



Bugaboo Pass

**Mountain goat monitoring in Canadian Mountain Holidays' Bugaboo and Bobbie Burns
heli-hiking areas, East Kootenay, September 2002**

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ABSTRACT

An aerial survey for mountain goat (*Oreamnos americanus*) was conducted within Canadian Mountain Holiday's (CMH) Bobbie Burns and Bugaboo summer heli-hiking tenure areas in the northern East Kootenay, British Columbia, during 12–15 September 2002. The objectives of this study were to determine the number and distribution of mountain goats within these areas during late summer-early fall in order to measure and monitor trends in goat population size and distribution across the landscape. The study area covered approximately 1,410 km² and included complete mountain blocks within the tenure areas and along most boundaries. The study area aligned with the northern edge of goat management zone A, all of zone B and the southern edge zone C of Management Unit (MU) 4-34, and the north-eastern edge of zone C of MU 4-27. Within the study area we surveyed a 797-km² census zone of potential goat habitat, which generally included steep or cliff habitat above 6,000–6,500 feet elevation or within the trees down to about 5,000 feet. (Feet are provided as the unit of measure because the helicopter's altimeter was in feet). We used a Bell 206B helicopter using standard survey techniques, and classified all goats to kid or non-kid (adults and yearlings; hereafter adults). No sightability correction surveys were conducted. Survey conditions were excellent with clear skies or high overcast; temperatures were slightly higher than normal for this time of year.

We spent 19.8 hours on survey within the census zone, for an average survey intensity of 1.5 minutes/km². We observed 205 goats in 75 groups, an average of 0.26 goats/km² within the census zone and 0.15 goats/km² within the study area. Group size ranged from 1 to 21. Elevations of goats ranged from 6,300 to 9,100 feet; 50% of censused goats occurred in the 7,700–8,500 foot band (mean and median 8,100 feet). We counted 34 kids; a 20:100 kid to adult ratio. Based on our professional judgement and comparison with other surveys, we believe we observed approximately 60% of the goats present, resulting in an estimate of roughly 340 goats in the study area (0.43 goats/km² within the census zone and 0.24 goats/km² within the study area). We estimated approximately 172 goats within zone 4-34 B.

A review of existing data suggests that mountain goat numbers in much of the Rocky Mountain chain and associated mountain ranges have declined over the past 10–15 years, although the magnitude of this decline and differences among areas are unclear. Establishing historic long-term or even short-term trends for goat populations within the CMH study area is difficult. Our results do suggest, however, that goat densities within the study area are comparable to estimates derived in other areas (including portions of the Rocky Mountains) over the past several years.

A review of the literature suggests that the accuracy of individual helicopter surveys for mountain goats is questionable, results of single surveys should be interpreted with caution, and that aerial surveys of goats appear to be useful only as trend indicators. We recommend that to establish long-term population trends for goat populations within the CMH tenure area, all or at least 50% of the study area be surveyed annually, with an effort to standardize survey timing, effort and observers/pilot among years.

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INTRODUCTION

Mountain goats (*Oreamnos americanus*) occur over much of the mountainous areas of the East Kootenay in southeastern British Columbia, ranging in relative density from few to plentiful within this distribution (Shackleton 1999). Populations have fluctuated over time, thought in large part to be due to human-related causes, primarily overhunting during the mid-1900s through to the early 1970s (Phelps et al. 1983; Hebert and Smith 1986). Although little inventory activity on mountain goats occurred in the East Kootenay from the mid-1980s to late 1990s, surveys conducted since 1998 have suggested that goat numbers appear to have decreased substantially throughout much of the region (Davidson 2000; Halko and Hebert 2000; Teske and Forbes 2001; B. Forbes, Section Head, BC Ministry of Water, Land and Air Protection [WLAP], Cranbrook, BC, letter of 5 June 2000; J. Woods, Parks Canada, Revelstoke, BC, personal communication; R. Owchar, Parks Canada, Lake Louise, Alberta, personal communication; A. Dibb, Parks Canada, Radium Hot Springs, BC, personal communication). Some authorities have cited increases in helicopter flights, much of this associated with the burgeoning heli-hiking industry, as one of the primary causes of the apparent decline in goat numbers (B. Forbes, WLAP, letter of 5 June 2000).

Canadian Mountain Holidays (CMH) has tenure to conduct winter heli-skiing and summer heli-hiking operations in the Bugaboo and Bobbie Burns areas of the Purcell Mountains in the East Kootenay of southeastern British Columbia. Surveys conducted in 1998 found far fewer goats than previously estimated for the area (Davidson 2000, Teske and Forbes 2001). The Bugaboo and Bobbie Burns summer areas were also surveyed at a reconnaissance level in early September 2000 (Wilson and Shackleton 2001). Although more goats were observed than during the 1998 survey, Wilson and Shackleton (2001) suggested that goats here appeared to occur at relatively low densities, and that habitat quality for goats was lower than in surrounding regions such as the Rocky Mountains.

