Copper Fox Metals Inc.

Schaft Creek Project: Wildlife Habitat Suitability Baseline

Rescan-Tahltan Environmental Consultants (RTEC)
Sixth Floor - 1111 West Hastings Street
Vancouver, BC Canada V6E 2J3
Tel: (604) 689-9460 Fax: (604) 687-4277

November 2010

SCHAFT CREEK PROJECT:
Wildlife Habitat Suitability Baseline

November 2010
Project #1039-001-07

Prepared for:

Copper Fox Metals Inc.

Prepared by:

Rescan™ Tahltan Environmental Consultants
Vancouver, British Columbia

Citation: Rescan™ Tahltan Environmental Consultants (RTEC). 2010. *Schaft Creek Project: Wildlife Habitat Suitability Baseline*. Prepared for Copper Fox Metals Inc. November 2010.

Executive Summary

Executive Summary

Copper Fox is a Canadian mineral exploration and development company focused on developing the Schaft Creek deposit located in northwestern British Columbia. The deposit is situated within the upper source regions of Schaft Creek, which drains northerly into Mess Creek and onwards into the Stikine River. The Schaft Creek Project (the Project) is located within the traditional territory of the Tahltan Nation. The Project entered the British Columbia Environmental Assessment (EA) process in August 2006.

This report presents the results of wildlife habitat suitability mapping conducted within the regional study area (RSA) of the Schaft Creek Project. The RSA is approximately 312,548 ha. The process of selecting species on which to conduct habitat suitability modelling relied on identifying species at risk and of social, economical, and biological concern in BC, including keystone species, umbrella species, or species of particular importance to regional governing agencies, residents of BC, or to the Tahltan Nation. Habitat suitability mapping was conducted for moose (*Alces alces*) early and late winter habitat; mountain goat (*Oreamnos americanus*) summer and winter habitat; stone's sheep (*Ovis dalli stonei*) summer and winter habitat, northern caribou (*Rangifer tarandus*) early and late winter habitat, grizzly bear (*Ursus arctos*) spring, summer, and fall habitat; American marten (*Martes americana*) winter habitat; and hoary marmot (*Marmota caligata*) growing habitat. The results of habitat suitability mapping are summarized in Table 1.

Table 1. Habitat Suitability for Seven Species in the Project Area

	Total Area (ha)											
Species	**High**	**%[1]**	**Moderately High**	**%[1]**	**Moderate**	**%[1]**	**Low**	**%[1]**	**Very Low**	**%[1]**	**Nil**	**%[1]**
Moose												
Early Winter	6,288	2	45,386	15	103,667	33	11,501	4	140,809	45	4,849	2
Late Winter	4,669	1	16,947	5	62,773	20	14,869	5	7,172	2	206,070	66
Mountain Goat[2]												
Winter	61,050	20	27,110	9	37,054	12	47,246	15	140,061	45		
Summer	10,819	3	66,244	21	29,380	9	35,163	11	170,916	55		
Stone's Sheep[2,3]												
Winter	9,790	12	4,421	5	6,566	8	24,962	30	38,283	46		
Summer	8,953	11	1,907	2	9,010	11	2,087	2	62,064	74		
Northern Caribou[3]												
Early Winter	1,206	2	8,905	13	3,179	4	5,201	7	39,140	55	13,324	19
Late Winter	16,373	23.1	21,319	30	2,526	3.6	5,140	7.2	62	0.1	25,535	36
Grizzly Bear												
Spring	41,842	13	17,255	6	77,688	25	42,407	14			133,357	43
Summer	447	0.1	62,454	20	100,986	32.3	15,304	4.9	74,004	23.7	59,353	19
Fall	53,127	17	27,732	9	79,586	25	18,747	6	74,004	24	59,353	19
Marten												
Winter	56,277	18			18,258	6	24,841	8			213,172	68
Hoary Marmot[4]												
Growing	302	1.6			1,526	8	27	0			17,189	90.3

[1] Percent of Habitat in the RSA (312,548 ha). For hoary marmot, the percentage is percent of habitat in the LSA (17,018 ha).
[2] Very Low includes Nil Rated Habitat (i.e., Very Low/Nil)
[3] Stone's sheep and northern caribou habitat suitability was modelled with a portion of the RSA. Therefore, the percentage is percent of total modelled areas for Stone's sheep (84,021 ha) and northern caribou (70,955 ha).

Moose are economically and socially important as a species for harvest by First Nations and non-Aboriginal hunters alike. Guide outfitting and associated harvest also contributes substantial economic return to local communities. As such, substantial effort has been directed at monitoring moose populations and identifying moose habitat within the study area (Demarchi 2000; Yazvenko, Searing, and Demarchi 2002). Maintaining suitable habitat to support sustainable moose numbers remains a goal of the regulating agencies. The results of winter habitat suitability modelling suggest that the regional study area contains both early and late winter habitat for moose. However, there appears to be more proportionally more High and Moderately High rated early winter habitat as opposed to late winter habitat, as two thirds of the RSA was rated as Nil suitability in the late winter. Nil habitats occur on slopes that are too high and/or steep to be usable by moose because the late winter snowpack in those areas would be prohibitively deep..

Modelling was conducted for mountain goats and Stone's sheep; two mountain ungulate species which broadly overlap in their habitat preferences. A key element of both these species' habitat is suitable escape terrain (i.e., steep rocky topography): research has shown that goats and sheep are rarely found beyond several hundred meters from escape terrain throughout the year. Because of the abundance of suitable, rocky terrain throughout the RSA, roughly a quarter of the RSA is Moderately High to Highly suitable winter and summer for mountain goats (Table 1). Goat observations collected during baseline studies confirm that several of higher rated habitat areas are occupied. Stone's sheep modelling was conducted primarily within the eastern portion of the RSA east of Mess Creek. The results suggest that roughly a quarter of the modelled area is Moderately High to Highly suitable winter and summer habitat for sheep (Table 1); however, few of these higher rated habitats were confirmed as occupied by sheep. It was noted that some small isolated patches of higher suitability habitats east of Mess Creek adjacent to the proposed access road were consistently occupied by goats in the winter and summer. This observation suggests that the even isolated patches are functional and that habitat isolation likely does not preclude use.

Grizzly bear are a biologically, socially, and economically important species. Grizzly bears are considered as a species of special concern by the Committee on the Status of Endangered Species in Canada (COSEWIC) and are on the provincial blue list. Efforts have been initiated in the past to identify grizzly bear population, distribution, and habitat use within the Nass Wildlife Area (Demarchi and Johnson 2000). The RSA supports between 20 and 26% of Moderately High to Highly suitable feeding habitat for grizzly bear in the growing season (i.e., spring., summer, and fall) (Table 1). The combination of wetlands, riparian habitat, numerous avalanche chutes, and other higher elevation sites supporting abundant herbs and shrubs, contribute to the availability of early seral stage vegetation capable of providing abundant forage for bears during all seasons. Mid to high elevation habitats in the eastern RSA were consistently rated Moderately High to Highly suitable from the spring through the fall, due the abundance of early seral stage vegetation.

Marten habitat was assessed because of this species economic and social contribution to local communities, as well as their contribution to biodiversity. Of all furbearers trapped within trapline tenures in the study area, marten accounted for majority of animals caught (80% of registered harvest). Winter is generally acknowledged as the limiting season for marten; therefore, modelling of the winter habitat was undertaken. High and Moderate rated winter habitat was extensively distributed throughout low elevation mature and old growth conifer forests along major river valleys, including the Mess, Schaft, and More Creek drainages. High and Moderate rated habitat accounted for just less than a quarter of the total RSA.

Hoary marmots were selected as a species for habitat modelling because of their cultural significance and importance as a prey species for larger carnivores. Marmot growing season habitat was modelled within the local study area (LSA). High and Moderate accounted for less than 10% of the LSA and were generally located on the southerly aspects within the alpine zone on Mount LaCasse. As marmots are generally an alpine dwelling species, much of habitat in the LSA (90%) is not suitable for marmots because it occurs in lower elevation forested habitat along the Schaft and Mess Creek valleys.

Acknowledgements

copper FOX metals inc.

RTEC Keepers of the Land

Acknowledgements

This report was prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. Fieldwork was conducted by Ryan Durand (B.Sc., Dip.T., R.P.Bio) and Frank Doyle (M.Sc., R.P.Bio); report preparation was conducted by Julia Shewan (B.Sc.), Shaun Freeman (B.Sc., Dipl. T., R.P.Bio), and Nicole Anderson (B.Sc.). Wildlife program and report writing was managed and technically reviewed by Brandie Harding (B.Sc., M.Sc. candidate) and Leslie Bol (M.Sc., R.P.Bio.).

Table of Contents

copper FOX metals inc.

RTEC Keepers of the Land

SCHAFT CREEK PROJECT: WILDLIFE HABITAT SUITABILITY BASELINE

Table of Contents

List of Appendices

List of Figures

List of Tables

TABLE **PAGE**

List of Plates

PLATE **PAGE**

Acronyms and Abbreviations

Acronyms and Abbreviations

BC CDC	*British Columbia Conservation Data Centre*
BEC	*Biogeoclimatic Ecosystem Classification*
CEAA	*Canadian Environmental Assessment Act*
COSEWIC	*Committee on Status of Endangered Wildlife in Canada*
CWD	*Coarse Woody Debris*
DE	*Denning*
DEM	*Digital Elevation Model*
EAO	*Environmental Assessment Office*
ESSF	*Engelmann Spruce Sub-alpine Fir*
FD	*Feeding*
FN	*First Nation*
FRPA	*Forest and Range Practices Act*
GIF	*Ground Inspection Form*
GPS	*Global Positioning System*
GWM	*General Wildlife Measures*
HSR	*Habitat Suitability Rating*
ICH	*Interior Cedar Hemlock*
ILMB	*Integrated Land Management Bureau*
IWMS	*Identified Wildlife Management Strategy*
LI	*Living*
LRMP	*Land and Resource Management Plan*
MOE	*Ministry of Environment*
MSRM	*Ministry of Sustainable Resource*
MWLAP	*Ministry of Water, Land and Air Protection*
NWA	*Nass Wildlife Area*
QA/QC	*Quality Assurance/Quality Control*
RIC	*Resource Inventory Committee*
RISC	*Resource Inventory Standards Committee*
SARA	*Species at Risk Act*
SH	*Shelter*
TEM	*Terrain Ecosystem Mapping*
TK	*Traditional Knowledge*
TRIM	*Terrain Resource Information Management*
TU	*Traditional Use*

UWR	*Ungulate Winter Range*
WHA	*Wildlife Habitat Area*
WHF	*Wildlife Habitat Feature*
WHR	*Wildlife Habitat Rating*
VRI	*Vegetation Resources Inventory*

1. Introduction

1. Introduction

1.1 SCHAFT CREEK PROJECT SUMMARY

Copper Fox Metals Inc. (Copper Fox) is a Canadian mineral exploration and development company focused on developing the Schaft Creek deposit located in north-western British Columbia, approximately 60 km south of the village of Telegraph Creek (Figure 1.1-1). The Schaft Creek deposit was discovered in 1957 and has since been investigated by prospecting, geological mapping, geophysical surveys as well as diamond and percussion drilling. The deposit is situated within the upper source regions of Schaft Creek, which drains northerly into Mess Creek and onwards into the Stikine River. The Stikine River is an international river that crosses the US/Canadian border near Wrangell, Alaska. The Schaft Creek deposit is a polymetallic (copper-gold-silver-molybdenum) deposit located in the Liard District of north-western British Columbia (Latitude 57° 22′ 42″; Longitude 130°, 58′ 48.9″). The property is comprised of 40 mineral claims covering an area totalling approximately 20,932 ha within the Cassiar Iskut-Stikine Land and Resource Management Plan (Figure 1.1-2).

The Schaft Creek Project (the Project) is located within the traditional territory of the Tahltan Nation. Copper Fox has been in discussions with the Tahltan Central Council (TCC) and the Tahltan Heritage Resources Environmental Assessment Team (THREAT) since initiating exploration activities in 2005. Copper Fox will continue to work together with the Tahltan Nation as work on the Schaft Creek Project continues.

The Schaft Creek Project entered the British Columbia Environmental Assessment (EA) process in August, 2006. Although a formal federal decision has not yet been made, the Project will likely require federal approval as per the *Canadian Environmental Assessment Act*. Copper Fox has targeted the third quarter of 2010 for submission of their Schaft Creek EA Application.

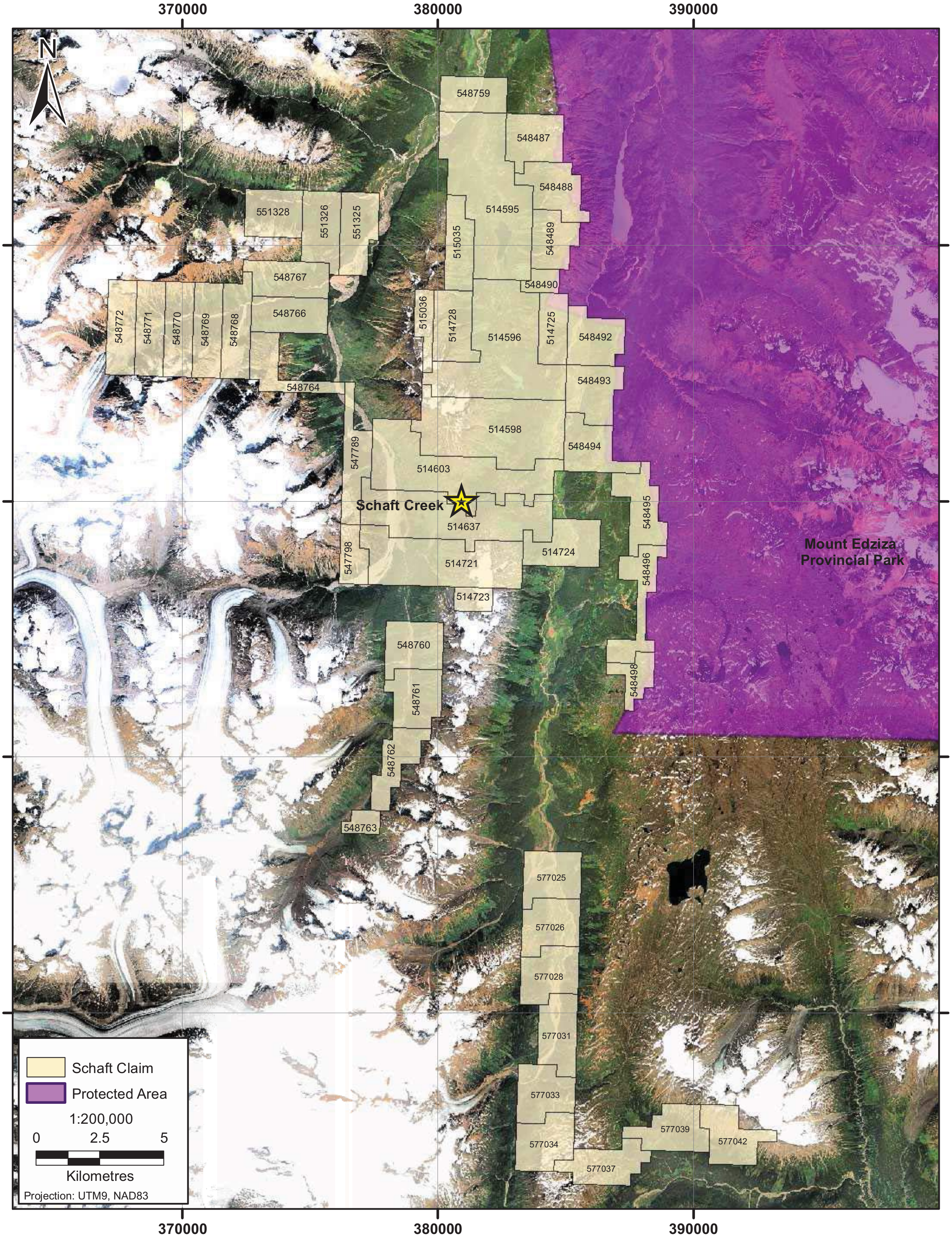
The current mine plan would see ore mined from an open pit at a rate of 100,000 tonnes per day. The mine plan includes 812 million tonnes of Measured and Indicated Mineable resources providing for an estimated 23 year mine life. The Project is estimated to generate up to 2,100 jobs during the construction phase and approximately 700 permanent jobs during mine operations.

The deposit will be mined with large truck/shovel operations and typical drill and blast techniques. The ore will be crushed, milled, and filtered on site to produce separate copper and molybdenum concentrates. The Process Plant will include a typical comminution circuit (Semi-Autogenous Mill, Ball Mill, and Pebble Crusher) followed by a flotation circuit and a copper circuit with thickener, filtration, and concentrate loadout and transportation. The Process Plant includes a designated molybdenum circuit with thickener, filtration, drying, and bagging. A tailings thickener and water reclaim system will be used to recycle process water. The circuit will have a design capacity of 108,700 tonnes per day and a nominal capacity of 100,000 tonnes per day (36,000,000 tonnes per year). Approximately 293,000 tonnes of concentrates will be produced each year, which will be transported via truck to the port of Stewart, BC, for onward shipping to markets.

Copper Fox will construct an access road to the mine site (Schaft Creek Access Road; Schaft Road) to the 65.1 kilometre point (65.1 km) of the Galore Creek Access Road (Galore Road). The Schaft Road will cover a distance of 39.5 km from the Galore Road to the Schaft mine site (Figure 1.1-3). Both the Galore and Schaft roads will be gravel roads with six metre wide driving surface. Pullouts and radio controls will be used to manage two-way traffic on the road. The Schaft Road will be a private road used to service the Schaft Creek mine.

FIGURE 1.1-1

Location Map for Schaft Creek Project



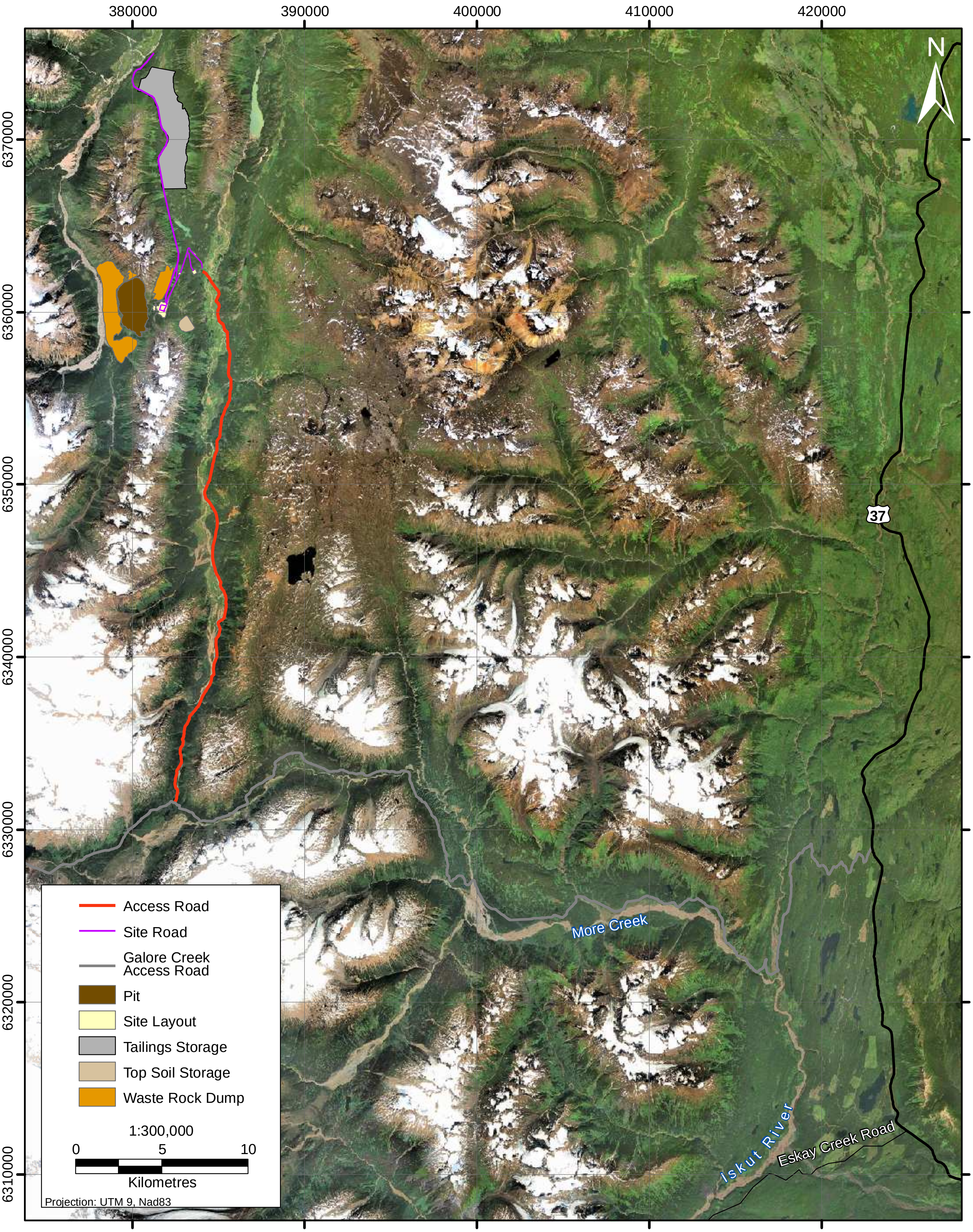
copper FOX metals inc.

Schaft Creek Project Mineral Claims

FIGURE 1.1-2

RTEC Rescan

gis no. SCH-15-037 Job No. 1039-001-01 November 30, 2009



copper FOX metals inc.

FIGURE 1.1-3

Schaft Creek Access Road
Mess Creek Valley Option

RTEC Rescan™

The Galore Road is a fully permitted multi-use road; B.C. MOF Special Use Permit (S24637). The Galore Road is being constructed by Galore Creek Mining Corporation. Currently, Galore Creek Mining is only planning to construct the Galore Road to 40 km while they review the current Galore Creek Project for which the road was to service. Copper Fox will engage Galore Creek Mining with respect to the completion of the Galore Road, and if necessary, arrange to transfer the MOF Special Use Permit to Copper Fox as the Schaft Creek Project advances.

The Galore Road connects to Highway 37 near Bob Quinn Lake. The total road distance from the Schaft mine site to Highway 37 is 105 km. The majority of the 39.5 km Schaft Road is within the Mess Creek watershed. In order to avoid geohazards along the Mess Creek valley, the Schaft Road will cross Mess Creek twice (Figure 1.1-3). Mess Creek is considered navigable per Transportation Canada criteria.

After crossing Mess Creek at the north end of the Schaft Road (32.5 km), the route rises up the side of Mount LaCasse crossing Shift Creek (10 m bridge) and Big B Creek (10 m bridge). The route terminates at Snipe Lake (39.5 km). Conventional 30-tonne trucks will be used to transport concentrate from the mine site to the Bob Quinn area along the Schaft and Galore roads. From Bob Quinn to Stewart, convention B-train commercial truck haulage can then be utilized along Highway 37 and 37A. There will be 30 concentrate trucks along this route over a 24 hour period, seven days per week.

Electrical power to the mine site will be provided via a 138 kV transmission line, extending from Bob Quinn Lake to the Project along the proposed corridor for the Galore and Schaft roads. The proposed transmission line assumes that electrical power will be supplied from British Columba Transmission Corporation's (BCTC) proposed new 287 kV Northwest Transmission Line from a point near Bob Quinn Lake.

The Schaft Pit will encompass an area of 4.9 km^2 at the end of the mine life (Figure 1.1-4). The Pit will extend 330 m below the current elevation (520 masl). An ore stockpile and crusher will be located between the Pit and Schaft Creek. Crushed ore will be conveyed to the Plant site on the saddle just east of the Pit. Tailings from the Process Plant will be piped to the Skeeter Tailings Storage Facility (TSF) as a slurry (55% solids).

Over the life of the mine the Project will generate over 812 million tonnes of tailings, which will be managed in the Skeeter TSF. The TSF will not span the low relief watershed divide between Skeeter and Start watersheds. The Skeeter TSF will require three embankments to contain the tailings generated over the life of the mine (Figure 1.1-5). Based on average climatic conditions, the TSF will have a positive water balance. Discharge from the TSF will be to Skeeter Creek.

The Project will generate an estimated 1,547 million tonnes of waste rock. Waste rock dumps are proposed around the perimeter of the Schaft Pit, with the majority of the material being placed on the east side of Schaft Creek (Figure 1.1-4). The current plan assumes the waste rock will be non-acid generating and will not leach metals at or near neutral pH. The plan is subject to change as work progresses on the metal leaching and acid rock drainage program.

The Project will be a fly-in, fly-out operation, and a new airfield capable of handling a Boeing 737 will be constructed to the east of the Pit (Figure 1.1-3). The preliminary design includes a 1,600 m compacted gravel landing strip, terminal building, fuelling facilities, small maintenance facility and control and lighting systems.

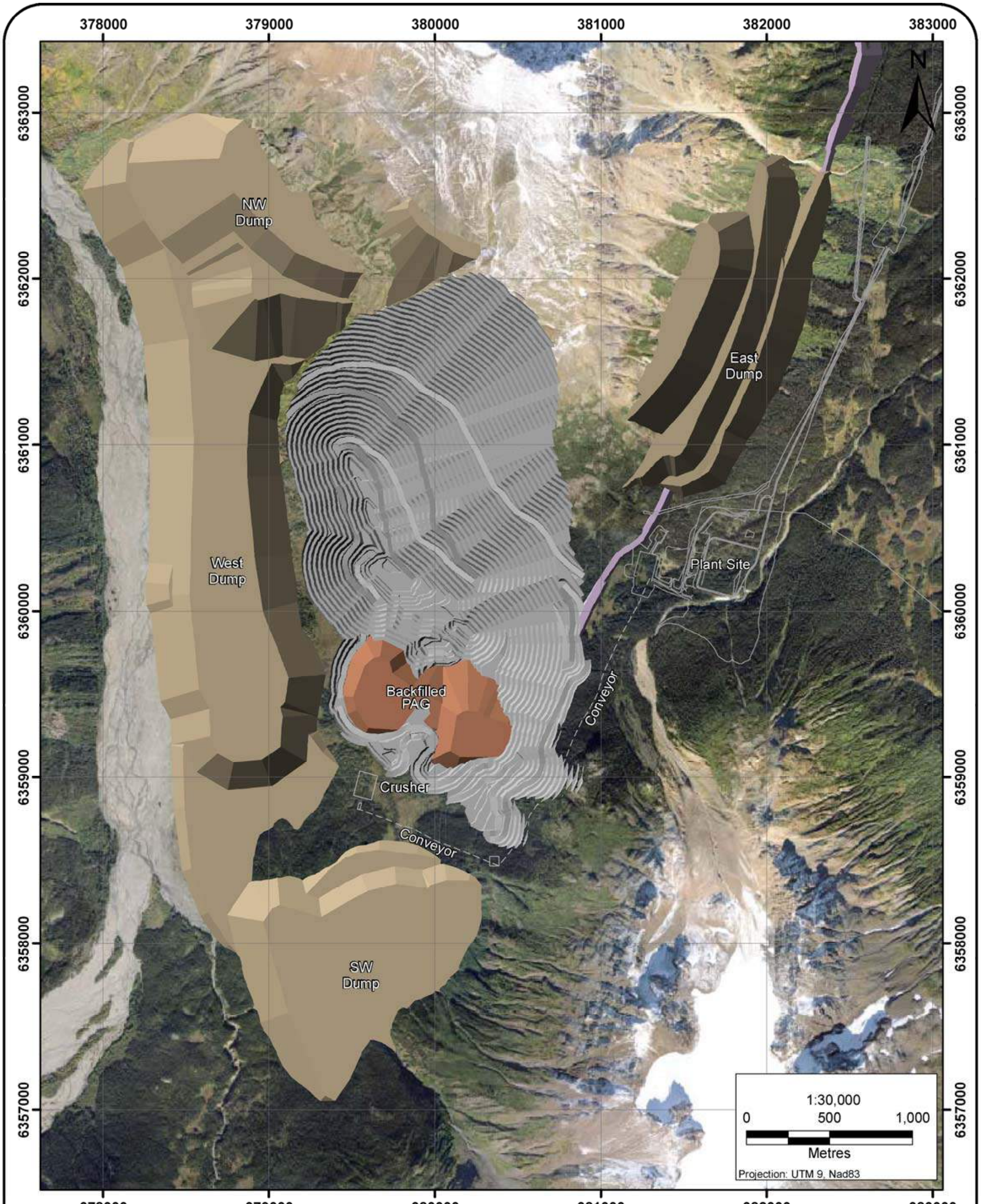
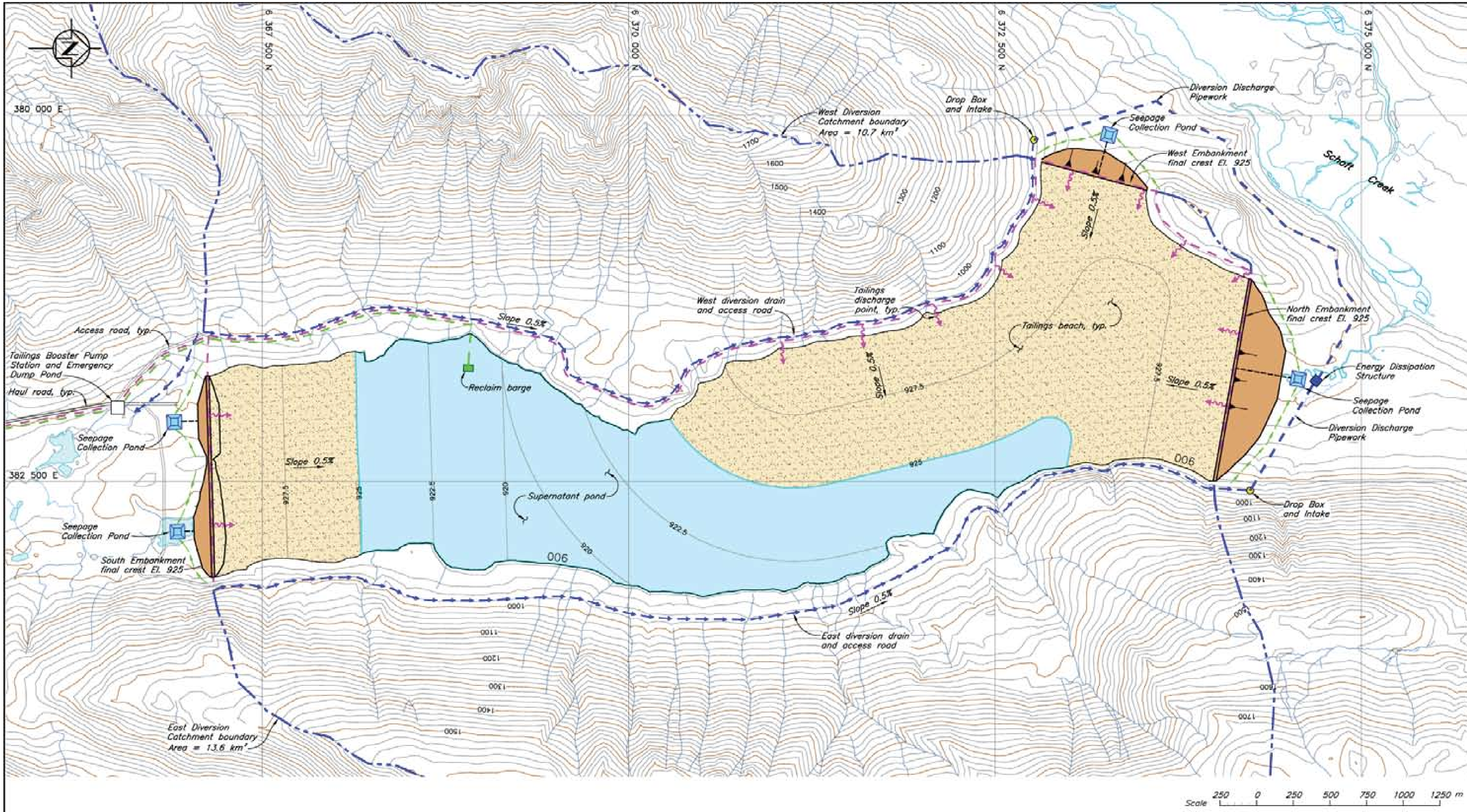


FIGURE 1.1-4

copper FOX metals inc.

Schaft Creek Project Mine Site

RTEC Rescan



Source: Knight Piésold Consulting

Note: This layout represents the tailings storage facility in the final years of operation prior to closure. Several years before the end of operations and closure, the tailings deposition pattern will be modified to relocate the supernatant pond towards the north of the facility, where a permanent spillway will be constructed in the west abutment of the North Embankment.

FIGURE 1.1-5

Schaft Creek Project - Skeeter Tailings Storage Facility

A permanent camp will be constructed to support approximately 700 employees. Other facilities include a truck shop, warehouse, administration, maintenance laboratory, explosive storage, water treatment facilities and potable water storage.

1.2 HABITAT SUITABILITY MODELLING OVERVIEW

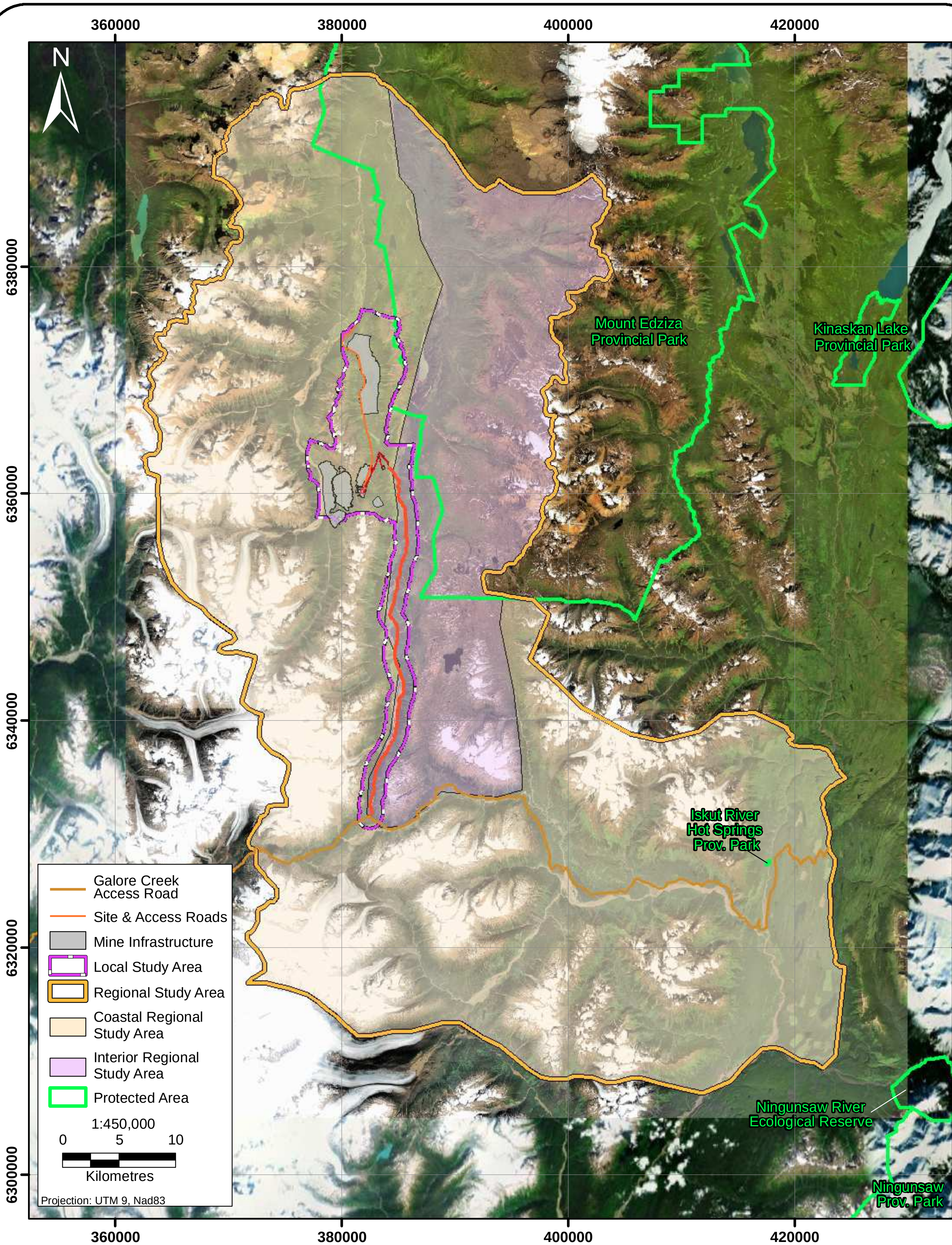
Office and field-based studies were conducted to identify suitable wildlife habitat within the study area in addition to highlighting important habitat features for several species. Species selected for habitat suitability modelling include those of conservation concern in BC, species of biological importance (i.e., keystone species, umbrella species), and species of particular economic or social importance to regional governing agencies, residents of BC, or to the Tahltan Nation. Habitat suitability models were created in conjunction with Ecosystem Mapping (RTEC 2010f) for the following species and seasons/attributes: moose (*Alces alces*) early and late winter habitat; mountain goat (*Oreamnos americanus*) summer and winter habitat; stone's sheep (*Ovis dalli stonei*) summer and winter habitat, northern caribou (*Rangifer tarandus*) early and late winter habitat, grizzly bear (*Ursus arctos*) spring, summer, and fall habitat; American marten (*Martes americana*) winter habitat; and hoary marmot (*Marmota caligata*) growing habitat. Where available, habitat suitability maps from other sources were used to supplement these models.

Field studies to identify species at risk as well as other wildlife inhabiting the area of the proposed Project were undertaken independently of habitat suitability field studies. The results of the wildlife inventory studies are presented separately (RTEC 2007a, 2007b, 2008b, 2008c, 2010a, 2010b, 2010c).

1.3 STUDY AREA

Two study areas were considered for wildlife habitat suitability mapping for the Project, a local study area (LSA) and a regional study area (RSA) (Figure 1.3-1). The local study are covers 17,018 ha and includes the proposed mine site and associated infrastructure as well as a 2 km wide corridor along the proposed access road. Ecosystem mapping within the local study area included both Terrestrial Ecosystem Mapping (TEM) within the proposed mine site and Predictive Ecosystem Mapping (PEM) along the proposed road route (for further details see RTEC 2010f).

The regional study area was defined using ecological boundaries (e.g., lowest and highest elevation zones in surrounding areas), watersheds, and likely zones of influence of the proposed Project on ecosystems and wildlife. The RSA reflects an area that provides habitat for wildlife species that may come in contact with proposed Project infrastructure during the course of a season or lifetime. Species information, including home range sizes, habitat use, and seasonal movement patterns, were considered when selecting the RSA boundary. The RSA covers 312,548 ha. Ecologically, the RSA is diverse, with moist coastal ecosystems transitioning to drier interior ecosystems. The eastern RSA is characterized by expansive high elevation plateaus while the west is more representative of rugged coastal mountainous terrain, with Mess Creek forming the effective border between these two geomorphologies. For the purposes of habitat suitability mapping for several species (moose, goat, sheep, and caribou), the RSA was further divided into two distinct and geographically separate areas based on geomorphology: coastal versus interior. These areas are referred to as the coastal regional study area (cRSA) and interior regional study area (iRSA), where applicable (Figure 1.3-1).



copper FOX metals inc.

FIGURE 1.3-1

Schaft Creek Wildlife Study Areas

RTEC Keepers of the Land

The Schaft Creek Project is located within the rugged Boundary Ranges and the more subdued terrain of the Tahltan Highlands. The Project area includes low, middle, and high elevation habitats. The Boreal White and Black Spruce (BWBS) and Interior Cedar Hemlock (ICH) Biogeoclimatic Ecosystem Classification (BEC) zones occur at low elevations along major river valleys. These BEC zones transition to the Spruce Willow Birch (SWB) and Engelmann Spruce Subalpine Fir (ESSF) BEC zones at higher elevations, and finally to the mountainous alpine within the Alpine Tundra BEC zone.

Specifically, the study area falls within eleven BEC units, including:

- Alpine Tundra Undifferentiated (ATun)
- Boreal White and Black Spruce Dry Cool Subzone Stikine Variant (BWBSdk1);
- Interior Cedar Hemlock Wet Cold Subzone (ICHwc);
- Engelmann Spruce Subalpine Fir Moist Cold Subzone (ESSFmc);
- Engelmann Spruce Subalpine Fir Wet Moist Cold Parkland Subzone (ESSFmcp);
- Engelmann Spruce Subalpine Fir Wet Very Cold Subzone (ESSFwv);
- Engelmann Spruce Subalpine Fir Wet Very Cold parkland Subzone (ESSFwvp);
- Engelmann Spruce Subalpine Fir Very Wet Very Cold Subzone (ESSFvv);
- Engelmann Spruce Subalpine Fir Very Wet Very Cold Parkland Subzone (ESSFvvp);
- Spruce Willow Birch Undifferentiated Subzone (SWBun); and
- Spruce Willow Birch Undifferentiated Parkland Subzone (SWBunp).

The forested habitat types within the area provide different habitat values to wildlife species. Pure deciduous stands, such as cottonwood forests, are commonly associated with riparian areas along major river valleys (Schaft and Mess Creeks). Deciduous tree species in the RSA include black cottonwood (*Populus balsamifera* ssp *trichocarpa*), paper birch (*Butula papyrifera*), and trembling aspen (*Populus tremuloides*). Both coniferous and deciduous stands usually support cavities that are used by wildlife, such as resting sites for American marten during the winter. Conifer tree species commonly found in the RSA include; white spruce (*Picea glauca*), Engelmann spruce (*Picea engelmannii*), and hybrid spruce (*Picea* spp); subalpine-fir (*Abies lasiocarpa*); western hemlock (*Tsuga heterophylla*); lodgepole pine (*Pinus contorta)*; and tamarack (*Larix laricina*). Coniferous stands provide shelter for moose during the winter. A substantial amount of mature and old growth conifer forest is present at lower elevations within all BEC zones. Large trees found in old growth forests offer important wildlife microhabitat features such as cavities used as natal sites by grizzly bears. Old growth pine and spruce forests produce a variety of arboreal and terrestrial lichens that are an important food source for caribou throughout the year. In addition to terrestrial habitat, numerous wetlands, including lakes, marshes, swamps, bogs, and streams of various sizes and forms, are also present. Wetlands, and riparian forest habitat supported by wetlands, provide high valued habitat to a diverse wildlife community. For example, riparian vegetation is an important food source for moose and sedge vegetation in riparian areas is important to grizzly bears in the spring.

There are two provincial parks within the Project study area and several other parks and protected areas in close proximity to the Project. The southwest portion of Mount Edziza Provincial Park is included in the regional study area, which is part of a volcanic complex (BC MOE 2010c). The Iskut River Hot Springs Provincial Park is located within the RSA on the western bank of the Iskut River, approximately 15 km northwest of Bob Quinn Lake along the Galore Creek road (BC MOE 2010a). To the southeast of the RSA is the Ningunsaw Provincial Park and ecological reserve, which protects a number of inter-related ecosystems and biogeoclimatic zones, from the Ningunsaw river valley, to the high alpine (BC MOE 2010d). To the north, the Stikine River Provincial Park connects the Mt. Edziza and Spatsizi Plateau Wilderness Provincial Parks, and includes the internationally-renowned Grand Canyon of the Stikine (BC MOE 2010e). Adjacent to Highway 37, south of Iskut, the Kinaskan Lake Provincial Park provides angling opportunities (Kinaskan and Natadesleen lakes) and camping facilities for highway travelers (MOE 2010b). On the east side of Highway 37 the Todagin South Slope Provincial Park (and adjoined wildlife management area), protects habitat for local wildlife, including large game (BC MOE 2010f).

1.4 OBJECTIVES

The goal of the wildlife habitat suitability baseline modelling was to determine the current quantity and quality of wildlife habitat in the study area. This baseline information is needed for assessing the potential effects of the Project on wildlife species and habitat in the area and for mitigation and management planning. The specific objectives of the wildlife habitat suitability baseline study were to:

- conduct field assessments of habitat for wildlife species selected for modelling;
- produce habitat models to quantify suitable habitat available for select wildlife species within the Project wildlife study area; and
- identify important wildlife habitat and habitat features within the Project wildlife study area.

2. Background Information

2. Background Information

2.1 WILDLIFE LEGISLATION

Wildlife is managed provincially by the Ministry of Environment (MOE). The Project is within MOE Region 6 (Skeena). The Pacific/Yukon division of Environment Canada is the federal agency responsible for wildlife and species at risk in the region. Wildlife habitat and wildlife habitat features are protected under several forms of federal and provincial legislation. The BC *Wildlife Act* (1996) protects wildlife habitat features on a local scale, such as the protection of nest sites. It also affords protection to selected red- or blue-listed species within the province, whereby important habitat of these species may be designated as a Critical Wildlife Management Area. The Canada *Species at Risk Act* (2002) protects federally-listed endangered and threatened species and also stipulates that Environmental Assessments must consider the effects of potential projects on these wildlife species as well as those listed as special concern, their critical habitat, and their residences (Government of Canada 2008). The BC *Water Act* (1988) affords protection to riparian areas and stipulates that all instream works must protect fish and wildlife habitat.

The BC *Forest Range and Practices Act* (FRPA; 2004) provides some of the most pertinent legislation surrounding the identification and protection of wildlife habitat within BC. Its intent is the integration of wildlife conservation with forest development. Under the FRPA, areas that are important or critical to ungulates and sensitive wildlife are legally protected and managed for forest and range practices. The BC FRPA is the regulatory authority for establishing Ungulate Winter Range (UWR), Wildlife Habitat Area (WHA), and Wildlife Habitat Feature (WHF) areas. Ungulate Winter Range is an area that contains habitat necessary to meet the winter habitat requirements of an ungulate species. WHAs are areas necessary to meet the habitat requirements of an Identified Wildlife element. An Identified Wildlife element is a wildlife species that is either at risk in the province or is regionally sensitive, thus requiring special management attention. The *Identified Wildlife Management Strategy* (IWMS; BC MWLAP 2004) provides direction, policy, procedures, and guidelines for managing Identified Wildlife (BC MWLAP 2004). A WHF is a specific area that is important to a wildlife species and may require special management, examples of which are mineral licks, wallows, or nest sites of bald eagle, osprey, great blue heron, or bird species at risk (BC MWLAP 2004). In addition, BC FRPA establishes General Wildlife Measures (GWMs), which are management practices that should be implemented for the WHA and WHF areas to be rendered effective.

2.2 WILDLIFE HABITAT: INTERPRETATION AND APPLICATION

2.2.1 Wildlife Habitat Suitability Modelling in the Province

In BC, the interpretation of data derived from ecosystem maps and other biophysical information allows for the development of spatial inventories of wildlife habitat that can then be used for land management purposes. Mapping wildlife habitat identifies areas that contain suitable habitat for a wildlife species, provides a basis to evaluate the effects of development on wildlife habitat, and allows for the loss or alteration of these habitats to be placed into a local and regional context.

Wildlife suitability mapping is a relatively recent development for inventorying and identifying areas of special importance to wildlife. As defined by the Resources Information Standards Committee (RIC 1999a), suitability models and maps identify areas which, in their current condition, provide functioning (i.e., suitable) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The development of models requires three steps:

1. A description of the ecology of each wildlife species considered, including habitat characteristics (variables) appropriate to the region.
2. The development of habitat suitability models for each species of interest using local data such as topography, slope, and vegetation (from the ecosystem mapping products) and the general variables identified in (1).
3. The testing of habitat suitability models against field observations of habitat quality and wildlife use of the area, which may require a number of iterations before an appropriate product is achieved.

The first step is commonly a desk-based exercise, accomplished by reviewing literature to identify critical habitats (e.g., habitats most limiting to a wildlife species, such as winter range for ungulates) and biophysical components that constitute the habitat. Critical habitat features may include slope, aspect, elevation limitations, or biological features such as vegetation, which provides forage and/or shelter. As regional differences (e.g., climate, temperature, and snow fall) often influence wildlife use of an area, site specific field studies can help identify features that can be used to predict important habitats prior to the development of models.

The second step of model development is to identify suitable habitat used by each species. First, ecosystem mapping products identify a variety of ecosystems (“ecosystem units”) throughout the study area. A “wildlife habitat rating” is then assigned to each ecosystem unit, based on the characteristics of each species and season and its requirements for food, security, and thermal protection. For instance, areas that produce sedges in the spring could be given a high rating for grizzly bears. Second, additional variables, such as elevation, slope, aspect and distance to escape terrain, can be incorporated into the ecosystem units that have already been assigned wildlife habitat ratings. Combining these attributes with the ecosystem units from the ecosystem mapping products further refines the models produced in the first stage.

To evaluate the models’ ability to predict field conditions, and thus assess their limitations, wildlife models are then field-tested to identify how well they identify suitable habitat. Field testing of models requires the collection of data in the field that describes biophysical conditions as well as wildlife use of an area. Field testing may include sampling plots located in various representative habitat types identified by the model. The model evaluation can be supplemented with wildlife surveys (aerial or ground, track, pellet group, etc.) to evaluate use and local habitat selection. For example, moose and mountain ungulate models can be evaluated for their ability to predict areas of high habitat quality by overlaying aerial observations of animals.

2.2.2 Important Wildlife Habitat

Wildlife habitat suitability modelling is a useful method for creating a broad scale representation of suitable habitat for selected species and particular seasons of use. In addition, documenting wildlife habitat features or important wildlife habitat at a finer scale is integral in understanding the quality of habitat for any one species. Examples of these fine-scale features are migration routes, mineral licks, salmon spawning channels, nest sites, and bear dens. Such features may be essential for the subsistence of a wildlife population. For example, migration routes connect habitat that is exploited during different times of the year and also facilitate gene flow between adjacent wildlife populations (Beier and Noss 1998; Mech and Hallett 2001). Habitat suitability mapping may highlight the location of the broad-scale habitats where these features may be found; however, their precise locations usually cannot be accurately predicted by suitability modelling alone. Intensive and directed field studies may be the only means available to confidently identify the presence of important wildlife habitat. Important wildlife habitat and/or habitat features (wherever available) are discussed in conjunction with the habitat modelling results to allow for more qualitative interpretations of the habitat present in the area.

2.3 EXISTING WILDLIFE INFORMATION

2.3.1 Land Management

Several wildlife information sources exist for the Project area. In particular, land and resource management planning is a useful source of information on some wildlife that is region specific. The proposed Project is completely within the area considered in the Cassiar Iskut-Stikine Land and Resource Management Plan (CIS LRMP; BC MSRM 2000). Land and Resource Management Plans (LRMPs) are sub-regional, integrated resource plans that establish the framework for land use and resource management objectives and strategies, and provide a basis for detailed management planning. The entire study area falls within the General Management Direction (GMD) of the Cassiar Iskut-Stikine LRMP. Objectives and strategies of the GMD apply throughout the LRMP area, outside of Protected Areas (e.g., provincial parks). In addition to the GMD, there are objectives and strategies for area-specific Resource Management Zones (RMZs). One RMZ falls within the RSA, the Middle Iskut RMZ. Wildlife-related management objectives of both the GMD and Middle Iskut RMZ of the Cassiar Iskut-Stikine LRMP are described in Table 2.3-1. Also, habitat suitability mapping has been conducted for a number of species within the plan area (e.g., moose, mountain goat, Stone's sheep, and caribou winter range; Table 2.3-1).

Table 2.3-1. Wildlife Objectives of the Cassiar Iskut-Stikine LRMP

Management Direction	Wildlife-Related Resource	Wildlife-Related Management Objectives
Cassiar Iskut-Stikine LRMP (BC MSRM 2000)		
General Management Direction – Access Management	Access Management	• Keep to a minimum impacts on wildlife habitat and sensitive ecosystems during road construction and use. • Manage game populations by controlling hunting and fishing access, where required. • Provide access for long-term resource management and economic development needs while minimizing impacts on environmental social, cultural heritage, and wildlife habitat values and commercial activities. • Minimize disturbance to wildlife due to aircraft use, particularly during sensitive periods.
General Management Direction – Biodiversity/ Ecosystem Health	Aquatic Ecosystems and Riparian Habitat	• Conserve riparian habitat by minimizing disturbance to the structural and functional features of riparian habitat, including critical habitat features.

(continued)

Table 2.3-1. Wildlife Objectives of the Cassiar Iskut-Stikine LRMP (completed)

Management Direction	Wildlife-Related Resource	Wildlife-Related Management Objectives
	Endangered Plants and Animals	• Maintain habitats of rare, threatened, and endangered animals, plants and plant communities as described in the BC Conservation Data Centre lists. • Maintain habitat of fisher were populations are known to exist. • Maintain nesting and foraging habitat for nest sites of raptors, particularly rare and endangered species, including northern goshawk, short-eared owl, gyrfalcon, peregrine falcon. • Minimize disturbance of critical habitat areas for trumpeter swans (e.g., nesting and over-wintering areas, including early spring migration stops).
	Special Landforms: Plateaus	• Minimize impacts of motorized activities on plateaus and their habitats • Maintain connectivity for wildlife between plateaus and adjacent plateaus and mountain ranges.
	Wildlife : General	• Maintain habitat to support healthy wildlife populations. • Manage development and access to conserved important habitat features and wildlife.
	Wildlife: Moose	• Maintain functional integrity of moose winter range by maintaining critical habitat features (i.e., thermal and snow interception cover, winter forage, and visual screening), and by managing harvesting activities to minimize impact on winter habitat.
	Wildlife: Caribou	• Maintain large areas of high value caribou habitat including spring, summer and winter habitat by maintaining the integrity of important habitat characteristics such as forests with lichen, areas of contiguous mature and old forest, and wetland complexes. • Maintain the functional integrity of mapped caribou winter range, with particular reference to the Three Sisters, Kehlechoa River and the Stikine. Also the range north and east of Spatsizi Park by maintaining winter forage opportunities and snow interception cover, and managing access and harvesting activities to minimize impact to winter habitat.
	Wildlife: Mountain Goat and Stone's Sheep	• Maintain large areas of high value Stone's sheep and mountain goat habitat and avoid disturbing animals during kidding and lambing. • Maintain functional integrity of mapped winter range for mountain ungulates by maintaining critical habitat features (i.e., thermal and snow interception cover and winter forage), and by managing access to minimize impact to winter habitat.
	Wildlife: Grizzly Bear	• Maintain large areas of high value habitat by maintaining areas of well-distributed, seasonally important habitats for grizzly bear across the landscape and through time. • Reduce human-bear interactions. • Manage hunting and other activities to limit bear mortality from all human causes to less than 4% of the estimated population so harvest of females does not exceed 30% of annual allowable harvest and the total kill is not area-concentrated. • Minimize bear/human conflicts and disruption of bear habitat use. • Monitor overall effectiveness of habitat management for grizzly bear.
	Wildlife: Marten	• Maintain large areas of high value marten habitat by maintaining important habitat characteristics (i.e., forest structural attributes and mature and old forest providing interior forest conditions).
Area-Specific Resource Management Zone – Middle Iskut	General	• Maintain habitat to support healthy wildlife populations. • Manage development and access to conserved important habitat features and wildlife.

2.3.2 Inventories and Academic Studies

Over the years, there have been several relevant studies conducted on wildlife in the region that are helpful in evaluating local habitat selection and use and that can be used to supplement habitat suitability modelling results. More specifically, multi-year assessments have been conducted on moose and grizzly bear in the Nass Wildlife Area (NWA) and North Nass Timber Supply Area (TSA), in addition to the Galore Creek Project area directly to the south of the proposed Project (Demarchi 2000; RTEC 2006a, 2006b; McElhanney 2007a, 2007b). Numerous studies have been conducted on mountain ungulates in the region, including mountain goats, Stone's sheep, and caribou (Hatler 1986; BC MRSM 2000; RTEC 2006c).

