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# Timber Harvesting Practices and Mountain Goat Habitat in the Babine Watershed – GIS Mapping & Analyses (Project 2008–3)

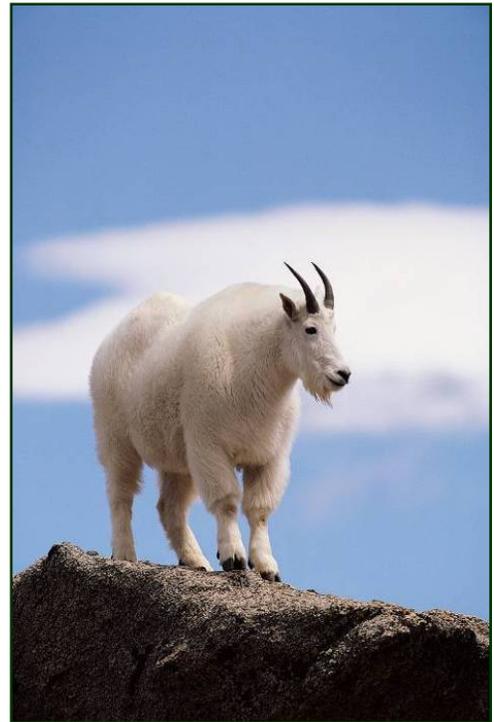
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## *Final Report*

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## **Executive Summary**

Mountain goats have been identified as a monitoring priority for the Babine Watershed Monitoring Trust (BWMT) for the last two years. In 2007, the BWMT initiated a background review to gather information and/or data made available after the inception of the Monitoring Framework in 2004 (Project 2007–3). As an extension of that work, the focus of this project was to develop a current harvest and road database relevant to mountain goats within the Babine watershed. These data were then analysed for different buffer widths (200m, 500m, 1000m and 2000m) around the Ungulate Winter Ranges (UWRs) and Mapped Habitats used to manage goat habitat and goat populations within the Babine watershed. The results indicate that overall, there is very little harvesting within 500m of any of these areas identified for goats, with the exception of the UWR polygon in the Gail Creek area. The goat population that utilizes this area has been known to be in decline over the last few years. There is also a higher road density (in association with the forest harvesting) in the Gail Creek area. The results from both this project and the background review will be used to update the current BWMT Monitoring Framework. It is anticipated that during this process the data will be used to re-assess the indicators currently in use to measure the success of meeting objectives set for mountain goats within the BWMT area. The addition of indicators such as movement between habitats, and evidence of use for existing identified habitats would correlate with work being conducted in other parts of British Columbia. In addition, these data would further reduce uncertainty with respect to the risk of forest harvesting activities to goat habitat and goat populations within the Babine watershed.

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## 1.0 Introduction

Mountain goats have been identified as a monitoring priority for the Babine watershed Monitoring Trust (BWMT) for the last two years. In 2007, the BWMT initiated a background review to gather information and/or data made available after the inception of the Monitoring Framework in 2004 (Project 2007–3). The Monitoring Framework is designed to determine the effectiveness of strategies (and associated indicators or targets) set out in the land-use plans for the Babine watershed (Price and Daust 2005). The intention of the BWMT is to continually update the framework with new data as they become available, and then reassess monitoring priorities.

The purpose of this project was to develop a current harvest and road database relevant to mountain goats within the Babine watershed. Once collected, road and harvest data were analysed for increasing buffer widths around the Ungulate Winter Ranges (UWRs) and Mapped Habitats used to manage goat habitat and goat populations within the Babine watershed. This information was then used to reduce uncertainty for the preliminary risk curves created in 2004. Eventually, the results of this project will be used to update the mountain goat portion of the monitoring framework, and to reassess indicators currently in use to meet the objectives established in the land-use plans.

## 2.0 Background

In September of 2004, two objectives for mountain goats were identified from the summary of the various land-use plans for the Babine watershed: to maintain mountain goat habitat, and to maintain goat populations. The purpose of these objectives was to achieve the overall goal of maintaining mountain goats in the Babine watershed.

As part of the Monitoring Framework, risk curves were established for each indicator if sufficient data were available. It was recognized at this time that there was a need to reduce uncertainty around the current indicator data in order to better detect the consequences of harvesting near critical goat habitat and during critical times (e.g., during the natal period) (D'Arcy 2007).

The indicators identified to determine the success of meeting the objective to maintain mountain goat habitat were:

- type and patch-size distribution of harvest within 200m of identified goat habitat, and
- presence of forested connectors between mountain ranges in Kotsine Pass (Price and Daust 2005).

No indicators specific to the maintenance of mountain goat habitat in the West Babine portion of the watershed were developed due to a lack of available data (Price and Daust 2005).

A preliminary risk curve was generated to assess the risk to mountain goat habitat in relation to the percentage of unmodified habitat within 200m of identified mountain goat habitat. A relatively high level of uncertainty was noted, and attributed to the absence of harvesting information between 200 and 400m from identified habitat (Price and Daust 2005).

With respect to maintaining mountain goat populations, the following indicators were identified from the land-use plans:

- density of accessible roads within one kilometre of identified habitat, and
- amount of harvesting within 200m of habitat during the natal period.

Preliminary risk curves were included in the monitoring framework with respect to road density within one kilometre of identified goat habitat and the level of disturbance experienced by goats when harvesting occurred during the natal period (Price and Daust 2005). Again, the uncertainty around both preliminary risk curves was high due to the lack of available data.

One of the most significant developments for mountain goats since 2005 is the establishment of legislated Ungulate Winter Ranges (UWRs) under the Forest and Range Practices Act (FRPA) on the west side of the BWMT area (governed by the West Babine SRMP). These winter ranges were established throughout the Kispiox-Cranberry TSA, and were chosen based on information collected during a study conducted by Ardea Biological Consulting (Robertson et al. 2005). BC Timber Sales (BCTS) and Gitksan Forest Enterprises are the two forest licensees operating within the area governed by the UWR Order.

Of the winter ranges identified within the Babine watershed, two are linked to canyon-dwelling goat populations. The primary escape terrain for the winter range polygon located off a tributary of the Shelagyote River is a rocky bluff; for all other UWR polygons in the BWMT area the goats use high elevation (alpine and sub-alpine) rock and ice outcrops as escape terrain.

Mapped Habitat areas have been identified for mountain goats within the Bulkley TSA portion of the Babine watershed. These areas have been identified and are subsequently governed by management recommendations in Pacific Inland Resource's (PIRs) 2007 Forest Stewardship Plan (FSP). The FSP is based on the Objectives Set by Government for the Bulkley LRMP area established in 2006. The majority of the Mapped Habitat areas within the Babine watershed are high elevation, and occur along the east side of the Nilkitkwa and Babine Landscape Units (LUs). There is another Mapped Habitat area in the southwest corner of the Babine LU, on and around French Peak. In addition to the Mapped Habitat, Special Management Zone 1 (no harvest) in the northern part of the Nilkitkwa LU is also being used to manage goat habitat.

The Mapped Habitat areas that occur within the Babine watershed are interwoven with other planning priorities, and much of the Mapped Habitat is inoperable from a forestry perspective. Although the formation of an UWR Order has been considered for goats in the Bulkley TSA, nothing has been established to date.

The two portions of the Babine watershed are managed slightly differently for mountain goats and mountain goat habitat. Pacific Inland Resources (PIR) is the primary licensee operating on the Bulkley TSA side of the watershed. The buffer width observed by PIR in their Forest Stewardship Plan for habitat identified for mountain goats is 200m (harvesting is permitted, but not between April 15 and July 15). In the West Babine portion of the watershed, a 500m buffer is indicated in the General Wildlife Measures indicated in the UWR Order. Again, harvesting within the 500m is permitted as long as it does not "result in material or adverse disturbance to goats". Price and Daust (2005) indicated in the Knowledge Base that goats may be disturbed by activities up to 1.5km away during the natal period.

