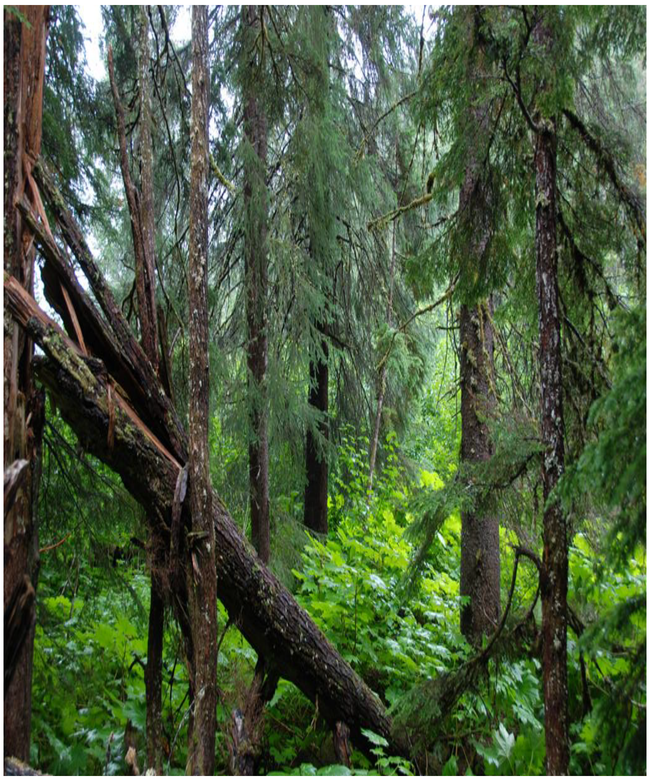
APPENDIX 18-B
2009 WILDLIFE HABITAT SUITABILITY BASELINE REPORT

Seabridge Gold Inc.

KSM PROJECT
2009 Wildlife Habitat Suitability Baseline Report

SEABRIDGE GOLD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KSM PROJECT

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Prepared for:

SEABRIDGE GOLD

Seabridge Gold Inc.

Prepared by:

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Executive Summary

This report presents the habitat suitability mapping studies undertaken by Rescan Environmental Services Ltd. (Rescan) on behalf of Seabridge Gold Inc. (Seabridge). The KSM Project is a gold/copper project located in the mountainous terrain of northwestern British Columbia (BC), approximately 950 km northwest of Vancouver, BC, and approximately 65 km northwest of Stewart, BC. The proposed project lies approximately 20 km southeast of Barrick Gold's recently-closed Eskay Creek Mine and 30 km northeast of the Alaska border.

The process of selecting species on which to conduct habitat suitability modelling relied on identifying species at risk and of cultural, 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 Aboriginal peoples. Habitat suitability mapping was conducted for moose (*Alces alces*) early and late winter habitat; mountain goat (*Oreamnos americanus*) summer and winter habitat; grizzly bear (*Ursus arctos*) spring, summer, fall, and hibernating habitat; American marten (*Martes americana*) winter habitat; and hoary marmot (*Marmota caligata*) growing season (combined spring, summer, and fall) habitat. The results of habitat suitability mapping within the regional study area (RSA) are summarized in Table 1. The area of mapped habitat is approximately 338,000 ha. Two species' models, grizzly bear hibernating habitat and hoary marmot growing habitat, were mapped only within the Local Study Area (LSA), which totals approximately 54,785 ha and encompasses areas of proposed development. The results of suitability mapping within the LSA for all focal species are summarized in Table 2. Moose, mountain goat, and grizzly bear feeding habitat in the spring, summer, and fall were rated using a 6-class rating system; grizzly bear winter hibernating habitat, American marten winter habitat, and hoary marmot growing season habitat were rated using a 4-class rating system (see section 3.2.2 for details).

Table 1. Habitat Suitability for Four Species in the Regional Study Area

Species and Season	Area of Modelled Habitat (ha)											
	High	%[1]	Moderately High	%[1]	Moderate	%[1]	Low	%[1]	Very Low	%[1]	Nil	%[1]
Moose												
Early Winter	21,557	6	19,080	6	67,633	20	76,141	23	15,099	4	138,548	41
Late Winter[2]	12,395	7	8,533	5	14,483	8	15,016	8	1,930	1	132,465	72
Mountain Goat												
Winter[3]	33,861	10	24,650	7	22,933	7	14,699	4	241,789	72	-	-
Summer[3]	33,126	10	43,591	13	47,221	14	39,876	12	174,116	52	-	-
Grizzly Bear												
Spring	15,515	5	74,862	22	87,105	26	79,048	23	75,349	22	6,053	2
Summer	14,929	4	114,380	34	50,039	15	73,050	22	79,481	24	6,053	2
Fall	1,138	< 1	25,394	8	117,277	35	108,590	32	79,481	24	6,053	2
Marten												
Winter	77,988	23			6,980	2	5,200	2			247,765	73

