

# Inventory of Mountain Goats in Non-Alpine Habitats in the Morice and Lakes Forest Districts

## *2002 Final Report*



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## **EXECUTIVE SUMMARY**

This report summarizes a multiyear inventory of non-alpine habitat areas potentially used by mountain goats (*Oreamnos americanus*) in the Morice and Lakes Forest Districts. The central portions of the two Districts contain numerous rocky bluffs, cliffs and canyons within a forested landscape away from mountainous areas, which are used by a population of over 100 mountain goats. The situation is relatively unique for mountain goats in terms of the isolation of numerous, relatively small habitat areas with limited escape terrain, within a forested landscape. This situation may make this goat population sensitive to natural and human related mortality factors and disturbance. Due to this potential sensitivity a study was initiated in 1998 to examine mountain goat distribution, movement patterns, habitat selection and potential implications of forest development activities on the population of mountain goats inhabiting this forested landscape. This inventory project is one component of the larger study. The specific objectives of this project were to conduct a systematic inventory of potential non-alpine goat habitat within the two Districts, survey a subsample of potential habitat areas to determine patterns of use, and develop a model to predict use of areas not directly surveyed.

Initially, potential habitat areas were identified using a Geographic Information System (GIS) query of slope attributes and forest cover information. Each distinct area of steep terrain or rock outcrop was then evaluated using stereo pairs of air photos, or digital orthophotographs for the presence and extent of steep rock or cliff (escape terrain). The approximate boundary of each potential mountain goat habitat area was mapped in using a GIS and a preliminary habitat suitability rating of Nil, Low, Moderate or High was assigned based on the extent and subjective quality of the escape terrain. From the total sample of potential habitat areas identified across the two Districts, a subsample of areas were surveyed to determine current or recent use by goats based on sign. Using the results of the ground surveys and habitat variables for each potential habitat area derived from the GIS, resource selection functions were developed to identify the key habitat variables, and levels those variables, that described use by mountain goats.

A total of 1291 potential non-alpine mountain goat habitat areas were identified. Approximately half of the areas were rated as Nil (no goat habitat potential) based on air photo interpretation, GIS review, aerial surveys, or ground surveys, resulting in a total of 593 habitat areas that offered suitable habitat for mountain goats (442 Morice, 151 Lakes).

Ground sign surveys were conducted at 103 potential habitat areas (approximately 17% sample intensity) and mountain goat sign was detected at 56 of these sites. The proportion of areas used by goats differed between the two Districts, with much lower frequency of use in the Lakes (31%) than in the Morice (65%). The pattern of use in the Lakes appears to be demarcated by a distinct east-west range boundary. This boundary runs approximately from Tchesinkut Lake - Burns Lake - Augier Lake - Babine Lake.

Several specific areas were identified as having very high use by mountain goats. These areas appear to be core population centres that likely function as population sources for the surrounding areas. Maintenance of these core areas may be critical to the persistence of mountain goat use over the larger area. A summary of these key areas is detailed in the report.

Two different models were tested as part of the resource selection function (RSF) analysis and both found that the only habitat variable that was significantly correlated with use by mountain goats was the amount of escape terrain. Further, the results indicated that if any escape terrain was available then there was a significant probability that goats could use the area. Based on this result it is recommended that forest and wildlife planners consider any potential habitat area within our observed range boundary with a rating other than Nil, as a candidate goat habitat. The use of the interpreted habitat suitability ratings is recommended over the RSF model predictions because the interpreted product assessed escape terrain from multiple sources (air photos, forest cover information, TRIM slope models, aerial assessment, and ground assessment for a subsample of areas) whereas the RSF models are based solely on information derived from a digital elevation model.

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## **INTRODUCTION**

The purpose of this project is to investigate the use of potential non-alpine habitat areas by mountain goats (*Oreamnos americanus*, hereafter goats) previously identified in the Lakes and Morice Forest Districts (Turney *et al.* 2001, 2002) and to correlate observed use with habitat attributes and subjective suitability ratings.

