

# **Draft Protocol for Monitoring the Effectiveness of Mountain Goat Winter Ranges**

DRAFT

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**Prepared by:**

Steven F. Wilson, Ph.D., R.P.Bio., EcoLogic Research, 406 Hemlock Avenue, Gabriola, BC.

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## PART I: INTRODUCTION

### Background

Mountain goats (*Oreamnos americanus*) are a relatively common resident of British Columbia's most rugged habitats. More than 50% of the world's population resides in BC (Shackleton 1999) and, as a result, the Province has a significant responsibility to sustain their distribution and abundance. Winter is considered a critical period for goats and other ungulates because of poor foraging conditions and high-energy expenditures related to thermoregulation and mobility in snow (Wilson 2005). Consequently, provisions in the *BC Forest and Range Practices Act* (FRPA) allow for legal designation of Ungulate Winter Ranges (UWRs) under Section 12 of the Government Actions Regulation. UWRs are intended to provide sufficient habitat to ensure the over-winter survival of the species for which they are established. Mountain goat winter ranges have been either established or are proposed in most regions of the Province.

Because the FRPA is results-based, an important component of its implementation is effectiveness monitoring in relation to specific values that are addressed under the legislation, including UWR. This report outlines a protocol for monitoring the effectiveness of mountain goat winter ranges.

### Objectives

The objectives of monitoring mountain goat winter ranges are to determine whether:

1. the characteristics of winter range areas important to mountain goats are being maintained over time;
2. winter ranges are receiving use by mountain goats; and,
3. the distribution and abundance of winter ranges and other legally protected areas are providing sufficient habitat to ensure the winter survival of mountain goats.

### Monitoring Questions

The following are key monitoring questions related to assessing the effectiveness of goat winter ranges under the FRPA.

#### *A. Small scale (individual winter ranges)*

1. Does the winter range provide the habitat elements required to fulfil the life requisites of mountain goats during winter?
2. Is the winter range receiving sustained use by mountain goats?
3. Is human-related disturbance affecting use of the winter range by mountain goats?

#### *B. Medium scale (watershed or management unit)*

1. Are there barriers outside of the winter range that prevent the movements of mountain goats between winter ranges?
2. Is the distribution and abundance of winter ranges sufficient to ensure over-winter survival in typical and severe winters?

#### *C. Large scale (subregional or regional populations)*

1. Is the distribution and abundance of winter ranges and other protected mountain goat habitat sufficient to sustain the regional mountain goat population?
2. Is the current suite of management practices sufficient to meet regional mountain goat objectives (e.g., maintenance or recovery)?

## Indicators

The following are indicators that have been developed to address the monitoring questions:

### 1. Forest cover characteristics (monitoring question A1)

Forest cover is an important characteristic of some mountain goat winter ranges; particularly in coastal regions where deep, unconsolidated snow forces mountain goats to elevations below tree line where dense canopies intercept snowfall and reduce snow depths on the ground (Wilson 2005). Ensuring that forest canopy conditions are sufficient to moderate snow depths on winter ranges, and ensuring that canopy conditions persist over time, are the reasons for monitoring forest cover characteristics.

The forest characteristics of the winter range at the time of legal establishment form the ecological baseline against which future monitoring results should be assessed, unless recovery of forest characteristics is an objective for the winter range.

### 2. Snow depth and consolidation (monitoring question A1)

Mountain goat winter ranges are characterized by features that moderate snow depths. This allows goats to access forage and to minimize their energy expenditure. At snow depths of >50 cm, forbs and ferns become unavailable and goats forage on conifer leaves and lichens from standing trees and litterfall, and on mosses from substrates not covered by snow (Fox and Smith 1988).

Research on similarly sized ungulates (e.g., mule deer) suggests that mobility becomes increasingly restricted as snow depths exceed 25 cm and can significantly restrict movements if depths exceed 50 cm (Ungulate Winter Range Technical Advisory Team 2004 and references therein). Based on these results, I propose an ecological baseline of snow depths <40 cm and sinking depths of <25 cm to indicate suitable winter range snow conditions for mountain goats.

### 3. Evidence of sustained winter Use (monitoring question A2)

Evidence of consistent winter use by mountain goats over many years is the most important indicator of the effectiveness of winter range management. The ecological baseline for sustained winter use should simply be continued relative use over time, based on whatever lines of evidence may be available.

There are two monitoring questions that extend beyond the scope of the FREP; question A3 is related to disturbance, which in only some instances is related to forest and range activities. Question C2 is intended to address the entire scope of management actions, including harvest management. Interpreting FREP-related monitoring results depends on adequate monitoring related to these other questions.