1 Percent of habitat in the RSA (338,058 ha).
2 A total of 153,235 ha (45% of RSA) was not rated for moose late winter habitat suitability (Section 4.2.4).
3 Very Low includes Nil Rated Habitat (i.e., Very Low/Nil)

Table 2. Habitat Suitability for Five Species in the Local Study Area

	Area of Modelled Habitat (ha)											
Species and Season	High	%[1]	Moderately High	%[1]	Moderate	%[1]	Low	%[1]	Very Low	%[1]	Nil	%[1]
Moose												
Early Winter	2,410	5	3,794	7	12,799	25	14,926	29	3,105	6	14,233	28
Late Winter[2]	412	1	278	1	1,279	4	1,473	5	219	1	28,299	89
Mountain Goat												
Winter[3]	5,650	10	2,821	5	3,902	7	1,554	3	40,858	75	-	-
Summer[3]	5,491	10	5,674	10	8,277	15	5,035	9	30,308	55	-	-
Grizzly Bear												
Spring	2,697	5	14,289	26	17,208	31	13,174	24	7,043	13	375	1
Summer	2,080	4	21,671	40	10,933	20	12,109	22	7,617	14	375	1
Fall	19	< 1	4,659	9	22,574	41	19,542	36	7,617	14	375	1
Hibernating[4]	476	2			3,101	11	1,641	6			23,530	82
Marten												
Winter	15,026	27			1,227	2	1,139	2			37,393	68
Hoary Marmot												
Growing[5]	2,494	5			12,859	26	1,480	3			32,269	66

1 Percent of habitat in the LSA (54,785 ha).
2 A total of 19,306 ha (38% of LSA) was not rated for moose late winter habitat suitability (Section 4.2.4).
3 Very Low includes Nil Rated Habitat (i.e., Very Low/Nil).
4 A total of 26,036 ha (48% of LSA) was not rated for grizzly bear hibernating habitat suitability (Section 4.4.4).
5 A total of 5,684 ha (10% of LSA) was not rated for hoary marmot growing habitat suitability (Section 4.6.4).

Moose are economically and socially important as a species for harvest by Aboriginal and non-Aboriginal hunters. Guide outfitting and associated harvest also contributes substantial economic return to local communities. 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 RSA contains both early and late winter habitat for moose. However, there appears to be proportionally more High and Moderately High rated early winter habitat as opposed to late winter habitat, as almost half (45%) of the RSA was not rated for late winter suitability because the habitat occurred in high elevation Biogeoclimatic zones (BECs) where there would be permanent snow or ice cover (glaciers) during the late winter. Similar results were attained within the LSA, where there was far more early winter habitat for moose than late winter habitat (Table 2). Some areas in the eastern LSA, such as within and surrounding the proposed Tailing Management Facility and along the Teigen Access Road, contained Moderately High to Highly suitable early winter habitat, whereas very few areas of proposed development overlapped with suitable late winter habitat.

A key element of mountain goat habitat is suitable escape terrain (i.e., steep rocky topography). Research has shown that goats are rarely found beyond several hundred meters from escape terrain throughout the year. Because of the abundance of suitable, rocky terrain throughout the RSA, almost one quarter (23%) of the RSA is Moderately High to Highly suitable summer habitat, and 17% is Moderately High to Highly suitable winter habitat for mountain goats (Table 1). Goat observations collected during baseline studies confirm that several higher rated habitat areas are occupied. Within the LSA, roughly a quarter was identified as Moderately High to Highly suitable winter (15%) and summer (20%) habitat (Table 2). Most of these higher rated habitats occur within the western LSA surrounding the proposed mining area.

Grizzly bears are a biologically, socially, and economically important species. Grizzly bears are considered 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). Between 27 and 38% of the RSA is classed as Moderately High to Highly suitable feeding habitat for grizzly bear in the spring and the summer. In comparison, a smaller amount (roughly 8%) of the RSA was identified as Moderately High to Highly suitable fall feeding habitat (Table 1), as there were fewer habitats capable of producing and sustaining late season berries, roots, and tubers. In addition, areas where bears can supplement their vegetation diet with animal protein were identified during the modelling process, such as those where carrion from winter weakened moose may be available during the spring and along major tributaries where salmon spawn in the summer and fall. A total of 48,552 ha were identified as areas with the greatest potential for bears to find winter weakened moose; these were distributed along the Unuk River drainage in the western RSA and along the Bell-Irving River, lower Treaty Creek, and Bowser River drainages in the eastern RSA. Roughly 8,730 ha of habitat surrounding the Unuk River, Treaty Creek, Bell-Irving River, lower Teigen Creek, and Bowser River (west of Bowser Lake) drainages were identified as valuable areas for grizzly bears to access salmon. Similar proportions of Moderately High to Highly suitable spring, summer, and fall habitats were mapped within the LSA as were identified within the RSA (Tables 1 and 2). The focus of the grizzly bear hibernating model was to identify alpine habitat above the treeline capable of supporting grizzly bear dens; approximately half (48%) of the LSA was not rated because it fell below the treeline (< 1,100 m elevation). The results of suitability mapping suggest that 12% of the remaining high elevation habitat within the LSA is Highly to Moderately suitable grizzly bear hibernating habitat (Table 2). Of the seasonal habitat identified in the LSA for all species, there appears to be more Moderately High to Highly suitable grizzly bear summer habitat surrounding areas of proposed development (44% of the LSA) than any other habitat identified during the modelling process.

