



UNDERSTANDING THE ECOLOGY OF MOUNTAIN GOATS: THE LONG-TERM STUDY OF CAW RIDGE

By Dr. Steeve D. Côté

The mountain goat is one of the least-studied ungulates in North America. It is a unique species sensitive to harvesting and thus cannot be managed in the same manner as other large herbivores. A decline in mountain goat populations in west-central Alberta during the 1980s prompted the initiation of a long-term research program on the ecology, population dynamics, and management of mountain goats on Caw Ridge. Sport hunting of mountain goats was closed from 1988 to 2000. In 2001, following the recovery of some populations, wildlife managers re-opened the mountain goat hunting season in a few areas based on the population dynamics information provided by the Caw Ridge study. Almost 4,000 applications for three tags were received across Alberta the first year and the interest in this hunt has remained high since. In comparison, there are about 3,000 sheep hunters in the province.

Concerns persist about the causes of population decline and about whether or not goat populations have recovered to historic levels. Wildlife managers charged with the duty to be good stewards of Alberta's mountain goats have limited information on the basic biology of this species. Little is known about the year-to-year variability in mortality and recruitment and the factors that affect individual reproductive success are still not well understood. Moreover, for reasons that are also not well documented, mountain goat populations recover very slowly following declines and are much more sensitive to hunting losses than other big game species. Information on vital rates such as survival and reproduction is required to ensure the success of transplants and to minimize the impact of hunting through harvest regulations. The Caw Ridge mountain goat study set out to provide answers to these questions.

Following preliminary work in 1988, the study of the Caw Ridge mountain



A nursery group of mountain goats in June. PHOTO: S. D. CÔTÉ

goat population began in June 1989 and has continued ever since. The study essentially monitors marked individuals; much recent research has shown that long-term monitoring of marked individuals is the most useful protocol to adopt to provide information useful for conservation and wildlife management. Long-term data from marked individuals are necessary to quantify the effects of individual variation, climate, predation pressure, population age-sex structure, density and other variables that may affect individual reproductive success and population dynamics.

Caw Ridge, about 30 km northwest of Grande Cache, Alberta, is ideal for intensive wildlife studies because of its accessibility and open terrain. It is home to the largest mountain goat population in Alberta outside of the National Parks. Alpine areas used by mountain goats range in elevation from 1750 to 2170 m. Goats on Caw Ridge have not been hunted since 1969 (Limited entry goat hunts now occur in three Wildlife Management Units (WMUs) in the Grande Cache area – outside from Caw

Ridge – and one WMU in the Crowsnest region). Caw Ridge is located east of the Rocky Mountains; it is separated from the main mountain range by 10 to 30 km of coniferous forest. About 250 bighorn sheep also inhabit the ridge but they mostly use the eastern part of Caw Ridge and adjacent lands. Caw Ridge is on a major migration route for the Redrock Prairie Creek caribou herd; several hundred caribou are observed on the ridge annually. Carnivores known to prey upon goats in the study area include wolves, grizzly bears and cougars.

The first step in our study of the Caw Ridge mountain goats is to capture and mark them. We use remotely controlled box traps baited with salt blocks. Two blinds are used to monitor the traps so researchers do not disturb the goats. Captured goats are drugged except for yearlings and most two-year olds who are handled without drugs. Goats receive canvas collars or ear tags with unique colour and symbol patterns that allow us to identify the goats from a distance. Since 1988 we have marked a total of 427 mountain goats. In September 2009



Mountain goats are captured in box traps baited with salt blocks. PHOTO: S. D. CÔTÉ

there were 134 goats in the population, of which 120 were marked.

Body mass is one of the most important life-history traits so we weigh goats at capture using platform scales with remote indicators. In mountain goats, sexual dimorphism or distinctiveness in body mass develops post-weaning and increases gradually up to at least six to eight years of age (Fig. 1). Females complete their mass gain at about six to seven years of age, when males are about 35 percent heavier than females; mid-summer body mass is near 100 kg for males and 75 kg for females (Fig. 1). In contrast, horn length is similar in adults and this helps to explain why nearly half the animals harvested are females.