The objectives of this study were to determine the number and distribution of mountain goats during late summer-early fall within CMH's Bugaboo and Bobbie Burns summer operating areas. This information will be used to establish long-term monitoring for goats within these areas in order to measure and monitor trends in mountain goat population numbers and distribution across the landscape. This research will compliment the surveys currently being conducted in other portions of the northern East Kootenay (e.g., north of Golden and the national parks), and provide a basis for long-term tracking of the areas' mountain goat populations.

STUDY AREA

The CMH mountain goat study area is within the northern Purcell Mountains of the Columbia Mountains, west of the Rocky Mountain Trench (Fig. 1). The Bugaboo summer and winter tenure areas cover approximately 380 and 1,000 km², respectively, while the Bobbie Burns areas cover approximately 690 and 1,050 km², respectively. The Bugaboo and Bobbie Burns areas abut one another within Bugaboo Provincial Park. These tenure areas align with all of goat management zone B, the western half of zone A and the southern edge of zone C of Management Unit (MU) 4-34, and the north-eastern half of zones B and C of MU 4-27.

The area is made up of 2 biogeoclimatic zones: Englemann Spruce-Subalpine Fir (ESSF) zone and the Alpine Tundra (AT) zone above tree line, which is between 1900-2150 m (6,250-7,050 ft). July and January mean temperatures for Golden, 20 km north of the study area, are 17.2°C and -10.1°C, respectively (Environment Canada climate normals, unpublished data). Golden receives an average of 490 mm of precipitation including 184 cm of snowfall annually. Climate varies within the study area, with cooler temperatures and deeper snowfalls at higher elevations and on north and east-facing slopes. High on the valleys, hybrid white-Engelmann spruce (*Picea glauca x engelmannii*), subalpine fir (*Abies lasiocarpa*), and lodgepole pine (*Pinus contorta*) dominate, with scattered stands of whitebark pine (*Pinus albicaulis*) at the highest elevations (Parish et al. 1996). In the AT zone conifers are present only in

stunted krummholz forms. Extensive areas of glacier with associated moraine deposits are found throughout the study area, some of them many square kilometres in extent.

The study area was selected to include all mountainous terrain within CMH's summer tenure areas, and included entire mountain blocks where the tenure boundary cut across heights of land. This maximized the likelihood of sampling discrete populations. Within the 1,410-km² study area we surveyed a 797-km² census zone of potential goat habitat, which generally included steep or cliff habitat above 6,000–6,500 feet elevation and below tree line down to about 5,500 feet. (Feet are provided as the unit of measure because the helicopter's altimeter was in feet). Glaciers >1 km² in size were removed from calculation of the census zone area.

STUDY DESIGN AND METHODOLOGY

Mountain goats are notoriously difficult to survey (RIC 2002). The heterogeneous nature of mountainous terrain and the frequency of forest use by goats likely affect sightability (Houston et al. 1986). Total count surveys conducted from the air have been the most common survey method (summarized in RIC 2002). A stratified random survey design using fixed-wing reconnaissance flights has been used previously to survey mountain goats (Houston et al. 1986, van Drimmelen 1986); however, high coverage was required to obtain a confidence interval of <20% of the estimate (90% confidence level), and the stratification produced highly variable counts of the medium density stratum. Random sample unit surveys have been attempted (e.g., Poole et al. 2000), but provide unduly wide confidence limits unless sampling effort is high and goat distribution is comparatively uniform (or accurate stratification of the area is possible; Poole et al. 2000). Studies point to the large variation in sightability obtained during goat surveys (Hebert and Langin 1982, Smith 1984, Smith and Bovee 1984, Cichowski et al. 1994, Poole et al. 2000, Gonzalez-Voyer et al. 2001).

Following RIC (2002) standards, the study design for the CMH study consisted of a total count survey of the entire study area. We did not attempt to calibrate a sightability correction factor during the survey (see Discussion). We broke the census zone into 13 blocks (survey units), which generally consisted of discrete mountain blocks that we were able to survey within 1–2.5 hours to avoid observer fatigue and minimize the risk of animal movement within and out of blocks during the survey period.

We conducted the census between 12 and 15 September 2002. Survey conditions were generally excellent with clear skies or high overcast; temperatures were slightly higher than normal for this time of year (10–13 C in the census zone). We used a Bell 206B Jet Ranger helicopter with pilot, navigator, and 2 observers. The pilot, navigator, and primary observer remained the same throughout the census, but 2 people (CMH personnel) were used as the second observer. All occupants participated in locating mountain goats. We surveyed all terrain above and including alpine and open subalpine habitat, as well as areas of broken or disjointed cliffs below tree line. Starting at the lowest elevation, we flew roughly 150 m (500 foot) contour lines at 80–100 km/hr, 75–100 m out from the hillsides. We mapped approximate flight lines, survey coverage and location of goats on 1:50,000 scale topographical maps and recorded broad habitat type and elevation (to the nearest 100 feet) of goat groups from the helicopter's altimeter. We also recorded goat locations with a hand-held global positioning system (GPS) unit. We classified goats only into kids and non-kid (yearlings and older; hereafter called adults) based on body size (B. L. Smith 1988) to reduce survey time, to minimize harassment (Côté 1996), and because researchers familiar with classification from aircraft agree more detailed age and sex classification is not reliable (Houston et al. 1986, Stevens and Houston 1989, Gonzalez-Voyer et al. 2001, S. Côté, Université de Sherbrooke, personal communication).