2.3.2.1 Moose

Population demographics and movement patterns of moose in the NWA were assessed from 1997 to 2000 using radio-telemetry and aerial surveys (Demarchi 2000). A significant portion (69%) of the moose that were radio-collared crossed over the Nass River around Vandyke Island. Moose are known to be traditional in their use of migration corridors (LeResche 1972), and Demarchi (2000) suggests that the Nass River migration corridor may have been in use for decades. This highlights the importance of migration corridors for moose in the region. This is an example of a key habitat feature that cannot be identified through habitat suitability mapping alone and must be obtained from additional studies. Demarchi (2000, 2003) also suggests that snow depth is the primary factor influencing migration between winter and non-winter ranges. Moose typically responded to increasing snowpack by moving to lower elevations where snow depths were shallower.

During mapping of moose winter range in the North Nass TSA, McElhanney (2007b) concluded that the best winter forage for moose was found on the floodplains and tributaries of large rivers and at the toe of mountainous slopes with productive understory shrubs. This is supported by the results of moose surveys and habitat mapping for moose in the Galore Creek Project area (RTEC 2006b; 2006d), which identified higher value habitat for moose along lower elevation river valleys, including More Creek, Porcupine Creek, and the Stikine River basin. Yazvenko et al. (2002) mapped moose winter habitat in the Nass Wildlife Area and based the majority of the habitat rankings on forage value; the areas with high forage potential were associated with flood planes and river valleys. Forests with adequate canopy cover to minimize snow depths (good snow interception) were also important for moose in the North Nass TSA, as the average winter snowpack was on the order of 3 m or more (McElhanney 2007b). Snow depths such as these are known to restrict moose movement (Coady 1974; Kelsall and Prescott 1971; Doerr 1983). McElhanney (2007b) also noted that while closed canopy forests provided the best areas for good snow interception, open canopy forests in the ICHvc BEC also had value for snow interception. The trees in ICHvc forests have much fuller crowns and significant individual tree wells below where moose could find available forage within several metres.

2.3.2.2 Grizzly Bear

The distribution and movement, relative abundance, and seasonal habitat use of grizzly bears in the NWA was examined during a three year study using radio-telemetry, hair capture/DNA analyses, and aerial surveys (Demarchi and Johnson 2000). Three ecotypes of grizzly bear in the NWA were identified based on aerial observations and movement patterns of collared bears (Demarchi and Johnson 2000). Those ecotypes were divided as follows: (1) grizzly bears that use only high elevation habitat, (2) grizzly bears that use both high elevation and valley bottoms and (3) grizzly bears that use only valley bottoms. The second ecotype is generally the most well known behavioural pattern for grizzly bears in the province. Typically, grizzly bears follow the phenology of plants as the seasons progress, utilizing habitats with the most productive and nutritious forage available at that time (Gyug, Hamilton, and Austin 2004; COSEWIC 2002a). Starting in low elevation river valleys and floodplains during spring, they progress slowly up avalanche chutes towards high alpine meadows where they remain during the late summer months, returning to the valley bottoms once again in the fall (Blood 2002; Gyug, Hamilton, and Austin 2004). During mapping of grizzly bear habitat in the North Nass TSA, McElhanney (2007a) identified the highest value grizzly bear habitats across the spring, summer, and fall on avalanche tracks within the ESSFvw BEC and on floodplains and wetland habitat within the ICHvc and ICHmc BECs.

Access to salmon bearing streams in the late summer and fall is important for grizzly bears in many parts of the province. Demarchi and Johnson (2000) and McElhanney (2007a) noted that salmon was an important dietary component for bears in the North Nass TSA and NWA, and highlighted the importance of access to salmon spawning habitat in the fall, particularly within the Hanna and Tintina Creek watershed. RTEC (2006a) also confirmed the importance of salmon to grizzly bears in the Galore Creek Project area using DNA and stable isotope analysis of grizzly bear hair. Over the two year study, it was observed that grizzly bears in coastal habitats, which included the lower Stikine and Iskut River watersheds, were highly reliant on salmon during all seasons (RTEC 2006a). During the spring, salmon constituted just under a quarter of grizzly bear diets, and increased to over half of their diet during the summer and fall (RTEC 2006a). In addition, the largest movements of grizzly bears were those bears moving towards fish bearing streams in the later summer and fall. However, it was found that salmon was not significant dietary component of grizzly bears occupying more interior habitats, such as those around Bob Quinn and along the More Creek watershed (RTEC 2006a). These “interior” bears had less than 26% contribution of salmon in their diet in any one season, suggesting that they rely more heavily on alternative food sources such as berries, plants, and possibly ungulates or small mammals.

2.3.2.3 Mountain Goat

There have been several studies directed at identifying important and suitable mountain goat habitat in areas near the Project. Keim (2004a) determined winter movements, winter habitat selection, and core winter habitat of GPS collared mountain goats in the Taku River drainage to the north of the proposed Project. The results of this study were also used to develop a winter mountain goat habitat suitability index model, which was then applied to habitat surrounding the Bell II area (Keim 2004b). Keim (2004b) also assessed the late winter distribution of mountain goats in the Bell II area to validate and verify the applicability of the model developed for the Taku River drainage to other areas. Keim (2004a, 2004b) concluded that many of the areas identified as suitable habitat were occupied by goats during the winter; however, some use outside of suitable habitats was also observed. The results of these studies have been applied by other researchers and led to the designation of approximately 78,649 ha of approved mountain goat UWR in and around the Bell II area in 2008 (BC MoE 2008). It was also found that mountain goats had fidelity to winter ranges; goats in the Taku River tended to re-use core winter habitats over multiple years (Keim 2004a).

Mountain goat populations were monitored in the Galore Creek Project area to the south of the proposed Project (RTEC 2006c). Aerial surveys were conducted in the winter and summer over a two year period to establish population trends, seasonal habitat use, and distribution. These surveys indicated that a relatively large and stable population of goats inhabit the area. In addition, goats did not appear to vary largely in their selection of elevation between summer and winter over the two year study (RTEC 2006c). This is contrary to what has been observed in several other studies including the baseline studies on mountain goats for the Schaft Creek Project, where goats typically move to lower elevations in the winter (Schoen and Kirchoff 1982; Fox, Smith, and Schoen 1989; Shackleton 1999; RTEC 2010c).

2.3.2.4 Stone's Sheep

Population inventories have been conducted on Stone's sheep in areas to the east of the proposed Project over several years. In particular, the Todagin Wildlife Management Area is known to support a large sheep population (BC MRSM 2000). This area is also a RMZ within the CIS LRMP. The wildlife-related management objective within the Todagin RMZ is to "conserve Stone's sheep populations and habitat and other wildlife values integrated with mineral exploration and development" (BC MSRM 2000). Studies on Stone's sheep within the Spatsizi Plateau Wilderness Park in 1988, 1992, 1993, and 2003 suggested that sheep populations over the 15 year period appeared to be increasing in several areas, specifically the Carmel and Eaglenest Park Management Zones (PMZ) (Cichowski 2002 in Marshall 2003; Marshall 2003, *unpublished data*). Other areas, such as the Marion PMZ, had a high population count in 1988 followed by substantially lower counts in 1992, 1993, and 2003 (Cichowski 2002 in Marshall 2003; Marshall 2003, *unpublished data*). Across all surveyed areas, Marshall (2003, *unpublished data*) recorded 518 Stone's sheep in 2003 and further cautioned that observed population trends may have been influenced by several factors including differences in visibility of animals and seasonal snowpacks between surveys. For example, animals are more difficult to observe in lower elevation timbered areas, which result in lower observations in those areas. In addition, snow depth can influence habitat use in the winter, where animals may limit their use of areas with deeper snowpack (Demarchi and Hartwig 2004). Thus, differences in snow depths may have resulted in fewer animals utilizing surveyed habitats, which can also result in fewer observations.

2.3.2.5 Caribou

There are two caribou sub-populations recognized by the BC government in the vicinity of the proposed Project, the Mount Edziza and Spatsizi sub-populations. The Mount Edziza sub-population is the closest to the Schaft Project, occupying habitat to the north and east of the Project within and surrounding the Mount Edziza Provincial Park throughout the year. The Spatsizi sub-population ranges in areas further to the east of the proposed Project, within the Spatsizi Plateau Wilderness Provincial Park on the east side of Highway 37. The Mount Edziza sub-population is a relatively understudied population. There is evidence to suggest that the population is relatively small, comprised of 100 to 150 individuals (Cichowski, Kinley, and Churchill 2004; Rick Marshall, BC MoE unpublished data). In comparison, the Spatsizi sub-population has been relatively well studied since the mid 1970's.

Currently, the BC government recognizes only one caribou herd, the Spatsizi, that ranges within the Spatsizi Plateau Wilderness Provincial Park (Cichowski, Kinley, and Churchill 2004; Marshall 2003, *unpublished data*). However, previous research proposed various separate herd designations based on population dynamics. During the late 1970s, two caribou herds were proposed to occupy the region: the Spatsizi Park herd and the Todagin-Tumeka Lake herd (Bergerud 1978). The Spatsizi Park and Todagin-Tumeka Lake herds appeared to occupy distinct seasonal ranges; the Spatsizi Park herd in the eastern and northern portion of the larger Park area and the Todagin-Tumeka Lake herd in the northwest and western portion. A four year telemetry study of caribou in the Spatsizi Plateau Wilderness Provincial Park area produced data on physical characteristics, home ranges, movements, seasonal dispersion and distribution, habitat selection and use, and aggregation patterns (Hatler1986). Rather than the two herd designations proposed by Bergerud (1978), Hatler (1986) suggested a split of the general population of caribou that use habitat within and in the vicinity of the Spatsizi Plateau Wilderness Provincial Park into three separate "herds" or "rutting groups". These herds or rutting groups were used to describe animals in terms of their fidelity to particular summer ranges and rutting locations. These designations were: 1) Spatsizi herd, ranging in the summer in the northwest half of the Spatsizi Park, 2) upper Stikine herd, ranging in the summer in the southern and western portions of Spatsizi Park, and 3) a herd in the Lawyers

Pass-Tatlatui Park area, ranging in the summer in the extreme east portion of the Spatsizi Plateau Wilderness Provincial Park and northern portions of Tatlatui Provincial Park.

Some of the earliest population data on the Spatsizi caribou dates back to surveys in the late 1970s. In 1976, at least 1,993 caribou occupied areas within and adjacent to the Spatsizi Plateau Wilderness Provincial Park and the Park itself contained at minimum 1,246 caribou (Osmond-Jones et al. 1977). Additional survey data from the late 1970s indicated that the Spatsizi herd was in serious decline and that predation was a main factor causing the decline (Bergerud 1978; Bergerud and Butler 1978). However, evidence collected over a four year study in the 1980s did not support the earlier conclusions of a decline in the Spatsizi herd (Hatler 1986). It was also concluded that weather factors may be at least as important as predation in determining population size (Hatler 1986). Weather was also implicated as being an important factor influencing the survival of calves, and possibly of greater importance than predation effects. Hatler (1986) reported that the poorest calf survival occurred during the year with the wettest early summer. Currently, the Spatsizi herd is deemed stable at 2,200 individuals (Cichowski, Kinley, and Churchill 2004).

Caribou in the Spatsizi Plateau Wilderness Provincial Park occupy a wide range of habitats that change seasonally (Boonstra and Sinclair 1984). During late winter, the largest concentrations of caribou were found in the sub-alpine zone within the northern half of the Park (Boonstra and Sinclair 1984). As the snow melted in the spring and summer, caribou shifted southwards to calving grounds located in open brush and burn areas. During the rutting period in the fall, caribou preferred open alpine areas and avoided spruce and mixed spruce/pine forests in alpine zones (Boonstra and Sinclair 1984). Hatler (1986) also concluded that the most noticeable movements were by female caribou from their wintering grounds in the north to calving grounds in the south; an annual movement that generally followed the same path each year. Calving grounds were usually on high mountain ridges (higher than 1,500 m) above the timberline with good visibility, a flat area for calving and sparse or no vegetation (Geist 1971; Bergerud and Butler 1978; Bergerud, Butler, and Miller 1984; Hatler 1986).

2.3.3 Traditional Knowledge

The BC Environmental Assessment Office (EAO) requires that traditional ecological or community knowledge information be considered and integrated into an environmental assessment process (e.g. BC EAO 2010). The proposed Schaft Creek Project falls within the traditional territory of the Tahltan Nation. At the time of writing, the Tahltan Use and Knowledge study for the proposed Project was under development. Therefore, Tahltan Use and Knowledge information was not available for integration into this report. The results of the Tahltan Use and Knowledge study are planned to be used in combination with information from baseline studies to prepare the Environmental Assessment Certificate Application for the Project.

3. Methods

3. Methods

The initial development of habitat suitability models, including collection of field data and model assumption development, was conducted during 2007 and 2008. In 2010, preliminary habitat models were developed and tested against field data. Model assumptions and appropriate algorithms were then revised to reflect the survey results. A generalized approach is described here, while greater detail describing habitat mapping assumptions for individual wildlife species is included within each species section.

A vegetation baseline was written for the Project and includes the results of the Terrestrial and Predictive Ecosystem Mapping (TEM and PEM, respectively). Terrestrial Ecosystem Mapping was conducted within the local study area surrounding the proposed mine site following TEM Standards (RIC 1998a); TEM was based primarily on interpretation of aerial photos (orthophotos). The regional study area was mapped using PEM, which was modelled using input from Terrain Resource Information Management (TRIM) data, a Digital Elevation Model (DEM), and satellite imagery. Mapping followed the principles outlined in Predictive Ecosystem Mapping Standards (RIC 1999b). Field data collected in 2007 and 2008 were utilized to guide and refine both TEM and PEM. Full details of the mapping process are provided in the Schaft Creek Project: Ecosystems and Vegetation Baseline Report 2010 (RTEC 2010f).

3.1 WILDLIFE HABITAT RATINGS DEVELOPMENT

Wildlife habitat ratings (WHRs) were developed for ecosystem units within the RSA, as identified by the PEM (i.e., PEM ecosystem units). For hoary marmot, no WHRs were developed (see Section 4.8). The development of the wildlife habitat ratings followed the Resource Information Standards Committee (RISC) standards (RIC 1999a). These standards included:

- the development of species accounts (background information on the biology and habitat requirements of a species) and preliminary wildlife habitat ratings;
- field evaluation; and
- ratings adjustments (where applicable).

3.1.1 Species Accounts

Species accounts are summaries of the geographic distribution, life requisites, seasonal use of habitats, limiting factors, and habitat attributes for an animal species within a geographic range (RIC 1999a). The species accounts (Appendices 1 to 7) were primarily developed from literature reviews, with particular emphasis on the ecology of the study area. Information on species biology and habitat selection in regional and provincial contexts was also included wherever possible. Species accounts for focal species that were available on Ecocat, the provincial reports catalogue (BC MSRM 2001), were also consulted and modified for the ecology of the Project study area. This information helped guide the formulation of WHRs and habitat models.

3.1.2 Wildlife Habitat Ratings

WHRs are relative values assigned to an ecosystem/map unit as a way of characterizing the suitability of that unit to support a wildlife species for a particular life requisite and season (RIC 1999a). Ratings are based on assumptions regarding the habitat requirements of the species and are defined in the species-habitat model. For this Project, these assumptions and algorithms are described in the relevant species chapter (Sections 4.2 to 4.8). For the hoary marmot model, no WHRs were developed (discussed below and in detail in Section 4.8.2).

The WHRs assigned to the ecosystem map product were based primarily on the vegetation present in the area. When ratings were assigned, a number of different aspects were considered, including plant phenology and vegetation structure. Plant phenology refers to the developmental state of plants at a particular time of year (e.g., vegetation emergence, flowering, berry production). Developing wildlife habitat ratings based on vegetation phenology and chronology allow for the identification of habitat with the greatest value during a period of time. This method also provides the capacity to alter the habitat models in order to reflect changes in climate, annual weather variation (e.g., mild versus severe winters), and/or influences of elevation, slope, and aspect.

There are two important aspects with regards to vegetation structure that influence the habitat value of any particular site: structural stage and crown closure (also called canopy closure). As defined in the TEM standards, the structural stage of an ecosystem unit (RIC 1998a) is divided into seven classes ranging from un-vegetated areas (structural stage 1) to old-growth forest (structural stage 7). Each structural stage has a different composition of plant species. For example, early structural stages (1-3) are defined by grasses, herbs and shrubby habitats, whereas later structural stages (4-7) are typically forested habitats with varying degrees of understory cover. Thus, each structural stage may be useful for different sets of species throughout the year. Canopy closure has an important influence on habitat values by direct impacts on vegetation composition and production in the understory, which in turn exerts a major influence on the wildlife that will use the area.

Habitat of each identified focal species was evaluated for the specific seasons and life requisites outlined in Table 3.1-1. According to RISC standards (RIC 1999a), wildlife habitat ratings were developed according to either a 6-class or a 4-class system, depending on the level of knowledge of the species (Table 3.1-2). In some cases, WHRs based on the ecosystem map product were combined with additional models so that abiotic features could also be included (Table 3.1-1). These features included the identification of capable winter topography for moose and caribou and suitable escape terrain and topography for mountain goat and Stone's sheep. The modelling techniques that were used for these species are discussed in further detail in the following sections.

Table 3.1-1. Focal Species and Habitats Rated

Species Rated	Season	Life Requisite[1]	Rating Scheme	Additional Modelling[2]
Moose	Early and Late Winter	LI (FD emphasis for final HSR)	6 class	Yes
Mountain Goat	Winter and summer	LI (FD and SH used for final HSR)	6 class	Yes
Stone's Sheep	Winter and summer	LI (FD and SH used for final HSR)	6 class	Yes
Northern Caribou	Early and Late Winter	LI (FD and SH used for final HSR)	6 class	Yes
Grizzly Bear	Spring, Summer, and Fall	LI (FD emphasized for final HSR)[3]	6 class	No
Marten	Winter	LI	4 class	No
Hoary Marmot	Growing	LI	4 class	Yes

[1] *Life requisites are supplied by the species' habitat and include food (FD), shelter (SH) and thermal (TH) (RIC 1999a). The life requisite called living (LI) includes general activities that are mostly comprised of feeding, using cover for security and thermal purposes, and moving between the habitats required for these activities*
[2] *Additional modelling refers to the use of additional data (e.g., TRIM-based topography) to refine the habitat suitability model.*

Table 3.1-2. Wildlife Habitat Rating (WHR) and Habitat Suitability Rating (HSR) Class Schemes[1]

% of Provincial (Regional) Best[2]	Rating Class	Rating Code	
		6-Class Scheme[3]	4-Class Scheme[3]
100-76	High	1	H
75-51	Moderately High	2	M
50-26	Moderate	3	M
25-6	Low	4	L
5-1	Very Low	5	L
0	Nil	6	N

[1] As described in RIC 1999a.
[2] % of best represents a conceptual frame work for evaluating the habitat value based on the potential or expected use of the habitat as related to a provincial or regional benchmark. It is thus a qualitative representation of habitat value within the scale of the project.
[3] The 6 class scheme is used for bears and ungulates with a rating of 1 the best and a rating of 6 suggesting virtually no habitat value. The 4 class scheme is used for species such as marten and marmot.

The WHRs and, where applicable, the combination or weighting of various abiotic habitat features, were used to develop a final Habitat Suitability Rating (HSR) for the ecosystem unit. Often WHRs and HSRs are synonymous; however, the HSR is the rating used for the final map product. Like the WHRs, HSRs were assigned following the rating schemes outlined in the RISC Standards (RIC 1999a). The only exception was the hoary marmot growing habitat model, which utilized a combination of modelling techniques that then assigned the final HSR to specific ecosystem units, i.e., no preliminary WHRs were developed (refer to Section 4.8.2 for more details).

For the Schaft Creek PEM, a structural stage was assigned to each of the classes identified from the classified satellite image. Structural stages 4 and 5 are young forest, but could not be differentiated using the satellite imagery. Based on field surveys, the PEM area consisted largely of structural stages 6 and 7, with a minor component of structural stage 5 (RTEC 2010f). Therefore, all areas classified as "conifer" from the image classification were assumed to be structural stages 6 and 7 (RTEC 2010f). Canopy closure could not be reliably ascertained either. To assign wildlife habitat ratings to PEM ecosystem units that could have more than one habitat rating based on either structural stage and/or canopy closure, the higher habitat rating was chosen, based on the precautionary principle. For example, some open canopied older forests (Structural Stage 6 and 7) in the ESSFwv have higher habitat value for grizzly bears during the summer over younger forests with predominately closed canopy in the same BEC, as these open canopy mature forests tend to have better growing conditions for understory plants that are selected by grizzly bears during that time (e.g., blueberries and huckleberries). Thus, it is likely that forested habitats may contain patches of different value habitats for any one particular species.

3.1.3 Field Evaluations

Habitat models are limited by the knowledge of the habitat preferences of the species being assessed. This is why it is useful to field test models (i.e., verify habitat suitability) by evaluating a variety of habitats to see how well the model predicts actual field conditions (RIC 1999a).

Field assessment was conducted during the summer of 2007 and 2008 in conjunction with ecosystem and soils mapping. This wildlife assessment work was conducted prior to completion of wildlife habitat suitability models. Data collection used Wildlife Habitat Assessment field cards (FS 882 (5) HRE 98/5) and data were recorded using RISC standards (1999a). The collection of ecosystem descriptions and wildlife habitat assessments were used to supplement preliminary habitat suitability models and maps. Where certain ecosystem units were not evaluated in the field, preliminary WHRs were developed by comparing the species habitat requirements (as outlined in the species accounts) to the ecosystem descriptions provided in Beaudry et al. (1999), Banner et al. (1993), and MacKenzie and Moran (2004).

3.1.4 Model Adjustments and Evaluation

To evaluate the model, field ratings collected in 2007 and 2008 were compared to the preliminary ratings based on habitat suitability model outputs for each focal species using the final ecosystem map product. This comparison was achieved by overlaying the location of field plots onto habitat suitability maps and analyzing each rating predicted for that location. The difference between the field and model HSR was calculated and habitat models developed for each species were deemed adequate if more than 70% of the field plot ratings were equivalent or within one rating class of the model rating. Where field and model ratings differed from each other by more than one rating class, field notes and photographs were consulted and a comparison of the ecosystem classification between the field and the model was conducted to determine the cause. If consistent patterns in misclassification were identified, the habitat model was adjusted accordingly to assign the final HSRs. Model ratings were compared to field ratings once again after adjustments to ensure consistency (i.e., within one rating class more than 70% of the time). An additional method of evaluation was performed for moose, mountain goat, and Stone's sheep. Observations of these species were overlaid with final suitability maps to assess whether wildlife presence corresponded with habitat quality.

There exists no provincial quantitative standard for quality assurance/quality control (QA/QC) of habitat suitability maps. It is acknowledged that there may be subjectivity in field evaluations and potential classification errors associated with ecosystem mapping products. Some potential reasons for the differences in field and model ratings included the misidentification of ecosystem attributes (e.g., structural stage, canopy closure), incorrect assumptions regarding habitat value from the model attributes, or a combination of both. However, comparing field and theoretical (i.e., model) ratings should result in a higher level of accuracy in final HSRs, and is recommended by RIC (1999a).

3.2 SOURCES OF ERROR AND LIMITATIONS

Shortfalls in the knowledge of local species biology limit the confidence of models. For instance, marten have been known to use deciduous forest during the winter in northern areas of the province (Poole et al. 2004; Porter, St. Clair, and deVries 2005). The results of these studies suggest that marten exhibit finer-scale habitat selection within deciduous forests for particular activities (e.g., feeding, resting). Attempting to extend these results to the Project study area may be ineffective because habitat suitability mapping occurs on a much broader scale. On the other hand, there may be a paucity of local knowledge available for certain species, such as hoary marmot living/denning habitat, and that may limit the value of the final models. For example, model assumptions for hoary marmot habitat were developed from studies elsewhere in the province and Canada (e.g., the Kootenays, Yukon Territory); therefore, there are potential limits on how applicable these results are to the Project area.

An additional consideration is the theoretical nature of the data used in the habitat modelling process (i.e., the PEM). The PEM is not an exact representation of the distribution of ecosystems in the study area, but rather indicates the most likely distribution of these ecosystems. However, the accuracy is sufficient to evaluate the quantity and quality of wildlife habitat within the area.

Considering these limitations, the habitat suitability maps presented should provide sufficient accuracy to evaluate potential impacts from the Project on wildlife species at a landscape scale. The map products are not intended to be used for stand level management (i.e., for attributes within an ecosystem unit polygon).

4. Species Habitat Suitability Models

4. Species Habitat Suitability Models

4.1 SUMMARY

4.1.1 Habitat Suitability Mapping Results

The results of habitat suitability mapping for candidate species are summarized in Table 4.1-1. More detailed information can be found in the following sections and within species accounts (Appendices 1 to 7). The WHRs used to develop habitat maps for observed PEM ecosystem types are provided in Appendix 8. These WHRs represent the vegetative qualities of each ecosystem type to provide for the species in question (i.e., forage opportunities for moose, appropriate forest structure for marten). In the case for species where no additional modelling was available or required, these WHRs are the final ratings (i.e., HSR) given to identified ecosystem units within the study area. For moose, mountain goat, Stone's sheep, and caribou, these WHRs represent the vegetation potential of ecosystem types to provide for the feeding life requisite only, and do not take into account the additional topographic modelling. For hoary marmot, no preliminary WHRs were given to PEM ecosystem units (discussed in detail in Section 4.8.2). A summary of final Habitat Suitability Ratings (HSRs) is provided in Appendix 9.

Table 4.1-1. Habitat Suitability for Seven Species in the Project Area

	Total Area (ha)											
Species	**High**	**%[1]**	**Moderately High**	**%[1]**	**Moderate**	**%[1]**	**Low**	**%[1]**	**Very Low**	**%[1]**	**Nil**	**%[1]**
Moose												
Early Winter	6,288	2	45,386	15	103,667	33	11,501	4	140,809	45	4,849	2
Late Winter	4,669	1	16,947	5	62,773	20	14,869	5	7,172	2	206,070	66
Mountain Goat[2]												
Winter	61,050	20	27,110	9	37,054	12	47,246	15	140,061	45		
Summer	10,819	3	66,244	21	29,380	9	35,163	11	170,916	55		
Stone's Sheep[2,3]												
Winter	9,790	12	4,421	5	6,566	8	24,962	30	38,283	46		
Summer	8,953	11	1,907	2	9,010	11	2,087	2	62,064	74		
Northern Caribou[3]												
Early Winter	1,206	2	8,905	13	3,179	4	5,201	7	39,140	55	13,324	19
Late Winter	16,373	23.1	21,319	30	2,526	3.6	5,140	7.2	62	0.1	25,535	36
Grizzly Bear												
Spring	41,842	13	17,255	6	77,688	25	42,407	14			133,357	43
Summer	447	0.1	62,454	20	100,986	32.3	15,304	4.9	74,004	23.7	59,353	19
Fall	53,127	17	27,732	9	79,586	25	18,747	6	74,004	24	59,353	19
Marten												
Winter	56,277	18			18,258	6	24,841	8			213,172	68
Hoary Marmot[4]												
Growing	302	1.6			1,526	8	27	0			17,189	90.3

[1]Percent of Habitat in the RSA (312,548 ha). For hoary marmot, the percentage is percent of habitat in the LSA (17,018 ha)
[2]Very Low includes Nil Rated Habitat (i.e., Very Low/Nil)
[3] Stone's sheep and northern caribou habitat suitability was modelled with a portion of the RSA. Therefore, the percentage is percent of total modelled areas for Stone's sheep (84,021 ha) and northern caribou (70,955 ha)

4.2 MOOSE

4.2.1 Background

Moose were selected as a candidate species for habitat suitability mapping in the study area because of their biological, social, and cultural importance. Moose are an important component of the regional biodiversity and they are also a significant social and economical resource as they are harvested by First Nations, resident hunters, and non-resident hunters. They make up a significant portion of the winter diet of the Tahltan (School District 87 2000).

Considering their importance, effort has been directed in the past to track moose populations, their distribution, and the features associated with suitable habitat in the region (Demarchi 2000; Yazvenko, Searing, and Demarchi 2002; McElhanney 2007b). This information helps to direct management and conservation policies, so that a sustainable population of moose may persist. Ungulate Winter Ranges and their objectives for conserving critical winter habitat is one example of how inventory and habitat modelling efforts have been integrated for management purposes (Section 2.1).

Winter is considered to be one of the most difficult seasons for ungulates. During the winter, moose are in their poorest body condition, and experience high metabolic demands when moving through deep snow (Safford 2004). In addition, forage resources available at this time of year are limited and also of reduced nutritional quality. Habitat suitability mapping for moose focused on the identification of habitat that may be used during the early and late periods of winter. Snow depth in the early winter is not anticipated to limit the movements of moose, and moose may exploit a variety of habitats across a landscape. However, the snowpack during the late winter is expected to become prohibitively deep so as to restrict movement. In response to increasing deeper snowpack, moose typically move to lower elevation, as Demarchi (2000, 2003) observed with moose in the Nass Wildlife Area (NWA).

4.2.2 Habitat Suitability Model Development

4.2.2.1 Model Rating Assumptions

<u>Early Winter</u>

An early winter habitat suitability model was developed to identify areas where moose are able to find preferred forage. The model is intended to represent the period of time in the winter when snowpack is not limiting movement, generally when packed snow is less than 1 m deep throughout the landscape , but also when snow may be deeper but less dense, and is thus easier for moose to travel through. Therefore, the early winter model applies to the period of time when snow begins to accumulate in October until such time that the snowpack becomes limiting, which will vary on annual basis.

In general, early winter habitat suitability ratings assigned to PEM ecosystem units were based on forage production. Specifically, areas that may produce abundant preferred moose winter forage (e.g., willow, red osier dogwood, scrub birch) were given higher habitat suitability ratings. Other studies have confirmed that moose select habitats during the winter with high forage potential. Demarchi (2000) concluded that areas with a greater availability of forage were preferred within the winter home range of radio-collared moose in the NWA. Similarly, during habitat suitability modelling of winter moose habitat in the NWA, Yazvenko, Searing, and Demarchi (2002) assigned 90% of the overall habitat suitability index value of the ecosystem unit to the food-producing component of the model. The use of security cover is recognised as important; however, this component of moose winter habitat often does not produce forage (e.g., younger closed canopy conifer forests) but may be very close to highly productive forage areas. Authors have reported that habitat interspersion, which is the proximity of winter habitats that provide different functions (e.g., forage and shelter), is a key contribution to habitat suitability for moose (e.g., Dussault et al. 2005); however the complexity of integrating habitat interspersion in the models precluded its incorporation in the final ratings.

In developing the early winter model, the following general assumptions were made for both the interior and coastal portions of the RSA:

- High and Moderately High value habitat (WHR 1 and 2) included open areas of structural stage 3 (shrub) vegetation on moist to wet sites within all BEC zones. High value habitat also included swamps and wetlands. Moderately High value habitat also included drier to mesic structural stage 3 vegetation within all BECs and some drier deciduous forests on steep slopes, particularly those dominated by trembling aspen, within the BWBS BEC. Drier shrubby sites may support plant species that could be used as winter forage, and dry sites are often the result of abiotic factors such as microclimate or aspect that result in lower winter snowpack. Some open canopied structural stage 6 and 7 forests on wet, nutrient rich sites, typically adjacent to floodplains and riparian areas near rivers, may also provide accessible winter forage (e.g., willow) and was rated Moderately High. All the aforementioned areas were generally on topography with gentle or no slopes, with the exception of aspen forests on steeper slopes.
- Moderate value habitats (WHR 3) included open areas of structural stage 2 (herb and grass stage) vegetation across all BEC zones that were likely to support pockets of preferred winter shrub forage. WHR 3 habitat also included forested sites that had substantial winter forage produced under the canopy, generally associated with more open-canopied mature to old growth forests. This type of habitat could be found within low elevation forests with more nutrient-rich regimes (mesic to wet forest) and also in some drier forests on mountain slopes in the SWB, ESSF, and BWBS BECs. Moderate valued sites also included waterways and gravel bars, which are associated with riparian corridors that support preferred winter forage (e.g., willow).
- Low and Very Low value habitat included areas that had relatively low winter forage; this included barren sites, dry herb vegetation, or closed canopy conifer forest unlikely to produce winter shrub forage. It also included lakes or ponds that would be frozen during winter and capable of providing some sparse amounts of rooted forage around the shore of the wetlands.
- Nil value habitat included areas of permanent ice or snow.
- A capability component was not included with the early winter model as it was intended to represent the period when snow pack would not prohibit use of higher elevations. This capability component was only used in the late winter model, as described below.

These assumptions used in the development of the early winter habitat suitability model were based on current knowledge of moose habitat selection and use as detailed in the species account (Appendix 1). The early winter WHRs developed from these assumptions and assigned to the PEM ecosystem units are provided in Appendix 8.

<u>Late Winter</u>

The late winter habitat suitability model was intended to identify the most important areas used during more severe winter conditions, when deeper snowpacks become a major impediment to moose movement (Coady 1974; Dussault et al. 2005). Generally, dense snowpacks greater than 1 m deep were assumed to restrict moose movement within the study area. Dense snowpacks are anticipated to start around December or January with some annual variation. However, it is acknowledged there may also be times during the late winter when non-restrictive snow conditions typical of early winter are present (e.g., shoulder periods or during spring thaw), and the early winter model may be more applicable during these times.

Like the early winter model, habitat suitability ratings given to PEM ecosystem units were primarily driven by the forage potential of the site (see assumptions below). However, moose generally congregate at low elevations across the landscape during the late winter in response to increasing snowpack at higher elevations (Demarchi 2000, 2003). Thus, the late winter model also integrated topographic considerations to isolate the areas with potentially shallower snow and more accessible forage. The topographic model was developed based on the local distribution of moose recorded during surveys in the winter of 2006 (RTEC 2007b); the model assumed that the most capable habitat during late winter across the entire RSA was areas below 1,100 m and on slopes of less than 60%. Capable habitat is defined by RIC (1999) as "the ability of the habitat, under the optimal natural (seral) conditions for a species to provide its life requisites, irrespective of the current condition of the habitat". For moose, this definition was modified as the habitat type that is most able to provide for the late winter life requisites, due to the limiting nature of winter habitat and its relative importance to moose. Area that did not meet these criteria of capable habitat was assumed to have no value as late winter habitat and, therefore, was given a rating of Nil suitability. However, there were two exceptions to this rule (described in Section 4.2.3.2).

In rating the forage potential of ecosystem units, the following general assumptions were made:

- High and Moderately High value habitat for the late winter included all the same habitat as was identified during the early winter. However, some areas within the BWBSdk1 BEC, including mixed coniferous and deciduous forest near valley bottoms and areas just above, were also rated as Moderately High.
- Moderate value habitats for the late winter included all the same habitat as was identified during the early winter.
- Low and Very Low value habitat included areas that had relatively low winter forage, similar to that of the early winter model. It also included waterbodies where rooted forage around the shore of the wetlands may be sparsely available.
- Nil value habitat included areas of permanent ice or snow.
- A capability component was included in this model as it was assumed that snowpack would restrict the use of steeper high elevation areas. As such, with the two exceptions described below, all areas above 1,100 m and steeper than 60% slope received a Nil rating by default.

These assumptions used in the development of the late winter habitat suitability model were based on experience and current knowledge of moose habitat selection within the region and were used as detailed in the species account (Appendix 1). The late winter WHRs developed from these assumptions and assigned to the PEM ecosystem units are provided in Appendix 8.

4.2.2.2 Methods

While the entire study area was rated for both early and late winter habitat based on forage production, only ecosystem units or portions thereof that met the criteria of capable habitat were included for consideration as late winter moose habitat. Capable habitat was modelled using 1:20,000 Terrain Resource Information Management (TRIM) data (including Digital Elevation Model [DEM] information) purchased from the BC government for the Scahft Creek Project (RTEC 2010f).

Capable habitat included low elevation topography below 1,100 m on gentle slopes (≤ 60%) across the RSA. However, the results of 2006 winter surveys suggest that a small proportion of moose may be found on slightly steeper slopes of up to 76% in both the coastal and interior portions of the study area, and also to an elevation of 1,300 m within the interior portion (RTEC 2007b). To account for this use and ensure that these areas were not given a Nil rating by default, capable habitat also included; 1) any habitat below 1,100 m that occurred on steeper slopes from 61 to 76% across the entire RSA (i.e., cRSA and iRSA), and 2) any habitat on slopes less than 60% that occurred at elevations from 1,101 and 1,300 m within the iRSA. Habitat ratings assigned to any PEM ecosystem units that fell in these areas were downgraded by one rating class (i.e., HSR 2 becomes HSR 3). All polygons or portions thereof above 1,300 m in the iRSA and 1,100m in the cRSA and greater than 76% slopes were assigned a rating of Nil.

A large area of the south and west facing slopes around Mount LaCasse surrounding the proposed Schaft Pit and western Waste Rock Dump had been subject to a wildfire in the recent past (see Figure 4.2-1). However, this information was not available during the ecosystem mapping process and could not be incorporated within the PEM product. Thus, there may be a larger amount of preferred winter forage (e.g., shrubby, early seral stage vegetation) in this area than was accounted for by the PEM product. In order to address this, a post hoc adjustment was made to the early and late winter model to account for the burn, and all final habitat ratings within the burn area were upgraded by one rating class (i.e., HSR 3 becomes HSR 2).

It should be also noted that all PEM ecosystem units classified as mature/old forest may contain some areas of lower rated habitat than was identified, e.g., a PEM ecosystem unit pixel that was assigned a WHR 3 may contain some patches of WHR 4 or WHR 5 habitat. This resulted from the inability to distinguish young vs. old forests with the available satellite imagery.

4.2.3 Model Analysis and Evaluation

The early winter habitat rating assumptions were verified by comparing field ratings to theoretical model ratings (Section 3.1.4). The resulting habitat model was either equal to field ratings or came within one rating class of field ratings 70% of the time. This was based on the comparison of field and model ratings at the same geographic location (i.e., N=233). Similar results were achieved for the late winter model, where the model was either equal to or came within one rating class of field ratings 70% of the time at 232 common locations.

An additional model evaluation was conducted by overlaying moose group observations collected during the late winter 2006 survey with the results of the late winter modelling. Of the 101 groups of moose that were observed within the modelled area, 61 (61%) were observed in habitat classified as High and Moderately High; and 92% of observations were encompassed by habitat rated from High to Moderate (HSR 1, 2, and 3) (Figure 4.2-1). The proportion of moose in each habitat suitability ratings class was also compared to the amount of habitat available in each class. There were a greater proportion of moose observations in higher ratings classes and these ratings classes made up proportionately less area of the entire RSA (Figure 4.2-1). It is acknowledged that there may have been some sightability bias for moose in open areas vs. areas of closed canopy forest, which could affect the results of these comparisons. However, the relative difference in sightability of moose between habitat ratings classes was assumed to be minimal given that the vegetation cover recorded at moose observation sites during the late winter survey was similar.

The comparisons and evaluations suggest that the model is sufficiently robust in predicting the local habitat conditions and their value for moose in the winter, as shown by the similarity between model and field ratings and the presence of moose in higher rated habitats. No adjustments were deemed necessary.

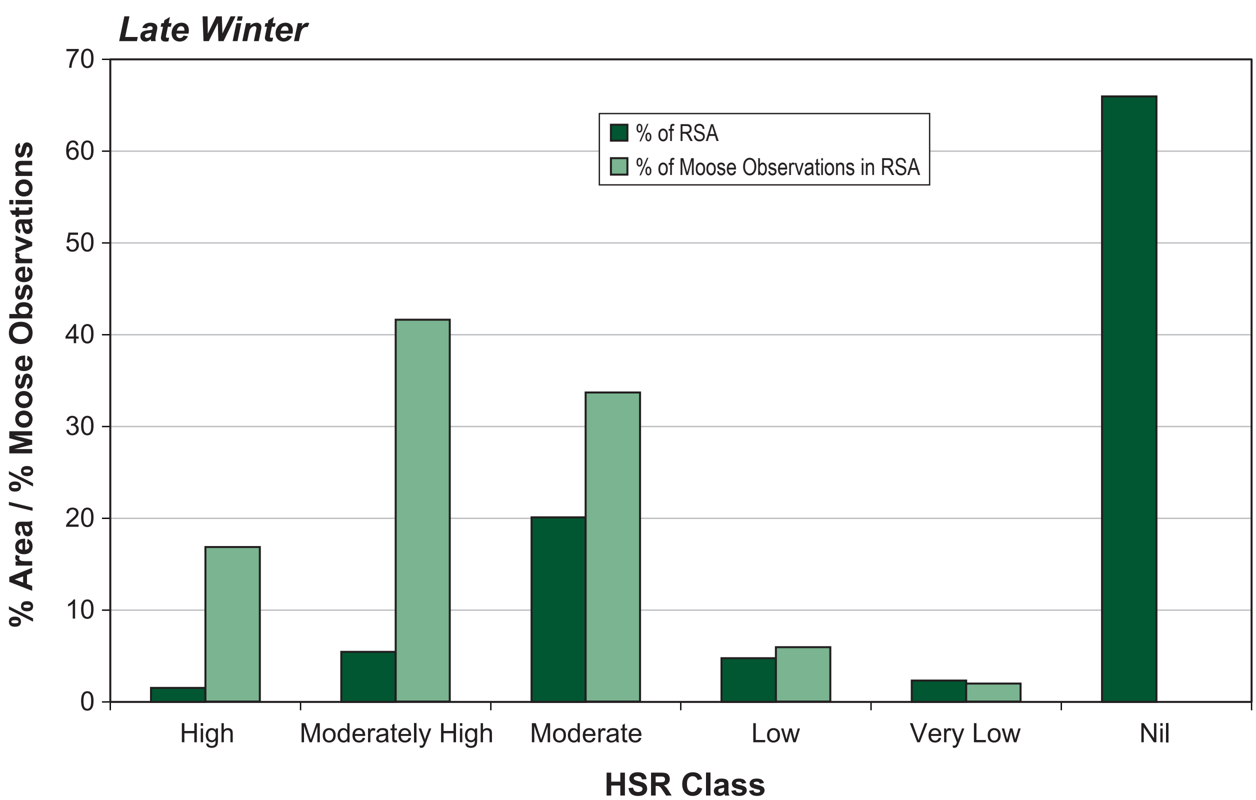


FIGURE 4.2-1

Moose Survey Observations vs. Availability of Late Winter Habitat

4.2.4 Results

4.2.4.1 Early Winter Habitat

The results of habitat suitability modelling for moose in the early winter are presented in Figure 4.2-2 and Table 4.2-1. A summary of the final Habitat Suitability Ratings (HSRs) are provided in Appendix 9.

Table 4.2-1. Area of Moose Habitat – Early Winter

Habitat Suitability Rating	Area (ha)	% *
High	6,288	2
Moderately High	45,386	15
Moderate	103,667	33
Low	11,501	4
Very Low	140,809	45
Nil	4,849	2

Percent of Habitat in the RSA

Approximately 17% (51,674 ha) of the RSA is Moderately High to Highly suitable (combination of HSR 1 and 2) early winter habitat for moose (Table 4.2-1). High rated habitat tended to be concentrated along the Schaft and Mess Creek watersheds, particularly in association with large wetland complexes along Mess Creek (Figure 4.2-2; Plate 4.2-1). The burned area on the southern and western slopes of Mount LaCasse was also predominately rated High and Moderately High (Plate 4.2-1). Much of the higher elevation plateau habitat of the eastern RSA within Mount Edziza Provincial Park was rated Moderately High, particularly for the early seral stage vegetation that is available in those areas. A large proportion of the RSA was rated Moderate (33%); these habitats were generally distributed across all major river valleys within the RSA (Figure 4.2-2). Moderate habitat are those that did not have ideal composition and abundance of preferred winter forage but are still able to produce browse in modest quantity. Of the remaining habitat that was rated, 4% was rated as Low: the rest was classed as Very Low (45%) and Nil (2%) (Table 4.2-1). These areas tended to be higher elevation mountainous habitats that are sparsely vegetated.

Plate 4.2-1. High to Moderately High Early Winter Moose Habitat: wetland complexes along Mess Creek (Left) and burned area on southwest slopes of Mount LaCasse (Right).

4.2.4.2 Late Winter Habitat

The results of habitat suitability modelling for moose during late winter are presented in Figure 4.2-3 and Table 4.2-2. A summary of the final Habitat Suitability Ratings (HSRs) are provided in Appendix 9.

Table 4.2-2. Area of Moose Habitat – Late Winter

Habitat Suitability Rating	Area (ha)	% *
High	4,669	1
Moderately High	16,947	5
Moderate	62,773	20
Low	14,869	5
Very Low	7,172	2
Nil	206,070	66

Percent of Habitat in the RSA

The results suggest that only 6% (21,616 ha) of the RSA is Moderately High to Highly suitable (combination of HSR 1 and 2) late winter habitat. The largest concentration of High rated habitat was found along Mess Creek to the east of the proposed mine site (Schaft Pit and Waste Rock Dumps); this area is predominately wetland and riparian habitat (Plate 4.2-1). Like the early winter modelling, the burned area on Mount LaCasse was Moderately High to Highly suitable habitat during the late winter. Moderate rated habitats accounted for 20% of the RSA, and were well distributed along lower elevation river valleys and adjacent upslope areas across the RSA (Figure 4.2-3). A small amount of habitat were rated Low (5%) and Very Low (2%). A substantial portion of the RSA (66%) was rated as Nil habitat for moose in the late winter, as it is too high and/or steep to be usable.

4.2.5 Discussion

The results of winter habitat suitability modelling suggest that the regional study area contains both early and late winter habitat for moose. However, there appears to be more High and Moderately High rated early winter habitat as opposed to late winter habitat, as a significant amount of habitat (66% of total RSA) was rated as Nil for late winter suitability (Tables 4.2-1 and 4.2-2). Nil rated habitats represent areas where late winter snowpack would be prohibitively deep so as to restrict moose movement.

Habitats that received the highest habitat suitability ratings (e.g., High or Moderately High) can be described as “most suitable habitats” for moose. For the proposed Schaft Project, the most suitable habitats that provided moose with preferred winter forage vegetation (e.g., willows and other woody browse) were centered primarily around wetland-timber complexes and floodplains of large rivers, such as those along the Schaft and Mess Creek drainages. Two areas in particular were identified as Moderately High to Highly suitable habitat for moose in both early and winter late winter; the large meandering wetland complex along Mess Creek to the east of the proposed Schaft Pit and associated infrastructure and the south and western slopes of Mount LaCasse that had been burned in the recent past (Figures 4.2-2 and 4.2-3). Both of these habitats provide an abundance of early shrub-seral stage vegetation and are used by moose, as evidenced by the 16 groups of moose observed in these two areas during late winter surveys in 2006 (Figure 4.2-3).

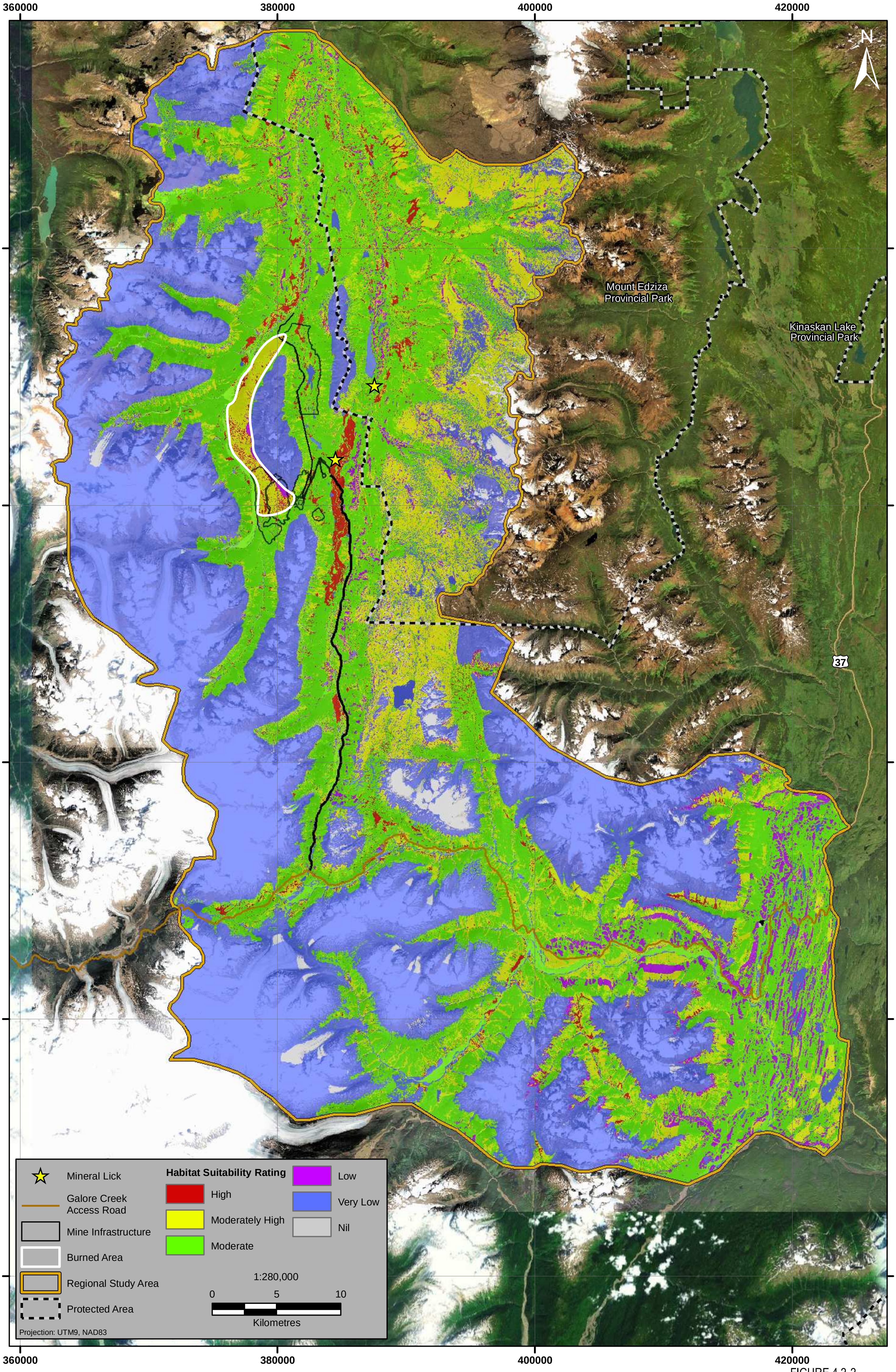


FIGURE 4.2-2

copper FOX metals inc.

Schaft Creek Project: Moose Early Winter Habitat Suitability

RTEC Keepers of the Land

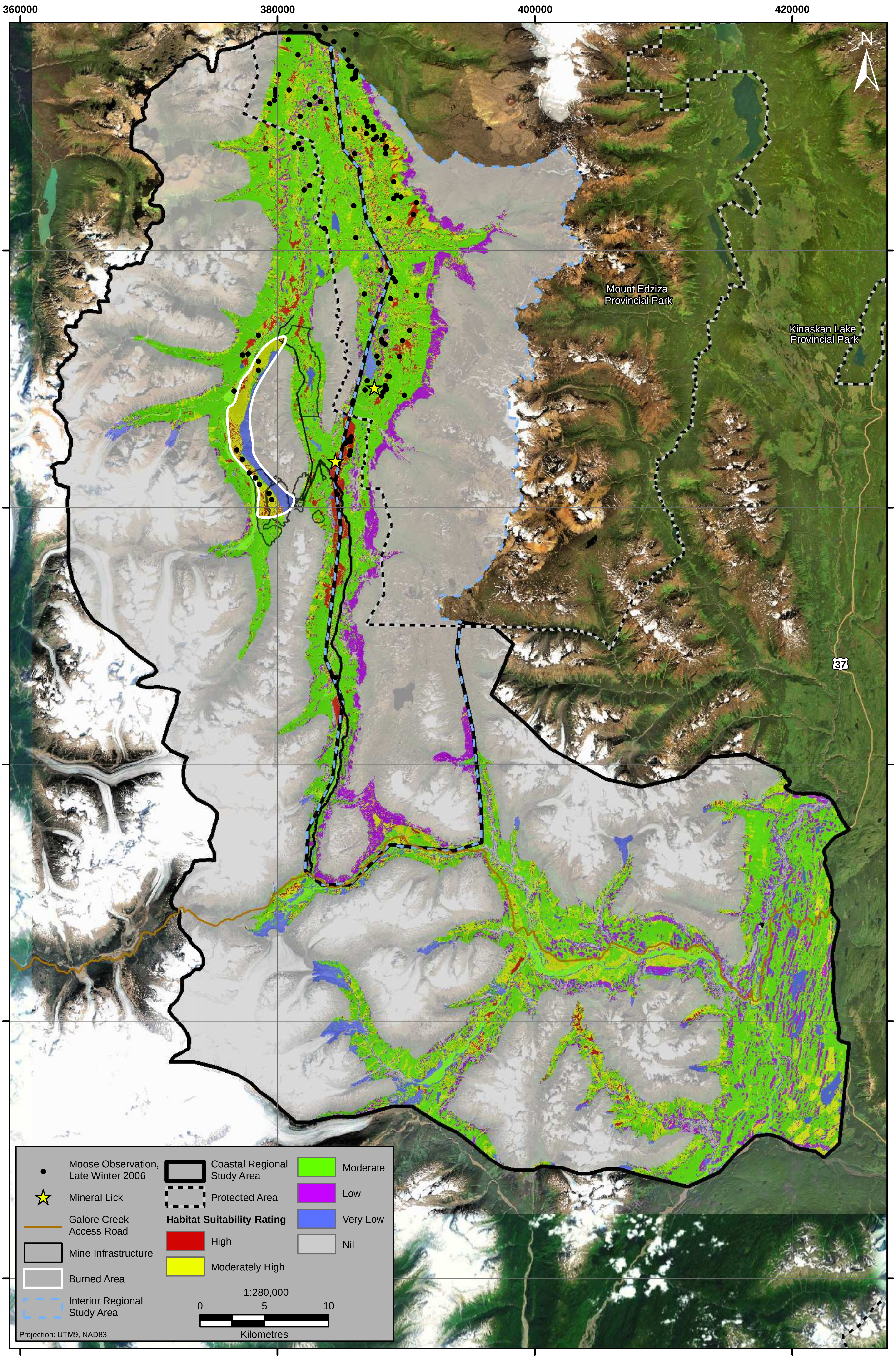


FIGURE 4.2-3

copper FOX metals inc.

Schaft Creek Project: Moose Late Winter Habitat Suitability

RTEC Keepers of the Land

Habitat modelling for moose in the late winter was conducted to predict which habitats moose are likely to exploit during severe winter conditions. Winter is the most difficult season for ungulates because they require more energy than other seasons (for thermoregulation) and forage resources are more limited (Safford 2004). Demarchi (2000) and Yazvenko, Searing, and Demarchi (2002) provided evidence that for moose in the NWA, forage availability was a better indicator of moose habitat preference than the availability of cover for snow interception. Dussault et al. (2005) also concluded that food availability was an important factor in winter habitat preference, but that when snow depths increased, moose preferentially selected habitat with abundant food resources interspersed with closed canopy forests for cover/shelter. This research suggests that the importance of forage availability verses shelter/thermal requirements is based on winter conditions and that the proximity of the two resources is important for moose during severe winter conditions.

High value habitat for moose has been identified within the Cassiar Iskut-Stikine LRMP (BC MRSM 2000). This habitat was mapped as a broad representation of moose winter range, taking into account of forage, security, and/or thermal capabilities of habitats (i.e., habitat interspersion). Therefore, habitats that also provide shelter and thermal requirements identified by the BC MRSM can be evaluated against high value habitats identified in the current report. A large area along the lower Schaft and Mess Creeks draining northwards into the Stikine River basin was identified as high value habitat in the CIS LRMP (BC MSRM 2000); a portion of this high value habitat overlaps the northern portion of the RSA south to approximately Mess Lake. Within the area of overlap, the early and late winter models identify numerous pockets of Moderately High to Highly suitable foraging habitats (Figures 4.2-1 and 4.2-2; BC MSRM 2000). There may be adequate cover and security habitat in proximity to these pockets of Moderately High to Highly suitable foraging habitats. The high value habitat overlapping with the northern RSA was also an area where a large number of moose were observed during late winter surveys in 2006; 93 groups totalling 142 individuals, just over 65% of all survey observations, were seen in this area (Figure 4.2-2; RTEC 2007b). The northern portion of the RSA appears to be some of the most important wintering habitat for moose in the area.