A very important applied result of our long-term study concerns adult sex ratio. The number of adult males in the population has consistently been much lower than the number of adult females, limiting hunting opportunities (Fig. 2). Recently, however, the sex-ratio bias in favour of females has decreased, concomitant with an increase in total population size (Fig. 2). The proportion of male kids born increases substantially with maternal age: young females (\leq six years old) produce approximately 35 percent sons while old females (\geq 10 years old) produce about 70 percent sons.

The survival of all age-sex classes has varied between years. Adult female survival (average of 89 percent) is higher than adult male (83 percent) survival. Kid survival averages 63 percent but varies widely from year to year, as is typical of ungulates. Sensitivity analyses comparing survival and fecundity estimates among age and sex classes

revealed that adult females' survival has the greatest potential to influence changes in population size and suggest that harvesting adult females can have strong impacts on population dynamics. In addition, age at primiparity (first-time successful pregnancy) of female mountain goats at Caw Ridge is very late. It averages almost five years of age and thus has a strong impact on population growth rate. Goat mortality varies greatly from year to year, underlining the value of our long-term approach to the study of

population dynamics. The causes of these yearly changes in mortality are unknown. But, because of the relatively small number of animals in a mountain goat population, stochastic (randomly determined) events could have drastic effects on population dynamics. For example, if just four additional males were killed in one year by predators or hunters, male mortality would increase by 15 to 25 percent depending on the year.



The author, with Goat #56, on Caw Ridge. PHOTO: C. HINS



Adult female mountain goat with her kid in September. PHOTO: S. D. CÔTÉ

The reproductive effort of polygynous (having more than one mate) male ungulates consists mainly of male-male competition and the courting of females during the rut. This competition and courting can incur substantial costs in term of mass loss. In mountain goats, very little is known about male reproductive strategies and the determinants of reproductive success. Based on field observations conducted during the rut at Caw Ridge in November and December, male mountain goats start to participate actively in the rut when they reach three years of age. The level of participation in the rut increases until about eight years of age when males reach their maximum mass (Fig. 1) and slightly decreases afterwards, likely as a result of reproductive senescence (old age). Mature dominant males defend oestrus females whereas subordinates attempt to obtain matings by pursuing females. Using molecular markers, we found that the annual reproductive success of males increased with age and peaked at eight years but declined afterwards in older males (Fig. 3). Mass was also a strong determinant of male reproductive success, as males with increased mass

sired more offspring. As opposed to other polygynous ungulates such as bighorn sheep, horn length in males does not seem to affect reproductive success. This is not

surprising because mountain goats show no sexual dimorphism for this trait. Our results showed that male mountain goats must survive to at least six years of age to

