



Vertigo

**Mountain goat survey in Canadian Mountain Holidays' Bobbie Burns and Bugaboo
summer operating areas, Kootenay region, British Columbia, September 2008**

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October 2008



ABSTRACT

An aerial survey for mountain goat (*Oreamnos americanus*) was conducted within Canadian Mountain Holiday's (CMH) Bobbie Burns and Bugaboo summer operating areas in the Purcell Mountains, Kootenay region, British Columbia, during 15–18 September 2008. The objectives of this survey were to determine the numbers and distribution of mountain goats during early fall in these areas and to compare survey results with historic data. Standard survey techniques were followed using a Bell 206B helicopter.

We used 19.3 hrs of helicopter time, including 16.5 hrs on survey, and surveyed a 611-km² census zone of potential goat habitat under good survey conditions. Overall survey effort averaged 1.6 min/km². We observed 268 goats (213 adults, 55 kids) in 113 groups. Kids comprised 21% of total goats (26 kids:100 adults [non-kids]). Groups were distributed from 1,710 to 2,680 m (5,600 to 8,800 feet) elevation. I applied a sightability correction factor of 65% to derive an estimate of 412 goats for the census zone (density of 0.67 goats/km²). Other wildlife observed included 3 grizzly bears (*Ursus arctos*), 1 black bear (*U. americanus*) and a group of 3 wolverines (*Gulo gulo*).

Comparison of results with previous surveys suggests that goat populations in the census zone are roughly 15–20% higher than found in 2002 and 2003. It is unlikely that large movements of animals resulted in this apparent increase in goat numbers. Harvest numbers in the area since 2000 were low (1.8 goats/year; 0.5% harvest rate), likely having little impact on the population. Kid ratios were close to average for the Kootenays. In general, goat populations appear to be healthy and productive, with densities similar to other areas in the Purcell Mountains.

Although there are legitimate concerns with disturbance of mountain goat from helicopter-supported recreation in mountain goat range throughout western North America, obvious population-level effects are not apparent in this area. Policies adopted by CMH to minimize disturbance of mountain goats and other wildlife may have reduced potential impacts from disturbance. To monitor population status I recommend that the area be re-surveyed at 3–5 year intervals.

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INTRODUCTION

Canadian Mountain Holidays (CMH) has tenure to conduct winter heli-skiing and summer heli-hiking operations in the Bobbie Burns and Bugaboo areas of the Purcell Mountains straddling the East and West Kootenays of southeastern British Columbia. Mountain goats (*Oreamnos americanus*) are the most plentiful large mammal found in these subalpine and alpine habitats, and there are concerns that helicopter disturbance may affect goat habitat use and demography (Côté 1996, Wilson and Shackleton 2001, NWSGC 2004). Surveys conducted in 1998 found far fewer mountain goats than previously estimated for the area (Davidson 2000, Teske and Forbes 2001). However, surveys conducted in mid-September 2002 and 2003 found healthy populations and significantly higher numbers of goats within the CMH summer operating area compared to previous surveys (Poole and Adams 2002, Poole 2003).

In addition to CMH operations, human use of the area includes non-guided hiking and climbing, guided and non-guided snowmobiling, limited mineral exploration, and hunting. Although much of the area is difficult to access, residents hunt goats on a Limited Entry Hunting (LEH; lottery) system, and one outfitter has licence to operate in the study area east of the height of land and north of the Bugaboo Creek drainage. The CMH Bobbie Burns and Bugaboo summer operating areas covered in this survey encompass all of mountain goat management subzone 4-34B, the southern edge of 4-34A, and the northeast half of 4-27C.

Evidence from studies in western Alberta 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 are primarily useful as trend indicators (Gonzalez-Voyer et al. 2001). Hence, periodic surveys are required to update population estimates and provide trend data to ensure that harvests are sustainable and populations remain healthy. In keeping with CMH's goal to be responsible stewards of the environments in which they work

(http://www.canadianmountainholidays.com/stewardship/vision_goals/), CMH requested that a goat survey be conducted during 2008 to follow up on the 2002/2003 surveys and to provide long-term population trends. The objectives of this 2008 study were to determine the numbers and distribution of mountain goats during early fall within all of CMH's Bobbie Burns summer operating area and the northern half of their Bugaboo summer operating area, and to compare survey results with historic data.