RESULTS

We spent 19.8 hours on survey within the census zone (survey area), an average survey intensity of 1.5 minutes/km² (range among blocks: 1.1–2.0 minutes/km²; Table 1). We observed 205 goats in 75 groups (Fig. 1). Group size ranged from 1 to 21 and averaged 2.7 ± 0.35 (mean \pm SE). Two-thirds (67%) of goats groups consisted of 1–2 animals, and only 14 goat groups (19%) contained half of the total number of goats observed. We counted 34 kids (17% of total goats); a 20:100 kid to adult ratio. Elevations of goats ranged from 6,300 to 9,100 feet; 50% of censused goats occurred in the 7,700–8,500 foot band (mean and median 8,100 feet). Elevation of goat groups did not differ between kid and non-kid groups (*t*-test, *t* = 1.22, 73 df, *P* = 0.23). We observed goats in a variety of habitats, including scree (34% of total goats), cliffs (32%), alpine meadows or barrens (16%), ridge tops (8%), broken cliffs (6%) and on moraines (4%). Roughly 40% of goats were adjacent to or closely associated with features related to glaciers.

Eight goats in 5 groups were >1 km outside CMH's tenure boundary, primarily in the front ranges of the Septets (block 13; Fig. 1). Divided by MU, 83 goats were in MU 4-27 and 122 goats were in MU 4-34 (Fig. 2). However, 68 goats (33% of the total) were observed <1 km from the MU 4-27 – 4-34 boundary. By goat management zone, we observed 27 goats in 4-27 B, 56 in 4-27 C, 11 in 4-34 A, 103 in 4-34 B, and 8 in 4-34 C (Fig. 2). Zone 4-34 B was the only zone completely surveyed.

Mean density was 0.26 goats/km² within the census zone (range 0.11–0.61 among blocks; Table 1) and 0.15 goats/km² within the study area. Highest densities of goats among blocks were observed in Conrad Glacier-Vertigo (block 4), and Carbonate (block 9). There was no correlation between survey effort and goat density among blocks (Spearman rank correlation, *P* = 0.31). Based on our professional judgement and comparison with other surveys (see Discussion), we believe we observed approximately 60% of the goats present, resulting in an estimate of 340 goats in the study area (0.43 goats/km² within the census zone and 0.24 goats/km² within the study area). Within zone 4-34 B we estimated 172 goats.

Table 1. CMH mountain goat survey results by block, 12–15 September 2002. Block numbers correspond to map numbers in Fig. 1.

Date	Block no.	Name	Time on survey (min)	Survey area (km ²)	Survey effort (min/km ²)	Non-kids	Kids	Total	Density (goats/km ²)
12-Sep-02	1	Grizzly Ridge	75	44.5	1.7	8	2	10	0.22
12-Sep-02	2	Warren Ck	164	131.0	1.3	37	6	43	0.33
12-Sep-02	3	Vowell Glacier, Malloy Ck	80	58.0	1.4	5	2	7	0.12
13-Sep-02	4	Conrad Glacier, Vertigo	55	29.8	1.8	12	4	16	0.54
13-Sep-02	5	Giegerich, Crystalline Pass	82	73.1	1.1	13	1	14	0.19
13-Sep-02	6	Hatteras	53	46.3	1.1	6	2	8	0.17
13-Sep-02	7	Syncline	75	52.0	1.4	8	2	10	0.19
13-Sep-02	8	Vermont, Malachite	62	30.6	2.0	3	2	5	0.16
14-Sep-02	9	Carbonate	132	71.8	1.8	39	5	44	0.61
14-Sep-02	10	Bobbie Burns	100	74.1	1.3	8	0	8	0.11
14-Sep-02	11	Spires	66	44.3	1.5	9	3	12	0.27
15-Sep-02	12	Quintets, Groovy	153	80.5	1.9	17	3	20	0.25
15-Sep-02	13	Septets	92	61.2	1.5	6	2	8	0.13
Total			1189	797	1.5	171	34	205	0.26