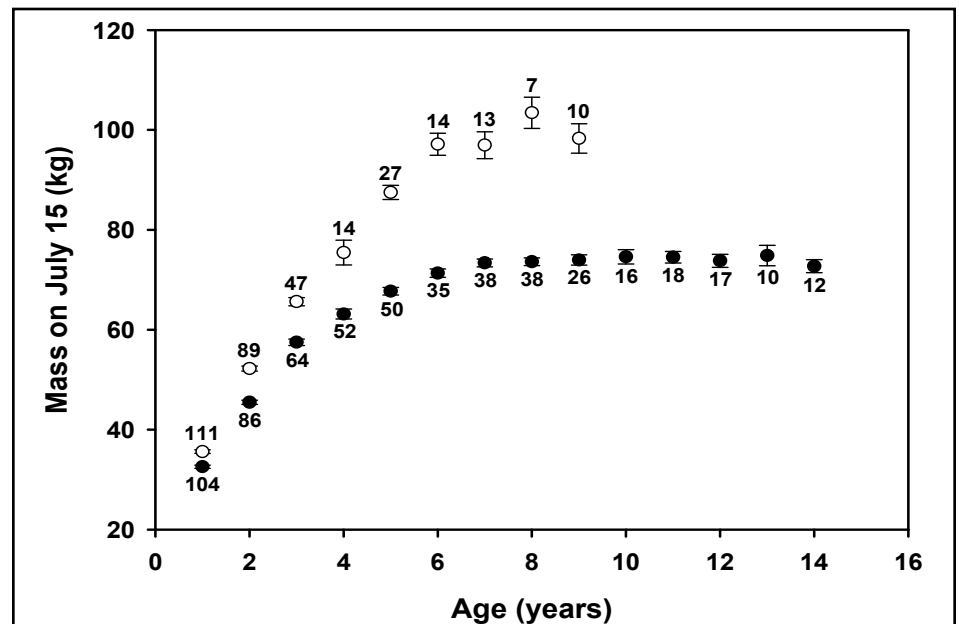


Figure 1: Development of sexual dimorphism in body mass of mountain goats from Caw Ridge, Alberta. Body mass was adjusted to mid-summer using the sex-specific growth rate of each age class. Mean body mass (\pm SE: plus or minus one standard error) for males (open circles) and females (closed circles) are accompanied by sample size. The last data point in each series shows the average for all males aged nine years and older, and all females aged fourteen and older.

increase their probability of contributing to future generations. They must also reach a high body mass and social rank to successfully compete with other males for access to females; only a few males achieve this. Out of 96 offspring assigned to a father only five males sired 51 percent of the 57 individuals tested; the mating system is highly polygynous.

In alpine environments, the growth of animals is tightly linked to seasonality. We used the Normalized Difference Vegetation Index (NDVI) - a satellite-based measurement that correlates strongly with surface vegetation productivity and with the timing in the availability of high-quality vegetation - to explore how annual variations in the timing of vegetation onset and in the rate of change in plant production during green-up affected mountain goats. Yearly average kid mass differed by up to 16 percent between years with low and high maximal increases in NDVI. Rapid changes in NDVI likely led to a shorter period of availability of high-quality forage over a large spatial scale, decreasing the opportunity to exploit such high-quality forage. Our results suggest that attempts to forecast how warmer winters and springs will affect goat population dynamics and life histories in alpine environments should consider factors influencing the rate of changes in plant production during green-up and the timing of vegetation onset.

Our research has firmly established that mountain goats are more sensitive

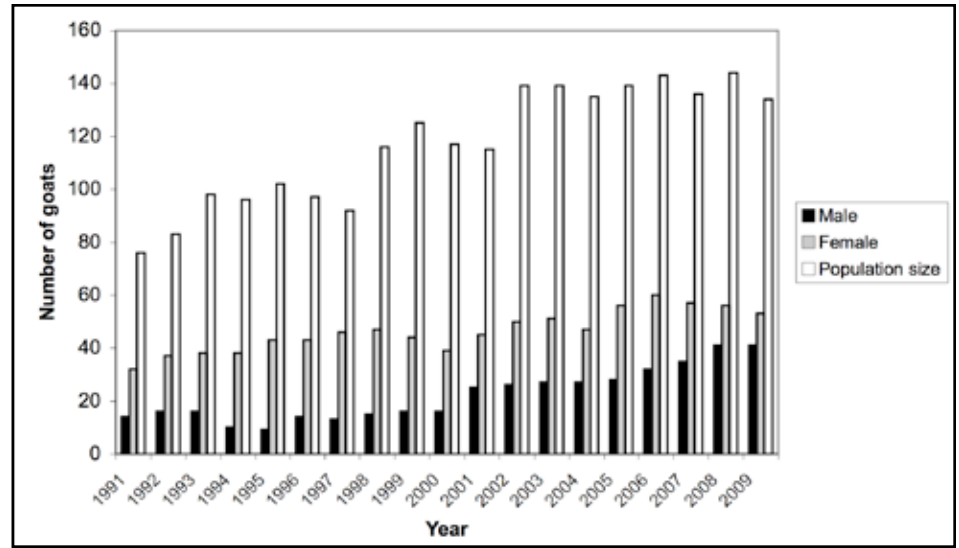


Figure 2: Total population size and number of adult (≥ 3 -year-old) male and female mountain goats in September in the Caw Ridge population from 1991 to 2009.