Mountain goats are generally associated with mountainous areas and most frequently inhabit alpine and subalpine habitats (Banfield 1974, Haynes 1994). Use of forested areas adjacent to mountain cliffs is common and goats will also often travel through forest to reach mineral licks, during travel between seasonal ranges, and during dispersal (Hebert and Cowan 1971, Chadwick 1973). Forests are also used frequently as winter range in coastal regions, where they provide snow interception, snow pack stabilization and forage (Hebert and Turnbull 1977, Smith 1986). There are few occurrences, however, where goats occupy predominantly forested landscapes away from mountainous areas. Two circumstances where this has been reported are for clusters of small, discreet cliffs and rock outcrops surrounded by forest (Smith and Raedeke 1982, Turney *et al.* 2001, 2002) and in canyons (Foster and Rahe 1985, Harrison 1999, Mahon and Turney 2002). A combination of these two types of features occur in the southern Morice and Lakes Districts over an area of approximately 13,000 km<sup>2</sup>, which are used by a population of at least 100 goats. Limited escape terrain with a fragmented distribution, low density and isolated population structure, long distance to core populations in more typical mountainous habitats, and extensive human activity throughout the area may make this goat population especially sensitive to natural and human related disturbance.

In conjunction with a broader scale mountain goat study initiated in 1998, Ardea Biological Consulting and WildFor Consultants Ltd. conducted an initial inventory of non-alpine goat habitat in the Morice and Lakes Forest Districts in 2000 and 2001, respectively (Turney *et al.* 2001, 2002). Potential habitat areas were identified using a Geographic Information System (GIS) query of slope attributes and forest cover information. Each distinct area of steep terrain or rock outcrop was then evaluated using stereo pairs of air photos, or digital orthophotographs for the presence and extent of steep rock or cliff (escape terrain). The approximate boundary of each potential mountain goat habitat area (polygon) was mapped in the GIS and a preliminary habitat suitability rating of Nil, Low, Moderate or High was assigned based primarily on the amount of escape terrain. A summary of the criteria used for preliminary rating of potential mountain goat habitat is provided in Table 1. Approximately 1300 potential mountain goat habitat polygons were identified across the two Districts as part of the GIS and air photo assessments. Aerial assessments were conducted for almost all potential goat areas rated Low, Medium and High, and approximately 20% of those sites rated as Nil, to confirm or revise the preliminary rating. Finally, ground assessments were conducted at a small subsample of sites to identify use by goats and evaluate habitat potential.

The purpose of the work conducted in 2002 was to conduct ground assessments at a larger subsample of potential goat habitat polygons and to correlate goat occurrence and level of use with the characteristics of potential goat habitat areas (including the habitat suitability ratings). This information was used to develop a model to predict goat occurrence and level of use across other potential goat habitat areas within the study area.

### **Objectives**

The specific objectives of this year's project were to:

1. Develop a preliminary mountain goat presence / level of use model by examining correlations between goat use and polygon attributes from the limited existing ground assessment data.
2. Conduct ground assessments on a larger subsample of potential mountain goat habitat areas.
3. Use the new ground assessment data to validate and refine the predictive model.

Table 1. Summary of the criteria used for rating potential mountain goat habitat features.



Photo 1



Photo 2

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**Nil Value (Likely No Value)**

Potential sites considered to have nil value for mountain goats include gently to moderately sloped hill features, mostly covered by forest. These features may have limited areas of talus (Photo 1), but do not offer security habitat such as cliff or rock outcrops, or seepage/earthen type mineral licks. In these features, feeding habitat is also non-existent, or if present to any extent, is with the absence of security habitat (Photo 2).



Photo 3



Photo 4

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**Low Value (Habitat Useable)**

Potential sites considered to be of low value are those that offer some limited security habitat within extensive feeding habitat (Photo 3), or extensive security habitat, but little feeding habitat (Photo 4). Small areas of discontinuous cliff and rock outcrop are present. Limited feeding habitat is found adjacent to these small areas of escape terrain. Low value habitat features do not contain a mineral lick.

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Table 1 continued.



Photo 5



Photo 6

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**Moderate Value (Habitat Useable)**

Potential sites that are considered to be of moderate value are those that offer both security and feeding habitat, but are generally physically smaller features (Photo 5 and Photo 6). These features can support a small number of goats for limited periods. Seepage/earthen type mineral licks with little or no adjacent security habitat are also considered to be of moderate value.



Photo 7



Photo 8

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**High Value (Habitat Useable)**

High value features are those sites that contain extensive regions of security habitat, including cliff and rock outcrops, with feeding habitat in close proximity (Photo 7). These features may contain a mosaic of rock and cliff, small herbaceous meadows, scrub forest and steep talus lower slopes. Summer thermal cover is available through nearby forest and cliff shading. Winter thermal cover is provided by nearby forest, or the site may have a southerly aspect. Such sites that also fulfill an important habitat function, such as a mineral lick or a kidding area, are of high value. Photo 8 shows a known mineral lick that also offers excellent security habitat, as well as feeding habitat along the forested crest and lower talus slopes.