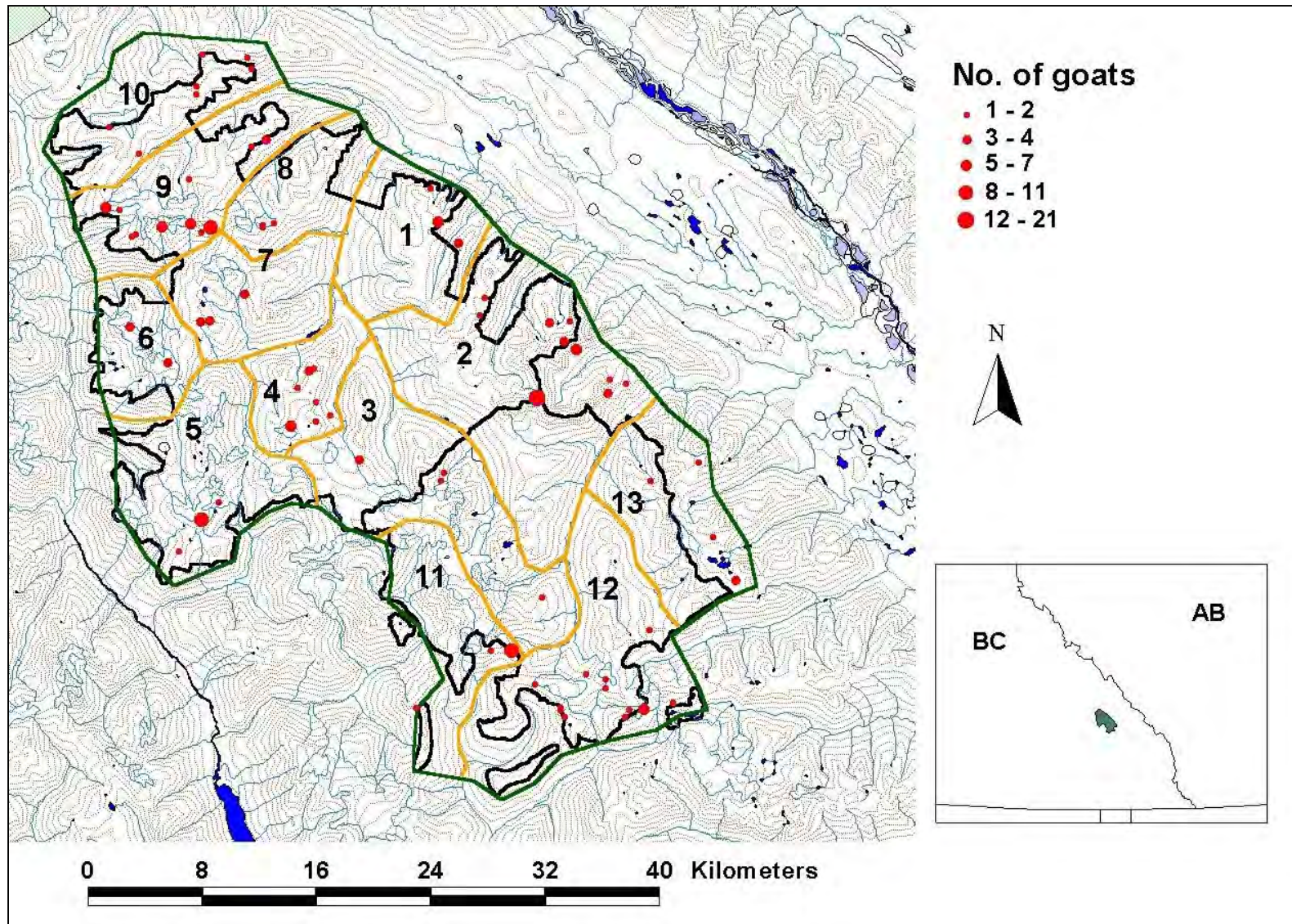


Figure 1. CMH mountain goat survey area, 12–15 September 2002. Numbers of goats observed shown by red dots scaled to number of animals observed in the group. Dark green outline depicts the approximate study area; black outlines show the Bobbie Burns (upper) and Bugaboo (lower) summer tenure areas, orange outlines and numbers refer to survey blocks (Table 1). The census zone covered potential goat habitat generally above 6,000–6,500 feet elevation.