STUDY AREA

The 2002 survey covered a 797-km² census zone of potential goat habitat within the Bobbie Burns and Bugaboo summer operating areas (Poole and Adams 2002). Half of this area (395 km² census zone) was surveyed in 2003 (Poole 2003). Given budget constraints, in 2008 we surveyed a larger area than 2003, but smaller than 2002. The 2008 study area covered 611 km², and was bounded by the Spillimacheen River to the northeast, McMurdo Creek to the north, Duncan River to the west, Geigerick Creek and the Conrad Icefield to the south, and Bugaboo Creek to the east (blocks 1–10; Poole and Adams 2002)(Fig. 1). This area was chosen as a discrete set of mountain blocks to maximize the likelihood of sampling distinct goat populations (c.f. Gonzalez Voyer et al. 2003:214) and to minimize the potential for movement out of the census zone among years. Much of Bugaboo Provincial Park was surveyed, although the mountains surrounding the access into the Conrad Kain Hut were avoided to eliminate disturbance of hikers in the area. The Conrad Kain Hut area was also avoided in 2002; there are few if any goats present in this valley (T. Cardon, CMH, personal communication).

The study area is within the northern Purcell Mountains of the Columbia Mountains, west of the Rocky Mountain Trench (Fig. 1). The area surveyed is made up of 2 biogeoclimatic zones: Engelmann Spruce-Subalpine Fir (ESSF) zone and the Alpine Tundra (AT) zone above tree line (located roughly between 1900 and 2150 m [6,250–7,050 ft]) (Braumandl and Curran 1992). 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 annually, including 184 cm of snowfall. 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 valley sides, 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. A census zone of potential goat habitat was surveyed, which generally included steep or cliff habitat above 5,500 feet (1,700 m) elevation in most areas. (Feet are included as the unit of measure because the helicopter's altimeter was in feet).