Data on the level of harvest and the amount of forested area were collected in 2005 by Robertson et al. for all of the then-proposed UWRs within the Kispiox-Cranberry TSA. However this information was already two years out of date when the background review was conducted by the BWMT in 2007, and did not include any data for the Bulkley TSA portion of the Babine watershed.

### 3.0 Methods

The results of the background review conducted by the BWMT in 2007 indicated that there was a need to update the mapping information in order to then update the monitoring framework and potentially explore the addition of new indicators. All of the mapping work for this project was completed by William Elliott (formerly GeoBorealis, now Azimuth Geospatial) of Smithers, BC.

Table 1 summarises the input meta-data collected to create the GIS database for this project. As indicated below, much of the data were gathered using Provincial resources. In the case of the forest opening and road data from PIR, permission to use this information *explicitly for this project* was granted by Alan Baxter at PIR.

**Table 1. Meta-data description and source (provided by W. Elliot, GeoBorealis).**

Description	Source
Base features built on enhanced geotiff raster files	Prov of BC/BMGS
Babine watershed boundary	Prov of BC, Babine Watershed Monitoring Trust
Bulkley District Mapped Mtn Goat Habitat	Prov of BC, MOF/dbu
Kispiox District Ungulate Winter Range	Prov of BC, MOF/dki
Depleted Blocks	PIR/IFPA/NWDSN
Bulkley HLP combined forest cover and Management Zones	Prov of BC, MOF/dbu
Vegetation Resource Inventory	Prov of BC, MOF/LRDW
Timber Harvesting Landbase (THLB) - Bulkley District	Prov of BC, MOF/dbu
Timber Harvesting Landbase (THLB) - Gitanyow Territory	Prov of BC, MOF/dki
Timber Harvesting Landbase (THLB) - Kispiox District	Prov of BC, MOF/dki
Forest openings in Gitxsan territory	Prov of BC, MOF/dki
Forest openings in Gitanyow territory	Prov of BC, MOF/dki
Map of UWR units in Babine watershed	Prov of BC, MOE
Roads	PIR/IFPA/NWDSN
Kispiox District Roads	Prov of BC, MOF/dki

UWR polygons within the BWMT area were labelled to facilitate the data analysis<sup>1</sup>. Labels were chosen based on proximity to a main topographical feature. The UWR polygons within the Atna Range were grouped together under one label (Atna); the others were labelled Shelagyote,

<sup>1</sup> Initially the UWR area named Shegisie was mistakenly called Shegisle. This has been corrected in the analysis spreadsheet and on the map, but is not corrected for the various data layers.

Shegisie, Gail Creek and Thoen (near Mt. Thoen). Only a small portion of the Shegisie UWR polygon is within BWMT area – the remainder is in the Skeena River watershed.

The Mapped Habitat areas identified on the Bulkley TSA side of the BWMT area were numbered from one through four. Figure 1 shows the different UWRs and Mapped Habitat areas (grey); a two kilometre buffer has been drawn around each of the goat management areas (green).

Vegetation Resource Inventory (VRI), forest opening and road data were assembled and then analysed for the each of the UWR/Mapped Habitat areas, and then for increasing buffer widths around these areas. The buffer widths – 200m, 500m, 1000m and 2000m – were based on both the current management buffers for goat habitat for both the Bulkley TSA and West Babine portions of the watershed, and the uncertainty identified in the Knowledge Base with respect to the impact of forest harvesting and road density greater than 200m from identified goat habitat.

The resulting database was then analysed according to the following parameters:

- No. hectares of forested area (THLB, non-THLB and total area) for three age class categories:
  - Young: 0–60 yrs (age classes 1–3)
  - Mid: 60–120 yrs (age classes 4–6)
  - Old: 120 years and older (age classes 7–9)
- No. hectares of non-forested area (THLB, non-THLB and total area)
- No. hectares of harvested<sup>2</sup> area (THLB, non-THLB and total area)
- No. hectares within different harvest patch size categories:
  - 0–5 hectare openings
  - 5–40 hectare openings
  - 40–80 hectare openings
  - 80+ hectare openings
- Road length (primary and secondary) and density (m/ha)

The forest, harvest and road data analyses were conducted for each UWR and Mapped Habitat separately, and then for each of the increasing buffer widths. The full data analysis is included in Appendix I. Old forest, non-forested areas and harvested areas were compared by calculating the percentage of the total area for each UWR/Mapped Habitat and the respective buffer widths. Harvest patch-size data were calculated by removing all interior block borders (multi-aged blocks were thus grouped together). Harvest patch-size data are cumulative for the analysis of each buffer width (i.e., the 2000m buffer analysis includes all harvested data). Harvested patch and road distribution were analysed qualitatively using the map included in this report (Figure 1).

Data from the 200m buffer width analyses were used to assess risk to mountain goat habitat for each of the identified areas within the watershed using the preliminary risk curve for unmodified habitat within the Knowledge Base (Appendix II).

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<sup>2</sup> Harvested data were summarised using the depleted block layers from the various licensees operating within the BWMT area. Although for the majority of forest openings depleted means harvested, openings created through burning are also included in this layer.