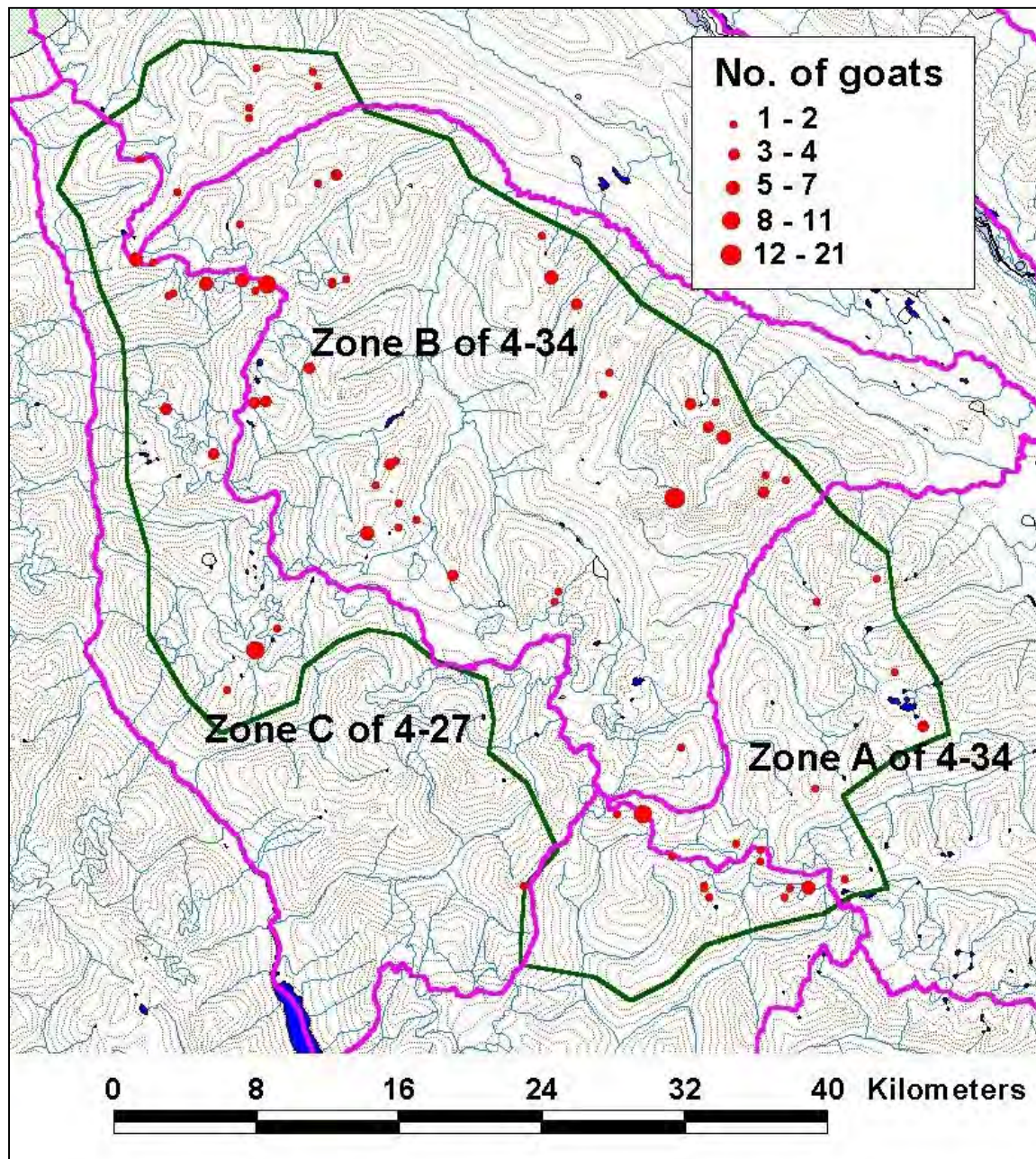


Figure 2. Distribution of mountain goat observations (red dots scaled to number of animals observed in the group) in relation to mountain goat management zones (purple boundaries) within the CMH mountain goat survey area, 12–15 September 2002 (green outline).

DISCUSSION

Survey and sightability correction

The CMH survey followed RIC (2002) standards and was conducted under near-optimal survey conditions with good weather and generally excellent visibility. The pilot was highly familiar with the study area; he had >20 years flying experience in the region and had flown a reconnaissance level survey for goats in the same area in September 2000 (Wilson and Shackleton 2001). The CMH observers had 10–25 years experience in the study area. Our coverage was generally complete, in that we surveyed most of the discrete mountain blocks on the borders of the CMH tenure area in all but portions of the southern boundary. One potential weak point in our survey was our inability (due to funding limitations) to completely survey the extensions of the Septet Range east of block 13 (Fig. 1). These extensions, however, were up to 7–8 km from the tenure boundary, and it was difficult to justify this coverage.

We suggest that we observed approximately 60% of the goats present, and corrected our observed count accordingly to provide an estimate of goats present within the census zone. This correction was based on our survey effort compared to other studies, and limited experience with sightability obtained using collared goats in similar habitat at the same time of year (Poole et al. 2000; see below). No logistic regression-based sightability models are available for mountain goats, and development of a model for goats based on vegetation cover and terrain/topography (including cliff size, shape and morphology) would be difficult (Poole et al. 2000). RIC (2002) recommends the mark-resight method of calculating sightability to correct for missed animals. However, the manual is somewhat vague on alternative methods (e.g., paint balls fired from helicopters; Cichowski et al. 1994) beyond collared goats and acknowledges that more testing is necessary. The paint ball method is poorly tested and relatively invasive (RIC 2002), and given the reaction of goats to close approaches by helicopters (Côté 1996), may unduly bias subsequent survey results (given the short window of time between marking goats and loss of marks).

Lacking collared goats, one potential option to determine sightability correction is intensive resurvey of a number of randomly selected survey units within the study area (c.f., McDonald et al. 1990 and Loranger and Spraker 1994 for Dall's sheep (*Ovis dalli*); Poole et al. 1999 for moose (*Alces alces*)). This would involve returning to a survey unit either immediately or some days after the initial survey to resurvey (and re-map) goat distribution and numbers, using twice the survey effort (minutes/area) as initially used. However, this technique will accurately correct visibility bias only when all goats seen during the initial survey are seen during the intensive resurvey, and when all goats present in the sample unit are seen during the intensive survey (Poole et al. 1999); neither assumption is generally met (Loranger and Spraker 1994, Strickland et al. 1994). Goats often react to close approaches by helicopters (Côté 1996), and re-flying the blocks immediately after an initial survey may result in lower counts because of animal behaviour and increases overall stress on individuals with limited return. Movement over a period of days, potentially off of survey units or mountain blocks, or in or out of tree line where sightability would vary, may negate the assumptions required to validate mark-resight estimates (Caughley 1977, Smith and Bovee 1984, Cichowski et al. 1994).