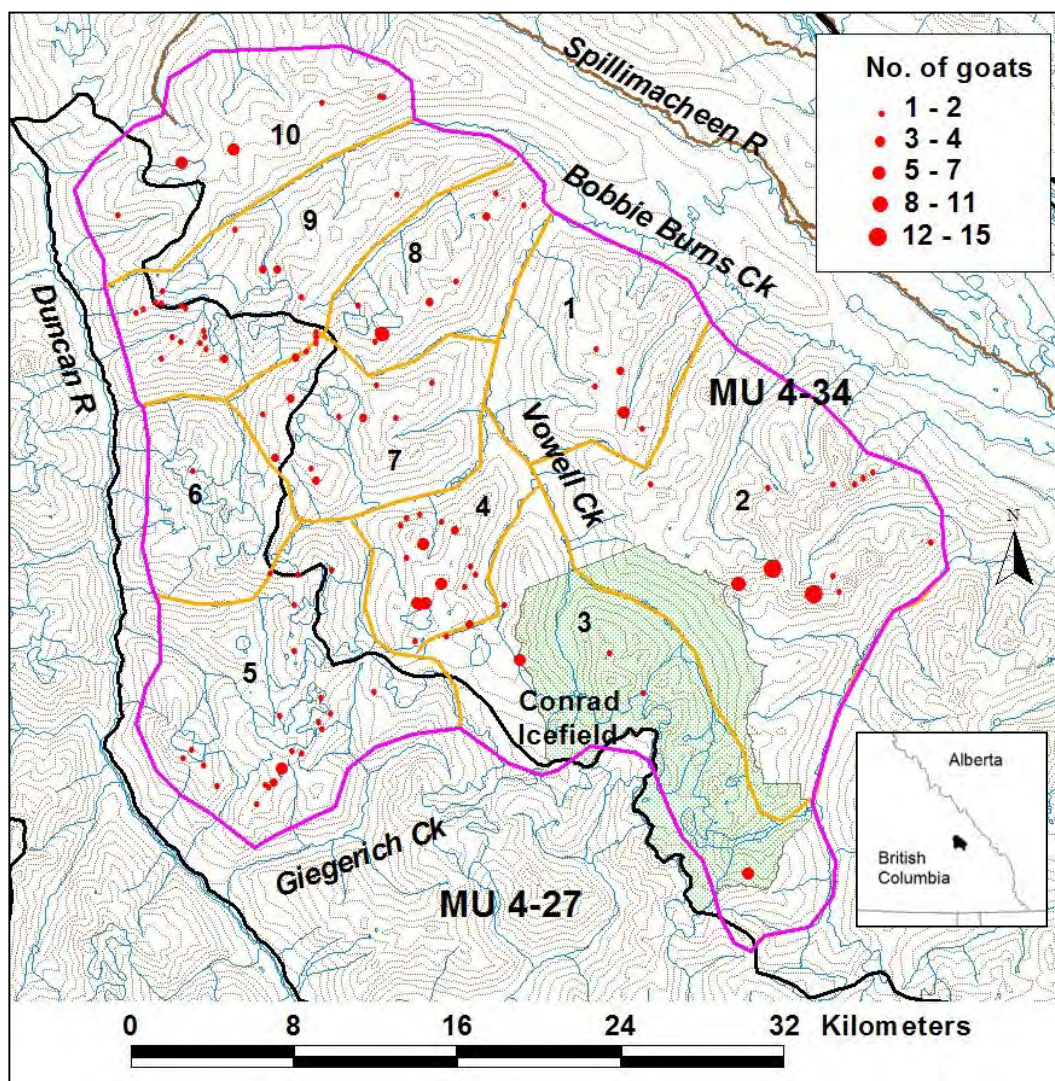


Figure 1. Location of mountain goats observed during the survey of Canadian Mountain Holidays' Bobbie Burns and Bugaboo summer operating areas, 15–18 September 2008. Purple outline depicts the study area; orange outlines with black numbers refer to survey blocks (Table 1); black outline is management unit boundaries. All potential goat habitat was surveyed, generally cliff and alpine habitat above 1,700 m (5,500 feet) elevation.

STUDY DESIGN AND METHODOLOGY

Study design and methodology generally followed RISC standards (RISC 2002, Poole 2007), and consisted of a total count survey, with sightability correction subjectively applied afterwards. The survey was consistent with methodology followed in past surveys in the area (Poole and Adams 2002, Poole 2003). To minimize potential variability and maximize repeatability in surveys among years, I attempted to ensure that timing, methodology, survey effort, and pilot and observers were consistent with previous surveys. To this end, survey timing, the helicopter pilot, and 2 of the 3 observers remained the same, and we attempted to conduct similar survey effort (approximately 1.5–1.9 min/km²; see results and discussion). Survey effort is in large part a function of the number of passes along a mountain face and the speed of those passes.

The census zone was broken into survey blocks (survey units), which generally consisted of discrete mountain blocks that we were able to survey within approximately 1–2.5 hours to avoid observer fatigue and to minimize the risk of animal movement within and out of blocks during the survey period. Block boundaries and the census zone within each block were the same as those used in past surveys.

We used a Bell 206B Jet Ranger helicopter with pilot, navigator, and 2 observers. The helicopter was equipped with bubble windows in the rear, and sliding windows in the front. All occupants participated in locating mountain goats, and all had extensive experience at aerial surveys. We surveyed all alpine, open subalpine, and forested cliff habitats. We flew roughly 150–200 m (500–650 foot) contour lines at 80–120 km/hr, 75–100 m out from the hillsides. We rarely used >10 minutes between adjacent contour flights to minimize the potential for excessive vertical movement of goats between passes. We mapped approximate flight lines and survey coverage on 1:50,000 scale topographical maps and calculated the census zone from the maps based on the area surveyed. Goat locations (corrected to the location of the group relative to the helicopter) and helicopter flight tracks were recorded with a hand-held global positioning system (GPS) unit, which were later downloaded to a computer. For each goat sighting we also recorded broad habitat type, and elevation from the helicopter's altimeter (estimated to the nearest 100 feet). We classified goats only into kids and non-kid (yearlings and older; hereafter called adults) based on body size (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). Incidental wildlife sightings were also recorded.

