

**Mountain Goat Inventory - GO79
Babine Mountains Provincial Park (LEH 6-08F)
March 2022**



Prepared for:
BC Parks
Ministry of Environment and Climate Change Strategy
and
BC Fish and Wildlife
Ministry of Forests
Smithers, BC

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Executive Summary

On March 12, 2022, Limited Entry Hunting (LEH) zone 6-08F which encompasses Babine Mountains Provincial Park was surveyed by helicopter to obtain a minimum count of mountain goats (*Oreamnos americanus*) following standards established by the Resources Information Standards Committee (RISC). The survey was completed in two flights, with high overcast and patchy cloud and snow conditions occurring in the morning, but clear skies during the afternoon flight. We observed 131 mountain goats (107 adults, 24 kids) overall with 75 adults and 19 kids in the North survey unit and 32 adults and 5 kids in the South survey unit. An overall population was estimated at 164 mountain goats using a sightability correction factor of 1.25. As this population is lower than the previous population of 220 mountain goats completed in 2003, a review of the number of LEH authorizations is recommended.



Disclaimer

This report has been prepared by Laurence Turney, R.P.Bio. of Ardea Biological Consulting Ltd. (Ardea) for BC Parks and BC Fish and Wildlife (the Clients) to outline the results of a population survey for mountain goats in Limited Entry Hunting zone 6-08F within Babine Mountains Provincial Park. The information contained in this report has been obtained and prepared in accordance with generally accepted biological survey standards and is intended for the exclusive use of the Clients. The information and analyses contained in this report is dependent on the conditions at the time and any recommendations or conclusions are based on the author's best judgement at the time of preparation. The Clients acknowledge that ecological conditions can change over time and that the conclusions and recommendations outlined in this report are time sensitive.

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Introduction

Background

The global population of mountain goats (*Oreamnos americanus*) is estimated to be between 80,000 to 120,000 animals (Festa-Bianchet and Côté 2008) with the population for British Columbia (BC) estimated as 43,000 to 71,000 animals (BC MFLNRO 2018). The Skeena Natural Resource Region population is estimated to be 20,000 to 40,000 and stable (BC MFLNRO 2018), but a review of available historic and current population data by Blythe and Kriss (2018) found limited numbers of recent surveys in harvested populations and limited ability to detect trends in population numbers or densities.

Mountain goats have been blue listed in BC since 2015, which indicates they are “of special concern” (BC Conservation Data Centre 2020). Although the species is widespread across the province, it faces threats throughout much of its range related to habitat loss, habitat fragmentation, isolation (Wilson and Morely 2007) and predation; and has experienced localized declines, with continuing declines in some areas of the province.

Mountain goats are sensitive to overharvest, particularly if female harvest is high (Hamel et al. 2006). British Columbia’s Mountain Goat Management Plan (Mountain Goat Management Team 2010) outlines recommendations for mountain goat population management to ensure sustainable harvest. Building on the recommendations from this strategy, the Province of BC developed Mountain Goat Harvest Management Procedure (BC MFLNRO 2014). It recommends a conservative harvest rate of $\leq 3\%$ per year for populations ≥ 100 adults, less if the female harvest exceeds 30% of the annual allowable harvest in a given year or if the population is <100 . Harvest closures are recommended in mountain goat populations with less than 50 adults. Further, hunted populations of goats estimated between 50 and 100 adults should be monitored at least every three years to ensure the harvest is sustainable. Hunters are encouraged to avoid harvesting females; harvesting a female accompanying a kid or a female in a nanny group (females and kids) is prohibited.

The Skeena region manages mountain goat harvest through General Open Season (GOS) in remote areas with limited hunter access, and through Limited Entry Hunting (LEH) in areas with easier hunter access and pressure. LEH zones allow wildlife managers to adjust the number of LEH authorizations issued yearly to reflect changes in harvest pressure population metrics. A GOS system has no limit to number of permits issued.

The Mountain Goat Management Team (2010) recommended that mountain goat surveys provide sufficient detail to allow others to compare data among areas and over time by including time on survey (to calculate survey effort), area of potential mountain goat habitat surveyed (to calculate survey effort and density), and age/sex breakdown of sightings (as appropriate). This survey was conducted and the report has been prepared to meet these recommendations using the survey objectives outlined below.

Survey objectives were as follows:

- (1) Count, classify by age, and record mountain goat groups and distribution;
- (2) Obtain an adult/kid ratio (% kids) and a kids per 100 adult ratio;
- (3) Obtain a minimum count, population estimate and population density for the surveyed population;
- (4) Provide an estimate of survey effort based on the amount of area surveyed; and
- (5) Using the population estimate, determine LEH authorizations to meet the Provincial Mountain Goat Management Plan and Regional Harvest Strategy guidelines.

Study Area

LEH zone 6-08F encompasses portions of the Wet'suwet'en Nation and Lake Babine Nation traditional territories (BC Treaty Commission 2022) as well as Babine Mountains Provincial Park (Babine Mountains Park) and the Babine Mountains Park Trails Protected Area (Figure 1). It is located on the east side of the Bulkley River northeast of the town of Smithers, BC. LEH zone 6-08F is approximately 84,871 ha and contains sub-boreal spruce (SBSdk and SBSmc2), Engelmann spruce sub-alpine fir (ESSFmc and ESSFmcp) and boreal alтай fescue alpine (BAFAun) biogeoclimatic subzones (Banner et al. 1996). Elevations range from 420 m to 2,380 m, with a variety of forested, wetland, sub-alpine and alpine habitats.

Methods

Survey Unit Delineation

Determining survey effort and population density requires that survey units be identified and delineated which likely contain mountain goats that can be counted efficiently and effectively. The criteria for the delineation of the survey unit needs to be documented so that others can use it for comparison to compare historic or subsequent surveys.

Within LEH zone 6-08F, Cichowski (1993) outlined North and South survey units within Babine Mountain Park based on the 4,500 ft (1,370 m) contour using 1:250,000 topographic maps; calculating the total area for the zones as 324 km² (Cichowski et al. 1994). Since no digital version of the North and South survey units is available, we used the 1,300 m contour linework from 1:250,000 CanVec mapping (Natural Resources Canada 2015a) to re-create it. We used the stream network lines from CanVec 1:250,000 mapping (Natural Resources Canada 2015b). For Driftwood and Cronin creeks as per Cichowski (1993) for the North and South survey units. We then reviewed the mountain goat habitat model for the Skeena Region developed using habitat features such as slope, aspect and historic mountain goat population and telemetry locations (Keim and Lele 2006). Several modelled polygons were on the border of the initial survey units and we adjusted the boundary to include those that were known to have historic use from available inventory locations (Cichowski 1993 to 1997, Cichowski et al. 1994, Schultz 2003). The total area of the final version of the survey units is 313.2 km², the North unit is 174.1 km², while the South unit is 139.0 km². Figure 2 outlines the North and South survey units and the mountain goat habitat model polygons in relation to the LEH zone.