Mineral licks or wallows are an important habitat feature for moose (Klaus and Schmid 1998). Used for mineral supplementation, moose mainly visit licks in the early spring (Couturier and Barrette 1988) but may also use them during the early winter (Read, Hodder, and Child 2004). A significant mineral lick or wallow may be designated as a Wildlife Habitat Feature (WHF) and managed under the BC Forest and Range Practices Act (FRPA 2004). There were two mineral lick/wallow locations identified within the RSA by BC MOE regional biologists, one northeast of Mess Lake and the other on the west bank of Mess Creek near the terminus of the Mess Creek Access Road (Figure 4.2-2). The former of these two licks is located in Moderately suitable early and late winter habitat while the latter is located in Highly suitable early and late winter habitat (Figure 4.2-2 and 4.2-3). These areas are likely important for the local moose population.

4.3 MOUNTAIN GOAT

4.3.1 Background

Mountain goat were selected as a candidate species for habitat suitability mapping in the study area because of their contribution to regional biodiversity, as well as the social and economic value provided from their harvest. Goats are also included as a species of management concern in Cassiar Iskut-Stikine LRMP. While goats are not listed as a species at risk in BC, they are sensitive to disturbances from human activities, particularly helicopter over-flights (Côté 1996; Blood 2000a; Goldstein et al. 2005).

Habitat suitability modelling was conducted for both winter and summer seasons for goats. Similar to other ungulate species, winter is generally considered one of the most stressful periods of the year due to limited food resources and severe climatic conditions. During the summer, particularly during the kidding period in June and July, goats may be vulnerable to noise and visual disturbance (Côté 1996; Goldstein et al. 2005).

4.3.2 Habitat Suitability Model Development

4.3.2.1 Model Rating Assumptions

The four main components of mountain goat habitat assumed to have the greatest influence on overall habitat value were escape terrain, forage availability and quality, elevation, and aspect. The following is a general description of the model rating assumptions that were used in the development of winter and summer models based on current knowledge of goat habitat selection in the province (Appendix 2).

The presence of escape terrain is the key component of goat habitat. As such, distance from escape terrain was assumed to have the greatest influence on habitat value. The general assumptions surrounding escape terrain was that habitats in very close proximity to escape terrain had the highest habitat values and that the value of habitat steadily decreases with increasing distance from escape terrain. As several authors have documented that goats are seldom found further than 500 m from escape terrain (Fox 1983; Gross et al. 2002), habitats beyond 400 m of escape terrain in the iRSA and beyond 500 m of escape terrain in the cRSA were assumed to have very low to no value for goats. These distances were based on observations of goat behaviour collected by RTEC in nearby areas with similar ecology and geomorphology.

Escape terrain was identified using a topographic model to isolate areas of steep, mountainous topography devoid of vegetation. Escape terrain was modelled differently within the iRSA versus the cRSA, given the different geomorphologies between these two areas (refer to Figure 1.3-1). In the cRSA, escape terrain was identified as areas with slopes between 40° and 70° with no vegetation (Plate 4.3-1). In the iRSA, escape terrain included all barren habitats on slopes steeper than 40°. There was no upper limit on escape terrain slope in the iRSA because escape terrain was associated with steep cliffs on the escarpments of the Big Raven Plateau east of Mess Creek. These steep or nearly vertical cliffs have narrow ledges and terraces that can be used by mountain ungulates. The coarse resolution of the TRIM DEM might not detect this terracing on an otherwise sheer face, and these patches of escape terrain would have been excluded if an upper slope limit was assigned in the iRSA (i.e., 70° as in the cRSA). Both winter and summer habitat suitability is highly dependent on availability of escape terrain.

In addition to escape terrain, model assumptions considered the vegetative potential of habitat for foraging opportunities. For winter habitat, subalpine forest stands that provide a diverse range of arboreal and rooted plant forage adjacent to escape terrain were assumed to have the highest habitat values. Consequently, tree and shrub cover on steep, rocky ledges also affords thermal protection during sunny weather (solar radiation) and during storms, and provides cover from snow. Moderate habitat values were given to windswept alpine areas with an availability of terrestrial lichens and grasses. In addition, aspect was also assumed to influence the value of winter habitat in the cRSA, with more southerly aspects enhancing habitat value because snow accumulation is lower and food can be found more readily (Wilson 2005).

Plate 4.3-1. Mountain goat escape terrain.

During summer, goats move to higher elevations in response to plant phenology to exploit newly emerged high quality food sources. Areas with potentially abundant high quality forage, particularly high protein early seral stage vegetation (e.g., grasses and herbs), were given the highest habitat values. However, as goats are generalist herbivores, they will tend to eat whatever is available (Côté and Festa-Bianchet 2003) and therefore a wider range of habitats were considered to have higher forage potential during the summer than the winter. Laundré (1994) reported that goats consumed a large amount of shrubby vegetation during the summer, particularly the young leaves of willow and dwarf birch in habitats around the treeline. Habitat in proximity to escape terrain that could produce either herb or shrub vegetation, even in small quantities, were given moderate ratings for summer. Cooler northerly aspects were also given greater consideration, as these provide goats with a refuge from biting insects and hotter temperatures during the summer (RTEC 2010c).

The assumptions generalised above were used to assign WHRs to PEM ecosystem units, which were based solely on the vegetative potential of habitat, i.e., WHRs only addressed the feeding habitat life requisite (Appendix 8). Parameters based on escape terrain, elevation, and aspect were taken into consideration in the final modelling process (Section 4.3.3.2) that assigned Habitat Suitability Ratings (HSR) to PEM ecosystem units.

4.3.2.2 Methods

<u>Interior Regional Study Area (iRSA)</u>

Winter

Mapping of suitable winter habitat for goats has been conducted in the region for several years, and there were several sources available that provided information during model development.

A winter model for the iRSA was developed based on criteria used for an adjacent project in the Kutcho and Turnagin Creek drainages, which are similar in topography to the iRSA. This included using a model to identify escape terrain as defined in Table 4.3-1, and scoring certain topographic and vegetation features based on their importance as components of winter habitat (Table 4.3-2). Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models produced by RTEC staff for multiple projects in the northwest area of the province. However, results from these habitat modelling efforts are currently unavailable for public review. Wherever possible, scoring criteria also incorporated field observation data from winter goat surveys (RTEC 2010c). As all goat winter observations were below 1,500 m in the iRSA, greater emphasis was placed on habitat below 1,500 m in the vicinity of escape terrain (Table 4.3-2). This elevation roughly corresponds to the height of the Mess Creek escarpment (Plate 4.3-2). The WHR value for the food rating of identified PEM ecosystem units is provided in Appendix 8. A score was developed for each polygon defined by the model and this was converted to an HSR rating consistent with the 6-class rating scheme recognized by the province (RIC 1999a; Table 4.3-3). For the purposes of habitat modelling for goats in all seasons and areas, HSR 5 and 6 classes were combined to represent areas which have little to no function for goats, termed Very Low/Nil suitability habitat.

Table 4.3-1. Model Definition of Escape Terrain for Mountain Goat in the iRSA

Escape Terrain Attribute	Value	Value Source
Slope	>40°	Digital Elevation Model (DEM) information and 1:20,000 Terrain Resource Information Management (TRIM) data
Vegetation	barren areas	Satellite Image Classification

Table 4.3-2. Topographic and Vegetation Features for Modelling Mountain Goat Winter Habitat in the iRSA

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 100	1	Buffer around Escape Terrain (Table 4.3-1)
101 - 200	2	
201 - 400	7	
≥ 401	12	
Elevation (m)		
≤ 1,500	1	DEM information and TRIM data
≥ 1,501	2	
Vegetation		
WHR 1, 2	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 3, 4	2	
WHR 5, 6	3	

Table 4.3-3. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Interior Mountain Goat Winter Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
3, 4, 5, 6	1	High	100 – 76
7, 8, 9	2	Moderately-High	75 – 51
10, 11,12	3	Moderate	50 – 26
14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

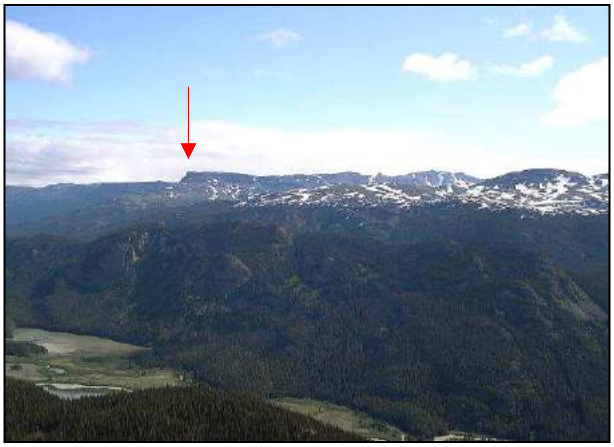


Plate 4.3-2. Mess Creek escarpment, showing approximate 1,500 m escarpment edge.

Summer

Relative to the mapping of winter habitat for mountain goats in northern BC (Section 2.3.1), relatively less effort has been directed at identifying suitable summer habitat. Similar to the winter models, the summer habitat suitability model parameters were also based on those developed for the Kutcho and Turnagain River drainages. Escape terrain remained an essential habitat feature during the summer. Highly suitable habitat during the summer are areas that produce abundant, high quality forage. This habitat is generally associated with early seral stage vegetation, particularly high protein grasses and herbs.

Summer habitat for goats was rated using a model to identify escape terrain (Table 4.3-1) and a score for topographic and vegetation features (Table 4.3-4). Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models produced by RTEC staff for multiple projects in the northwest area of the province. Similar to the winter model, the elevation criteria corresponded to the elevation of the Mess Creek escarpment. Most goats (70%) observed during the summer in the iRSA were seen below this elevation. The final score was transformed into a six-class HSR rating scheme (Table 4.3-5).

Table 4.3-4. Topographic and Vegetation Features for Modelling Mountain Goat Summer Habitat in the iRSA

Habitat Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 100	1	Buffer around Escape Terrain (Table 4.3-1)
101 – 200	2	
201 - 400	7	
≥ 401	12	
Aspect (°)		
Cool Northerly (285 -135)	1	DEM information and TRIM data
Warm Southerly (135 - 285)	2	
Elevation (m)		
≤ 1,500	1	DEM information and TRIM data
≥ 1,501	2	
Vegetation		
WHR 1, 2, 3	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 4, 5, 6	3	

Table 4.3-5. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Mountain Goat Interior Summer Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
4, 5, 6	1	High	100 – 76
7, 8, 9	2	Moderately-High	75 – 51
10, 11,12	3	Moderate	50 – 26
13, 14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

Coastal Regional Study Area (cRSA)

Winter

A winter model for the cRSA was developed based on the criteria used for an adjacent project within the Bell-Irving River drainage located to the southeast of the proposed Project. Escape terrain was modelled using slopes and vegetation attributes defined in Table 4.3-6. Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models produced by RTEC staff for multiple projects in the northwest area of the province.

The coastal model considered aspect, which was not used in the interior model. Warmer southerly aspects were given higher habitat value over cooler north facing slopes. In addition, areas up to 500 m away from escape terrain were also anticipated to have value in the cRSA. The elevation criteria in the coastal model incorporated results from goat surveys (RTEC 2010c) and also local ecology. The elevation of 1,680 m is approximately the elevation where the subalpine transitions to alpine. About 70% of goats were seen below 1,680 m in the winter in the cRSA. As a result, the models placed greater emphasis on areas near escape terrain below 1,680 m (Table 4.3-7).

Similar to the interior winter model, each identified ecosystem unit was scored based on important topographic and vegetation features for the winter (Table 4.3-7), which was then translated into a final habitat suitability rating (Table 4.3-8). The WHR value for the food rating of identified PEM ecosystem units is provided in Appendix 8.

Table 4.3-6. Model Definition of Escape Terrain for Mountain Goat in the cRSA

Escape Terrain Attribute	Value	Value Source
Slope	40º - 70º	DEM information and TRIM data
Vegetation	barren areas	Satellite Image Classification

Table 4.3-7. Topographic and Vegetation Features for Modelling Mountain Goat Winter Habitat in the cRSA

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 125	1	Buffer around Escape Terrain (Table 4.3-6)
126 - 235	2	
236 - 500	7	
≥ 501	12	

(continued)

Table 4.3-7. Topographic and Vegetation Features for Modelling Mountain Goat Winter Habitat in the cRSA (completed)

Model Features	Score	Data Source
Aspect (°)		
Warm Southerly (135 - 285)	1	DEM information and TRIM data
Cool Northerly (285 -135)	2	
Elevation (m)		
≤ 1,680	1	DEM information and TRIM data
≥ 1,681	2	
Vegetation		
WHR 1, 2	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 3, 4	2	
WHR 5, 6	3	

Table 4.3-8. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Mountain Goat Coastal Winter Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
4, 5, 6	1	High	100 – 76
7, 8, 9	2	Moderately-High	75 – 51
10, 11,12	3	Moderate	50 – 26
13 and 14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

Summer

The parameters in the summer habitat suitability model were also based on those developed within the Bell-Irving River drainage. The steps to identify summer habitat for goats were similar to the winter model, and included a model to identify escape terrain (Table 4.3-6) and a score for topographic and vegetation features (Table 4.3-9). Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models produced by RTEC staff for multiple projects in the northwest area of the province. The elevation criteria were based on observational data from summer goat surveys (RTEC 2010c) where 95% of goat groups in the cRSA were observed above 1,576 m. A six-class HSR scheme (Table 4.3-10) was developed for production of the habitat suitability map.

Table 4.3-9. Topographic and Vegetation Features for Modelling Mountain Goat Summer Habitat in the cRSA

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 125	1	Buffer around Escape Terrain (Table 4.3-6)
126 - 235	2	
236 - 500	5	
≥ 501	12	
Elevation (m)		
≥ 1,577	1	DEM information and TRIM data
≤ 1,576	2	
Vegetation		
WHR 1, 2	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 3 - 6	3	

Table 4.3-10. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Mountain Goat Coastal Summer Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
3, 4	1	High	100 – 76
5, 6	2	Moderately high	75 – 51
7, 8	3	Moderate	50 – 26
9 ,-14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

4.3.3 Model Analysis and Evaluation

The models were evaluated by comparison with field ratings. However, in 2007 and 2008 there were very few field visits to locations that were in close proximity to escape terrain and therefore fewer higher rated habitats (e.g. High and Moderately High) were evaluated using field data.

The final winter habitat model was either equal to field ratings or came within one rating class of field ratings 84% of the time (N=136). Similarly during summer, the habitat suitability model was either equal to or came within one rating class of field ratings 81% of the time (N=134).

An additional evaluation was conducted by overlaying mountain goat group observations collected during 2006 and 2008 surveys with the results of the winter and summer modelling. Of the 92 groups of mountain goats that were observed during winter surveys in 2006 and 2008, 78 (85%) were observed in habitat classified as High. Overall, 98% of all winter group observations were located in habitats rated from High to Moderate (HSR 1, 2, and 3) (Figure 4.3-1).

Of the 62 groups of goats observed during the summers, only 21% were located in High rated habitat (HSR 1), but 90% of all goat groups fell within habitat rated from High to Moderate (HSR 1, 2, and 3) (Figure 4.3-1). The proportion of mountain goat observations in each HSR class was also compared to the amount of available habitat in each class. A greater proportion of goat observations were located in higher ratings classes and these ratings classes made up proportionately less of the entire RSA area (Figure 4.3-1).

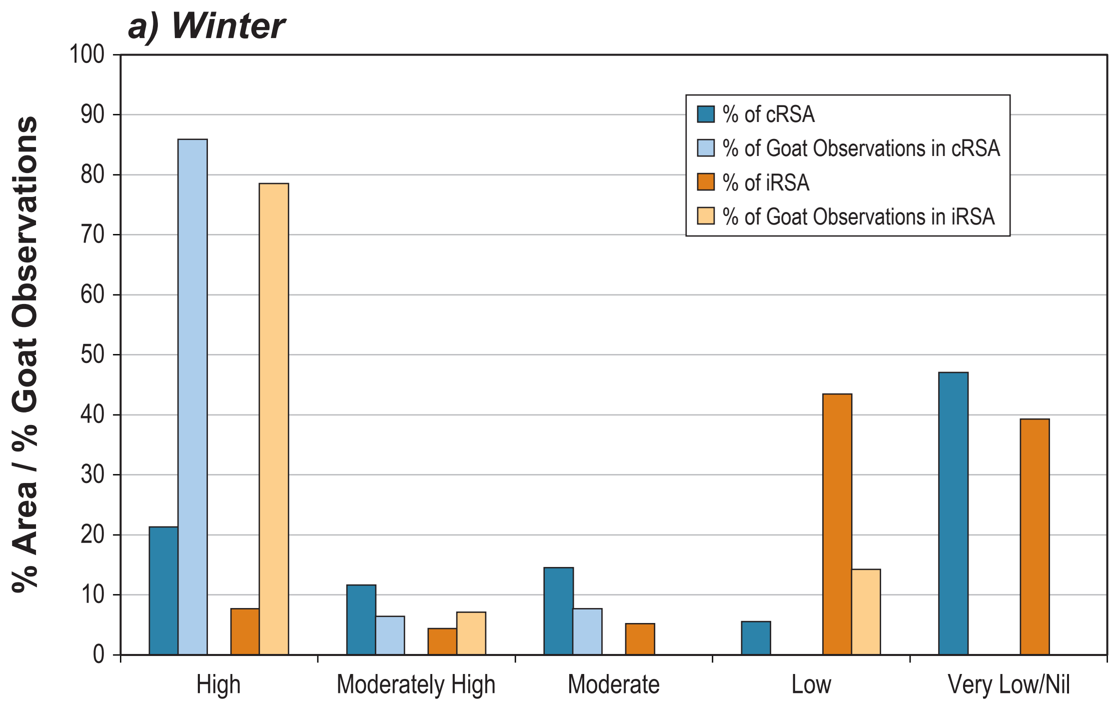
The above evaluations suggest that the habitat models are robust in predicting habitat value based on the similarity between model and field ratings of common locations and the presence of goats in higher rated habitats. No adjustments were deemed necessary.

4.3.4 Results

There is an abundance of rocky, alpine habitat in the RSA that is suitable as escape terrain. Most of the mountainous habitat across the RSA contained some proportion of each habitat suitability class (HSR 1 through 6). A summary of final HSRs is provided in Appendix 9.

4.3.4.1 Winter Habitat

The results suggest that roughly a third of the cRSA is Moderately High to Highly suitable winter habitat for goats, while 12% of the iRSA is High to Highly suitable winter habitat (Figure 4.3-2; Table 4.3-11). In addition, the majority of the higher rated habitats within the cRSA are larger, continuous patches, whereas many small, isolated patches of higher rated habitat occur within the iRSA (Figure 4.3-2). Nevertheless, several groups of mountain goats were observed in these small isolated patches in the iRSA. Moderately High to Highly suitable habitats are areas in close proximity to escape terrain that support high quality forage, such as shrub and herb vegetation. Across the entire RSA, 29% (88,160 ha) is classified as Moderately High to Highly suitable winter habitat.



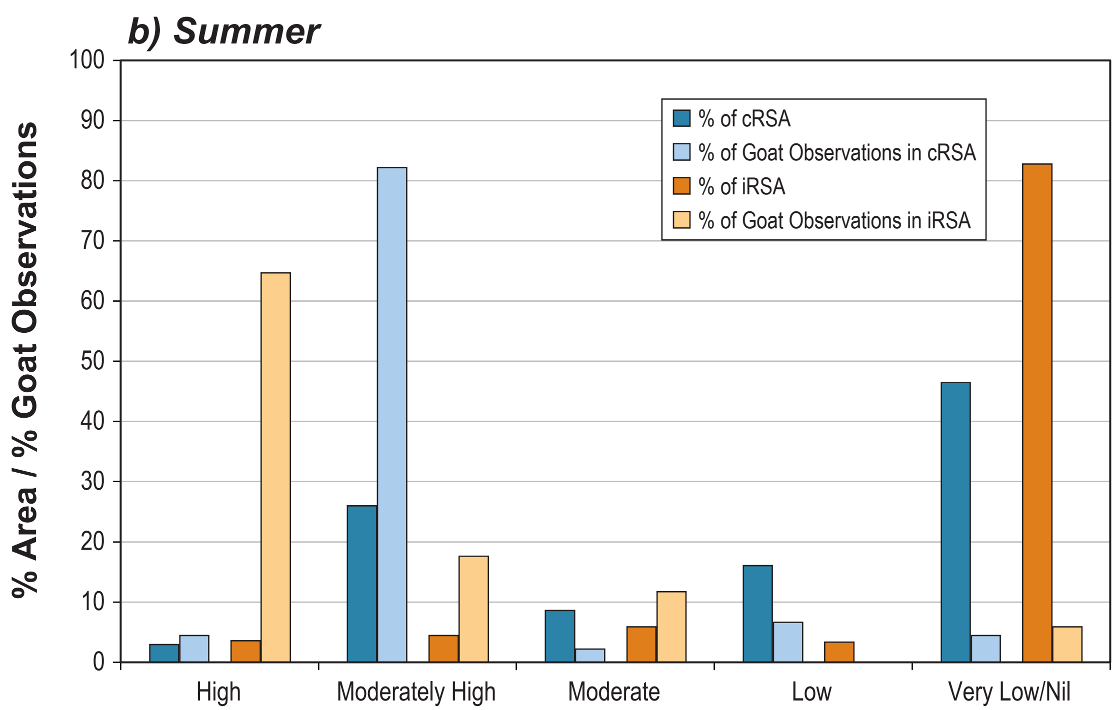


FIGURE 4.3-1

copper FOX metals inc.

Goat Survey Observations vs. Availability of Winter and Summer Habitat

Rescan™ RTEC Keepers of the Land

Table 4.3-11. Area of Goat Winter Habitat by cRSA, iRSA, and Total RSA

	cRSA		iRSA		Total RSA	
Habitat Suitability Rating	Area (ha)	%*	Area (ha)	%*	Area (ha)	%*
High	55,593	23	5,457	8	61,050	20
Moderately High	23,916	10	3,193	5	27,110	9
Moderate	33,476	14	3,578	5	37,054	12
Low	14,977	6	32,270	45	47,246	15
Very Low/Nil	113,604	47	26,457	37	140,061	45

** Percent of Habitat in the RSA*

A total of 14% of the cRSA and 5% of the iRSA were rated as Moderate. Some Moderate rated habitats were located at higher elevations above more suitable habitat (HSR 1 and 2) where goats may find available forage in wind swept areas. However, the majority of Moderate habitats were located at elevations just below more suitable habitats. These areas were rated lower primarily based on distance from escape terrain. A total of 12% (37,054 ha) of the total RSA was rated as Moderate.

The remaining habitat fell within the lower suitability classes (HSR 4, 5, and 6), which covered roughly 187,307 ha (59%) of the RSA (Table 4.3-11). Low and Very Low/Nil habitats covered all lower elevation habitats along the river valleys in the cRSA and iRSA, as well as the subalpine plateaus in the iRSA where no suitable escape terrain occurs.

4.3.4.2 Summer Habitat

The summer modelling results were very similar to winter (Figure 4.3-3, Table 4.3-12). Comparable proportions of Moderately High to Highly suitable habitat were identified in the cRSA (29%) and iRSA (8%) and summer habitats within the higher suitability classes were generally situated in the same areas as higher rated winter habitats (Figure 4.3-3). However, there was less Highly suitable summer habitat than Highly suitable winter habitat in both the cRSA and iRSA (Tables 4.3-11 and 4.3-12). This was likely the result of the model identifying a smaller amount of higher elevation habitat (~1,500 m and above) that supported the most preferable summer forage for goats (e.g., lush herb vegetation) in close proximity to escape terrain. This was very apparent in the cRSA where steep, rocky terrain was not vegetated at highest elevations. Like the winter model, Moderately High to Highly suitable habitats in the cRSA were more continuous than those identified in the iRSA, but goat presence confirmed that isolated higher rated habitat patches within the iRSA were used (Figure 4.3-3). Across the entire RSA, a total of 24% (77,053 ha) was rated as Moderately High to Highly suitable summer habitat. Moderate rated habitats were generally located in elevations just below more suitable habitats in the summer (Figure 4-3-3), occupying 10% of the cRSA and 6% of the iRSA. A total of 9% (29,380 ha) of the total RSA was rated as Moderate.

The remaining habitat fell within the lower suitability classes (HSR 4, 5, and 6), which covered roughly 206,079 ha or 66% of the RSA (Table 4.3-12). The iRSA contained proportionally more habitat (86%) within the lower suitability classes as compared to the cRSA (62%). This is due to a smaller quantity of suitable escape terrain in the east.

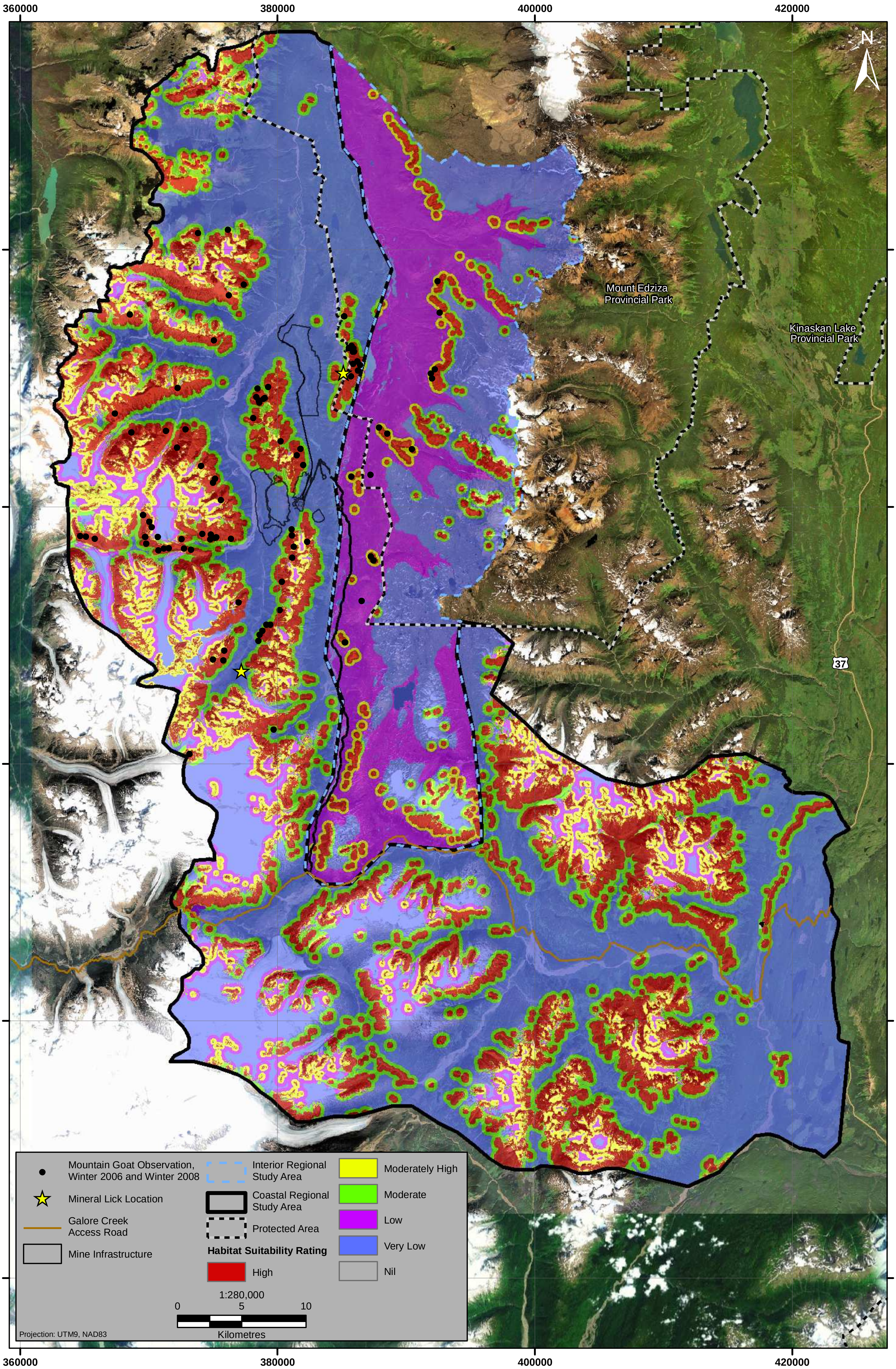


FIGURE 4.3-2

copper FOX metals inc.

Schaft Creek Project: Mountain Goat Winter Habitat Suitability

RTEC Keepers of the Land

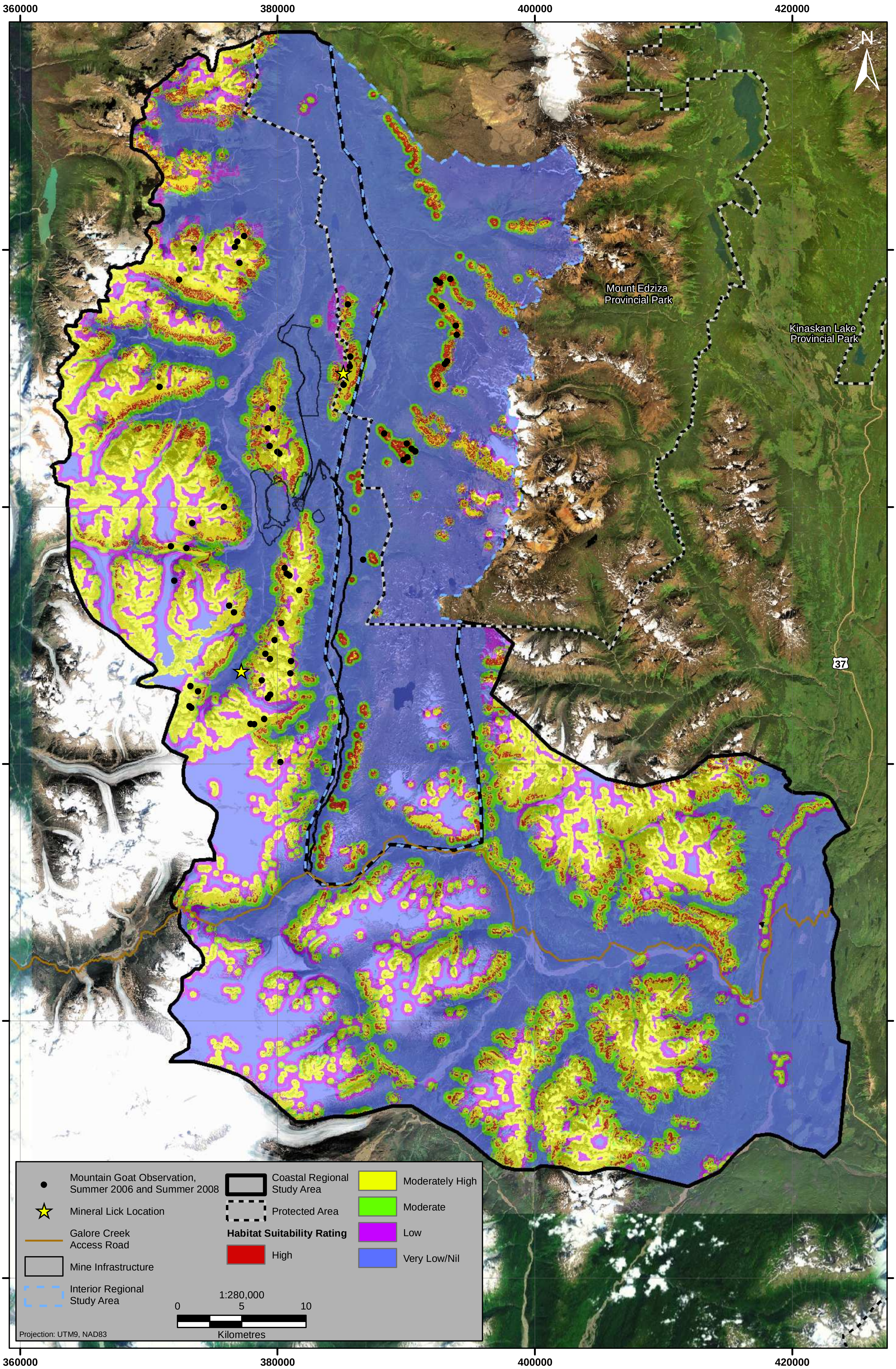


FIGURE 4.3-3

copper FOX metals inc.

Schaft Creek Project: Mountain Goat Summer Habitat Suitability

RTEC Keepers of the Land

Table 4.3-12. Area of Goat Summer Habitat by cRSA, iRSA, and Total RSA

Habitat Suitability Rating	cRSA		iRSA		Total RSA	
	Area (ha)	%*	Area (ha)	%*	Area (ha)	%*
High	8,091	3	2,728	4	10,819	3
Moderately High	63,284	26	2,960	4	66,244	21
Moderate	24,969	10	4,411	6	29,380	9
Low	33,034	14	2,129	3	35,163	11
Very Low/Nil	112,189	46	58,727	83	170,916	55

** Percent of Habitat in the RSA*

4.3.5 Discussion

In general, the Project area contains a large amount of year-round habitat for mountain goats. Roughly 20 to 30% of the RSA was Moderately High to Highly suitable winter and summer habitat. Several of these higher suitability habitats were occupied by goats (Figures 4.3-2 and 4.3-3), verifying the ability of the models to predict suitable habitat, and confirming the importance of those habitats for the local goat population. The Moderately High to Highly suitable winter habitat on the southern slopes around the headwaters of Schaft Creek and isolated mountain to the east of the Skeeter Tailing Storage Facility had the most goat observations in the winter (Figure 4.3-2). It should be noted that some small isolated patches of higher suitability habitats east of Mess Creek were consistently occupied by goats in the winter, some of which occur near the proposed access road. These observations suggest that even isolated patches are functional and that habitat isolation may not preclude use. Goats were similarly distributed across higher suitability (Moderately High to High) habitats in the summer, particularly on the isolated mountain between Skeeter Lake and Mess Lake and other isolated patches east of Mess Creek (Figure 4.3-3).

The presence of escape terrain is the most important habitat feature for goats. Overall, the majority of goats observed in 2006 and 2008 were found across Highly, Moderately High, and Moderately suitable habitats in the winter (90 of 92 groups) and summer (56 of 62 groups). These ratings classes (HSR 1 – 3) are only found within 400 to 500 m of suitable escape terrain. Escape terrain provides shelter as well as security from predators such as grizzly bears, wolves, or other mammals (Fox and Streveler 1986). There may be a trade-off between forage and shelter/security requirements in the winter, as the nutrition value of forage in the vicinity of escape terrain may be limited. During the summer, goats may range farther from escape terrain but bedding and kidding sites are typically found under the protection of overhanging rocks or cliffs and often in areas with high visibility of their surroundings (Tesky 1993). Movements between seasonal ranges are generally along ridges in proximity to escape terrain (Demarchi, Johnson, and Searing 2000).

Habitat mapping conducted for the Cassiar Iskut-Stikine LRMP area identified high value mountain goat habitat, which was broadly representative of goat winter range (BC MRSM 2000). Within the regional study area, higher suitability (Moderately High and High) winter habitats generally overlapped with high value habitats for mountain goats identified in the CIS LRMP (Figure 4.3-2; BC MSRM 2000). These areas of overlap occur on the southwest facing slopes of Mount LaCasse above the proposed Schaft Pit and west of the Waste Rock Dump, the opposite northeast facing slope directly across Schaft Creek, and other southeastern slopes on the west side of Schaft Creek (Figure 4.3-2; BC MSRM 2000). The isolated mountain between Skeeter Lake and Mess Lake as well as some southwest facing slopes within Mount Edziza Provincial Park were also rated as providing higher value habitats by the models in this report and the CIS LRMP (Figure 4.3-2; BC MSRM 2000). The areas of overlap may represent some of the more important winter habitats for the local population of goats.

Natal or kidding habitats were also mapped in the CIS LRMP and were generally smaller pockets of habitat located within high value habitat (i.e., winter habitats) (BC MRSM 2000). Kidding habitats are used during the summer and are located in areas with open sightlines (for detecting predators) and in close proximity to suitable escape terrain (Tesky 1993). As the winter and summer habitat models were similar in the spatial distribution of Moderately High and Highly suitable habitats, many of these higher suitability habitats contain the small pockets of kidding habitat identified in the CIS LRMP (Figure 4.3-3; BC MSRM 2000).

Mineral licks are also an important habitat feature for mountain goats, used primarily during the summer to compensate for mineral deficiencies or imbalances in the goats' diet (Ayotte, Parker, and Gillingham 2008). A significant mineral lick or wallow may be designated as a Wildlife Habitat Feature (WHF) and managed under the BC *Forest and Range Practices Act* (FRPA 2004). There were two mineral lick locations identified within the RSA during wildlife baseline studies in 2006 and 2008 (Figure 4.3-3; RTEC 2010c). Both of these locations are located within Moderately High suitability summer habitat (Figure 4.3-3). In addition, goats were seen in the vicinity of these mineral licks during the summer, especially near the mineral lick that occurs to the east of the proposed Skeeter Tailings Storage Facility. Thus, these areas likely receive annual use and are important for the local mountain goat population.

4.4 STONE'S SHEEP

4.4.1 Background

Stone's sheep (*Ovis dalli stonei*) is one of two thinhorn sheep subspecies in BC, the other being Dall's sheep (*O. d. dalli*). Like mountain goat, Stone's sheep are an important contributor to regional biodiversity as well as having social and economic value. Stone's sheep are highlighted as a species of management concern in the Cassiar Iskut-Stikine LRMP (BC MRSM 2000). It is not known whether Stone's sheep may be as sensitive to disturbance as other mountain ungulates such as goats and caribou, but further research is needed (Paquet and Demarchi 1999; Demarchi and Hartwig 2004). Evidence collected on the closely related Dall's sheep in Alaska suggests animals exhibit a similar sensitivity to visual and auditory disturbance as mountain goats (Frid 2003), and regional observations of Stone's sheep behaviour collected by RTEC supports this conclusion. Thus, sheep were selected as a candidate species for habitat suitability mapping in the study area.

Habitat suitability modelling was conducted for both winter and summer seasons for Stone's sheep. Similar to other ungulate species, winter is generally considered one of the most energetically demanding periods of the year for Stone's sheep. The lambing period in June and July can also be a stressful time as sheep are particularly vulnerable to noise and visual disturbance (Paquet and Demarchi 1999; Blood 2000b) at this time.

4.4.2 Habitat Suitability Model Development

4.4.2.1 Model Rating Assumptions

Modelling parameters were very similar to those of mountain goats, with four main components (escape terrain, forage availability and quality, elevation, and aspect) exerting the greatest influence on overall habitat value for Stone's sheep. The rating assumptions used for the identification of suitable Stone's sheep habitat are detailed in the species account (Appendix 3) and are generalized below.

The presence of escape terrain was the key component of sheep habitat. Inventory in the region has documented that sheep use nearly the same escape terrain as do mountain goats. For this reason, the same models used to identity mountain goat escape terrain in the iRSA and cRSA were applied to Stone's sheep (Section 4.3.2.2). Also, habitat value was assumed to be influenced by proximity to escape terrain, with habitats closest to escape terrain receiving the highest habitat values. Habitats beyond 500 m of escape terrain were assumed to have little to no value for sheep.

After escape terrain, model assumptions considered the vegetative potential of habitat. For winter habitat, windswept alpine areas where terrestrial lichens and dried graminoids, such as ryegrass, bluegrass, and other grasses are plentiful were given the highest habitat values. Stone's sheep may also exploit habitats at lower elevations than do mountain goat, such as subalpine meadows and adjacent forested areas, provided that escape terrain is nearby (Demarchi and Hartwig 2004). Drier forests that provide cover from snow, shelter, and a diverse range of arboreal and rooted plant forage received moderate habitat ratings, whereas wetter forests were rated as very low. In addition, warmer, southerly aspects enhanced winter habitat in the cRSA.

In the summer, alpine habitats that produce abundant high quality forage, such as grasses and lush herb and shrub vegetation, were given the highest habitat values. Some dry mature forests where shrubby and woody browse are available were also considered to provide moderate habitat value. Similar to the goat model, cooler northerly aspects were also given greater consideration for thermal regulation and avoidance of biting insects.

The assumptions generalised above were used to assign WHRs to PEM ecosystem units, which were based solely on the vegetative potential of habitat, i.e, WHRs only addressed the feeding habitat life requisite (Appendix 8). Parameters associated with escape terrain, elevation, and aspect were considered during development of the final (Section 4.4.3.2) Habitat Suitability Ratings (HSR) of PEM ecosystem units.

4.4.2.2 Methods

<u>Interior Regional Study Area (iRSA)</u>

Winter

A winter Stone's sheep model for the iRSA was developed based on criteria used for an adjacent project in the Kutcho and Turnagin Creek drainages, areas similar in topography to the iRSA. Similar to the goat modelling, the Stone's sheep model integrated escape terrain (Table 4.3-1) and scores for habitat characteristics based on their importance as components of winter habitat (Table 4.4-1). Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models produced by RTEC for multiple projects in the northwest area of the province. The elevation of the Mess Creek escarpment (1,500 m) was used to define the elevation criteria in a similar fashion to the interior mountain goat winter model. The WHR value for the food rating of identified ecosystem units is provided in Appendix 8. The model rating was then converted to an HSR rating consistent with the 6-class rating scheme recognized by the province (RIC 1999a; Table 4.4-2).

Summer

As with winter, escape terrain remains an essential habitat feature during the summer. The summer habitat suitability model definitions were based on those developed for the Kutcho and Turnagain River drainages. Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models produced by RTEC for multiple projects in the northwest area of the province. However, results from these habitat modelling efforts are currently unavailable for public review.

Table 4.4-1. Topographic and Vegetation Features for modelling Stone's Sheep Winter Habitat in the iRSA

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 170	1	Buffer around Escape Terrain (refer to Table 4.3-1)
171 - 270	2	
271 - 500	7	
≥ 501	12	
Elevation (m)		
≤ 1,500	1	DEM information and TRIM data
≥ 1,501	2	
Vegetation		
WHR 1, 2	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 3, 4	2	
WHR 5, 6	3	

Table 4.4-2. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Interior Stone's Sheep Winter Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
3, 4, 5, 6	1	High	100 – 76
7, 8, 9	2	Moderately-High	75 – 51
10, 11,12	3	Moderate	50 – 26
14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

Summer habitat was modelled using the parameters in Table 4.4-3, with a score for topographic and vegetation features. The final score was transformed into a six-class HSR rating scheme (Table 4.4-4) for development of the habitat suitability map.

Table 4.4-3. Topographic and Vegetation Features for Modelling Stone's Sheep Summer Habitat in the iRSA

Habitat Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 170	1	Buffer around Escape Terrain (Table 4.3-1)
171 - 270	2	
271 - 500	7	
≥ 501	12	
Aspect (°)		
Cool Northerly (285 -135)	1	DEM information and TRIM data
Warm Southerly (135 - 285)	2	
Elevation (m)		
≤ 1,500	1	DEM information and TRIM data
≥ 1,501	2	
Vegetation		
WHR 1, 2, 3	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 4, 5, 6	3	

Table 4.4-4. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Stone's Sheep Interior Summer Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
4, 5, 6	1	High	100 – 76
7, 8, 9	2	Moderately-High	75 – 51
10, 11,12	3	Moderate	50 – 26
13 and 14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

Coastal Regional Study Area (cRSA)

Winter

The winter model for Stone's sheep in the cRSA was restricted to the extreme northwestern portion of the cRSA (refer to Figure 4.4-1; RTEC 2010c), the only area where sheep were observed west of Mess Creek. Modelling was not extended to the rest of the cRSA based on the distribution of Stone's sheep as proposed by the BC MOE. Shackleton (1999) suggested that Stone's sheep are rare south and west of the modelling extent used in the current report. There were no sheep observations in this area, supporting the suggested range distribution in Shackleton (1999). As there were no field observations in most of the cRSA, the applicability of the model for the entire cRSA could not be verified. The model for this study was developed based on habitat modelling for Stone's sheep within the Bell-Irving River drainage to the southeast of the proposed Project.

Escape terrain was modelled in the cRSA with the same slope and vegetation attributes used for goats (Table 4.3-6). Each identified ecosystem unit was scored based on important topographic and vegetation features for the winter (Table 4.4-5), which was then converted into a final habitat suitability rating (Table 4.4-6). Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models produced by RTEC for multiple projects in the northwest area of the province. The WHR value for the food rating of PEM ecosystem units is provided in Appendix 8.

Table 4.4-5. Topographic and Vegetation Features for Modelling Stone's Sheep Winter Habitat in the cRSA

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 125	1	Buffer around Escape Terrain (Table 4.3-6)
126 - 235	2	
236 - 500	7	
≥ 501	12	
Aspect (°)		
Warm Southerly (135 - 285)	1	DEM information and TRIM data
Cool Northerly (285 -135)	2	
Elevation (m)		
≥ 1,631	1	DEM information and TRIM data
≤ 1,630	2	
Vegetation		
WHR 1, 2	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 3, 4	2	
WHR 5, 6	3	

Table 4.4-6. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Mountain Goat Coastal Winter Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
4, 5, 6	1	High	100 – 76
7, 8, 9	2	Moderately-High	75 – 51
10, 11,12	3	Moderate	50 – 26
13 and 14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

Summer

As with the winter model, the Stone's sheep summer model was restricted to the northwestern corner of the cRSA. The model was developed based on parameters used in previous habitat modelling conducted by RTEC in the Klappan River Drainage to the southeast of the proposed Project. Higher elevations above the treeline were given greater habitat value, as these areas produce abundant forage. A score was developed for topographic and vegetation features within PEM ecosystem units (Table 4.4-7), which was converted into a final habitat rating in a similar fashion to the winter model (Table 4.4-8). Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models for multiple projects in the northwest area of the province.

Table 4.4-7. Topographic and Vegetation Features for Modelling Stone's Sheep Summer Habitat in the cRSA

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 125	1	Buffer around Escape Terrain (Table 4.3-6)
126 - 235	2	
236 - 500	5	
≥ 501	12	
Elevation (m)		
≥ 1,851	1	DEM information and TRIM data
≤ 1,850	2	
Vegetation		
WHR 1, 2, 3	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 4, 5, 6	3	

Table 4.4-8. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Stone's Sheep Coastal Summer Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
3, 4	1	High	100 – 76
5, 6	2	Moderately high	75 – 51
7, 8	3	Moderate	50 – 26
9 - 14	4	Low	25 – 6
≥ 15	5/6	Very Low/Nil	5 – 0

4.4.3 Model Analysis and Evaluation

Models were evaluated by comparing results to field ratings. However, there were few locations that were rated in the field for Stone's Sheep winter and summer habitats in 2007 or 2008. The final winter habitat model was either equal to field ratings or came within one rating class of field ratings 74% of the time (N=31). Habitat ratings predicted in the summer model were equal to or came within one rating class of field ratings 71% of the time (N=32).

There were few Stone's sheep observations to compare to model results. Six sheep groups were observed within the RSA during winter surveys in 2008, of which five were located in High rated habitat and the remaining group in Moderate habitat. Five groups of sheep were observed during summer surveys in 2006 and 2008 and they were located in habitats that were modelled as High (three groups), Moderate (one group), and Very Low (one group).

Although there were few data to evaluate the Stone's sheep model, the general concordance between model results and field observations of sheep occurrence suggest that the models are robust in predicting habitat value.

4.4.4 Results

Since mountain goat and sheep models were developed using similar methods (Sections 4.3.2.2 and 4.4.2.2), the results of sheep habitat suitability mapping were very similar to that of goats. The main difference was that only a small portion (~1,310 ha) of the cRSA was modelled for winter and summer suitability for Stone's sheep. For reporting purposes, the results are discussed by total mapped area, which covers approximately 84,024 ha. A summary of final HSRs is provided in Appendix 9.

4.4.4.1 Winter Habitat

A total of 15% of the mapped area was rated as Moderately High to Highly suitable winter habitat, which was distributed across most mountainous ridges within the mapped area and along south and south western facing slopes (Figure 4.4-1; Table 4.4-9).

Moderate rated habitats accounted for 8% of the mapped area, predominately located around areas of higher rated habitats. Of the remaining habitat, a total of 24,962 ha (30%) was rated as Low and 38,283 ha (46%) was rated as Very Low/Nil.

Table 4.4-9. Area of Sheep Winter and Summer Habitat

	Winter		Summer	
Habitat Suitability Rating	Area (ha)	%*	Area (ha)	%*
High	9,790	12	8,953	11
Moderately High	4,421	5	1,907	2
Moderate	6,566	8	9,010	11
Low	24,962	30	2,087	2
Very Low/Nil	38,283	46	62,064	74

** Percent of Habitat in RSA*

4.4.4.2 Summer Habitat

The summer modelling results were nearly identical to the winter results, where roughly equal proportions of High and Moderately High suitability habitats occurred in similar locations within the mapped area (Figure 4.4-2; Table 4.4-9). Moderate rated habitats, totalling 11% of the mapped area, generally surrounded more suitable habitats, suggesting that they were identified based solely on distance from escape terrain. The remaining 76% of the mapped habitat was rated Low (2%) and Very Low/Nil (74%).

4.4.5 Discussion

Stone's sheep habitats were primarily mapped within the drier, rolling plateau habitats of the iRSA, as this area supported the most sheep observations during surveys in 2006 and 2008. The results of habitat modelling suggest that just under a quarter of the mapped area is Moderately High to Highly suitable year round habitat for sheep. Within these higher suitability summer and winter habitat, sheep consistently occupied the southwest facing slopes just east of Mess Lake (Figures 4.4-1 and 4.4-2). In relation to the proposed Project, there are some patches of higher suitability habitats to the east side of the proposed access road route along Mess Creek.

Habitat mapping conducted in the Cassiar Iskut-Stikine LRMP area identified high value habitat for Stone's sheep, used broadly as a representation of winter range (BC MRSM 2000). Within the area that was mapped for Stone's sheep, higher suitability (Moderately High and High) winter habitats generally overlapped with high value habitats identified in the CIS LRMP (Figure 4.2-1; BC MSRM 2000). The areas of overlap occur on some southwest facing slopes within Mount Edziza Provincial Park as well as pockets of habitat surrounding Arctic Lake in the southern iRSA and on southeast facing slopes above Schaft Creek in the extreme northwest cRSA (Figure 4.2-1; BC MSRM 2000). Natal or lambing habitats were also mapped in the CIS LRMP and were generally smaller pockets of habitat located within high value habitat (i.e., winter habitats) (BC MRSM 2000). As the winter and summer habitat models were similar in the spatial distribution of Moderately High and Highly suitable habitats, many of these higher suitability habitats contain small pockets of lambing habitat also identified in the CIS LRMP (Figure 4.2-2; BC MSRM 2000). Therefore, these areas of overlap between Moderately High to Highly suitable habitat identified in the current report and those identified in the CIS LRMP may represent more important habitat within the RSA since multiple sources have indicated their value to Stone's sheep.

Given the similarity in habitat selection between goats and sheep, the same habitat features that are important for mountain goats (escape terrain and mineral licks) are applicable for sheep (Section 4.3.4.2). At this time, there are no mineral lick locations identified in areas where Stone's sheep were observed during aerial surveys in 2006 or 2008.

4.5 NORTHERN CARIBOU

4.5.1 Background

Northern caribou were selected for habitat modelling because they are a provincial and federal species of conservation concern and they are a regional species of management concern within the Cassiar Iskut-Stikine LRMP (BC MRSM 2000). Northern caribou are on the provincial blue list and are considered a species of special concern by COSEWIC (BC CDC 2010; COSEWIC 2002b). In addition, caribou area an Identified Wildlife element under the Identified Wildlife Management Strategy (IWMS), meaning the species requires special conservation measures within the province (Cichowski, Kinley, and Churchill 2004).

gis no. SCH-23-028

Job No. 1039-001-07-04

October 13 2010

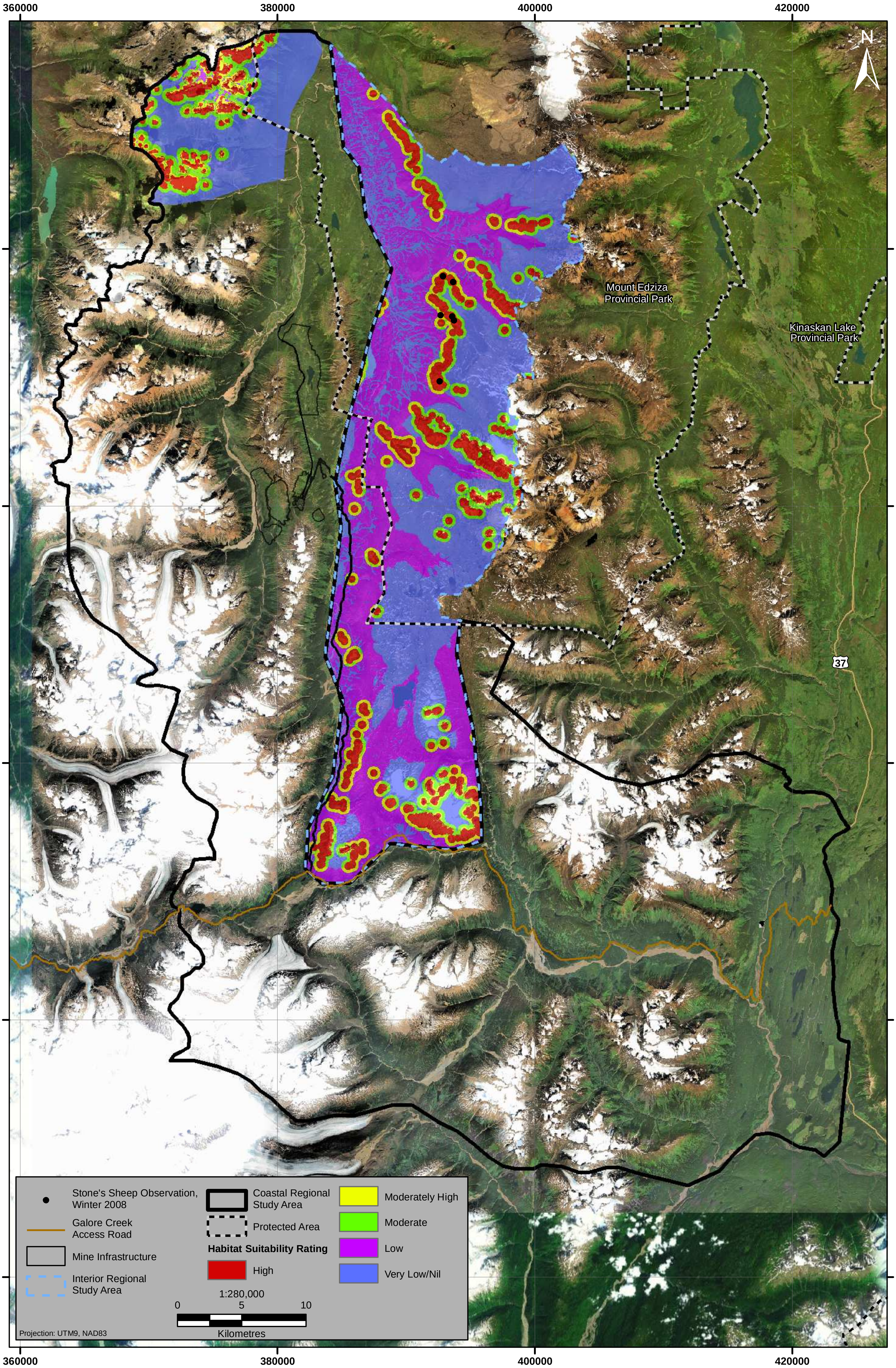


FIGURE 4.4-1

copper FOX metals inc.