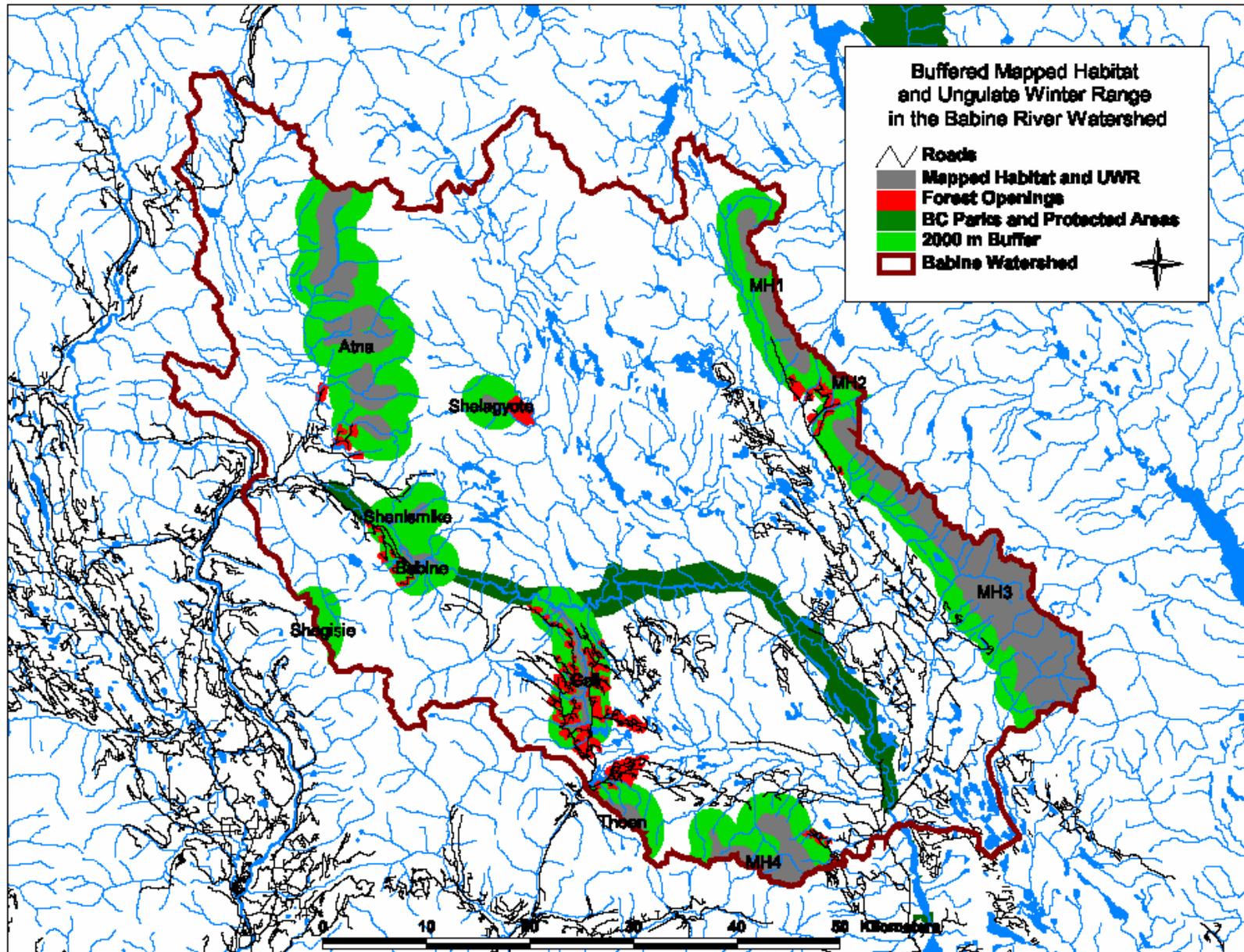


Figure 1. Map depicting Mapped Habitat and Ungulate Winter Range areas within the Babine Watershed (green is 2000m buffer).

## 4.0 Results

Initially, the size (in hectares) of each of the areas identified for mountain goats was compared to get a sense of proportion of the different habitat areas with no buffers (Figures 2 and 3). On the West Babine side of the watershed, the dominant UWR area occurs along the Atna Range (several UWR polygons were grouped for the purposes of this project). Also within the West Babine portion of the watershed, both the Shenismike and the Babine UWR polygons intersect the Babine River Corridor, a protected area along the Babine River.

The Mapped Habitats are less discrete than the UWR polygons, hence the much bigger size overall for each area (Figure 3). MH-2 is a grouping of two small areas located in Kotsine Pass. MH-3 is the largest of the four Mapped Habitat areas; it extends down the length of the Bait Range. MH-4 is located in the south-western portion of the Babine LU (on and around French Peak).

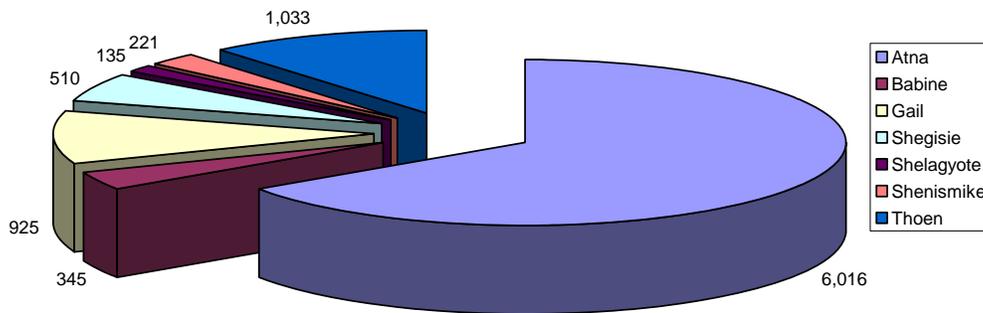


Figure 2. Relative size (in hectares) of each of the UWRs (no buffer) within the Babine Watershed Monitoring Trust area.

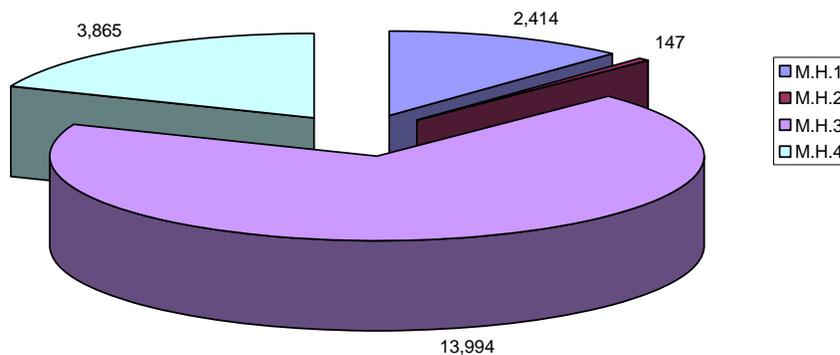


Figure 3. Relative size (in hectares) of each of the Mapped Habitat units within the Babine Watershed Monitoring Trust area.

### 4.1 Forest Age Class Analysis

Old forest (greater than 120 years) is the most critical of the three age class groupings as it provides snow interception, cover and forage during the winter months (Figure 4). The three

UWR polygons with the highest percentage of old forest are Babine, Shenismike and Shelagyote (84%, 88% and 68% of the UWR polygon, respectively). Both Babine and Shenismike link up to the Babine River Corridor Park. For most of the areas identified as high value goat habitat, it is anticipated that the core habitat may be dominated by escape terrain, with the percentage of forested area increasing with increased buffer width. This is most clearly demonstrated with the Mt. Thoen UWR polygon. The UWRs along the Atna Range and MH-3 do not follow this trend; this is likely due to the steep terrain in these high elevations areas. The UWR polygon around Gail Creek, which is also atypical, has been heavily impacted by forest harvesting.

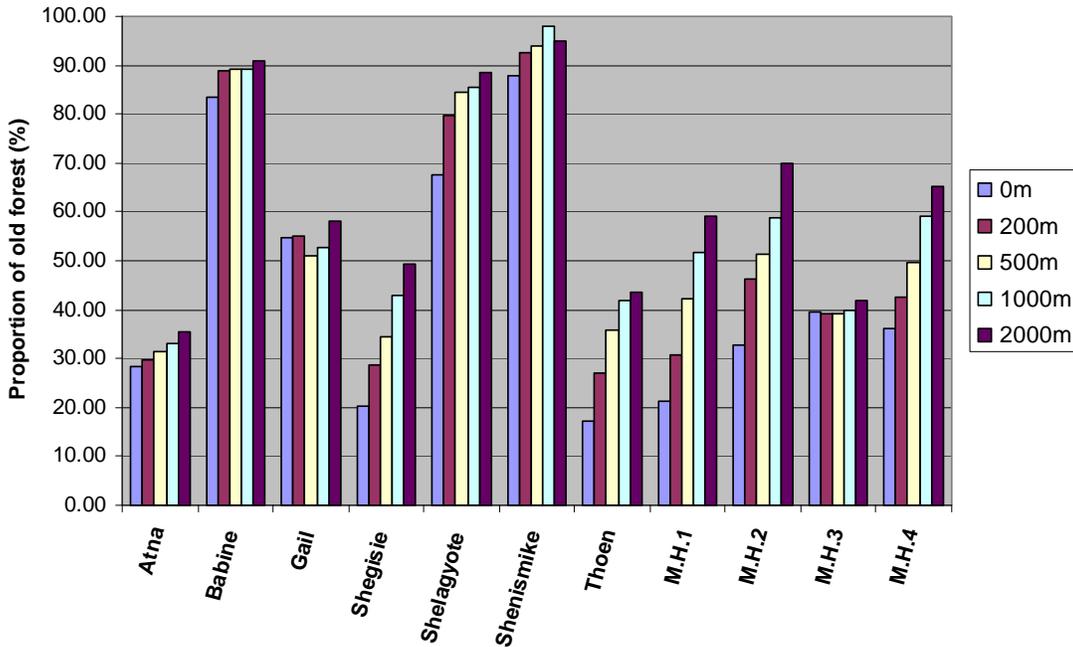


Figure 4. The proportion of old forest (>120 yrs) expressed as a percentage of the total area for UWR and Mapped Habitat areas (and their associated buffers) within the Babine watershed.