Aerial Survey Methods

A Bell 206 Long Ranger helicopter (Canadian Helicopters, Smithers, BC) equipped with rear bubble windows was used to count and classify mountain goat adults and kids in LEH zone 6-08F generally following the RISC survey standards for aerial surveys of mountain goats (BC MSRM 2002). The survey crew included one pilot and three observers: Rob Henderson (pilot), Laurence Turney (navigator/ observer), Darren Fillier (observer/ recorder) and Gary Michelle (observer).

The survey area was completed using a GPS enabled tablet (Samsung S3) running Avenza Maps software (Avenza Systems Inc.), and a map developed by Ardea containing topographic features, the LEH boundary, North and South survey zones, and the mountain goat habitat model. Real-time tracking was used to track the areas for survey as well as those that had been surveyed to ensure coverage of the study area. We surveyed starting at lower contour lines from approximately 1,000 m to 2,150 m, approximately 100 m from the mountainside, at a target speed ranging from 60 to 120 km/hr (Poole 2007). We concentrated on surveying sub-alpine (ESSFmc and ESSFmcp) and alpine (BAFAun) areas as the majority (58%) of the modelled goat habitat is in BAFAun and approximately 35% is in the ESSFmc and ESSFmcp BGC subzones (Banner et al. 1993).



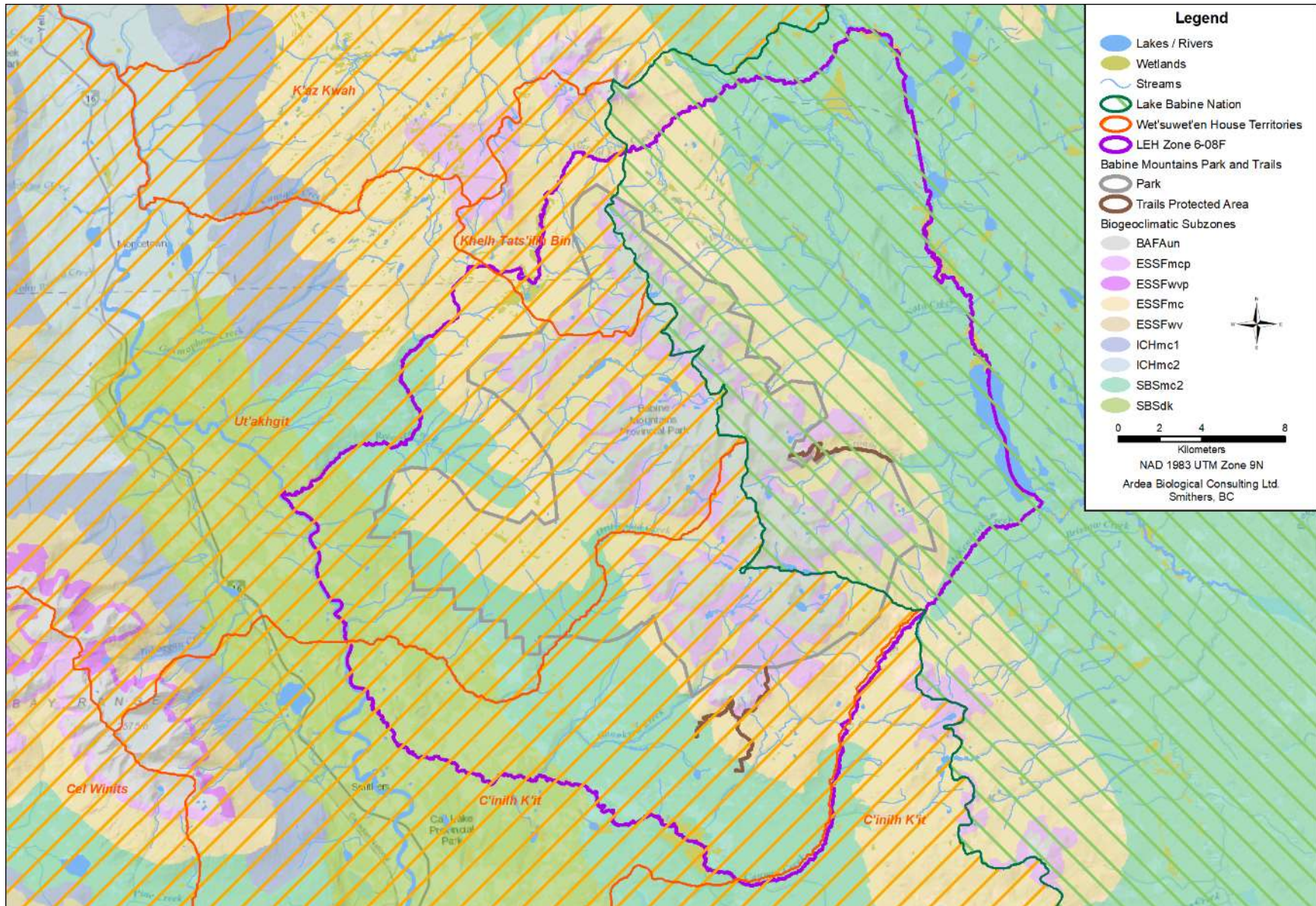


Figure 1. Traditional territories, limited entry hunting (LEH) zone 6-08F, Babine Mountains protected areas and biogeoclimatic subzones.