Where surveys have used collars or marked goats, survey sightability has ranged from 30–46% in coastal populations (Hebert and Langin 1982, Smith 1984, Smith and Bovee 1984) to 67–70% in interior mountain goat populations (Cichowski et al. 1994, Poole et al. 2000, Gonzalez-Voyer et al. 2001). All surveys were conducted in late summer/early fall, but vegetation and terrain differed among areas, as did, in all likelihood, the proportion of the population in vegetated habitats. The Smith and Bovee (1984) study used fixed-wing aircraft at survey efforts of 0.9 minutes/km² to determine 46% sightability (6/13 collared goats observed in 2 separate surveys). A series of population reductions (by goat removal) and 8 surveys conducted over 3 years (at 4.4 minutes/km² average survey effort) estimated a sightability efficiency of 66% in the Olympic Mountain Range, Washington (Houston et al. 1986). Sightability of

goats during annual surveys conducted over 11 years on the well-studied population at Caw Ridge in west-central Alberta averaged 70%, but ranged from 55 to 84% during any one survey (Gonzalez-Voyer et al. 2001). Caw Ridge is a single, small (21 km²) block of high hills with a high-density goat population (>4 goats/km²) that can be easily covered by a single flight around the perimeter. Survey effort was consistent among years at roughly 3.0 minutes/km² (K. Smith, Alberta Fisheries and wildlife Management, Edson, Alberta, personal communication). The 70% sightability figure may not be readily comparable to other areas, given the high familiarity of the study population to the observers, and the relatively simple topography (M. Festa-Bianchet, University of Sherbrooke, Québec, personal communication). Therefore, given the much higher survey effort provided in studies that established 66–67% sightability correction (Houston et al. 1986, Poole et al. 2000) and the small study area, relatively simple terrain and high level of knowledge of the Caw Ridge surveys which determined an average 70% sightability, we feel the 60% sightability used in the CMH survey is a reasonable estimate.

Comparison with other southern interior ecotype populations

We observed uncorrected goat densities of 0.26 goats/km² for the census zone and 0.15/km² for the entire study area, and estimated corrected densities of 0.43 and 0.24 goats/km², respectively. In the mid to late 1970s, uncorrected goat densities were estimated at 1.5 goats/km² (census zone) and 0.45 goats/km² (study area; entire park) for Yoho National Park (McCrary et al. 1977), and 0.20–0.22 goats/km² (study area; entire park) for Glacier and Mt. Revelstoke national parks (McCrary 1979). In 1998 Poole et al. (2000) used a random block sampling design with correction for sightability (collared goats) to estimate goat densities at 0.77 goats/km² for the census zone and 0.33/km² for the entire study area located along the Robson Valley in east-central B.C. In the Rocky Mountains north of Golden, Poole and Mowat (2002) estimated 0.28 goats/km² in a census zone covering MUs 4-36 and 4-40. Mountain goat surveys were conducted in 10 MUs in the East Kootenay in 1998 and 2000 (Teske and Forbes 2001). No density estimates were provided, but the highest numbers of goats were observed in MUs 4-22 (Bull River), 4-23 (Elk River), 4-24 (White River) and 4-35 (Beaverfoot River). Comparisons of goat densities among studies must be conducted cautiously because of differences in study area size and definition, study design, survey timing and intensity (which is often not documented), and other factors.

The area flown in the 2002 CMH study was surveyed at a reconnaissance level in early September 2000, using about 5 hours on survey (roughly 0.4 minutes/km²); 55 goats were observed, including 10 kids (Wilson and Shackleton 2001). Columbia Basin Fish and Wildlife Compensation Program (CBFWCP) and WLAP staff surveyed all of MU 4-34 during August-September 1998; this study area overlapped with a large portion of the CMH study area. Twenty-five goats were observed in the entire MU 4-34, of which 7 were within zone 4-34 B (Davidson 2000, Teske and Forbes 2001). A 40% sightability correction factor was applied to this block, to obtain an overall estimate of 63 goats for MU 4-34, and 18 goats for zone 4-34 B (Teske and Forbes 2001). No kids were observed within MU 4-34 during the 1998 survey. We observed 103 goats and estimated 172 goats within zone 4-34 B.

A host of factors can influence mountain goat survey results and sightability (Fox 1984); potentially the most important factors might be changes in behaviour and distribution (e.g., hiding below tree line), differential sightability by terrain and vegetation, survey effort, seasonal effects, and weather conditions. Even at the well-known and concentrated Caw Ridge site, sightability among years varied from 55 to 84% (Gonzalez-Voyer et al. 2001). Although changes in animal distribution may have contributed to the unusually low number of goats observed during the 1998 survey, we question whether differences in survey effort are at least partially responsible for the vastly differing results. According to Davidson (2000), 156 minutes were spent on survey in zone 4-34 B during the 1998 flights. We spent about 610 minutes on survey in the same zone, almost 4 times the effort. Intuitively, at lower survey effort, proportionately more goats will be missed. This relationship is likely not linear, but surveying at too low an effort may result in higher variability among counts and less repeatability. The September

2000 reconnaissance survey of the study area occurred at roughly 27% of the effort (1.5 versus 0.4 minutes/km²), and located 27% of the goats we observed (55 versus 205; Wilson and Shackleton 2001). Thus, survey effort during the 1998 and 2000 surveys was roughly ¼ the effort expended during our survey and resulted in one-ninth to one-quarter of the goats observed in 2002. It is possible that goat movements resulting from unusually hot, dry conditions may have hampered surveys during 1998. Anecdotal evidence from reconnaissance flights for goats (some collared) in the Cayoosh range in southern BC suggests significant changes in distribution and/or habitat use during summer-fall 1998, attributed in part to the hot, dry weather (Hatler et al. 1999).

