POPULATION ESTIMATION OF MOUNTAIN GOATS
IN THE SOUTHERN YUKON

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Norman Barichello

Jean Carey

Ron Sumanik

Yukon
Renewable Resources

INTRODUCTION

Results of aerial mountain goat (<u>Oreamnos americanus</u>) surveys have always been viewed with some uncertainty. Mountain goats are difficult to count; they live in rugged country where visibility is limited by the ruggedness of the terrain, and they tend to hide rather than to flee from aircraft.

In the Yukon, the standard procedure for goat census has been a complete visual coverage in alpine and subalpine range, using a helicopter and three observers. Results have been viewed as a minimum population count. The reliability of this technique or the error around these estimates is unknown.

The intention of this study was to assess the reliability of summer helicopter surveys.

STUDY AREA

The study area is a rugged, discrete mountain range in the Coastal Mountains, straddling the Yukon/B.C. border, and referred to as the Bennett Range (Figure 1). On the Yukon side, the mountain range is within Game Management Subzone 7-35. The entire block covers approximately 134 km^2, and is considered to be good goat habitat.

METHODS

Three surveys were undertaken from 21 June to 4 July, 1989. A complete visual search was made of all alpine and subalpine habitat using a helicopter and three observers, and flying at about 200 m above the ground at a ground speed of approximately 90 km/hr. To minimize the risk of goats moving in or out of the surveyed portion during the census and being missed or double-counted, smaller blocks within the range were surveyed entirely before proceeding to the adjacent blocks. All surveys were done from 900-1200 hours to standardize diurnal differences in goat activity patterns. Weather was ideal during the survey period.

The survey block was long and narrow and separated on all sides by lakes or major river valleys. Surveys were completed within a two-week period. Therefore, we assumed that there would be minimal movements by goats into and out of the study area.

The location of each group of goats was mapped on a 1:250,000 topographic map, and the composition of kids and non-kid goats within each group was recorded. A group consisted of any number of goats, including one. Kids were distinguished based on size. We refer to nursery goats as those goats in the presence of kids; they include nannies, and yearlings and two-year olds of both sexes (Chadwick 1983). Groups of goats without kids were referred to as non-kid groups.
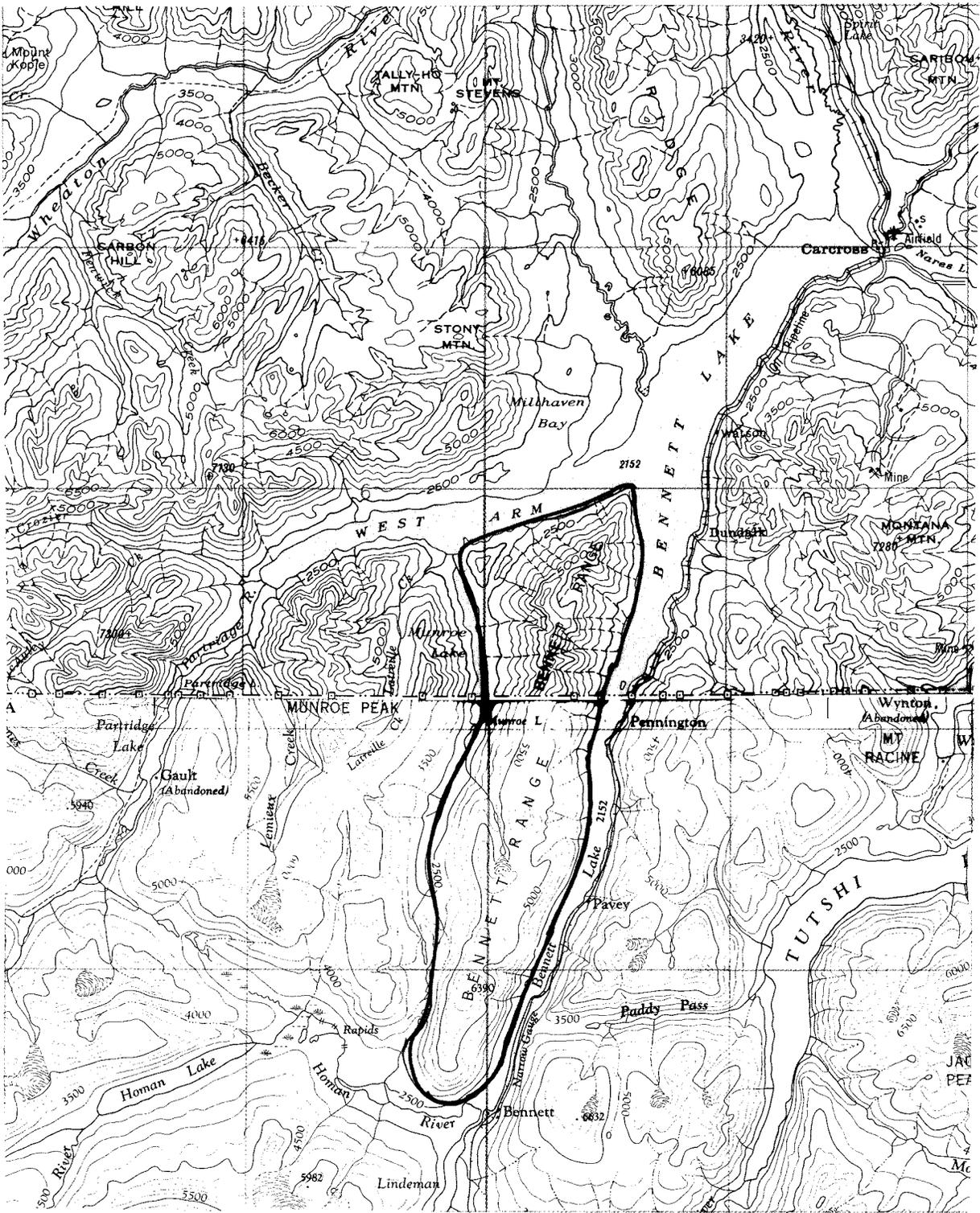
Figure 1.   Study area.