Schaft Creek Project: Stone's Sheep Winter Habitat Suitability

RTEC Keepers of the Land

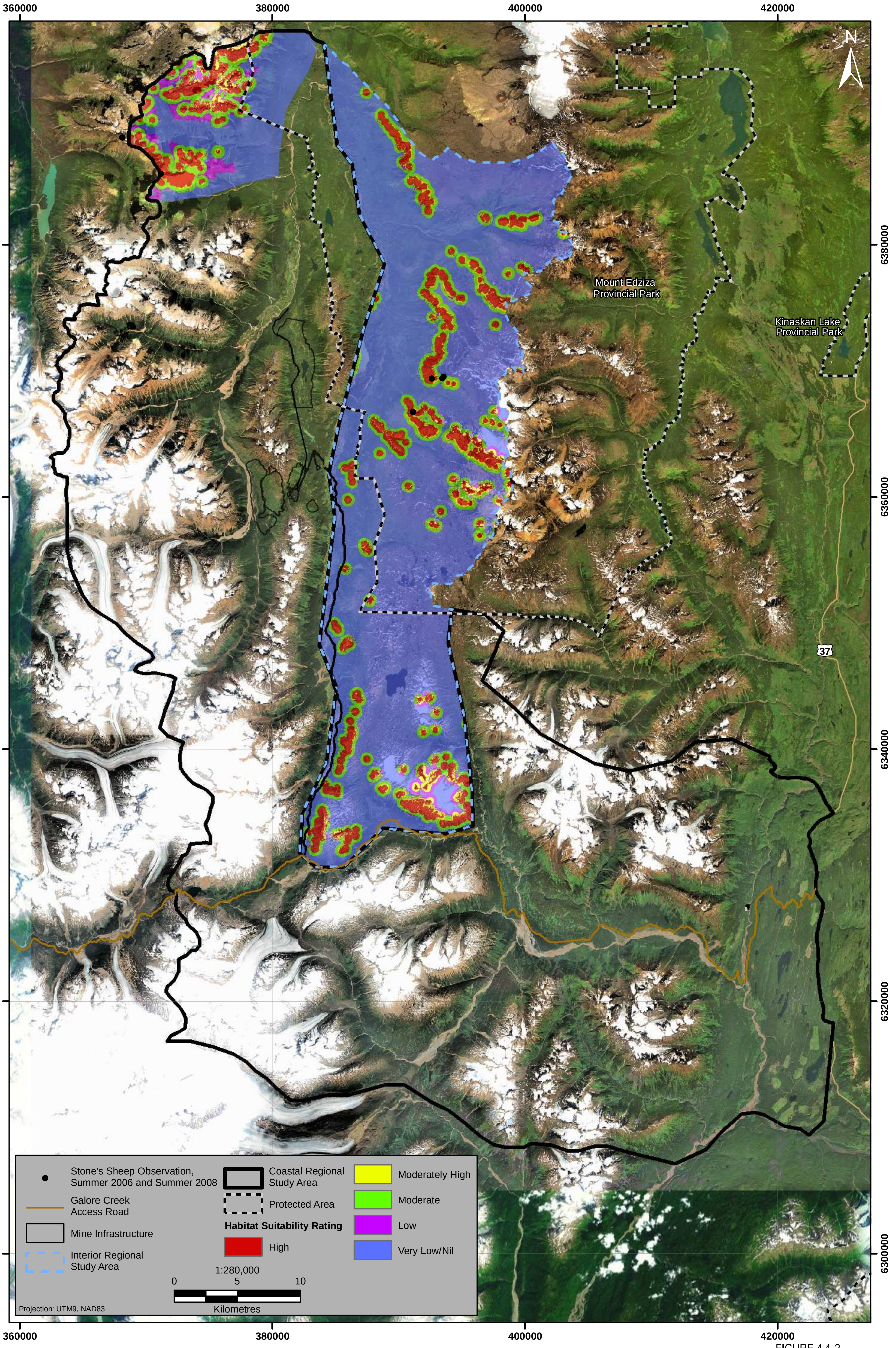


FIGURE 4.4-2

copper FOX metals inc.

Schaft Creek Project: Stone's Sheep Summer Habitat Suitability

RTEC Keepers of the Land

Northern caribou live in mountainous habitat and adjacent plateau areas that have relatively low snowpacks in the west-central and northern interior of BC. This species is characterized by shifts in elevation between and within summer and winter ranges, and some individuals also travel long distances between summer and winter ranges. A variety of habitat types are used during both the winter and summer, including low elevation forested habitat and high elevation alpine habitat (Cichowski, Kinley, and Churchill 2004). The Mount Edziza sub-population of northern caribou is the closest subpopulation to the RSA, inhabiting the park for the majority of the year. Prior to 2004, this sub-population was estimated at around 100 individuals (Cichowski, Kinley, and Churchill 2004). Aerial reconnaissance flights around Mount Edziza on March 30, 2006, counted approximately 151 caribou (Marshall 2006, *unpublished data*). Three individuals were observed within the eastern portion of the RSA during seasonal surveys in 2006 and 2008 (RTEC 2010c). Northern caribou habitat models focused on identifying suitable early and late winter habitats due to limiting resources during these periods.

4.5.2 Habitat Suitability Model Development

4.5.2.1 Model Rating Assumptions

The rating assumptions used for the identification of early and late winter caribou habitat are detailed in the species account (Appendix 4) and are generalized below.

Early winter habitat suitability ratings assigned to PEM ecosystem units were based on forage production. During early winter, caribou generally remain in forested areas with sufficient structure and canopy closure to provide cover from snow and adequate forage. The highest value early winter caribou habitat included dry pine forests that produce terrestrial lichen as well as spruce forest that provides cover from snow and produces arboreal lichens. For this reason, lower elevation BEC zones (i.e., BWBS) were rated high while the higher elevation zones (i.e., AT) were rated lower, as forested habitats at higher elevations do not provide enough structure for protection from snow.

During the late winter, it was assumed that caribou would shift to windswept subalpine or alpine habitats where terrestrial lichens may be available, and these habitats were given the highest habitat values. The Spatsizi herd of caribou, which occupy the Spatizi Plateau Wilderness Park to the east of the proposed Project, occurs at high elevations during the late winter where wind scouring provides greater access to terrestrial lichens than lower areas where the snowpack is deeper (Hatler 1986). Appropriate subalpine or alpine habitats were identified through the combination of terrain features (slope and elevation) (Section 4.5.4.4). Some habitats similar to that identified in the early winter model (forested habitats where terrestrial and arboreal lichens are available) were also assumed to have habitat value for the late winter model, provided that they occurred at higher elevations.

4.5.2.2 Methods

Modelling for winter caribou habitat was limited to the iRSA only, as no caribou were documented in the western portion of the RSA during surveys (RTEC 2010c). It was not known to what extent the model definitions could be extended to the rest of the RSA where caribou observations were lacking.

<u>Early Winter</u>

The early winter model relied on wildlife habitat ratings, as identified by the ecosystem mapping products, in order to determine habitat suitability. No topographic features were considered for the development of the early winter model.

Late Winter

A late winter model for the iRSA was developed based on the criteria used from caribou habitat modelling in the Kutcho and Turnagin Creek drainages, areas similar in topography to the iRSA. Scoring criteria were developed and refined based on professional expertise, review, and evaluation of unpublished ungulate models for multiple projects in the northwest area of the province. Habitat features, including slope, elevation, and vegetation potential (as identified by preliminary WHRs) were scored as described in Table 4.5-1 in a similar fashion to the other mountain ungulate species (mountain goat and Stone's sheep). The WHR value for the food rating of PEM ecosystem units is provided in Appendix 8. A final score was converted to a 6-class HSR scheme recognized by the province (RIC 1999a) (Table 4.5-2).

Table 4.5-1. Topographic and Vegetation Features for modelling Northern Caribou Late Winter Habitat in the iRSA

Model Features	Score	Data Source
Slope (°)		
15 - 33	1	DEM information and TRIM data
≤ 14	2	
34 - 45	2	
≥ 46	4	
Elevation (m)		
≥ 1,601	1	DEM information and TRIM data
1,200 - 1600	3	
≤ 1,199	100	
Vegetation		
WHR 1 or 2	1	Food rating assigned to PEM ecosystem units (Appendix 8)
WHR 3	2	
WHR 4, 5	5	
WHR 6	100	

Table 4.5-2. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Interior Northern Caribou Late Winter Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)	Percent of Provincial Best (RIC 1999)
3, 4	1	High	100 – 76
5 ,6	2	Moderately high	75 – 51
7, 8	3	Moderate	50 – 26
9, 10	4	Low	25 – 6
12	5	Very low	5 – 1
≥100	6	Nil	0

4.5.3 Model Analysis and Evaluation

Model results could not be evaluated with field ratings as there was as insufficient number of field plots located within the modelled area (i.e., iRSA).

4.5.4 Results

4.5.4.1 Early Winter Habitat

The results of habitat modelling for caribou in the early winter indicated that a quarter of the iRSA is Moderately High to Highly suitable habitat (Figure 4.5-1, Table 4.5-3). These higher rated habitats were sparsely distributed in forested habitats around Mess Lake and in areas just upslope of the lower Mess Creek drainage in the northern portion of the iRSA (Figure 4.5-1). Moderate rated habitats, accounting for 4% of the iRSA, generally covered the rest of the mature forested habitats located at lower elevations. The remaining habitat was rated as Low (7%), Very Low (55%) and Nil (19%). The majority of habitat falling in the lower suitability classes was found within the higher elevation subalpine and alpine areas, with the exception of some small patches of Low rated habitat located within lower elevation mature forests. These lower suitability patches are characterized by stunted Krummholz forests, early seral stage vegetation (e.g., shrubs and herbs), as well as rocky, barren areas, all of which were assumed to provide little forage value for caribou during the early winter.

Table 4.5-3. Area of Northern Caribou Early and Late Winter Habitat

	Early Winter		Late Winter	
Habitat Suitability Rating	Area (ha)	%*	Area (ha)	%*
High	1,206	2	16,373	23.1
Moderately High	8,905	13	21,319	30.0
Moderate	3,179	4	2,526	3.6
Low	5,201	7	5,140	7.2
Very Low	39,140	55	62	0.1
Nil	13,324	19	25,535	36.0

4.5.4.2 Late Winter Habitat

Over half of the iRSA (53%) was rated as Moderately High to Highly suitable habitat during the late winter (Figure 4.5-2). This was largely driven by the availability of gently rolling terrain with abundant early seral stage vegetation and/or sparsely vegetated habitats at higher elevations, areas which received the highest habitat scores in the late winter model. A small amount of Moderate rated habitat (4% of iRSA) was identified. The remaining habitat was rated as Low (7%), Very Low (0.1%) and Nil (36%). Moderate rated habitats were primarily small patches of habitat on slightly steeper gradients or those supporting more shrubby type vegetation. Low and Very Low rated habitats included some subalpine areas that are transitioning to forests that likely do not produce an abundance of either terrestrial or arboreal lichens. Nil habitats included all lower elevation forested habitats as well as areas of steep topography (> 46°).

4.5.5 Discussion

The results of habitat modelling for caribou were restricted to the gently sloping topography in the eastern portion of the study area (iRSA). Within the modelled area, there appears to be an abundance of Moderately High to Highly suitable late winter habitat (53.1% of iRSA) and a relatively small portion of higher rated early winter habitat (15% of iRSA). None of these higher suitability early and late winter habitats are located in the vicinity of proposed Project infrastructure. Generally, these habitats are located further to the north along Mess Creek below Mess Lake and within Mount Edziza Provincial Park (Figures 4.5-1 and 4.5-2).

The BC Ministry of Environment has identified some important habitat features for northern caribou. In general, large and contiguous patches of older growth forests are acknowledged as important for the local population of northern caribou (Cichowski, Kinley, and Churchill 2004; BC MSRM 2000). These forest types contain a plentiful supply of arboreal lichens that are eaten by caribou throughout the year in addition to satisfying security and thermal requirements. Older forests that have less shrubby undergrowth tend to have better visibility to detect predators and have a sufficient canopy closure for protection from the snow in the winter (Cichowski, Kinley, and Churchill 2004).

Habitat mapping conducted in the Cassiar Iskut-Stikine LRMP area identified high value habitat for caribou, used broadly as a representation of spring, summer, and winter habitat (BC MRSM 2000). The majority of Mount Edziza Provincial Park is identified as high value habitat for caribou, with the exception of the high elevation, barren volcanic plateaus (BC MSRM 2000). There were several areas identified as Moderately High to Highly suitable early and late winter habitat identified by suitability modelling that overlap with areas of high value habitat for caribou identified within the CIS LRMP, particularly those in the northeast portion of the iRSA (Figures 4.5-1 and 4.5-2; BC MSRM 2000). However, there were many areas in the iRSA identified as Moderately High to Highly suitable late winter habitat that were not considered as high value habitat in the CIS LRMP because their mapping product also encompassed spring and summer habitats (BC MRSM 2000).

4.6 GRIZZLY BEAR

4.6.1 Background

Grizzly bears were selected as a candidate species for habitat suitability mapping in the study area because of their conservation status, their social and economic importance, their important biological role within the ecosystem, and the fact that they are considered an umbrella species. Conservation of umbrella species, due to their large home ranges and habitat requirements, subsequently affords protection to other species with similar or smaller home ranges or life requisites (Roberge and Angelstam 2004). Grizzly bears are considered a species of special concern by COSEWIC and are blue-listed in BC (BC CDC 2010; COSEWIC 2002a). In addition, grizzly bears are an Identified Wildlife element under the Identified Wildlife Management Strategy (IWMS), meaning the species requires special conservation measures within the province. Grizzly bear populations are managed for harvest throughout BC and have significant social and economic value for First Nations, and resident and non-resident hunters.

4.6.2 Habitat Suitability Model Development

4.6.2.1 Model Rating Assumptions

<u>Overview</u>

The main consideration for assigning wildlife habitat ratings (WHRs) to PEM ecosystem units was the feeding potential of the site (i.e., the availability of vegetation forage, the value of that forage, and the biomass that could be produced). Wherever possible, seasonal forage preferences consistent with regional knowledge (MacHutchon and Mahon 2003) were incorporated into WHRs. It was assumed that preferred grizzly bear spring vegetation included abundant grasses, sedges and herbs. Preferred summer vegetation was dominated by early berry-producing shrubs (e.g., *vaccinium* spp, soopolalie) and late season herbs (e.g., fireweed, cow parsnip). Fall vegetation had substantial overlap with summer values, but also included later berry-producing shrubs (e.g., red osier dogwood, crowberry), persistent berries (e.g., high bush cranberry) or root and tuber producing species (e.g., arctic lupine).

gis no. SCH-23-030 Job No. 1039-001-07-04 October 13 2010

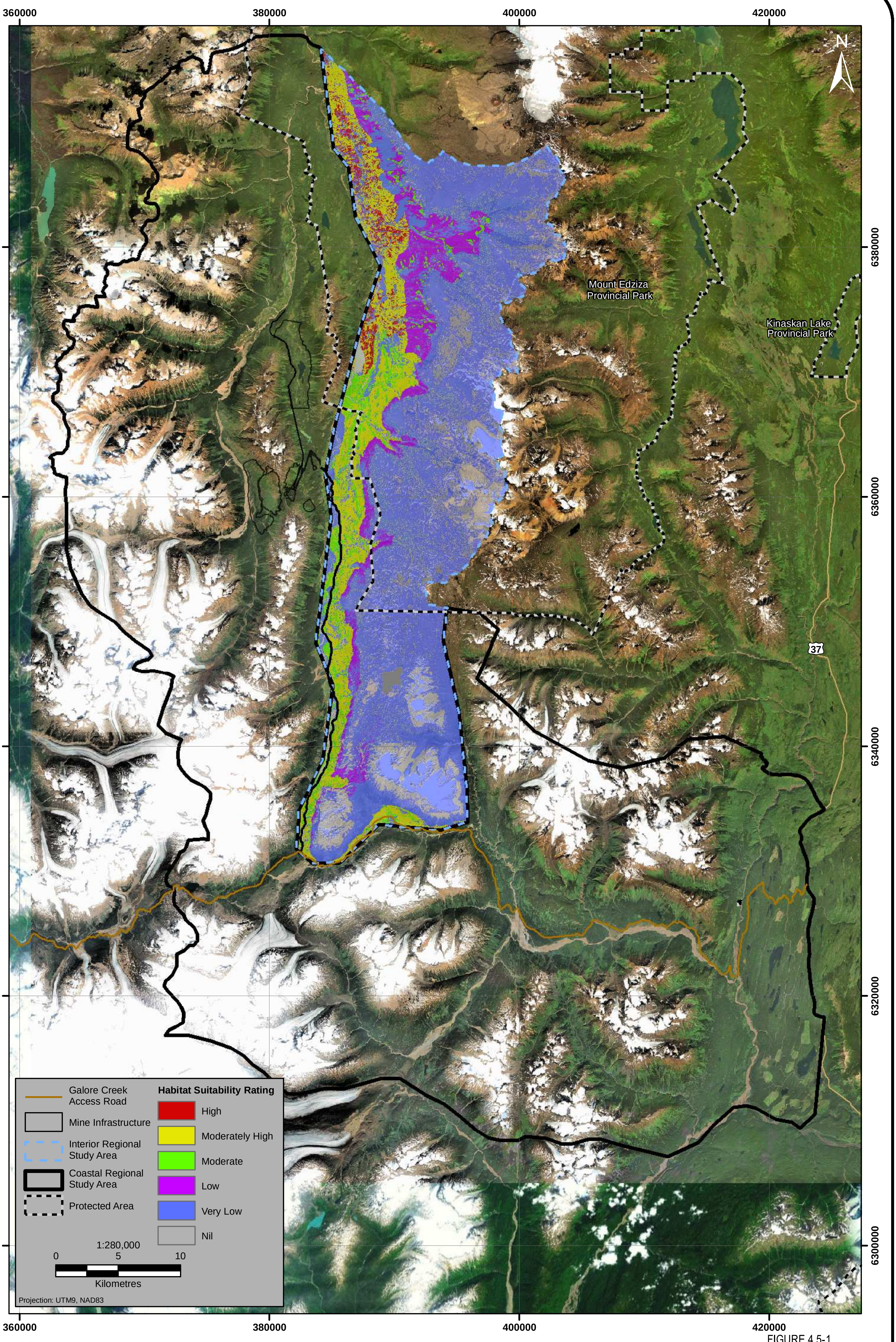


FIGURE 4.5-1

Schaft Creek Project: Northern Caribou Early Winter Habitat Suitability

copper FOX metals inc.

RTEC Keepers of the Land

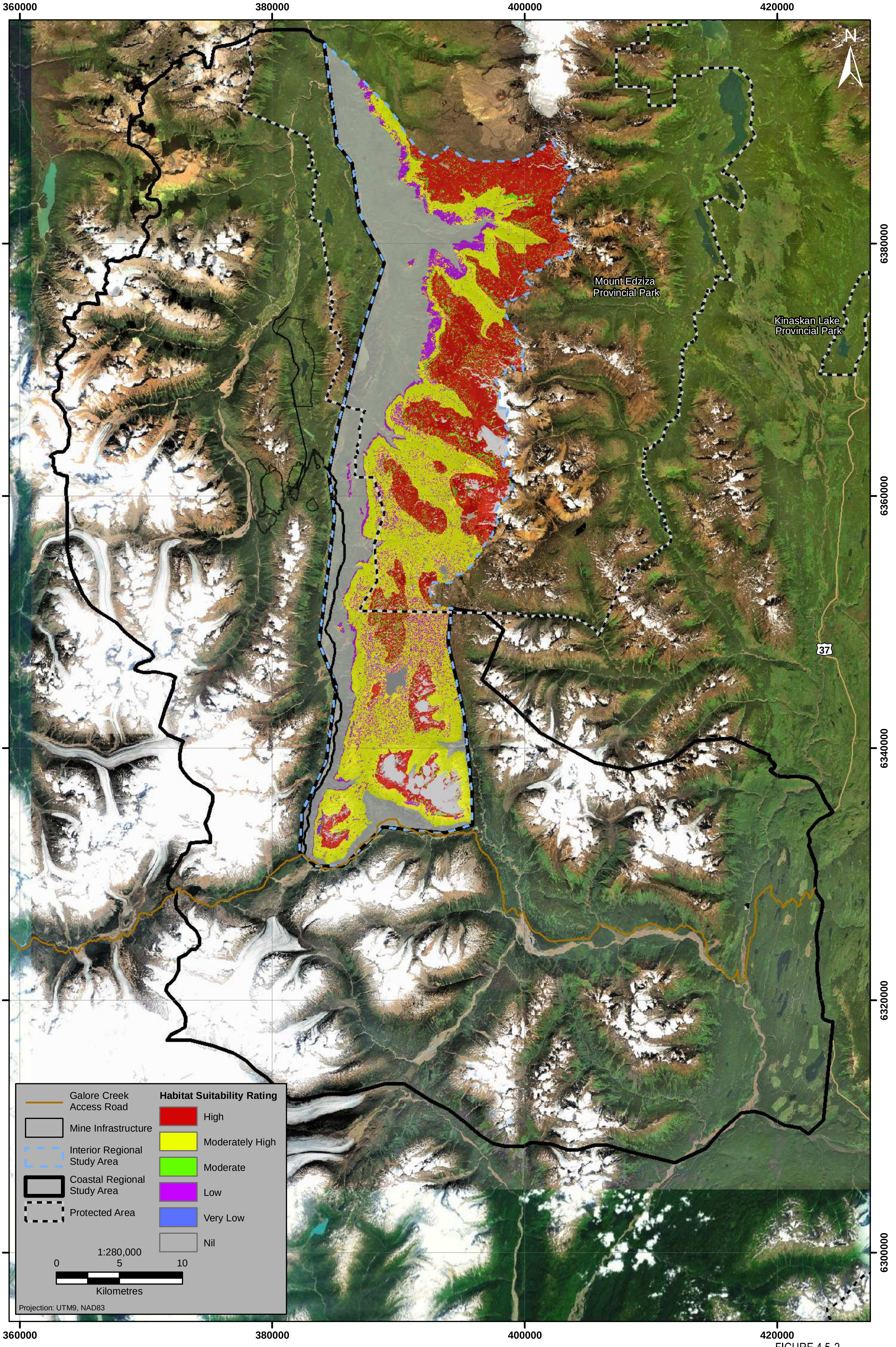


FIGURE 4.5-2

copper FOX metals inc.

Schaft Creek Project: Northern Caribou Late Winter Habitat Suitability

RTEC Keepers of the Land

Access to salmon prior to hibernation is extremely important to some bear populations (Demarchi and Johnson 2000), but no salmon spawning has been identified within the Schaft, Mess, and More Creek watersheds (RTEC 2005a, 2005b, 2008a, 2010d). Other sources of animal protein were considered (hoary marmot, described in Section 4.6.2.2). The assumptions used for the development of spring, summer, and fall habitat model ratings for grizzly bears are detailed in the species account (Appendix 5) and are generalized below.

Spring Model Assumptions

Grizzly bear assumptions for foraging habitat use in the spring were:

- High and Moderately High rated habitat included sites capable of producing an abundance of highly favoured plant forage including grasses and herbs. These habitats were typically associated with structural stage 2 (herb) and structural stage 3 (shrub) vegetation on nutrient rich and moist sites (e.g., wetlands, avalanche chutes) in all BEC zones. In addition, some open canopied mature (structural stage 6 and 7) forest capable of early berry production (e.g., crowberry) within the BWBS were rated as Moderately High.
- Moderate rated habitat included less productive sites of structural stage 2 and 3 vegetation, typically those on dry to mesic moisture regimes. Also, higher structural stage (5-7), open canopy forested areas across all BEC zones with potential for producing moderate amounts of herbs or shrub species such as devils club and willow were assigned a WHR of 3. These forests tended to be present in wetter areas. Rivers and associated riparian areas also received a Moderate rating.
- Low rated habitat included sites with intermediate stage wet forest (structural stage 4 or 5) or closed canopy mature forest with dry to mesic nutrient regimes, conditions which likely limit the plant growth on the forest floor. Some open canopy forests of structural stage 6 or 7 in the ESSF, ICH, BWBS, and SWB with poorly defined understorey herb and shrub layers (i.e., less productive sites on dry to mesic moisture regimes) were also rated as Low.
- Very Low and Nil value habitat included areas that were barren or could not support plant growth (e.g., glaciers, open water, roads), as well as intermediate closed canopy forests not otherwise rated as Low.

Summer Model Assumptions

Grizzly bear assumptions for foraging habitat use in the summer were:

- High and Moderately High rated habitat included sites capable of producing abundant *Vaccinium* species or other berries. These habitats were characterized as structural stage 2 and 3 vegetation on mesic to wet sites (e.g., wetlands, shrubby areas, and avalanche chutes) in all BEC zones as well as open canopied high structural stage forests in certain variants of the BWBS and ESSF.
- Moderate rated habitat included sedge wetlands and riparian areas where high protein herb vegetation would be abundant in early summer within suitable microsites. Areas where there is sparse cover of *Vaccinium* or other berry producing species also had moderate summer value, such as drier shrubby habitat in the ICH, BWBS, and ESSF zones, and open canopied forested areas of high structural stage (6 and 7) and wetter nutrient regimes within variants of all BEC zones.

- Low rated habitat included avalanche chutes that were dominated by alder and dry structural stage 2 vegetation, which do not produce suitable forage for grizzly bears, or were anticipated to have low protein value (e.g., dried grass) in summer. Forested areas with poor berry and herb production in the understory also received Low ratings. Examples of these types of habitat were drier, closed canopy mature forests in most BEC zones, and both open and closed canopy mature forests associated with the lower slope of mountains or toes of slopes, characterized as boggy or swampy areas with poorly drained soils.
- Very Low and Nil value habitat included areas with structural stage 4 and 5 forests with closed canopy not otherwise rated above and all barren and anthropogenic sites (e.g., glaciers, open water, roads).

<u>Fall Model Assumptions</u>

The plant species that have value to bears as fall forage occupied a wide range of moisture and nutrient site-regime combinations, making it somewhat difficult to generalize ratings.

- High and Moderately High rated habitat included areas that produce plant species of high fall forage value including shrubs that produce late season berries (e.g., high bush cranberry, *Vaccinium* spp, Soopolallie) or herbs that produce roots or tubers of value (e.g., Arctic lupine, cow parsnip). These habitats included open structural stage 2 and 3 vegetation on suitable sites and very open canopy mature forest upslope of valley bottoms.
- Moderate sites were those that could produce valuable fall plant forage, but did not have the potential to produce it in abundance, or could produce abundant forage of marginal value. This habitat included open-to-moderately closed canopy mature, old growth forests within all moisture regimes, and swamps.
- Low rated habitat included sites with intermediate forest or closed canopy mature forest that was likely to limit plant growth on the forest floor resulting in very little forage production. Rivers and adjacent riparian areas were also rated as Low. Dry herb vegetation and marshes also have limited forage production and had low summer value.
- Very Low and Nil value habitat included closed canopy intermediate and mature forests not rated above and areas that were barren or could not support plant growth (e.g., glaciers, open water, roads).

4.6.2.2 Methods

The grizzly bear seasonal habitat models relied on the results of ecosystem mapping and the vegetation potential identified in each ecosystem unit. The forage value was the principle factor in establishing the final HSR. Plant species assumed to be of greatest value to bears were identified by the list provided in MacHutchon and Mahon (2003). Appendix 8 includes the WHRs provided for PEM ecosystem units available in the study area, which also represent the final HSRs.

Furthermore, researchers have identified hoary marmots, and the sympatric Arctic ground squirrel, as a common summer food item for bears dwelling in the alpine (MacHutchon, Himmer, and Bryden 1993; Gyug, Hamilton, Austin 2004). Therefore, a qualitative comparison is presented of highly to moderately suitable summer habitat for grizzly bears with that of marmot in Section 4.6.3.2 (refer to Section 4.8 for modelling details for hoary marmots). It was assumed that areas of highly to moderately suitable hoary marmot habitat would support healthy marmot populations that would be available for alpine-dwelling grizzly bears to prey on.

4.6.3 Model Analysis and Evaluation

Field ratings were compared to theoretical model ratings for evaluative purposes (Section 3.5.5). The resulting habitat models were equal to field ratings or came within one rating class of field ratings 71% of the time for the spring model (N=244), 75% of the time for the summer model (N=247), and 67% of the time for the fall model (N=242).

The comparisons indicate that the spring and summer models are robust enough in predicting habitat values for grizzly bears during those seasons, while the fall model fell below the 70% benchmark identified in Section 3.1.4. However, the fall season tends to be one of the more difficult seasonal habitats to rate for vegetation, so this model was considered adequate.

4.6.4 Results

4.6.4.1 Spring Habitat

A total of 19% of the RSA is identified as Moderately High to Highly suitable spring habitat for grizzly bears (Figure 4.6-1; Table 4.6-1). These areas are found in a large portion of the eastern RSA within Mount Edziza Provincial Park, primarily mid to higher elevations on south and west facing slopes. Here grizzly bears may find early seral stage vegetation and also dig out roots and tubers of plants from previous years. Several larger wetlands along Schaft and More creeks and particularly Mess Creek were rated as High and Moderately High. Open avalanche chutes across the entire RSA where abundant lush vegetation is available were also rated as High and Moderately High. Moderate rated habitats accounted for a quarter of the RSA and were distributed across riparian habitats along Schaft, Hickman, and More creeks, as well as some drier habitats within the SWB that could produce early spring vegetation (e.g., devil's club). The lower habitat rating classes (Low [14% of RSA] and Nil [43%]) accounted for over 57% of the RSA.

Table 4.6-1. Area of Grizzly Bear Habitat by Season

	Spring		Summer		Fall	
Habitat Suitability Rating	**Area (ha)**	**%***	**Area (ha)**	**%***	**Area (ha)**	**%***
High	41,842	13	447	0.1	53,127	17
Moderately High	17,255	6	62,454	20.0	27,732	9
Moderate	77,688	25	100,986	32.3	79,586	25
Low	42,407	14	15,304	4.9	18,747	6
Very Low	0	-	74,004	23.7	74,004	24
Nil	133,357	43	59,353	19.0	59,353	19

** Percent of Habitat per Total Regional Study Area*

4.6.4.2 Summer Habitat

In comparison to the spring, a similar percentage (20.1%) of the RSA was identified as Moderately High to Highly suitable summer habitat for grizzly bears, although only a very small proportion (0.1%) was identified as Highly suitable (Figure 4.6-2; Table 4.6-1). Highly suitable habitat only occurred in small patches in the south portion of the RSA on the height of land between the More and Mess Creek drainages (Figure 4.6-2). These were identified as the areas with the best potential to support abundant summer berries (*Vaccinium* spp.). Moderately High habitats were more broadly distributed across the RSA, especially across the mid and higher elevation habitat within Mount Edziza Provincial Park. The large wetland along Mess Creek to the east of the proposed mine site was also rated Moderately High. A total of 32.3% of the RSA was rated as Moderate, primarily located in the northern RSA within the BWBS and SWB BEC zones. Approximately 47% of the RSA fell in the lower suitability classes [Low (4.9%), Very Low (23.7%), and Nil (19%)].

The results of habitat suitability modelling for hoary marmot (Section 4.8.3) were compared to results of the summer grizzly bear model. There is a small portion of habitat on the south facing slopes of Mount LaCasse that were rated High and Moderate for marmot that overlapped with Moderately High summer habitat for bears. Therefore, the overall forage potential of these areas could be increased by the presence of hoary marmot colonies.

4.6.4.3 Fall Habitat

Approximately 26% of the RSA was identified as Moderately High to Highly suitable fall habitat for grizzly bears (Figure 4.6-3; Table 4.6-1). Many of the areas identified as Moderately High to Highly suitable habitat in previous seasonal models were rated similarly for the fall, particularly the eastern portion of the RSA (i.e., mid and higher elevation habitat within and surrounding Mount Edziza Provincial Park). In addition, higher suitability habitats were also concentrated in subalpine and alpine habitat around Mount LaCasse and within river valleys to the west (e.g., Schaft and Hickman Creek). Many of the mid elevation habitats along the lower More Creek drainage were also rated Moderately High to High (Figure 4.6-3). Moderate rated habitats, totalling 25% of the RSA, were located in the northern RSA in the SWB and BWBS BEC, as well as dispersed along More Creek drainage in the south. The remaining 49% of the RSA was rated Low (6% of RSA), Very Low (24%) and Nil (19%).

4.6.5 Discussion

The RSA supports between 20 and 26% of Moderately High to Highly suitable feeding habitat for grizzly bears during the growing season (i.e., spring., summer, and fall) (Table 4.4-1). The combination of wetlands, riparian habitat, numerous avalanche chutes, and other higher elevation sites supporting herbs and shrubs of early seral stage, provide abundant forage for bears during all seasons. Areas of higher suitability (High and Moderately High rated habitat) in relation to the Project included the large wetland complex associated with Mess Creek along the proposed access road west of the proposed mine site (which was rated Moderately High in the spring and summer) and the slopes of Mount LaCasse within and above the proposed Schaft Pit and Waste Rock Dump areas (which rated Moderately High to High in the spring, summer, and fall).

Overall, a large amount of Moderately High to Highly suitable habitat was located in mid to high elevation habitat within and surrounding Mount Edziza Provincial Park through all seasons (Figures 4.6-1 to 4.6-3). This large and expansive area was identified as primarily grass, herb, and shrub dominated habitats across a variety of nutrient and moisture regimes (RTEC 2010f). As a result, this habitat may provide bears with a variety of different types of forage throughout the growing season, such as early berries (crowberries) during the spring, lush herbs such as indian hellebore (*Veratrum viride*), arctic lupine (*Lupinus arcticus*), and cow parsnip (*Heracleum maximum*) in the summer, and a variety of herbs, shrubs, and rooted forage in the fall. In addition, the south facing slopes of Mount LaCasse just above the proposed Schaft Pit were rated Highly suitable and Moderately suitable hoary marmot growing habitat (Section 4.8.3.1), representing an area where grizzly bears may supplement their vegetation diet with animal protein.

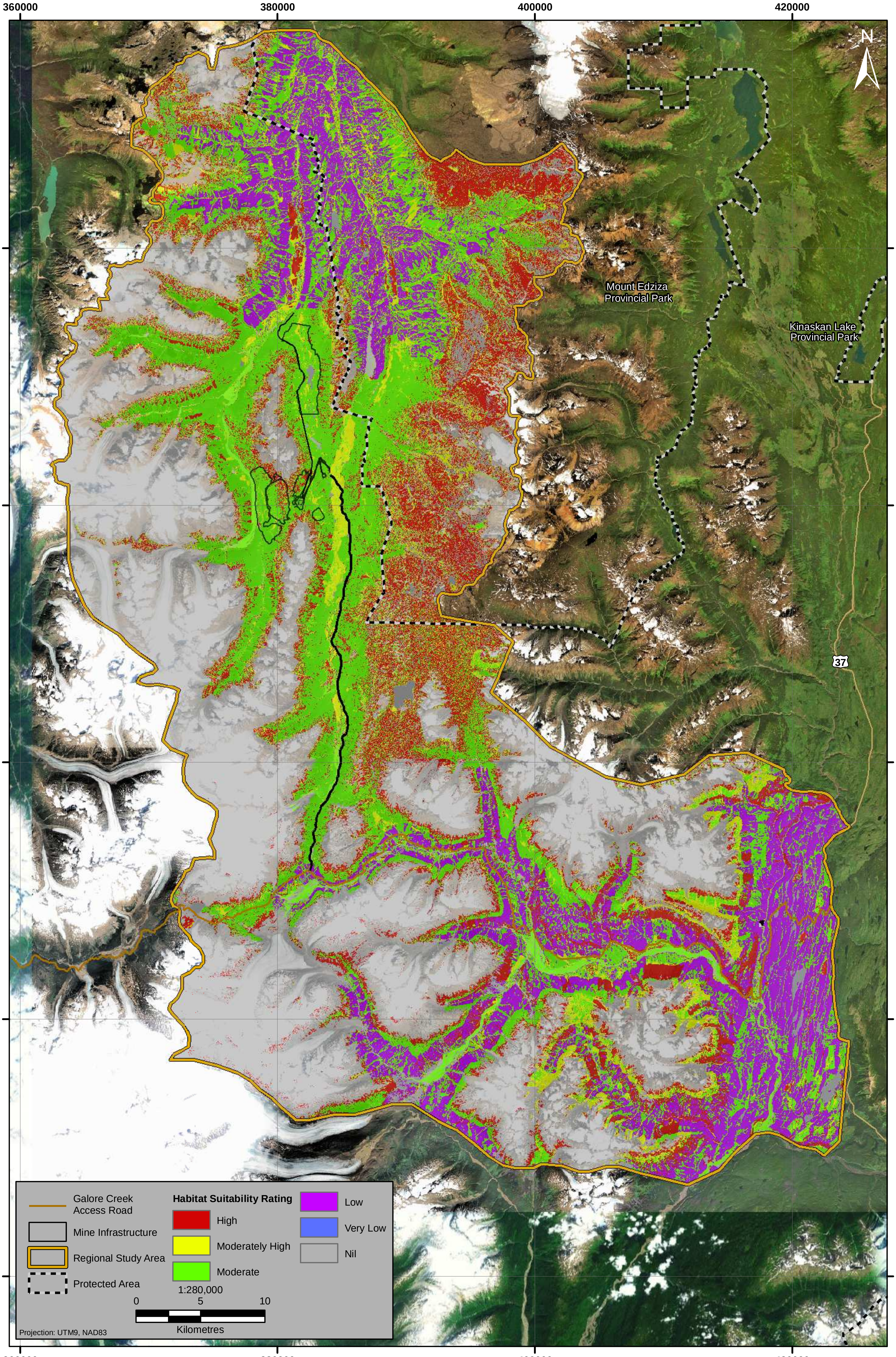


FIGURE 4.6-1

copper FOX metals inc.

Schaft Creek Project: Grizzly Bear Spring Habitat Suitability

RTEC Keepers of the Land

gis no. SCH-23-033 Job No. 1039-001-07-04 October 13 2010

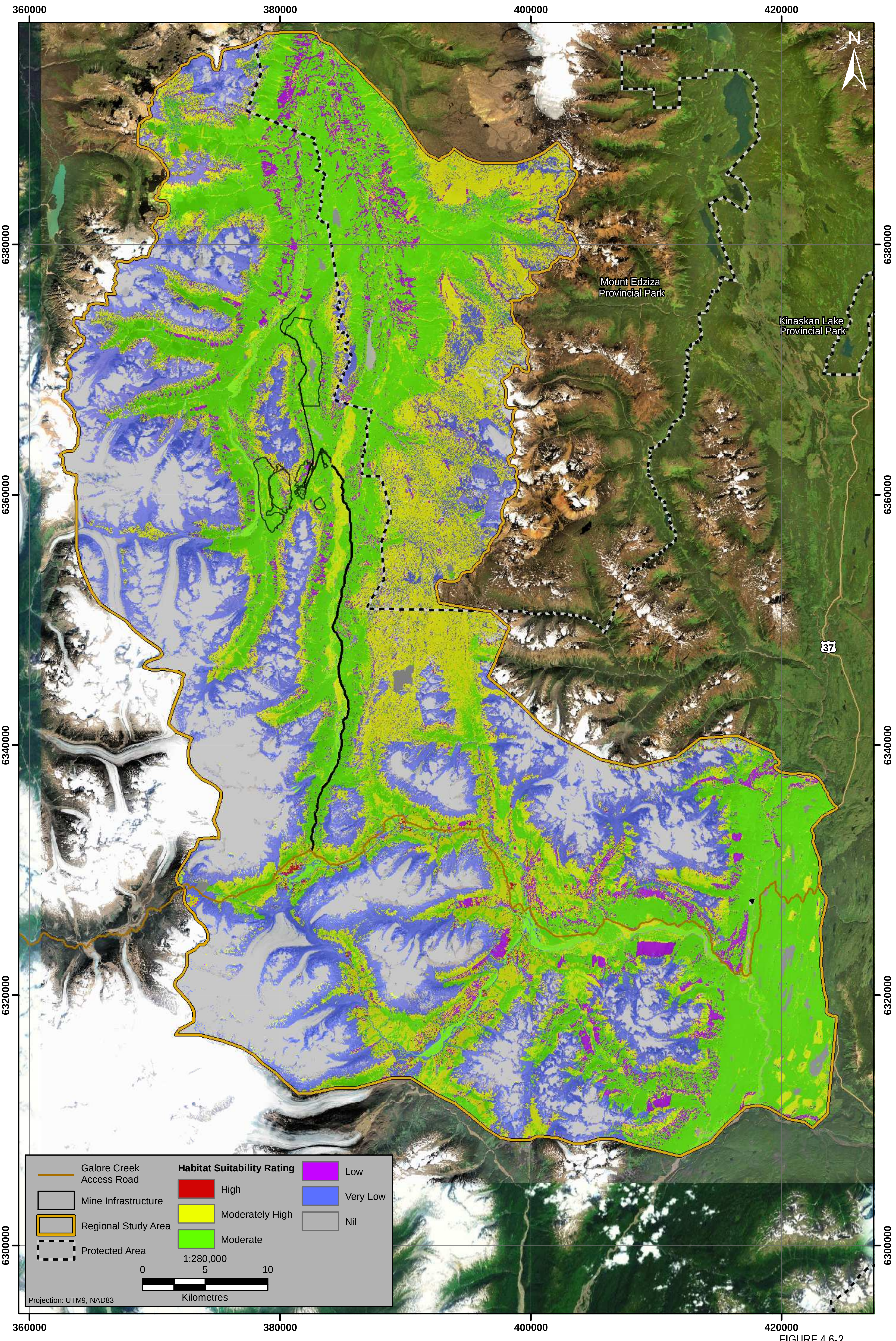


FIGURE 4.6-2

copper FOX metals inc.

Schaft Creek Project: Grizzly Bear Summer Habitat Suitability

RTEC

gis no. SCH-23-034 Job No. 1039-001-07-04 October 13 2010

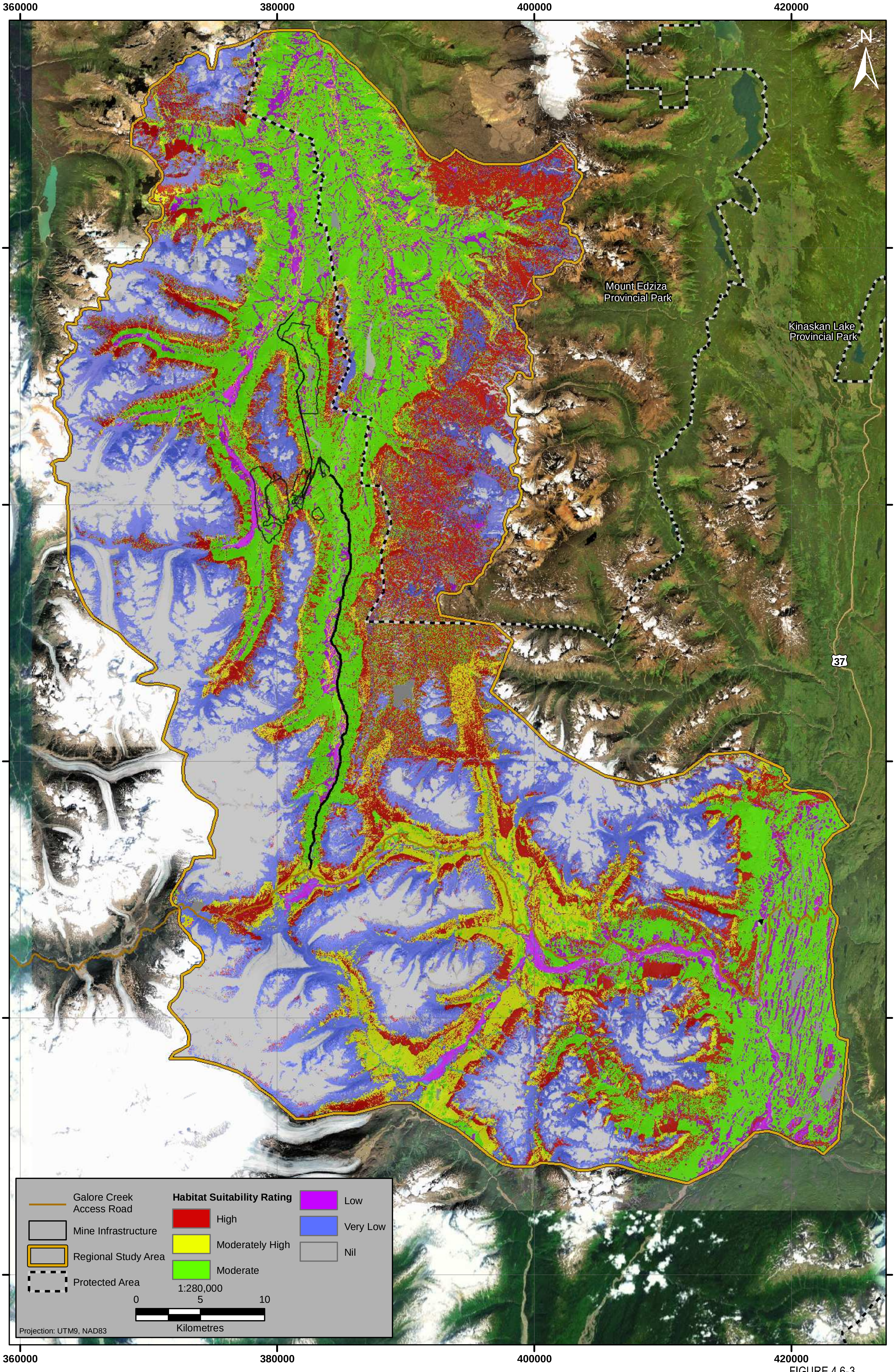


FIGURE 4.6-3

copper FOX metals inc.

Schaft Creek Project: Grizzly Bear Fall Habitat Suitability

RTEC Keepers of the Land

High value habitats for grizzly bears have been identified by the Cassiar Iskut-Stikine LRMP (BC MRSM 2000). These areas provide important habitat for the local grizzly bear population across one or more seasons (e.g., avalanche chutes, sedge fens, high berry producing sites). Similar areas identified as high value grizzly habitat in the Cassiar Iskut-Stikine LRMP were rated as Moderately High to Highly suitable habitat in this report. During the spring season, the areas with the greatest amount of overlap between Moderately High to Highly suitable habitat and high value grizzly habitat identified in the CIS LRMP occurred along the More Creek watershed from Bob Quinn, higher elevation habitat around Mount LaCasse above the proposed Schaft Pit and Waste Rock Dump areas, and the upslope area to the west and east of Schaft Creek north of the proposed mine infrastructure (Figure 4.6-1; BC MRSM 2000). In the summer, overlap areas were mainly limited to the headwaters of More Creek leading to Bob Quinn (Figure 4.6-2; BC MRSM 2000). During the fall, the overlap areas were generally similar to those identified during the spring (Figure 4.6-3; BC MRSM 2000). These overlapping areas, such as those along the More Creek watershed, are indicative of important habitat for the local population of grizzly bears.

4.7 MARTEN

4.7.1 Background

Furbearers, especially marten, are important economic and cultural resources within the Project area. BC MOE harvest data collected between 1985 and 2003 shows that marten represented 58% of the total number of animals harvested in the Skeena Region (BC Stats 2005). Within the study area, marten accounted for 80% of the registered harvest from 1985 to 2007 (Table 4.7-1). Although marten are abundant across most of the province and are not subject to any provincial or federal conservation concern, initiatives within the CIS LRMP have emphasized provisions for managing furbearer populations as a sustainable resource (BC MSRM 2000). Considering their regional economic importance, marten were selected as a candidate species for habitat suitability mapping.

Table 4.7-1. Registered Harvest of Furbearer Species in Identified Trapline Tenures in the RSA

Species	Scientific Name	Total Harvest (1985–2007)
American Marten	*Martes americana*	5,425
Black Bear	*Ursus americanus*	32
Beaver	*Castor canadensis*	270
Coyote	*Canis latrans*	11
Fisher	*Martes pennanti*	45
Lynx	*Lynx canadensis*	239
Mink	*Neovision vison*	140
Muskrat	*Ondatra zibethicus*	12
Red Fox	*Vulpes vulpes*	63
River Otter	*Lontra canadensis*	1
Red squirrel	*Tamiasciurus hudsonicus*	235
Short-tailed Weasel (Ermine)	*Mustela erminea*	122
Wolf	*Canis lupus*	39
Wolverine	*Gulo gulo*	145
Total		**6,779**

Winter is considered the most limiting time for marten and protecting their winter habitat is an area of focus for fur harvesters. Therefore, habitat suitability modelling focused on identifying suitable winter habitat for marten. The presence of coarse woody debris (CWD), snags, rootballs or other structures that provide access underneath the snow (i.e., subnivean) has been identified as an important component of winter habitat for marten (Steventon and Major 1982; Buskirk et al. 1989; Takats et al. 1999; Lofroth and Steventon 1990; Sherburne and Bissonette 1994). Areas with abundant CWD provide subnivean spaces and habitat for their prey and thus are high-quality hunting grounds for marten (Buskirk and Powell 1994; Sherburne and Bissonette 1994). Subnivean spaces are not only used for hunting, but also for resting during harsh winter conditions (Wilbert, Buskirk, and Gerow 2000). In addition to coarse woody debris, canopy cover for snow interception is an important habitat feature for marten during winter (Koehler and Hornocker 1977). Canopy cover prevents excessive snow buildup in the understory, and allows continued subnivean access throughout the winter.

4.7.2 Habitat Suitability Model Development

4.7.2.1 Model Rating Assumptions

Mature and structurally diverse conifer forests (e.g., structural stage 6 and 7 forests with large diameter trees and interlocking canopies) are a main feature of winter habitat for marten (Appendix 6). Habitat values are further enhanced by the presence of coarse woody debris, which provides both cover for small mammals and access points for marten to seek out prey under the snow. The generalized assumptions for development of the habitat suitability map were as follows:

- High (H) rated habitat included closed canopy Structural Stage 6 and 7 conifer forest on mesic to moist sites within lower elevation BEC zones (ICH, ESSF, and BWBS);
- Moderate (M) rated habitat included wetter open canopied Structural Stage 6 and 7 forests present at lower elevations, as well as some dry open and closed canopy forests in the ICH, ESSF, and BWBS. Structural stage 4 and 5 conifer dominated, closed canopy forests on mesic to moist sites were also rated Moderate.
- Low (L) rated habitat included all forests in parkland variants of the ESSF, very wet mature forests within the BWBS; and all mature forest of open and closed canopy in the SWB;
- Nil (N) rated habitats included the remaining vegetation and areas of early seral stage vegetation (structural sage 2 and 3) (e.g., barren areas, lakes, wetlands, rivers).

4.7.2.2 Methods

The preliminary WHRs developed from the model assumptions represent the final HSRs for ecosystem types present in the study area using a four-class system. These habitat ratings are provided in Appendix 8 (WHRs) and final HSRs are summarized in Appendix 9.

All forests were classified as mature/old growth in the PEM so closed canopy forests could not be reliably distinguished from open canopy forests (Section 3.1.2). Based on the precautionary principle, a higher habitat rating was assigned when PEM ecosystem units could have more than one rating based on structural stage and canopy closure.

4.7.3 Model Analysis and Evaluation

Model assumptions were verified by comparing field ratings to theoretical model ratings. The final winter habitat model was either equal to field ratings or came within one rating class of field ratings 80% of the time (N=152). Therefore, the model was deemed appropriate to predict habitat value for marten.

4.7.4 Results

Functional marten habitat, represented as High and Moderate rated habitat, occupies nearly a quarter of the RSA and is widely distributed throughout lower elevation forested habitats (Figure 4.7-1). Of the top two ratings classes, proportionately more habitat was rated as High than Moderate (Table 4.7-2). Much of the High rated habitat forms large continuous patches, especially in mature forests along the upper Schaft and Mess Creek watersheds (Figure 4.7-1). Moderate rated habitats, generally pockets of forests located on drier moisture regimes, were primarily very small habitat patches surrounded by High rated habitat in the northern portion of the RSA within the BWBS and the southeastern portion of the RSA along the More Creek (Figure 4.7-1). The remaining three quarters of the RSA fell within the lower two rating classes, classified as Low (8% of RSA) and Nil (68%). Low rated habitat included all forested habitats upslope of more suitable habitat (High and Moderate), while Nil habitat constituted all the higher elevation alpine areas dominated by herb, shrub, and sparsely vegetated habitats that do not provide any cover for marten during the winter.

Table 4.7-2. Area of Marten Habitat – Winter

Habitat Suitability Rating	Area (ha)	%*
High	56,277	18
Moderate	18,258	6
Low	24,841	8
Nil	*213,172*	68

** Percent of Habitat in the RSA*

4.7.5 Discussion

The majority of the forested habitat within the RSA is Highly suitable winter habitat for marten (Figure 4.7-1). Not only is this High rated habitat found within the entire study area, large continuous blocks of High rated habitat can be found (Figures 4.7-1), particularly along the Schaft and Mess Creek drainages. In relation to the Project, High rated habitats are present along the proposed access road along Mess Creek and within and surrounding the proposed Skeeter Tailings Storage Facility, Schaft Pit, and Waste Rock Dumps (Figure 4.7-1).

Although marten are often associated with late successional, coniferous forests throughout most of their range (Payer and Harrison 2003), recent studies suggest that other forest types at younger age classes may also be suitable habitat for marten (Poole et al. 2004). Specifically, younger forests which are structurally capable of providing cover for prey habitat, protective thermal microenvironments, and protection from predators have been found to provide suitable life requisites for marten (Poole et al. 2004). Thus, areas that were rated as Moderately suitable, which include younger forest types, may also provide winter life requisites for marten.

High value habitat for marten has been identified within the Cassiar Iskut-Stikine LRMP (BC MRSM 2000). High value habitat were identified as areas with the potential to provide abundant forage vegetation and small mammal prey populations, as well as areas with subnivean access during winter (BC MRSM 2000). A large area along the lower Schaft and Mess Creeks draining northwards into the Stikine River basin was identified as high value marten habitat in the CIS LRMP (BC MSRM 2000). A portion of this high value habitat overlaps the extreme northern portion of the RSA. Pockets of Highly and Moderately suitable winter habitat identified in the current report overlap with the high value habitat identified in the CIS LRMP, confirming the importance of this area for marten (Figure 4.7-1; BC MSRM 2000).

4.8 HOARY MARMOT

4.8.1 Background

Hoary marmots were selected as a species for habitat modelling because of their cultural significance to the Tahltan and importance as a prey species for carnivores such as grizzly bears and golden eagles. The hoary marmot is a relatively sedentary species, generally living in family colonies consisting of several burrows in mountainous alpine and subalpine habitats (Nagorsen 2005). Hoary marmots hibernate in their burrows for up to eight months and are generally active through the months of April to late August, depending on latitude (RIC 1998b). Modelling focused on identifying suitable growing season habitat (combined spring, summer, and fall habitat) since marmots are only active during snow-free months.

4.8.2 Habitat Suitability Model Development

4.8.2.1 Model Assumptions

For the marmot model, preliminary WHRs were not assigned to PEM ecosystem units, as identical ecosystem units present on different soils, aspects, or slopes may differ in overall habitat value for marmots. For example, as marmots are a burrowing species, they require habitat with appropriate underlying soil structure both to facilitate burrowing and also uphold the structural integrity of burrows over time (Amitage 2000). Aspect and slope also influence duration of annual snowpack in the alpine, which in turn influences not only plant composition and cover but also the length of time marmots have to acquire nutrient resources during the growing season. To account for all of these differences, a growing habitat model was developed using multiple inputs (e.g., digital topographic data and ecosystem and soils mapping products [RTEC 2010e, 2010f]), which were then combined to assign the final HSR to PEM ecosystem units.

Species biology and information on habitat selection used for the identification of suitable hoary marmot growing habitat are detailed in the species account (Appendix 7). It was assumed that only a few types of soils had the appropriate structure for burrows, primarily those with morainal or colluvial surficial materials. For habitat present on morainal or colluvial soils, the highest ratings were assigned to those that could produce an abundance of highly favoured plant forage including grasses and herbs (structural stage 2 or less) across all dry to mesic moisture regimes. Preference was also given for warmer aspects and relatively gentle topography, as these areas may be snow-free for the longest periods during the growing season. Areas of relatively flat and steep topography, as well as those supporting mixed herb and shrub vegetation on appropriate soil types received Moderate and Low habitat ratings. All habitat that did not have the appropriate soil structure for supporting marmot burrows automatically received a Nil habitat rating for marmots. In addition, since marmots generally live in open alpine areas, forested areas of Structural Stage 4 or greater were assumed to have no habitat value for marmots.