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## STUDY AREA

The main study area for the fieldwork conducted this year encompasses approximately 13,000 km<sup>2</sup> of the central and southern Lakes and Morice Forest Districts (Figure 1). The study area is bounded in the west by the Morice River and the Coast Range Mountains, in the south by Whitesail Reach and Ootsa Lake, and in the east by the Lakes Forest District Boundary. The area also extends to just north of Babine Lake in the Lakes District and just north of Highway 16 and Houston in the Morice District.

The digital map coverages provided with this report include all potential non-alpine mountain goat habitat areas previously identified for both entire Districts, however, only selected areas within the core study area described above have been updated with applicable ground survey data.

## METHODOLOGY

### ***Ground Assessment of Potential Mountain Goat Habitat Areas***

A combination of random and systematic selection procedures were used to select a subsample of sites for ground assessment during the 2002 field season. Random sites accounted for approximately 80% of the total and were selected from all potential mountain goat habitat areas within the study area. A small number of additional sites were systematically selected to ensure geographic coverage across the study area and full representation with respect to the Habitat Suitability Ratings previously assigned to each bluff.

Sample sites were accessed using a Bell 206 Jet-Ranger helicopter. Prior to landing at each site a fly-over was conducted to assess whether goats were currently present in the area. Ground assessments of each site consisted of a detailed sign survey transect and a reconnaissance-level investigation covering much of the polygon area. The detailed sign survey consisted of a 100 m-long, 2 m-wide belt transect located along the top of the most significant escape terrain in the area (where goat use and sign is typically highest). Each transect was marked with flagging tape or spray paint in the field, and the UTM locations of the start and end points were recorded using a hand-held GPS, to facilitate resampling. For data recording and marking purposes the transects were divided into 10 m long segments. Within each 10 m segment observers counted the number of pellet groups, hair tufts, tracks, trails and beds, and noted any feeding sign. An estimate of the age of the sign was also recorded (fresh = <1 week old, young = <1 year old, and old = >1 year old). In addition to the detailed transect, crews searched representative habitats and ensured broad geographic coverage of each potential habitat polygon, to ensure detection of goat sign if that area was indeed used by goats.

Once the ground assessment was completed, crews assigned a *Ground Habitat Suitability Rating* to the feature based on the quality of escape terrain and presence of high value foraging areas nearby. This new rating was then compared to the existing final suitability rating for the feature and used to update the data where appropriate.

A *Goat Use Class Rating* was also developed to categorize the relative amount of use among areas by goats based on the abundance of sign detected during ground surveys. Four categories, Very High (VH), Moderate to High (MH), Low (L), and Not Detected (N) were used to describe the amount of use. Levels of sign associated with each *Goat Use Class* are outlined in Table 2. It is important to emphasize the difference between the *Habitat Suitability Ratings* and the *Goat Use Classes* since both utilize a similar class scheme. The *Habitat Suitability Ratings* are an assessment of the potential value of the habitat areas to goats based on characteristics that goats are known to select for (primarily the amount of escape terrain). The *Goat Use Classes* indicate actual intensity of use by mountain goats as indexed by the ground sign surveys. These two ratings are often correlated but they are not necessarily always equal (i.e. a high *Habitat Suitability Rating* might not be presently used by goats and conversely a high *Goat Use Class* may not necessarily always be in the highest rated habitat).