Harvest data were obtained from British Columbia Ministry of Environment (MoE) compulsory inspection (CI) files to 2005, updated with 2006 and 2007 data obtained from MoE (I. Teske, MoE, Cranbrook, unpublished data).

RESULTS

Survey

We conducted the survey 15–18 September 2008, surveying between 7:05 am and 12:20 pm. Survey conditions and lighting were generally good with clear skies. Overall weather was clear and slightly warm for this time of the year. Although overnight lows dropped to 2–5°C in Golden, temperatures within the census zone generally ranged from 8–12°C at survey time. To minimize the risk that we were missing goats that might have been seeking thermal cover during the heat of the day, we stopped surveying before noon on 3 of the 4 days of survey. We used 19.3 hrs of helicopter time,

including 16.5 hrs on survey, and surveyed a census zone of 611 km². Overall survey intensity averaged 1.6 min/km² (range among blocks: 1.2–2.4 min/km²; Table 1).

We observed 268 goats in 113 groups (Fig. 1), for an average observed density of 0.44 goats/km². Group size ranged from 1 to 15 goats and averaged 2.4 ± 0.22 ($\bar{x} \pm SE$). “Typical” group size, an animal-centred measure of the group size within which the average animal finds itself (Jarman 1974, Heard 1992), was 4.6 (± 0.24). Eighty-two percent of goat groups consisted of 1–3 animals. Overall we counted 55 kids (21% of total goats), a 26 kids:100 adults ratio. Based on past experience and other research (summarized in Poole 2007) and considering the survey effort and habitat, I applied a sightability correction factor of 65% to derive an estimate of 412 goats for the census zone (density of 0.67 goats/km²).

The bulk of goats were observed in subzone 4-34B (178 goats) and 4-27C (75 goats), with few goats observed in 4-34C (15 goats). Dividing the census zone into the front ranges (east of the Vowell Creek) and the areas west of Vowell Creek, densities were about 17% lower in the front ranges (however, 3 of the 4 largest groups were observed in the front ranges). Block 2 (Warren Creek) had the largest number of goats, and block 4 (Conrad Glacier, Vertigo) had the highest density (Table 1).

Table 1. Mountain goats observed by block, Canadian Mountain Holidays’ Bobbie Burns and Bugaboo Summer operating areas, September 2008. “Adults” refers to non-kids (yearlings and older).

Date	Block no.	Name	Time on survey (min)	Survey area (km ²)	Survey effort (min/km ²)	Total	Adults	Kids	Density (goats/km ²)
18 Sep 08	1	Grizzly Ridge	82	44.5	1.8	13	12	1	0.29
18 Sep 08	2	Warren Creek	157	131.0	1.2	53	42	11	0.40
17 Sep 08	3	Malloy Ck	76	58.0	1.3	15	11	4	0.26
17 Sep 08	4	Conrad Glacier, Vertigo	71	29.8	2.4	44	32	12	1.48
16-17 Sep 08	5	Giegerich, Crystalline	119	73.1	1.6	36	29	7	0.49
16 Sep 08	6	Hatteras	67	46.3	1.5	4	4	0	0.09
15-16 Sep 08	7	Syncline	93	52.0	1.8	28	25	3	0.54
16 Sep 08	8	Vermont, Malachite	71	30.6	2.3	23	17	6	0.75
15 Sep 08	9	Carbonate	157	71.8	2.2	36	29	7	0.50
15 Sep 08	10	Bobbie Burns	112	74.1	1.5	16	12	4	0.22
Total			1005	611	1.6	268	213	55	0.44

Goat groups were distributed from 1,710 to 2,680 m (5,600 to 8,800 feet) at a median of 2,345 m (7,690 feet), with 77% of groups observed between 2,150 and 2,550 m (7,050–8,370 feet; Fig. 2). We observed 39% of goat groups in cliff/broken cliff complexes ($n = 113$ groups). Other habitats used included scree/talus (23%), alpine meadows (13%), cliffs associated with open timbered habitat (10%), ridge tops (5%), areas associated with glaciers (4%), avalanche chutes (often with heavy alder [*Alnus* spp] coverage; 4%), and snow patches (2%).