### 4. Evidence of movement among winter ranges (monitoring question B1)

Winter ranges are established only where suitable habitat exists; therefore, they tend to be small and distributed within a matrix of less suitable habitat. Although some mountain goats remain within areas smaller than most established winter ranges for large parts of the season, more typically animals move between patches of suitable habitat (Taylor et al. 2004). As a result, it is important that forest harvesting activities occurring in areas between ranges do not interfere with movements of mountain goats between ranges. However, there has been little research on the effects of harvesting on movement of mountain goats between winter ranges. As a result, it is important to document such movements wherever possible.

Ecological baselines related to evidence of movement among winter ranges are difficult to establish because a failure to detect movements among winter ranges does not necessarily indicate that the winter ranges are ineffective or that the intervening forest matrix is unsuitable.

## 5. Proportion of suitable or capable habitat managed as Mountain Goat winter range (monitoring questions B2, C1, C2)

The proportion of suitable or capable habitat under management indicates how extensively habitat is managed to benefit mountain goats. Whether suitable or capable habitat is used for the calculation depends on the population goal (i.e., maintenance or recovery of the local mountain goat population).

There is no ecological baseline associated with the proportion of suitable or capable habitat managed as mountain goat winter range; rather, the indicator provides a management baseline that reflects the landscape-level potential for managing and protecting mountain goat winter range. The goal of capturing all winter ranges in designated UWRs or other managed or protected areas can be justified by the relative scarcity of suitable or capable winter habitat for mountain goats.

## PART II: SAMPLING DESIGN

### Study design

The design of the monitoring programme will depend on the distribution and abundance of mountain goat winter ranges in a region or subregional area of interest, and on available resources. The general approach is to use GIS analyses and office-based procedures to monitor relevant indicators over the largest extent practical, and to then subsample specific watersheds and individual ranges more intensively (see below).

### Stratification

The following is a proposed stratification for the effectiveness-monitoring programme:

1. Proportion of suitable habitat under management - entire region or subregion of interest, based on GIS analyses.
2. Forest cover characteristics, evidence of sustained winter use, evidence of movement among winter ranges (anecdotal) - sample of watersheds for aerial reconnaissance, forest cover analysis and aerial photo review.
3. Forest cover characteristics, snow depth and consolidation, evidence of sustained winter use - sample of individual ranges that are safe to traverse on the ground.
4. Evidence of movement among winter ranges, evidence of sustained use - analysis of telemetry data where available.

### Study population

Mountain goats are widespread throughout large areas of the Province (Figure 1). Goats are most common in Skeena, Kootenay and the Coastal range of the Lower Mainland. Goats are relatively rare and more at risk in the Cascades range of the Lower Mainland and in the Okanagan Region, or anywhere that goats are using low-elevation terrain close to potential disturbances.

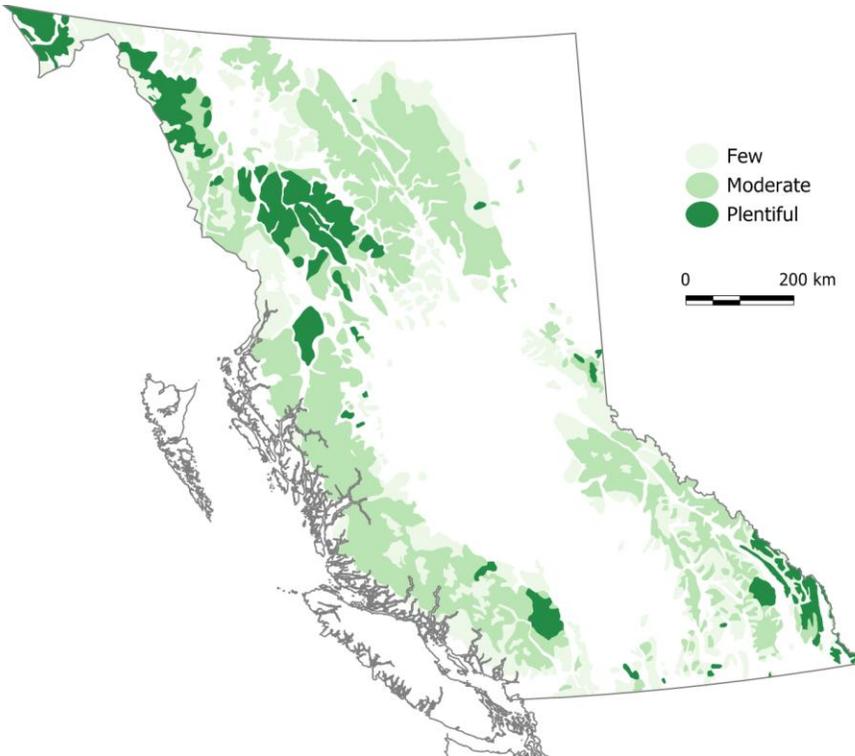


Figure 1. Range of mountain goats in British Columbia (Shackleton 1999).