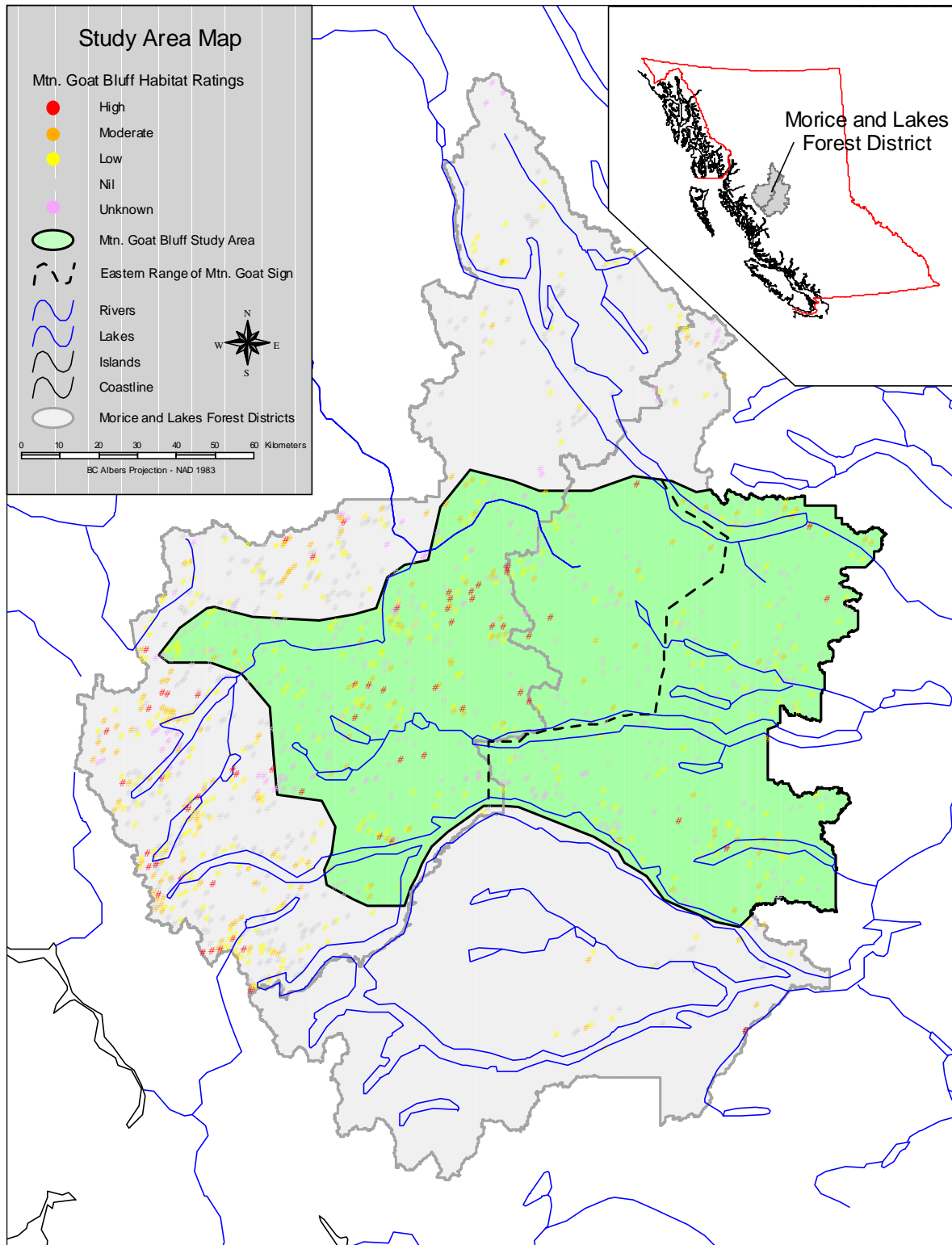


Figure 1. Distribution of potential mountain goat habitat areas within the Morice and Lakes Forest Districts. Study area for ground assessments is shaded in green. The dashed line indicates approximate eastern extent of goat sign detected.

Table 2. Description of Goat Use Classes

Goat Use Class	Level of Sign	Average Mountain Goat Sign per 100m					Corresponding Goat Use	Comments
		Pellet Groups	Beds	Hair	Tracks	Trails		
Not Detected	No sign	0	0	0	0	0	No use	
Low	Typically only one or two types of sign and in one age class; trails typically not present	≤ 5	≤ 1	≤ 1	≤ 1	≤ 1	Sporadic or limited use by individuals or very small numbers of goats; generally not used every year or every season	
Moderate - High	Most type of sign present and usually of multiple ages; well defined trails along top of escape terrain	5 – 50	1 – 3	1 – 5	1 – 2	1 – 3	Used most years, seasonal or full year use by <12 animals	Broad category
Very High	All types of sign present and of multiple ages;  Very well defined trails along top of escape terrain	> 50	> 3	> 5	> 2	> 3	Persistent, multiyear, multi-season use by many animals (>12)	Core populations that may function as source populations for surrounding area; half dozen highest use areas

### **Developing the Goat Use Model**

GIS analysis of goat habitat areas was not completed prior to the fall 2002 field surveys. As a result model development did not follow the two step process of 1) initial model development using past data, and 2) model testing and refinement using 2002 data, as outlined in the workplan. Instead, all of the data was used to develop a model in a one step process.