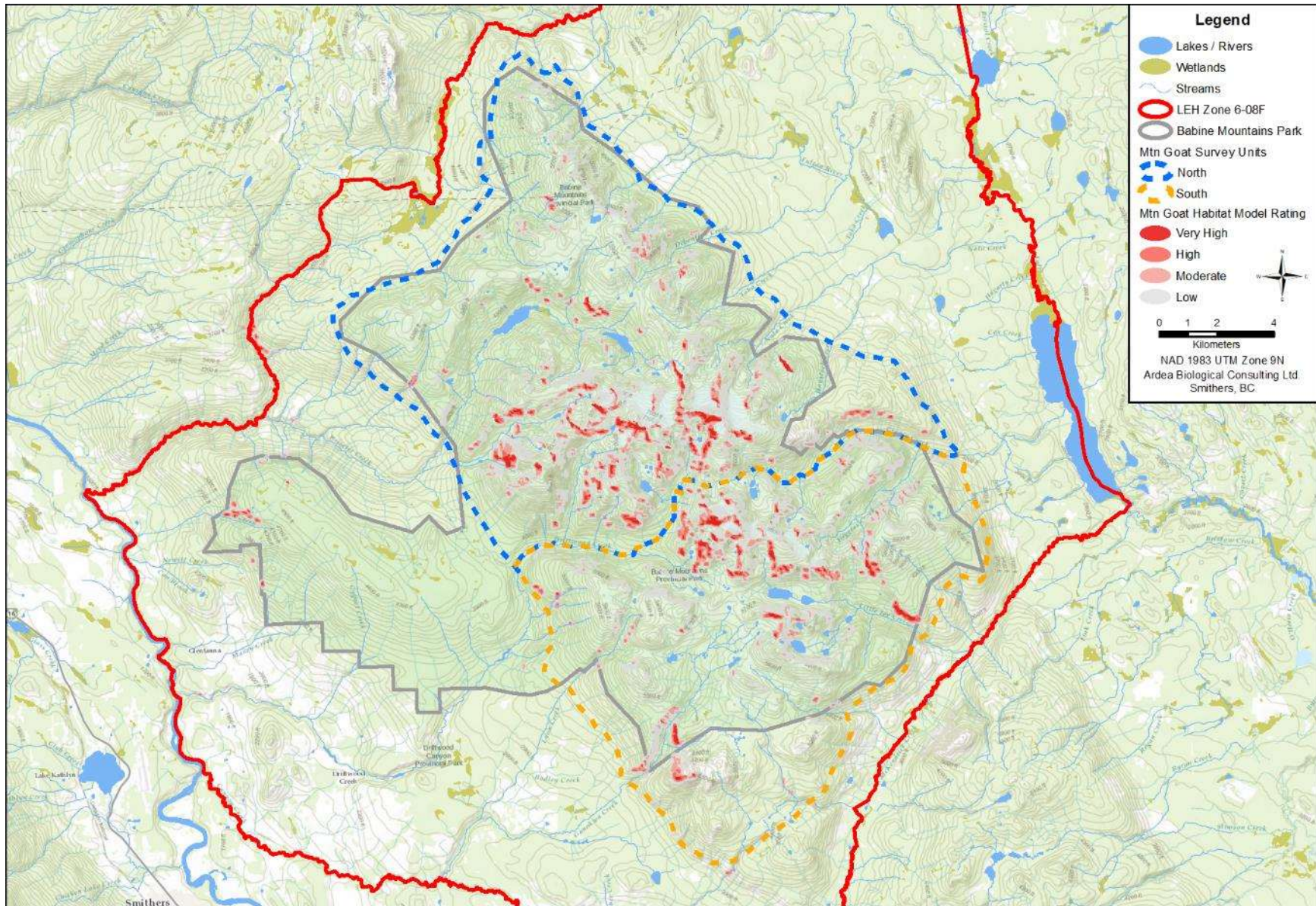


Figure 2. Survey units and mountain goat habitat modelled within LEH zone 6-08F and Babine Mountains Park.

The goal of the survey was to survey at least 80% of the modelled mountain goat habitat, with multiple passes completed along mountain sides starting from the lower elevation of the modelled habitat area to ensure coverage of the habitats. We also surveyed other potential habitats that were observed opportunistically between the modelled, which included steep rocky habitats and ridges suitable for mountain goat resting, foraging and escape terrain. Goats were classified as adults or young born the previous spring (kids) based on relative size. Adults were not classified by sex as it is difficult to determine from the air without disturbance to the animals and these data are generally not required as part of the current mountain goat management strategy. Sighting information for each waypoint were recorded off-set to the survey flight-line in real-time on the tablet. For each waypoint the number of animals, age class, habitat observed and any comments relevant to the sighting was recorded on paper survey sheets. Additional waypoints to record incidental wildlife species sightings and human motorized and non-motorized use were also recorded.

Data Analysis

Sightability Correction Factors

It is expected that some goats present in the survey area are missed by observers due to being obscured by vegetation, rock features or when observers are concentrating on other goats. The Mountain Goat Management Team (2010) has identified the variability and lack of reliable sightability correction factors (SCFs) in mountain goat inventories as a challenge in mountain goat population management.

The average sightability during mountain goat surveys for interior BC populations has been reported as low 60 to 70% (SCF = 1.43 to 1.67) (Gonzalez-Voyer et al. 2001, Poole 2006) up to 85% (SCF = 1.18) for interior populations in Washington (Rice et al. 2009). Blythe and Kriss (2018) outline a range of SCFs that have been used to calculate population estimates for surveys completed within the Skeena Region. The most common SCF was 1.15 (87% sightability) up to 2010, with a SCF of 1.25 (80% sightability) appearing to be used as the standard since 2012. Calculated SCFs for mountain goats in the Skeena region include a value of 1.16 by Schultze (1997) using collared mountain goats in three mountain blocks (Thoen, Morice and Nadina mountains); while a SCF of 1.47 (68% sightability) can be calculated from a mark-recapture study of paint-marked goats in Babine Mountain Park by Cichowski et al. (1994). To maintain consistency between recent surveys and allow comparison to historic surveys population estimates were provided using a SCF of 1.25.

Survey Effort and Population Density

Survey effort is based on the minutes flown actively searching for mountain goats within a survey area (e.g. survey minutes/km² surveyed) (Poole 2007, Mountain Goat Management Team 2010). To calculate the actual areas surveyed, we applied a 300 m buffer to our survey track within each survey unit within the survey area. To test if we met our goal of assessing at least 80% of the modelled habitat we calculated the amount of modelled mountain goat habitat observed within the 300 m buffer in relation to the total amount within the survey units and the entire survey area. Total animals observed and population estimates using the SCFs were used to calculate densities contained within the North and South survey units and the total survey area.

