

A PRELIMINARY ANALYSIS OF INTENSIVE, UNREPLICATED SURVEY DATA  
FOR MOUNTAIN GOAT POPULATIONS IN BRITISH COLUMBIA

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ABSTRACT

Mountain goat (*Oreamnos americanus*) populations were surveyed at 19 locations throughout the province. Composition data, group size and density were collected or calculated for each location. Density estimates were compared to previous qualitative estimates (Blower 1977) and relationships among density, group size and productivity were examined.

INTRODUCTION

Based on qualitative estimates provided by regional wildlife biologists (Blower 1977), the British Columbia (B.C.) mountain goat population was estimated at approximately 63,000 animals (Macgregor 1977) between 1970 and 1980. Currently the provincial mountain goat species plan (Ministry of Environment 1979) estimated approximately 45,000 (+20 percent) animals in the province, although few populations had been adequately surveyed (Hebert & Turnbull 1977, Hebert 1978). In general, most early surveys (1960-1975) were reconnaissance in nature and did not allow good estimates of total numbers or composition. Intensive surveys began on the south central coast of B.C. in 1974 (Hebert & Turnbull 1977) and increased throughout the province until the present. However, replication of surveys to estimate variance and determine sampling intensity have not been undertaken in B.C.

Intensive surveys were increased because management of mountain goat populations by harvest data led to problems of overharvest in the past (Phelps et al. 1984, Foster 1976, Kuck 1977). The harvest of many mountain goat populations changed from an open season to harvest under a Limited Entry Hunting (L.E.H.) program necessitating better information on total numbers (minimum estimates), composition and distribution.

This paper is an attempt to examine actual survey information and evaluate its use in revising Blower's (1977) estimates. In addition, it examines the relationship between specific population parameters, to determine if management biologists could better evaluate goat populations using these criteria and relationships.

Intensive surveys were conducted throughout the province in a preliminary attempt to gather information from representative mountain blocks. Density estimates from these surveys could be used to extrapolate population estimates for larger areas in order to develop regional wildlife species plans. In association, density was related to other observable population parameters such as group size and productivity in order to develop preliminary provincial ecotype boundaries for mountain goats.

## STUDY AREA

The study area consisted of 19 survey locations in the province of British Columbia (Fig. 1). In the southern portion of the province 13 surveys were completed: 3 on the outside of the Coast range, 6 on the inside of the Coast range, 2 in the Rocky Mountains, 1 in the Monashee Mountains and the other in the Cariboo Mountains.

Six surveys were completed in the northern portion of the province: 2 in the Stikine Mountains, 2 in the Omineca Mountains, 1 in the Rocky Mountains and the northernmost one in the St. Elias Range of the Coast Mountains.

## METHODS

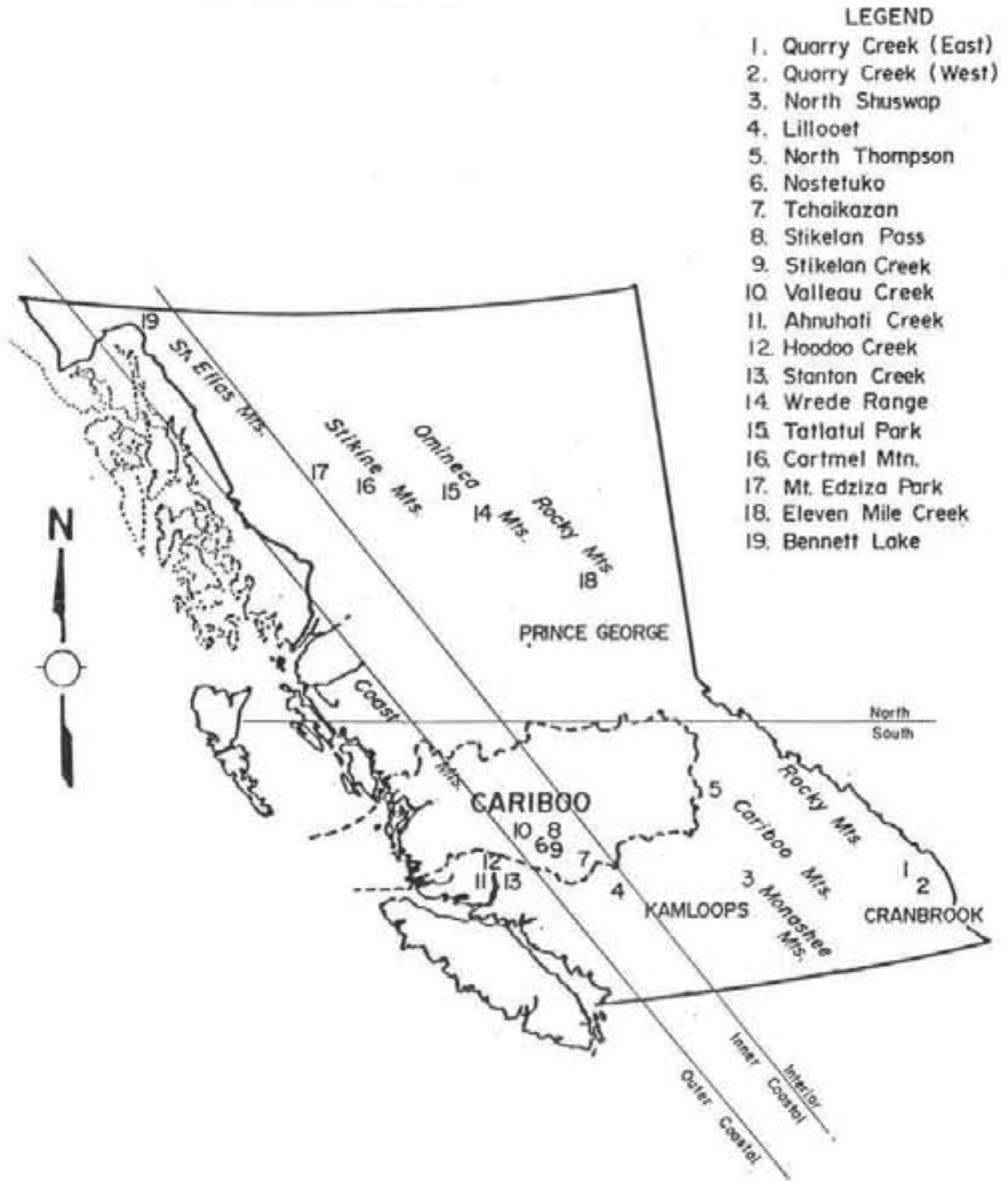
Intensive mountain goat survey data from 19 different areas were obtained from regional Fish and Wildlife Branch offices and the Provincial Parks Branch in Victoria. Surveys varied in detail; 16 with complete classification of all or most goats and 3 with partial classification. All surveys were done using a 206B Jet Ranger helicopter between 1975 and 1983 (Table 1). The majority of surveys were undertaken during 1982 and 1983 (Table 1). Where possible, surveys were standardized according to methodology from Hebert and Turnbull (1977), Hebert (1978), Fox (1972) and Nichols (1980) in lieu of replication.