We assessed use of potential goat habitat areas by mountain goats, and developed a predictive model of use, using resource selection function methods (Manly *et al.* 2002). Two types of mathematical models were considered; logistic regression and linear regression, using the dependent variables used/not used (discrete) and number of pellet groups (continuous), respectively. Logistic regression models, that evaluate probability of use of resource units based on observations of resource units being used/not used, are the classical method for determining resource selection functions (Manly *et al.* 2002). A limitation of the logistic regression method, however, is that it is limited to dichotomous dependent data (0 or 1), which does not indicate degree of use. This is a limitation in this study because detected use by goats ranged from limited, old sign that corresponded to use by one or a few animals intermittently, to abundant multiple aged sign that corresponded to use by many animals continuously over several years. To address this issue of degree of use, a second model was tested based on a multiple linear regression model, using the number of pellet groups/100m detected at each goat habitat area. Pellets groups were selected as the best sign type to use because they could be definitely linked to goats (i.e. compared to browse sign), they were less susceptible to seasonal influences (i.e. compared to hair), and because their detection was not strongly affected by site substrate (i.e. compared to tracks or trails). All types of sign were also strongly correlated. A square root transformation was applied to the pellet data so that it would conform to normal distribution, which is an assumption of the linear regression model.

We identified several potential independent variables that could affect use of potential goat habitats based on experience gained from previous study and information from the literature (e.g Harrison 1999, Haynes 1994, Gross *et al.* 2002). A list of the ecological conditions considered and the specific corresponding habitat variables included in the models is provided in Table 3. All statistical analysis was conducted using SPSS software (SPSS 2001). Both the logistic regression and linear regression were run using all 13 independent variables in Table 3, and a stepwise variable entry method with an entry probability of 0.05 and removal probability of 0.10.

Table 3. Potential ecological factors affecting use of goat habitat areas (GHA) and corresponding specific habitat variables that were included in the models.

Ecological Requisite	Specific Habitat Variables	Description/comments
GHA Size	Size (ha) of potential goat habitat area	Size of interpreted polygons mapped around all possible goat habitat areas
Escape Terrain	Area of escape terrain (m <sup>2</sup> )	Length x height of escape terrain
	Area with slope >30 degrees (ha)	Based on 50m pixels in a digital elevation model (DEM)
	Area with slope >40 degrees (ha)	Based on 50m pixels in a DEM
Feature Type	Feature type	Bluff or canyon
Amount of Rock	Area of rock outcrop (ha)	From provincial forest cover maps
Elevation	Maximum elevation	From 50m pixel DEM
	Minimum elevation	From 50m pixel DEM
Aspect	% of GHA with warm aspect	From 50m pixel DEM (157.5-337.5°)
	% of GHA with cool aspect	From 50m pixel DEM (337.5-157.5°)
Amount of Surrounding GHAs	Area of GHA within 2.5km (ha)	Sum of GHA size for all GHAs within 2.5km
	Area of GHA within 5km (ha)	Sum of GHA size for all GHAs within 5km
	Area of GHA within 10km (ha)	Sum of GHA size for all GHAs within 10km

## RESULTS

A total of 1291 potential non-alpine mountain goat habitat features have been identified in the Morice and Lakes Forest Districts (927 in the Morice and 364 in the Lakes). A breakdown of the Habitat Suitability Ratings for these features is provided in Table 4. Approximately half of the potential areas identified through the GIS exercise were rated Nil (no goat potential) based on air photo, aerial, and/or ground assessments of the areas. This results in a total of 593 habitat areas that offer potentially suitable habitat for mountain goats (442 Morice, 151 Lakes).

Table 4. Summary of Habitat Suitability Ratings for potential non-alpine mountain goat habitat areas within the Lakes and Morice Forest Districts.

Habitat Suitability Rating	Entire Study Area (n=1291)	Lakes District (n=364)	Morice District (n=927)
High (H)	61 (4.7%)	9 (2.5%)	52 (5.6%)
Moderate (M)	170 (13.2%)	39 (10.7%)	131 (14.1%)
Low (L)	362 (28.0%)	103 (28.3%)	259 (27.9%)
Nil (N)	624 (48.3%)	201 (55.2%)	423 (45.6%)
Not Rated	74 (5.7%)	12 (3.3%)	62 (6.7%)

Ground sign surveys have now been conducted at 103 potential habitat areas (approximately 17% sample intensity) and mountain goat sign was detected at 56 of these sites. The proportion of areas used by goats differed between the two Districts, with much lower frequency of use in the Lakes (31%) than in the Morice (65%). The pattern of use in the Lakes appears to be demarcated by a distinct east-west range boundary. This boundary runs approximately from Tchesinkut Lake - Burns Lake - Augier Lake - Babine Lake (Figure 1). A summary of the intensity of use observed at the sampled areas is provided in Table 5.

Table 5. Observed intensity of use by mountain goats within a subsample of potential non-alpine mountain goat habitat areas within the Lakes and Morice Forest Districts.