### 4.2 Non-forested Area

Non-forested areas include alpine tundra (rock, ice, alpine vegetation and krummholtz) (primarily outside the THLB) and areas classed as non-productive (within the THLB, likely subalpine parkland in this analysis). For all of the UWR polygons and Mapped Habitats, the majority of the non-forested area is not included in the THLB. Typically, high value goat habitat would be dominated by escape terrain and would thus have a high proportion of non-forested area. This is true for most of the identified goat habitat with these exceptions: Babine, Gail Creek, Shelagyote and Shenismike UWRs (Figure 5). The escape terrain for the Gail Creek and Shenismike UWR polygons is provided by canyons rather than high elevation terrain. The Shelagyote UWR polygon is a combination of rocky bluffs and old forest (D. Filler, MOE, pers. comm.).

### 4.3 Harvested Area

It is clear from the data analyses that despite the passage of four years since the original UWR work, there is very little to no harvest within the majority of the habitat identified for goats in the Babine watershed (less than one percent for all core areas except Gail Creek Canyon which is 2.6% harvested). The Gail Creek Canyon site is indisputably the most heavily impacted, with

24% of the total area harvested within the 1000m buffer zone. There is an overall trend of increased harvesting activity between the 1000m and 2000m buffers. The ‘harvest’ data for the Shelaygote UWR polygon is actually an old burn (Glen Buhr, MOFR, pers. comm.).

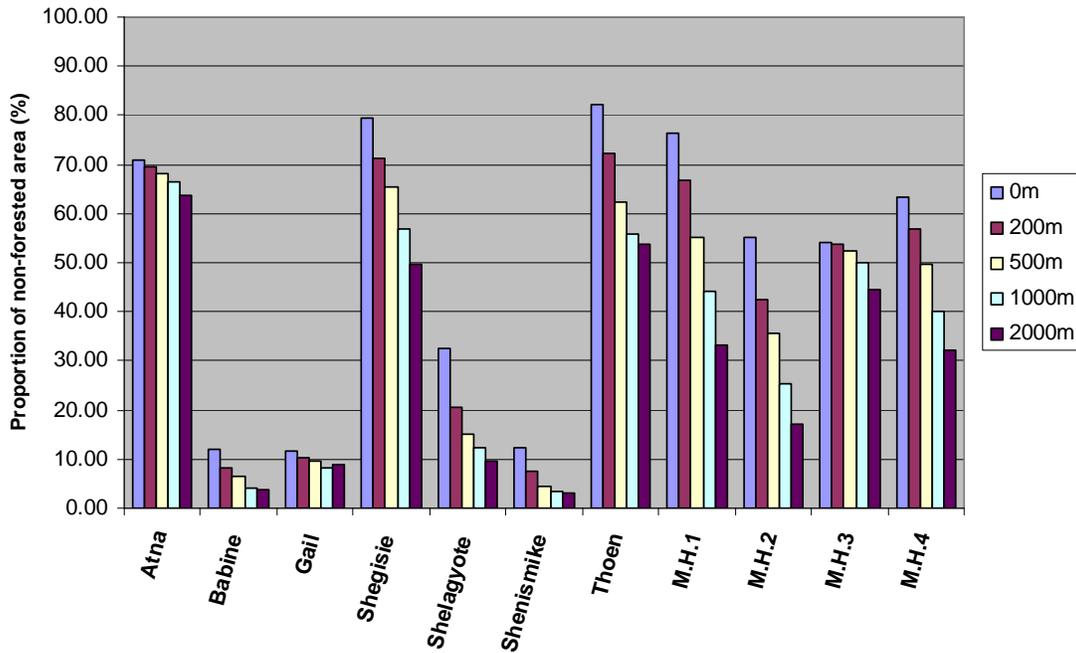


Figure 5. The proportion of non-forested area expressed as a percentage of the total for both UWR and Mapped Habitat areas (and their associated buffers) within the Babine watershed.

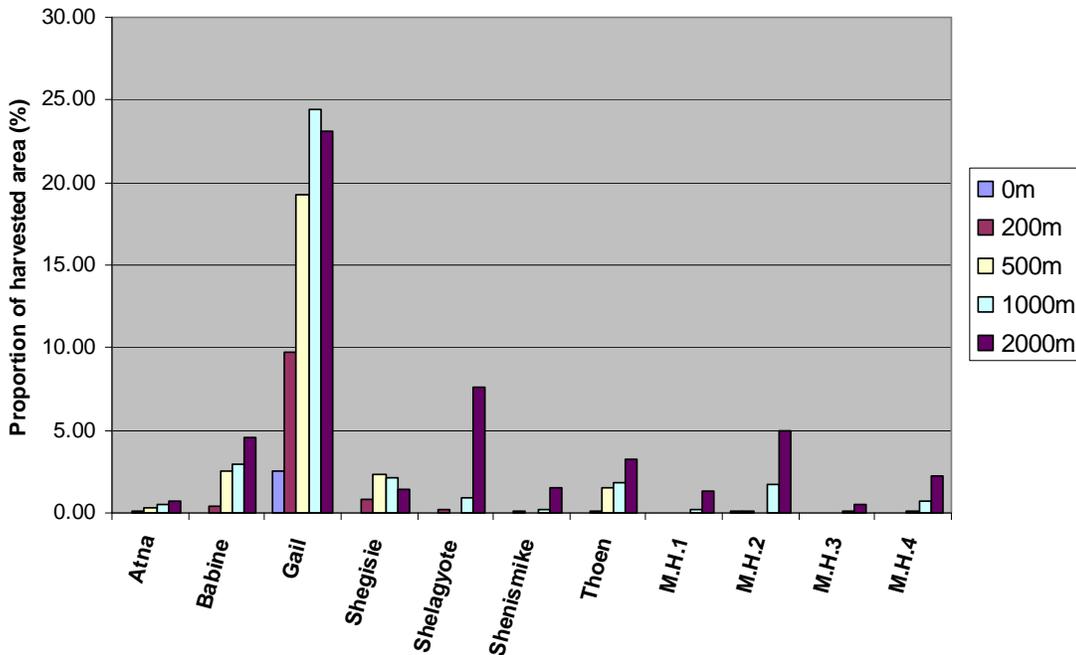
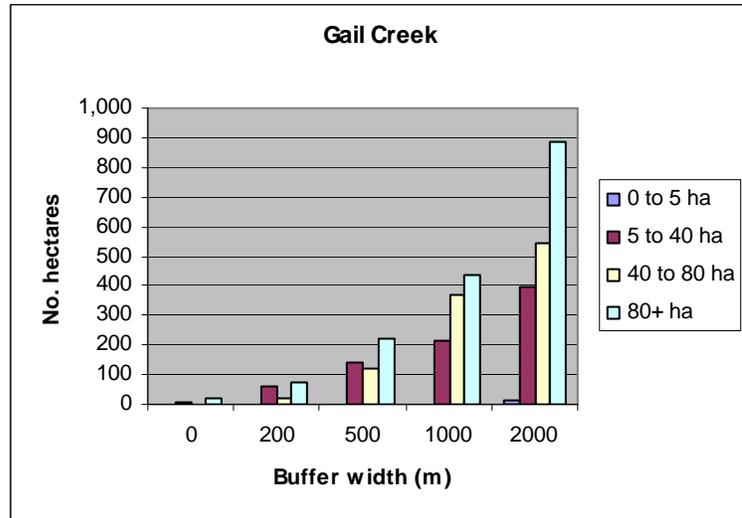


Figure 6. Proportion of harvested area expressed as a percentage of total area for both UWR and Mapped Habitat areas (and their associated buffers) within the Babine watershed.