## Monitoring schedule

The following is a proposed schedule for the effectiveness-monitoring programme:

1. Proportion of suitable habitat under management -when winter ranges are established or are being considered for legal establishment.
2. Forest cover characteristics, evidence of sustained winter use, evidence of movement among winter ranges (anecdotal) - every 5-10 years.
3. Forest cover characteristics, snow depth and consolidation, evidence of sustained winter use - repeated sampling every 3-5 years.
4. Evidence of movement among winter ranges, evidence of sustained use -when data are available.

## PART III: DATA COLLECTION

### Required equipment and information

The following equipment and data are required for conducting the monitoring programme:

#### *Office procedures*

- GIS software for analysis of: Vegetation Resources Inventory (VRI) or forest cover data, Terrain Resource Information Mapping (TRIM) and derived digital elevation models (DEM), digital coverages of winter ranges boundaries, digital orthophotos or high-resolution satellite images (e.g., SPOT-5). Hard-copy aerial photos can also be used for interpretation.

### Field procedures

- Standard safety equipment and personal field gear;
- Clinometer, compass, GPS, camera, graduated pole, tape measure, flagging tape; and,
- Reference materials: *Field Manual for Describing Terrestrial Ecosystems* (BC Ministry of Environment, Land and Parks and BC Ministry of Forests 1998), *Estimating the Abundance of Arboreal Forage Lichens* (Armleder et al. 1992)
- Field Data Forms (as per Appendix 1).

### Required skills and training

Office procedures require skills in GIS analysis and simple modelling. Experience with photo-interpretation is helpful.

Field procedures require specific safety training as well as familiarity with field plot sampling procedures. Experience with tracking and identifying animal sign (tracks, pellets, browse) is important. For safety reasons, field crews should be familiar with the terrain to be surveyed.

### Safety procedures

Most mountain goat winter ranges are located at high elevations in steep terrain. Ground sampling must necessarily be limited to ranges that are accessible and safe to traverse. This will limit the scope of ground-sampling work and in many cases strict sampling protocols will not be practical to follow. The goal is to collect as much meaningful data as possible while maintaining a safe work environment. All Worksafe BC and Forest Safety Council regulations and procedures must be followed.

### Office procedures

Base Mapping and Summary Statistics: All metrics are developed using data available in Vegetation Resources Inventory (VRI) and Terrain Resource Information Mapping (TRIM) databases (Land and Resource Data Warehouse: [lrdw.ca](http://lrdw.ca), maintained by the Integrated Land Management Bureau). A 25-m resolution digital elevation model is derived from TRIM to define watersheds, slopes and aspects.

The following summary statistics are calculated for each winter range:

1. total area;
2. vegetated area;
3. forested area; and,
4. area of consolidated rock.

Proportion of Suitable Habitat Under Management: The entire watershed is used to define the area of interest for the analysis of suitable habitat. In addition to mountain goat winter ranges established under the FRPA, other areas considered “under management” are Parks and Protected Areas, Wildlife Habitat Areas and Old Growth Management Areas. Threats to high elevation, suitable habitat located outside these areas are limited, but there is no legal protection; therefore, these areas are included in the analysis as areas not under management.

In order to provide a simple and consistent ecological baseline for determining the abundance and distribution of suitable habitat, a generalized model of mountain goat habitat has been proposed. It was designed to correspond roughly to the area that could be considered potentially suitable for mountain goats under a broad range of conditions. The model defines suitable habitat as areas with all of the following characteristics:

1. Warm aspects - 135-315°;

2. Steep slopes - 30-60°; and,
3. Consolidated rock or forest cover >120 years.

Areas meeting these criteria are queried in the spatial database in order to map potentially suitable habitat within watersheds. Then the proportion of this area that falls within legally established goat winter ranges and other protected or reserve areas is calculated.

Field-verified, local models or winter range can also be used for measuring this indicator, although results will not be comparable to other areas.