Goat Use Class	Entire Study Area (n=103)	Lakes District (n=32)	Morice District (n=71)
Very High (VH)	10 (9.7%)	1 (3.1%)	9 (12.7%)
Moderate to High (MH)	28 (27.2%)	5 (15.6%)	23 (32.4%)
Low (L)	18 (17.5%)	4 (12.5%)	14 (19.7%)
Not Detected (N)	47 (45.6%)	22 (68.8%)	25 (35.2%)

Several areas were identified as having very high use by mountain goats. Based on high levels of multi-aged sign, direct observations of numerous goats over the past 5 years, and historic sighting reports from WALP, forest licensees, and the public, these areas appear to be core population centres that likely function as population sources for the surrounding areas. Maintenance of these core areas may be critical to the persistence of mountain goat use over the larger area. A summary of these key areas is provided in Table 6.

Table 6. Core areas with the highest mountain goat sign in the Morice and Lakes Forest Districts.

General Area	District	Min. No. Mt.Goats	Comments
Nadina Mountain	Morice	~ 75	Non-alpine habitat includes a major bluff system to the west including a major mineral lick linked by a heavily used 5 km trail; numerous bluffs on southern flank of Nadina just below treeline are used extensively during the winter
Morice Mountain	Morice	-- 65	Non-alpine habitats include several large cliff complexes and small bluff networks south of Morice Mt. into the Swiss Fire
Foxy Canyon	Lakes	30-50	20 km long canyon with extensive goat sign.
Bob Creek	Morice	12-20	Extensive canyon and cliff system on east side of Buck Cr.
Klo Creek	Morice	12-20	Includes several large bluffs and moderately developed canyons
Dungate	Morice	12-20	Large system of bluffs and cliffs immediately east of Bob Cr.
Mosquito Hills	Morice	12-20	Large system of bluffs and a few small canyons. Sighting of 17 goats reported in 1999. 2-6 generally observed while flying over area. Very well defined trails currently have low use suggesting goat densities may have been higher in past.
Shelford Hills	Morice	12-20	Use is concentrated in 2 canyons on north and northwest side of area

Generally there is good correlation between the habitat suitability ratings and observed goat use (Figure 2). No goat sign was detected at any potential habitat areas with a final habitat suitability of Nil. There was one case however, where the photo/flight rating was Nil and goat sign was detected, but the final habitat suitability rating was revised to Low based on the ground assessment. Additional misclassification errors are possible, but for general management purposes it is appropriate to assume no goat use at areas rated Nil. The proportion of potential habitat areas with evidence of use by goats increases with suitability rating (Table 7). For management purposes all areas with a suitability rating other than Nil, should be considered as goat habitat with a reasonable probability of use.

### ***Predictive Model***

The results from both the logistic and linear regression models indicate that only escape terrain is significant in predicting use of potential habitat areas by goats. In the logistic regression model only the amount of escape terrain (length of feature x height) was significant. The logistic model was better at predicting used areas (80.4% correct) than not used areas (48.4% correct). In the linear regression model both the amount of escape terrain and amount of area with >30 degrees slope were significant. What these models indicate is that if escape terrain is present, then there is a reasonable probability of the areas being used by goats. Since the presence of escape terrain has been directly assessed from multiple sources (air photos, forest cover information, TRIM slope models, aerial assessment, and ground assessment for a subsample of areas) as part of the *Habitat Suitability Ratings*, it is recommend that those ratings be considered as the primary inventory source for management purposes.