4.8.2.2 Methods

A growing habitat model included areas with appropriate soil structure and topography to support marmot burrows (soil surficial material, slope, and aspect) in addition to areas that would support preferred forage for marmots (PEM Site Series and Structural Stage; Table 4.8-1). High and Low rated habitats included a very narrow range of soil, topographic, and vegetation features, while Moderate rated habitats included several combinations of features (Table 4.8-1).

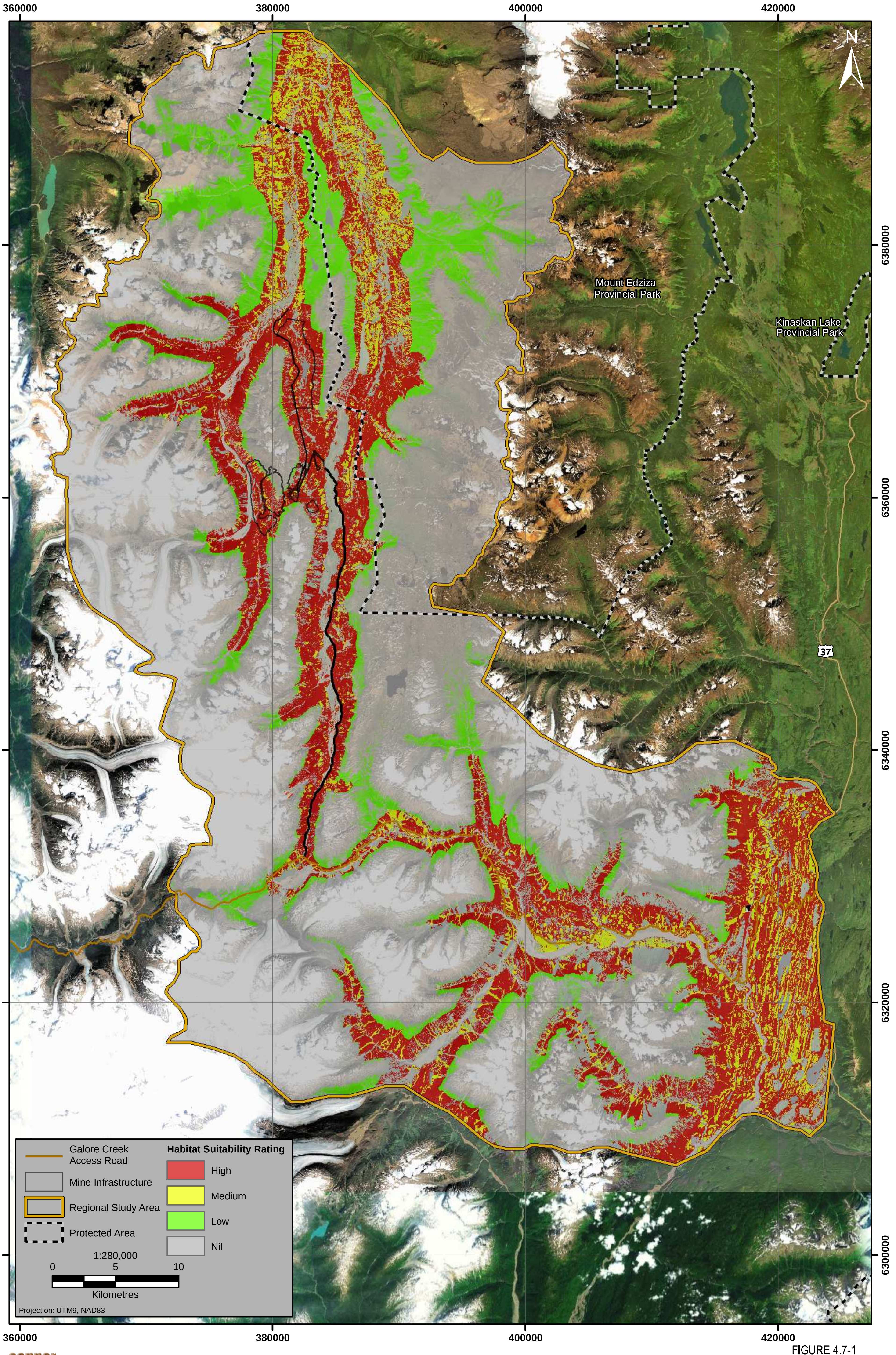


FIGURE 4.7-1

copper FOX metals inc.

Schaft Creek Project: American Marten Winter Habitat Suitability

RTEC Keepers of the Land

Table 4.8-1. Soil, Topographic, and Vegetation Features for Modelling Hoary Marmot Growing Habitat

HSR	Soil and Topographic Features			Vegetation Features	
	Soil Surficial Material[1]	Slope (%)[2]	Aspect (°)[2]	PEM Site Series[3]	Structural Stage[3]
H	Morainal/ Colluvial	25-60	Warm (67.5 – 292.5)	Herbaceous Meadow (AM), Barren (BA), Dry Herb (DH), Escape Terrain (ET), Herb-dominated Avalanche Track on moderate slopes (GTm)	≤ 2
M	Morainal/ Colluvial	≤ 24	Warm (67.5 – 292.5)	All site series identified above in HSR H	≤ 2
	Morainal/ Colluvial	61 - 90	Warm (67.5 – 292.5)	All site series identified above in HSR H	≤ 2
	Morainal/ Colluvial	≤ 60	Cool (292.5 -67.5)	All site series identified above in HSR H	≤ 2
	Morainal/ Colluvial	≤ 60	all	Herb-dominated Avalanche Track on steep slopes (GTs), Wetter Herb (VW), Dwarf Vegetation (DV), Dry Shrub(DS), Krummholtz (KH), Mesic Shrub (VF), Wetter Shrub (VS), Shrub-dominated Avalanche Track on moderate slopes (AVm), Shrub-dominated Avalanche Track on steep slopes (AVs), Tree Island (TI)	≤ 3
	Morainal/ Colluvial	61 - 90	Cool (292.5 -67.5)	All site series identified above and in HSR H	≤ 3
L	Morainal/ Colluvial	≥ 90	all	All site series identified HSR H and M	≤ 3
N	All areas that do not meet the soil, topographic, and vegetation criteria listed above				

Sources: [1] Terrain and Soils Mapping (RTEC 2010e), [2] Digital Elevation Model (DEM) information and 1:20,000 Terrain Resource Information Management (TRIM) data, [3] Predicitive Ecosystem Mapping (PEM) (RTEC 2010f)

The hoary marmot model was restricted to the local study area (17,018 ha), as soil surficial material information was only available for this area. A small portion of habitat outside of the LSA boundary, totalling approximately 2,026 ha, also had soils information and was included in the hoary marmot model. The total modelled area was 19,044 ha.

4.8.3 Model Analysis and Evaluation

Model assumptions were verified by comparing field ratings to theoretical model ratings. Field ratings for hoary marmot were only collected during 2007 and few field plots were located within the modelled area. The final growing habitat model was either equal to field ratings or came within one rating class of field ratings 89% of the time (N=27). Thus, the model was deemed robust in predicting habitat values for marmots.

4.8.4 Results

The results of the habitat suitability modelling indicated that less than 10% of the LSA (and the additional mapped area outside LSA boundary) is Highly suitable and Moderately suitable growing season habitat for marmots (Figure 4.8-1; Table 4.8-2).

Table 4.8-2. Area of Marmot Habitat – Growing

Habitat Suitability Rating	Area (ha)	%*
High	302	1.6
Moderate	1,526	8.0
Low	27	0.1
Nil	*17,189*	90.3

** Percent of Habitat in the Local Study Area including additional mapped areas outside LSA boundary*

Higher suitability habitats (High and Moderate) were located for the most part on Mount LaCasse, particularly on the south and west facing slopes around the proposed Schaft Pit and Waste Rock Dumps and on several high elevation slopes to the west of the proposed Skeeter Tailings Storage Facility (Figure 4.8-1). The remainder of the LSA was rated in the lower suitability classes (Low and Nil), which for the most part was Nil habitat (90.3%) because the majority of the LSA occupies lower elevation forested habitat along the Schaft and Mess Creek valleys.

4.8.5 Discussion

There were few areas within the LSA that were identified as functional growing season habitat for hoary marmots (Figure 4.8-1; Table 4.8-2). Less than 10% of the modelled area was rated as Highly and Moderately suitable habitat. On a whole, the higher suitability (High and Moderate) habitat was located in alpine habitats on Mount LaCasse, which in relation to proposed infrastructure, overlapped with some of the proposed Schaft Pit and west Waste Rock Dump.

Habitat mapping for hoary marmots in northern BC is relatively new, so there is no regional information within the CIS LRMP or other academic literature that allows for a qualitative comparison of the current model to identify areas of importance. It should also be noted that areas within the larger RSA likely contain high quality habitats for hoary marmots, but these areas could not be identified in the current report as soils information was not available outside of the LSA.

gis no. SCH-23-036 Job No. 1039-001-07-04 April 9, 2010

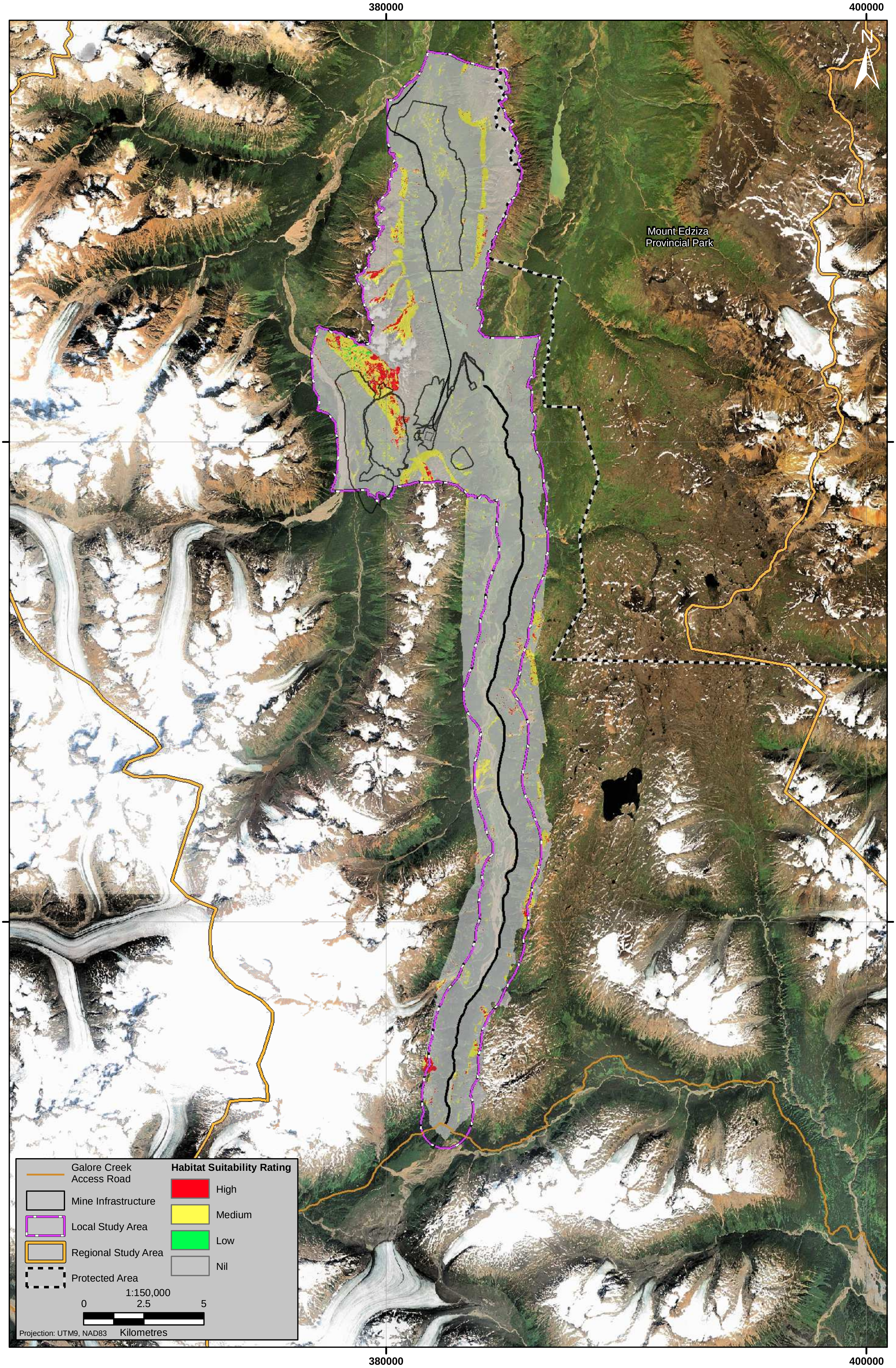


FIGURE 4.8-1

copper FOX metals inc.

Schaft Creek Project: Hoary Marmot Growing Habitat Suitability

RTEC Keepers of the Land

5. Summary

5. Summary

Habitat suitability modelling conducted for the Schaft Creek Project included the following species and seasons/attributes: moose (*Alces alces*) early and late winter habitat; mountain goat (*Oreamnos americanus*) summer and winter habitat; Stone's sheep (*Ovis dalli stonei*) summer and winter habitat; northern caribou (*Rangifer tarandus*) early and late winter habitat; grizzly bear (*Ursus arctos*) spring, summer, and fall habitat; marten (*Martes americana*) winter habitat; and hoary marmot (*Marmota caligata*) growing habitat.

The objective of developing habitat suitability models is to identify areas that provide high quality habitat for wildlife. The focus of several habitat suitability models within this report was on winter habitat. Winter is the most difficult season for many wildlife species in British Columbia for two reasons: animals use more energy to stay warm during this cold, wet season and food resources are more limited. In contrast, growing season (spring, summer and fall) models were produced for species that rely on certain vegetation characteristics and qualities during this season, such as grizzly bears that require large amounts of food in the growing season to sustain them during winter hibernation.

The suitability mapping conducted for the Project helped to identify areas of relative importance for selected species across the entire RSA. For example, low elevation habitat along the Mess and Schaft Creek valleys was rated highly for several species, including, moose, marten, and grizzly bear. The combination of wetland, riparian corridors, and mature forests within these areas provides good forage habitat for moose in the winter and grizzly bears in the spring, summer, and fall. In particular, the large wetland complex along Mess Creek just to the east of the proposed mine site infrastructure rated Moderately High to Highly suitable for moose in the early and late winter, and for grizzly bears in the spring and summer. For marten, the mature forests along Mess and Shaft Creeks rated High because they provided the best forest structure for accessing prey populations during the winter. Much of the rolling, alpine areas within Mount Edziza Provincial Park in the eastern RSA rated highly for caribou in the late winter and grizzly bears across the spring, summer, and fall. In addition, a quarter of the high elevation, alpine areas within the RSA was Moderately High to Highly suitable winter and summer habitat for mountain goats.

References

copper FOX metals inc.

RTEC Keepers of the Land

References

1988. Water Act: Water Regulation. BC Reg 204/88.

1994. Canada Migratory Birds Convention Act. R.S.C.

1996. British Columbia Wildlife Act. RSBC.

2002. Species at Risk Act.

2004. BC Forest and Range Practices Act.

Armitage, K. B. 2000. The evolution, ecology, and systematics of marmots. *Oecologia Montana* 9 (1-2): 1-18.

Ayotte, J.B., K. L. Parker, and M. P. Gillingham. 2008. Use of Natural Licks by Four Species of Ungulates in Northern British Columbia. Journal of Mammalogy, 89(4):1041–1050.

Banner, A., W. MacKenzie, S. Haeussler, S. Thomson, J. Pojar, and R. Trowbridge. 1993. A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region. LMH No. 26, Ministry of Forests.

BC CDC. 2010. *BC Species and Ecosystems Explorer: Search Criteria - Species Group "Mammal"*. BC Ministry of Environment, Victoria, BC. http://a100.gov.bc.ca/pub/eswp/

BC EAO (British Columbia Environmental Assessment Office). 2010. Application Information Requirements template. 29 March. http://www.eao.gov.bc.ca/pdf/AIR_Template_mar2010.pdf (Accessed April 2010).

BC MOE. 2008. Order – Ungulate Winter Range (mountain goat) #U-6-002. Nass Timber Supply Area + Upper Portion of Ningunsaw & Unuk Watersheds. British Columbia Ministry of Environment Victoria BC.

BC MOE. 2010a. Iskut River Hot Springs Provincial Park. British Columbia Ministry of Environment, Parks and Protected Areas Division. http://www.env.gov.bc.ca/bcparks/explore/parkpgs/iskut.html

BC MOE. 2010b. Kinaskan Lake Provincial Park. British Columbia Ministry of Environment, Parks and Protected Areas Division. http://www.env.gov.bc.ca/bcparks/explore/parkpgs/kinaskan.html

BC MOE. 2010c. Mount Edziza Provincial Park and Recreation Area. British Columbia Ministry of Environment, Parks and Protected Areas Division. http://www.env.gov.bc.ca/bcparks/explore/parkpgs/mt_edziza/

BC MOE. 2010d. Ningunsaw Provincial Park. British Columbia Ministry of Environment, Parks and Protected Areas Division. http://www.env.gov.bc.ca/bcparks/explore/parkpgs/ningunsaw/

BC MOE. 2010e. Stikine River Provincial Park. British Columbia Ministry of Environment, Parks and Protected Areas Division. http://www.env.gov.bc.ca/bcparks/explore/parkpgs/stikine/

BC MOE. 2010f. Todagin South Slope Provincial Park. British Columbia Ministry of Environment, Parks and Protected Areas Division. http://www.env.gov.bc.ca/bcparks/explore/parkpgs/todagin/

BC MSRM. 2000. *Cassiar Iskut-Stikine Land and Resource Management Plan*. Available at http://srmwww.gov.bc.ca/ske/lrmp/cassiar/approved_lrmp-plan/toc.htm. British Columbia Ministry of Sustainable Resource Management.

BC MSRM. 2001. *EcoCat: The Ecological Reports Catalogue*. BC Ministry of Sustainable Resource Management, Victoria, BC.

BC MWLAP. 2004. *Procedures for Managing Identified Wildlife – V. 2004*. BC Ministry of Water, Land and Air Protection, Victoria, BC

BC Stats. 2005. *British Columbia's Hunting, Trapping & Wildlife Viewing Sector*. Accessed April 2010. http://www.bcstats.gov.bc.ca/data/bus_stat/busind/fish/wildlife.pdf

Beaudry, L. J., R. A. Coupe, C. DeLong, and J. Pojar. 1999. *Plant Indicator Guide for Northern British Columbia; Boreal, Sub-Boreal, and Subalpine Biogeoclimatic Zones: BWBS, SBS, SBPS, and northern ESSF*. Land Management Handbook 46. BC Ministry of Forests and Range.

Beier, P and R.F. Noss. 1998. Review: Do Habitat Corridors Provide Connectivity? *Conservation Biology*, 12(6): 1241–1252.

Bergerud, A.T. 1978. The status and management of woodland caribou in British Columbia. Report to Fish and Wildlife Branch, Victoria. 138 pp.

Bergerud, A.T. and H.E. Butler. 1978. Life History Studies of Caribou in the Spatsizi Wilderness Park 1977-78. Mininstry of Recreation and Conservation, Parks Branch, Province of British Columbia. 156 pp.

Bergerud, A.T., H.E. Butler, and D.R. Miller. 1984. Antipredator tactics of calving caribou: dispersion in mountains. *Canadian Journal of Zoology*, 62:1566–1575.

Blood, D.A. 2000a. *Mountain Goats in British Columbia, Ecology, Conservation and Management*. British Columbia Ministry of Environment, Lands and Parks. http://www.env.gov.bc.ca/wld/documents/mtngoat.pdf (accessed April, 2010)

Blood, D.A. 2000b. *Thinhorn sheep in British Columbia, Ecology, Conservation and Management*. British Columbia Ministry of Environment, Lands and Parks. http://www.env.gov.bc.ca/wld/documents/thinhorn.pdf (accessed April, 2010)

Blood, D.A. 2002. *Grizzly Bears in British Columbia, Ecology, Conservation and Management*. Ministry of Water, Land and Air Protection, Victoria, BC.

Boonstra R., and A.R.E. Sinclair. 1984. Distribution and habitat use of Caribou, Rangifer tarandus caribou, and Moose, Alces alces andersoni, in the Spatsizi Plateau Wilderness Area, British Columbia. *Canadian Field-Naturalist*, 98(1): 12–21.

Buskirk, S. W., S. C. Forrest, M. G. Raphael, and H. J. Harlow. 1989. Winter resting site ecology of marten in the central Rocky Mountains. *Journal of Wildlife Management*, 53:191–196.

Buskirk, S. W. and R. A. Powell. 1994. *Habitat ecology of fishers and American martens*. In: Buskirk, S.W., Harestad, A.S., Raphael, M.G., Powell, R.A. (Eds.), Martens, Sables and Fishers: Biology and Conservation. Cornell University Press, New York, pp. 283–296.

Cichowski. D. B. 2002. Unpublished data quoted in Marshall 2003.

Cichowski, D. B., T. Kinley, and B. Churchill. 2004. Identified Wildlife Management Strategy: Accounts and Measures for Managing Identified Wildlife - Northern Interior Forest Region. Victoria, B.C.: Province of British Columbia.

Coady, J. W. 1974. Influence of snow on behaviour of Moose. *Naturaliste Canadienne*, 101:417–436.

COSEWIC. 2002a. *COSEWIC assessment and status report on the grizzly bear* Ursus arctos *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa: vii + 91 pp. http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_grizzly_bear_e.pdf (Accessed April, 2010).

COSEWIC. 2002b. *COSEWIC assessment and update status report on the woodland caribou* Rangifer tarandus caribou *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 98 pp. http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_woodland_caribou_e.pdf (April, 2010)

Côté, S. D. 1996. Mountain Goat Responses to Helicopter Disturbance. *Wildlife Society Bulletin*, 24(4): 681–685.

Côté, S. D. and M. Festa-Bianchet. 2003. Mountain goat *Oreamnos Americanus*. In *Wild Mammals of North America: Biology, Management & Conservation*. Ed G. A. Feldhamer, B. Thompson and J. Chapman. p 1061-1075. The John Hopkins University Press, Baltimore.

Couturier,S . and C. Barrette. 1988. The behaviour of moose at natural mineral springs in Quebec. Canadian *Journal of Zoology*, 66:522-528.

Demarchi, M. W. 2000. *Moose in the Nass Wildlife Area*. Unpublished report for Forest Renewal BC and BC MOELP, Smithers, BC.

Demarchi, M. 2003. Migratory patterns and home range size of moose in the central Nass Valley, British Columbia. *Northwestern Naturalist,* 84:135–41.

Demarchi, M. W. and S. R. Johnson. 2000. *Grizzly bears in the Nass Wildlife Area*. Unpublished report to Forest Renewal BC, and BC MOELP, Smithers, BC.

Demarchi, M. W., S. R. Johnson, and G. F. Searing. 2000. Distribution and Abundance of Mountain Goats, *Oreamnos americanus*, in Westcentral British Columbia. *Can Field Nat*, 114(2): 301–306.

Demarchi, R.A. and C.L. Hartwig. 2004. Status of Thinhorn Sheep in British Columbia. Wildlife Bulletin No. B-119. British Columbia Ministry of Water, Land and Air Protection, Biodiversity Branch. Victoria, B.C.

Doerr, J.G. 1983. Home range size, movement and habitat use in two moose, *Alces alces*, populations in southeastern Alaska. *Canadian Field-Naturalist*, 97(1): 79–88.

Dussault, C., J. P. Ouellet, R. Courtois, J. Huot, L. Breton, and H. Jolicoeur. 2005. Linking moose habitat selection to limiting factors. *Ecography,* 28(5): 619–628.

Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. *Biol Conservat* 110 (3): 387-99.

Fox, J. L. 1983. Constraints on winter habitat selection by the mountain goat (Oreamnos americanus) in Alaska. Ph.D. Dissertation, University of Washington, Seattle.

Fox, J.L., and G.P. Streveler. 1986. Wolf predation on Mountain Goats in southeastern Alaska. *Journal of Mammalogy*, 67:192–195

Fox, J.L, C.A. Smith, and J.W. Schoen. 1989. Relation between Mountain Goats and their habitat in southeastern Alaska. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. PNW-GTR-246.

Geist, V. 1971. Mountain Sheep: A study in behaviour and evolution. University of Chicago Press. Chicago. 383 pp.

Goldstein, M. I., A. J. Poe, E. Cooper, D. Youkey, B. A. Brown, and T. L. McDonald. 2005. Mountain goat response to helicopter disturbance overflights in Alaska. *Wildlife Society Bulletin,* 33:688–699.

Government of Canada. 2008. The Species at Risk Act and You: Information for Businesses. http://www.sararegistry.gc.ca/involved/you/business_e.cfm. (accessed April 2010)

Gross, J. E., M. C. Kneeland, D. F. Reed, and R. M. Reich. 2002. GIS-based habitat models for mountain goats. *Journal of Mammalogy*, 83: 218–228.

Gyug, L., T. Hamilton, and M. Austin. 2004. Grizzly Bear *Ursus arctos*. Identified Wildlife Management Strategy: Accounts and Measures for Managing Identified Wildlife. Ministry of Water, Land and Air Protection, Victoria, BC.

Hatler, D.F. 1986. *Studies of Radio-collared Caribou in the Spatsizi Wilderness Park Area, British Columbia, 1980-1984*. Prepared for the Spatsizi Association for Biological Research. December 1986.

Keim, J. 2004a. Modeling core winter habitats from habitat selection and spatial movements of collared mountain goats in the Taku River drainage of north-west British Columbia. *Bienn. Symp. North . Wild Sheep and Goat Counc.* 14:65–86.

Keim, J. 2004b. Confirming Winter Mountain Goat Habitats from a Habitat Suitability Model in the Bell II Study Area. Submitted, Proceedings from the Northern Wild Sheep and Goat Council 2004 Symposium.

Kelsall. J.P., and W. Prescott. 1971. Moose and deer behavior in snow. Canadian Wildlife Service Report Series – Number 15. 25 pp.

Klaus, G. and B. Schmid. 1998. Geophagy at natural licks and mammal ecology: a review. *Mammalia,* 62:481-497.

Koehler, G. M. and M. G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitterroot wilderness. *J Wildl Manag.,* 41:500–505.

Laundré, J. W. 1994. Resource overlap between mountain goats and bighorn sheep. *Great Basin Naturalist,* 54:114–21.

LeResche, R. E. 1972. Migrations and population mixing of moose on the Kenai Peninsula (Alaska). *Proceedings of the North American Moose Conference and Workshop*, 8:185-207.

Lofroth, E. C. and J. D. Steventon. 1990. *Managing for marten habitat in interior forests of British Columbia.* Paper presented at Wildlife Forestry Symposium: A Workshop on Resource Integration for Wildlife and Forest Managers, Prince George, BC: Forestry Canada.

Marshall, R. 2003. Spatsizi Wildlife Survey: Thinhorn sheep, Mountain Goat, and Caribou. Unpublished report prepared by the BC Ministry of Environment.

MacKenzie, W. H. and J. R. Moran. 2004. *Wetlands of British Columbia: A guide to identification. Land Management Handbook #52, British Columbia Ministry of Forests*. Victoria, British Columbia, Canada. 287 p.

MacHutchon, G. A., and T. Mahon. 2003. *Habitat use by grizzly bears and implications for forest development activities in the Kispiox Forest District*. Unpublished report for Forest Investment Account and Forest Renewal BC, Skeena Region, Smithers BC.

MacHutchon, A. G., S. Himmer, and C. A. Bryden. 1993. *Khutzemateen Valley Grizzly Bear Study*. Victoria, B.C.: British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests.

McElhanney. 2007a. Grizzly Bear Habitat Assessment and Candidate WHA Submission: Northern Nass Timber Supply Area. Report prepared for the Ministry of Environment by McElhaney Consulting Ltd. March 2007.

McElhanney. 2007b. Moose Winter Range Identification: North Nass Timber Supply Area. Report prepared for the Ministry of Environment by McElhaney Consulting Ltd. March 2007.

Mech, S. G., and J. G. Hallett. 2001. Evaluating the effectiveness of corridors: a genetic approach. *Conservation Biology*, 15:467–474

Nagorsen, D. W. 2005. *Rodents and Lagomorphs of British Columbia*. Vol. 4, The Mammals of British Columbia Victoria, B.C.: Royal B.C. Museum.

Osmond-Jones, E. J., M. Sather, W. G. Hazelwood, and B. Ford. 1977. Wildlife and fisheries inventory of Spatsizi and Tatlatui Provincial Parks, British Columbia, Provincial Parks Branch. Victoria. 292 pp.

Paquet, M.M. and R.A. Demarchi. 1999. Stone's Sheep of the northern Rockies: the effects of access. Foundation for North American Wild Sheep and Guide Outfitters Association of BC. MAIA Publishing Ltd., Port Alberni, BC.

Payer, D. C. and D. J. Harrison. 2003. Influence of forest structure on habitat use by American marten in an industrial forest. *Forest Ecology and Management,* 179:145–156.

Poole, K. G, A. D. Porter, A. deVries, C. Maundrell, S. D. Grindal and C. C. St. Clair. 2004. Suitability of a young deciduous dominated forest for American marten and the effects of forest removal. *Canadian Journal of Zoology*, 82:423–435.

Porter, A. D, C. C. St. Clair, and A. deVries. 2005. Fine-scale selection by marten during winter in a deciduous forest. *Canadian Journal of Forest Resources*, 35: 901–909.

Rea, R.V., D.P. Hodder, and K. N. Child. 2004. Considerations for natural mineral licks used by moose in land use planning and development. *Alces*, 40: 161-67.

RIC. 1998a. *Standard for Terrestrial Ecosystem Mapping in British Columbia*. Ecosystems Working Group Terrestrial Ecosystems Task Force, Resources Inventory Committee. Victoria, BC. May 1998.

RIC. 1998b. Inventory Methods for Pikas and Sciurids: Pikas, Marmots, Woodchuck, Chipmunks and Squirrels. Standards for Components of British Columbia Biodiversity No 29. Prepared by Ministry of Environment, Lands and Parks, Resources Inventory Branch for Terrestrial Ecosystem Task Force, Resources Inventory Committee. Victoria, BC. December 1998.

RIC. 1999a. *British Columbia Wildlife Habitat Ratings Standards Version 2.0*. BC Ministry of Environment Lands and Parks: Victoria, BC: 97pp.

RIC. 1999b. *Standards for Predictive Ecosystem Mapping, Inventory Standard*. Ministry of Sustainable Resource Management: Victoria BC.

Roberge, J. M. and P. Angelstam. 2004. Usefulness of the umbrella species concept as a conservation tool. *Conservation Biology,* 18:76–85.

RTEC. 2005a. *2004 Galore Creek Aquatic Baseline Studies Report*. Prepared for NovaGold Canada Ltd. By by Rescan Tahltan Environmental Consultants. November 2005.

RTEC. 2005b. *2005 Galore Creek Aquatic Baseline Studies Report*. Prepared for NovaGold Canada Ltd. By by Rescan Tahltan Environmental Consultants. December 2005.

RTEC. 2006a. *Galore Creek Grizzly Bear Study Baseline Report 2004/2005*. Report Prepared for NovaGold Canada Inc by Rescan Tahltan Environmental Consultants. March 2006.

RTEC. 2006b. *Galore Creek Moose Studies Baseline Report 2005*. Report Prepared for NovaGold Canada Inc by Rescan Tahltan Environmental Consultants. March 2006.

RTEC. 2006c. *Galore Creek Mountain Goat Baseline Report 2004-2005.* Report Prepared for NovaGold Canada Inc by Rescan Tahltan Environmental Consultants. March 2006.

RTEC. 2006d. *Galore Creek Wildlife Habitat Rating and Enhanced Habitat Suitability Models for Six Focal Species, 2004-2005*. Report Prepared for NovaGold Canada Inc by Rescan Tahltan Environmental Consultants. March 2006.

RTEC. 2007a. *Schaft Creek Bird Studies Baseline Report 2006*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. May 2007.

RTEC. 2007b. *Schaft Creek Project 2006 Moose Baseline Report*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. November 2007.

RTEC. 2008a. *Schaft Creek 2007 Fisheries Baseline Report*. Produced for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. March 2008.

RTEC. 2010a. *Schaft Creek Bird Baseline Studies, 2008 Addendum*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants . January 2010.

RTEC. 2008b. *Schaft Creek Bat Inventory, 2007*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. March 2008.

RTEC. 2008c. *Schaft Creek Western Toad Baseline 2007*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. March 2008.

RTEC. 2010a. *Schaft Creek Bird Baseline Studies, 2008 Addendum*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants . January 2010.

RTEC. 2010b. *Schaft Creek Moose Literature Review 2008*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants . January 2010.

RTEC. 2010c. *Schaft Creek Mountain Ungulate Baseline, 2006 and 2008*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. January 2010.

RTEC. 2010d. *Schaft Creek Fisheries Baseline 2008*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. February 2010.

RTEC. 2010e. *Schaft Creek Project DRAFT Soils Baseline*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. February 2010.

RTEC. 2010f. *Schaft Creek Vegetation and Ecosystem Mapping Baseline 2010*. Report Prepared for Copper Fox Metals Inc. by Rescan Tahltan Environmental Consultants. March 2010.

Safford, K. R. 2004. Modelling critical winter habitat of four ungulate species in the Robson Valley, British Columbia. *BC Journal of Ecosystems and Management*, 4(2), http://www.forrex.org/jem/2004/co14/no2/art9.pdf

School District 87. 2000. Tahltan Nation. School District 87 and the Tahltan Band Council.

Shackleton, D. M. 1999. *Hoofed mammals of British Columbia*. Vol. 3: Mammals of British Columbia. Royal BC Museum, Victoria and UBC Press, Vancouver BC.

Sherburne, S. S. and J. A. Bissonette. 1994. Marten Subnivean Access Point Use: Response to Subnivean Prey Levels. *Journal of Wildlife Management*, 58(3): 400–405.

Schoen, J. W. and M. D. Kirchoff. Unpublished Report for the Alaska Department of Fish and Game. 1982. *Habitat Use by Mountain Goats in Southeast Alaska.* Juneau, Alaska.

Steventon, J. D. and J. T. Major. 1982. Marten use of habitat in a commercially clear-cut forest. *J Wildl Manag.,* 46:175–82.

Takats, L., R. Stewart, M. Todd, R. Bonar, J. Beck, B. Beck, and R. Quinlan. 1999. American marten winter habitat: Habitat suitability index model version 5. 8 pp.

Tesky, J. L. 1993. *Oreamnos americanus*. U.S. Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Fire effects information system. Available online at http//www.fs.fed.us/database/feis/animals/mammal/oram/all.html. September, 2002.

Wilbert, C. J., S. W. Buskirk, and G. Gerow. 2000. Effects of weather and snow on habitat selection by American martens (*Martes americana*). *Canadian Journal of Zoology*, 78:1691–1696.

Wilson, S. F. 2005. *Desired conditions for coastal mountain goat winter range*. BC Ministry of Water, Land and Air Protection Wildlife Working Report No. WR-107.

Yazvenko, S. B, G. F. Searing and M. W. Demarchi. 2002. Wildlife habitat assessment in the Nass Wildlife Area. Unpublished report for Forest Renewal BC and Ministry of Sustainable Resource.

Appendix 1

Species Account for Moose

Appendix 1. Species Account for Moose

Name:	*Alces alces*	
Species Code:	M-ALAL	
Status*:	**Global:**	G5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.
	Provincial:	S5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.
	COSEWIC:	Not listed.
	BC List:	Yellow-listed. Includes uncommon and common, declining and increasing species that are apparently secure and not at risk of extinction.
	Identified Wildlife:	Not listed.

**References: (BC CDC 2010).*

DISTRIBUTION

Provincial Range

Moose are distributed throughout the entire interior of British Columbia. They are most abundant in the central and sub-boreal mountains, the northern boreal mountains, and the boreal plains of northeastern B.C. The northern areas of the province are home to over 70% of the population, with other moderate to plentiful populations located in the Cariboo-Chilcotin, Thompson-Okanagan and Kootenay regions (B.C. MELP, 2000). Moose are found on the coast of the province in low densities and are absent from coastal islands and grasslands of the southern interior.

Elevation Range

Moose are widespread throughout a variety of habitats from sea-level to alpine. Moose migrate between elevation ranges seasonally, frequenting valley bottoms in winter and spring, and higher-elevations (up to 2,600 m) in summer and autumn (Cowan and Guiget, 1978; Stevens, 1995). Areas higher than 1,300 m are seldom used in the winter.

Provincial Context

Moose are one of the most widely distributed ungulates in British Columbia. Moose populations in B.C. were likely low or non-existent prior to the late 1800's and have increased significantly since then, moving from northeastern B.C. and Alaska southwards in the last 100 years (Peterson 1955 in Kelsall and Telfer, 1974; Cowan and Guiget, 1978). Populations are currently rated stable, and there are an estimated 170,000 moose in British Columbia (B.C. MELP, 2000), a slight decline from the 1979 population estimate of 240,000 (B.C. MoE, 1979).

Project Area

- **Ecoprovince:** Northern Boreal Mountains, Sub-Boreal Interior
- **Ecoregions:** Boreal Mountains and Plateaus; Yukon-Stikine Highlands; Skeena Mountains
- **Ecosections:** Tahltan Highland (THH)/Stikine Highland (STH), Southern Boreal Plateau (SBP); Northern Skeena Mountains (NSM)

- **Biogeoclimatic Zones:** Alpine Tundra (ATun), Boreal White and Black Spruce (BWBSdk1), Engelmann Spruce-Subalpine Fir (ESSFmc, ESSFmcp, ESSFwv, ESSFwvp, ESSFvv, ESSFvvp); Interior Cedar Hemlock (ICHwc); Spruce Willow Birch (SWBun, SWBunp).
- **Project Map Scale:** 1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

Moose utilize a variety of different habitats depending on the season. Moose are generalist herbivores and are described as "browsers", obtaining their food from aquatic plants, grasses, lichens, bark, twigs, and young shoots of trees and shrubs. Common browse species throughout their range include willow (*Salix* sp.), black cottonwood (*Populus balsamifera* sp. *trichocarpa*), red-osier dogwood (*Cornus stolonifera*), Douglas maple (*Acer glabrum*), birch (*Betula* sp.), and trembling aspen (*Populus tremuloides*) (Ehlers *et al*., 1998; United States Forest Service, 2006). Browse, an important component of their diet, varies depending on the availability, palatability and nutritional value of other available plant species.

Kelsall and Telfer (1974) attribute climate as the most likely limiting factor to moose expansion, with high winter snowfalls and high summer temperatures determining the extent of moose range. Winter is the critical season for moose and the presence of forest cover adjacent to foraging areas is essential. In winter, moose exist on woody, low-quality, difficult to digest browse; however, when snow cover allows, they may consume non-woody vegetation and succulent species (LeResche and Davis, 1973). Moose are adapted for high snowfall areas, having long legs and low foot loads (Coady, 1974; Kelsall and Telfer, 1974), and can usually use areas where snow depths are high (Kelsall and Prescott, 1971; Coady, 1974; Kelsall and Telfer, 1974). Snow density and crusting has an effect on the depth of snow that a moose can use, with higher density snow allowing for deeper snow use (Kelsall and Prescott, 1971; Coady, 1974). Moose will also feed on the bark of deciduous trees, especially aspen in late winter. The availability of woody food plants and snow conditions (especially snow depths greater than 1 m), limit moose winter distribution. In winter, moose move towards valley bottoms and into more mature stands of Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*). These forest stands provide security, protection from deep snow, bedding, and adequate forage in the understory (Halko *et al*., 2001; Serrouya and D'Eon, 2002). Other habitats utilized by moose during the winter include: riparian habitats, floodplains and other shrub dominated habitats such as shrub lands, wetlands and their edges, burns, cutovers, and other open areas (Demarchi, 1986; Sopuck *et al*., 1997).

During the summer, moose may move to higher elevation ranges to utilize forest stands for cover from heat and predation, and food resources (Sopuck *et al*., 1997). Moose are attracted to cool water features in the summer months, spreading out along ponds, lake shores, and swamps. Other summer habitats utilized by moose consist of the same type of habitat as the winter range: floodplains, riparian habitats and adjacent forests. Wetland habitats are used extensively for spring, summer, and fall foraging. Sedge meadows are important habitats in spring, as sedges are among the first plants to emerge from dormancy. Graminoids and forbs are preferred in spring and early summer as they become less nutritious in fall and winter (Himmer and Power, 1999). Riparian areas along rivers and lakes are also favoured habitats but are not used as heavily as the spruce and shrub wetlands.

Moose are easily heat stressed even at temperatures as low as -5°C. In the summer, extreme panting occurs at temperatures from 14°C to 20°C (Renecker and Hudson, 1986). Areas with climates having temperatures that exceed 27°C for long periods and lack of shade do not support moose (Kelsall and Telfer, 1974). Lakes, ponds, bogs, wetlands and the forests associated with these habitats are important in the summer to alleviate heat stress and provide abundant forage (Kelsall and Telfer, 1974; Schwab, 1985; Renecker and Hudson, 1986; Demarchi and Bunnell, 1993, 1995).

Moose migrate seasonally from high elevations in the summer, to elevations below 1,300 m in the winter (Sopuck *et al*., 1997). The extent of seasonal migrations may vary depending on topography, snow fall patterns, and forage availability in certain areas. Seasonal home ranges average 2 to 10 km^2 in size and vary depending on the season, although further migration occurs between seasons (Stevens and Lofts, 1988).

Moose seasonal habitat use varies depending on the area studied, sex, age, social status and reproductive status of the animal. General seasonal use patterns are difficult to predict and quantify due to the differences in migratory patterns (LeResche *et al*., 1974) and food preferences (Peek, 1974) described by various authors. During the winter, moose are severely restricted in their movements when snow levels are greater than 90 cm, are relatively mobile if the snow levels are less than 60 cm, and prefer areas where snow depths are less than 40 cm (Coady, 1974). In general, more open habitats such as burns, shrublands, and cutblocks are used during early winter or when snow levels are low and more closed canopy coniferous forests are used when snow levels increase (Coady, 1974; Eastman, 1974; LeResche *et al*., 1974; Peek *et al*., 1976; Eastman, 1977; MacCracken *et al*., 1997). Spring, summer, and fall habitats tend to be open types such as cutblocks, burns, shrublands, and wetlands that have abundant browse species and aquatic habitats such as ponds, which provide aquatic browse plants (Peek, 1974; Peek *et al*., 1976; Doer, 1983; MacCracken *et al*., 1997).

The life span of moose is variable but estimated to last approximately 20 years. Full maturity is reached at approximately 5 or 6 years of age, and maximum fecundity occurs at the age of 10 or 11 (Peterson, 1974).

<u>Reproduction</u>

Moose mate in late September to early October during the rutting period, which is a time of intense social interaction between males and between males and females (Lent, 1974). The rutting period begins in mid to late September and usually lasts for approximately three weeks, but may last longer. Habitat requirements for rutting appear to be varied with respect to vegetation, topography, and proximity to human disturbance (Stevens and Lofts, 1988; Sopuck *et al*., 1997). Usually one calf is born in late May and early June although two calves are not uncommon, especially when habitat quality is high (Franzmann and Schwartz 1985 in MacCracken *et al*., 1997). Calves stay with the female moose until the next spring and sometimes on into the fall (Stringham, 1974). Female moose can become sexually mature after the first year but consistent reproductive success is not usually established until they are over 2.5 years (Simkin, 1974).

The most important habitat requirement in the summer is security cover for cows with young calves. This is required in order to minimize predation (Sopuck *et al*., 1997). Such sites are often found in large forest stands with dense cover of shrubs and forest canopy. The primary predators of moose are wolves, black bears and grizzly bears.

HABITAT USE – LIFE REQUISITES

Habitats for moose are rated separately for two seasons: growing and winter. The life requisites that will be evaluated for moose will be *living* for the early and late winter, because winter habitat was considered to be the main constraint on habitat suitability. The life requisites that will be rated for moose are: *feeding* (FD), *security habitat* (SH) and *thermal habitat* (TH), which are described in detail below.

Feeding Habitat (FD)

Moose are generalist herbivores, with a diet consisting of a variety of different species (Table 1). Feeding requirements for moose are tied closely to food availability and season.

Table 1. Plant Species Consumed by Moose in British Columbia

Common Name	Scientific Name
Trees and Shrubs	
Balsam fir	*Abies balsamea*
Balsam	*Abies* spp.
Douglas maple	*Acer glabrum*
Sitka alter	*Alnus crispa*
Saskatoon	*Amelanchier alnifolia*
Bog birch	*Betula glandulosa*
Paper birch	*Betula papyrifera*
Swamp birch	*Betula pumila*
Birch	*Betula* sp.
Red osier dogwood	*C. stolonifera*
Hazelnut	*Corylus californica*
Black twinberry/bearberry honeysuckle	*Lonicera involucrate*
Myrtle pachistema/Falsebox	*Pachistima myrsinities*
Black cottonwood	*Populus balsamifera ssp. trichocarpa*
Quaking aspen	*Populus temuloides*
Trembling aspen	*Populus tremuloides*
Cherry	*Prunus* sp.
Cascades rhododendron	*Rhododendron albiflorum*
Scouler willow	*S. scouleriana*
Willow	*Salix* spp.
Elderberry	*Sambucus* sp.
Western mountain ash	*Sorbus scopulina*
Mountain ash	*Sorbus* spp.
Western Pacific yew	*Taxus brevifolia*
Western redcedar	*Thuja plicata*
Highbush cranberry/Lowbush cranberry	*Viburnum edule*
Forbs	
Clematis	*Clematis* sp.
Bunchberry dwarf dogwood	*Cornus canadensis*
Fireweed	*Epilobium angustifolium*
Skunk cabbage	*Lysichtiton kamtschaktkense*
Claspleaf twistedstalk	*Streptopus amplexifolius*

(continued)

Table 1. Plant Species Consumed by Moose in British Columbia (completed)

Common Name	Scientific Name
Aquatic	
Water arum	*Calla palustris*
Yellow waterlily	Nuphar lutea *ssp.* polysepala
Large-leaf pondweed	*P. amplifolius*
Grassleaf pondweed	*P. gramineus*
Floating-leaf pondweed	*P. natans*
Richardson pondweed	*P. richardsonii*
Robinson pondweed	*P. robbinsii*
Pondweed	*Potamogenton* spp.
Burreed	*Sparganium* spp.
Horsetail	
Horsetail	*Equisetum* spp.
Water horsetail	*E. fluviatile*
Grasses and sedges	
Sedge	*Carex* spp.
Grass	*Gramineae* spp.

Source: Renecker and Schwartz, 1998.

Early Spring

Early spring foods may include aquatic vegetation and/or new leaves from woody plants, especially willows. Deciduous leading stands on south facing slopes are considered to provide the most suitable spring range conditions. These areas typically provide relatively open conditions, young aspen trees and abundant preferred browse species.

In general, moose spring range consists primarily of areas that provide early green forage (e.g., herbs, new leaf buds of woody plants). Moose have also been reported to strip bark from willow and aspen trees during early spring (Miquelle and Van Ballenberghe, 1989). Although the nutritional benefits of bark stripping remain unclear, some researchers suggest feeding on bark by moose is related to mineral requirements (McIntyre, 1972) and seen as a sign of starvation, often due to low quality or scarcity of higher quality browse, or deep heavy snow conditions (Miquelle and Van Ballenberghe, 1989).

Overall, spring food sources are not well documented. Vaccinium spp., freshly exposed herbaceous vegetation, and grasses (Gramineae spp.) have been identified as important spring foods (Ritcey, undated; Peek, 1974). Singleton (1976) indicated that there is an overlap between winter foods and spring foods so most riparian shrubs, including willow and cottonwood, will still be selected. This may explain the use of creeks and riparian areas.

Late Spring / Summer / Fall

Late spring is associated with a rapid increase in leaf consumption, followed by the introduction of forbs and graminoids as spring progresses into summer and this continues into autumn. During summer, moose continue to browse (especially willows) by stripping leaves and reducing the amount of consumed woody forage. Depending on availability, moose can also increase the proportion of succulent vegetation in their diet. Studies of moose habitat relationships have indicated that moose seek aquatic macrophytes during summer as their primary source of succulent vegetation.

The concentration of minerals in aquatic vegetation (particularly sodium) has been suggested as the limiting nutrient moose attempt to replenish during the summer (Belovsky and Jordan, 1981). Thus, many moose populations (particularly cow/calves) tend to concentrate their feeding activities during early and mid-summer in and around wetland areas where aquatic vegetation is most accessible (shallow open ponds and small lakes) and where the cool water may provide relief from warm ambient temperatures. Potential aquatic food plants include yellow water lily (Nuphar lutea ssp. polysepala); pondweed (Potamogeton spp.), horsetails (Equisetum spp.); water arum (Calla palustris) and sedges (Carex spp.).

Not all wetlands will provide optimum feeding conditions. The capability of wetlands to produce aquatic macrophytes and preferred browse species has been shown to vary with substrate, pH, soil temperatures and flow rates (Fraser et al., 1984). Therefore, Adair et al. (1991) suggested that small lakes (1-5 ha) with organic bottoms, slow streams and beaver ponds provide higher abundance of aquatic macrophytes and higher summer habitat values than other wetland types.

Besides aquatic vegetation, preferred terrestrial species include willow, horsetail, and swamp birch (Betula pumila) (Singleton, 1976). Willow and horsetail have both been identified as the most important non-aquatic species (Peek, 1974; Singleton, 1976). Other important browse species for this season include red-osier dogwood (Cornus stolonifera), highbush cranberry (Viburnum edule), trembling aspen, Saskatoon (Amelanchier albiflorum), and black twinberry (Lonicera involucrata).

Winter

The most important winter food for moose is willow, as it is both palatable and abundantly available (Ritcey, undated; MOE, 1979). The winter diet is close to 100% trees and shrubs, with the occasional consumption of frozen sedges if they can be found (Schwartz et. al., 1988). A food preference list for British Columbia identifies willows, falsebox (Pachistima myrsinites), balsam (Abies spp.), saskatoon (Amelanchier alnifolia), paper birch (Betula papyrifera), and mountain ash (Sorbus spp.) as preferred winter browse species (Singleton, 1976). Red-osier dogwood (Cornus stolonifera), western redcedar (Thuja plicata) regeneration, Vaccinium spp., and alder (Alnus sp.) are also noted as important winter food sources (Ritcey, undated; Peek, 1974; Petticrew and Munro, 1979). Use of any particular browse species, however, is contingent on the population density, abundance and distribution of browse species, and season of use (Peek, 1974).

Most authors identify winter habitat as the limiting factor in moose production (Kelsall and Prescott, 1971; McNicol and Gilbert, 1980; Thompson and Vukelich, 1981; Risenhoover, 1985; Hatler, 1988). Winter habitat is primarily low elevational riparian communities, especially along dynamic riverine systems, where much of the riparian vegetation is in a sub-climax seral stage (LeResche et al., 1974; Van Drimmelen, 1987; Modaferri, 1992). Winter range can include clearcut areas as well as forested sites. Habitat preferences in winter are for floodplain riparian habitats along major rivers, riparian shrub thickets along tributary streams, or on warm aspect regenerating burns at lower elevations.

Moose browse tends to be most abundant in natural openings as well as those areas that have been recently disturbed through fire or clearcut logging. As such, structural stage is an important variable that is strongly correlated with the availability of shrubby vegetation and winter browse. Consequently, 10-20 year old clearcuts typically provide abundant moose browse and have been reported to receive relatively high early winter use (Oct-Dec) in the central interior of B.C. (Westworth et al., 1989). Hence, structural stages 1 and 2 would have relatively low foraging and cover value whereas structural stages 3 (low and high shrub) would likely provide the most suitable early winter foraging habitats. Late winter foraging habitats could also be found in structural stage 3; however, adequate mature forest (structural stage 6 or 7) cover needs to be present.

Van Dyke (1995) suggested high value winter feeding areas have > 30% shrub cover, relatively low mature tree density (< 200 stems/ha) and gentle slopes (< 7%). Romito et al. (1996) suggested a minimum of 50% shrub cover to provide optimal moose browse.

Mineral licks, or natural salt licks, are a critical part of a moose's dietary intake. While at the sites, the animals consume water and soil. The chemical and nutrient composition of lick water and soil varies, but many are characterized by high sodium, calcium, and/or magnesium levels. As stated earlier, these salt licks are described as critical for both maintaining sodium levels as well as balancing stomach acidity (Klaus and Schmid, 1998; Bechtold, 1996). The lick areas are identified by a well-used large network of trails leading to the area, the presence of spring water or mineral seeps, hoof prints, concentrated faecal matter and urine, and polished rocks (Bechtold, 1996).

Security Habitat (SH)

The main predators of moose are wolves, grizzly bears and black bears. Predation is a primary factor in calf mortality, with estimates of 3-52% of calf deaths caused by grizzlies, and 2-18% by wolves for a given population. The density of the moose population does influence the number of deaths by black bear predation but not by grizzlies. Grizzly kill rates are approximately 0.6 to 3.9 adult moose per year. A pack of wolves (ranging from 2 to 22 wolves) is said to be responsible for 1 adult moose death per 6 to 16 days.

Security cover for moose is most critical during spring calving when cow moose seek out islands and gravel bars on river floodplains for calving; landscape features adjacent to water provide escape from predators. At calving time, dense growth of tall shrubs (e.g., willows) and mature stands of white spruce-poplar with at least a moderately dense understorey also provide cover for moose. Cow moose and calves can find secure habitat during calving season in dense deciduous stands, or tall shrubs with canopy cover > 50% (MacCracken et al., 1997).

During summer/fall, security cover is provided by the same habitat types mentioned above. As well, the summer habitat preference for water may provide some shelter against predation. Moose also experience relief from insects in the deeper waters (Peek, 1998). Moose at upper elevations (i.e., SBSmk) use coniferous and mixed forests, shrub thickets in riparian habitats, and willow thickets on plateaus as cover.

During winter, deep and persistent snow has been shown to have a negative impact on the physical condition of the moose and thus increasing its risk of predation. It is suspected that double canopy winter habitats are used as an effort to be in locations with greater potential mobility. The northwestern British Columbia coastal forests of Sitka spruce, western hemlock and western red cedar support moose and improve their mobility in riparian areas during the wet winters (Eastman and Ritcey, 1987).

Thermal Habitat (TH)

The high energy needs of moose require that they find, consume and digest food at a rapid rate. It is critical for success that thermal stress is reduced to a minimum and does not interfere with the time required to locate food (Renecker and Schwartz, 1998). Thermal stress is induced at temperatures greater than 5.1°C in winter and 14°C in summer. At ambient temperatures higher than this (when panting occurs), moose rapidly seek shade or the cooling effects of water (Schwabb and Pitt, 1991).

No lower critical temperature for moose is known, as Karns (1998) reports that moose have been observed unaffected at temperatures lower than -40°C. Moose are described as "chionophyls", or lovers of snow, and are well adapted to snow environment. The long length and strength of their legs enables better negotiation of snow. However, movement is impeded at depths greater than 70 cm, and moose seek out habitat with better cover, lower elevation or "yard" microhabitat with packed snow (Peek, 1998).

SEASONS OF USE

Moose require thermal, security, and feeding habitat throughout the year. Table 2 summarizes the life requisites for moose for each month of the year in which they will be rated.

One season will be rated for moose: Early and Late Winter.