### 4.3.1 Patch size and distribution

The level of forest harvesting within the UWR and Mapped Habitat areas (and associated buffers) is so low that there is little value in charting patch size for each one. Patch size has been charted for Gail Creek, however, due to the higher level of harvesting in and around this canyon site. The patch sizes, measured in hectares, are cumulative as the buffer size increases, so that the correct way to read Figure 7 is that there are 884ha of harvested area in patch sizes greater than 80ha within the UWR and a 2000m buffer around it. Within the UWR polygon there are a total of 24ha harvested; one smaller opening of 7ha and portion of a larger opening that totals 17ha.

**Figure 7. Harvest opening patch size distribution for the Gail Creek Canyon UWR polygon.**



Referring back to the map in Figure 1, the patch distribution indicates that there is extensive harvesting in and around the Gail Creek Canyon UWR, particularly in the lower half of the polygon/buffer complex. A few other significant points about harvest patch size and distribution are listed below.

- There is some relatively recent harvesting that has been done in the southern portion of the Atna UWR amalgamation (this information is yet to be incorporated into the VRI). The majority of these openings are in the 40 to 80ha category.
- The Shelagyote has one large area of depleted forest between the 1000m and 2000m buffers (total of 172ha) that is actually a burned area from around 40 years ago (G. Buhr, MOFR, pers. comm.).
- The harvest openings within the buffer zones of the Babine and Shenismike UWR polygons are all south-west of the Babine River Corridor Park boundary; the majority are 5 to 40 hectares in size.
- There is basically no harvesting within 500m of any of the Mapped Habitats, and very little harvesting (a total of 114ha for all four areas) within 1000m. The majority of harvesting occurs between the 1000 and 2000m buffer widths, and is focused on the eastern border of MH-4 and around Kotsine Pass.
- There is a large patch of harvest activity outside the northern most tip of the 2000m buffer for the UWR polygon near Mt. Thoen, but a relatively low level of activity within the 2000m buffer itself (159ha total, 104ha occur in openings from 5 to 40 hectares in size).
- The Shenismike and Shegisie UWR polygons (including the 2000m buffer) have the lowest level of harvest. There is some harvesting within the 2000m buffer for the Shegisie polygon outside the BWMT area that was not included in the analysis.

### 4.4 Road Density

The two UWR polygons that have the highest road concentration are Babine and Gail Creek (Figure 8). Both polygons have secondary roads within the core UWR polygon (720m and 241m for Babine and Gail Creek, respectively). Much lower road densities are observed for all of the other areas identified as goat habitat—the Shelagyote UWR polygon has no primary or secondary roads identified at all. There is a fairly extensive road network that exists between the Mapped Habitat areas and the Babine River Corridor (and extending north), but the road densities within each of the Mapped Habitat areas is quite low. Similar to the harvest opening distribution, the highest concentration of roads within the Mapped Habitat is around Kotsine Pass.

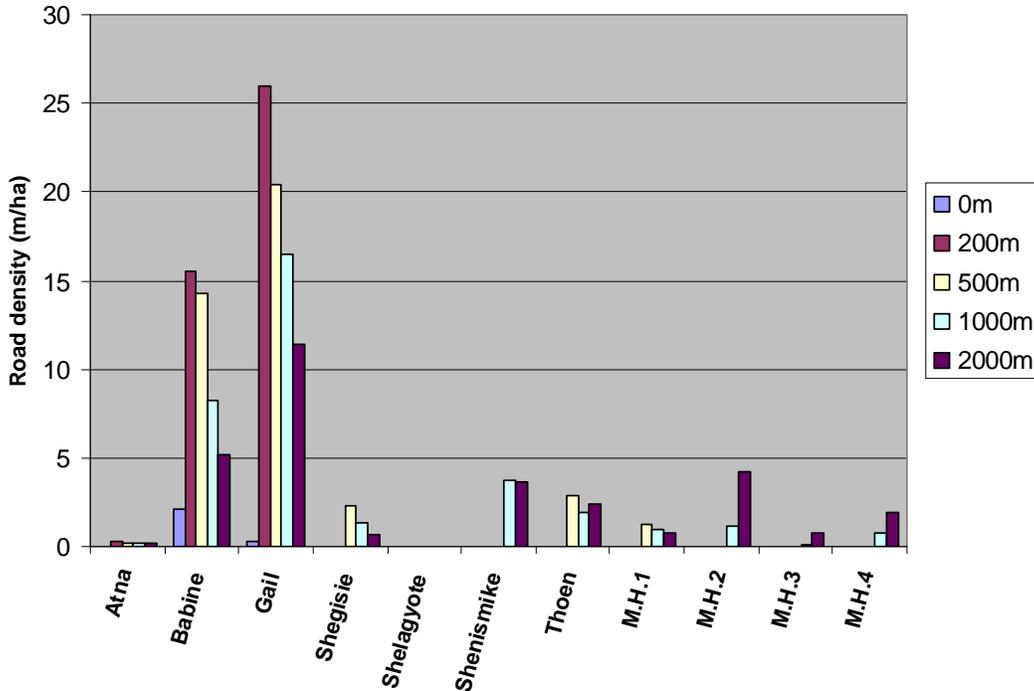


Figure 8. Road density (m/ha) for both the UWR and Mapped Habitat areas (and their associated buffers).

### 4.5 Incorporation into Existing BWMT Framework

The majority of these data will be used to update the BWMT Monitoring Framework during the course of another project initiated by the BWMT this year. At this time the results from both this project and the background review will be used to generate new risk curves and explore new indicators.

The preliminary risk curve generated for the indicator: type and patch-size distribution of harvest within 200 m of identified goat habitat is included in this report in Appendix II. The results from this project for the proportion of non-harvested area within the 200m buffer were transposed onto the curve to determine the level of risk to mountain goat habitat (Table 2). A low level of risk was indicated for all of the areas managed for goats. In reality, the goat population within the Gail Creek area is in decline, inferring that either the decline is not due to forest harvesting and the associated increase in roads (within 200m), or that the indicator needs to be modified to more accurately reflect the level of risk presented by forest harvesting to mountain goat habitat. The latter seems more probable – outside of the BWMT area there are other canyon-dwelling goat

populations that are being impacted by forest harvesting activities. In fact, the licensees operating within the Kispiox-Cranberry TSA have agreed to work with a 1000m buffer around these UWR polygons (with canyon-dwelling goat populations) (D. Fillier, MOE, pers. comm.).

**Table 2. Assessment of risk based on the percentage of old forest within 200m of identified goat habitat.**

	<b>% Unmodified &lt;200m from Habitat</b>	<b>Level of Risk</b>
<b>Atna</b>	99.85	Low
<b>Babine</b>	99.64	Low
<b>Gail</b>	90.23	Low
<b>Shegisie</b>	99.20	Low
<b>Shelagyote</b>	99.81	Low
<b>Shenismike</b>	99.89	Low
<b>Thoen</b>	99.92	Low
<b>M.H.1</b>	99.99	Low
<b>M.H.2</b>	99.94	Low
<b>M.H.3</b>	100.00	Low
<b>M.H.4</b>	100.00	Low

The second objective for goats as outlined in the land-use plans for the BWMT area is to maintain goat populations. One of the preliminary risk curves in the Knowledge Base evaluates the level of risk associated with increasing road density (measured in km/km<sup>2</sup>) (Appendix II). The assumption built into this risk curve is that the relationship between road density (within one kilometre of goat habitat) and the level of risk is linear (Price and Daust 2005). The results of this project (and from the background review conducted the year prior) indicate that the Gail Creek UWR polygon has a relatively high road density within one kilometre (Table 3). There is an access control point identified in the West Babine Sustainable Resource Management Plan (SRMP) near the Gail Creek UWR, but it is at the northern end (on the west side) and thus does not prevent people from accessing the polygon and buffer zones. The Access map from the West Babine SRMP is included in Appendix III.