Other wildlife observed included 3 grizzly bear (*Ursus arctos*) in 2 groups off Fitch Creek and Hatteras Creek (blocks 5 and 6), 1 black bear (*U. americanus*) at Bugaboo Pass (block 3), and a group of 3 wolverines (*Gulo gulo*) north of Bennison Creek (block 10; likely a female with 2 grown young of the year). Five mule deer (*Odocoileus hemionus*) in 3 groups were also observed in the subalpine above Bobbie Burns and Malachite creeks (blocks 8, 9, and 10). We counted 16 golden eagles (*Aquila chrysaetos*), and observed 6–8 falcons at high elevation (likely peregrine falcons [*Falco peregrinus*] and prairie falcons [*F. mexicanus*]; R. Ferguson, SUNRISE Birding Tours, Golden, personal communication).

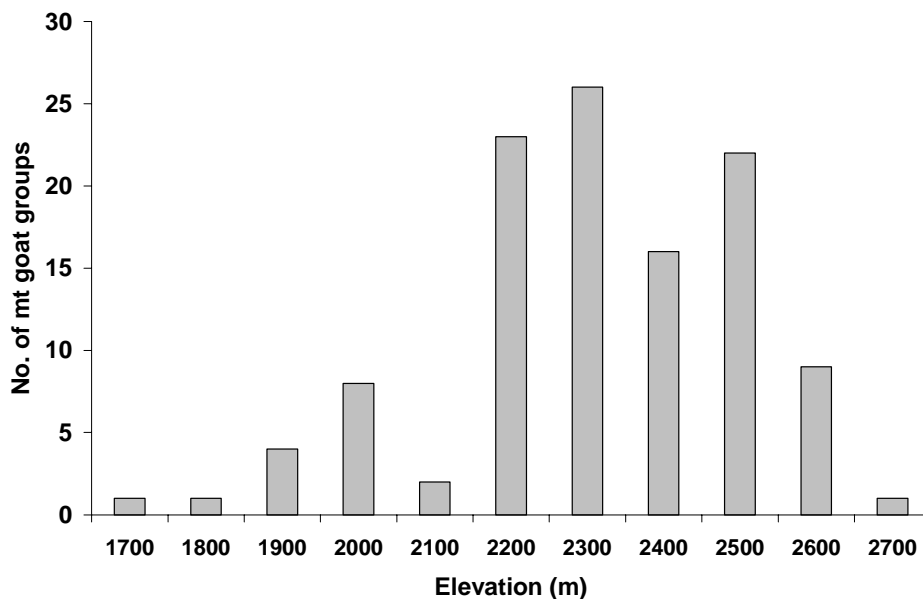


Figure 2. Elevation distribution of mountain goats observed during survey of Canadian Mountain Holidays' Bobbie Burns and Bugaboo summer operating areas, September 2008 ($n = 113$ goat groups). Elevations were estimated based on the helicopters' altimeter.

Harvest data

The bulk of the survey area was within subzones 4-34B and 4-27C, with only a small portion of 4-34C covered; therefore, the harvest analysis was restricted to the former 2 subzones. The current (2008) number of authorizations available for resident LEH hunters in subzones 4-34B and 4-27C is 134 tags, although in both subzones the number of tags available far exceeds the number of hunters applying (0.2:1 to 0.6:1 odds for 2007 for subzones 4-27C and 4-34B, respectively). The current non-resident goat allocation for the outfitter in the area is 16 goats over 5 years (2007–11), averaging 3.2 goats/year (maximum annual quota of 5 for 2008).