The proportion of kids we observed (17%) was roughly similar to the percent kids observed during summer/early fall surveys in southern interior B.C. (15–23%, McCrory 1979; and 10–31%, Hebert and Woods 1984), the Robson Valley (25%; Poole et al. 2000), and the adjacent Golden study area (17%; Poole and Mowat 2002). The proportion of kids observed in 10 management units in the East Kootenay in 1998 and 2000 ranged from 0–28%, and averaged 20% (Teske and Forbes 2001). Comparisons among years and areas should be conducted carefully because the accuracy of kid estimates varies with survey techniques (ground-based, fixed-wing or rotary-wing surveys), time of year and other sightability factors (Festa-Bianchet et al. 1994). Estimates of the proportion of kids in goat populations obtained from aerial surveys are generally biased low (Gonzalez-Voyer et al. 2001).

Trend in goat numbers in the study area

A review of existing data suggest that mountain goat numbers in much of the Rocky and Columbia mountain chains have declined over the past 10–15 years (Halko and Hebert 2000; Teske and Forbes 2001; B. Forbes, WLAP, letter of 5 June 2000), although the magnitude of this decline and differences among areas are unclear (Hatler 2001). Anecdotal observations from pilots with >20 years flying experience in the northern (D. McTighe, Alpine Helicopters, Golden, B.C., personal communication) and southern East Kootenay (L. Earl, Kootenay Airways, Cranbrook, B.C., personal communication) support this downward trend. Declines in goat numbers in Yoho National Park have been suggested from surveys conducted in 1975–1976 (McCrory et al. 1977) to those flown in recent years, but the magnitude of these declines have not been established (R. Owchar, Parks Canada, personal communication). Similar declines are suspected for Kootenay National Park between the 1980s and 1999 (A. Dibb, Parks Canada, Radium Hot Springs, BC, personal communication). Potential causes for this decline are numerous and generally untested. They include over-harvest, increased predation, weather (primarily severe winters in 1995–1996 and 1996–1997), habitat change (from fire suppression or logging), and increased disturbance from human activity, including helicopters and snowmobiles. In national parks, obviously, some of these potential causes would have no or limited influence.

It is difficult to establish long-term or even short-term trends for goat populations within the CMH study area. To the best of our knowledge, it appears that the 1998 survey was the first conducted for that area (centred on zone 4-34 B; B. Forbes, WLAP, letter of 5 June 2000; Hatler 2001). Previous estimates of goat numbers were apparently obtained from local knowledge, extrapolation from adjacent areas, modeling of perceived increases through the 1980s and early 1990s, and subjective estimates based on assessed mountain goat habitat capability (B. Forbes, WLAP, letter of 5 June 2000). The 1998 survey found very few goats in comparison to previous “estimates”, and while the 2000 reconnaissance survey observed more goats, these observers suggested that goats here appeared to occur at relatively low densities, and that habitat quality for goats was lower than in surrounding regions such as the Rocky Mountains (Wilson and Shackleton 2001). The 2002 survey obtained considerably higher goat counts, but it would be tenuous to use the results from 3 surveys over 4 years, 1 which produced questionably low estimates, 1 acknowledged reconnaissance level survey, and 1 survey with higher survey effort and possibly more thorough coverage, to determine a reliable short-term population trend. Our results do

suggest, however, that goat densities within the study area are comparable to estimates derived in other areas (including the portions of the Rocky Mountains) over the past several years.

Goat harvest levels in MU 4-34 have fluctuated at about 16 ± 1.1 goats/year between 1985 and 1998, but after 1998 harvests dropped to 4–7 annually (Fig. 3). Zone 4-34 B has contributed an average of 32% of the MU harvest (5 goats/year during 1985–1998). About 60% of the harvest in the study area has been in the front ranges, primarily the east ends of blocks 2, 8, 10 and 13 (Fig. 1; B. Warkentin, WLAP, Cranbrook, BC, unpublished data). From our estimate of 172 for zone 4-34 B, the average harvest levels between 1985 and 1998 suggest a harvest rate of roughly 3%, while harvest rates from 1999 onward were closer to 1%. Males made up 55% of the goat harvest in the MU. Native (i.e., not introduced) goat populations may not be able to sustain a yearly harvest greater than 2–3% (Côté et al. 2001) or even 1% (Gonzalez-Voyer et al. 2002).