Table 2. Monthly Life Requisites for Moose

Life Requisites	Month	Season*
Food, Security, and Thermal	January	Early/Late Winter
Food, Security, and Thermal	February	Late Winter
Food, Security, and Thermal	March	Late Winter
Food, Security, and Thermal	April	Late Winter/Spring
Food, Security, and Thermal	May	Late Winter/Spring
Food, Security, and Thermal	June	Spring/Summer
Food, Security, and Thermal	July	Summer
Food, Security, and Thermal	August	Summer
Food, Security, and Thermal	September	Fall
Food, Security, and Thermal	October	Fall/ Early Winter
Food, Security, and Thermal	November	Early Winter
Food, Security, and Thermal	December	Early Winter

** Seasons defined for Coast and Mountains and Northern Boreal Mountains per the Chart of Seasons by Ecoprovince (RIC 1999).*

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Table 3 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 3. Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Moose

Life Requisite	TEM Attribute
Food Habitat	○ Site: site disturbance, elevation, slope, aspect, structural stage
	○ Soil/terrain: bedrock, terrain texture, flooding regime
	○ Vegetation: Percent cover by layer, species list by layer, cover for each species for each layer
Security Habitat	○ Site: elevation, slope, aspect, structural stage
	○ Soil/terrain: terrain texture
	○ Vegetation: total percent cover, percent cover by layer
	○ Mensuration: tree species, diameter at breast height, height
Thermal Habitat	○ Site: elevation, slope, aspect, structural stage
	○ Soil/terrain: terrain texture
	○ Vegetation: Percent cover by layer, total percent cover
	○ Mensuration: tree species, dbh, height

Ratings

There is a detailed level of knowledge of the habitat requirements of Moose in British Columbia to warrant a 6-class rating scheme (RIC, 1999) (Table 4).

Provincial Benchmark (winter season)

Ecosection:	Peace Lowland (PEL)
Biogeoclimatic Zone:	BWBSmw
Broad Ecosystem Unit:	Boreal White Spruce-Trembling Aspen (structural stage 2-3)

Ratings Assumptions

1. Rating of feeding habitat will represent the overall habitat suitability provided polygon is within winter capable habitat
2. Winter habitat will be representative of areas used during severe or late winter conditions when snow pack is limiting.
3. Areas that are believed to be capable of producing larger quantities of preferred winter forage will be considered of greatest importance and therefore will be given highest habitat suitability ratings.
4. Non preferred forage species such as subalpine-fir and alder will be considered for evaluating lower quality habitats (e.g. 3 to 6).
5. Productive floodplains and their associated glaciofluvial benches, riparian habitat, and regenerating burns will be rated as either class 1 or 2 moose winter living habitat depending on available forage species and cover.
6. Habitats with high shrub density (structural stages 3a and 3b on willow benchlands) will be rated class 1 or 2 winter feeding habitat.
7. Areas associated with wetlands will receive a HSR of 3 for forage if identified as a structural stage 2 given the likely high value of wetland edge for shrub production. For the same reason, ponds, rivers etc. may also be given HSR of 3 considering value of the edge.
8. Capable winter habitat (based on observational data from winter flights) is restricted to CWH and ICH BECs within the study area. Areas outside of this BEC will be ranked as 6.

Table 4. Summary of General Habitat Attributes for Moose

Habitat Use	Specific Attributes for Suitable Moose Habitat	Structural Stage
Winter Feeding Habitat	Mixed shrub species composition including Willow, birch, red osier dogwood Riparian areas and areas of past forest development	3
Security Habitat	Tree Species Composition Mixed Conifer/Deciduous Mature Conifer. Shrub Cover > 40%. Canopy Closure	6,7
Thermal Cover	Tree Species Composition Mixed Conifer/Deciduous Mature Conifer Shrub Cover Canopy Closure >66%.	3, 5-7

Ratings Adjustments

Final habitat capability and suitability map products may incorporate adjustment in HSR considering:

1. polygon heterogeneity and connectivity;
2. habitats adjacent to significant anthropogenic disturbance regimes (roads, settlements etc); and
3. interspersion of different structural stages within an ecosection polygon

LITERATURE CITED

Adair, W., P. Jordon and J. Tillma. 1991. Aquatic forage ratings according to wetland type: modifications for the Lake Superior moose HIS. *Alces*. 27: 140-149.

B.C. Species and Ecosystems Explorer. 2005. Victoria, British Columbia, Canada. Available: http://srmapps.gov.B.C..ca/apps/eswp/ May 4, 2005.

Bechtold, J.P. 1996. Chemical characterization of natural mineral springs in northern British Columbia, Canada. *Wildlife Society Bulletin*. 24:649-654.

Belovsky, G.E., and P.A. Jordon. 1981. Sodium dynamics and adaptations of a moose populations. *Journal of Mammalogy*. 62: 613-621.

Demarchi, D. 1986. *Biophysical Resources of the East Kootenay Area Wildlife*. MOE Technical Report 22. B.C. Ministry of Environment, Victoria, B.C.

Eastman, D.S. and R. Ritcey. 1987. Moose habitat relationships and management in British Columbia. *Swedish Wildlife Research Suppliment*. 1:101-118.

Ehlers, T., S. Bennett and P. Corbett. 1998. *TFL #14 Ungulate Winter Range Inventory: Year 2 1996/1997*. unpublished report for Crestbrook Forest Industries Ltd. Parson, B.C.

Fraser, D., E.R. Chavez, and J. E. Paloheimo. 1984. Aquatic feeding by moose: selection of plant species and feeding areas in relation to plant chemical composition and characteristics of lakes. *Canadian Journal of Zoology*. 62: 80-87.

Hatler, D.F. 1988. History and importance of wildlife in Northern British Columbia. In *The Wildlife of Northern British C olumbia*. Rosemary J. Fox (ed) Spatsizi Association for Biological Research, Smithers, B.C. Pp. 10-11.

Himmer, S. and D. Power. 1999. *Wildlife species habitat models and final wildlife suitability ratings for the Itcha / Ilgachuz area*. Cariboo Region, Wildlife Branch, B.C. Environment, Williams Lake, B.C.

Karns, P.D. 1998. Population distribution, density and trends. In: *Ecology and Management of the North American Moose*. A.W. Franzmann and C.C. Schwartz (Eds.). Smithsonian Institution Press. Washington, D.C.

Kelsall, J.P. and W. Prescott. 1971. *Moose and Deer Behaviour in Snow in Fundy National Park, New Brunsick*. Can. Wild. Serv. Rep. Ser. No. 15, Ottawa. Pp. 27.

Kelsall, J.P., and E.S. Telfer. 1974. Biogeography of moose with particular reference to western North America. *Naturalist Canadien*.. 101: 117-130.

Klaus, G., and B. Schmid. 1998. Geophagy at natural licks and mammal ecology: a review. *Mammalia*. 62:481-497.

LeResche, R.E. and J.L. Davis. 1973. Importance of nonbrowse foods to moose on the Kenai Peninsula, *Alaska. Jour. Wildl. Management*. 37(3): 279-287.

LeResche, R.E., R.H. Bishop, and J.W. Coady. 1974. Distribution and habitats of moose in Alaska. *Naturaliste Can*. 101:143-178.

MacCracken, J.G., V. Van Ballenberghe, and J.M. Peek. 1997. Habitat relationships of moose on the Copper river delta in coastal south-central Alaska. *Wildlife Monographs* 136. 54 pp.

McIntyre, E.G. 1972. Bark stripping – a natural phenonmenon. *J.R. Scottish For. Soc*. 26: 43-50.

McNicol, J.G. and F.F. Gilbert. 1980. Late winter use of upland cutovers by moose. *J. Wildl. Manage*. 44(2): 363-371.

Ministry of Environment, Lands and Parks. 2000. *Moose in British Columbia: Ecology Conservation and Management.* Province of British Columbia.

Ministry of Environment. 1979. *Preliminary Moose Management Plan for British Columbia.* Province of British Columbia.

Miquelle, D.G. and V. Van Ballenberghe. 1989. Impact of bark stripping by moose on aspen-spruce communities. *Journal of Wildlife Management* 53: 577-586.

Modaferri, R.D. 1992. *Lower Susitna valley moose population identity and movement study. Project W-23-4.* Alaska Dept. of Fish and Game, Div. of Wildl. Conservation, federal Aid in Wildlife Restoration, Research Progress report. 34 pp.

Peek, J.M. 1974. A review of the Moose Food Habits Studies in North America. *Naturaliste Canadien*. 101: 195-215.

Peek, J.M. 1998. Habitat relationships. In: *Ecology and Management of the North American Moose.* A.W. Franzmann and C.C. Schwartz (Eds.). Smithsonian Institution Press. Washington, D.C.

Peterson, R.L. 1974. A review of the general life history of moose. *Naturaliste Canadien.* 101:9-21.

Petticrew, P.S. and W.T. Munro. 1979. *Preliminary moose management plan for British Columbia*. Fish and Wildlife Branch, Victoria. Pp. 29.

Renecker, L.A. and C.C. Schwartz. 1998. Food habits and feeding behaviour. In: *Ecology and Management of the North American Moose.* A.W. Franzmann and C.C. Schwartz (Eds.). Smithsonian Institution Press. Washington, D.C.

Renecker, L.A. and R.j. Hudson. 1986. Seasonal energy expenditures and thermoregulatory responses of moose. *Can. Jour. Zool*. 64: 322-327

Resources Inventory Committee (RIC). 1999. *British Columbia Wildlife Habitat Ratings Standards. Version 2.0.* B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.. 97 Pp.

Risenhoover, K.L. 1985. *Intraspecific variation in moose preference for willows. Proceedings – Symposium on Plant-Herbivore Interactions*. Snowbird, Utah. August 7-9, 1985. Ed. F.D. Provenza, J.T. Flinders and E.D. McArthur. Intermountain Research Station Forest Service. USDA.

Ritcey, R. *Moose in British Columbia*. Ministry of Environment Lands and Parks, B.C.

Romito, A., K. Smith, B. Beck, J. Beck, M. Todd, R. Bonnar, and R. Quinlan. 1996. Moose (Alces alces) winter habitat – draft habitat suitability index (HIS) model. In: *Habitat Suitability Index Models for 35 Wildlife Species in the Foothills Model Forest*. Draft report. Beck, B., J. Beck, W. Bessie., R. Bonnar, and M. Todd (eds.). Foothills Model Forest, Hinton, Alberta. 266 pp.

Schwabb, F.E. and M.D. Pitt. 1991. Moose selection of canopy cover types relative to operative temperature, forage and snow depth. *Canadian Journal of Zoology*. 69:3071-3077.

Schwartz, C.C., Hubbert, M.E., and A.W. Franzmann. 1988. Energy requirements of adult moose for winter maintenance. *Journal of Wildlife Management.* 52:26-33.

Serrouya, R. and D'eon, R. 2002. *Moose habitat selection in relation to forest harvesting in a deep snow zone of British Columbia: Winter 2002*. Ministry of Sustainable Resource Management/FRB.C. report, B.C., Canada.

Singleton, J. 1976. *Food habits of wild ungulates in British Columbia: bibliography and plant synopsis*. Environment and Land Use Committee Secretariat, Department of Environment, Victoria, B.C. Pp. 4-9.

Sopuck, L., K. Ovaska and R. Jakimchuk. 1997. *Literature Review and Problem Analysis of Moose/Forestry Interactions in the Cariboo Forest Region*. Ministry of Forests, Williams Lake, B.C.

Stevens, V. and S. Lofts. 1988. *Wildlife Habitat Handbooks for the Southern Interior Ecoprovince. Volume 1: Species Notes for Mammals*. Wildlife Report No. R-15. Ministry of Environment, Wildlife Branch, Victoria, B.C.

Thompson, I.D. and M.F. Vukelich. 1981. Use of logged habitats in winter by moose cows with calves in northeastern Ontario*. Can. J. Zool*. 59(11): 2103-2144.

United States Forest Service. 1998. *Alces alces. Biological data and habitat requirements*. Internet.http://svinet2.fs.fed.us/databases/feis/animals/mammal/ALAL/BIOLOGICAL_DATA_AND_HABITAT_REQUIREMENTS.html

Van Drimmelin, B. 1987. *Coastal Skeena moose survey*. British Columbia Wildlife Branch, Ministry of Environment, Northern Region. Smithers, British Columbia. 18 pp.

Van Dyke, F. 1995. Microhabitat characteristics of moose winter activity sites in south-central Montana. Alces 31:27-33.

Westworth, D., L. Brusnyk, J. Roberts and H. Veldhuzien. 1989. Winter habitat use by moose in the vicinity of an open-pit mine in north-central British Columbia. *Alces* 25:156-166.

WLAP (Ministry of Water, Land and Air Protection). 2002. *Species Ranking in British Columbia*. Government of British Columbia, Victoria, B.C..

Appendix 2

Species Account for Mountain Goat

Appendix 2 – Species Account for Mountain Goat

Name:	*Oreamnos americanus*		
Species Code:	M-ORAM		
Status*:	**Global:**	G5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.	
	Provincial:	S4 – Apparently Secure. Uncommon but not rare, and usually widespread in the province, but possible cause for long-term concern.	
	COSEWIC:	Not listed.	
	BC List:	Yellow-listed. Includes uncommon and common, declining and increasing species that are apparently secure and not at risk of extinction. Mountain goats are considered to be *regionally important* because they require older age class forests for winter cover.	
	Identified Wildlife:	Not listed.	

**References: (BC CDC 2010).*

Provincial Range

Mountain goat range extends from the Rocky Mountains south of the 49th parallel to the Yukon border. In British Columbia, goats are present in most mountainous ranges except for those on Vancouver Island, the Queen Charlottes, and other coastal islands (B.C. MELP, 2000). Populations exist in the Cassiar Mountains in north-central B.C., the Cariboo Mountains of the upper Fraser River system, the Purcell, Selkirk and Monashee Mountains of south-east B.C. and the Coast Mountains from the lower Fraser River to the extreme north-west portion of the province (B.C. MoF, 1996, 1997).

Elevation Range

Mountain goats are seen in mountainous regions, ranging from as low as 300 m elevation in the winter to approximately 2,500 m in the Rockies (Houston *et al.*, 1986). Mountain goats generally occur in mountainous terrain at >1,500 m.

Provincial Context

Mountain goats are restricted to the northwest portion of North America, including British Columbia. British Columbia has more native goat range than any other province. Populations are rated stable, and there is an estimated 50,000 mountain goats in British Columbia (B.C. MELP, 2000), a slight decrease from the 1977 population estimate of 63,000 (Macgregor, 1977).

Project Area

- **Ecoprovince:** Northern Boreal Mountains, Sub-Boreal Interior
- **Ecoregions:** Boreal Mountains and Plateaus; Yukon-Stikine Highlands; Skeena Mountains
- **Ecosections:** Tahltan Highland (THH)/Stikine Highland (STH), Southern Boreal Plateau (SBP); Northern Skeena Mountains (NSM)
- **Project Map Scale:** 1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

The mountain goat is a generalist herbivore, obtaining their food by both grazing and browsing on alpine and sub-alpine grasses, sedges, rushes and forbs in summer, and on a variety of shrubs, conifers, mosses and lichens in winter (MOF, 1997). Habitat selection is determined more by topographical features rather than by the presence of specific forage species. Mountain goats inhabit rugged terrain comprised of cliffs, ledges, projecting pinnacles and talus slopes in subalpine and alpine habitats. Forage sites for mountain goats must be suitable landforms to which they can retreat in times of danger. Steep escape terrain is a critical factor in habitat selection. One study showed that summering goats made little use of foraging areas over 400 m from cliffs (Boyd et al., 1986).

Mountain goats may migrate a few kilometres between winter-spring and summer ranges, but many seasonal migrations are just local shifts in elevation (MELP, 2000). Winters are spent on well ledged or fractured cliffs, and very steep terrain with interspersed vegetation and low snow accumulation. These habitats are usually on steep south to southwest aspects with slopes exceeding 40 degrees and access to forage. Along the coast, winter ranges are invariably at low elevations because snow is much shallower in depth or even absent to expose forage (MELP, 2000).

In spring, coastal mountain goats usually remain at low elevations in order to take advantage of the earliest flush of green vegetation. As spring progresses into summer, they will follow the melting snow line up slope and feed on emerging young, succulent vegetation on other aspects. During summer months, goats often use areas of lush herbaceous forage in alpine grasslands, meadows, and grassy slide-rock slopes of the AT and ESSF parklands. Timbered areas and avalanche tacks in the ESSF subzones may also be used during migration or movement between cliff bands and feeding areas. When crossing areas that are without escape terrain goats repeatedly use the same trails (Boyd et al., 1986).

The life span of the mountain goat is variable but estimated to last approximately 12 years. Full maturity is reached at 4 years of age, while female fecundity first occurs at 2.5 years of age (MELP, 2000). Males are capable of procreating at that age but are generally out-dominated by older males.

The mating season, or rut, peaks in late November and early December. Mountain goats are polygamous during this time. After gestation period of six months, nannies (mothers), retire to secluded, precipitous ledges to give birth to kids in late May or early June. The kids are nursed intensively for 6 weeks, at which time they begin to forage near their mothers. Weaning occurs after four months, in August or September. The mothers are very protective of their young and are extremely attentive until the next kid is born the following year.

Mountain goats are moderately social creatures, forming herds (or bands) for short periods of the year. Nursery bands of four or five nannies and their kids are common, but may increase up to 15 or 20 after kidding. Billies are less social, occurring singly or in groups of 2 to 4 animals. Males and females live apart except during breeding (Tesky, 1993).

HABITAT USE – LIFE REQUISITES

The life requisites that will be rated for mountain goat are: feeding (FD), security (SH), and thermal (TH) habitats, which are described in detail below.

Feeding Habitat (FD)

Mountain goats select habitat more for its topographical features than for the availability of specific forage species. Mountain goats will feed on a variety of habitats adjacent to escape terrain such as alpine tundra, alpine/subalpine wet meadow, subalpine parkland, talus shrublands and subalpine forest burns. Goats may feed in lower coniferous forests during winter in wet snow areas, or may use windswept ridges in dry interior locations (Stevens and Lofts, 1988).

Mountain goats feed on a variety of plant foods (Table 1). Grasses, sedges, rushes, ferns, forbs, lichens, shrubs and conifers are important in different seasons. During the winter goats will feed upon whatever plants are available or emerging from the snow, from dried grasses to conifer needles and even litterfall, mosses and both arboreal and terrestrial lichens. Mar-Terr Enviro Research (1981) estimate the average winter food habits of mountain goats to be 80-95% shrubs and trees, 0% forbs, and 15% grasses.

Table 1. Plant Species Consumed by Mountain Goats in British Columbia

Common Name	Scientific Name
Trees and Shrubs	
Mountain Heath	*Phyllodoce aleutica*
Moosewood	*Viburnum edule*
Highbush cranberry/ Lowbush cranberry	*Viburnum pauciflorum*
Sitka alter	*Alnus crispa*
Scrub birch	*Betula glandulosa*
Hazelnut	*Corylus californica*
Alpine fir	*Abies lasiocarpa*
Western red cedar	*Thuja plicata*
Western service berry	*Amelanchier alnifolia*
Common juniper	*Juniperus communis*
Sitka spruce	*Picea crispa*
Quaking aspen	*Populus temuloides*
Black cottonwood	*Populus trichocarpa*
Willow	*Salix* spp.
Scouler willow	*Salix scouleriana*
Western and mountain hemlock	*Tsuga* spp.
Forbs	
Lupine	*Lupine* spp.
Bunchberry dogwood	*Cornus canadensis*
Red osier dogwood	*Cornus stolonifera*
Foamflower	*Tiarella trifoliate*
Mountain bluebell	*Mertensia* spp.
Polemonium	*Polemonium* spp.
Kinnikinnick	*Arctostaphylos uva-ursi*
Ferns	
Alpine lady fern	*Athyrium alpestre*
Oak fern	*Gymnocarpium dryopteris*
Maindenhair spleenwort	*Asplenium trichomanes*
Maindenhair spleenwort	*Asplenium trichomanes*

(continued)

Table 1. Plant Species Consumed by Mountain Goats in British Columbia (completed)

Common Name	Scientific Name
Moss and Lichens	
Lichen	*Cetraria*
Lichen	*Cladina*
Lichen	*Cladonia*
Moss	*Dicranum*
Moss	*Hedwigia ciliate*
Moss	*Hylocomium*
Grasses and sedges	
Wheatgrass	*Agropyron* spp.
Bentgrass	*Agrostis scarbra*
Reedgrass	*Calamagrostis* spp.
Fescue	*Festuca* spp.
Bluegrass	*Poa* spp.
Grass	*Gramineae* spp.
Sedge	*Carex* spp.

(Foster and Rahs, 1981; Fox et al., 1982)

Summer diet is more varied with a higher proportion of forbs (35-70%), grasses (22-62%) and sedges (Mar-Terr Enviro Research, 1981). Studies done near the Galore Creek project area indicated that conifers, lichens, and mosses were more prevalent in the diet of the mountain goat (Mar-Terr Enviro Research, 1981; Fox and Smith, 1988).

Mountain goats, like many other ungulates, seek out mineral supplementation in the form of natural (mineral) salt licks. These salt licks are described as critical for both maintaining sodium levels as well as balancing stomach acidity (Klaus and Schmid, 1998; Bechtold, 1996). The lick areas are identified by a well-used large network of trails leading to the area, the presence of spring water or mineral seeps, hoof prints, concentrated faecal matter and urine, and polished rocks (Coté and Festa-Bianchet, 2003). The goats use the licks during the summer, beginning in April or May (males) or early June (females).

Security Habitat (SH)

Security terrain is critical at all times of the year for mountain goats. Escape terrain is characterized as steep, broken surface with cliffs, rock outcroppings, ledges and talus slopes for predator avoidance (Herbert and Turnbull, 1977). Exposure is generally south or west and slopes are generally steep, ranging from 30 to 45 in summer and up to 55 in winter.

The adaptation to steep rugged terrain by the mountain goat is an effective strategy against predation by grizzly bears, wolves and other mammals (Fox and Streveler, 1986). The location of escape terrain limits the distribution of populations. Goats usually remain within 400 m of escape terrain in summer and within 250 m in winter (McFetridge, 1977; Schoen *et al*., 1980; Fox *et al*., 1982). Bedding and kidding sites nearly always feature high visibility of the surroundings on high points, under the protection of overhanging rocks and usually near cliffs (Tesky, 1993). Movements between seasonal ranges are generally along ridges in proximity to escape terrain and migration routes through forested areas are normally well-used paths that the goats will frequently run along in order to return to safer territory (Demarchi *et al.,* 2000).

Thermal Habitat (TH)

Thermal cover for mountain goats consists of southerly aspects in the ESSF during winter. The winter ranges ideally lack persistent snow cover, often windy west/south-facing steep (>40°) slopes at the tree line or just below tree line. Tree and shrub cover on steep, rocky ledges affords thermal advantage during sunny weather (solar radiation) and during storms. Goats in coastal ranges may use low elevation habitats, wintering in coniferous forests at or just above sea level (Coté and Festa-Bianchet, 2003; Demarchi et. al., 2000). Goats in more northern regions may remain in high elevation areas associated with the BAFA (boreal alti fescue alpine) or SWB (spruce willow birch) biogeoclimatic zones.

The upper ESSF, BAFA, or SWB biogeoclimatic zones and northern aspect cliffs provide cooler habitats in summer, providing for thermal regulation during hot periods. Summer habitat use is at higher elevations, in alpine tundra, alpine meadows, talus shrub lands, and high elevation burns or grassy slopes.

SEASONS OF USE

Mountain goats require feeding and security habitat differentially throughout the year. Table 2 summarizes the life requisites for mountain goats for each month of the year.

Table 2. Monthly Life Requisites for Mountain Goats

Life Requisites	Month	Season*
Food, Security	January	Winter
Food, Security	February	Winter
Food, Security	March	Winter
Food, Security	April	Winter
Food, Security	May	Winter
Food, Security	June	Growing (Spring)
Food, Security	July	Growing (Summer)
Food, Security	August	Growing (Summer)
Food, Security	September	Growing (Fall)
Food, Security	October	Winter
Food, Security	November	Winter
Food, Security	December	Winter

**Seasons defined for Coast and Mountains, Northern Boreal Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (Appendix B, RIC1999).*

The two seasons for which ratings will be applied to are summer and winter.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Table 3 outlines how each life requisite relates to specific ecosystem attributes (*e.g.*, site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 3. Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Mountain Goats

Life Requisite	TEM Attribute
Food Habitat	○ Site: site disturbance, elevation, slope, aspect, structural stage ○ Soil/terrain: bedrock, terrain texture ○ Vegetation: Percent cover by layer, species list by layer, cover for each species for each layer
Security Habitat	○ Site: elevation, slope, aspect, structural stage ○ Soil/terrain: terrain texture ○ Vegetation: Percent cover by layer ○ Mensuration: tree species, diameter at breast height, height

Ratings

There is a detailed level of knowledge of the habitat requirements of mountain goats in British Columbia to warrant a 6-class rating scheme (RIC, 1999).

Provincial Benchmark (winter season)

Ecoprovince:	Coast and Mountains	Southern Interior Mountains
Ecosection:	Nass Ranges (NAR)	Southern Park Ranges (SPK)
Biogeoclimatic Zone:	MHmm	ESSFdk
Broad Ecosystem Unit:	Mountain Hemlock-Amabilis Fir/ RO-Rock	Engleman Spruce-Subalpine Fir/ RO-Rock

Provincial Benchmark (summer season)

Ecoprovince:	Coast and Mountains	Southern Interior Mountains
Ecosection:	Nass Ranges (NAR)	Southern Park Ranges (SPK)
Biogeoclimatic Zone:	AT	AT
Broad Ecosystem Unit:	Alpine Meadow	Alpine Meadow

Habitats: Mature to old-growth forests, subalpine parkland and seepage areas with cliffs, rock bluffs, talus slopes, and avalanche tracks, on steep (greater than 40° slope), south to southwest aspects. Mountain goats may at times use habitats on gentle to moderate slopes but usually within close proximity to steep escape terrain. Northerly aspects may be used in winter if windswept of snow accumulations.

Ratings Assumptions

1. TEM methods alone are not adequate for identifying suitable mountain goat habitat due to limitations in detecting escape terrain, and its importance based on its adjacency to areas providing other habitat functions. Alternate methods are required to adequately incorporate escape terrain into the models
2. Localized winter ranges are critical to maintenance of mountain goat populations.
3. Due to dependence on escape terrain, lamb-rearing areas are similar to summer habitat and can be identified analogously to summer range. Kidding (natal) areas may include both winter and summer range

4. In the study area, forested habitats adjacent to escape terrain are highly rated for winter habitat value.
5. Forage exploited by goats in winter includes a wide range of forage, ranging from lichen to conifer, and thus areas producing abundant vegetation will receive the highest ranking for FD.
6. Summer forage includes higher protein content plants, areas with an abundance of green herbs, grasses and sedges as well as early shrub foliage will be rated highest for food
7. Elevation and aspect provide thermal relief in summer and higher, colder aspects will be ranked marginally higher. Thermal influences from topography may also provide relief at low elevations, however these sites may be difficult to predict
8. A wider range of elevation is exploited by goats in winter and elevation is not key to winter ratings
9. Conifer vegetation provides snow interception and oblique cover. This habitat may also provide abundant rooted and arboreal forage (e.g., litterfall) and will be ranked high.

Ratings Adjustments

Final capability and suitability map products will incorporate: A topographically derived model of escape terrain will be used in conjunction with the EM product to determine the suitability of habitat based on its distance from escape terrain. Only the features predicted by will be incorporated into the final model from the EM product.

LITERATURE CITED

B.C. Species and Ecosystems Explorer. 2005. Victoria, British Columbia, Canada. Available: http://srmapps.gov.B.C..ca/apps/eswp/ May 4, 2005.

Bechtold, J.P. 1996. Chemical characterization of natural mineral springs in northern British Columbia, Canada. Wildlife Society Bulletin. 24:649-654.

Boyd, Raymond J., A.Y. Cooperrider, P.C. Lent and J.A. Bailey. 1986. Ungulates. In: Inventory and monitoring of wildlife habitat. A.Y. Cooperrider, R.J. Boyd and H.R. Stuart (eds). Denver, CO: U.S. Department of the Interior, Bureau of Land Management, Service Center: 519-564. [10856]

Coté, S.D. and M. Festa-Bianchet. 2003. Mountain goat. In Wild Mammals of North America: Biology, Management, and Conservation. G.A. Feldhamer, B. Thompson, and J. Chapman (Eds.) The Johns Hopkins University Press. Baltimore, Maryland.

Demarchi, M.W., Johnson, S.R., and G.F. Searing. 2000. Distribution and abundance of mountain goats Oreamnos americanus, in Westcentral British Columbia. The Canadian Field-Naturalist. 114:301-306.

Fox, J. L. and C. A. Smith. 1988. Winter mountain goat diets in southeast Alaska. Journal of Wildlife Management 52(2): 362-365.

Fox, J.L. and G.P. Streveler. 1986. Wolf predation on mountain goats in southeastern Alaska. Journal of Mammalogy. 67:192-195.

Fox, J.L., K.J. Raedeke and C.A. Smith. 1982. Mountain goat ecology on Cleveland Peninsula, Alaska 1980-82. Final Rep. Pacific Northwest For. Range Exp. Stn. Contract PNW-Supp. 165-AO#2. USDA Forest Service. For.Sci.Lab., Juneau, Alaska. 55 Pp.

Herbert, D.M. and W.G. Turnbull. 1977. A description of southern interior and coastal mountain goat ecotypes in British Columbia. In: Proceedings First International Mountain Goat Symposium. W. Samuel and W.G. MacGregor. Eds. Queen's Printer, Victoria, B.C..

Houston, D.B., B.B. Moorhead and R.W. Olson. 1986. An aerial census of mountain goats in the Olympic Mountain Range, Washington. Northwest Sci. 60: 131-136.

Klaus, G. and B. Schmid. 1998. Geophagy at natural licks and mammal ecology: a review. Mammalia. 62:481-497.

Macgregor, W.G. 1977. Status of Mountain Goats in British Columbia. In Proceedings of the first International Mountain Goat Symposium. W. Samuel and W.G. Macgregor (Eds.). Ministry of Recreation and Conservation, Fish and Wildlife Branch. Province of British Columbia. Kalispell, Montana. February 19, 1977.

Mar-Terr Enviro Research. 1981. Relationships between mountain goat ecology and proposed hydroelectric development on the Stikine river, B.C. July 1981.

McFetridge, R.J. 1977. Strategy and resource use by mountain goat nursery groups. Pp 169-173. In Proceedings of the first International Mountain Goat Symposium. W. Samuel and W.G. Macgregor (Eds.). Ministry of Recreation and Conservation, Fish and Wildlife Branch. Province of British Columbia. Kalispell, Montana. February 19, 1977.

MELP (Ministry of Environment, Lands and Parks). 2000. Mountain Goat in British Columbia: Ecology Conservation and Management. Government of British Columbia, Victoria, B.C..

MIWG (Managing Identified Wildlife Guidebook). 1996. Forest Practices Code of B.C.. Draft, February 1996.

MOF (Ministry of Forests). 1997. Species and plant community accounts for identified wildlife. Volume 1. Species #36 – Mountain Goat (Oreamnos americanus). B.C. Forest Practices Code. Government of British Columbia. Victoria, B.C..

RIC (Resources Inventory Committee). 1999. British Columbia Wildlife Habitat Ratings Standards. Version 2.0. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.. 97 Pp.

Schoen, J.W., M.D. Kirchoff and O.C. Walmo. 1980. Winter habitat use by mountain goats. Juneau, Alaska. Department of Fish and Game. Federal Aid in Wildlife Restoration Project W-17-10, 11 and W-21-1-2. Final Report, job.12.4. 67 Pp.

Stevens, V. and S. Lofts. 1988. Wildlife Habitat Handbook for the Southern Interior Ecoprovince. Volume I: Species Notes for Mammals. Wildlife Report No. R-15. Ministry of Environment, Wildlife Branch. Victoria, B.C..

Tesky, J.L. 1993. Oreamnos americanus. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, fire Sciences Laboratory. http://www.fs.fed.us/database/feis/ May 26, 2004.

WLAP (Ministry of Water, Land and Air Protection). 2002. Species Ranking in British Columbia. Government of British Columbia, Victoria, B.C..

Appendix 3

Species Account for Stone's Sheep

Appendix 3 – Species Account for Stone's Sheep

Name:	*Ovis dalli stonei*	
Species Code:	M-OVDA	
Status*:	**Global:**	G5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.
	Provincial:	S4 – Apparently Secure. Uncommon but not rare, and usually widespread in the province, but possible cause for long-term concern.
	COSEWIC:	Not listed.
	BC List:	Yellow-listed. Includes uncommon and common, declining and increasing species that are apparently secure and not at risk of extinction.
	Identified Wildlife	Not listed.

** References: (Demarchi and Hartwig 2004; BC CDC, 2010).*

DISTRIBUTION

Global Range

Stone's sheep (*Ovis dalli stonei*) are distributed throughout three Canadian provinces/territories (British Columbia, Yukon and Northwest Territories), three ecozones (Montane Cordillera, Boreal Cordillera, and Taiga Plains), and 12 ecoregions (Central Canadian Rocky Mountains, Omineca Mountains, Fraser Basin, Yukon Plateau – North, Pelly Mountains, Yukon – Stikine Highlands, Boreal Mountains and Plateaus, Northern Canadian Rocky Mountains, North Ogilvie Mountains, Mackenzie Mountains, Selwyn Mountains, and Muskwa Plateau) (Demarchi and Hartwig, 2004). This existing distribution of Stone's sheep has remained relatively constant to the historical records (Davidson and Dawson, 1990; Demarchi and Hartwig, 2004).

Provincial Range

In general, the distribution of Stone's sheep in British Columbia remains north of the 56th parallel and runs northwest to southeast (Shackleton, 1999; Wood, 1999). This distribution spans to include the east side of Bennett Lake on the British Columbia–Yukon border, the eastern side of the northern Coast Mountains, the north portion of the Skeena Mountains, the Cassiar and Omineca mountains, the northern Rocky Mountains, and the Peace Arm of the Williston Reservoir (Shackleton, 1999). In addition, 28 Stone's sheep were successfully translocated to the Mount Frank Roy and Mount Monteith area in B.C. in early 1990's (Backmeyer, 2000).

Elevation Range

Stone's sheep are widespread throughout a variety of biogeoclimatic zones including Alpine Tundra (AT), Boreal White and Black Spruce (BWBS), Engelmann Spruce-Subalpine Fir (ESSF), Sub-Boreal Spruce (SBS), and Spruce–Willow–Birch (SWB) but most often utilize AT, SWB and BWBS zones (Demarchi and Hartwig, 2004). In general, Stone's sheep are located at elevations between 1,400 and 1,800 m (Walker, 2002). However, this species will move to lower elevations in the spring to exploit new vegetative growth and subsequently migrate to higher elevations as higher vegetation progresses with warmer summer weather (Demarchi and Hartwig, 2004).

Provincial Context

Roughly 75 % of the global population of Stone's sheep inhabit the northern portion of British Columbia (Demarchi and Hartwig, 2004). This population size has remained relatively stable since the 1970's with approximately 14,000 individuals in B.C. and 18,500 individuals in total (Demarchi and Hartwig, 2004). The highest densities of stone's sheep in British Columbia have been reported in the Muskwa and Kechika River drainages and portions of the Spatsizi-Stikine river watersheds in northern BC (Elliott, 1985; Shackleton, 1999).

Project Area

- **Ecoprovince:** Northern Boreal Mountains, Sub-Boreal Interior
- **Ecoregions:** Boreal Mountains and Plateaus; Yukon-Stikine Highlands; Skeena Mountains
- **Ecosections:** Tahltan Highland (THH)/Stikine Highland (STH), Southern Boreal Plateau (SBP); Northern Skeena Mountains (NSM)
- **Project Map Scale:** 1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

Stone's sheep (*Ovis dalli stonei*) are herbivorous and populations are primarily limited by winter and spring habitat availability and predation. Stone's sheep exhibit segregation between sexes and between maternal and non-maternal females (Geist, 1971; Walker *et al*., 2006) . In general, male sheep occupy areas of superior nutritional content, at the cost of escape habitat, to ensure maximum growth and size while females (and specifically, females with lambs) will occupy areas in greater proximity escape habitat, at the cost of nutritional content, to ensure survival of offspring (Corti and Shackleton, 2002; Demarchi and Hartwig, 2004; Walker *et al*., 2006).

Male Stone's sheep have been documented to have up to six seasonal ranges throughout the year including pre-rut, rutting, mid-winter, late winter/spring, salt lick and summer ranges while females have been documented to have up to four including winter, spring, lambing and summer ranges (Krausman and Bowyer, 2003; Demarchi and Hartwig, 2004). Males will move to pre-rut ranges between late September and early October where they will remain for two to five weeks and then move on to the rutting range until late December and the wintering ranges thereafter (Demarchi and Hartwig, 2004). Females arrive to the wintering grounds later than males and depart earlier (Geist, 1971). In the spring, Stone's sheep descend to lower elevations to exploit new vegetation and will subsequently follow the vegetation growth up to high elevations as the summer progresses (Demarchi and Hartwig, 2004). Female sheep will migrate to lambing ranges between late May and July while barren females, juveniles and males move to summer range between late June and early July (Demarchi and Hartwig, 2004). Stone's sheep may also visit mineral licks en route to the summer ranges (Demarchi and Hartwig, 2004).

Habitat Selection

Winter and spring habitat availability is the most critical of all habitats exploited by Stone's sheep and acts as the limiting factor for their populations (Walker, 2002). Winter habitat selection included exposed alpine and subalpine sites, mid-elevation conifer bluffs, and low-elevation, south aspect shrubs and grasslands with adjacent escape terrain (Nichols and Bunnell, 1999; Backmeyer, 2000). While sheep are tolerant to direct effects of strong wind and freezing temperatures, some evidence of selection for wind sheltered habitat has also been documented during winter months (Nichols and Bunnell, 1999). Spring habitat selection appears to be selective to alpine and subalpine sites which facilitated migration to summer range which included high elevation alpine ridges (Backmeyer, 2000; Walker, 2002). In addition, some Stone's sheep have been documented to use burned ranges during the spring and exhibited higher production, due to increased plant growth and associated nutritional content, than sheep that did not use burned ranges (Seip and Bunnell, 1985b).

Stone's sheep in the southern portion of the Muskwa-Kechika Management Area in winter and spring ranges were selective to slopes greater the 30°, southeast, south and southwest aspects, elevations greater than 1,400 m, alpine/subalpine shrub, alpine/subalpine grassland, and alpine deciduous shrub (Walker, 2002). The same populations of Stone's sheep also exhibited avoidance of slopes less than 30°, northerly aspects, elevations below 1,400 m, and both deciduous and coniferous trees (Walker, 2002). In the Toad River region, Stone's sheep were found to utilize habitats between 1,500 and 2,200 m (Seip, 1983). However, other studies have indicated that the highest densities of Stone's sheep occur on the lower mountain areas (1,200 to 1,400 m) on the northeast side of high-elevation mountains where ample precipitation and wind promote gramanoid production, winter snow removal, and summer drying (Nichols and Bunnell, 1999; Demarchi and Hartwig, 2004). Stone's sheep ranges also occur on west-facing slopes in the Stikine and the Tatshenshini regions (Demarchi and Hartwig, 2004).

Diet

Stone's sheep are a herbivorous species that consume between 50 to 120 species of vegetation at various times throughout the year, of which only 10 to 15 are consumed throughout the entire year (Nichols and Bunnell, 1999). Diets of stone's sheep included graminoids, shrubs, mosses, terrestrial lichens, and forbs and proportional intake is largely dependent on availability (Corbould, 1998). However, one species of graminoid (*Poa* spp.) was actively selected for throughout the entire year despite being sparsely distributed (Seip, 1983).

In the Toad River area, Stone's sheep consumed primarily sedges (*Carex* spp.) and bluegrass (*Poa* spp.) in alpine sites, and rye grass (*Elymus innovatus*) and bluegrass in subalpine sites during the winter months (Seip, 1983; Seip and Bunnell, 1985a). However, Stone's sheep will cease foraging efforts when snow depths exceed 30 cm (Seip and Bunnell, 1985a). As such, lichens (mainly *Cladonia* spp.) are generally only consumed in high snow depth years when wind swept habitat provides the only accessible forage during the winter (Seip and Bunnell, 1985a).

In the spring and summer, Stone's sheep generally feed on grasses and sedges but will also utilize forbs and browse (Seip, 1983; Seip and Bunnell, 1985a). Specifically, sheep select locoweed (*Oxytropis* spp.), yarrow (*Achillea* spp.) and willow (*Salix* spp.) early in the growing season (Seip, 1983). Subsequently, these species begin producing chemical deterrents (tannins and phenolics) at which time Stone's sheep switch to grazing on grasses and sedges (Demarchi and Hartwig, 2004). In addition, poplar (*Populus* spp.) growing at lower elevations is selected for until sheep migrate above the altitude limitation of this species (Seip, 1983; Demarchi and Hartwig, 2004). Stone's sheep will also use mineral licks during June and July to obtain sodium that is lacking in their diet and is particularly important for nursing females (Seip, 1983; Demarchi and Hartwig, 2004).

Predation

Predation is also considered a limiting factor to Stone's sheep and evolutionary strategies have enabled this species to persist throughout their historic range. Seven carnivore and one raptor species are known to prey on Stone's sheep including grizzly bear (*Ursus arctos horribilis*), black bear (*Ursus americanus*), grey wolf (*Canis lupus*), coyote (*Canis latrans*), lynx (*Lynx canadensis*), wolverine (*Gulo gulo*) and golden eagle (*Aquila chrysaetos*) (Demarchi and Hartwig, 2004). Anti-predation strategies developed by Stone's sheep include remaining in close proximity to escape habitat (generally less than 500 meters) and occupying habitats with reduced predation pressure (Demarchi and Hartwig, 2004). Females with lambs will particularly select habitat that has adequate escape terrain and cover at the cost of nutritional content to reduce predation risks and ensure survival of their offspring. Escape terrain is defined as very steep rugged cliffs and generally refers to slopes greater than 30%, elevations above 1,400 m, and southerly aspects with ample visibility (Gross *et al*., 2002; Demarchi and Hartwig, 2004; Worley et al., 2004; Wilson, 2005; Loehr, 2006). Stone's sheep possess the agility to occupy such steep terrain alongside a high degree of predator vigilance and keen eyesight which facilitate reduced risks of predation through detection and evasion of predatory pursuits.

HABITAT USE – LIFE REQUISITES

Habitats for Stone's sheep are rated separately for two seasons: growing and winter. The life requisites rated for Stone's sheep are feeding habitat and security habitat, and are described in detail below.

Feeding Habitat (FD)

Stone's sheep are generalist herbivores, with a diet consisting of a variety of different species. Feeding requirements for Stone's sheep are tied closely to food availability and season.

<u>Growing</u>

During the spring, Stone's sheep will migrate to lower elevations to exploit new vegetative growth present at lower elevations and will migrate back up in elevation as they follow spring green-up at increasing altitudes (Demarchi and Hartwig, 2004). Early in the growing season, sheep will take advantage of the nutritional content of forbs and browse including locoweed (*Oxytropis* spp.), yarrow (*Achillea* spp.), willow (*Salix* spp.) and poplar (*Populus* spp.)(Seip, 1983; Seip and Bunnell, 1985a; Demarchi and Hartwig, 2004). However, as the season progresses, chemical deterrents develop in many of these species and Stone's sheep will subsequently shift their diet to grasses (*Poa* spp., *Elymus innovatus*) and sedges (*Carex* spp.) (Demarchi and Hartwig, 2004). Blue grass (*Poa* spp.) is also documented as potentially the only vegetative species that Stone's sheep exploit disproportionate to its availability and will actively consume this species throughout the entire year despite its sparse distribution.

Mineral licks, or natural salt licks, are a critical part of a Stone's sheep dietary intake and are generally utilized in June and July. The chemical and nutrient composition of licks will vary but are characterized by high sodium, calcium, and/or magnesium levels. As previously stated, licks are important for maintaining sodium and mineral levels that are lacking in the diet Stone's sheep and are particularly critical for nursing females (Demarchi and Hartwig, 2004).

<u>Winter</u>

During the winter season, Stone's sheep are limited by available forage and snow depth. In the Toad River area, Stone's sheep consumed primarily sedges (*Carex* spp.) and bluegrass (*Poa* spp.) in alpines sites and rye grass (*Elymus innovatus*) and bluegrass in subalpine sites during the winter months (Seip, 1983; Seip and Bunnell, 1985a). However, snow depth in these alpine habitats is a limiting factor as Stone's sheep cease foraging efforts when snow accumulation exceeds 30 cm even if ample subnivean vegetation is available. As such, lichens (mainly *Cladonia* spp.) are generally only consumed in high snow depth years when windswept habitat provides the only accessible forage during the winter (Seip and Bunnell, 1985a). In order to increase foraging opportunities during winter months, Stone's sheep select slopes exceeding 30% and predominant aspects in which prevailing winds reduce the amount of snow cover. In the southern portion of the Muskwa-Kechika Management Area, Stone's sheep selected south and southwest aspects (Walker, 2002), whereas west-facing slopes were selected in the Stikine and the Tatshenshini regions (Demarchi and Hartwig, 2004).

While windswept alpine slopes provide the majority of winter habitat for Stone's sheep, brushlands areas at lower elevations are also used (Demarchi and Hartwig, 2004). Specifically, Stone's sheep in the Muskwa-Kechika Management Area use deciduous shrub habitat during the winter, but generally avoid both deciduous and coniferous treed habitat as these regions are too dense for graminoid and shrub growth. However, Stone's sheep will use forested habitat if natural (*e.g.,* fire) or anthropogenic disturbances (*e.g.,* forestry) thin out such regions thereby promoting growth of early successional species including cottonwood, aspen, and willow (Walker, 2002; Demarchi and Hartwig, 2004). Winter range alpine sites of Stone's sheep are generally composed of graminoids, forbs and shrubs including wheatgrasses (*Agropyron* spp.), bluejoint reedgrass (*Calamagrostis canadensis*), sedges, wildrye (*Elymus* spp.), fescues, bluegrasses (*Poa* spp.), kinnikinnick (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*), soopolallie (*Shepherdia canadensis*) and prickly rose (*Rosa acicularis*) on drier sites, and willows, scrub birch (*Betula nana*), bog blueberry (*Vaccinium uliginosum*) and lingonberry (*V. vitis-idaea*) on moist sites (Nichols and Bunnell, 1999).

Security Habitat (SH)

Stone's sheep are also limited by predation and have developed anti-predator strategies to reduce the risk of predation. Stone's sheep select habitat based on the proximity to escape terrain (generally less than 500 meters) and is particularly evident in nursing females who select habitat near escape terrain with inferior nutritional content over superior sites with no escape terrain (Demarchi and Hartwig, 2004). Escape terrain is defined as very steep rugged cliffs and generally refers to slopes greater than 30%, elevations above 1,400 m, and southerly aspects with ample visibility (Gross *et al.*, 2002; Demarchi and Hartwig, 2004; Worley *et al.*, 2004; Wilson, 2005; Loehr, 2006). These areas are less conducive for predators and permit visual detection of predator presence facilitating ample time for sheep to evade predatory pursuits.

SEASONS OF USE

Stone's sheep require security and feeding habitat throughout the year. Table 1 summarizes the life requisites for Stone's sheep for each month of the year.

Two seasons will be rated for Stone's sheep: Winter and Summer.

Table 1. Monthly Life Requisites for Stone's Sheep

Life Requisites	Month	Season*
Food, Security	January	Winter
Food, Security	February	Winter
Food, Security	March	Winter
Food, Security	April	Winter
Food, Security	May	Winter
Food, Security	June	Growing (Spring)

(continued)

Table 1. Monthly Life Requisites for Stone's Sheep (completed)

Life Requisites	Month	Season*
Food, Security	July	Growing (Summer)
Food, Security	August	Growing (Summer)
Food, Security	September	Growing (Fall)
Food, Security	October	Winter
Food, Security	November	Winter
Food, Security	December	Winter

** Seasons defined for Northern Boreal Mountains and Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC, 1999).*

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Table 2 outlines how each life requisite relates to specific ecosystem attributes (*e.g.*, site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 2. Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Stone's Sheep

Life Requisite	TEM Attribute
Food Habitat	• Site: ecosystem type, elevation, slope, aspect, structural stage • Soil/terrain: terrain texture, soil drainage • Vegetation: Percent cover by layer, species list by layer, cover for each species for each layer
Security Habitat	• Site: ecosystem type, elevation, slope, aspect, structural stage • Soil/terrain: terrain texture • Vegetation: total percent cover, percent cover by layer

RATINGS

There is a moderately high level of knowledge of the habitat requirements of Stone's sheep in British Columbia to warrant a 6-class rating scheme (RIC, 1999).

Provincial Benchmark (winter season)

Ecosection: Muskwa Foothills (MUF)
Biogeoclimatic Zone: SWBmk
Habitats: BA/1 – Boreal White Spruce- Trembling Aspen/RO - Rock

Provincial Benchmark (growing season)

Ecosection: **Muskwa Foothills (MUF)**
Biogeoclimatic Zone: **AT**
Habitats: **SM – Subalpine Meadow**

Ratings Assumptions

1. Proximity to escape terrain dictates Stone's sheep use of habitat. Highest value are within 125 m from escape terrain, lower value from 125 to 500 m, and very little value beyond 500 m during any season.
2. Escape terrain will be modelled using a TRIM-based digital elevation model (DEM) and then combined with vegetation data from TEM/PEM. Generally, escape terrain will be rocky, barren

areas on slopes between 40° and 70° in steep, rugged coastal areas and on slopes greater than 40° in more interior topography.

3. Sheep may potentially exploit habitat at all elevations within the study area, however winter use will be predominantly in higher unforested BECs (BAFAun, SWBmks), while the lower BWBS and SWBmk will not be readily exploited.
4. In winter, drier site series are more likely to be equated to those with lower snowpack, including areas that may be windswept within the BAFAunp and SWBmks BEC and given higher habitat value due to increased availability of forage.
5. In growing season, more moist and more nutrient rich sites are anticipated to be of higher value due to the increased forage producing capability associated with these areas.
6. During all seasons, structural stage 2 will be given the highest value for food (FD) with 3a also rated as highly suitable. Structural stage 3b will be considered as moderate to moderately high value.
7. Forested habitats (structural stage 4, 5, 6, and 7) with open (<45% canopy closure) will be given low to moderate value for forage (FD) production. Sheep should select for early to late successional growth (cottonwood, aspen, and willow) in disturbed forested areas resulting from fire or forestry (*i.e.*, 1st 20 years or so).
8. Forested habitats with closed canopy (>45%) will be given low value for forage (FD) production. Dense forested habitats are avoided by Stone's sheep as there is no graminoid production.
9. During winter, exposed structural stage 1 may be given moderate value if on a dry site due to potential production of terrestrial lichen, however, it will be nil rated for FD during the growing season. This habitat is especially important in the winter season if no other foraging habitat is available.

Habitat attributes for Stone's sheep are summarized in Table 3.

Table 3. Summary of General Habitat Attributes for Stone's Sheep

Habitat Use	Specific Attributes for Suitable Stone's Sheep Habitat	Structural Stage
Feeding Habitat	*Growing* Subalpine and alpine grassland and shrub habitat at elevations above 1,200 m with adequate grasses, sedges, forbs, browse and mineral licks.	2-3
	Winter Subalpine and alpine habitat with elevations above 1,400 m, southerly or westerly aspects, slopes greater than 30% and snow accumulation less than 30 cm.	2-3
Security Habitat	All habitats in close proximity to escape terrain. Escape terrain includes topography >30%, elevations >1,400 m, and southerly aspects with ample visibility	All

Ratings Adjustments

Final habitat capability and suitability map products will incorporate:

- A combination of the TEM, and PEM food ratings with a capability layer generated from topographic data.

LITERATURE CITED

B.C. CDC. Available: http://srmapps.gov.bc.ca/apps/eswp/ (accessed January 19, 2007). 2006. *B.C. Species and Ecosystems Explorer.* Victoria, B.C.

Backmeyer, R.J. The Peace/Williston Fish & Wildlife Compensation Program. 2000. *Seasonal Habitat Use and Movements Of Transplanted and Source Herd Stone's Sheep, Peace Arm of Williston Reservoir (1990-1994).* Report No. 226.

Corbould, F.B. The Peace/Williston Fish & Wildlife Compensation Program. 1998. *Winter Diets of Stone's Sheep, Rocky Mountain Elk and Mule Deer: Peace Arm and Ospika River Drainages.* Report No. 182.

Corti, P. and D.M. Shackleton. 2002. Relationship between predation-risk factors and sexual segregation in Dall's sheep (*Ovis dalli dalli*). *Canadian Journal of Zoology*, 80: 2108-2117.

Davidson, P.W. and R. Dawson. The Peace Williston Fish & Wildlife Compensation Program. 1990. *Williston Wildlife Compensation Program Management Plan, 1990.* Report No. 5.

Demarchi, R.A. and C.L. Hartwig. British Columbia Ministry of Water, Land and Air Protection, Biodiversity Branch. 2004. *Status of Thinhorn Sheep in British Columbia.* Wildlife Bulletin No. B-119. Victoria, B.C.

Elliott, J.P. 1985. The Status of Thinhorn Sheep (*Ovis dalli*) in British Columbia. In: *Wild Sheep: Distribution, Abundance, Management and Conservation of the Sheep of the World and Closely Related Mountain Ungulates.* p43-47. Whitehorse, Yukon Territory: Northern Wild Sheep and Goat Council.

Geist, V. 1971. *Mountain Sheep: A Study in Behaviour and Evolution.* Chicago, IL: University of Chicago Press.

Gross, J.E., M.C. Kneeland, D.F. Reed and R.M. Reich. 2002. GIS-based habitat models for mountain goats. *Journal of Mammalogy*, 83: 218-228.

Krausman, P.R. and R.T. Bowyer. 2003. Mountain Sheep (*Ovis canadensis and O. dalli*). In: *Wildlife Mammals of North America.* Baltimore, MD: The Johns Hopkins University Press.

Loehr, J. 2006. Thinhorn sheep evolution and behaviour. *Jyvaskyla Studies in Biological and Environmental Studies* 165.

Nichols, L. and F.L. Bunnell. 1999. Natural History of Thinhorn Sheep. In: *Mountain Sheep of North America.* p23-77. Tucson, AZ: University of Arizona Press.

RIC. Resources Inventory Committee, British Columbia Ministry of Environment, Lands and Parks. 1999. *British Columbia Wildlife Habitat Ratings Standards.* Version 2.0. Victoria, B.C.

Seip, D. and F. Bunnell. 1985a. Foraging behaviour and food habits of Stone's sheep. *Canadian Journal of Zoology*, 63(7): 1638-1646.

Seip, D. and F. Bunnell. 1985b. Nutrition of Stone's sheep on burned and unburned ranges. *Journal of Wildlife Management*, 49(2): 397-405.

Seip, D.R. British Columbia Ministry of Environment. 1983. *Foraging Ecology and Nutrition of Stone's Sheep.* Fisheries and Wildlife Reports R-9. Victoria, B.C.

Shackleton, D. 1999. *Hoofed Mammals of British Columbia.* Vancouver, B.C.: UBC Press.

Walker, A. *A Comparison of Winter and Spring Habitat Selection and Rates of Movement Between Two Populations of Stone's sheep (Ovis dalli stonei).* December, 2002. UNBC Report. http://www.gis.unbc.ca/courses/geog413/projects/2002/walkera/project.html.

Walker, A.B.D., K.L. Parker and M.P. Gillingham. 2006. Behaviour, habitat associations, and intrasexual differences of females Stone's sheep. *Canadian Journal of Zoology*, 84: 1187-1201.

Wilson, S.F. British Columbia Ministry of Water, Land and Air Protection, Biodiversity Branch. 2005. *Desired Conditions for Coastal Mountain Goat Winter Range.* Wildlife Working Report No. WR-107. Victoria, B.C.

Wood, M.D. The Peace/Williston Fish & Wildlife Compensation Program. 1999. *Rainbow Rocks Stone's Sheep Health Evaluation: Working Plan.* Report No. 203.

Worley, K., C. Strobeck, S. Arthur, J. Carey, H. Schwantje, A. Veitch and D.W. Coltman. 2004. Population genetic structure of North American thinhorn sheep (*Ovis dalli*). *Molecular Ecology*, 13(9): 2545-2556.