Results

Survey Conditions and Survey Statistic

The survey was conducted in two flights on March 12, 2022 (Figure 3). The first flight was from 08:15 to 11:15 encompassing the South zone and the eastern portion of the North zone, while



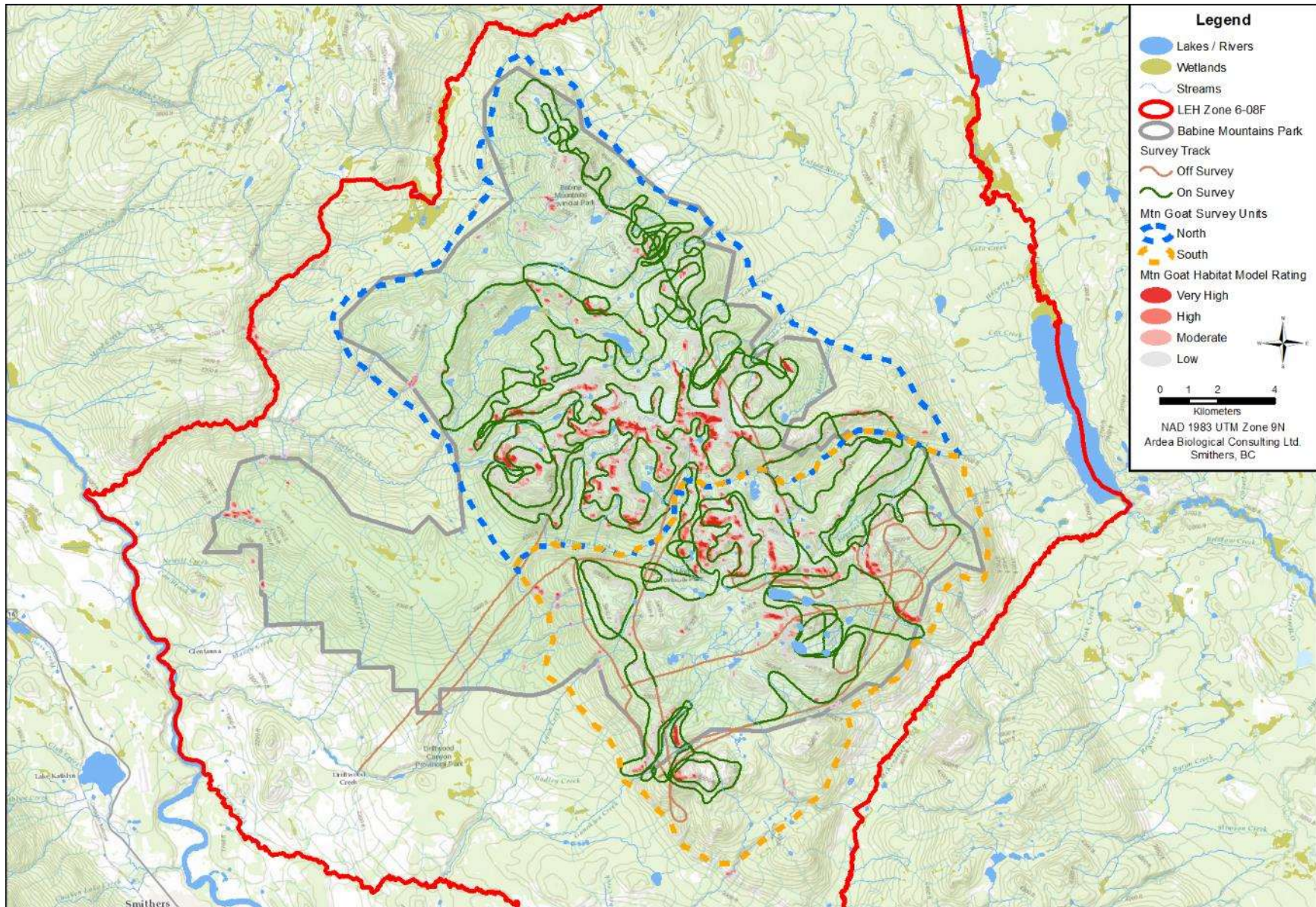


Figure 3. Survey track of mountain goat survey March 12, 2022 within LEH zone 6-08F and Babine Mountain Park.

the second flight occurred from 12:00 to 13:34 in the western and central portions of the North zone and small areas of the South zone that were missed due to clouds during the morning flight. Weather during the morning survey was good, with temperatures around -20°C approximately 20% cover and winds light from 10 to 20 km/hr, although some areas within the eastern sides of the mountains in the North zone experienced downdraft conditions with wind speeds estimated at up to 50 km/hr. During the afternoon survey, temperatures were slightly higher at -10°C and wind levels had decreased to less than 30 km/hr. Snow depths varied and were estimated to range between less than 10 cm on windblown areas to greater than 100 cm in accumulation areas; the last snowfall in the area occurred within the previous 2 to 3 days.

We surveyed starting at the lower contour lines from approximately 1,000 m to 2,150 m, with a survey pass initiating at the lower portion of the modelled mountain goat habitat and up to two additional passes completed approximately 200 apart where additional modelled habitat occurred. Each pass was conducted approximately 100 m from the mountainside, survey speeds ranging from 11 km/hr to over 180 km/hr, with 71% to 78% (average 74%) of the survey conducted between the target speed range of 60 to 120 km/hr (Figure 4).