RESULTS AND DISCUSSION

The counts and classification of goats sighted in the study area
are presented in Table 1. Most of the goats were observed north
of the BC/Yukon border. This distribution was relatively
consistent between surveys, and similar to previous summer
surveys. Nursery groups tended to occur on more gentle pastures
than groups which were without kids.

The initial survey yielded the highest nursery count and the
highest total count (see Table 1). The number of nursery goats
was also less variable between surveys than the non-kid count
(coefficient of variation = 14.19, and 41.67, respectively; Table
2). In fact, two of the three surveys yielded nearly identical
numbers of nursery goats.

Group size of goats observed without kids was smaller (p<0.01),
and subjectively, we noted that they were in more rugged terrain,
than nursery groups. Chadwick (1983) similarly noted that small
groups of goats occupied more rugged terrain than large groups,
and were typically bachelor groups. Risenhoover and Bailey (1982)
also found that groups without kids were significantly smaller
than nanny-kid/yearling groups, and in more rugged terrain.

Chadwick (1983) reported that nursery groups were typically
composed of nannies, two-year olds, yearlings and kids, while
small bachelor groups were male goats 3 years and older.
Risenhoover and Bailey (1982) noted that during late summer
surveys, nanny/kid groups contained up to 37% males, and
non-kid/yearling groups contained only males, 2 years and older.

Chadwick (1983) also estimated there to be 70 to 90 adult billies
for every 100 adult nannies, and calculated the annual mortality
of kids, at between 27 and 41%, and of yearlings, at between 15
and 41% in his study population. Risenhoover and Bailey (1982)
estimated there to be 80 adult males per 100 adult females, and

found that this ratio was unaffected by hunting, which was only 58% selective to males. In the Yukon, since 1973, approximately 64% of the harvest has been male (n=216). In the study area we observed between 18 and 46 goats in non-kid groups for every 100 goats in kid-groups. Therefore, we assume that our surveys inconsistently tallied male goats.

Variation in the kid count may have reflected a tendency for kids to remain hidden during helicopter overflights, or the possibility of mortality during the study period. In any case, we observed between 24 and 35% kids in the study population, and between 46 and 64 kids/100 nursery goats.

The high count during the initial survey may have been due to the time of year. Nannies may be more conspicuous shortly after giving birth due to the lack of mobility of kids, or they may be more active to replenish energy reserves closer to the date of birth, and therefore more obvious. Also, goats may learn to minimize harassment by hiding from the helicopter, decreasing their sightability with successive goat surveys. Finally, a decrease in the nursery count from June to July may reflect changes in group size, or the dispersal of young males away from nanny/kid groups. There was a discrepancy between Chadwick's (1983) and Risenhoover and Bailey's (1982) assessment of composition of nanny-kid groups. Chadwick (1983) reported that kid-groups were exclusively females and yearling males, while Risenhoover and Bailey (1982) observed as many as 37% mature males within kid/yearling-groups.

Mean group sizes of nursery goats increased over the study period, accompanied by a decrease in the number of nursery groups observed and an increase in the variability of nursery group size between surveys (Table 3). The opposite trend was observed of groups without kids; group size declined, the number of groups increased, and there was a decrease in the group size variance (see Table 2). It is possible that from June to July young males in nanny/kid

groups disperse and lactating females and young aggregate. If so, we would expect an increase in the ratio of kids to non-kids in nursery groups, assuming mortality of kids was minimal.

From 21 to 26 June, a decrease in the number of nursery goats was accompanied by a slight increase in the number of kids observed, therefore the ratio of kids to nursery goats in nursery groups increased from 0.48 to 0.64. However, no such pattern was observed from June to July; a reduction in the kid/non-kid ratio in nursery groups was observed. Group size of non-kid groups increased from 27 June to 4 July.

We suspect there are a number of factors changing over time which will influence the count. Kids become more mobile and able to find cover and therefore they may be more easily missed; there may be learning or habituation which will result in hiding or minimal movement during overflights to reduce sightability; and group size may be changing (see Table 3) as fewer males remain associated with large nursery groups. We suspect that changes in sightability with time and survey replication are yielding variable results, with the most accurate count derived from one mid-June survey.