Appendix 4

Species Account for Northern Caribou

Appendix 4 – Species Account for Northern Caribou

Name:	*Rangifer tarandus pop. 15*	
Species Code:	M-RATA-15	
Status*:	**Global:**	G5T4Q – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions. Northern caribou population is Apparently Secure: Uncommon but not rare; some cause for long-term concern due to declines or other factors.
	Provincial:	S3S4 – Vulnerable to Apparently Secure. Uncommon but not rare, and usually widespread in the province and possible cause for long-term concern. Vulnerable due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.
	COSEWIC:	Threatened/Special Concern: A species that is likely to become endangered if limiting factors are not reversed/A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
	BC List:	Blue-listed (northern caribou): Includes any indigenous species or subspecies of Special Concern (formerly Vulnerable) in British Columbia. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered, or Threatened.
	Indentified Wildlife:	Yes. Species at risk in British Columbia that have been designated by the Chief Forester (Ministry of Forests and Range) and Deputy Minister (Ministry of Environment) as requiring special management attention during forest and range operational planning or higher level planning.

** References: (BC CDC 2010)*

DISTRIBUTION

Global Range

Rangifer tarandus has a circumboreal distribution. In northern Europe and Asia, this species is known as Reindeer, and includes domestic, semi-domesticated, and wild populations. In North America, the species is known as Caribou and exists primarily in the wild. Extant wild subspecies in North America are:

1. Barren-ground Caribou from just south of the treeline northward in northernmost Saskatchewan and Manitoba, the Northwest Territories, Nunavut, and western Greenland, totalling over 1 million;
2. Alaska Caribou in northern Yukon and much of Alaska, estimated at approximately 1 million;
3. Peary Caribou on the Arctic islands of the Northwest Territories and western Nunavut, totalling approximately 2,000;
4. Woodland Caribou in southern Yukon, southwestern Northwest Territories, northern, west-central and southeastern British Columbia, extreme northeastern Washington, extreme northern Idaho, west-central and northern Alberta, boreal portions of Saskatchewan and Manitoba, and the boreal and arctic portions of Ontario, Quebec, Newfoundland, and Labrador, totalling over 1 million.

There are three ecotypes of caribou in British Columbia, which have no formal taxonomic designation but are defined on the basis of distinct patterns of habitat use and diet/feeding behaviour. Mountain caribou occur in the Columbia Mountains, Idaho, and Washington, and parts of the western slopes of the Rocky Mountains in British Columbia. Northern caribou are found in mountainous and adjacent low-elevation plateaus in west-central British Columbia and in northern British Columbia west of and in the Rocky Mountains. Boreal caribou are found in boreal forests east of the Rocky Mountains in northeastern British Columbia. The ecotype described in this account is the Northern caribou (Heard and Vagt, 1998).

Provincial Range

Northern caribou occur in west-central British Columbia, in and around the Itcha, Ilgachuz, Rainbow, and Trumpeter mountains as well as in and around northern Tweedsmuir Provincial Park and Entiako Provincial Park and Protected Area. They also occur in the Telkwa Mountains and around the northern part of Takla Lake. Northern caribou range from the Williston Lake area north to the Yukon border and northwest to Atlin, and southeast along the east side of the Rocky Mountains to the Alberta border near Kakwa Park.

Elevation Range

Northern caribou are found at a variety of elevations depending on season and local population. During winter, Northern caribou are generally found either at high elevations above treeline on windswept alpine slopes, or at low elevations in forested habitat beneath significant tree cover. In British Columbia, lower elevation forested habitat ranges from approximately 500 to 1,500 m, while high-elevation winter habitat generally ranges from 1,500 m to over 2,000 m. Some high elevation winter range also includes subalpine forests. During summer, Northern caribou may be found as low as 500 m in coastal areas in west-central British Columbia to over 2500 m in mountainous areas.

Biogeoclimatic units

Northern caribou use a wide range of biogeoclimatic subzones and variants, partly because of the extent of their distribution throughout northern and west-central British Columbia. BAFA (AT) is used by most local Northern caribou populations during both winter and summer. In the northern part of British Columbia, low elevation forested winter ranges occur in the BWBS zone and higher elevation ranges occur in the SWB. In north-central British Columbia, Northern caribou low elevation winter ranges occur in SBS and BWBS, with high elevation ranges in ESSF. In west-central British Columbia, low elevation winter ranges occur in SBS, SBPS, and to some extent in the MS with high elevation ranges in the ESSF. In addition, some Northern caribou summer ranges in west-central British Columbia lie within the MH at higher elevations and CWH at lower elevations.

Broad ecosystem units

Degree of use of broad ecosystem units (BEUs) varies between local populations.

Project Area

- **Ecoprovince:** Northern Boreal Mountains, Sub-Boreal Interior
- **Ecoregions:** Boreal Mountains and Plateaus; Yukon-Stikine Highlands; Skeena Mountains
- **Ecosections:** Tahltan Highland (THH)/Stikine Highland (STH), Southern Boreal Plateau (SBP); Northern Skeena Mountains (NSM)

- **Biogeoclimatic Zones:** Alpine Tundra (ATun), Boreal White and Black Spruce (BWBSdk1), Engelmann Spruce-Subalpine Fir (ESSFmc, ESSFmcp, ESSFwv, ESSFwvp, ESSFvv, ESSFvvp); Interior Cedar Hemlock (ICHwc); Spruce Willow Birch (SWBun, SWBunp).
- **Project Map Scale:** 1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

Population Trends

In 2002, there were an estimated 5,235 Northern caribou within the Southern Mountains National Ecological Area (SMNEA) and 11,000 Northern caribou within the Northern Mountains National Ecological Area (NMNEA) in British Columbia. The Schaft Creek Project falls within the NMNEA. While numbers may have increased slightly since the late 1970s, it is likely that some of the perceived increase is from more intensive survey efforts combined with radio-telemetry studies, which have enabled a more reliable status assessment of this ecotype.

Northern caribou in the NMNEA are distributed within 16 local populations. Metapopulation structure has not yet been assessed for these local populations. In 2002, one local population was declining, seven were stable and the status of eight local populations was unknown. Six local populations have 200 or fewer animals. According to local population risk criteria, 12 local populations are considered Vulnerable and 5 local populations are considered Not at Risk. Little information is available for many of the Northern caribou populations in the NMNEA.

Currently, Northern caribou in the SMNEA are distributed within 13 local populations, which form two metapopulations. The west-central metapopulation includes the Charlotte Alplands, Itcha-Ilgachuz, Rainbows and Tweedsmuir-Entiako. Four local populations have 100 or fewer animals. According to local population risk criteria, two local populations are considered Endangered, six local populations are considered Threatened, four local populations are considered Vulnerable, and one local population is considered Not at Risk. The north-central metapopulation includes the other eight local populations in the SMNEA. In 2002, four local populations were declining, two were stable, four were increasing, and the status of three local populations was unknown. An overall increase in Northern caribou numbers in the SMNEA has been strongly influenced by the increase of the Itcha-Ilgachuz caribou population over the last 8 years (from 1,400 to 2,500), which is the largest local population in the SMNEA.

Diet and Foraging Behaviour

During the winter, Northern caribou forage primarily by digging through the snow for terrestrial lichens of the genera *Cladina*, *Cladonia*, *Cetraria,* and *Stereocaulon*. *Cladina* species are preferred but the other genera are also selected. Northern caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. Arboreal lichen use increases as snow hardness increases later in winter with melt/freeze conditions. During milder winters, frequent melt/freeze episodes could make cratering for terrestrial lichens difficult earlier in the winter, especially when ice crusts form close to the ground, forcing caribou to increase their reliance on arboreal lichens. *Bryoria* spp. are the most abundant arboreal lichens on most Northern caribou winter ranges. Because of the relatively low snowpacks on most Northern caribou winter ranges, caribou can forage on terrestrial lichens in low elevation forested habitats, or on windswept alpine slopes. The use of forbs and graminoids increases in the spring season and summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs.

Reproduction

The mating system of caribou is polygynous, with dominant bulls breeding with a number of cows in late September to mid-October. Rutting group size varies, with up to 20 (or more) for Northern caribou. Anti-predator strategies during calving include calving alone in isolated, often rugged locations and calving on islands in lakes in low elevation forested habitat (Shoesmith and Storey, 1977; Bergerud *et al*., 1984; Bergerud and Page, 1987).

The productivity of caribou is low compared with deer and moose because caribou only have one young per year and calves and most yearlings are not pregnant. The population growth rate rarely exceeds 26% per year. Pregnancy rate of females range from 90 to 97% (Seip and Cichowski, 1996). Gestation is about 230 days, and calves are born in late May or early June. Calves are notably precocious, moving with their mothers shortly after birth. Calf mortality during the first few months of life is high, often 50% or greater. Causes of calf mortality may include predation, abandonment, accidents, and inclement weather. Calves generally make up 27–30% of the population at birth, but by recruitment age (1 yr old, after which mortality generally stabilizes to adult levels), their proportion is generally <20%.

Site Fidelity

Fidelity patterns are complex. Some cows calve in the same location repeatedly, while others shift locations annually. Similarly, rutting sites may be occupied each year or only sporadically. Home ranges rarely remain fixed throughout an animal’s life. Individual caribou typically use a predictable series of activity centres over a season or several years, but most eventually make temporary or permanent shifts to new areas. From spring through early winter, individuals may travel with several other caribou temporarily and then shift to another band. Membership in late-winter aggregations is also inconsistent between years. At the local population level, fidelity to broad landscapes is stronger, but even at this scale there are occasional shifts of individuals and groups to areas that were not used for the past several years. Consistent use of mineral licks has been reported.

Home Range

Home range sizes are highly variable depending on local population size and the horizontal movement distance between summer and winter ranges. In northern and north-central British Columbia, home ranges average 1,100–1,900 km^2 for some populations and 150 km^2 for others (Hatler, 1986; Terry and Wood, 1999; Wood and Terry, 1999; Poole *et al*., 2000).

Movements and Dispersal

Although Northern caribou are characterized by feeding primarily on terrestrial lichens during winter, local populations in British Columbia exhibit variable seasonal movement and habitat use strategies. Some local populations migrate long distances between summer and winter ranges while others do not. Use of high elevation versus low elevation winter ranges differs between local populations, and within local populations between winters. Variations in seasonal behaviour reflect differences in topography, snow accumulation, and availability of low elevation winter ranges between areas. In general, Northern caribou can be described as using habitat during four seasonal time periods in British Columbia. Exact dates vary for each population depending on local conditions.

Snowfall in November triggers caribou movement out of high elevation summer ranges to lower elevation early winter ranges. Early winter ranges may be adjacent to the summer range or at a greater distance. In the early winter, caribou continue to seek out terrestrial forage and avoid deeper snow accumulations where terrestrial forage is difficult to access. Fall migration between summer and winter ranges tends to be diffuse, as caribou migrate in response to snow accumulation.

During early winter, snow depth at low elevations may be highly variable between years. In general, snow depth on low elevation winter ranges is lowest during early winter and gradually increases as the winter progresses. Shallower snow depths in early winter allow caribou to use the higher and more open portions of their forested plateau winter ranges (Itcha-Ilgachuz), or low elevation forested habitats (Wolverine) that are abandoned as snow accumulates during mid- to late-winter.

By mid- and late-winter, caribou have moved to low elevation forested winter ranges, or high elevation alpine/subalpine winter ranges to feed primarily on terrestrial lichens. In low elevation forested habitat, caribou prefer forests where terrestrial lichens are abundant; these are often on drier sites or sites with low productivity and in older forests (80 – 250 years old). Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. At higher elevations, caribou prefer windswept alpine slopes that allow cratering for terrestrial lichens. Subalpine forests are also used for arboreal lichen feeding, and to a lesser extent, terrestrial lichen feeding.

By late April, caribou that migrate between winter and summer ranges begin moving back to calving and summering areas. Spring migration is more concentrated than fall migration both geographically and temporally. During spring, caribou migrate along relatively snow-free low elevation routes to reach summer ranges (Cichowski, 1993; Johnson *et al.*, 2002). Caribou that winter at higher elevations move to lower elevations in spring to take advantage of an earlier green-up. Spring ranges may be adjacent to late-winter ranges or may be a function of migration patterns. Female caribou reach calving areas by late May and calve in early June. Most caribou calve at higher elevations in alpine or subalpine habitat where food availability and quality is relatively poor to reduce predation risk since predators focus on other prey that remain at lower elevations where more nutritious forage is available.

During summer, caribou prefer high elevation habitats but can be found in a variety of habitats at all elevations because snow does not limit movement, and herb and shrub forage are abundant. Consequently, Northern caribou are highly dispersed during summer, more so than during any other season. During the rut in October, some caribou move to rutting areas at higher elevations while others rut within their summer ranges. Portions of some local populations concentrate on rutting ranges, usually in open alpine or subalpine habitat.

Although studies of radio-collared Northern caribou populations indicate that range use by adjacent local populations may overlap, especially during winter, all radio-collared caribou return to their summering areas. Northern caribou may be dispersing between local populations but no studies have yet reported any evidence of dispersal by radio-collared animals.

HABITAT USE – LIFE REQUISITES

Structural Stage

Structural stage 7 is consistently preferred throughout most of the year for forage, predator avoidance (typically good lines of sight and only dispersed populations of other ungulates), ease of travel, snow interception in early winter, and possibly heat avoidance in the summer (Apps and Kinley, 2000a, b, c;

Apps *et al.*, 2001). Structural stage 5 is particularly good for terrestrial lichen forage, while the older and more open habitats of stage 6 also provide useful habitat. Other structural stages are used to varying degrees. Structural stage 1a and 1b are used for calving sites when occurring in rough terrain (June), predator avoidance (good line of sight), insect avoidance (spring and summer), and resting areas. Structural stages 2 and 3a provide moderate to high forage value in spring and summer but also provide forage for other ungulates, especially below treeline. The least valuable stands to caribou are those in stages 3b and 4, where line of sight is poor for predator avoidance and forage value is generally low for caribou but can be high for other ungulates, especially moose (3b). In some cases, these stages may form partial barriers to movement and act to isolate adjacent patches of habitat from one another.

Table 1 summarizes the life requisites in terms of TEM attributes.

Table 1. Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Caribou

Life Requisite	TEM Attribute
Food Habitat	• Site: ecosystem type, elevation, slope, aspect, structural stage • Soil/terrain: terrain texture, soil drainage • Vegetation: Percent cover by layer, species list by layer, cover for each species for each layer
Security Habitat	• Site: ecosystem type, elevation, slope, aspect, structural stage • Soil/terrain: terrain texture • Vegetation: total percent cover, percent cover by layer

Feeding Habitat (FD)

Foraging habitat is provided by large, contiguous patches of old forest. Specific values of such areas are as follows:

1. Arboreal hair lichen such as Bryoria is usually abundant only in older forests. Terrestrial lichens such as Cladina, Cladonia, and Cetraria are often most abundant in mature and older forests but are also abundant in younger forests on some site types.
2. Old trees with large crowns provide good snow interception, which facilitates cratering and movement in winter.
3. The more contiguous that foraging habitat is, the less energy is expended in moving between patches.
4. The suite of forage plants in old forest is different than that available in other habitat types.

Thus, old forests provide more than simply lichen for late-winter foraging, and old forests are selected across seasons and a range of spatial scales. Old stands of lodgepole pine (*Pinus contorta*) or lodgepole pine and white spruce (*Picea glauca*) in low elevation forested habitat are widely used by most local populations.

Northern caribou use alpine habitat during summer and winter. During summer, emergent vegetation provides nutritious forage and in winter, alpine habitat yields terrestrial lichens.

<u>Mineral Licks</u>

Another vulnerable habitat element is mineral licks. Licks are used consistently between years, but can be effectively located only by monitoring local populations of caribou.

Security Habitat (SH)

Old forests typically have good visibility relative to younger forests, due to open stand architecture, leading to an improved ability to detect those predators that do occur there. Old forests and peatland complexes also provide a cooler microclimate during summer. During winter, windswept alpine slopes provide good visibility for detecting predators. In summer, open vistas also provide good visibility for detecting predators. All three ecotypes of Woodland caribou avoid predation by staying away as possible from habitat of their predators, especially during calving. Northern caribou move into high elevation habitat for calving, presumably to avoid high densities of predators.

There are generally fewer elk (*Cervus elaphus*), deer (*Odocoileus* spp.), or moose (*Alces alces*) within old-growth forests than in or near non-forested areas (avalanche tracks, meadows, shrubby riparian zones, recent clearcuts), because this more abundant suite of other ungulate species tends to concentrate in early seral sites with abundant shrubs and forbs. Thus, the predators of other species also tend to occur less commonly within old forest than at the edge or outside of old forest or in peatland complexes.

Habitat fragmentation due to the creation of early seral patches within old forest is likely to bring other prey species close to caribou, resulting in a greater incidence of predator encounters (Kinley and Apps, 2001). The potential for increased prey populations on some very dry Northern caribou ranges may be somewhat reduced where shrub regeneration following disturbance is less pronounced (*e.g.*, Itcha-Ilgachuz caribou winter range). The major habitat variable that affect numbers is space to avoid predation (Bergerud, 1980; Bergerud *et al*., 1984; Bergerud and Page, 1987; Bergerud, 1992).

<u>Breeding</u>

Calving sites and rut locations are vulnerable habitat elements, but predicting their locations by habitat type is not feasible. Calving sites are dispersed, may vary between years, and appear to be defined primarily on the basis of isolation from other caribou, other ungulates, and predators. Rutting sites are likely to be more consistent between years, but can be effectively located only with site specific knowledge gained by monitoring individual caribou populations.

The most critical aspect of Northern Caribou ranges is access to undisturbed high elevation calving grounds. In fact, access to undisturbed high elevation calving areas where caribou can distance themselves from other prey and predators, is the common feature among Northern Caribou local populations. Historically occurring local populations of Northern Caribou without access to high elevation calving ranges no longer exist in British Columbia.

SEASONS OF USE

Table 2 summarizes the life requisites of caribou for each month of the year, and Table 3 summarizes the attributes for structural stages.

The winter season, both early and late winter, will be the focus of habitat mapping.

Table 2. Monthly Life Requisites for Caribou

Life Requisites	Month	Season*
Food, Security	January	Early/Late Winter
Food, Security	February	Late Winter
Food, Security	March	Late Winter

(continued)

Table 2. Monthly Life Requisites for Caribou (completed)

Life Requisites	Month	Season*
Food, Security	April	Late Winter/Spring
Reproducing (birthing) and Security	May	Spring
Reproducing (birthing) and Security	June	Summer
Food, Security	July	Summer
Food, Security	August	Summer
Food, Security	September	Summer
Food, Security	October	Summer/Early Winter
Food, Security	November	Early Winter
Food, Security	December	Early Winter

** Seasons defined for Mountain caribou in the Northern Interior Forest Region as per Cichowski et al (2004).*

Table 3. Summary of General Habitat Attributes for Caribou

Habitat Use	Specific Attributes for Suitable Caribou Habitat	Structural Stage
Feeding Habitat	Large, contiguous tracts of mature forest with abundant arboreal lichen; mature stands of lodgepole pine (*Pinus contorta*) and white spruce (*Picea glauca*) in low elevation areas; alpine habitat with terrestrial lichens	2,3a, 5-7
Security Habitat	Mature forests with unrestricted sightlines, windswept alpine slopes, open vistas	1a/1b (esp. during calving), 7

Ratings

There is a moderately high level of knowledge of the habitat requirements of caribou in British Columbia to warrant a 6-class rating scheme (RIC, 1999).

Provincial Benchmark (winter season)
Ecosection: Muskwa Foothills (MUF)
Biogeoclimatic Zone: AT
Habitats: AG – Alpine grassland

Provincial Benchmark (growing season)
Ecosection: Muskwa Foothills (MUF)
Biogeoclimatic Zone: AT
Habitats: AG – Alpine grassland

Ratings Assumptions

1. Forested habitats will be used in early winter, and higher elevation treeless areas will be used in late winter.
2. Warmer aspect slopes will be favoured over cooler aspect slopes.
3. Windswept and exposed areas will be favoured over more sheltered areas in winter due to better snow-shedding and more compact snowpacks.
4. Mature stands of forest (structural stage 5+) will be favoured over younger forests due to higher arboreal lichen production.

LITERATURE CITED

Apps, C.D. and T.A. Kinley. Columbia Basin Fish and Wildlife Compensation Program, Nelson, B.C. and British Columbia Ministry of Environment, Prince George, B.C. 2000a. *Mountain Caribou Habitat Use, Movements, and Factors Associated with GPS Location Bias in the Robson Valley, British Columbia.*

Apps, C.D. and T.A. Kinley. East Kootenay Environment Society, Kimberley, B.C., and Tembec Industries Inc., Cranbrook, B.C. 2000b. *Multi-Scale Habitat Associations of Mountain Caribou in the Southern Purcell Mountains, British Columbia.*

Apps, C.D. and T.A. Kinley. British Columbia Ministry of Environment, Lands and Parks, Williams Lake, B.C. 2000c. *Multiscale Habitat Modeling for Mountain Caribou in the Columbia Highlands and Northern Columbia Mountains Ecoregions, British Columbia.*

Apps, C.D., B.N. McLellan, T.A. Kinley and J. Flaa. 2001. Scale-dependent habitat selection by mountain caribou in the Columbia Mountains, British Columbia. *Journal of Wildlife Management*, 65: 65-77.

B.C. CDC. *B.C. Species and Ecosystems Explorer.* British Columbia Ministry of Environment. Victoria, B.C. http://srmapps.gov.bc.ca/apps/eswp/ (accessed January 19, 2007).

Bergerud, A.T. 1980. A Review of the Population Dynamics of Caribou and Wild Reindeer in North America. In: *Proceedings of the Second International Reindeer/Caribou Symposium, held in Roros, Norway September 17-21, 1979*: Directoratet for vilt og ferskvannsfisk, Trondheim, Norway. p556-581.

Bergerud, A.T. 1992. Rareness as an Antipredator Strategy to Reduce Predation Risk for Moose and Caribou. In: *Wildlife 2001: Populations.* p1008–1021. New York, N.Y.: Elsevier Applied Science.

Bergerud, A.T., H.E. Butler and D.R. Miller. 1984. Antipredator tactics of calving caribou: dispersion in mountains. *Canadian Journal of Zoology*, 62: 1566-1575.

Bergerud, A.T. and R.E. Page. 1987. Displacement and dispersion of parturient caribou at calving as antipredator tactics. *Canadian Journal of Zoology*, 65: 1597-1606.

Cichowski, D.B. British Columbia Ministry of Forests. 1993. *Seasonal Movements, Habitat Use, and Winter Feeding Ecology of Woodland Caribou in West-Central British Columbia.* Land Management Handbook No. 79. Victoria, B.C.

Cichowski, D.B., T. Kinley and B. Churchill. Province of British Columbia. 2004. *Identified Wildlife Management Strategy: Accounts and Measures for Managing Identified Wildlife - Northern Interior Forest Region.* Victoria, B.C.

Hatler, D.F. 1986. Studies of Radio-collared Caribou in the Spatsizi Wilderness Park Area, British Columbia. *Spatsizi Association Forest Biology Research Report*, 3: 202.

Heard, D.C. and K.L. Vagt. 1998. Caribou in British Columbia: A 1996 status report. *Rangifer*, Special Issue 10: 117–123.

Johnson, C.J., K.L. Parker, D.C. Heard and M.P. Gillingham. 2002. A multiscale behavioral approach to understanding the movements of woodland caribou. *Ecological Applications*, 12(6): 1840-1860.

Kinley, T.A. and C.D. Apps. 2001. Mortality patterns in a subpopulation of endangered mountain caribou. *Wildlife Society Bulletin*, 29: 158-164.

Poole, K.G., D.C. Heard and G. Mowat. 2000. Habitat use by woodland caribou near Takla Lake in central British Columbia. *Canadian Journal of Zoology*, 78: 1552-1561.

RIC. Resources Inventory Committee, British Columbia Ministry of Environment, Lands and Parks. 1999. *British Columbia Wildlife Habitat Ratings Standards.* Victoria, B.C.

Seip, D.R. and D.B. Cichowski. 1996. Population ecology of caribou in British Columbia. *Rangifer*, Spec. Issue No. 9: 73-80.

Shoesmith, M.W. and D.R. Storey. 1977. Movements and associated behaviour of woodland caribou in central Manitoba. *Proceedings of the International Congress on Game Biology*, 13: 51-64.

Terry, E.L. and M.D. Wood. Peace/Williston Fish and Wildlife Compensation Program. 1999. *Seasonal Movements and Habitat Selection by Woodland Caribou in the Wolverine Herd, North-Central British Columbia. Phase 2: 1994-1997.* Report Number 204.

Wood, M.D. and E.L. Terry. Peace/Williston Fish and Wildlife Compensation Program. 1999. *Seasonal Movement and Habitat Selection by Woodland Caribou in the Omineca Mountains, North-Central British Columbia. Phase 1: The Chase and Wolverine Herds (1991-1994).* Report Number 201.

Appendix 5

Species Account for Grizzly Bear

Appendix 5 – Species Account for Grizzly Bear

Name:	*Ursus arctos horribilis*	
Species Code:	M-URAR	
Status*:	**Global:**	G4 – Apparently Secure. Uncommon but not rare, and usually widespread in the province, but possible cause for long-term concern.
	Provincial:	S3 – Vulnerable. Rare and local, found only in a restricted range, or some other factor(s) make it susceptible to extirpation or extinction.
	COSEWIC:	SC – Special Concern (May 2002). Characteristics make it particularly sensitive to human activities or natural events.
	BC List:	Blue-listed. Includes any indigenous species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered, or Threatened.
	Indentified Wildlife:	Yes. Species at risk in British Columbia that have been designated by the Chief Forester (Ministry of Forests and Range) and Deputy Minister (Ministry of Environment) as requiring special management attention during forest and range operational planning or higher level planning.

** References: (BC CDC 2010)*

DISTRIBUTION

Provincial Range

Grizzly bears are found throughout British Columbia, except the Georgia Depression Ecoprovince, Vancouver Island and Queen Charlotte Islands. They are currently extirpated from parts of their former range including south-western portions of mainland B.C. around the Fraser Valley, a large section of south-central B.C., and a smaller area in mid-eastern B.C. and are considered to be threatened in many of the surrounding areas (Hamilton and Bunnell, 1992). Over four-fifths of the land area in British Columbia is range land for grizzlies. Grizzly bears can be found in all biogeoclimatic ecosystem classification zones within B.C. except for Coastal Douglas-fir (CDF), Bunchgrass (BG), and Ponderosa Pine (PP) (Stevens, 1995).

Elevation Range

Grizzly bears occupy a broad elevational range, from sea level and river-valley riparian areas to high level alpine regions (Stevens, 1995).

Provincial Context

Grizzly bears occur dispersed throughout their range. Populations are rated as vulnerable or threatened. The current provincial population of grizzly bears is estimated to be 16,887 (Hamilton et al., 2004). This number indicated a slight increase in the population from the previous year's estimate of 13,800 (B.C. WLAP, 2003), and an even greater increase compared to the 1987 population estimate of 6,000 to 7,000 (Fuhr and Demarchi, 1990). The British Columbian population is estimated to comprise approximately one half of the Canadian population of grizzly bears (B.C. MELP, 1995).

Project Area

- **Ecoprovince:** Northern Boreal Mountains, Sub-Boreal Interior
- **Ecoregions:** Boreal Mountains and Plateaus; Yukon-Stikine Highlands; Skeena Mountains
- **Ecosections:** Tahltan Highland (THH)/Stikine Highland (STH), Southern Boreal Plateau (SBP); Northern Skeena Mountains (NSM)
- **Biogeoclimatic Zones:** Alpine Tundra (ATun), Boreal White and Black Spruce (BWBSdk1), Engelmann Spruce-Subalpine Fir (ESSFmc, ESSFmcp, ESSFwv, ESSFwvp, ESSFvv, ESSFvvp); Interior Cedar Hemlock (ICHwc); Spruce Willow Birch (SWBun, SWBunp).
- **Project Map Scale:** 1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

Grizzly bears are a North American subspecies of the brown bear. Varying from creamy yellow to dark brown, these large bears are known for their prominent shoulder hump, rounded head, and small, heavily furred ears. Their weight is dependent upon season and food availability; they are generally 30 to 40% heavier in the fall than in the spring. Adult male grizzly bears weigh approximately 220 kg in spring; females are smaller at 130 kg (B.C. WLAP, 2003).

Grizzly bears are omnivorous and opportunistic in their feeding habits (McLellan and Hovey, 2001). Grasses, herbs, roots, corns, and berries comprise 60 to 90 percent of grizzly bear diet (Bunnell and McCann, 1993). Habitat selection is governed by season and forage availability during the growing season. Forest cover is required for security, but its importance varies according to individual vulnerability and type of cover. Grizzly bear diet also changes with the seasons to make use of the most digestible foods.

Some variation occurs in feeding patterns between coastal and interior grizzly bears. On the coast, beginning in the spring, grizzly bears feed on early green vegetation such as skunk cabbage (*Lysichiton americanum*) and sedges located in the estuaries and seepage sites that become snow-free first. As the season advances, bears follow the receding snow up the avalanche chutes and feed on emerging vegetation and roots. Ripe berries attract grizzlies onto the floodplain and sidehills where they eat devil's club (*Oploplanax horridus*), salmonberry (*Rubus spectabilis*), raspberry (*Rubus* sp.), black twinberry (*Lonicera involucrata*), elderberry (*Sambucus* sp.), and a variety of blueberries (*Vaccinium* sp.). Grizzly bears feed on salmon as they become available in the spawning channels and continue to do so until late fall. After the main salmon runs in August and early September, they often feed on late-senescing plants, autumn berries, roots and insects before hibernation (B.C. WLAP, 2003).

In the interior during spring, grizzly bears congregate in moist, lower elevation sites such as wetlands and avalanche chutes, feeding on the roots of hedysarum, carrion and opportunistically prey on winter-weakened ungulates. As the green vegetation emerges, the bears begin to graze on grasses, horsetails, rushes and sedges. In the summer, bears switch to berries, feeding mainly on soopolallie (*Shepherdia canadensis*), huckleberries (*Vaccinium* sp.) and blueberries in subalpine burns. Interior bears have less access to salmon than coastal grizzly bears, but they make more use of alternate foods like lily bulbs, sweet-vetch roots, and ground squirrels. They also seek out the carcasses of ungulates that have died during the winter and prey on deer fawn and moose and elk calves born in the spring. Interior grizzly bears forage at a variety of elevations, from valley bottoms to alpine meadows (B.C. WLAP, 2003).

Home Range

Grizzly bears, except females with cubs, are solitary for most of the year except during mating season. The area that a grizzly bear will use as a home range is dependent on factors such as sex, age, social status, population levels, and habitat availability (LeFranc *et al.*, 1987). Large male grizzly bears are highly mobile and can range over hundreds of kilometres a year, while sub-adults or females with cubs maintain a much smaller home range, moving between habitat as new habitats become productive (LeFranc *et al.*, 1987; Simpson, 1992; MacHutchon *et al.*, 1993). The amount of overlap between adjacent grizzly bear home ranges is variable and dependent on the region, sex, age and reproductive and social status of the animal (LeFranc *et al.*, 1987). Mace and Waller (1997) found that the amount of habitat overlap between adjacent females in Montana was between 0 and 94% (avg. 24%), and that 76% of the females showed no territoriality between animals. Interactions between males and females showed that numerous female home ranges were enclosed in a single male home range. Overlap zones for females and males were also shown to contain important habitat features such as avalanche chutes, grass/rock lands, and shrub lands (Mace and Waller, 1997). Home range size for adult females is 25 to 200 km^2, while adult males range from 60 to 700 km^2, although estimates of up to 2300 km^2 have been reported (McLellan, 1981; Demarche et. al., 2000).

Reproduction

Breeding occurs between the end of April and end of June (Mundy and Flook, 1973; Aune, 1985), but because of delayed implantation, cubs are born in the den between January and March. The female bear and her cubs will stay in the den in hibernation until mid-April on the coast of B.C., and until May in the interior of the province. The average age of first reproduction for females in southeastern B.C. is 6 years, the time period between litters is 2.7 years, and the mean number of cubs per litter is 2.3 (McLellan, 1988). In southern grizzly populations, cubs tend to stay with their mothers for approximately 2.5 years. The life span of the grizzly is variable but estimated to last approximately 30 years with reproduction possible until a maximum of 25 years (B.C. WLAP, 2003).

Grizzlies' reproductive rate is the one of the lowest of all the land mammals in North America, with litters ranging from 1 to 4 cubs and averaging 2 cubs (LeFranc *et al.*, 1987). McLellan (1989) found litter sizes in southeast B.C. averaged 2.26 cubs in 31 litters, while MacHutchon *et al.* (1993), reported 2.4 cubs per litter (n = 8) in B.C. coastal forests. A female grizzly will usually have her first litter when she is 5-7 years old (Craighead *et al.*, 1974; McLellan and Shackleton, 1989; Eberhardt *et al.*, 1994; Hovey and McLellan 1996 in McLellan and Hovey, 2001). After this, females remain fertile throughout the remainder of their life but are only receptive every 3 to 4 years (Craighead *et al.*, 1995).

Hibernating Habitat

Grizzly bears den from mid-October to May. Generally, adult males remain active longer and emerge from dens earlier than females, especially females with cubs (Wielgus, 1986). Grizzly bears sometimes dig more than one winter den before they are satisfied and occasionally move to a new site during the winter (B.C. WLAP, 2003). Grizzly bears dig dens at or near the treeline, and below the ridge crest where mid-winter thaws are unlikely (Vroom *et al.*, 1977). The dens are dug horizontally into the ground on steep slopes (20 - 40°) where prevailing winds result in deep, persistent snow cover, which provides insulation (Craighead and Craighead, 1972; Vroom *et al.*, 1977; B.C. WLAP, 2003).

The elevation of most dens on the B.C. coast is between 350 and 850 m, and between 2,000 and 2,350 m in the Rockies. Hibernation habitats tend to be sloped, and have dry, stable soil conditions that remain frozen during the winter (Bunnell and McCann, 1993). Grizzly bears usually den in the same area each year, but dig a new den each winter. Dens may be up to 4 m long and are characterized by a mound of excavated soil, an entrance tunnel about 0.7 m in diameter and a chamber that is 1 to 2 m wide (B.C. WLAP, 2003). Dens may be clustered in areas that have favourable environmental conditions (Vroom *et al.*, 1977; B.C. WLAP, 2003).

In most cases, dens are dug in well-drained sites and areas of dry, stable soil to avoid flooding. Supporting vegetation overhead consists of root-mat forming sod, shrubs or trees that will help prevent roof collapse. Occasionally, grizzly bears will den in a dug out area in the roots of a large conifer (B.C. WLAP, 2003). McLoughlin *et al.* (2001) found that esker landforms were selected preferentially over other sites, highlighting the importance of well-drained sites.

During hibernation, bears may not eat, drink, defecate or urinate for a period of 3 to 5 months and respiration, heart rate and core body temperature are significantly reduced (Sugg, 1987). Pregnant females give birth while in the den. The location of the den site and the physical condition of the female are important factors in maintaining pregnancy and cub survival.

HABITAT USE – LIFE REQUISITES

The life requisites that will be rated for grizzly bear are: feeding and security/thermal, which are described in detail below.

Feeding Habitat (FD)

Grizzly bears are omnivores, foraging for high nutrient, high protein plants and animals. Feeding requirements for grizzly bears are tied closely to food availability and season.

<u>Early Spring</u>

Early spring diet for grizzly bears consists of ungulates and roots (*e.g.*, *Hedysarum* spp., *Claytonia lanceolata, Erythronium grandiflorum*) (Table 1). Spring foods consist mainly of new, green vegetation and winter-killed or weakened ungulates. Forest openings such as meadows, wetlands and seepage areas, and southerly and westerly aspect herb-dominated avalanche paths provide the most abundant vegetable foods. Riparian areas are heavily-used, specifically low gradient areas with back channels and meandering streams, which provide the most favourable conditions for succulent forb and grass production (Ash, 1985).

Table 1. Plant and Other Food Species Consumed by Grizzly Bears in British Columbia

Common Name	Scientific Name
Trees and Shrubs	
Alpine fir	*Abies lasiocarpa*
Saskatoon	*Amelanchier alnifolia*
Western service berry	*Amelanchier alnifolia*
Kinnikinnick	*Arctostaphylos uva-ursi*
Red-osier dogwood	*C. stolonifera*
Bunchberry dogwood	*Cornus canadensis*
Crowberry	*Empetrum nigrum*
Black twinberry	*Lonicera involucrata*
Devil's club	*Oploplanax horridus*
Bog cranberry	*Oxycoccus oxycoccos*
White spruce	*Picea glauca*

(continued)

Table 1. Plant and Other Food Species Consumed by Grizzly Bears in British Columbia (continued)

Common Name	Scientific Name
Quaking aspen	*Populus temuloides*
Black cottonwood	*Populus trichocarpa*
Northern gooseberry	*R. oxyacanthoides*
Buckthorn	*Rhamnus alnifolia*
Black gooseberry	*Ribes lacustre*
Red raspberry	*Rubus idaeus*
Salmonberry	*Rubus spectabilis*
Scouler willow	*S. scouleriana*
Sitka mountain ash	*S. sitchensis*
Willow	*Salix* spp.
Red elderberry	*Sambucus racemosa*
Soopolallie	*Shepherdia canadensis*
Western mountain ash	*Sorbus scopulina*
Highbush cranberry/Lowbush cranberry	*V. pauciflorum*
Dwarf blueberry	*Vaccinium caespitosum*
Huckleberry	*Vaccinium* spp.
Moosewood	*Viburnum edule*
Forbs	
Angelica	*Angelica lucida*
Asters	*Aster sp.*
Vetch	*Astragalus* spp.
Fireweed	*Epilobium angustifolium*
Cow parsnip	*Heracleum lanatum*
Peavine	*Lathyrus* spp.
Desert-parsley	*Lomatium* spp.
Skunk Cabbage	*Lysichiton americanum*
Sweet cicely	*Osmorhiza* sp.
Colts foot	*Petasites* spp.
Rose hips	*Rosa* spp.
Solomon's seal	*Smilacina stellata*
Dandelion	*Taraxacum* spp.
Forbs	
White Clover	*Trifolium repens*
Clover	*Trifolium* spp.
Stinging nettle	*Urtica dioica*
Ferns	
Alpine lady fern	*Athyrium alpestre*
Spiny wood fern	*Dryopteris expansa*
Grasses and sedges	
Bromes	*Bromus* spp.
Sedges	*Carex* spp.
Tufted hairgrass	*Deschampsia caespitose*
Horsetails	*Equiseum* spp.

(continued)

Table 1. Plant and Other Food Species Consumed by Grizzly Bears in British Columbia (completed)

Common Name	Scientific Name
Grass	*Gramineae spp.*
Bluegrass	*Poa* spp.
Spike trisetum	*Trisetum spicatum*
Other food sources	
Moose	*Alces alces*
White sucker	*Castomomus commersoni*
Ants	*Formicidae*
Marmots	*Marmota* spp.
Voles	*Microtus spp.*
Mule deer	*Odocoileus hemionus*
Salmonids	*Oncorhynchus spp.*
Mountain goats	*Oreamnos americanus*
Caribou	*Rangifer tarandus*
Wasps	*Vespidae*

Source: Fuhr and Demarchi, 1990; Beaudry et al., 2001.

Late Spring/Early Summer

Important late spring and early summer foods are horsetails (*Equisetum* spp.), graminoids, willow catkins (*Salix* spp.), and lush forbs. Preferred forbs are cow parsnip (*Heraculum lanatum*), peavine (*Lathyrus* spp.), clover (*Trifolium* spp.), colts foot (*Petasites* spp.), desert-parsley (*Lomatium* spp.), angelica *(Angelica lucida),* and dandelion (*Taraxacum* spp.) (Mace and Bissell, 1986; Wielgus, 1986; McLellan and Hovey, 1995; McCann, 1997) (Table 1). Important habitats are avalanche chutes, low to mid elevation riparian habitats, wetlands, alpine meadows, seep areas, cutblocks, and floodplains.

Summer

Wet areas providing cow parsnip, sweet vetch and nettles on northern aspects continue to be used during the summer. Berries are most abundant at higher elevations; however, some low elevation habitats also supply some berries and a variety of other foods. Huckleberries (*Vaccinium* spp.), soopolallie (*Shepherdia canadensis*), and saskatoon (*Amelanchier alnifolia)* are the most important, while kinnikinnick (*Arctostaphylos urva-ursi),* crowberry (*Empetrum nigrum*), cranberry (*Viburnum edule*), buckthorn (*Rhamnus alnifolia*) and rose hips (*Rosa* spp.) are also consumed (Mace and Bissell, 1986; McLellan and Hovey, 1995; MacHutchon, 1996; McCann, 1997) (Table 1). Berries tend to be most abundant in natural openings as well as those areas that have been recently disturbed through fire or clear-cut logging. As a result, structural stage can be an important variable when correlated with the availability of berries. Regenerating burns and 10 to 20 year old clear-cuts typically provide abundant berries and receive relatively high summer use. In forested habitats, canopy closures of 20-50% are optimal for berry production (Ash, 1985).

Fall

Salmon spawning streams and rivers are very important to bears in the fall as fish are a large component of the grizzly bears diet. Late berry producing shrubs such as red osier dogwood and crowberry, persistent berries such as cranberry, and root and tuber producing species such as cow parsnip are consumed by grizzlies in the fall season. Coarse woody debris in all habitats is a source of insects and larvae. Grizzly bears will also opportunistically eat vegetation in order to prepare for hibernation.

Security Habitat (SH)

Security habitat for grizzly bears is variable, but is used to avoid intraspecific (*i.e.*, bear to bear) and interspecific (*e.g.*, bear to human) contact.

1. Bear/Bear avoidance: Forested habitats are used as security from other bears during the growing season. Therefore, forested habitats adjacent to early successional foraging areas are important (Jonkel, 1987). Females with cubs will tend to use forested habitats older than pole-sapling with diverse understories, and isolated rugged habitats in order to avoid aggressive males while foraging (Pearson, 1975).
2. Bear/human avoidance: Habitats adjacent to high-traffic roads (paved or active logging roads) are avoided especially if no forest cover exists nearby (McLellan and Mace, 1985; McLellan and Shackleton, 1988). Higher quality habitats adjacent to roads or other areas of human disturbance may not be used if adequate forest cover is not available (McLellan and Shackleton, 1989).

Thermal Habitat (TH)

Bears will seek shelter from precipitation in forested habitats. During hot weather, bears will bed in shady areas such as forests with coarse woody debris, under rock overhangs, or tall shrubs. During the summer, grizzly bears use forests of structural stage 4+ for shade. Water sources, such as ponds, streams, and wetlands are important cooling environments. Areas of dense cover (*e.g.*, alder thickets, riparian vegetation and dense coniferous forest) are used for bedding (Craighead *et al.*, 1983). Generally, these habitat features are too small to map as TEM polygons, and are difficult to rate. If located, these features will be identified in the 'Evidence of Use' section in the Wildlife Habitat Assessment Form.

<u>Seasons of Use</u>

Grizzly bears require different feeding, security and thermal habitat throughout the year. Table 2 summarizes the life requisites for grizzly bear for each month of the year for the Coast and Mountains and Sub-Boreal Interior ecoprovinces for the seasons in which they will be rated.

Table 2. Monthly Life Requisites for Grizzly Bear

Life Requisites	Month	Season*
Hibernating	January	Winter
Hibernating	February	Winter
Hibernating	March	Winter
Food, Security	April	Winter/Spring
Food , Security	May	Winter/Spring
Food , Security, Thermal	June	Spring/Summer
Food , Security, Thermal	July	Summer
Food , Security, Thermal	August	Summer
Food , Security, Thermal	September	Fall

(continued)

Table 2. Monthly Life Requisites for Grizzly Bear (completed)

Life Requisites	Month	Season*
Food , Security, Thermal	September	Fall
Food , Security, Thermal	October	Fall/Winter
Hibernating	November	Winter
Hibernating	December	Winter

**Seasons defined for Coast and Mountains, Northern Boreal Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (Appendix B, RIC 1999).*

Three seasons will be rated for Grizzly Bears: Spring, Summer, and Fall.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Table 3 outlines how each life requisite relates to specific ecosystem attributes (*e.g.*, site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 3. Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite of Grizzly Bears

Life Requisite	TEM Attribute
Feeding Habitat (FD)	o Site: site disturbance, elevation, slope, aspect, structural stage, site modifier
	o Soil/terrain: flooding regime, terrain texture
	o Vegetation: Percent cover by layer, species list by layer, structural stage modifier, stand composition, available forage
Security/Thermal (ST)	o Site: slope, structural stage
	o Vegetation: total percent cover, percent cover by layer, stand composition

Ratings

There is a detailed level of knowledge of the habitat requirements of grizzly bears in British Columbia which warrants a 6-class rating scheme (RIC, 1999). Table 4 summarizes the general habitat requirements of grizzly bears.

Table 4. Summary of General Habitat Attributes for Grizzly Bear

Habitat Use	Specific Attributes for Suitable Grizzly Bear Habitat	Structural Stage
Early Spring Feeding	o high forage plant diversity in lush herb layer with an abundance of grasses, sedges (Carex spp.) horsetails (Equisetum spp.); cow parsnip, stinging nettle, hellebore, dandelion, skunk cabbage, etc.	2-3, 6-7
	o See Table 1 for detailed preferred forage species).	
Late Spring/ Summer Feeding	o 15-30% total shrub cover	3, 6-7
	o shrub species composition dominated (>15%) by Vaccinium or other berry producers (e.g., soopolallie, thimbleberry, twinberry, devil's club, elderberry, high bush cranberry)	
	o shrub height < 2.5 m	
	o high coarse woody debris	
Fall Feeding	o salmon spawning areas	-
	o berry-producing areas close to salmon streams	
	o high coarse woody debris	
	o moist forests with abundant forage plants	

(continued)

Table 4. Summary of General Habitat Attributes for Grizzly Bear (completed)

Habitat Use	Specific Attributes for Suitable Grizzly Bear Habitat	Structural Stage
Security/Thermal Cover	o tree species composition mixed conifer/deciduous o mature conifer o shrub cover >50% o canopy closure >66%	3, 5-7
Hibernating Habitat	o deep, fine-textured soils o dry, moisture-shedding site o higher elevation, steep slope site	6,7

Provincial Benchmark (coastal British Columbia)
Ecosection: Kitimat Ranges (KIR)
Biogeoclimatic Zone: CWHvm1
Broad Ecosystem Unit: Coastal Western Hemlock-wet maritime

Habitats: skunk cabbage sites; floodplains, wetlands, estuaries/beaches; the Khutzymateen Valley is considered to be grizzly bear benchmark habitat in British Columbia.

Provincial Benchmark (interior British Columbia)
Ecosection: Border Ranges (BRR)
Biogeoclimatic Zone: ESSFdk; MSdk
Broad Ecosystem Unit: Engleman Spruce Subalpine Fir dry cool; Montane Spruce dry cool

Habitats: avalanche chutes, the Flathead Valley is considered to be interior grizzly bear benchmark habitat in British Columbia.

Ratings Assumptions

1. Grizzly bears make discrete choices of the plant food items consumed, and therefore, availability and abundance of food items are key factors in habitat selection by the bear (Hadden et al., 1985).
2. Areas in close proximity and accessibility to salmon spawning streams will be considered high habitat suitability areas.
3. Feeding habitats are assumed to be the limiting factors for grizzly bears, and thus an ecosystems production of vegetative forage will be equated to its habitat suitability.
4. Although it is recognized that other factors such as predation, disease, intra/inter specific competition and hunting influence grizzly bear population growth and distribution, this model does not include these factors. Grizzly bear habitat use is strongly influenced by intraspecific social interactions and the presence and activities of people. Grizzly bear habitat selection takes place at multiple scales and preferred bedding, hibernating, feeding and security/thermal habitats are scattered throughout large home ranges (Hamilton & Bunnell, 1992).
5. Ecosystem units with high forage plant diversity and abundance in a lush herb layer with an abundance of grasses, sedges (Carex spp.), horsetails (Equisetum spp.), skunk cabbage, cow parsnip, stinging nettle, hellebore, and dandelion represents class (1) grizzly bear spring,

feeding habitat. Habitat with lower plant diversity and abundance will be rated poorer than class (1).

6. Ecosystem units with substantial shrub cover dominated (i.e., >15%) by Vaccinium or other berry producers (e.g. soopolallie, thimbleberry, twinberry, devil's club, elderberry, high bush cranberry), and high concentrations of root species will be rated class (1) grizzly bear summer, feeding habitat.
7. Ecosystem units with high late-berry producing areas (e.g. red-osier dogwood, high brush cranberry), and high concentrations of species producing below ground forage (tubers and roots) will be rated moderately high (2) to high (1) for fall use.
8. Ecosystem units with high concentrations of root species will be rated moderately high (2) to high (1) for summer use.
9. Terrestrial animal protein, while recognized as important in the diet, can not be satisfactorily integrated into the habitat ratings using the TEM procedure, and as such alternate means will be used to integrate these values into habitat suitability mapping, specifically by developing sub models for integration.

Ratings Adjustments

Final habitat suitability map products may incorporate:

1. Proximity to mapped salmon spawning reaches will be independently evaluated for habitat suitability.

Ratings will be based on plant phenology, chronological adjustments may be incorporated. Sites with most abundant and diverse plant communities providing specific seasonal forage are anticipated to support vegetation that will have value chronological value. These sites may be upgraded for value for adjacent seasons.

LITERATURE CITED

Ash, M. 1985. Grizzly bear habitat component descriptions - Whitefish Range, Flathead and Kootenai National Forests. Manuscript report.

Aune, K. 1985. Rocky Mountain Front grizzly bear monitoring and investigation. Mont. Dep. Fish, Game, and Wildl. Helena, MT. 139 pp.

B.C. Species and Ecosystems Explorer. 2005. Victoria, British Columbia, Canada. Available: http://srmapps.gov.bc.ca/apps/eswp/ May 4, 2005.

B.C. WLAP (Ministry of Water, Land and Air Protection). 2002a. Species Ranking in British Columbia. Government of British Columbia, Victoria, BC.

B.C. WLAP (Ministry of Water, Land and Air Protection). 2003. Grizzly Bears in British Columbia: Ecology, Conservation and Management. Government of British Columbia, Victoria, BC.

B.C. WLAP (Ministry of Water, Land and Air Protection). 2003. British Columbia Grizzly Bear (Ursus Arctos) Population Estimate 2004 . Government of British Columbia, Victoria, BC.

Beaudry, L, Martin, M. and J. Paczkowski. 2001. Using silviculture to maintain and enhance grizzly bear habitat in six variants of the Prince George Forest Region. Prepared for Habitat Branch, Ministry of Environment, Lands and Parks. Province of British Columbia, Victoria, B.C.

Bunnell, F.L. and R.K. McCann. 1993. The Brown or Grizzly Bear. In: Bears Majestic Creatures of the Wild. Rodale Press. Emmaus, PA. 240pp.

Craighead, F.C. and J.J. Craighead. 1972. Grizzly bear prehibernation and denning activities as determined by radiotracking. Wildl. Monogr. No. 32. 35pp.

Craighead, J. J., J. S. Sumner and G. B. Scaggs. 1982. A definitive system for analysis of grizzly bear habitat and other wilderness resources. Wildlife-wildlands Institute Monograph No. 1. University of Montana, Missoula, Montana.

Demarche, W.M., Johnson, S.R. and G.F. Searing. 2000. Accidental grizzly bear, Ursos arctos, sightings during autumn mountain goat, Oreamnos americanus, surveys in westcentral British Columbia. The Canadian Field-Naturalist. V.114:657-660.

Fuhr, B. and D.A. Demarchi. 1990. Methodology for grizzly bear habitat assessment in British Columbia. B.C. Ministry of Environment Wildlife Bulletin No. B-67.

Hadden, D. A., W. J. Hann and C. Jonkel. 1985. An ecological taxonomy for evaluating grizzly bear habitat in the Whitefish Range of Montana. Paper presented at the Grizzly Bear Habitat Symposium, Missoula, MT, April 30-May 2, 1985.

Hamilton, A., and F. Bunnell. 1992. Integrating coastal grizzly bears and forest management at the regional, watershed, stand and microsite levels. Draft report.

Jonkel, C.J. 1987. Brown bear. In: Wild Furbearer Management and Conservation in North America. M.Novak, J.A. Baker, M.E. Obbard, and B. Malloch eds. Pp 456-473. Ontario Min. Nat. Res. 1150pp.

Mace, R.D. and G.N. Bissell. 1986. Grizzly bear food resources in the flood plains and avalanche chutes of the Bob Marshall Wilderness, Montana. In: Proceedings- Grizzly bear Habitat Symposium, Missoula, Montana. G.P. Contreras and K. E. Evans, eds. Intermountain Research Station. Ogden, Utah. 252pp.

MacHutchon, A.G. 2003. Habitat Use by Grizzly Bears and the Implications for Forest Development Activities in the Kispiox Forest District. Forest Investment Account & Forest renewal B.C. Smithers, British Columbia. 67pp.

MacHutchon, A.G. 1996. Grizzly bear habitat use study, Ivvavik National Park, Yukon. Western Arctic District, Parks Canada. Inuvik, NWT. 142 pp.

McCann, R.K. 1997. Kluane National Park grizzly bear research project. Year-end report. Draft. 76 pp.

McLellan, B.N. 1981. Akamina-Kishinena grizzly bear project. Progress Report 1980. B.C. Fish and Wildlife Branch, Victoria. 88 pp.

McLellan, B.N. 1988. Dynamics of a grizzly bear population during a period of industrial resource extraction. III. Natality and rate of increase. Can. J. Zool. 67: 1865-1868.

McLellan, B.N. and D.M. Shackleton. 1988. Grizzly bears and resource extraction industries: effects of roads on behaviour, habitat use and demography. J. Applied Ecology 25:451-460.

McLellan, B.N. and D.M. Shackleton. 1989. Immediate reactions of grizzly bears to human activities. Wildl. Soc. Bull. 17:269-274.

McLellan, B.N. and F.W. Hovey, 1995. The diet of grizzly bears in the Flathead River drainage of southeastern British Columbia. Can. J. Zool. 73:704-712.

McLellan, B.N. and F.W. Hovey. 2001. Habitats selected by grizzly bears in a multiple use landscape. Journal of Wildlife Management. 65:92-99.

McLellan, B.N. and R.D. Mace. 1985. Behaviour of grizzly bears in response to roads, seismic activity, and people. Prel. Rep. Can. Border Grizzly Project. Cranbrook, B.C. 53 pp.

McLoughlin, P.D., Cluff, H.D. and F. Messier. 2001. Denning ecology of barren-ground grizzly bears in the central arctic. Journal of Mammology. 83:188-198.

Mundy, K.R. and D.R. Flook. 1973. Background for managing grizzly bears in the National Parks of Canada. Can. Wildl. Serv. Rep. Ser. No. 22. 35 pp

Pearson, A.M. 1975. The northern interior grizzly bear Ursus arctos L. Can. Wildl. Serv. Rep. No 34, Ottawa, ON. 86 pp.

Resources Inventory Committee (RIC). 1999. British Columbia Wildlife Habitat Ratings Standards. Version 2.0. BC Ministry of Environment, Lands and Parks, Victoria, BC 97 pp.

Sugg, W.C. 1987. Body temperature, respiration, and heart rate. In: Grizzly Bear Compendium. Interagency Grizzly Bear Committee. M.N. LeFranc, M.B. Moss, K.A. Patnode, and W.C. Sugg. eds. p.21. The National Wildlife Federation. Washington, D.C. 540pp.

Vroom, G. W., S. Herrero, and R. T. Ogilvie. 1977. The ecology of grizzly bear winter den sites in Banff National Park, Alberta. Paper presented at 4th Intl. Conf. on Bear Res. and Mgmt., Kalispell, Montana, February 1977.

Wielgus, R.B. 1986. Habitat ecology of the grizzly bear in the southern Rocky Mountains of Canada. MSc thesis. Univ. of Idaho. 136 pp.

Appendix 6

Species Account for American Marten

Appendix 6 – Species Account for Marten

Name:	*Martes americana*	
Species Code:	M-MAAM	
Status*:	**Global:**	G5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.
	Provincial:	S4S5 – Apparently Secure to Secure. Includes taxa that are common and uncommon, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions but have possible cause for long-term concern.
	COSEWIC:	Not listed.
	BC List:	Yellow-listed. Includes uncommon and common, declining and increasing species that are apparently secure and not at risk of extinction.
	Identified Wildlife:	Not listed.