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 (73% of registered harvest). Winter is generally acknowledged as the limiting season for marten; therefore, modelling of the winter habitat was undertaken. High rated winter habitat was extensively distributed throughout low elevation mature and old growth conifer forests along major river valleys, including the Unuk, Bell-Irving, and Treaty Creek drainages. High and Moderate rated habitat accounted for a quarter of the total RSA. Within the LSA, roughly 27% of the total area was rated Highly and Moderately suitable winter habitat for marten. Highly suitable winter habitat was identified in all part of the LSA except for the Mitchell-Teigen Corridor.

Hoary marmots were selected as a species for habitat modelling because of their cultural significance and importance as a prey species for larger carnivores. High and Moderate habitat accounted for over a quarter of the LSA and was distributed in alpine habitat throughout the entire LSA. As marmots are generally an alpine dwelling species, approximately 66% of the LSA that was modelled was not suitable (i.e., of Nil suitability) for marmots and 10% of the LSA was not rated because it occurs in lower elevation forested habitat along the major river valleys.

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Acronyms and Abbreviations

The following presents a glossary of terms as well as acronyms and abbreviations used in this document. Acronyms and abbreviations are defined where they are first used. The following list of abbreviations will assist readers who may choose to review only portions of the document.

Alpine	High-elevation land above the tree-line. Alpine vegetation on zonal sites is dominated by low shrubs, herbs, bryophytes and lichens. Although treeless by definition, patches of stunted (krummholz) trees may occur. Much of the alpine is covered by rock and ice rather than vegetation.
AIR	Application Information Requirements. The AIR specifies the information that will be needed to conduct an environmental assessment (EA) and that should be provided by the Proponent in their Application.
BAFA	Boreal Altai Fescue Alpine BEC zone.
BC	British Columbia
CDC	Conservation Data Centre - collects and disseminates information on plants, animals and ecosystems (ecological communities) at risk at the provincial level, and is tied to NatureServe, an international, non-profit organization of cooperating Conservation Data Centres and Natural Heritage Programs all using the same methodology to gather and exchange information on the threatened elements of biodiversity.
ILMB	Integrated Land Management Bureau.
MAL	Ministry of Agriculture and Lands.
MOE	Ministry of Environment.
BEC	Biogeoclimatic Ecosystem Classification – a standard, hierarchical classification system for mapping terrestrial ecosystems in British Columbia.
Biogeoclimatic subzone	A level of the biogeoclimatic classification system that defines the climate of an area, as characterized by the plant association occurring on zonal sites, e.g., Engelmann Spruce – Subalpine Fir Zone - Very Cold Subzone (ESSFwv) (BC Ministry of Forests and Range 2007).
Biogeoclimatic units	A general term referring to any level of Biogeoclimatic zones, subzones, variants or phases. Biogeoclimatic units are inferred from a system of ecological classification based on a floristic hierarchy of plant associations. The recognized units are a synthesis of climate, vegetation, and soil data (Pojar, Klinka, and Meidinger 1987).
Biogeoclimatic variant	A further subdivision of biogeoclimatic subzone reflecting further differences in regional climate. Variants are described as warmer, colder, drier, wetter, or snowier than the 'typical' subzone, e.g., Mountain Hemlock-Leeward Moist Maritime variant (MHmm2), where leeward (2) is the particular variant.
Biogeoclimatic zone	Geographical areas having similar patterns of energy flow, vegetation and soils as a result of a broadly homogeneous macroclimate. Biogeoclimatic zones are comprised of biogeoclimatic subzones with similar zonal climax ecosystems (BC Ministry of Forests and Range 2007).