Forest Cover Characteristics: The integrity of forest cover is indexed by examining the proportion of forested area in stands >120 years old. This represents late-mature seral conditions in most forest types found in BC. This age is only a coarse estimate; the actual forest age required to provide suitable attributes will vary by forest type and with biogeoclimatic characteristics. More detailed forest cover characteristics (e.g., blowdown, forest health issues, harvest treatments) in and near winter ranges can be assessed by examining aerial photos, digital orthophotos or high-resolution satellite imagery (e.g., SPOT-5).

Evidence of Movement Among Winter Ranges and Evidence of Sustained Winter Use: Movements within and between winter ranges can be determined through analysis of telemetry location data, where available.

## Field Procedures

### Aerial Reconnaissance

Field procedures can include data collected from aerial reconnaissance surveys and ground surveys. Aerial reconnaissance can include:

- Forest Cover Characteristics: blowdown, forest health issues, forest harvesting treatments;
- Evidence of Movement Among Winter Ranges: anecdotal evidence of movement between winter range areas can sometimes be observed on flights if tracks can be located outside winter ranges; and,
- Evidence of Sustained Winter Use: winter aerial inventory surveys (Resources Inventory Committee 2002) are most commonly used to establish occupancy of mountain goat winter ranges; data can be used to index intensity and distribution of use as well as regional trends in abundance.

### Ground Sampling

The following procedure outlines the steps to be taken during ground sampling, where it can be conducted safely:

1. Establish a point of origin outside the winter range boundary. Ideal locations are in clearcuts near the winter range boundary on shallow slopes and on an aspect similar to most of the winter range. Points should permit transects to be navigated at approximately 45 degrees up or downslope, if practical. Points of origin should be marked as waypoints on a GPS and flagged so they can be located in future years and data collected along the same (or similar) transect locations.
2. Navigate from the point of origin and select area for plot approximately 20 m from winter range boundary with no forest overstorey, if possible. Record plot data on the Plot Card ( Appendix I).
3. Mountain goat tracks encountered along transects can be followed to look for evidence of browse, beds, hair, etc. Effort spent backtracking depends on the abundance of tracks and time available.
4. If areas of intense use (see below) by goats are encountered (e.g., large pellet concentrations and hair, often on rocky outcrops with little or snow cover), note GPS location and take photographs.

Mark the area with paint blazes and a tree marker and make detailed notes of the location to ensure that future surveyors can find the area.

5. Return to the plot location and take a bearing that traverses the winter range at an approximate 45-degree angle (either upslope or downslope, depending on point of origin, if possible). Establish next plot 20 m inside winter range boundary and repeat steps 1-3.
6. Continue establishing plots at either 20 or 50 m intervals, depending on the size of the winter range and the feasibility of navigating along the transect line. The objective should be to capture data at at least 5 plots along the transect within the winter range boundary. The number of transects and, hence, the sampling intensity is expected to vary because of the size of the winter range and the feasibility of navigating terrain.

**Table 1. Data to be collected at each plot along winter range transects.**

Indicator	Variable	Methods
Plot context	Site characteristics	Estimate slope with clinometer, aspect with compass, elevation from altimeter or GPS; UTM coordinates from GPS, other site characteristics (Ministry of Environment, Lands and Parks and Ministry of Forests 1998), take photograph
Snow depth and consolidation	Snow depth	Measure to nearest 5 cm with graduated pole at 10 locations within 20 x 20 m plot; note depth of crust layers
	Snow consolidation	Sink graduated ski pole into snow using strength of one arm, record sinking depth to nearest 5 cm at 10 locations within 20 x 20 m plot
Forest cover characteristics	Forest canopy	Percent cover for tree layer, dominant species in A1, A2 and A3 layers within 20 x 20 m plot (Ministry of Environment, Lands and Parks and Ministry of Forests 1998)
Forage availability	Shrub, herb and moss abundance	Percent cover for shrub, herb and moss layers above the snow line within 20 x 20 m plot (Ministry of Environment, Lands and Parks and Ministry of Forests 1998)
	Lichen/Litterfall	Plot estimate of lichen abundance, qualitative assessment of lichen-bearing branch litterfall within 20 x 20 m plot (Armleder et al. 1992)
Evidence of use by mountain goats	Visible sign	Record all tracks (and sinking depth), pellets, hair, etc. evident in the 20 x 20 m plot and the number of tracks encountered along transects

Areas of intense use can be further monitored by clearing pellets from small plots (e.g., 1 m<sup>2</sup>) at the beginning of the winter and returning in the spring to assess use. Pellets can be dried and weighed, counted or simply photographed to assess relative use.