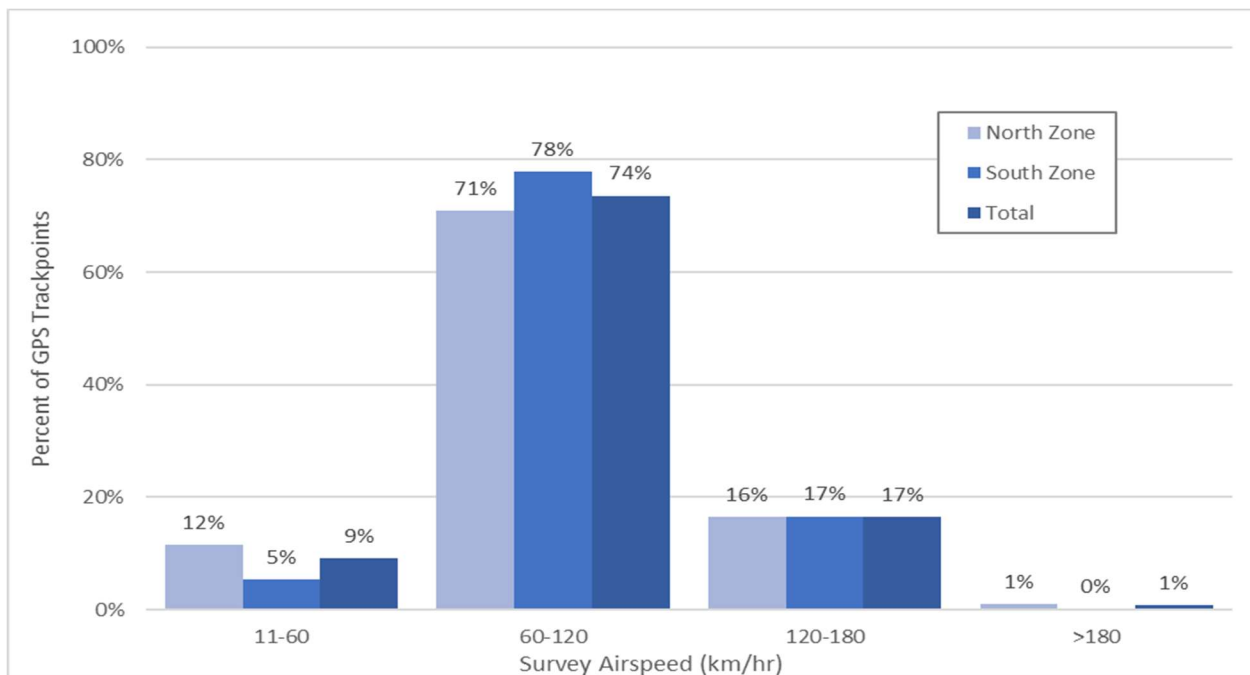


Figure 4. Distribution of helicopter airspeeds from GPS trackpoints during surveys within the North and South survey units.

The time on-survey for the South zone was 1.7 hrs and 2.7 hrs for the North zone, with an additional 0.5 hrs ferrying from the base to the survey areas and 0.5 hrs during the surveys ferrying between survey areas. The total cost for the 5.4 hrs of helicopter time was \$8,700.90.

Mountain Goat Observations and Population Estimates

During the surveys a total of 131 mountain goats were observed in 47 groups within LEH zone 6-08F, with 107 adults (81.7%) and 24 kids (18.3%) identified. Within the South survey unit, a total of 37 goats (28.2% of total goats) were observed in 14 groups; 86.5% were adults and 13.5% were kids, while in the North survey unit 94 goats (71.8% of total goats) were observed in 33 groups with 79.8% being adults and 20.2% identified as kids. Based on a SCF of 1.25, a population estimate of 46 goats was calculated for the South zone (40 adults, 6 kids), 118 goats for the North zone (94 adults, 24 kids) and 164 goats for LEH 6-08F (134 adults, 30 kids).

Table 1. Number of mountain goats observed (SCF = 0) and calculated population estimates (SCF = 1.25) in the South and North survey units and the total survey area.

Survey Units	SCF	Adults	Kids	Total	% Kids	Kids per 100 Adults
South Unit	0	32	5	37	13.5	16
	1.25	40	6	46	13.0	15
North Unit	0	75	19	94	20.2	25
	1.25	94	24	118	20.3	26
Total Survey Area	0	107	24	131	18.3	22
	1.25	134	30	164	18.3	22

Survey Effort and Mountain Goat Density

Based on the 300 m buffer on the on-survey GPS track lines, 89% (24.3 km² of 27.4 km²) of the modelled mountain goat habitat was identified as inside the buffer in the North zone and 84% (16.7 km² of 19.8 km²) was inside the buffer in the South zone. The total amount of modelled goat habitat within the 300 m track line buffers within LEH zone 6-08F was 82% (41.0 km² of 49.7 km² in the LEH), meeting our target of surveying at least 80% of modelled mountain goat habitat.

The tablet and Avenza Maps gathered track waypoints while on-survey approximately every 2 seconds (98% of 7,600 points), which allowed us to accurately calculate flight distances and speeds during the survey. Within the North unit we were on-survey for 159.6 minutes, while we were on-survey within the South unit for 100.3 minutes and off-survey in the survey area for 33.7 minutes. The total time spent within the survey area was 4.9 hours. Based on the survey unit areas, our survey effort was 0.9 minutes/km² for the North unit, 0.7 minutes/km² for the South unit and 0.8 minutes/km² for the entire survey area.

Table 2 outlines the population densities for the survey units and the total survey area for observed animals (SCF = 0) and a population estimate based on a SCF of 1.25.

Table 2. Total number of mountain goats observed and calculated population estimates (SCF = 1.25) in the South and North survey units and the total survey area.

Survey Units and Area (km ²)	SCF	Number of Mtn Goats	Population Density Estimate (Mtn Goats/km ²)
South Unit	0	37	0.27
139.0 km ²	1.25	46	0.33
North Unit	0	94	0.54
174.1 km ²	1.25	118	0.68
Total Survey Area	0	131	0.42
313.2 km²	1.25	164	0.52

Historic Mountain Goat Licenced Harvest in LEH Zone 6-08F

The number of male and nannie (female) mountain goats harvested within LEH zone 6-08F from 1996 to 2021 is outlined in Figure 5 and ranges from 2 to 11 animals per year (range of males 1 to 9 goats per year; nannies 0 to 7 goats per year) over this 25-year period. A total of 171 mountain goats were harvested (125 males, 46 nannies) with the proportion of nannies within the total harvest per year averaging 24.6% (range 0.0% to 87.5%), and the highest proportion of nannies harvested occurring in 2000. The age classes of the 46 harvested nannie mountain goats (nannies) from 1996 to 2021 are outlined in Table 3 and shows that 52.2% (24 animals) were considered established breeding animals.