Seventeen of the surveys were done according to methods standardized by Hebert & Turnbull (1977), primarily during July and August. The North Shuswap and Wrede Range surveys consisted of a single flight transect, while all others had two or more at 150 m intervals.

The area used to calculate population density was determined with an Apple computer and digitizing planimeter, on maps ranging in scale from 1:50,000 to 1:250,000. Difference in scale produced minor differences in the area calculation. Population densities were determined from the area between the 1,250 m contour line (approximate treeline) and height of land in each individual watershed (Hebert & Turnbull 1977). At present, the calculation of density does not account for slight differences in treeline from south to north nor for the amount of rock or nonvegetated area above treeline. Similarly, differences in slope were minimal and differences were not accounted for.

Statistical procedures followed Zar (1974). Correlation coefficients were calculated using the parametric produce-moment and non parametric Spearman rank correlation coefficients for group size, density and productivity for the surveyed areas. Based on statistical theory, kid percentages were initially transformed with the arcsine transformation ( $y = \arcsin y$ ) to better approximate a normal distribution. However, this procedure did not change the results so correlations with untransformed kid percentages were reported.

Figure 1. Locations of Mountain Goat Surveys in various mountain blocks throughout B.C. between 1975 & 1983



## RESULTS

### Composition

Classification of the majority of goats observed (75 percent) was possible on 11 of the 19 surveys (Table 1). Where possible, at least females with kids were classified on the 8 remaining surveys. The average productivity as measured by observed percent kids was 20.8 and 60.3 kids per 100 females.

### Group Size

The average group size for the 19 survey areas (Table 2) was approximately 3.72 (SE = .41). Stratification of the survey areas into North-South and Coast-Interior areas indicated that average group size varied little throughout the province: Coast - 3.5, (SE = .55); Interior - 4.0, (SE = .65); North - 5.2, (SE = .98); South - 3.4, (SE = .42). By comparison, Smith (1977) found group sizes of 2.18 and 1.46 goats during mild and harsh winters in Montana while Smith and Raedeke (1982) found group sizes of 6.4 in southeast Alaska. Similarly, group size for the adjacent north-east portion of B.C. was 6.1 (Bennett Lake).