## PART IV: EVALUATING RESULTS

### Data Analysis

Most of the monitoring data require only summary statistics and qualitative comparisons. The exceptions are data related to snow and sinking depths, crown closure and pellet removal plots. The relationship between snow and sinking depths and canopy characteristics can be explored using regression analyses by forest type. Relative use of pellet removal plots can be compared among years

using frequency analyses if pellets are counted (e.g., chi-squared, g-tests or log-linear analyses), or comparisons among means (t-tests, ANOVA) where pellets are weighed and data are available for several sites and/or years.

For analysis of telemetry data there are a variety of techniques that can visually illustrate evidence of movement among winter ranges. Simple scatter plots or maps of home ranges (minimum convex polygon or kernel estimators) are useful.

## Evaluation Matrix

Results of the monitoring program can be evaluated in the context of an evaluation matrix (Table 2).

**Table 2. Evaluation matrix summarizing indicators, baselines and possible outcomes for monitoring the effectiveness of mountain goat winter ranges.**

Indicator	Desired Condition	Direct Measures	Indirect or anecdotal evidence
Proportion of suitable/capable habitat managed as mountain goat winter range	100% of field-verified suitable habitat legally protected	GIS overlay of goat winter range and other legally protected areas on coverages of suitable habitat	Where habitat as not been field-verified, modelled habitat can be substituted, but <100% is acceptable
Forest characteristics	Multi-storied, dense forest canopy in forested (i.e., not consolidated rock) areas of the range	Canopy characteristics measured in plots, supplemented with interpretation of high-resolution imagery	Forest cover analysis, interpretation of high-resolution imagery
Evidence of movement among winter ranges	Data indicating movement among winter ranges	Telemetry data of movements	Observations of tracks between winter ranges, suitable travel conditions (low slash and few roads)
Snow depth and consolidation	Snow depths under canopy <40 cm and sinking depths <25 cm in moderate-severe winter conditions	Snow depth and consolidation measures in winter range plots	Aerial observations of snow conditions
Evidence of sustained winter use	Data indicating use of winter ranges in every year the area is surveyed	Observations of animals from the air or on the ground; pellets, browse, tracks; telemetry data	Reports of observations from other sources

## PART VI: DATA MANAGEMENT

### Quality Assurance

Quality assurance of monitoring projects consists of two components:

1. Office review of reports and databases to required standards - digital coverages, databases and reports should be reviewed to ensure that they have been prepared to required standards.
2. Field review of plot data - sample plots can be revisited in the field to check for repeatability of sampling results.

## PART V: REPORTING

Reporting consists of three components:

1. Relevant digital coverages, to provincial standards ([http://ilmbwww.gov.bc.ca/dm/dms\\_s\\_a.html](http://ilmbwww.gov.bc.ca/dm/dms_s_a.html));
2. Database of plot data; and,
3. Report (Appendix II).

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## APPENDIX I: FIELD DATA FORMS AND CODES

### Plot card:

<b>SITE</b>	
(1)Date:	(22)Succ Status :
(2)Plot Number:	(23)Struct Stage :
(3)Project ID:	(25)Site Disturb:
(5)Surveyors:	(26)Photo No:
(7)Forest Region:	(27)Elevation:
(8)Mapsheet:	(28)Slope:
(9)UTM zone:	(29)Aspect:
(10)X:	(30)Mesoslope:
(10)Y:	
<b>VEG</b>	
(2)Percent cover	(A)Trees:
	(B)Shrub:
	(C)Herb:
	(D)Moss/Lichen:
(6/7)Dom spp and %	A1:
	A2:
	A3:
	B1:
	B2:
(LL)Lichen Load:	(v)Litterfall:
<b>WHA</b>	
(13)Species/(16)Activity:	
(19)Comments - long-lining results:	

Field descriptions and standard codes for plot card variables can be found in field forms from “Field manual for Describing Terrestrial Ecosystems” (Province of BC 1998). Numbers refer to explanations in the manual.

**Snow card:**

<b>SNOW</b>				
Date:	X:			
Plot Number:	Y:			
Project ID:	Elevation:			
Surveyors:	Temperature:			
Forest Region:	Precipitation:			
Mapsheet:	Site description:			
UTM zone:				
#	Snow depth (cm)	Crust depth (cm)		Sinking depth (cm)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Comments:				

## **APPENDIX II: SUGGESTED REPORT TABLE OF CONTENTS**

**Introduction**

**Study Area**

**Summary of Previous Monitoring Work**

**Study Design**

**Methods**

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Evidence of movement among winter ranges

Proportion of suitable/capable habitat managed as mountain goat winter range

**Discussion**

**Recommendations**