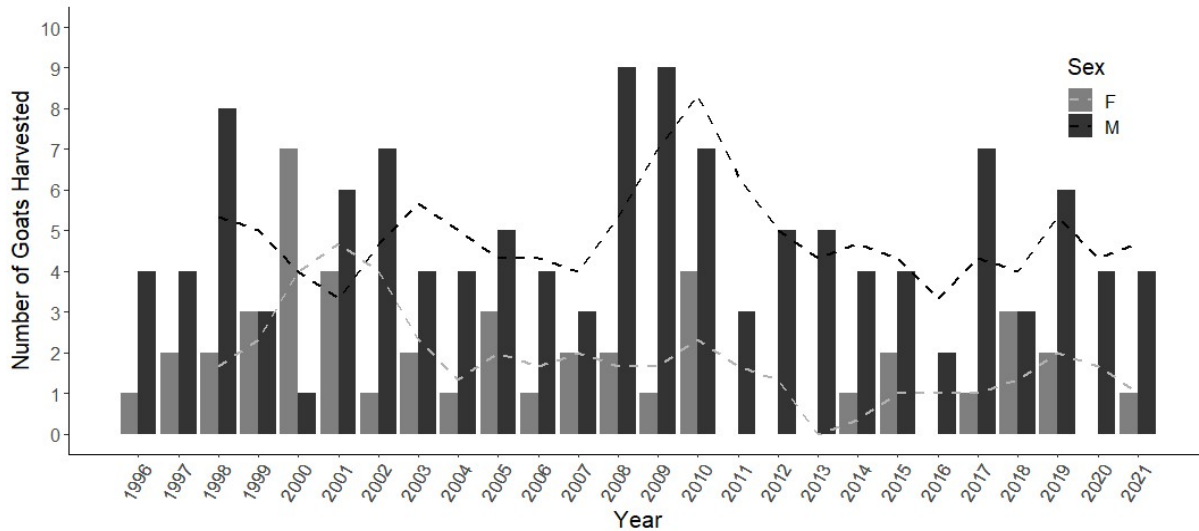


Figure 5. Licenced mountain goat harvest in LEH zone 6-08F from 1996 to 2021 (dashed line represents 3-year moving average of harvest).

The number of LEH authorizations in LEH zone 6-08F from 2017-2021 was seven animals per year from 2017 to 2020 seasons and six animals for the 2021 season for a total of 34 animals.

Harvest statistics for the five- year period from 2017 to 2021 (Figure 5) show that 31 mountain goats were harvested (range of 4 to 8 goats per year (average 6.2 goats per year) and that 7 nannies were harvested. The proportion of nannies within the total harvest during this period averaged 21.5% per year (range 0.0% to 50.0%) with the highest proportion occurring in 2018. A comparison of the ages of nannies harvested from 2017 to 2021 is outlined in Table 4 and shows that 57.1% were considered established breeding animals.

Discussion

Population Trends

For the period 1985 to 1997, six population surveys were completed within LEH 6-08F and Babine Mtns Park that were identified as total population surveys by Cichowski (2002). The most recent population survey was completed in 2003 (Schultz 2003), and along with this 2022 survey, a total of eight population surveys have been completed in the last 37 years (Table 5). For comparison purposes, a SCF of 1.25 has been selected for 2022, and using this SCF across the eight surveys, the population appears to have decreased from a high of 326 goats in 1995 to a low of 164 observed in this 2022 survey (Table 5 and Figure 6).

Table 3. Comparison of age classes of nanny mountain goats harvested from LEH zone 6-08F from 1996 to 2021.

Age Class	Nannie Class	Total Harvested	Percent of Nannie Harvest
Unknown	Unknown	5	10.9%
≤ 3.5	Immature	8	17.4%
3.5 ≤ 5.5	Recruiting	9	19.6%
> 5.5	Established	24	52.2%

Table 4. Comparison of age classes of nanny mountain goats harvested from LEH zone 6-09F from 2017 to 2021.

Age Group	Nannie Class	Total Harvested	Percent of Nannie Harvest
≤ 3.5	Immature	0	0.0%
3.5 ≤ 5.5	Recruiting	3	42.9%
> 5.5	Established	4	57.1%

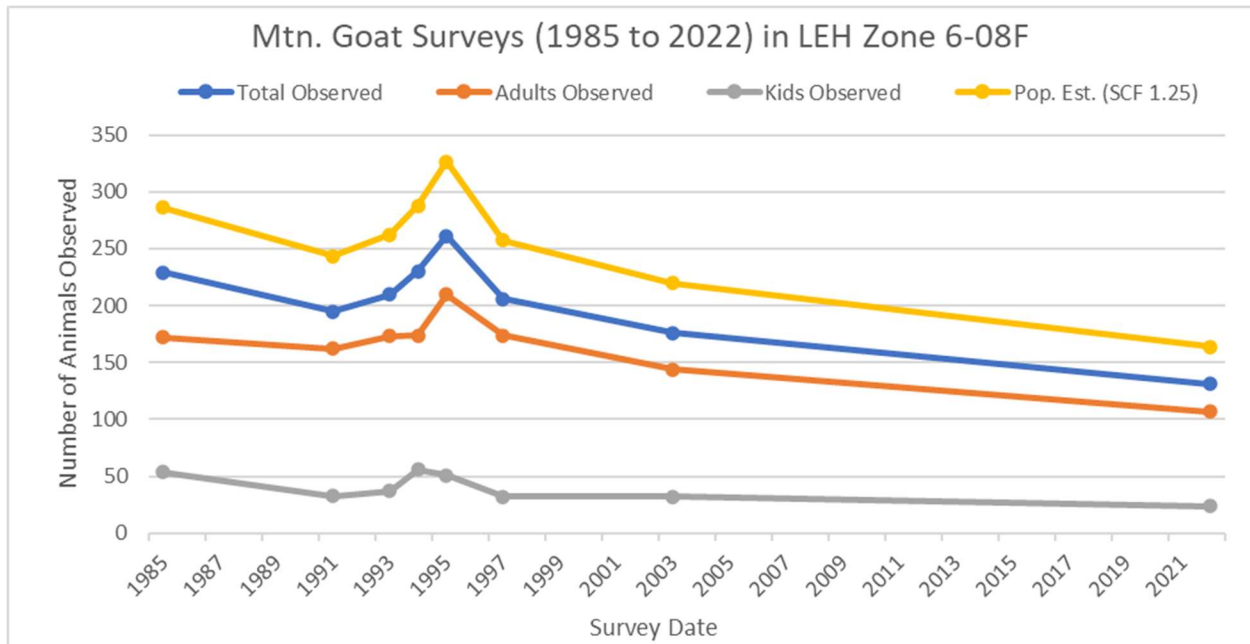


Table 5. Summary of mountain goat survey results for LEH zone 6-08F and Babine Mtns Park from 1985 to 2022.