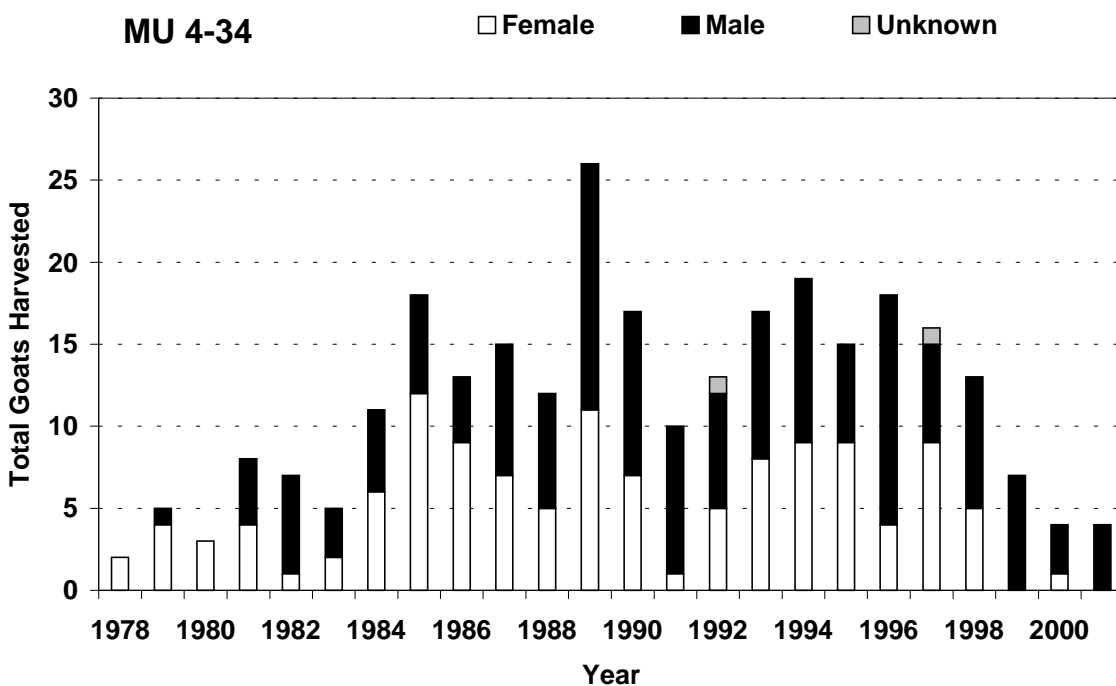


Figure 3. Mountain goat harvest in Management Unit 4-34, 1978–2001. Data supplied by BC Ministry of Water, Land and Air Protection, Cranbrook, British Columbia.

Management recommendations

Evidence from Caw Ridge suggests that the accuracy of individual helicopter surveys is questionable, results of single surveys should be interpreted with caution, and that aerial surveys of mountain goats appear to be useful only as trend indicators (Gonzalez-Voyer et al. 2001). These authors concluded that yearly surveys are required to monitor populations. Given these caveats, we recommend that to establish long-term trends for goat populations within the tenure area, all or (given budget limitations) at least 50% of the study area be surveyed annually. If a sample of the study area is surveyed on an annual basis, the full study area should be surveyed at 3-year intervals to enable trend and distribution data over the larger area. The sample chosen for annual survey should be a discrete mountain

block or chain to minimize the potential for goat movement out of the census zone among years. A proposed sample study area could be the block bounded by McMurdo Creek to the north, Duncan River to the west, Conrad Icefield to the south, and Vowell Creek to the east (blocks 4–10 and the northern half of block 3); we observed 111 goats in this sub-unit during the survey. This proposed sub-unit would ignore goats from the southern portion of the study area, but would probably provide the most discrete area possible for annual survey given budget limitations.

Where possible, to minimize potential variability and maximize repeatability in surveys among years, timing, effort, pilot and observers for annual surveys should remain constant from year to year. Goat habitat use, group size and distribution change over the course of the summer and early fall (and especially through winter; RIC 2002), and surveys conducted at different times of the year may produce different results because of differing sightability resulting from goat behaviour or movement among habitats.

Comparison of survey results among areas and years is sorely hampered by a lack of documentation from recent surveys. These comparisons would be easier if all researchers more accurately define and report census zone size, survey effort, and other factors affecting goat sightability than has been done in the past. In addition, among-year comparability may be compromised at lower survey efforts. Researchers may also consider standardizing survey effort (we recommend roughly 1.5 minutes/km²) in this area to facilitate among-area comparisons.

We suggest that any efforts directed at determining an empirically based sightability correction for goat surveys should focus on studies with radio-collared animals. Without collared goats we suggest there can be little confidence in the sightability correction number. Until research elsewhere proves otherwise, double sampling or marking other than with radio-collars will not likely produce reliable results for mountain goats. To our knowledge, with the exception of collars deployed on translocated animals, no radiocollaring studies on mountain goats have been conducted in the Kootenay Region to date.

Given the relatively large proportion of goats observed on or along heights of land that typically divide mountain goat management zones, and seasonal movements of these animals, it may be more appropriate to structure goat management zones on groups of mountain blocks rather than on a watershed drainage basis. Hunters may access goats primarily via drainages, but goats generally inhabit mountain blocks and might best be managed on a discrete block/sub-population basis.

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