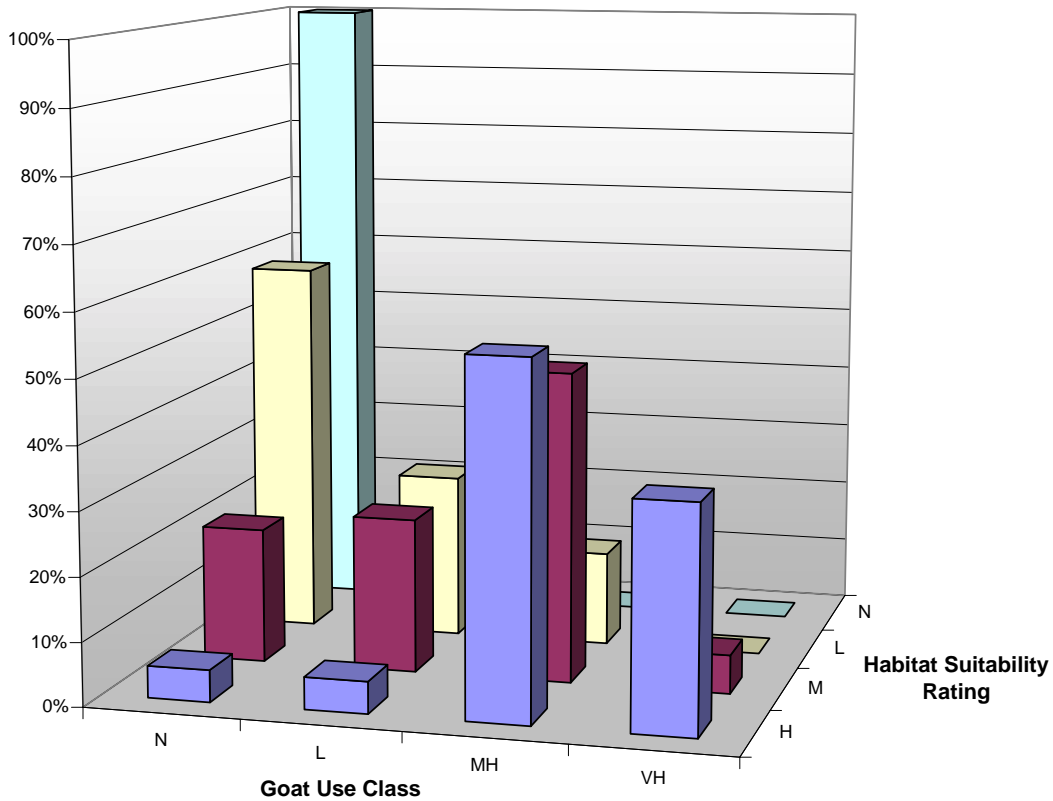


Figure 2. Correlation between habitat suitability ratings and observed level of mountain goat sign (areas outside of goat sign range excluded).

Table 7. Proportion of potential habitat areas used by mountain goats relative to habitat suitability ratings.

Habitat Suitability Rating	Within observed goat range		Entire study area	
	Proportion of areas with use	Number of areas sampled	Proportion of areas with use	Number of areas sampled
Nil	0%	7	0%	7
Low	41%	27	31%	35
Moderate	81%	32	68%	37
High	95%	20	83%	23

## **DISCUSSION**

The authors of this report are aware of only one other study that has documented a situation similar to the extensive use of non-alpine habitats by mountain goats that occurs in the central and southern Morice and Lakes Forest Districts. That area occurs on the Cleveland Peninsula in Alaska and contained a population of 50-70 animals within 800 km<sup>2</sup> (Smith and Raedeke 1982). Sub populations and groups occupied small patches of habitat consisting of slides, rock outcrops or forested areas exceeding 40 degrees, on discreet ridge complexes separated by forested valleys ranging from 0.8 to 2.4 km wide. Females were sedentary with small home ranges while males made extensive movements associated with the rut, crossed valleys and interacted with several groups. Smith and Raedeke suggested that small population size and patchy distribution has potential for inbreeding and periodic local extinction. Genetic exchange and mating occurred only because of male movements. Timber development was just beginning in the area and Smith and Raedeke predicted that habitat alteration, human activity and illegal hunting would reduce inter-ridge movement and increase mortality leading to reproductive isolation and instability of individual groups, and that those combined effects could lead to extirpation.

In contrast to the predictions of Smith and Raedeke (1982) for the Cleveland Peninsula, the mountain goat populations inhabiting the non-alpine areas in the Morice and Lakes have persisted for at least 30 years since major forest development activity began in the area. Currently, at least 5 major mainline haul roads bisect the area with an extensive network of secondary and block roads throughout the area. The negative impacts of forest development are largely unknown. Illegal hunting and native harvest are known to occur in the area (Schultze, *pers comm.*), and have resulted in the short-term extirpation of small groups of goats from individual bluffs, but the overall population impacts are not known. Of the 8 core population areas listed in Table 6, only the Mosquito Hills area appears to have fewer goats present now than historic reports and old sign suggest. Several factors in our study area may be mitigating population impacts and displacement observed in other studies (e.g. Chadwick 1973). Despite the easy access to many of the goat habitat areas, and known occasional poaching report, the presence of goats in the area is largely unknown and illegal hunting pressure is low. Core populations on Mt. Morice and Nadina Mountain may be providing strong source populations that provide an ongoing supply of dispersing animals into the surrounding area. A telemetry study initiated in the winter of 2002 will provide information on mortality rates, movement patterns, and other demographic parameters that will allow assessment of the population status and the primary factors affecting the population (Turney *et al.* 2003).

The results of the resource selection function models that found escape terrain was the only significant variable in predicting use of areas by goats are similar to results of a recent study of alpine habitats in Colorado (Gross *et al.* 2002). In that study the authors examined the location of mountain goats determined using telemetry with respect to elevation, slope (degrees), aspect and distance to escape terrain. Using similar logistic regression analysis as in this study, Gross *et al.* (2002) found that a model based only on distance to escape terrain provided the best correlation to observed locations of goats.