### Density

Population density was calculated for each survey area and ranged from a high of 7.30 goats/sq. km. in East Quarry Creek to a low of 0.08 goats/sq. km. in the Wrede Range, North Shuswap and Ahnuhati (Table 2). The average goat density for the 19 survey areas is 1.03 goats/sq. km. (SE = .47), however, when Quarry Creek densities are removed from the data the average drops to 0.35 (SE = .09) goats/sq. km. Stratification of the survey areas into North-South and Coast-Interior zones indicated major density differences between coastal areas (.35 goats/sq. km., SE = .05) and interior areas (1.79 goats/sq. km., SE = .96) and between north (.41 goats/sq. km., SE = .24) and south areas (1.3 goats/sq. km., SE = .68). Excluding Quarry Creek, densities for the interior area (.36 goats/sq. km., SE = .21) and southern areas (.31 goats/sq. km., SE = .06) are similar to the coastal and northern areas. By comparison, McCrory et al (1977) determined densities of 0.45 goats/sq. km. for the entire area of Yoho Park and 1.50 goats/sq. km. for potential habitat. The interior and southern density calculations were also done excluding Quarry Creek data because this watershed may not be entirely representative of the mountain blocks in the southern Rocky Mountains. It was chosen because of the abundance of goats, in order to adjust the L.E.H. harvest. However, it indicates a possible upper range of goat densities in B.C. habitat.

Additional surveys in southeastern B.C. may produce higher average estimates of both density and group size for the southern and interior sections of the province.

Surveyed densities were compared with densities estimated by Blower (1977) using the sign test. Nine of the densities were higher, 6 were the same or comparable and 4 were lower suggesting no significant difference ( $p > .10$ ). The sign test is not as powerful as other statistical tests and some large discrepancies between surveyed and estimated densities were apparent.

(e.g. Quarry Creek). The degree of similarity is largely due to the wide range given to the estimated densities.

#### Correlations

Correlations were run for the following: (productivity-density), kids-density, percent kids-density, kids/100 females-density; (productivity - group size), percent kids-groups size, kids per 100 females-group size (Table 3).

In general, the relationship between these parameters were not significant for most areas of the province. Parametric and non-parametric statistics indicated a significant relationship exists for number of kids in the population and density (interior) kids/100 females and density (northern and coastal areas) and between kids in the population and group size (south and all populations).

#### DISCUSSION

Species management is a continually evolving process. Mountain goat population estimates for B.C. have changed from approximately 100,000 (Macgregor 1977) in the early 1960's to 63,000 (Blower 1977) in the early 1970's when based on qualitative estimates, to 45,000 (+20 percent) in the provincial mountain goat species plan (Ministry of Environment 1979). Regardless of the estimate or the process used to derive the estimate, hunter harvest has been a significant mortality factor on many if not most mountain goat populations in B.C. (Phelps et al. 1984, Foster 1977). Thus, it is imperative that precise and accurate population estimates be derived as soon as possible. Unreplicated, intensive standardized surveys are but an interim step in the process. They allow new estimates to be developed by extrapolating densities from specific surveys to larger mountain blocks which they may represent and allow population characteristics to be examined in order to identify general ecotype boundaries.

At present there are no specific criteria which allow a standard, comparable calculation of population density. Blower (1977) varied his watershed base (include minor or major watersheds) throughout the province for his density calculation. Hebert (1977) examined density for an entire watershed, the area between 305 and 1525 m, the area above 1525 m and that for south slopes only. McCrory et al (1977) calculated density based on a qualitative definition of potential habitat. It is obvious and imperative that definitions and standardized measures of density be established as soon as possible.

Due to the extent of mountain goat habitat in B.C. and its diverse and rugged nature, only general population indices will be available to management biologists for the foreseeable future. Thus, density estimates, derived from unreplicated, standardized surveys of representative mountain blocks will be used to develop population estimates for mountain blocks, management units, regions and the province, in order to set reasonable harvest rates. The harvest of mountain goats has and will continue, with or without adequate information. Improvements in establishing estimates (minimum estimates) can only improve the level of management.

The current density estimates for B.C. vary from .08 to 7.3 goats/sq. km. due to the diversity of goat habitat surveyed. However, the average density (1.03/sq. km.) in B.C. is lower (average .35 without Quarry Creek) than several other density estimates (McCrorry and Blood 1977, Stevens 1983, Smith 1984). Also, since replication of surveys of large scale mountain blocks or management units, necessary for management purposes is impossible at this time, due to budget constraints, these population estimates are minimum estimates, useful in the evolving calculation of a provincial estimate and in the calculation of approximate harvest.

A preliminary comparison of southern interior and outer coastal goat populations suggested that productivity and group size may be related and indicated that these parameters (prod. = 34 kid/100 fem., 13.9 percent kids; group size = 1.69) (Hebert and Turnbull, 1977) may be lower for this outer coastal population than for the southern portion of the province. The low number of significant correlations between productivity and density and group size may result from inadequate definition of ecotype boundaries and individual samples which may not be representative of ecotypes. Larger samples within ecotypes may aid in the determination of these relationships. A comparison of data from Hodoo and Stanton Creek with that from all surveyed areas in the province suggests that productivity and group size are lower on this portion of the outer coast than for almost all areas throughout the province. Comparison of these criteria indicates that there is considerable overlap among southern, northern and inner coastal populations.

The reality of annual harvest and high hunter demand necessitate improvement in survey techniques and continual analysis of available data. Stratification of B.C. mountain goat populations into appropriate ecotypes is necessary in order to develop harvest strategies.

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