Blue-list	A list of ecological communities, and indigenous species and subspecies of special concern in British Columbia.
CMA	Coastal Mountain-heather Alpine BEC zone.
COSEWIC	Committee on the Status of Endangered Wildlife in Canada - A federal committee of experts that assesses and designates the level of threat to wildlife and vegetation species in Canada.
CPS	Call-playback Survey. A survey methodology for raptors.
CWH	Coastal Western Hemlock BEC zone.
DEM	Digital Elevation Model - a digital array of elevations for a number of ground positions at regularly spaced intervals.
Ecological Community	A term used by the BC CDC and NatureServe to include natural plant communities and plant associations and the full range of ecosystems that occur in British Columbia.
Ecosystem (terrestrial)	A volume of earth-space that is composed of non-living parts (climate, geologic materials, groundwater, and soils) and living or biotic parts, which are all constantly in a state of motion, transformation, and development. No size or scale is inferred.
ESSF	Engelmann Spruce – Subalpine Fir BEC zone.
GPS	Global Positioning System.
HSR	Habitat Suitability Rating. Like Wildlife Habitat Ratings (WHRs), HSRs characterize the suitability of an ecosystem unit to support wildlife species for a particular life requisite and season; however, HSRs are the rating used for the final map product.
ICH	Interior Cedar Hemlock BEC Zone.
Keystone species	Keystone species are those that have relatively low population numbers compared to their importance in maintaining a balanced ecosystem (Helfield and Naiman 2006). For example, moose are considered biologically important keystone species, as they are highly capable of modifying the local ecology, especially wetland vegetation (McLaren et al. 2000)
LRMP	Land and Resource Management Plan.
LSA	Local Study Area, 55,187 ha in size.
Mesic	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year. Available soil moisture reflects climatic inputs (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998).
MH	Mountain Hemlock BEC zone.
Moisture regime	Indicates, on a relative scale, the available moisture for plant growth in terms of the soil's ability to hold, lose, or receive water. Described as moisture classes from Very Xeric (0) to Hydric (8) (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998).

NWA	Nass Wildlife Area, as defined in the Nisga'a Final Agreement (NFA).
Nutrient regime	Indicates the available nutrient supply for plant growth on a site, relative to the supply on all surrounding sites. Nutrient regime is based on a number of environmental and biotic factors, and is described as classes from very poor (A) to very rich (E) and saline (F) (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998).
Parkland	Subalpine area characterized by forest clumps interspersed with open subalpine meadows and shrub thickets. Vegetation cover may vary in the proportion of treed patches, meadows, and shrub thickets. The term parkland can also be used for lower elevation forest that are open due to restricted moisture availability, such as occurs in the Ponderosa Pine zone.
PEM	Predictive Ecosystem Mapping - a modelled approach to ecosystem mapping using various spatial datasets as input. Mapping follows provincial standards and a pre-defined classification system.
Red-list	List of ecological communities, and indigenous species and subspecies that are extirpated, endangered or threatened in British Columbia. Red listed species and sub-species have- or are candidates for- official Extirpated, Endangered or Threatened Status in B.C. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.
RIC	Resource Inventory Committee. A body of the BC government that develops survey standards for BC wildlife and ecosystems.
RISC	Resource Information Standards Committee, formerly the Resource Inventory Committee.
RSA	Regional Study Area - 338,008 ha in size.
SARA	*Species at Risk Act* (2002) - A Canadian federal statute which is designed to meet one of Canada's key commitments under the International Convention on Biological Diversity. The goal of the Act is to protect endangered or threatened organisms and their habitats. It also manages species which are not yet threatened, but whose existence or habitat is in jeopardy.
Site series	Describes all land areas capable of producing the same late seral or climax plant community within a biogeoclimatic subzone or variant (Banner et al. 1993). Site series can usually be related to a specified range of soil moisture and nutrient regimes within a subzone or variant, but other factors, such as aspect or disturbance history may influence it as well. Site series form the basis of ecosystem units. Definition is taken directly from the RISC standards for Terrestrial Ecosystem Mapping.
SRMP	Sustainable Resource Management Plan.
Structural Stage	Describes the structural characteristics, and often the age, of vegetated ecosystems (RIC 1998b).
SU	Survey Unit. A delineated polygon for the purposes of wildlife surveys.
TEM	Terrestrial Ecosystem Mapping – delineation and attribution of ecosystem units based on air photo interpretation. Mapping follows provincial standards and a pre-defined classification system.

TK	Traditional Ecological Knowledge.
Topography	The configuration of a surface, including its relief and the position of its natural and man-made features.
TSA	Timber Supply Area.
TRIM	Terrain Resource Information Management – refers to the digital dataset of geographic base mapping completed for the province of BC in 1996 at a scale of 1:20,000. The dataset includes elevational data, stream networks, and so on.
TU	Traditional Use Knowledge.
Umbrella species	Umbrella species are often wide ranging animals that are protected at the regional, provincial, or federal level, e.g., grizzly bear. The umbrella species concept is that the protection that is afforded to these species results, directly or indirectly, in the protection of many other species with similar or smaller home ranges, or that require similar life requisites as the umbrella species (Roberge and Angelstam 2004a).
UTM	Universal Transverse Mercator.
UWR	Ungulate Winter Range. An area identified by the BC Ministry of Environment as "an area that contains habitat that is necessary to meet the winter habitat requirements of an ungulate species"
VRPC	Variable Radius Point Count. An inventory methodology for terrestrial breeding birds.
Wetland	Sites dominated by hydrophytic vegetation where soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development (MacKenzie and Moran 2004).
WHR	Wildlife Habitat Rating. A value assigned to an ecosystem or map unit to express the suitability of that unit to support wildlife species for a particular life requisite and season.
WMU	Wildlife Management Unit. The BC government divides the province into regions (i.e., WMU) for purposes of managing wildlife harvest.
Yellow List	List of ecological communities and indigenous species that are not at risk in British Columbia.