The 1989 counts were all higher than previous census results (Barichello and Carey 1988a). This is likely a reflection of good kid production and low overwinter mortality. Furthermore, there may be a positive association between the rate of kid production and the nursery count. The ratio of kids to nursery goats ranged from 0.46 to 0.64, and was higher than the average kid/nursery ratio from 1979-88 (Barichello and Carey 1988a, YTG file report). Sheep population trends in the central Yukon are related to the rate of production (Barichello and Carey 1988b), when productivity is high, there is population growth of non-lamb nursery sheep. Goats may experience the same demographic patterns; good winters may favour higher than average survivorship of all cohorts, and contribute to higher productivity the following spring.

However, the 1989 goat count was considerably higher than the 1988 count (YTG unpubl. data), and could not be explained by recruitment of the 1988 cohort. The 1989 counts may reflect a net increase through immigration from 1988 to 1989, or an improvement in the sightability of goats.

An adjacent mountain block was surveyed in June, 1989, and no decrease in the number of goats was observed from previous surveys (YTG unpubl. data). We suspect no major change in goat distribution between years.

Previous surveys were all carried out in mid to late July. June counts probably yield higher counts, smaller variation, and more accurate population estimates. Where sheep surveys in the Yukon have been replicated within the year, June counts have been consistently higher than July counts (Barichello et al. 1987; YTG unpublished data).

The rate of kid production may also influence the sightability of goats. When productivity is high, more females may aggregate into nursery groups, resulting in more and larger groups. Therefore, more goats may be observed in more productive years. Variation in productivity then, may result in variable population estimates.

POPULATION ESTIMATE FOR THE STUDY AREA

Non-kid groups are largely if not entirely male groups (Chadwick 1983; Risenhoover and Bailey 1982), and survey counts of these goats are highly variable. Risenhoover and Bailey (1982) suspected that they were able to account for only 62% of all male goats. In this study, we conclude that male goats are easily missed and therefore the count of goats in groups without kids is highly variable and inaccurate, and that the nursery count is accurate, particularly early in the summer. We consider that a more accurate estimate of billies can be derived based on the

ratio of adult males to nursery groups. Assuming that, (a) yearling and two-year old males remain with the nursery group early in the summer (Chadwick 1983), (b) there is minimal harvest, and (c) the average mortality of kids is 35% and of yearlings is 25% (Chadwick 1983), we expect an average of 50 adult billies (goats without kids) for every 100 nursery goats.

We have derived and compared 3 population estimates (excluding kids), based on 3 replicated surveys (Table 4). All estimates are based on a mean ratio of kids to nursery goats, and a projected ratio of 50 adult males for every 100 nursery goats. We have concentrated our comparisons on different estimates of nursery goats. One estimate is based on the maximum nursery count from 3 surveys, one is the upper limit of 95% confidence around the mean number of nursery goats observed, and one is derived around the range in nursery goats observed.

There was very little variation among the 3 estimates. Nursery goat estimates ranged from 48 to 51.2, and the population of non-kid goats ranged from 72 to 76.8.

CENSUS RECOMMENDATIONS

1. Conduct helicopter surveys in mid-June.

2. Coverage should be complete; at least two helicopter passes will be necessary in most goat habitat in the Yukon.

3. A population estimate should be derived as the total number of nursery goats observed, plus an estimate of billy goats based on a ratio of 50 billies to 100 nursery goats.

Table 1: Composition of goats observed from helicopter surveys in
          June and July, 1989.

                                        Date
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                     21 June   27 June   4 July
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Total count   83   71   71
Total non-kids   60   46   54
Nursery goats   48   39   37
Kids   23   25   17
Non-nursery goats   12   7   17
Percent kids   27.7   35.2   23.9
Kids/100 nursery   47.9   64.1   46.0
Non-nursery/100 nursery 25.0   18.0   46.0

Table 2:   Average number of goats and variance, of nursery, kids, and non-nursery goats.

Statistic	Classification		
	Nursery	Kids	Non-nursery
Range	37-48	17-25	7-17
Mean	41.3	21.7	12.0
Standard deviation	5.86	4.16	5.00
Coefficient of variation	14.19	19.17	41.67
Upper limit at 95% confidence			

Table 3: Group size of nursery and non-nursery groups, by date of
          survey.

Date	Nursery			Non-nursery		
	N	Mean	s.d.	N	Mean	s.d.
21 June	10	4.80	3.08	4	3.00	2.83
27 June	8	4.88	6.38	3	2.33	2.31
4 July	4	9.25	8.88	9	1.89	1.36

Table 4: Three goat population estimates, not including kids, based on three surveys, 21 June - 4 July, 1989.

Method	Nursery	Non-nursery	Total
Maximum count	48.0	24.0	72.0
Mean + U.L.@ 95%	51.2	25.6	76.8
Mean + (1-min/max)	50.8	25.4	76.2

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