age ( $\bar{x}$  = 6.0, SE = 0.29) significantly younger ( $t$  = 5.25,  $df$  = 130,  $P$  < 0.001) than did natural causes of mortality ( $\bar{x}$  = 10.8, SE = 0.87), but affected the age structure of the sexes similarly.

Remains of only adult mortalities were found in the Bitterroots. The remains of young goats likely disappear faster than the remains of older goats, as is the case with bighorn sheep (Buechner 1960:84, Geist 1971:293). To avoid this potential bias in examining effects of hunter harvest on longevity, the 11 yearlings (no kids were harvested) were removed from the sample of 123 harvested goats. Then the samples of harvested goats 22-years old and natural mortalities were compared. The null hypothesis that mean age of harvested goats ( $\bar{x}$  = 6.4, SE = 0.25) is not different than the mean age of natural mortalities ( $\bar{x}$  = 10.8, SE = 0.87) was rejected ( $P$  < 0.001).

## Factors Affecting Natural Longevity

Mortality sources among mountain goats have been well documented and most investigators concur that: (1) natural mortality is highest during the first 2 years of life (Brandborg 1955, Rideout 1974, Youds et al. 1980, Hebert and Turnbull 1977, Chadwick 1983:109-114); (2) juvenile mortality is correlated to winter severity (i.e., snowpack) (Cowan 1950, Brandborg 1955, Rideout 1974, Smith 1976, Chadwick 1983:109-114); and (3) avalanches in late winter and early spring and other accidents are responsible for significant numbers of mortalities (Brandborg 1955, Holroyd 1967, Macgregor 1977, Chadwick 1983:109-116).

Among one herd of 30 intensively studied goats in the Bitterroot Mountains, three had broken or deformed horns and several others had one or both horn tips missing. To examine injury rates of goats, due to avalanches, rock slides and climbing accidents, the cumulative, age-specific incidence of broken horns among 123 harvested goats was recorded (Table 1). Thirty percent had 4 mm or more broken off one or both horns. Percent horn breakage was significantly correlated ( $r = 0.993$ ,  $N = 4$ ,  $P < 0.01$ ) with age. However, 70% of all horn breakage had occurred by 3.5 years of age (20.9% horn breakage for ages 1.5-3.5 years). Chadwick's (1983:144) observations that juveniles suffer 80% of all climbing accidents precipitated by intraspecific aggression may explain the high incidence of broken horns among goats  $\leq 3.5$  years of age. Debilitating or potentially fatal accidents may contribute to the high rates of juvenile mortality reported for the Bitterroot Mountains (31% among kids, 23% among yearlings over 2 winters, Smith 1976) and elsewhere.

The higher, although nonsignificant ( $\chi^2 = 0.70$ , 2df,  $P > 0.5$ ), incidence of broken horns among males versus females (Table 1) may be attributable to male fighting during the rut (Geist 1964), or accidents resulting from rutting behavior and the subdominant status of males in the social hierarchy (Chadwick 1983).

Adult goats experience a far lower annual rate of mortality than juveniles. Life expectancy of adults, as with other ungulates, is largely dependent on the rate of wear of the teeth (Cowan and McCrory 1970). The incisors of most Montana goats over 9 or 10 years of age showed severe wear. An emaciated 12.5-year-old female harvested from the Bitterroots had only 1 incisor remaining, and an old male had none (from hunter questionnaire). Several other old goats were missing one or more incisors and/or had loose teeth. Casebeer et al. (1950) and Brandborg (1955) also reported loss of incisors in Bitterroot goats. Bitterroot goats strip foliose and fruticose lichens and mosses - high protein food items in winter - from rock surfaces with their incisors. Lost or severely worn incisors would reduce foraging efficiency on those plants and on fibrous herbaceous and woody vegetation as well (Smith 1976: 166).

### MANAGEMENT IMPLICATIONS

1) The maximum age of both male and female mountain goats that died or were harvested in western Montana was 15.5 years. This is the oldest male and second oldest female reported in the literature. However, 10-11

years was the average natural longevity of adult goats. Based upon population classifications (Smith 1976) and age distribution of adults (Table 1), <10% of the population exceeded 10.5 years of age. In the absence of population-specific age data, modelers of goat populations might use 10-11 years as the average maximum longevity of mountain goats.

2) The mean age (6.0 years) of harvested goats was significantly less ( $P < 0.001$ ) than the mean age (10.8 years) of natural mortalities. Despite the goat's trophy status, hunters harvest animals considerably younger (including subadults) than the mean age of those succumbing to natural causes. The difficulty in distinguishing the age of goats 23 years of age (Smith 1986) renders all adults, male and female, of similar trophy value to many hunters. Thus, adult females entering or within their reproductive prime are as likely to be harvested as those that are nearing their natural life expectancy. This has important management implications because of the mountain goat's relatively low fecundity and limited sexual dimorphism upon which to predicate harvest restrictions. Minimum horn length restrictions to protect juveniles and regulations that discourage or prohibit harvest of females (supported by hunter orientation classes and/or literature) could improve management of goat populations.

Table 1. Incidence of broken or deformed horns among 123 mountain goats harvested in western Montana 1973-1978.

Age Group	Number (% of total) in age group		Number (% of age group) with broken horns	
	Male	Female	Male	Female
1.5 - 3.5	31 (37)	12 (30)	7 (23)	2 (17)
4.5 - 6.5	27 (33)	11 (28)	8 (30)	3 (27)
7.5 - 9.5	17 (20)	12 (30)	7 (41)	4 (33)
10.5 - 15.5	8 (10)	5 (13)	5 (63)	1 (20)
Total	83 (100)	40 (101)	27	10
		Average	(33)	(25)

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#### QUESTIONS AND ANSWERS

Joseph Hamr, Ontario: I was wondering if you considered the possibility that the incidence of broken horns in males was due to fighting with one another? Chamois very often poke one another and I was wondering if the same was true for goats?

Bruce Smith: I did consider that. The difference between chamois and mountain goats is that when mountain goats fight, they fight in an anti-parallel orientation to each other. They're generally hooking one another in the flanks or rumps and its very unusual in watching rutting behavior to see billies strike one another head to head, but they'll use their horns for defense against predators. Although, I couldn't be sure that broken horns were just due to falls and accidents, most of the information available on goats, including how they rut, would make me believe that its probably from some type of fall. We did see quite a few falls with goats.