1. Introduction

1.1 PROJECT PROPONENT

The proponent for the KSM (Kerr-Sulphurets-Mitchell) Project is Seabridge Gold Inc. (Seabridge), a publicly traded junior gold company with common shares trading on the Toronto Stock Exchange in Canada and on the American Stock Exchange in the United States.

1.2 KSM PROJECT LOCATION

The KSM Project is a gold/copper project located in the mountainous terrain of northwestern British Columbia, approximately 950 km northwest of Vancouver, British Columbia, and approximately 65 km northwest of Stewart, British Columbia (Figure 1.2-1). The proposed Project lies approximately 20 km southeast of Barrick Gold's recently-closed Eskay Creek Mine and 30 km northeast of the Alaska border. The proposed processing plant and tailing management facility will be located about 15 km southwest of the community of Bell II on Highway 37.

The north and west parts of the Project area drain towards the Unuk River, which crosses into Alaska and enters the Pacific Ocean at Burroughs Bay. The eastern part of the Project area drains towards the Bell-Irving River, which joins the Nass River and empties into the Canadian waters of Portland Inlet. Elevations in the Project area range from under 240 m at the confluence of Sulphurets Creek with the Unuk River, to over 2,300 m at the nearby peak of the Unuk Finger.

1.3 KSM PROJECT DESCRIPTION

The KSM Project is a large proposed gold-copper mining project. Reserve figures released in a preliminary feasibility study announced on March 31, 2010 include 1.6 billion tonnes of ore containing 30.2 million ounces of gold, 7 billion pounds of copper, 133 million ounces of silver and 210 million pounds of molybdenum in the proven and probable categories. This environmental baseline study was designed to address a wide range of alternatives that have been assessed from engineering and cost perspective at various times during the baseline studies. The following project description is the base case for the March 2010 Preliminary Feasibility Study. Maps in subsequent sections of this baseline report may depict slightly different footprint configurations relating to earlier designs that prevailed at the time the fieldwork was completed.

The proposed Project as defined for the purposes of this environmental baseline study will be comprised of two distinct and geographically separate areas (the mining area and processing plant and tailing management area), shown in Figure 1.3-1. The proposed mining area is located in the drainage basin of Sulphurets Creek, a major tributary of the Unuk River. The proposed location of the processing plant and tailing management facility is in the headwaters of tributaries of Teigen and Treaty Creeks, which flow to the Bell-Irving River. The two areas will be connected by a pair of parallel tunnels. An overview of these proposed mine components is provided in the following two Sections.

1.3.1 Mining Area

It is proposed that the mining area will be accessed by a new road to be constructed from the current Eskay Creek mine road. The access road will be used to transport personnel, heavy mining equipment, mining supplies, and explosives. This new road will trend southwestwards to the headwaters of Coulter Creek and then follow the general course of Coulter Creek to the Unuk River. After crossing the Unuk ai no. a22127m Job No. 868-1 27/02/2009-12:00pm