The ground survey results of this study indicated an apparent range boundary for use by mountain goats running approximately north and south of the town of Burns Lake. The reason for this range boundary is unclear as the quality and density of potential goat habitat areas is comparable outside of the observed range of use. This suggests that factors other than habitat area suitability play an overriding role in determining use of areas by goats. One possible factor is that the observed range of goat use is a function of distance from core population areas such as Foxy Creek, Klo Creek and Bob Creek. As the distance of potential habitat areas from core area increases the probability of dispersing goats locating and colonizing them decreases.

## **MANAGEMENT IMPLICATIONS**

Results from this work have produced a comprehensive inventory of potential non-alpine mountain goat habitat areas in the Lakes and Morice Forest Districts. Based on observations of areas that are used and not used by goats, all habitat areas with a *Habitat Suitability Area* rating of Low, Moderate, or High, and that are within the observed mountain goat range boundary, should be considered as potential goat habitat for management purposes. A digital coverage of the potential goat habitat areas has been

distributed to the Ministry of Forests and major licensees in each respective District. A data dictionary explaining the coding in databases of the map coverages is provided in Appendix 1.

This component of the overall study did not focus on developing management recommendations to address habitat and movement requirements of the mountain goats using this area. Other past, and ongoing aspects of the larger goat study, are specifically examining those requirements. Detailed work in the Foxy Canyon area has produced specific management recommendations for that area (Mahon and Turney 2002). An ongoing management trial near Nadina Mountain is examining how goats respond to a road that will be built across a major trail that is used to access a mineral lick. This winter a telemetry study, using both VHF transmitters and GPS collars, was initiated to examine stand scale habitat selection and broader scale movement patterns among habitat areas (Turney *et al.* 2003). Results from these latter two aspects of the study will provide results that will facilitate effective management guidelines to address mountain goat habitat requirements at multiple scales. Until these results are available we recommend the following interim guidelines:

- The greatest potential risk to mountain goats in the area is likely increased human caused mortality (poaching/native harvest). To mitigate this risk:
  - Minimize road development that will provide access to goat habitat areas. Where possible avoid permanent roads within 1 km of goat habitat areas, deactivate/unbuild all spur and in-block roads within 500 m of habitat areas so that they do not provide vehicle or ATV access, and avoid developing any roads within 200 m of habitat areas.
  - Locate roads so that they do not provide direct lines of sight onto goat habitat areas and maintain visual screens of existing mature timber, where possible.
- Adjacent mature forest provides important screening, thermal cover, and snow interception. Harvesting adjacent to goat habitat areas should:
  - Maintain approximately 50% of the mature forest habitat within 200 m of the habitat areas.
  - Maintain forest screening to minimize direct lines of sight onto the habitat area from roads and cutblocks.
  - Utilize small patch clearcuts (preferably <2 ha) for any timber harvesting within 200 m of escape terrain.
- To address site-specific habitat issues, an assessment of a habitat area with proposed forest development near it should be conducted by a biologist.

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## APPENDIX 1. DIGITAL MAP COVERAGE DATABASE DICTIONARY

The revised digital mountain goat bluff coverages are provided as ArcView shapefiles with separate shapefiles for each Forest District. The file names and projection information for each District are:

Morice: dmo\_bluffs\_u9\_final (UTM 9, NAD83)

Lakes: dla\_bluffs\_u10\_final (UTM 10, NAD83)

Explanations of the field codes in the databases are provided in Table 7.

Table 8. An explanation of field codes in the databases of the mountain goat bluff map coverages.

Field Code	Comments
Poly_tag	Unique identifier for each potential habitat area
Bluff_id	Duplicate of poly_tag
District	Self explanatory
Bec_zone	Biogeoclimatic information down to variant
Utm_z	UTM zone
Utm_e	UTM easting
Utm_n	UTM northing
Area	Size of feature polygon in m <sup>2</sup>
Gen_loc	General location. Only completed for ground sampled areas.
Phtrate	Habitat suitability rating from aerial photo interpretation
Fltrate	Habitat suitability rating from overview flight
Ground_	Ground survey conducted?
Grndrat	Habitat suitability rating from ground assessment
Finalrat	Final habitat suitability rating
Userate	Goat use class rating
CorStudy	Lakes District only. Indicates whether the potential habitat area is within the range boundary where goat sign was found (Y) or not (blank).

Generally, the most useful fields to theme maps by are the final habitat suitability rating (Finalrat) and the goat use class (Userate)