**Table 3. Road density (m/ha) for each of the identified goat habitat areas and their associated buffers.**

	<b>Buffer width (m)</b>				
	<b>0m</b>	<b>200m</b>	<b>500m</b>	<b>1000m</b>	<b>2000m</b>
<b>Atna</b>	0.00	0.28	0.21	0.15	0.16
<b>Babine</b>	2.09	15.55	14.25	8.24	5.18
<b>Gail</b>	0.26	25.95	20.38	16.53	11.40
<b>Shegisie</b>	0.00	0.00	2.27	1.36	0.70
<b>Shelagyote</b>	0.00	0.00	0.00	0.00	0.00
<b>Shenismike</b>	0.00	0.00	0.00	3.71	3.67
<b>Thoen</b>	0.00	0.00	2.86	1.93	2.40
<b>M.H.1</b>	0.00	0.00	1.20	0.98	0.79
<b>M.H.2</b>	0.00	0.00	0.00	1.13	4.20
<b>M.H.3</b>	0.00	0.00	0.00	0.12	0.74
<b>M.H.4</b>	0.00	0.00	0.00	0.79	1.90

## 5.0 Discussion & Recommendations

The results of this project give a clearer picture of the current condition of the areas managed for mountain goats within the BWMT area, particularly with respect to potential levels of disturbance and the impact of this disturbance on habitat quality. Additional information documented in the background review from 2007 is included below to provide additional context for the mapping data.

- Areas such as the UWR polygons within the Atna-Shelagyote Range and some of the Mapped Habitat are associated with Special Management Zones and/or Protected Areas; it is assumed that this would inherently lower the risk of disturbance from harvesting. The Atna–Shelagyote Special Management Zone (SMZ) has been expanded to include the designated UWRs (D. Fillier, pers. comm.).
- UWR polygons associated with the Babine River Wilderness Corridor (Babine, Shenismike, Gail Creek) may receive some benefit from the associated habitat protection.
- The West Babine Sustainable Resource Management Plan (2004) indicates that there are access control points that protect the goat populations in the Atna, Shelagyote, Shenismike and Babine UWR polygons (Appendix III).

Given the extent of the information gathered by the BWMT thus far, the next logical step is to update the Monitoring Framework by incorporating these results into the Knowledge Base. As this process is already underway, it is recommended that the use of new and/or updated risk curves within Monitoring Framework be used to further clarify the picture for mountain goats in the Babine watershed. It is anticipated that one of the initiatives that result from the new and/or updated risk curves will be a re-analysis of the indicators that are currently being used to monitor the maintenance of mountain goat habitat and mountain goat populations. Steve Wilson (EcoLogic Research) has been working on effectiveness monitoring protocols for mountain goat winter ranges for the last several years. Wilson (2008) lists five key indicators:

1. proportion of suitable or capable UWR habitat;
2. forest cover characteristics;
3. evidence of movement between UWRs;
4. snow depth and consolidation; and
5. evidence of sustained winter use by mountain goats.

As UWRs have already been established for the West Babine portion of the watershed (through field work observing evidence of goat use), efforts could focus on improving the level of knowledge for the Mapped Habitats in the Bulkley portion. The Mapped Habitats were derived from the Land and Resource Management Planning (LRMP) process several years ago; it is likely these areas could be refined with more current information on vegetative cover and evidence of goat use.

Forest characteristics as defined by Wilson uses the proportion of forested area greater than 120 years old as an index of the integrity of forest cover. A similar analysis was completed in this project as forested areas were categorized by age class, with old forest including stands 120 years or older. Forest health and blowdown information was also included by Wilson during reconnaissance aerial surveys – this information could be added to the BWMT database as it becomes available.

Evidence of movement between UWRs (and Mapped Habitats) and evidence of use within these identified habitats are two indicators essential to successful effectiveness monitoring for mountain goats in the BWMT area. The BWMT area is frequently flown by people moving in and out of the area for recreation purposes and resource-related activities. A cost effective approach could include the documentation of incidental observations from these flights. GPS coordinates would assist the development of another GIS mapping layer that could be dedicated to the documentation of these observations.

Eventually, additional project work that looks at these indicators within an inventory context is the only way to get an accurate estimation of the use of the areas indicated for goats. Snow depth and consolidation measurements could be incorporated at this stage. These types of data are expensive to gather, however, as a combination of aerial and ground surveys would have to be conducted. The results from this project indicate that the risk to mountain goat habitat from harvesting (within 200m or less of the managed area) is low overall. Although this may be true within each of the managed areas, data for mineral licks and trails is still lacking.

It is recommended that baseline evidence of use data be collected for the current UWR and Mapped Habitats prior to further analysis of the impact of timing of harvesting activities on goats during the natal period. The UWR polygons established for goats were intended to provide these populations with habitat during critical winter months. More detailed knowledge about the use of these areas by goats (and movement between them) would facilitate the interpretation of the impact of harvest activities on movement patterns.

Finally, the objectives, indicators and strategies in the current Monitoring Framework are focused on the impact of disturbance due to forest harvesting and road density. Mining and mine exploration is becoming more and more prevalent throughout north-western BC. The West Babine SRMP (2004) indicates that there are several areas with very high mineral and energy potential. An increase in mining activities (blasting and additional landscape fragmentation) would likely increase pressure on goat populations and their habitat, particularly the escape terrain. The development of indicators relevant to mining activities will likely be necessary to meet the objectives of maintaining goat populations and their habitat within the BWMT area.

## 6.0 References

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## Appendix I. Data Analyses Results

			<i>Early</i>			<i>Mid</i>			<i>Old</i>		
			Non-THLB	THLB	Sum Area (ha)	Non-THLB	THLB	Sum Area (ha)	Non-THLB	THLB	Sum Area (ha)
<b>UWR</b>	<b>Name</b>	<b>Total Area (ha)</b>									
<b>Buffer (2000 m)</b>	Atna	21,451	0	0	0	92	31	123	5,217	2,421	7,638
	Babine	3,231	15	104	119	63	0	63	1,661	1,270	2,931
	Gail	7,941	45	1,052	1,097	1,146	372	1,518	1,859	2,748	4,607
	Shegisie	3,618	2	22	24	7	0	7	858	929	1,787
	Shelagyote	2,263	0	0	0	42	0	42	2,001	0	2,001
	Shenismike	3,182	12	28	40	16	0	16	1,428	1,597	3,025
	Toen	4,868	9	108	117	6	2	8	1,985	140	2,125
<b>Buffer (1000 m)</b>	Atna	14,003	0	0	0	68	1	70	3,824	813	4,637
	Babine	1,711	14	34	48	28	0	28	1,120	407	1,527
	Gail	4,184	34	656	690	664	271	935	971	1,238	2,209
	Shegisie	1,757	0	8	8	0	0	0	414	338	752
	Shelagyote	890	0	0	0	19	0	19	760	0	760
	Shenismike	1,513	6	0	6	11	0	11	735	746	1,481
	Toen	2,652	8	40	48	6	2	8	1,054	58	1,112
<b>Buffer (500 m)</b>	Atna	10,094	0	0	0	67	0	67	2,894	266	3,159
	Babine	967	10	15	25	17	0	17	779	84	863
	Gail	2,498	32	307	339	502	145	648	698	578	1,275
	Shegisie	1,057	0	0	0	0	0	0	267	97	364
	Shelagyote	436	0	0	0	1	0	1	368	0	368
	Shenismike	782	4	0	4	7	0	7	417	318	735
	Toen	1,769	4	22	26	6	2	8	591	40	631
<b>Buffer (200 m)</b>	Atna	7,678	0	0	0	67	0	67	2,220	60	2,280
	Babine	581	0	2	2	16	0	16	491	25	516
	Gail	1,541	28	74	101	390	46	436	590	256	846
	Shegisie	710	0	0	0	0	0	0	161	43	204
	Shelagyote	237	0	0	0	0	0	0	188	0	188
	Shenismike	408	0	0	0	0	0	0	280	97	377
	Toen	1,311	0	1	1	6	2	7	332	23	355
<b>No Buffer</b>	Atna	6,016	0	0	0	51	0	51	1,702	0	1,703
	Babine	345	0	0	0	16	0	16	287	1	288
	Gail	925	21	1	22	287	2	288	501	5	506
	Shegisie	510	0	0	0	0	0	0	103	1	104
	Shelagyote	135	0	0	0	0	0	0	91	0	91
	Shenismike	221	0	0	0	0	0	0	192	2	194
	Toen	1,033	0	0	0	4	0	5	179	0	179