A total of 117 goats were harvested within the 2 subzones between 1982 and 2007 (Fig. 3). The bulk of the harvest took place during the late 1980s to late 1990s ($\bar{x} = 6.8$ goats/year), during a period when the proportion of females in the harvest was high (39%). Since 2000 the harvest has averaged 1.8 goats/year, with slightly fewer females in the harvest (29%). Almost three quarters of the harvest has been by residents, with almost half of the non-resident harvest occurring between 1996 and 1999; the guide/outfitter harvested only 3 goats from 2000 to 2007.

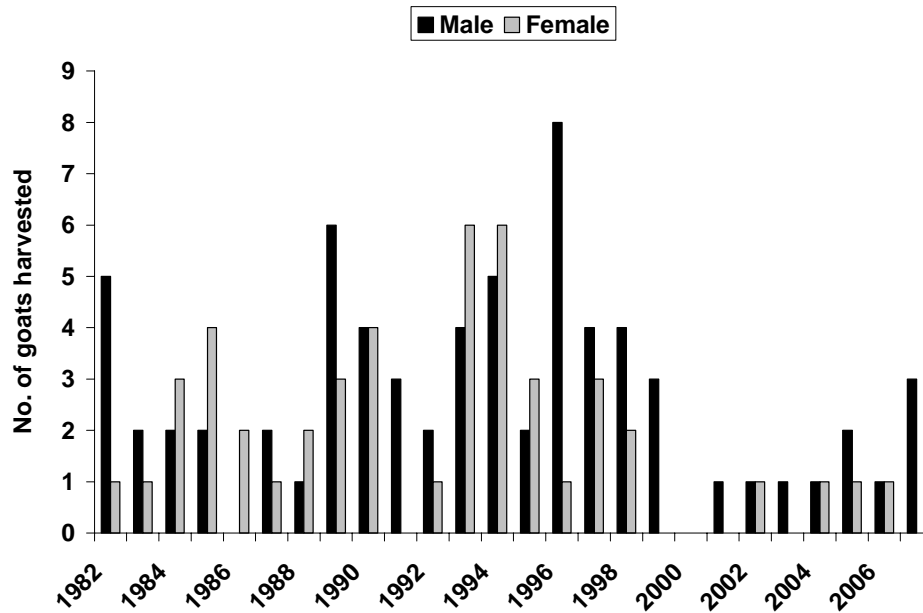


Figure 3. Mountain goat harvest data from 1982 to 2007 for subzones 4-34B and 4-27C combined, Kootenay region. One goat of unknown sex was also harvested in 1992.

DISCUSSION

Comparison with past surveys

The 2008 survey was conducted under very good survey conditions. Although temperatures within the census zone were higher than ideal, goats did not appear to be seeking thermal shelter in cliffs or forests prior to midday. The few small areas of fresh snow patches remaining at high elevation on north-facing slopes, a result of cool, wet weather earlier in the month, did not appear to hinder our ability to locate goats.

Studies point to the large variation in sightability obtained during goat surveys (summarized in Poole 2007). Our survey was designed to duplicate previous CMH surveys as much as possible, by using the same aircraft and pilot, and 2 of the 3 same observers, the same mid-September timing, and generally similar survey effort. Although the distribution of goats varied among surveys and average group size differed among years (PROC GLM on log transformed data; $F_{2,225} = 3.6$, $P = 0.03$) and was smaller in 2008 compared with 2003, mean elevation of goat groups was midway between the means observed in 2002 and 2003 ($F_{2,225} = 14.8$, $P < 0.0001$). Thus, based on elevation, it does not appear that goats were distributed vastly higher or lower than previous surveys. A relatively cool summer and wet, cool weather earlier in September may have resulted in differences in seasonal phenology that may have contributed to different goat distribution and group sizes.