FIGURE 1.2-1

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KSM Project Location

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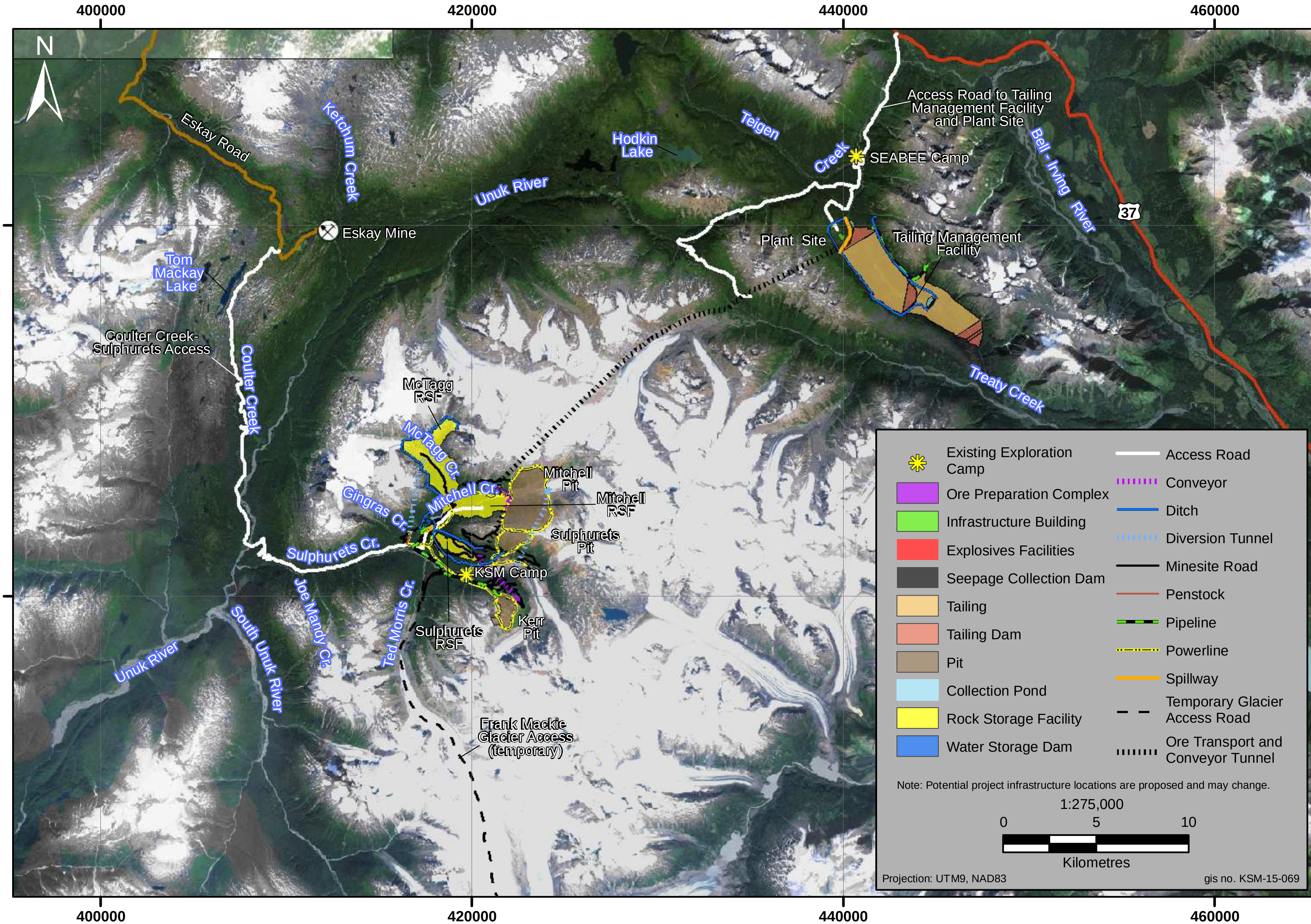

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FIGURE 1.3-1

KSM Project Layout and Road Access

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River it will follow the north side of the Sulphurets Creek Valley and cross Mitchell Creek. The Unuk River is considered navigable water under the *Navigable Waters Protection Act*. Branch roads will lead to each of the Kerr, Sulphurets and Mitchell deposits. Another branch road will head south parallel to Ted Morris Creek towards the toe of the north flowing tongue of Frank Mackie Glacier to provide access to the explosives manufacturing plant and related explosives magazines.

The support facilities for the mining area are proposed in the vicinity of the confluence of Sulphurets and Mitchell creeks. They will include accommodation for mine employees and administration and maintenance facilities.

The ore deposits will be bulk mined with large shovels and trucks and will use conventional drilling and blasting methods. The Kerr deposit is located on a ridge south of Sulphurets Lake. It is proposed that ore and non-ore mined rock will be transported from the Kerr deposit by conveyor to a tunnel portal (Sulphurets Mitchell tunnel) on the north side of Sulphurets Creek. These materials will be transported through the tunnel by conveyor to the Mitchell Creek Valley where they will be transported to the ore preparation complex or the Mitchell-McTagg rock storage facilities, respectively.

The Sulphurets deposit is located on the south side of the ridge north of Sulphurets Lake. It is proposed that ore will be transported by truck to the Sulphurets Mitchell tunnel and then by conveyor to the ore preparation complex. Non-ore mined rock will be transported to the Sulphurets rock storage facility on the south side of the ridge between the Mitchell Creek and Sulphurets Creek valleys, or to the Mitchell-McTagg rock storage facilities.

The Mitchell deposit straddles the Mitchell Creek Valley in an area recently exposed by the recession of the Mitchell Glacier. Mining of the deposit is proposed on both sides of the valley and to a depth of over 400 m below the current valley bottom. Seabridge proposes to construct a diversion tunnel from near the toe of the Mitchell Glacier, southwards towards the Sulphurets Creek Valley upstream of Sulphurets Lake to divert the flow of Mitchell Creek away from the proposed open pit area. It is proposed that the significant hydraulic head created by this tunnel will be used to drive a hydro-electric plant to generate a small portion of the electricity requirements of the Project.