			<i>Early</i>			<i>Mid</i>			<i>Old</i>		
			Non-THLB	THLB	Sum Area (ha)	Non-THLB	THLB	Sum Area (ha)	Non-THLB	THLB	Sum Area (ha)
<b>UWR</b>	<b>Name</b>	<b>Total Area (ha)</b>									
<b>Mapped Habitat</b>											
<b>Buffer (2000 m)</b>	M.H.1	11,532	38	38	76	606	230	836	5,159	1,648	6,806
	M.H.2	2,448	1	60	61	244	7	251	1,309	406	1,715
	M.H.3	33,071	382	1,146	1,528	2,619	361	2,980	9,162	4,711	13,873
	M.H.4	13,480	5	161	166	146	28	174	5,288	3,513	8,801
<b>Buffer (1000 m)</b>	M.H.1	6,971	23	10	34	201	107	308	2,837	760	3,598
	M.H.2	1,373	0	13	13	157	7	164	601	204	806
	M.H.3	23,644	146	506	652	1,498	268	1,766	6,442	2,997	9,439
	M.H.4	8,742	5	3	7	30	16	46	3,325	1,853	5,178
<b>Buffer (500 m)</b>	M.H.1	4,712	21		21	88	9	97	1,582	407	1,988
	M.H.2	680	0	0	0	89	0	89	304	45	349
	M.H.3	18,893	101	282	383	939	223	1,162	5,375	2,054	7,429
	M.H.4	6,310	5	0	5	30	3	33	2,176	967	3,143
<b>Buffer (200 m)</b>	M.H.1	3,333	14	0	14	64	0	65	865	164	1,028
	M.H.2	324	0	0	0	36		36	139	12	150
	M.H.3	15,977	69	199	268	665	189	854	4,669	1,575	6,244
	M.H.4	4,843	5	0	5	26	0	26	1,554	506	2,059
<b>No Buffer</b>	M.H.1	2,414	12	0	12	47	0	47	460	53	512
	M.H.2	147	0	0	0	18	0	18	47	1	48
	M.H.3	13,994	53	156	208	534	170	704	4,195	1,337	5,532
	M.H.4	3,865	2	0	2	16	0	16	1,077	327	1,403

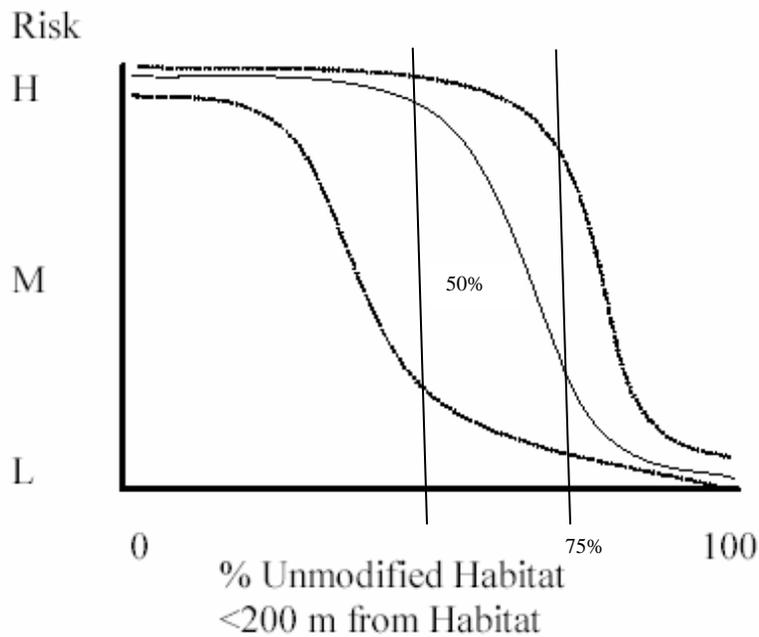
			<i>Non-Forested</i>			<i>Harvested</i>			<i>Harvested Patch Size</i>				
UWR	Name	Total Area (ha)	Non-THLB	THLB	Sum Area (ha)	Non-THLB	THLB	Sum Area (ha)	0 to 5 ha	5 to 40 ha	40 to 80 ha	80+ ha	Sum Area (ha)
<b>Buffer (2000 m)</b>	Atna	21,451	13,674	15	13,690	13	145	158	0	0	122	36	158
	Babine	3,231	118	0	118	15	134	149	0	109	40	0	149
	Gail	7,941	454	265	719	120	1,714	1,834	13	394	543	884	1,834
	Shegisie	3,618	1,771	29	1,800	4	49	53	0	53	0	0	53
	Shelagyote	2,263	219	0	219	172	0	172	0	0	0	172	172
	Shenismike	3,182	100	0	101	12	35	47	0	47	0	0	47
	Thoen	4,868	2,617	2	2,618	46	113	159	25	104	6	24	159
<b>Buffer (1000 m)</b>	Atna	14,003	9,296	0	9,296	10	58	68	0	0	68	0	68
	Babine	1,711	70	0	70	14	36	51	0	51	0	0	51
	Gail	4,184	236	114	350	68	954	1,022	0	216	371	435	1,022
	Shegisie	1,757	968	29	997	3	35	38	0	38	0	0	38
	Shelagyote	890	111	0	111	8	0	8	0	0	0	8	8
	Shenismike	1,513	53	0	53	3	0	3	0	3	0	0	3
	Thoen	2,652	1,483	0	1,483	8	40	48	25	23	0	0	48
<b>Buffer (500 m)</b>	Atna	10,094	6,867	0	6,867	6	27	33	0	0	33	0	33
	Babine	967	61	0	61	10	15	25	0	25	0	0	25
	Gail	2,498	161	75	236	37	444	481	0	141	122	218	481
	Shegisie	1,057	671	22	693	2	22	24	0	24	0	0	24
	Shelagyote	436	66	0	66	0	0	0	0	0	0	0	0
	Shenismike	782	36	0	36	0	0	0	0	0	0	0	0
	Thoen	1,769	1,104	0	1,104	4	22	26	19	7	0	0	26
<b>Buffer (200 m)</b>	Atna	7,678	5,331	0	5,331	4	7	11	0	0	11	0	11
	Babine	581	47	0	47	0	2	2	0	2	0	0	2
	Gail	1,541	123	34	157	30	121	150	0	58	20	73	150
	Shegisie	710	500	5	506	0	5	6	0	6	0	0	6
	Shelagyote	237	48	0	48	0	0	0	0	0	0	0	0
	Shenismike	408	31	0	31	0	0	0	0	0	0	0	0
	Thoen	1,311	947	0	947	0	1	1	1	0	0	0	1
<b>No Buffer</b>	Atna	6,016	4,262	0	4,262	2	0	2	0	0	2	0	2
	Babine	345	41	0	41	0	0	0	0	0	0	0	0
	Gail	925	109	0	109	23	1	24	0	7	0	17	24
	Shegisie	510	406	0	406	0	0	0	0	0	0	0	0
	Shelagyote	135	44	0	44	0	0	0	0	0	0	0	0
	Shenismike	221	27	0	27	0	0	0	0	0	0	0	0
	Thoen	1,033	849	0	849	0	0	0	0	0	0	0	0