Survey Counts										
Year	Date	Adults/ Yearlings	Kids (Young of Year)	Unclassified	Total Mtn. Goats	SCF Published	Published Population	Population (SCF = 1.25)	Kids per 100 Adults	Reference
1985	July 20	172	54	3	229	1.08 ¹	249	286	31.4	Cichowski 2002
1991	July 22 to 24	162	33		195	1.45 ¹	283	244	20.4	Cichowski et al. 1994
1993	March 24,28	173	37		210	1.25	263	263	21.4	Cichowski 1993
1994	March 28	174	56		230	1.25	288	288	32.2	Cichowski 1994
1995	March 27	210	51		261	1.25	326	326	24.3	Cichowski 1995
1997	March 15, 23	174	32		206	1.25	258	258	18.4	Cichowski 1997
2003	March 6	144	32		176	1.25	220	220	22.2	Schultz 2003
2022	March 12	107	24		131	1.25	164	164	22.4	Turney 2022

Notes: 1) Calculated based on published total animals and population estimate provided in references

Figure 6. Mountain goat survey and population results from 1985 to 2022 in LEH Zone 6-08F and Babine Mtns Park.



The lack of survey effort information for surveys completed before 2003 limits the ability to determine how the 2022 survey compares to those earlier surveys. The only survey effort data provided for the 2003 survey was that it was completed over approximately 5 hours of flying time, which is very similar to the 4.9 hours flying that occurred within the 2022 survey. Based on this limited survey effort information, the 2022 survey indicates a 25% population reduction from 2003 and a potential 50% reduction from the population estimate of 326 provided in 1995.

The number of kids per 100 adults has varied within LEH zone 6-08F and Babine Mtns Park from a high of 32.2 kids per 100 adults in 1994 to a low of 18.4 kids per 100 adults in 1997

(Table 5). Since 1995, the kids per 100 adults ratio has been relatively stable between 18.4 and 24.3 (average 21.8 kids per 100 adults). The current ratio of 22.4 is higher than the average since 1995, and higher than the average of 20.1 kids per 100 adults observed in population surveys near LEH zone 6-08F from 2012 to 2021 ($n = 10$, range 13.5 to 31.6) (Dixon 2015, 2016 and 2018, Blythe and Kriss 2018, MacAulay 2021, Widmeyer 2021). Based on this information, it appears that mountain goat recruitment is relatively good but mortality factors either of kids and/or adults appears to be occurring and causing the population decreases observed. A variety of factors may be involved in mountain goat mortality including increased predation risk, reduced fitness due to changes in climatic and/or vegetation condition or disease. Movements between sub-populations may also be occurring to cause individual sub-population changes.

Survey Effort

Both the *Management Plan for Mountain Goats* (Mountain Goat Management Team 2010) and the biologists in the Skeena Region (Blythe and Kriss 2018) have identified that a consistent method for calculating survey effort is required to allow comparison of population surveys. Unfortunately, this recommendation does not appear to have been implemented in the Skeena region, as recent surveys (e.g. Kriss 2021 and 2019, MacAulay 2021, Widmeyer 2021, Dixon 2018) do not provide a quantitative evaluation of survey effort or even survey unit area. Blythe and Kriss (2018) recommended standards for digital flight path and observations storage, and recent report mapping (e.g. Kriss 2021, Widmeyer 2021) show these flight paths; although no information on the survey unit area, proportion of survey units surveyed, potential mountain goat habitat surveyed or survey effort (e.g. $\text{km}^2 / \text{minute of survey}$) is provided.

Our survey effort ranged from 0.7 minutes/ km^2 to 0.9 minutes/ km^2 (average 0.8 minutes/ km^2 for the entire survey area), which is lower than the range of survey efforts outlined in Poole (2007) (1.3 to 6.1 minutes/ km^2) for his work, and the 1.0 to 1.9 minutes/ km^2 he outlined for several surveys completed in southeastern BC (BC Ministry of Environment unpublished data *In* Poole 2007). Poole (2007) indicated that survey efforts greater than 2.0 minutes/ km^2 do not appear to increase sightability and the likelihood of greater numbers of goats being observed.

Mountain Goat Harvest Levels

The current harvest authorizations for LEH zone 6-08F appear to be based on the 2003 population survey (Schultz 2003) of 220 mountain goats. As the current population estimate is 25% less than the 2003 population estimate, it may be necessary to review and adjust the future number of LEH authorizations.

Recommendations

The results of the March 2022 survey of LEH zone 6-08F strongly suggests that the population is decreasing, while the kid/adult ratio is relatively stable, which suggests that increased mortality or movements between sub-populations may have reduced the population of LEH zone 6-08F. Determining the current population trend will require that surveys be completed more frequently over the next three to five years.

- Surveys should be conducted so that adjacent population management units are completed within the same year, to potentially determine if movements between sub-populations are occurring.
- Along with increased surveys to help understand population trends, a review of mortality risks for mountain goat from predators, changes in vegetation condition, competition with other species, or stresses related to increased recreation, or vegetation changes due to climate or weather changes should be undertaken.



- To standardize methods for determining survey effort, digital survey areas and survey units within each survey area should be created using available mountain goat habitat mapping, previous survey locations, elevation, mountain goat ungulate winter range and BGC information.
 - Survey units can vary in size depending on topography, elevation and habitats but should be of a size that can be covered within 1 to 2 hours of flying.
- Ensure that digital trackline information is collected at a sufficient density (e.g. 1 point every 2 to 5 seconds) and survey notes/waypoints taken to identify on and off survey times during surveys.
- Either record on the survey form the estimated off-sets from the trackline of all mountain goat sightings, or place the sighting waypoints in real-time as the survey is underway to allow for relatively accurate location data for the sightings.
- Develop a standard method to quantify the area surveyed using a buffer on the trackline that is the effective area surveyed (e.g. 300 m either side of the trackline).
- Calculate survey effort (minutes of survey / km²) based on the area surveyed and the trackline distance that surveyors were on-survey so that this measure can be used to help compare successive surveys as well as between survey areas. Poole (2007) suggested that a target of 1.5 minutes/km² of survey area may be a reasonable search effort for survey effort.

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Rob Henderson from Canadian Helicopters in Smithers provided safe and skilled flying during the survey. The survey crew included Laurence Turney (Ardea) as navigator/observer, Darren Fillier (BC Parks) as observer/recorder and Gary Michelle (Office of the Wet'suwet'en) as observer. The survey was funded from the Parks Enhancement Fund (PEF), through the purchase of licence plates through the BC Parks Licence Plate Program. Thanks to Samantha Widmeyer (BC Fish and Wildlife) and Darren Fillier (BC Parks) for their review and feedback on earlier drafts, along with Matt Jones and Heidi Schindler (BC Fish and Wildlife) for their review and feedback on the final draft.