Large volumes of low grade or barren rock will be removed in order to access the ore in each of the deposits. Non-ore rock removed to access ore will consist of both potentially acid generating (PAG) and not potentially acid generating (not PAG) rock. Rock storage areas have been defined in the Mitchell Creek and McTagg Creek valleys and on the south-facing side of the ridge between Sulphurets Creek and Mitchell Creek valleys. Runoff and seepage from the rock storage areas will be collected in a water storage facility contained behind a dam, to be located in the lower reaches of Mitchell Creek, and treated prior to discharge to the environment. The piped flow from the storage facility to the water treatment plant may be used to drive a hydro-electric plant.

A second diversion tunnel is proposed to direct the flow of McTagg Creek to the Sulphurets Creek Valley, thus avoiding the rock storage areas. The discharge from this tunnel will be available to drive a hydro-electric plant.

A run-of-river hydro-electric plant is proposed to harness the hydraulic head of the cascade in the lower reaches of Sulphurets Creek.

Ore from the deposits will be transported to an ore preparation complex, consisting of crushing and grinding facilities and related ore storage stockpiles, located on the north side of the Mitchell Creek Valley west of the Mitchell pit. Prepared ore will be mixed with water and pumped through one of two parallel 23 km-long tunnels to the process plant, proposed to be located in the drainage of a north-flowing tributary of Teigen Creek. The tunnels will daylight for a short distance near the divide between the Unuk River drainage and Treaty Creek before proceeding to the plant site in the Teigen Creek drainage. They will accommodate two pipelines to transport ore slurry as well as a return water pipeline, a diesel fuel pipeline, and a transmission line. The tunnels will slope towards Mitchell Creek so that all drainage can be managed at the mine site and treated as necessary prior to release to the environment.

1.3.2 Processing and Tailing Management Area

The tunnel from the Mitchell Creek Valley will terminate on the south side of the valley formed by a north flowing tributary of Teigen Creek (South Teigen Creek) and a south flowing tributary of Treaty Creek (North Treaty Creek Tributary), adjacent to the plant site.

The plant will use a conventional grinding and flotation flowsheet to produce separate copper/gold and molybdenum concentrates, gold doré and tailing. It will process approximately 120,000 tonnes per day of ore to produce an average of 1,200 tonnes per day of concentrate. The concentrate will be dried and transported to the port of Stewart by truck. It is anticipated that approximately 20 to 30 round trips per day will be required using 40 tonne payload trucks.

Vehicle access to the plant site will be by a 14 km long road along Teigen Creek from Highway 37. This road will require bridges to cross Teigen creek, which may be considered to be navigable water, and smaller tributaries.

The tailing will be pumped through pipelines to the tailing management facility located in the upper reaches of the Teigen Creek Valley, extending southeast over the divide into a tributary of the Treaty Creek drainage. The facility will be constructed in two phases: the north cell will be developed between a north dam, to be located across the valley of the south tributary of Teigen Creek near the plant site, and a south dam, to be located near the crest of the valley floor; and a south cell that will be retained by a southeast dam, to be located in the headwaters of the north tributary of Treaty Creek. The proposed facility will have storage capacity for the life of the Project within an area about 8 km long and 1.5 km wide. Seepage from the south and southeast dams will be pumped back into the impoundment to reduce any potential impact on the Treaty Creek drainage. Water diversion channels will be constructed on both flanks of the impoundment, where feasible, to divert non-contact water away from the impoundment. Supernatant water will be recovered from the impoundment using barge mounted pumps and recycled to the plant for process water. In the event that discharge is required, the excess water in the impoundment will be pumped over the northern dam towards the Teigen Creek drainage. Treatment of discharge water may be required to meet permit conditions.

It is assumed that electricity to power the plant and mine site will be obtained from the provincial electricity grid. A secondary transmission line will be constructed from a switching station, to be located near the point where Highway 37 crosses Snowbank Creek. The secondary line will follow the general alignment of the access road, to the plant site, and then pass through the tunnel to the mine site.

1.4 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 Aboriginal peoples. Habitat suitability models were created in conjunction with Ecosystem Mapping (Rescan 2010d) for the following species and seasons/attributes: moose (*Alces alces*) early and late winter habitat; mountain goat (*Oreamnos* *americanus*) summer and winter habitat; grizzly bear (*Ursus arctos*) spring, summer, fall, and hibernating habitat; American marten (*Martes americana*) winter habitat; and hoary marmot (*Marmota caligata*) growing season (combined spring, summer, and fall) habitat.