Comparing total numbers of goats among surveys is of limited value because the census zones were not identical. Given expected movements by goats among blocks, I believed it was most appropriate to compare the number of adults observed within larger groups of blocks that may represent fairly discrete sub-populations. Acknowledging that “adults” as provided here means yearlings and older animals, this “adult” segment of the population is arguably more stable than the more variable production and survival of kids in their first few months of life.

Comparison of results with previous surveys suggests that goat populations in the census zone are at least 15–20% higher than found in 2002 and 2003 (Table 2). East of Vowell Creek in the front ranges 20% more adults were observed in 2008 compared with 2002 (Table 2). West of Vowell Creek, 15% more adults were counted in 2008 compared with 2003, and fully 67% more than observed in 2002. We cannot, of course, discount large movements of goats among mountain blocks as a major factor in the apparent increase in goat numbers. Given the general reluctance of goats to cross low-elevation, forested valleys, we attempted to geographically isolate our study area as much as possible, and likely accomplished this on the west (Duncan valley) and east (Columbia valley) sides. Although much of our northern boundary consisted of the Spillimacheen valley, high-elevation habitat occurs through part of our northern boundary at Silent Pass. High-elevation habitat also occurs around the Conrad Glacier and Bugaboo Pass on the south side of the study area, areas that typically harbour few goats. Collared mountain goats in the White and St. Mary rivers areas of the East Kootenay exhibited generally high fidelity to seasonal ranges (Poole et al. 2006), suggesting that broad-scale movements within seasons are rare. Given the fairly large areas surveyed, it is unlikely that immigration accounted for the bulk of the increased numbers of goats observed.

Population estimate

Although standardized surveys have greater utility in being used as indicators of broad population trend over time, rather than absolute estimates of population size (Gonzalez-Voyer et al. 2001, Poole 2007), management agencies still require estimates of population size based on infrequent surveys. Based on a 65% sightability factor I estimated a goat population of 412 goats for the census zone. In 2002 and 2003 we used 60% sightability to estimate goats numbers within the census zones (Poole and Adams 2002, Poole 2003). Subsequent to those surveys, sightability studies with collared goats in the East Kootenay and other research (summarized in Poole 2007) suggested that for the terrain, survey effort, and knowledge of the area, a 65% correction factor may be more appropriate. In recent surveys conducted in the East Kootenay, survey effort has ranged from 1.9–2.3 min/km², and a sightability correction of 60–65% has been applied (Poole and Klafki 2005; Poole 2006b, 2007).

Kid ratios

Kid ratios observed in 2008 (26 kids:100 adults) were less than ratios observed in 2003 (39:100; Poole 2003) but greater than ratios observed in 2002 (20:100; Poole and Adams 2002). Kid ratios in the East Kootenay have averaged 29:100 in 20 surveys conducted since 2000 (Poole 2006a). Kid production appears to be negatively associated with winter severity during pregnancy (Smith 1977, Adams and Bailey 1982, Swenson 1985) and April–May snowfall and snow depth (Thompson 1980, Hopkins et al. 1992). August kid ratios at Caw Ridge, Alberta, averaged 21:100 over the past 10 years (range 15–29:100), during a period when the population increased by approximately 50% (S. Côté, personal communication). Since much kid mortality can occur over winter and goats generally do not reproduce until 2–3 years of age, moderate to high kid ratios can provide an expectation of some recruitment, but are limited in their utility to predict population change (Côté and Festa-Bianchet 2003). Alternatively, low kid ratios may still result in increased populations if yearling and older mortality is low; if adult mortality is high, then higher recruitment is required to maintain a population.

Table 2. Comparison of combined block data among mountain goat surveys conducted in September 2002, 2003, and 2008, Bobbie Burns and Bugaboo summer operating areas. Note that the coverage for blocks 3N–10 includes a subsample of block 3, and is presented for comparison purposes with the 2003 survey. “Adults” refers to non-kids (yearlings and older).