References

- Banner, A., W. MacKenzie, S. Haeussler, S. Thomson, J. Pojar and R. Trowbridge. 1993. A field guide to site identification and interpretation for the Prince Rupert Forest Region. Land Management Handbook No. 26. Ministry of Forests Victoria, BC.
- BC Conservation Data Centre. 2020. BC Species and Ecosystems Explorer. B.C. Ministry of Environment. Victoria, B.C. Available: <http://a100.gov.bc.ca/pub/eswp/>.
- BC Ministry of Forests, Lands, and Natural Resource Operations (BC MFLNRO). 2014. Procedure Manual: Mountain goat harvest management. Available: http://www.env.gov.bc.ca/fw/wildlife/policy_procedures/docs/procedure/4_7_01.07.4.pdf.
- BC Ministry of Forests, Lands and Natural Resource Operations (BC MFLNRO). 2018. British Columbia ungulate species regional population estimates and status - Preseason 2017. Available: <http://www.env.gov.bc.ca/fw/wildlife/>. Accessed March 12, 2018.
- BC Ministry of Sustainable Resource Management (BC MSRM). 2002. Aerial-based Inventory Methods for Selected Ungulates: Bison, Mountain Goat, Mountain Sheep, Moose, Elk, Deer and Caribou. Province of British Columbia, Standards for Components of British Columbia's Biodiversity No. 32.



- BC Treaty Commission. 2022. Interactive map. Available: <https://www.bctreaty.ca/map>.
- Blythe, E. and K. Kriss. 2018. State of knowledge: Mountain goat populations in the Skeena Region. Fish and Wildlife Branch, Ministry of Forests Lands, Natural Resource Operations and Rural Development, Smithers BC.
- Cichowski, D. 1993. Babine Mountains Recreation Area - mountain goat distribution survey, March 24, 28, 1993. Ministry of Environment, Lands and Parks. Smithers, BC.
- Cichowski, D. 1995. Babine Mountains Recreation Area - mountain goat distribution survey, March 27, 1995. Ministry of Environment, Lands and Parks. Smithers, BC.
- Cichowski, D. 1997. Babine Mountains Recreation Area - mountain goat distribution survey, March 15, 23, 1997. Ministry of Environment, Lands and Parks. Smithers, BC.
- Cichowski, D. 2002. Wildlife inventory gap analysis and inventory strategy. Draft #1. Prepared for BC Parks Skeena District. Smithers, BC.
- Cichowski, D.B., D. Haas and G. Schultze. 1994: A method used for estimating mountain goat numbers in the Babine Mountains Recreation Area, British Columbia. Biennial Symposium of the Northern Wild Sheep and Goat Council 9: 56-64.
- Dixon, K. 2015. Mountain goat inventory - GO57, 6-09E Sibolas 2014. Skeena Region Technical Report, Ministry of Forests, Lands and Natural Resource Operations. Smithers, BC.
- Dixon, K. 2016. Mountain goat inventory - GO64, 6-08 Blunt and Seaton Mountains - 2016. Skeena Region Technical Report, Ministry of Forests, Lands and Natural Resource Operations. Smithers, BC.
- Dixon, K. 2018. Mountain goat inventory - GO70, 6-08 Blunt/Goat/Netalzul - September 2017. Skeena Region Technical Report, Ministry of Forests, Lands and Natural Resource Operations. Smithers, BC.
- Festa-Bianchet, M. and S.D. Côté. 2008. Mountain goats: ecology, behaviour, and conservation of an alpine ungulate. Island Press, Washington, DC.
- Hamel, S., S.D. Côté, K.G. Smith, and M. Festa-Bianchet. 2006. Population dynamics and harvest potential of mountain goat herds in Alberta. *Journal of Wildlife Management* 70:1044-1053.
- Keim, J.L. and S.R. Lele. 2006. Analyzing aerial survey observations for predicting mountain goat habitat suitability. BC Ministry of Environment, Skeena Region, Smithers, BC.
- Kriss, K. 2019. Mountain goat inventory - GO69, 6-08 Blunt/Goat/Netalzul - March 2017. Skeena Region Technical Report, Ministry of Forests, Lands and Natural Resource Operations. Smithers, BC.
- Kriss, K. 2021. Mountain goat inventory - GO75, Stikine Canyon and Tuya Canion (6-21C and 6-22A), March 2021. Skeena Region Technical Report, Ministry of Forests, Lands and Natural Resource Operations, and Rural Development. Smithers, BC.
- MacAuley, K. 2021. Mountain goat inventory - GO72, Natlan Peak, French Peak and Mount Thoen (6-08B), July 2020. Skeena Region Technical Report, Ministry of Forests, Lands and Natural Resource Operations, and Rural Development. Smithers, BC.
- Mountain Goat Management Team. 2010. Management plan for the mountain goat (*Oreamnos americanus*) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC.



- Natural Resources Canada. 2015a. CanVec 1:250,000 Elevation Features. Available: ftp.geogratis.gc.ca/pub/nrcan_rncan/vector/canvec/archive/canvec+_archive_20151029/
- Natural Resources Canada. 2015b. CanVec 1:250,000 Hydro Features. Available: ftp.geogratis.gc.ca/pub/nrcan_rncan/vector/canvec/archive/canvec+_archive_20151029/
- Poole, K.G. 2007. Does survey effort influence sightability of mountain goats *Oreamnos americanus* during aerial surveys? *Wildl. Biol.* 13: 113-119.
- Rice, C.G., K.J. Jenkins, and W. Chang. 2009. A sightability model for mountain goats. *Journal of Wildlife Management* 73:468–478.
- Schultz, B. 2003. Total count survey to document the winter abundance and distribution of mountain goat (*Oreamnos americanus*) in Babine Mountains Provincial Park. Ministry of Water, Land and Air Protection. Smithers, BC.
- Schultze, G. 1997. Kispiox mountain goat distribution and abundance survey: Natlan Peak., Mount Thoen, French Peak and Goat Mountain, (1996/97 Progress Report). BC Ministry of Environment. Smithers, BC.
- Wilson, S.F. and R.L. Morley. 2007. Mountain goat management and population restoration plan for the Okanagan Region. Unpublished report for B.C. Ministry of Environment, Penticton, BC.
- Widmeyer, S. 2021. Mountain goat (Klayyul) inventory - GO76, Nadina Mountain (LEH Zone 6-09G), February 2021. Skeena Region Technical Report, Ministry of Forests, Lands and Natural Resource Operations, and Rural Development. Smithers, BC.