to anthropogenic disturbance than other ungulates. For example, helicopters flying within less than 500 metres of mountain goats elicited a strong reaction 85 percent of the time. In addition, we also recorded goat responses to quads because the amount of quad traffic on the ridge has increased dramatically since the mid-1990s. The numbers of people driving quads on Caw Ridge has increased from about 30 to 40 per summer in 1994 and 1995 to more than 400 per summer in recent years. Our preliminary analyses indicate that the probability of mountain goats being disturbed by quads increases with the speed of vehicles. At a speed of 35 km/h, there are >50 percent chances that goats

would be alert for up to 10 minutes or move at least 100 metres. Another threat to mountain goats on Caw Ridge is coal mining and the unintentional helicopter harassment associated with exploration. Increasing resource exploration and exploitation poses a long-term threat to the habitat of many species in Alberta; the mountain goats on Caw Ridge are no exception to this threat.

This summer we will continue the monitoring of survival and reproduction of mountain goats on Caw Ridge. We will mark the new cohort of yearlings and focus our observations on maternal care behaviour and the influence of female characteristics on the development of kids. The results from the Caw Ridge project are essential. This is the only long-term study of mountain goats in the world and provides essential scientific data to better understand and manage mountain goats throughout the province and elsewhere. 🐐

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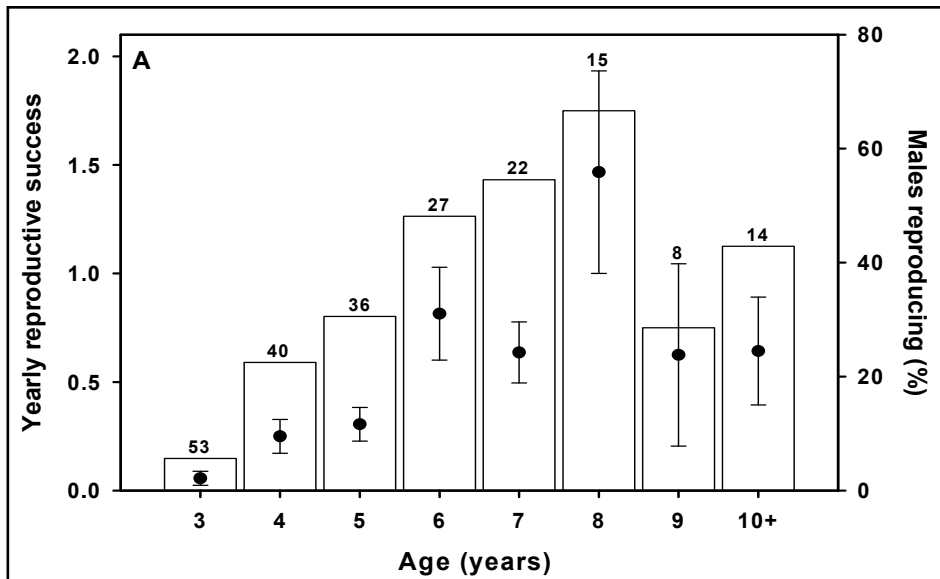


Figure 3: Mean annual number of kids sired (\pm SE) that survived to one year of age in relation to male age in mountain goats at Caw Ridge, Alberta. The percentages of males reproducing according to age (histograms, right Y axis) are also shown.