** References: (BC CDC 2010)*

DISTRIBUTION

Provincial Range

In British Columbia, martens occupy late-successional forest habitats throughout most of the province, existing in greatest densities in coastal old-growth forests. They are generally considered common in most of these habitats, except in the province's dry interior (Ponderosa pine biogeoclimatic zone), where their occurrence is considered sporadic (Stevens and Lofts, 1988; Stevens, 1995).

Elevation Range

Martens occupy a broad elevational range, from sea level to subalpine. They occur in most elevational habitats with the exception of the Alpine Tundra (BAFA, CMA, IMA) biogeoclimatic zone. This is largely due to the lack of forested habitats in this zone.

Provincial Context

Martens have undergone range contractions due to the expansion of residential and industrial land use, although this is largely limited to the Georgia Depression. Overall, martens are most abundant in central and northern British Columbia.

Project Area

- **Ecoprovince:** Northern Boreal Mountains, Sub-Boreal Interior
- **Ecoregions:** Boreal Mountains and Plateaus; Yukon-Stikine Highlands; Skeena Mountains
- **Ecosections:** Tahltan Highland (THH)/Stikine Highland (STH), Southern Boreal Plateau (SBP); Northern Skeena Mountains (NSM)
- **Biogeoclimatic Zones:** Alpine Tundra (ATun), Boreal White and Black Spruce (BWBSdk1), Engelmann Spruce-Subalpine Fir (ESSFmc, ESSFmcp, ESSFwv, ESSFwvp, ESSFvv, ESSFvvp); Interior Cedar Hemlock (ICHwc); Spruce Willow Birch (SWBun, SWBunp).
- **Project Map Scale:** 1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

Marten are residents of mature coniferous and mixed forests throughout North America. They are associated closely with late successional stands of mesic conifers, especially those with complex physical structure near the ground (Buskirk and Powell, 1994). However they will tolerate a variety of forest habitat types as long as specific habitat requirements are met (Strickland and Douglas, 1987). Marten prefer stands with various age and size classes, since these stands provide a greater diversity and abundance of foraging areas and protective cover than do even-aged stands. Marten can also be found in moist areas with shrubby understorey and coarse woody debris for both feeding and security cover. They avoid wetlands, dry open areas and areas of disturbance, such as burned or logged areas.

Marten are opportunistic predators and will feed on a variety of small mammals that are characteristic of boreal forest environments, including red squirrel (*Tamiasciurus hudsonicus*), red-backed vole (*Clethrionomys gapperi*), snowshoe hare (*Lepus americanus*), and numerous other small birds and mammals.

Home range size of martens has been shown to vary as a function of sex, geographic area, prey abundance, and habitat type. Males have larger home-ranges than females (Baker, 1992), which may be a consequence of the larger body size of males. Territory size has been estimated as 5.9 and 2.1 km^2 for males and females, respectively in the Yukon (Archibald and Jessup, 1984), and 6.8 and 3.7 km^2 for males and females in Alaska (Buskirk, 1984). The male home range may overlap with several females (Stordeur, 1985; Strickland and Douglas, 1987).

Marten often decline following the removal of forested habitat, increased human access and unrestricted trapping (Clarke *et al.*, 1987). Areas with a minimum of 25% removal were not used by martens, even in the presence of increased prey abundance or low fragmentation (Hargis and Bissonnette, 1997). The limiting factor for marten appears to be over-head cover provided by vegetation and coarse woody debris (Strickland and Douglas, 1987; Buskirk and Ruggiero, 1994; Thompson and Harested, 1994).

HABITAT USE – LIFE REQUISITES

The life requisites that will be rated for marten are: feeding, security and thermal habitat which are described in detail below.

Feeding Habitat (FD)

Marten are opportunistic foragers and consume a wide variety of food items throughout the year. They feed extensively, year-round, on small mammals with the primary prey species being red-backed voles (*Clethrionomys gapperi*), microtine voles (*Microtus* spp,), red squirrels (*Tamiasciurus hudsonicus*), and in some areas ground squirrels (*Spermophillus* spp.) (Strickland and Douglas, 1987; Lofroth and Steventon, 1990; Takats *et al.*, 1996).

Spring / Summer

Marten have a diverse spring and summer diet of mammals, eggs, birds, fish, insects, and carrion. Marten mostly hunt on the ground, but are good climbers, and may climb trees after squirrels or to access bird nests. In late summer, however, the importance of fruiting shrubs increases, as wild strawberry (*Fragaria virginiana*), black huckleberry (*Vaccinium membranaceum*), raspberry (*Rubus* spp.), wild sarsaparilla (*Aralia nudicaulis*), and saskatoon (*Amelanchier alnifolia*) become increasingly significant in the diet until winter (Thompson and Colgan, 1990; Buskirk and Ruggiero, 1994; Takats et al., 1996).

Due to diverse foraging opportunities in the spring and summer seasons, habitat use during this period is much more variable in comparison to winter periods. The use of non-forested habitats within the individual marten's home range has been documented to occur significantly less frequently in winter than summer (Spencer et al., 1983; Buskirk and Powell, 1994).

<u>Fall / Winter</u>

Quick (1955) identified the winter diet of marten in northern B.C. as including (in order of importance): red-backed vole, deer mouse, red squirrel, snowshoe hare, bird (spp. unknown), grouse, shrew, and porcupine. Squirrels and/or hares become more important in late winter and early spring (Buskirk and Macdonald, 1984; Buskirk and Ruggiero, 1994). Douglass et al. (1983) found voles to be the major winter food source of marten in the boreal forest of the Northwest Territories. A study by Koehler et al. (1990) on marten use of different successional stages in the winter confirmed previous findings that marten did not forage in younger successional stages but selected older-aged stands with higher occurrences of voles.

A crucial component of marten winter feeding habitat is availability of "entry" points to sub-nivean hunting grounds (Steventon and Major, 1982; Buskirk *et al.*, 1989; Takats *et al.*, 1996). Such "entry" points are believed to be critical to marten winter survival because they provide access to rodent prey that are active under deep snow (Lofroth and Steventon, 1990; Sherburne and Bissonette, 1994). Steventon and Major (1982) documented over 90% of marten winter feeding sites to be located at such "entry" points. Corn and Raphael (1992) found that marten used existing openings created by coarse woody debris at low snow depths and by lower branches of live trees in deeper snow. In the south-central Yukon Territory, marten were also found to use primarily passive means to gain access to the subnivean using tree trunks, deadfall, and saplings. Decayed stumps and trees of large diameter may also provide access (Steventon and Major, 1982; Hargis and McCullough, 1984).

However, excessive snow depth (>30 cm) limits access to subnivean prey and, therefore, overhead cover is also required in order to prevent excessively deep snow accumulation (Boyd, 1977; Koehler and Hornocker, 1977). In the Sub-Boreal Spruce biogeoclimatic zone, the best foraging habitats contain >100 m^3/ha of coarse woody debris at least 20 cm in diameter, 5 m^2/ha basal area of snags at least 20 cm in diameter, and at least 30% canopy closure (Lofroth and Banci, 1991).

Security Habitat (SH)

Marten select habitat based on the abundance of coarse woody debris, high shrub and low shrub closure, deciduous canopy closure, and abundance and size of trees and snags (Lofroth, 1993). Spruce and fir dominated habitats provide the most suitable cover types for marten (Buskirk, 1984; Takats et al., 1996). Stand composition of at least 40% spruce or fir provide optimal winter habitat (Strickland and Douglas, 1987). Canopy closures are optimal when >50% and acceptable between 30-50% (Spencer *et al.*, 1983; Strickland and Douglas, 1987; Lofroth and Steventon, 1990).

In summer, marten rest above ground, often in the canopy layer (Martin and Bennett, 1983). Overhead cover, especially near the ground is important as security cover to provide protection from both avian and terrestrial predators (Buskirk and Ruggiero, 1994; Thompson, 1994). Marten also require trees of pole size or bigger to climb to escape predation. Marten can occupy a variety of habitat types, but they tend to avoid habitats with minimal security cover: wetlands, young seral stages, dry, open areas including open forests, extensive stands of aspen or lodgepole pine and sub-alpine shrubland with only scattered stands of trees (B.C. MoE, 2003). They also avoid disturbed areas such as logged or burned areas.

Thermal Habitat (TH)

During winter, marten refuge and resting sites are usually beneath the snow. Access to these sites may be provided by coarse woody debris, leaning logs and trees, decayed stumps, large logs, and large diameter trees. Subnivean environments are important for winter thermoregulation, as marten are not physically well-adapted for cold temperatures. The long, thin bodies of martens have a high surface area to mass ratio, which increases heat loss, and, in addition, the fur has relatively poor insulative value. Inactive martens, therefore, need well-insulated winter resting dens. These dens are almost always subnivean and typically associated with coarse woody debris, cavities in decayed logs, squirrel middens, snags, stumps, and logs (Buskirk, 1984; Spencer, 1987; Buskirk and McDonald, 1989).

SEASONS OF USE

Food and security/thermal are required throughout the year, while reproducing habitats for birthing are required only in March and April. Table 1 summarizes the life requisites for marten for each month of the year.

Table 1. Monthly Life Requisites for Marten

Life Requisites	Month	Season*
Living	January	Winter
Living	February	Winter
Living and Reproducing (birthing)	March	Winter
Living and Reproducing (birthing)	April	Winter/Growing (Spring)
Living	May	Winter/Growing (Spring)
Living	June	Growing (Spring/Summer)
Living	July	Growing (Summer)
Living	August	Growing (Summer)
Living	September	Growing (Fall)
Living	October	Growing (Fall)/Winter
Living	November	Winter
Living	December	Winter

** Seasons defined for Northern Boreal Mountains and Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC, 1999)*

One season will be rated for marten: winter

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Table 2 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 2. Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Marten

Life Requisite	TEM Attribute
Feeding Habitat	• Site: site disturbance, elevation, slope, aspect, structural stage • Soil/terrain: • Vegetation: canopy closure, percent cover by layer, species list by layer, coarse woody debris (diameter at breast height, decay class, abundance), shrub diversity, shrub abundance
Security/Thermal Habitat	• Site: site disturbance, elevation, slope, structural stage • Soil/terrain: terrain texture, flooding regime • Vegetation: canopy closure, percent cover by layer, species list by layer, coarse woody debris, shrub diversity, shrub abundance • Mensuration: wildlife tree characteristics

Ratings

There is an intermediate level of knowledge of the habitat requirements of martens in British Columbia, which warrants a 4-class rating scheme (RIC, 1999).

Provincial Benchmark

- **Ecosection:** East Purcell Mountains (EPM)
- **Biogeoclimatic Zone:** ESSFdk
- **Broad Ecosystem Unit**: Engleman Spruce-Subalpine Fir dry cool
- **Habitats:** Mature-old growth spruce-subalpine fir forests

Ratings Assumptions

1. Drier subzones generally rate lower for all activities and seasons. Sites with vegetation that promotes abundant small mammal prey and provides winter shelter to marten will be rated highest.
2. Mesic, mature – structural stage 6 and 7 forests with closed canopy (>50%) and sufficient understory cover for prey species and abundant coarse woody debris will rate High for marten winter habitat.
3. Open, mesic Stage 6 and 7 forests with <50% canopy cover on wet sites and also on sites with drier than mesic stage 6 and 7 forests will both be rated moderate, as will stage 4 and 5 closed canopy conifer dominated forests on mesic to wet sites.
4. Stage 4 and 5 conifer dominated and deciduous forests will be rated Low.
5. Habitats with an absence of under-storey vegetation and coarse woody debris (closed canopy, intermediate structural stage forest) will be rated Low (necessary cover for prey animals).
6. Marshes, fens, meadows, rivers, open areas, and other areas of early seral stage vegetation will be rated nil.

Table 3 summarizes the habitat requirements for marten.

Table 3. Summary of Habitat Requirements for Marten in the Study Area

Season	Life Requisite	Structural Stage	Requirements
Winter	Feeding (FD)	6-7	Coniferous or mixed closed canopy, mature to old growth forests with abundant coarse woody debris. Understory vegetation and high density of prey species.
Winter	Security/Thermal (ST)	6-7	Coniferous or mixed closed canopy, mature to old growth forests with abundant coarse woody debris.

Ratings Adjustments Considerations

Habitat capability and suitability maps may incorporate:

1. Conifer forests of young age that function as later seral forest may be upgraded;
2. Habitats adjacent to significant anthropogenic disturbance regimes (e.g., settlements) may be down graded

LITERATURE CITED

Archibald, W.R. and R.H. Jessup. 1984. Population dynamics of the pine marten (*Martes Americana*) in the Yukon Territory. In: *Northern Ecology and Resource Management*. Olsen, R., Hastings, R. and F. Geddes. comps., (eds.) pp 81-97 . University of Alberta Press. Edmonton, Alberta.

Baker, D.Q. 1992. *Upland furbearer problem analysis*. Prepared for Williston Wildlife Compensation Program, B.C. Environment and B.C. Hydro. Prince George, B.C.

B.C. Species and Ecosystems Explorer. 2005. Victoria, British Columbia, Canada. Available: http://srmapps.gov.B.C..ca/apps/eswp/ May 4, 2005.

Boyd, M. 1977. *Analysis of fur production records by individual fur-bearing species for registered trapping areas in Alberta, 1970-1975*. Alberta Fish and Wildlife. 72 pp.

Buskirk, S.W. 1984. Seasonal use of resting sites by marten in south-central Alaska. *Journal of Wildlife Management* 48: 950-953.

Buskirk, S.W. and L.F. Ruggiero. 1994. American Marten. In: *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx and Wolverine in the Western United States. Gen. Tech. Report RM-254*. Ruggiero, L.F., K.B. Aubrey, S.W. Buskirk, L.J. Lyon and W.J. Zielinski (tech. eds.). U.S. Dept of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 184 p.

Buskirk, S.W. and L.L. MacDonald. 1984. Seasonal food habits of marten in south-central Alaska. *Canadian Journal of Zoology* 62: 944-950.

Buskirk, S.W. and R.A. Powell. 1994. Habitat ecology of fishers and American martens. In: *Martens, Sables, and Fishers: Biology and Conservation*. Buskirk, S.W., A.S. Harestad, and M.G. Raphael (eds.) Pp. 283-296 Cornell University Press. Ithica, N.Y.

Buskirk, S.W., S.C. Forrest, M.G. Raphael and H.J. Harlow. 1989. Winter resting site ecology of marten in the central Rocky Mountains. *Journal of Wildlife Management* 53: 191-196.

Clarke, T.W., E. Anderson, C. Douglas, and M. Strickland. 1987. *Martes americana*. Mammalian Species No. 289. The American Society of Mammalogists.

Corn, J.G. and M.G. Raphael. 1992. Habitat characteristics at marten subnivean access sites. *Journal of Wildlife Management* 56: 422-448.

Douglass, R.J., L.G. Fisher and M. Mair. 1983. Habitat selection and food habits of marten, *Martes Americana* in the Northwest Territories. *The Canadian Field Naturalist* 97: 71-74.

Hargis, C.D. and D.R. McCollough. 1984.Winter diet and habitat selection of marten in Yosemite National Park. *Journal of Wildlife Management* 48: 140-146.

Hargis, C.D. and J.A. Bissonnette. 1997. Effects of forest fragmentation on populations of American marten in the Intermountain west. In: *Martens: Taxonomy, Ecology, Techniques, and Management*. G. Proulx, N. Bryant, and P.M. Woodward (eds.) Provincial Museum of Alberta, Alberta.

Koehler, G.M., J.A. Blakesley, and T.W. Koehler. 1990. Marten use of successional forest stages during winter in north-central Washington. *Northwest Naturalist* 71: 1-4.

Koelhler, G.M. and M.G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitterroot Wilderness. *Journal of Wildlife Management* 41: 500-505.

Lofroth, E.C. 1993. *Scale dependent analysis of habitat selection by marten in the sub-boreal spruce biogeoclimatic zone, British Columbia*. M.Sc. Thesis. Simon Fraser University, B.C.

Lofroth, E.C. and J.D. Steventon. 1990. Managing for marten habitat in interior forests of British Columbia. In: *Symposium proceedings, Wildlife forestry symposium: a workshop on resource integration for wildlife and forest managers*. Chambers, A. (ed.). P. 97-75. Prince George, B.C. Forestry Canada.

Lofroth, E.C. and V Banci. 1991. *Marten habitat suitability research project – working plan*. Wildlife working report no. WR-50.

Martin, S.K. and R.H. Bennett. 1983. The importance of snags to pine marten habitat in the northern Sierra Nevada. In: *Proceedings of the Symposium On Snag Habitat Management GTR-RM-99*. Pages 114-116. United States Forest Service General Technical Report. Denver, CO. 226 pp.

Ministry of Environment. 2003. *Marten. Management Guidelines for British Columbia*. Wildlife Branch, B.C.

Northern Biomes Ltd. 1983. Winter *ecology of pine marten (Martes americana) in the south-central Yukon Territory*. 1980/81.

Quick, H.F. 1955. Food habits of marten (*Martes Americana*) in Northern British Columbia. *Canadian Field Nat*. 69: 144-147.

Resources Inventory Committee (RIC). 1999. *British Columbia Wildlife Habitat Ratings Standards. Version 2.0.* B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.. 97 Pp.

Sherburne, S.S. and J.A. Bissonette. 1994. Marten subniven access point use: response to subnivean prey levels. *Journal of Wildlife Management* 58: 400-405.

Spencer, W.D. 1987. Seasonal rest-site preferences of pine martens in the Northern Sierra Nevada. *Journal of Wildlife Management* 51: 616-621.

Spencer, W.D., R.H. Barrett and W.J. Zielinski. 1983. Marten habitat preferences in the Northern Siera Nevada. *Journal of Wildlife Management* 47: 1181-1186.

Stevens, V. 1995. *Wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds, and mammals in Biogeoclimatic zones*. British Columbia Ministry of Forests, Research Branch. Victoria, B.C.. 288 p.

Stevens, V. and S. Lofts. 1988. *Wildlife habitat handboods for the southern interior ecoprovince. Volume 1: species notes for mammals.* Wildlife Report no. R-15. Ministry of Environment, Wildlife Branch. Victoria, B.C.

Steventon, J.D. and J.T. Major. 1982. Marten use of habitat in a commercially clear-cut forest. *Journal of Wildlife Management* 46: 175-182.

Stordeur, L. 1985. *Marten in British Columbia with implications for forest management*. Res. Branch, B.C. Ministry of Forests, Victoria.

Strickland, M.A. and C.W. Douglas. 1987. Marten. In: *Wild fur-bearer management and conservation in North America*. M. Novak, J.A. Baker, M.E. Obard, and B. Malloch (eds.) Pages 530-546 Ontario Ministry of Natural Resources.

Strickland, M.A., C.W. Douglas, M. Novak and N.P. Hinziger. 1982. Marten. In: *Wild Mammals of North America*. Chapman, J.A. and G.A. Feldhamer (eds.). Pages 599-612. Johns Hopkins University Press. Baltimore, MD.

Takats, L., R. Stewart, M.Todd, R. Bonar, J. Beck and R. Quinlan. 1996. Marten (*Martes americana*) winter habitat: draft habitat suitability index (HIS) model. In*: Habitat Suitability Index Models for 35 Wildlife Species in the Foothills Model Forest*. B. Beck, J. Beck, W. Bessie, R. Bonar and M. Todd (eds). Pages 137-144. Foothills Model Forest. Hinton, Alberta. Pp. 266.

Thompson, I.D. 1994. Marten populations in uncut and logged boreal forests in Ontario. *Journal of Wildlife Management* 58: 272-280.

Thompson, I.D. and A.S. Harested 1994. Effects of logging on American marten with models for habitat management. In: *Martens, Sables and Fishers: Biology and Conservation*. Buskirk, S.W., A.S. Harested, M.G. Raphael (eds.). pp 355-366. Cornell University Press, Ithaca, N.Y.

Thompson, I.D. and P.W. Colgan. 1990. Prey choice by marten during a decline in prey abundance. *Oecologia* 83: 443-451.

WLAP (Ministry of Water, Land and Air Protection). 2002. *Species Ranking in British Columbia. Government of British Columbia*, Victoria, B.C..

Wynne, K.M., and J.A. Sherburne. 1984. Summer home range use by adult marten in northwestern Maine. *Canadian Journal of Zoology* 62: 941-943.

Appendix 7

Species Account for Hoary Marmot

Appendix 7 – Species Account for Hoary Marmot

Name:	*Marmota caligata*	
Species Code:	M-MACA	
Status*:	**Global:**	G5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.
	Provincial:	S5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.
	COSEWIC:	Not listed.
	BC List:	Yellow-listed. Includes uncommon and common, declining and increasing species that are apparently secure and not at risk of extinction.
	Identified Wildlife:	Not listed.

** References: (BC CDC 2010)*

DISTRIBUTION

Provincial Range

In British Columbia the hoary marmot occupies most of the mainland except for the northeast and low elevations in the dry interior.

Elevation Range

Hoary marmots occur at high elevations near the timber line on talus slopes and alpine and subalpine meadows and mountain slopes (Carling 1999).

Provincial Context

The hoary marmot is common in the high elevation, mountainous areas of the province.

Project Area

- **Ecoprovince:** Northern Boreal Mountains, Sub-Boreal Interior
- **Ecoregions:** Boreal Mountains and Plateaus; Yukon-Stikine Highlands; Skeena Mountains
- **Ecosections:** Tahltan Highland (THH)/Stikine Highland (STH), Southern Boreal Plateau (SBP); Northern Skeena Mountains (NSM)
- **Biogeoclimatic Zones:** Alpine Tundra (ATun), Boreal White and Black Spruce (BWBSdk1), Engelmann Spruce-Subalpine Fir (ESSFmc, ESSFmcp, ESSFwv, ESSFwvp, ESSFvv, ESSFvvp); Interior Cedar Hemlock (ICHwc); Spruce Willow Birch (SWBun, SWBunp).
- **Project Map Scale:** 1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

The hoary marmot inhabits high elevation talus slopes near timberline, and alpine and subalpine meadows and mountain slopes. They feed on a variety of herbaceous plants and grasses and seeds.

Hoary marmot can also be found in habitats with large boulders which they use to watch for danger and stretch out and sun themselves (Banfield 1981).

In areas where food is plentiful, marmots live in colonies consisting of one dominant adult male, a few females and their offspring, and perhaps one or more subordinate adult males. The dominant hoary marmots are called colony males and are the only males who mate with the females in the colony. Colony males are sometimes challenged by satellite males and physical fights can occur, however, these fights are not documented to be fatal (Lee and Funderburg 1982; Barash 1989).

In areas where food is scare, hoary marmots do not exist in colonies. Food shortage require hoary marmots to increase their ranges, which can become large enough that a male will not be able to guard more than one female and feed himself at the same time. In these cases, hoary marmots are monogamous with little male-male competition (Lee and Funderburg 1982; Barash 1989).

Hoary marmots have many vocalizations. A common call is the alarm call which is given anytime anything comes near a burrow. The alarm call is a high-pitched shrill whistle. The calls of the hoary marmots are usually higher in frequency and longer than the calls of other marmot species (Lee and Funderburg 1982; Barash 1989).

Hoary marmots spend the majority of the year in hibernation in burrows beneath the ground's surface. They begin hibernating as early as mid-September and usually emerge from their burrows around mid-May. These burrows are also used for security cover and cover from thermal extremes. Their dens may be found under the edge of a rock slide or in open hilly ground under a large boulder or in loose talus. The dens are lined with grasses which are replaced every spring with fresh grasses.

Marmots are only fertile in the first few weeks following their emergence from hibernation (Barash 1981). Mating typically occurs within two weeks of emergence from hibernation, April or May. Gestation takes about 30 days; hoary marmots use their dens as a nest for young, which are usually born in late May or June depending on latitude (Nagorsen 2005). After birth, it takes about another month for the young to become fully mobile and grow all their fur.

HABITAT USE – LIFE REQUISITES

The life requisites that will be rated for hoary marmot are Living (LI) which is satisfied by the presence of suitable feeding and security/thermal habitats. Hibernation (HI) habitat is described here as well, but will not be rated.

Living Habitat (LI)

<u>Feeding Habitat</u>

Hoary marmots are mainly herbivorous, and in the spring and early summer feed on leaves and blossoms of a variety of lush alpine grasses and forbs. Commonly eaten plants in British Columbia were reported to be western anemone (*Anemone occidentalis*), red Indian paintbrush (*Castilleja*), avalanche lily (*Erythronoim grandiflorum*), blue lupin (*Lupinus* spp.), wood betony (*Pedicualris bracteosa*), ragwort (*Senecio* spp.), grouseberry (*Vaccinium scoparium*), and false Indian hellebore (*Veratrum virdide*) (Gray 1967 in Hansen 1975). In late summer they feed on seeds (Lee and Funderburg 1982). Hoary marmots appear to drink almost daily and have frequently been observed eating snow. In places where standing water is scare, hoary marmots seem to acquire water from the plants they eat or morning dew (Lee and Funderburg 1982; Barash 1989; Parker 1990). Hoary marmots feed in the areas immediately around their dens and will travel up to 100 m around their dens to feed (Banfield 1981).

Security/Thermal Habitat

Hoary marmots live in open sites with lush plant growth and good visibility to see one another or detect predators. They are found in habitats with deep soils suitable for burrows and in areas of scattered boulders and rock ledges which are used for loafing and lookouts. When food is plentiful, hoary marmots may live in a colony and vocalize the presence of an approaching animal. The alarm call is a high-pitched shrill whistle that is usually higher in frequency and longer than the calls of other marmot species (Lee and Funderburg 1982; Barash 1989). Predators of the hoary marmot include golden eagles, lynx, coyotes, bears and wolverines.

Hibernating Habitat (HI)

Hoary marmots hibernate in deep burrows from October to May. Their burrows are located at high elevations in the alpine and subalpine meadows deep in the soil, often under a large boulder which provides protection from digging predators, such as grizzly bears. During hibernation they live on stored body fat.

SEASONS OF USE

Hoary marmots require living (food and security/thermal) habitats from June until September while hibernating habitats are required for the remaining months (October until May). Table 1 summarizes the life requisites required for hoary marmot for each month of the year.

Table 1. Monthly Life Requisites for Hoary Marmot

Life Requisites	Month	Season
Hibernating	January	Winter
Hibernating	February	Winter
Hibernating	March	Winter
Hibernating	April	Winter
Hibernating	May	Winter
Living	June	Growing (Spring)
Living	July	Growing (Summer)
Living	August	Growing (Summer)
Living	September	Growing (Fall)
Hibernating	October	Winter
Hibernating	November	Winter
Hibernating	December	Winter

** Seasons defined for Northern Boreal Mountains and Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC 1999).*

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Table 2 outlines how each life requisite relates to specific ecosystem attributes (*e.g.*, site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 2. Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Hoary Marmot

Life Requisite	TEM Attribute
Living Habitat (LI)	• Site: elevation, slope, aspect, structural stage • Soil/terrain: terrain texture, deep soils • Vegetation: Percent cover by layer, plant species • Boulder fields, talus, rock slides
Hibernating Habitat (HI)	• Site: elevation, slope, aspect, structural stage • Soil/terrain: terrain texture, deep soils • Vegetation: Percent cover by layer, plant species • Boulder fields, talus, rock slides

Ratings

There is an intermediate level of knowledge of the habitat requirements of hoary marmot in British Columbia and thus a 4-class rating scheme will be used (RIC 1999).

Provincial Benchmark
The provincial benchmark is currently unknown.

Ratings Assumptions

1. Alpine and Subalpine meadows (structural stage 2) with deep soils (for burrow excavation) and moderate warm aspects (<30% slope, 135 - 185° aspect, used more commonly because these are areas of early snowmelt and green-up) will rate high.
2. Cool aspects and shallow soils will rate down one.
3. Wet areas will be rated down one.
4. Very shallow soils rate nil.

Table 3 summarizes the habitat requirements for hoary marmots.

Table 3. Summary of Habitat Requirements for Hoary Marmot in the Study Area

Season	Life Requisite	Structural Stage	Requirements
Growing	Living (LI)	2-3	Alpine and subalpine meadows with deep soils, talus, boulder fields
Winter	Hibernating (HI)	2-3	Alpine and subalpine meadows with deep soils, talus, boulder fields

Ratings Adjustments

Final capability and suitability map products may incorporate:

1. landscape heterogeneity and connectivity;
2. habitats adjacent to significant anthropogenic disturbance regimes (e.g., settlements) and;
3. interspersion of different structural stages within the landscape.

LITERATURE CITED

Banfield, A. W. F. 1981. *The Mammals of Canada*. Toronto, ON: University of Toronto Press.

Barash, D. P. 1981. Mate guarding and gallivanting by male hoary marmots (*Marmota caligata*). *Behavioral Ecology & Sociobiology* 9 (3): 187-93.

Barash, D. P. 1989. *Marmots: Social Behavior and Ecology*. Palo Alto, CA: Stanford University Press.

Hansen, R. M. 1975. Foods of the hoary marmot on Kenai Peninsula Alaska, USA. *American Midland Naturalist* 94 (2): 348-53.

Lee, D. S. and J. B. Funderburg. 1982. Marmots. In *Wildlife Animals of North America: Biology, Management, and Economics*. Ed. J. A. Chapman and G. A. Feldhamer. p176-91. Baltimore, MD: Johns Hopkins University Press.

Nagorsen, D. W. 2005. *Rodents and Lagomorphs of British Columbia*. Vol. 4, The Mammals of British Columbia Victoria, B.C.: Royal B.C. Museum.

Parker, S. P. 1990. *Grzimek's Encyclopedia of Mammals*. New York, NY: McGraw-Hill Publishing Company.

Appendix 8

Predictive Ecosystem Mapping (PEM) Preliminary Wildlife Habitat Rating (WHR) Table

Appendix 8. Predicitive Ecosystem Mapping (PEM) Preliminary Wildlife Habitat Rating (WHR) Table

BEC unit	Site_S	PEM_Map_C	PEM_Eco_Unit	PEM_Eco_Unit_Name	GenEcoType	StStage	StStageClass	ALAL_FD_We (Coastal)	ALAL_FD_Wl (Coastal)	ALAL_FD_We (Interior)	ALAL_FD_Wl (Interior)	URAR_FD_P	URAR_FD_S	URAR_FD_F	ORAM_FD_S	ORAM_FD_W	OVDA_FD_S	OVDA_FD_W	RATA_FD_We	RATA_FD_Wl	MAAM_LI_W
ATun	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	1	N
ATun	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	5	N
ATun	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	2	5	2	5	1	2	1	1	1	1	1	5	2	N
ATun	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	4	5	4	5	2	4	1	2	1	2	1	5	1	N
ATun	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	5	3	5	2	3	4	1	3	3	3	5	6	N
ATun	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	5	3	5	1	2	1	1	2	2	1	5	2	N
ATun	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	5	2	5	3	3	3	3	1	2	2	5	1	N
ATun	00	KH	KH	krummholtz	Treed	3	Shrub	3	5	3	5	2	2	1	3	1	3	2	5	2	N
ATun	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	5	2	5	3	2	3	2	1	2	2	5	5	N
ATun	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	2	5	2	5	2	2	3	2	2	2	2	5	5	N
ATun	00	GSi	GSi	glacier/snow/ice	Snow/Ice	N/A	N/A	6	5	6	5	6	6	6	5	5	5	5	5	6	N
ATun	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ATun	00	RI	RI	river	Water	N/A	N/A	3	5	3	5	3	3	4	5	3	5	5	6	6	N
ATun	00	WA	WA	water	Water	N/A	N/A	4	5	4	5	6	6	6	5	5	5	5	5	6	N
BWBSdk1	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	5	N
BWBSdk1	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	4	4	4	4	1	2	2	1	1	5	5	5	5	N
BWBSdk1	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	4	4	4	4	2	4	1	2	1	3	2	5	5	N
BWBSdk1	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	3	3	3	3	5	6	N
BWBSdk1	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	5	5	5	5	N
BWBSdk1	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	4	4	4	4	3	2	1	2	1	3	2	5	5	N
BWBSdk1	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	1	1	1	1	2	3	3	3	2	5	5	5	5	N
BWBSdk1	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	3	2	3	2	3	3	3	3	1	5	5	5	5	N
BWBSdk1	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	2	3	2	5	5	5	5	N
BWBSdk1	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
BWBSdk1	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
BWBSdk1	01	SM	01	Sw - Knight's plume - Step moss	Mesic Forest	6/7	Mature/Old Forest	3	3	3	3	4	3	3	3	1	3	3	2	5	H
BWBSdk1	02	LL	02	Pl - Lingonberry - Feathermoss	Drier Forest	6/7	Mature/Old Forest	4	4	4	4	4	3	3	3	1	3	3	1	5	M
BWBSdk1	03	SW	03	Sw - Wildrye - Toad-flax	Drier Forest	6/7	Mature/Old Forest	2	2	2	2	4	3	3	3	1	3	3	1	5	M
BWBSdk1	04	BL	04	Sb - Lingonberry - Knight's plume	Drier Forest	6/7	Mature/Old Forest	2	2	2	2	4	3	3	3	1	3	3	1	5	H
BWBSdk1	05	SS	05	SwPl - Soopolallie - Twinflower	Drier Forest	6/7	Mature/Old Forest	3	3	3	3	4	3	3	3	1	3	3	1	5	H
BWBSdk1	06	SR	06	Sw - Scouring-rush - Step moss	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	4	4	3	1	5	5	2	5	M
BWBSdk1	07	BC	07	Sb - Lingonberry - Coltsfoot	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	4	4	3	1	5	5	2	5	M
BWBSdk1	08	SC	08	Sw - Currant - Horsetail	Wetter Forest	6/7	Mature/Old Forest	2	2	2	2	3	4	4	3	2	5	5	2	5	H
BWBSdk1	09	BH	09	Sb - Horsetail - Sphagnum (Wb09 - Sb - Common Horsetail - Peat Moss)	Wetter Forest	6/7	Mature/Old Forest	2	2	2	2	2	4	2	3	2	5	5	4	5	M
BWBSdk1	10(11)	BS(SG)	10(11)	Sb - Labrador tea - Sphagnum (Wb03 - Sb - Lingonberry - Peat-Moss)	Wetter Forest	6/7	Mature/Old Forest	2	2	2	2	2	4	2	2	2	5	5	4	5	M
ESSFmc	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	2	N
ESSFmc	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	3	N
ESSFmc	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	4	4	4	4	1	2	2	1	1	1	1	5	2	N
ESSFmc	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	4	4	4	4	2	4	4	2	1	2	1	5	2	N
ESSFmc	00	GTm	GTm	moderate avalanche herb	Avalanche Herb	2	Herb	4	4	4	4	1	2	1	1	1	2	2	5	2	N
ESSFmc	00	GTs	GTs	steep avalanche herb	Avalanche Herb	2	Herb	4	4	4	4	1	2	1	1	1	1	1	5	2	N
ESSFmc	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	2	3	4	1	3	3	3	5	6	N
ESSFmc	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	3	5	5	2	N
ESSFmc	00	AVm	AVm	moderate avalanche shrub	Avalanche Shrub	3	Shrub	2	2	2	2	1	4	1	2	1	3	3	5	2	N
ESSFmc	00	AVs	AVs	steep avalanche shrub	Avalanche Shrub	3	Shrub	2	2	2	2	1	4	1	2	1	2	2	5	5	N
ESSFmc	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	3	1	2	2	5	2	N
ESSFmc	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	1	1	1	1	2	2	3	2	2	5	5	5	5	N
ESSFmc	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	2	2	2	1	3	3	5	2	N
ESSFmc	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	1	2	2	4	3	5	5	N
ESSFmc	01(05)	FB(FT)	01(05)	Bl - Huckleberry - Leafy liverwort	Mesic Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	2	1	3	3	2	4	H
ESSFmc	02(03)	LC(FC)	02(03)	BlPl - Juniper - Cladonia	Drier Forest	6/7	Mature/Old Forest	4	3	4	3	3	3	3	3	1	3	3	2	4	M
ESSFmc	04	HH	04	Bl - Huckleberry - Heron's-bill	Drier Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	2	1	3	3	3	4	H
ESSFmc	06	FO	06	Bl - Oak fern - Heron's-bill	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	2	1	5	5	2	4	H
ESSFmc	07	FD	07	Bl - Devil's club - Lady fern	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	2	1	5	5	3	4	H
ESSFmc	09(08)	HG(FV)	09(08)	Bl - Horsetail - Glow moss (Ws08 - Bl - Sitka valerian - Common horsetail)	Wetter Forest	6/7	Mature/Old Forest	2	3	2	3	3	3	4	2	2	5	5	3	4	H
ESSFmc	10	FH	10	Bl - Horsetail - Leafy moss (Ws08 - Bl - Sitka valerian - Common horsetail)	Wetter Forest	6/7	Mature/Old Forest	2	3	2	3	3	3	4	2	2	5	5	3	4	H
ESSFmc	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ESSFmc	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
ESSFmc	00	WA	WA	water	Water	N/A	N/A	4	5	4	5	6	6	6	5	5	5	5	5	6	N
ESSFmcp	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	2	N
ESSFmcp	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	2	N
ESSFmcp	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	1	1	1	5	2	N
ESSFmcp	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	3	3	3	3	2	4	4	2	1	1	1	5	2	N
ESSFmcp	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	1	3	3	3	5	6	N
ESSFmcp	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	1	1	5	2	N
ESSFmcp	00	DV	DV	dwarf vegetation	Mesic Shrub/Herb	2d	Herb	4	4	4	4	2	3	2	1	2	3	2	5	2	N
ESSFmcp	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	3	1	3	2	5	2	N
ESSFmcp	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	3	3	3	3	2	2	3	2	2	2	2	5	6	N
ESSFmcp	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	2	2	2	1	2	2	5	2	N
ESSFmcp	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	1	2	2	2	2	5	5	N
ESSFmcp	00	TI	TI	conifer/tree island	Treed	6/7 (3)	Mature/Old Forest	3	3	3	3	3	3	1	2	1	3	3	4	2	L
ESSFmcp	00	GSi	GSi	glacier/snow/ice	Snow/Ice	N/A	N/A	5	6	5	6	6	6	6	5	5	5	5	5	6	N
ESSFmcp	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ESSFmcp	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
ESSFmcp	00	WA	WA	water	Water	N/A	N/A	4	5	4	5	6	6	6	5	5	5	5	5	6	N
ESSFvv	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	2	N
ESSFvv	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	2	N
ESSFvv	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	1	1	1	5	2	N
ESSFvv	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	3	3	3	3	2	4	4	2	1	1	1	5	2	N
ESSFvv	00	GTm	GTm	moderate avalanche herb	Avalanche Herb	2	Herb	3	3	3	3	1	2	1	1	1	2	2	5	2	N
ESSFvv	00	GTs	GTs	steep avalanche herb	Avalanche Herb	2	Herb	3	3	3	3	1	2	1	1	1	1	1	5	2	N
ESSFvv	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	1	3	3	3	5	6	N
ESSFvv	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	3	3	5	2	N
ESSFvv	00	AVm	AVm	moderate avalanche shrub	Avalanche Shrub	3	Shrub	2	2	2	2	1	4	1	2	1	3	3	5	2	N
ESSFvv	00	AVs	AVs	steep avalanche shrub	Avalanche Shrub	3	Shrub	2	2	2	2	1	4	1	2	1	2	3	5	5	N
ESSFvv	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	3	1	3	2	5	2	N
ESSFvv	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	2	2	2	1	3	2	5	2	N
ESSFvv	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	1	2	2	3	3	5	5	N
ESSFvv	01(05)	FA(FO)	01(05)	BlHm - Azalea	Mesic Forest	6/7	Mature/Old Forest	3	3	3	3	4	3	3	2	1	3	3	2	4	H
ESSFvv	02	FB	02	Bl - Huckleberry - Mountain liverwort	Drier Forest	6/7	Mature/Old Forest	4	3	4	3	3	3	3	3	1	3	3	2	4	M
ESSFvv	03(04)	FF(MH)	03(04)	BlHm - Feathermoss	Drier Forest	6/7	Mature/Old Forest	4	3	4	3	3	3	3	3	1	3	3	2	4	M
ESSFvv	06(07)	FD(FV)	06(07)	Bl - Devil's club - Lady fern	Wetter Forest	6/7	Mature/Old Forest	3	2	3	2	3	3	3	2	1	5	5	3	4	H
ESSFvv	08(09)	FH(FL)	08(09)	Bl - Horsetail - Glow moss	Wetter Forest	6/7	Mature/Old Forest	2	2	2	2	3	3	4	2	2	5	5	3	4	H
ESSFvv	00	GSi	GSi	glacier/snow/ice	Snow/Ice	N/A	N/A	6	6	6	6	6	6	6	5	5	5	5	5	6	N

Appendix 8. Predicitive Ecosystem Mapping (PEM) Preliminary Wildlife Habitat Rating (WHR) Table

BEC unit	Site_S	PEM_Map_C	PEM_Eco_Unit	PEM_Eco_Unit_Name	GenEcoType	StStage	StStageClass	ALAL_FD_We (Coastal)	ALAL_FD_Wl (Coastal)	ALAL_FD_We (Interior)	ALAL_FD_Wl (Interior)	URAR_FD_P	URAR_FD_S	URAR_FD_F	ORAM_FD_S	ORAM_FD_W	OVDA_FD_S	OVDA_FD_W	RATA_FD_We	RATA_FD_Wl	MAAM_Ll_W
ESSFvv	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ESSFvv	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
ESSFvv	00	WA	WA	water	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	5	6	N
ESSFvvp	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	2	N
ESSFvvp	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	1	N
ESSFvvp	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	1	1	1	5	2	N
ESSFvvp	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	3	3	3	3	2	4	4	2	1	1	1	5	2	N
ESSFvvp	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	1	3	3	3	5	6	N
ESSFvvp	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	2	2	5	2	N
ESSFvvp	00	DV	DV	dwarf vegetation	Mesic Shrub/Herb	2d	Herb	4	4	4	4	2	3	2	1	3	3	3	5	2	N
ESSFvvp	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	3	1	3	2	5	2	N
ESSFvvp	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	2	2	2	1	3	2	5	4	N
ESSFvvp	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	1	2	2	3	3	5	5	N
ESSFvvp	00	TI	TI	conifer/tree island	Treed	6/7 (3)	Mature/Old Forest	3	3	3	3	2	3	1	2	1	3	3	5	2	L
ESSFvvp	00	GSi	GSi	glacier/snow/ice	Snow/Ice	N/A	N/A	5	6	5	6	6	6	6	5	5	5	5	5	6	N
ESSFvvp	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ESSFvvp	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
ESSFwv	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	2	N
ESSFwv	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	2	N
ESSFwv	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	3	3	3	3	1	3	2	1	1	1	1	5	2	N
ESSFwv	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	3	3	3	3	2	4	4	2	1	1	1	5	2	N
ESSFwv	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	1	3	5	5	5	6	N
ESSFwv	00	AVm	AVm	moderate avalanche shrub	Avalanche Shrub	3	Shrub	2	2	2	2	1	4	1	2	1	2	2	5	2	N
ESSFwv	00	AVs	AVs	steep avalanche shrub	Avalanche Shrub	3	Shrub	2	2	2	2	1	4	1	2	1	2	2	5	2	N
ESSFwv	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	2	2	3	1	2	2	5	2	N
ESSFwv	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	1	1	1	1	2	3	3	2	2	3	3	5	5	N
ESSFwv	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	1	2	2	1	2	2	5	2	N
ESSFwv	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	1	2	2	3	3	5	5	N
ESSFwv	01(05)	FA(FO)	01(05)	BlHm - Azalea	Mesic Forest	6/7	Mature/Old Forest	3	3	3	3	4	2	2	2	1	3	3	2	4	H
ESSFwv	02	LC	02	BlPl - Cladonia	Drier Forest	6/7	Mature/Old Forest	4	3	4	3	3	3	3	3	1	3	3	2	4	M
ESSFwv	03(04)	FF(MH)	03(04)	BlHm - Feathermoss	Drier Forest	6/7	Mature/Old Forest	4	3	4	3	3	3	3	3	1	3	3	3	4	M
ESSFwv	06(07)	FD(FV)	06(07)	Bl - Devil's club - Lady fern	Wetter Forest	6/7	Mature/Old Forest	3	2	3	2	3	3	2	2	1	5	5	2	4	H
ESSFwv	08(09)	FH(FL)	08(09)	Bl - Horsetail - Glow moss	Wetter Forest	6/7	Mature/Old Forest	2	2	2	2	3	3	3	2	2	5	5	3	4	H
ESSFwv	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ESSFwv	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
ESSFwv	00	WA	WA	water	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	5	6	N
ESSFwvp	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	2	N
ESSFwvp	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	2	N
ESSFwvp	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	1	1	1	5	2	N
ESSFwvp	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	3	3	3	3	2	4	4	2	1	2	1	5	2	N
ESSFwvp	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	1	3	5	5	5	6	N
ESSFwvp	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	2	1	5	2	N
ESSFwvp	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	3	1	2	2	5	2	N
ESSFwvp	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	1	1	1	1	2	2	3	2	2	3	3	5	5	N
ESSFwvp	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	2	2	2	1	2	2	5	2	N
ESSFwvp	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	1	2	2	3	3	5	5	N
ESSFwvp	00	TI	TI	conifer/tree island	Treed	6/7 (3)	Mature/Old Forest	3	3	3	3	3	3	1	2	1	3	3	5	2	L
ESSFwvp	00	GSi	GSi	glacier/snow/ice	Snow/Ice	N/A	N/A	5	6	5	6	6	6	6	5	5	5	5	5	6	N
ESSFwvp	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ESSFwvp	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
ESSFwvp	00	WA	WA	water	Water	N/A	N/A	5	5	5	5	6	6	6	3	5	5	5	5	6	N
ICHwc	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	6	6	4	2	1	1	6	6	N
ICHwc	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	4	4	4	4	1	2	3	1	1	1	1	5	6	N
ICHwc	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	4	4	4	4	2	4	3	2	1	1	1	5	6	N
ICHwc	00	GTm	GTm	moderate avalanche herb	Avalanche Herb	2	Herb	4	4	4	4	1	2	1	1	1	1	1	6	6	N
ICHwc	00	GTs	GTs	steep avalanche herb	Avalanche Herb	2	Herb	4	4	4	4	1	2	1	1	1	1	1	6	6	N
ICHwc	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	3	3	2	2	5	6	N
ICHwc	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	4	1	2	1	1	6	6	N
ICHwc	00	AVm	AVm	moderate avalanche shrub	Avalanche Shrub	3	Shrub	4	4	4	4	1	4	1	2	1	2	2	5	6	N
ICHwc	00	AVs	AVs	steep avalanche shrub	Avalanche Shrub	3	Shrub	4	4	4	4	1	4	1	2	1	2	2	5	6	N
ICHwc	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	2	1	2	1	6	6	N
ICHwc	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	3	3	3	3	2	2	4	3	2	2	2	5	6	N
ICHwc	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	2	4	2	1	2	2	6	6	N
ICHwc	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	3	2	3	2	2	2	1	2	2	2	2	6	6	N
ICHwc	01	HO	01	HwBl - Oak fern	Mesic Forest	6/7	Mature/Old Forest	3	3	3	3	4	3	3	3	1	3	3	2	4	H
ICHwc	02	LC	02	HwPl - Feathermoss - Cladonia	Drier Forest	6/7	Mature/Old Forest	4	4	4	4	4	3	4	3	1	3	3	2	4	M
ICHwc	03	HM	03	Hw - Step moss	Drier Forest	6/7	Mature/Old Forest	4	4	4	4	4	3	4	3	1	3	3	2	4	M
ICHwc	04(05)	HD(SD)	04(05)	HwBl - Devil's club	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	3	1	3	3	3	4	H
ICHwc	06(05)	CD (SD)	06(05)	ActSx - Dogwood (Sx - Devil's club)	Wetter Forest	6/7	Mature/Old Forest	2	2	2	2	3	3	3	3	1	5	5	3	4	H
ICHwc	07(08)	HS(SH)	07(08)	HwSx - Blueberry - Sphagnum	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	3	2	5	5	3	4	H
ICHwc	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N
ICHwc	00	RI	RI	river	Water	N/A	N/A	3	3	3	3	3	3	4	5	3	5	5	6	6	N
ICHwc	00	WA	WA	water	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	5	6	N
SWBun	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	2	N
SWBun	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	5	N
SWBun	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	1	1	1	5	2	N
SWBun	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	3	3	3	3	2	4	2	2	1	2	1	5	2	N
SWBun	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	1	3	1	1	5	6	N
SWBun	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	2	1	5	2	N
SWBun	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	4	3	1	2	2	5	2	N
SWBun	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	1	1	1	1	2	3	3	2	2	2	2	5	5	N
SWBun	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	2	1	2	2	5	2	N
SWBun	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	3	2	2	2	2	5	5	N
SWBun	01	SB	01	Sw - Grey-leaved willow - Scrub birch	Mesic Forest	6/7	Mature/Old Forest	3	3	3	3	4	3	3	2	1	3	3	4	4	L
SWBun	02(03)	PL(SK)	02(03)	Sw - Scrub birch - Cladina	Drier Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	3	1	3	3	3	4	L
SWBun	04	SW	04	Sw - Arctic lupine - Step moss	Drier Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	2	1	3	3	4	4	L
SWBun	05	SL	05	Sw - Willow - Crowberry	Mesic Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	3	2	1	3	3	4	4	L
SWBun	06	SS	06	Sw - Willow - Step moss	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	4	2	1	5	5	4	4	L
SWBun	07	SC	07	Sw - Scrub birch - Bluejoint	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	4	2	1	5	5	4	4	L
SWBun	08	SH	08	Sw - Shrubby cinquefoil - Horsetail	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	4	2	2	5	5	4	4	L
SWBun	09	XW	09	Sw - Forested Wetland	Wetter Forest	6/7	Mature/Old Forest	3	3	3	3	3	3	4	2	2	5	5	4	4	L
SWBun	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	5	6	N
SWBun	00	WA	WA	water	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	5	6	N
SWBuns	00	BA	BA	sparse/barren	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	6	2	N

Appendix 8. Predicitive Ecosystem Mapping (PEM) Preliminary Wildlife Habitat Rating (WHR) Table

BEC unit	Site_S	PEM_Map_C	PEM_Eco_Unit	PEM_Eco_Unit_Name	GenEcoType	StStage	StStageClass	ALAL_FD_We (Coastal)	ALAL_FD_WI (Coastal)	ALAL_FD_We (Interior)	ALAL_FD_WI (Interior)	URAR_FD_P	URAR_FD_S	URAR_FD_F	ORAM_FD_S	ORAM_FD_W	OVDA_FD_S	OVDA_FD_W	RATA_FD_We	RATA_FD_WI	MAAM_LI_W
SWBuns	00	ET	ET	escape terrain	Sparse/Barren	1	Sparse / Bryoid	5	5	5	5	6	5	5	4	2	3	2	5	5	N
SWBuns	00	AM	AM	herbaceous meadow	Mesic Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	1	1	1	5	2	N
SWBuns	00	DH	DH	dry herb	Drier Shrub/Herb	2	Herb	3	3	3	3	2	3	2	2	1	2	1	5	2	N
SWBuns	00	MA	MA	marsh	Wetland Shrub/Herb	2	Herb	3	3	3	3	1	3	4	1	3	2	2	5	6	N
SWBuns	00	VW	VW	wetter herb	Wetter Shrub/Herb	2	Herb	3	3	3	3	1	2	2	1	2	2	1	5	2	N
SWBuns	00	DS	DS	dry shrub	Drier Shrub/Herb	3	Shrub	2	2	2	2	3	3	2	3	1	2	2	5	2	N
SWBuns	00	SA	SA	swamp	Wetland Shrub/Herb	3	Shrub	1	1	1	1	2	3	3	2	2	2	2	5	5	N
SWBuns	00	VF	VF	mesic shrub	Mesic Shrub/Herb	3	Shrub	2	2	2	2	3	3	3	2	1	2	2	5	2	N
SWBuns	00	VS	VS	wetter shrub	Wetter Shrub/Herb	3	Shrub	1	1	1	1	2	2	1	2	2	2	2	5	5	N
SWBuns	00	TI	TI	conifer/tree island	Treed	6/7 (3)	Mature/Old Forest	3	3	3	3	3	3	1	2	1	3	3	5	2	L
SWBuns	00	GSi	GSi	glacier/snow/ice	Snow/Ice	N/A	N/A	5	6	5	6	6	6	6	5	5	5	5	5	6	N
SWBuns	00	LA	LA	lake	Water	N/A	N/A	5	5	5	5	6	6	6	5	5	5	5	6	6	N

Appendix 9

Summary of Final Habitat Suitability Ratings in the Schaft Creek Project Area

Appendix 9
Summary of Final Habitat Suitability Ratings in the Scahft Creek Project Area

Species	Life Requisite	Season	Habitat Rating	Regional Study Area (ha)	Local Study Area (ha) Proposed Road Route	Proposed Minesite	Total	Proportion of Habitat in LSA Relative to the RSA (%)
Moose	Living	Early Winter	High	6,288	351	1,051	1,402	22
			Moderately High	45,386	719	1,494	2,213	5
			Moderate	103,667	3,927	5,740	9,666	9
			Low	11,501	385	340	725	6
			Very Low	140,809	282	2,729	3,011	2
			Nil	4,849	0.25	0.19	0.44	0
		Late Winter	High	4,669	344	939	1,283	27
			Moderately High	16,947	278	832	1,110	7
			Moderate	62,773	3,231	4,184	7,415	12
			Low	14,869	808	256	1,064	7
			Very Low	7,172	126	630	756	11
			Nil	206,070	877	4,514	5,391	3
Mountain Goat	Living	Winter	High	61,050	553	1,593	2,146	4
			Moderately High	27,110	509	316	825	3
			Moderate	37,054	275	1,249	1,524	4
			Low	47,246	3,009	876	3,885	8
			Very Low/Nil	140,061	1,327	7,322	8,650	6
		Summer	High	10,819	387	418	805	7
			Moderately High	66,244	142	1,324	1,467	2
			Moderate	29,380	756	1,049	1,805	6
			Low	35,163	52	574	626	2
			Very Low/Nil	170,916	4,336	7,990	12,327	7
Stone's Sheep	Living	Winter	High	9,790	616	68	685	7
			Moderately High	4,421	534	112	646	15
			Moderate	6,566	74	5	79	1
			Low	24,962	2,109	429	2,538	10
			Very Low/Nil	38,283	919	442	1,361	4
		Summer	High	8,953	597	68	664	7
			Moderately High	1,907	20	1	20	1
			Moderate	9,010	575	113	688	8
			Low	2,087	32	5	37	2
			Very Low/Nil	62,064	3,028	871	3,899	6
Northern Caribou	Living	Early Winter	High	1,206	-	-	-	-
			Moderately High	8,905	1,878	498	2,376	27
			Moderate	3,179	1,068	114	1,182	37
			Low	5,201	121		121	2
			Very Low	39,140	856	386	1,242	3
			Nil	13,324	330	58	388	3
		Late Winter	High	16,373	-	-	-	-
			Moderately High	21,319	309	3	311	1
			Moderate	2,526	4	0	4	0
			Low	5,140	106	23	130	3
			Very Low	62	5	1	6	10
			Nil	25,535	3,827	1,030	4,857	19
Grizzly Bear	Feeding	Spring	High	41,842	517	1,424	1,941	5
			Moderately High	17,255	465	1,266	1,731	10
			Moderate	77,688	4,272	6,877	11,149	14
			Low	42,407	131	69	199	0
			Very Low	0	-	-	-	-
			Nil	133,357	280	1,718	1,999	1
		Summer	High	447	7	-	7	2
			Moderately High	62,454	916	2,534	3,450	6
			Moderate	100,986	4,198	6,417	10,616	11
			Low	15,304	265	684	949	6
			Very Low	74,004	243	1,445	1,688	2
			Nil	59,353	37	273	310	1
		Fall	High	53,127	558	2,105	2,663	5
			Moderately High	27,732	543	667	1,210	4
			Moderate	79,586	3,527	5,950	9,477	12
			Low	18,747	758	914	1,671	9
			Very Low	74,004	243	1,445	1,688	2
			Nil	59,353	37	273	310	1
American Marten	Living	Winter	High	56,277	3,301	4,802	8,103	14
			Moderate	18,258	472	628	1,101	6
			Low	24,841	155	536	691	3
			Nil	213,172	1,737	5,388	7,125	3