Blocks	Survey area (km ²)	2002				2003				2008			
		Total	Adults	Kids	Survey effort (min/km ²)	Total	Adults	Kids	Survey effort (min/km ²)	Total	Adults	Kids	Survey effort (min/km ²)
1–2	176	53	45	8	1.4					66	54	12	1.4
3–10	436	112	94	18	1.5					202	159	43	1.8
3N–10	395	108	91	17	1.5	183	132	51	1.9	193	152	41	1.8

Harvest levels

The average annual harvest since 2000 within subzones 4-34B and 4-27C represents a 0.5% harvest rate. This rate is likely well below sustainable harvest levels for this population. Evidence from the western Alberta foothills suggest that harvest rates greater than 3% are not sustainable (Côté and Festa-Bianchet 2003, Gonzalez Voyer et al. 2003, Hamel et al. 2006). The East Kootenay has generally used a maximum 5% allocation in recent years (I. Teske MoE, Cranbrook, personal communication). Côté and Festa-Bianchet (2003) suggest that the best management strategy for native populations of mountain goats is to combine a 2–3% yearly harvest with a strong encouragement to harvest adult males. At 29% the proportion of females in the harvest is slightly higher than the average for the region (23%; Poole 2006a). Although hunters should be continually encouraged and educated to avoid killing females, the current harvest pressure within this area appears to be well within sustainable limits.

Management recommendations

Compared to surveys conducted in 2002 and 2003, the 2008 survey suggests that goat populations within the Bobbie Burns and Bugaboo summer operating areas have increased perhaps 15–20% over the past 5–6 years. Estimated density (0.67 goats/km²), while lower than estimated densities within the Rocky Mountains from Golden south to Highway 3 (range from 4 areas: 1.66–1.83 goats/km²), was similar to estimated densities obtained in management units 4-26 and 4-20 within the Purcell Mountains south of the current study (0.62–0.67 goats/km²; Poole 2006a). These consistencies lend support for an ecological basis for goat densities in the East Kootenay, possibly related to broad habitat carrying capacity or similar density-independent factors in operation (e.g., weather, predation, winter range limitations).

Hunter harvest levels are light within the study area. Ministry of Environment should continue to provide hunter education on goat sex identification for both resident and non-resident hunters/guides (e.g., using Duncan Gilchrist's goat identification DVD; www.wildramhunters.net).

In 2004 the Northern Wild Sheep and Goat Council adopted a position statement on helicopter-supported recreation and mountain goats that included a number of recommendations to avoid helicopter use near nursery and wintering areas during appropriate time periods (NWSGC 2004). These recommendations called for a 1.5 km no-fly zone around nursery groups and critical winter range. Goat populations within the Bobbie Burns and Bugaboo areas appear healthy despite 25 years of what could be considered fairly heavy helicopter use during the winter skiing and summer hiking seasons (relative to other non-tenured areas). Obvious population-level effects of helicopter disturbance are not apparent. Strict policies adopted by CMH to minimize potential disturbance of mountain goats and other wildlife may have reduced potential impacts from disturbance. Details of these goals and policies can be obtained at www.canadianmountainholidays.com/stewardship/, but include avoidance of landings and disuse of hiking trails if goats are observed in the area, and permanent avoidance of some areas known to be frequented by significant numbers of goats (e.g., Warren Creek and Kain Creek; T. Cardon, CMH, personal communication). CMH will undoubtedly continue to strengthen these policies and practises over time.

As noted earlier, standardized surveys have greater utility in being used as indicators of broad population trend over time, rather than absolute estimates of population size (Gonzalez-Voyer et al. 2001, Poole 2007). To monitor population status and provide long-term trend data, I recommend that the area be re-surveyed at 3–5 year intervals.

ACKNOWLEDGEMENTS

Canadian Mountain Holidays (CMH) funded this survey. I thank D. McTighe, Alpine Helicopters, Golden, for continued enthusiastic and skilled piloting, and T. Cardon, CMH, and I. Teske, MoE, Cranbrook, for their keen and competent assistance as observers. Interior Reforestation, Cranbrook, provided maps for the survey. D. Butler, CMH, provided logistic and administrative support, and reviewed an earlier draft of this manuscript.

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