			<i>Non-Forested</i>			<i>Harvested</i>			<i>Harvested Patch Size</i>				
UWR	Name	Total Area (ha)	Non-THLB	THLB	Sum Area (ha)	Non-THLB	THLB	Sum Area (ha)	0 to 5 ha	5 to 40 ha	40 to 80 ha	80+ ha	Sum Area (ha)
<b>Mapped Habitat</b>													
<b>Buffer (2000 m)</b>	M.H.1	11,532	3,808	6	3,814	0	156	156	0	37	21	99	156
	M.H.2	2,448	369	54	423	9	113	122	0	0	122	0	122
	M.H.3	33,071	14,150	540	14,690	9	166	175	0	24	151	0	175
	M.H.4	13,480	4,321	19	4,339	34	271	305	0	0	0	305	305
<b>Buffer (1000 m)</b>	M.H.1	6,971	3,071	0	3,071	0	12	12	0	10	0	2	12
	M.H.2	1,373	341	9	349	2	22	24	0	0	24	0	24
	M.H.3	23,644	11,387	400	11,787	0	16	16	0	0	16	0	16
	M.H.4	8,742	3,510	0	3,510	12	49	61	0	0	0	61	61
<b>Buffer (500 m)</b>	M.H.1	4,712	2,605	0	2,605	0	0	0	0	0	0	0	0
	M.H.2	680	242	0	242	0	0	0	0	0	0	0	0
	M.H.3	18,893	9,646	273	9,919	0	0	0	0	0	0	0	0
	M.H.4	6,310	3,130	0	3,130	1	7	8	0	0	0	8	8
<b>Buffer (200 m)</b>	M.H.1	3,333	2,226	0	2,226	0	0	0	0	0	0	0	0
	M.H.2	324	137	0	137	0	0	0	0	0	0	0	0
	M.H.3	15,977	8,410	201	8,611	0	0	0	0	0	0	0	0
	M.H.4	4,843	2,753	0	2,753	0	0	0	0	0	0	0	0
<b>No Buffer</b>	M.H.1	2,414	1,842	0	1,842	0	0	0	0	0	0	0	0
	M.H.2	147	81	0	81	0	0	0	0	0	0	0	0
	M.H.3	13,994	7,400	150	7,550	0	0	0	0	0	0	0	0
	M.H.4	3,865	2,444	0	2,444	0	0	0	0	0	0	0	0

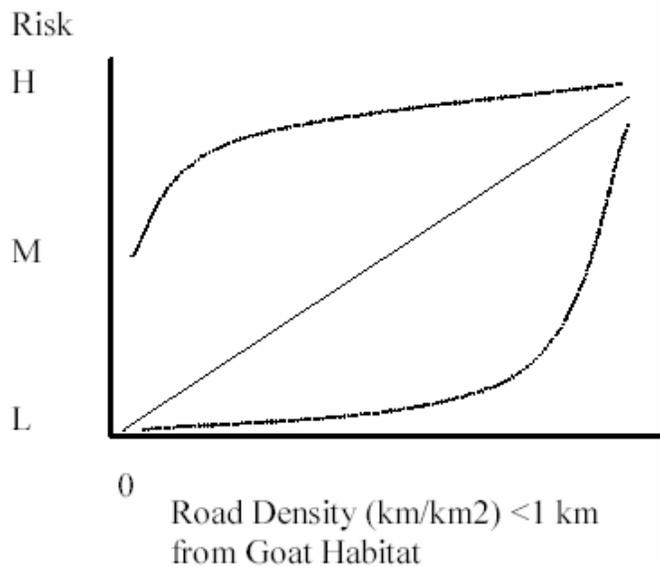
BWMT: Harvesting Practices and Mountain Goat Habitat

			<b>Road Density</b>			
<b>UWR</b>	<b>Name</b>	<b>Total Area (ha)</b>	<b>Primary</b>	<b>Secondary</b>	<b>Sum Length (m)</b>	<b>Density (m/ha)</b>
<b>Buffer (2000 m)</b>	Atna	21,451	0	3,533	3,533	0.165
	Babine	3,231	7,033	9,716	16,748	5.184
	Gail	7,941	37,966	52,559	90,525	11.400
	Shegisie	3,618	0	2,532	2,532	0.700
	Shelagyote	2,263	0	0	0	0.000
	Shenismike	3,182	3,212	8,470	11,681	3.671
	Thoen	4,868	3,721	7,961	11,682	2.400
<b>Buffer (1000 m)</b>	Atna	14,003	0	2,145	2,145	0.153
	Babine	1,711	7,033	7,070	14,103	8.243
	Gail	4,184	31,712	37,443	69,155	16.530
	Shegisie	1,757	0	2,396	2,396	1.363
	Shelagyote	890	0	0	0	0.000
	Shenismike	1,513	2,545	3,076	5,621	3.715
	Thoen	2,652	657	4,468	5,125	1.933
<b>Buffer (500 m)</b>	Atna	10,094	0	2,145	2,145	0.212
	Babine	967	7,033	6,743	13,775	14.251
	Gail	2,498	27,268	23,648	50,916	20.382
	Shegisie	1,057	0	2,396	2,396	2.267
	Shelagyote	436	0	0	0	0.000
	Shenismike	782	0	0	0	0.000
	Thoen	1,769	0	5,062	5,062	2.861
<b>Buffer (200 m)</b>	Atna	7,678	0	2,145	2,145	0.279
	Babine	581	0	9,027	9,027	15.550
	Gail	1,541	29,108	10,877	39,985	25.951
	Shegisie	710	0	0	0	0.000
	Shelagyote	237	0	0	0	0.000
	Shenismike	408	0	0	0	0.000
	Thoen	1,311	0	0	0	0.000
<b>No Buffer</b>	Atna	6,016	0	0	0	0.000
	Babine	345	0	720	720	2.089
	Gail	925	0	241	241	0.261
	Shegisie	510	0	0	0	0.000
	Shelagyote	135	0	0	0	0.000
	Shenismike	221	0	0	0	0.000
	Thoen	1,033	0	0	0	0.000
<b>Mapped Habitat</b>						
<b>Buffer (2000 m)</b>	M.H.1	11,532	7,628	1,514	9,142	0.793
	M.H.2	2,448	5,215	5,069	10,285	4.200
	M.H.3	33,071	7,137	17,496	24,633	0.745
	M.H.4	13,480	0	25,593	25,593	1.899
<b>Buffer (1000 m)</b>	M.H.1	6,971	6,865	0	6,865	0.985
	M.H.2	1,373	793	764	1,557	1.134
	M.H.3	23,644	0	2,861	2,861	0.121
	M.H.4	8,742	0	6,908	6,908	0.790
<b>Buffer (500 m)</b>	M.H.1	4,712	5,659	0	5,659	1.201
	M.H.2	680	0	0	0	0.000
	M.H.3	18,893	0	0	0	0.000
	M.H.4	6,310	0	0	0	0.000
<b>Buffer (200 m)</b>	M.H.1	3,333	0	0	0	0.000
	M.H.2	324	0	0	0	0.000
	M.H.3	15,977	0	0	0	0.000
	M.H.4	4,843	0	0	0	0.000
<b>No Buffer</b>	M.H.1	2,414	0	0	0	0.000
	M.H.2	147	0	0	0	0.000
	M.H.3	13,994	0	0	0	0.000
	M.H.4	3,865	0	0	0	0.000

**Appendix II. Risk curve generated based on one indicator for maintaining mountain goat habitat (Price and Daust 2005).**



**Figure 4.1. Risk to goat habitat versus % of unmodified habitat within 200 m of identified habitat.**



**Figure 4.2. Risk to goat population versus road density within 1 km of habitat. Note that values on X-axis are unspecified.**

### Appendix III: Access Map from West Babine Sustainable Resource Management Plan (2004)