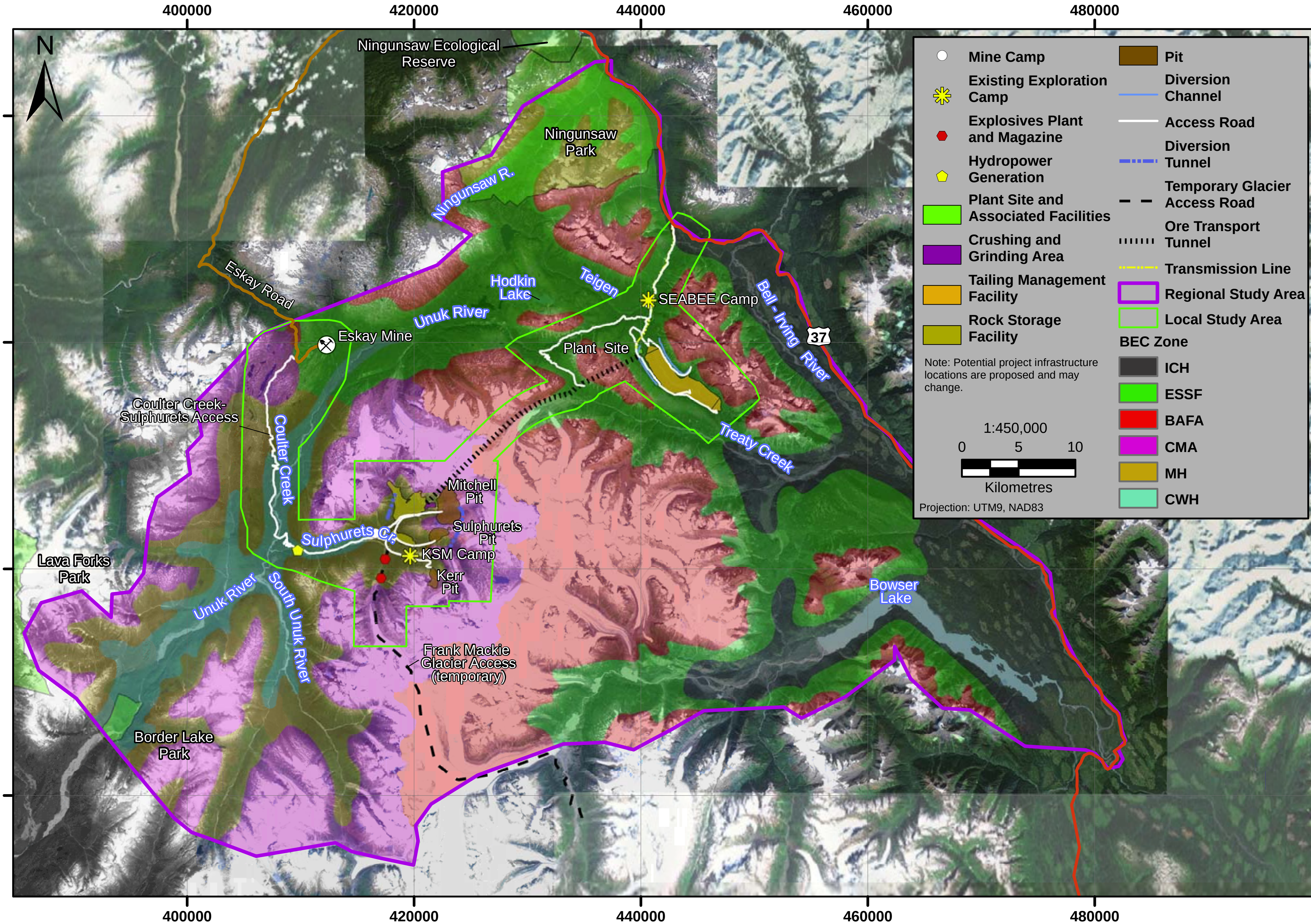
Field studies to identify species of conservation concern as well as other wildlife inhabiting the area of the proposed Project were undertaken independently of habitat suitability field studies. The results of the wildlife characterization studies are presented separately (Rescan 2009, 2010a, 2010e).

1.5 STUDY AREA

Two study areas were considered for wildlife inventories for the Project: a local study area (LSA) and a regional study area (RSA) (Figure 1.5-1). The LSA is based on the Terrestrial Ecosystem Mapping area (Rescan 2010d) and includes a buffer extending at least to the height of land or 1.5 km around the outer limits of the proposed infrastructure (e.g., the proposed plant site, open pits, and TMF), which ever comes first. The LSA also includes a buffer extending at least to the height of land or 1.5 km along either side of the centre line of the linear developments (i.e., access roads, pipelines, and transmission line), which ever comes first. For the purposes of this environmental baseline studies report, the LSA is divided into four distinct and geographically separate areas: Western, Eastern, Mitchell-Teigen Corridor, and the Coulter Creek Access Corridor. The Coulter Creek Access Corridor and Western area represent a more coastal influenced climate. The Coulter Creek Access Corridor includes the proposed Coulter Creek Access Road and the Sulphurets Canyon small hydro plant, and the western area includes the mining area (i.e., proposed pits, rock disposal areas, accommodation, associated maintenance facilities, and related access). The Eastern area represents a transitional climate from coastal to interior and includes the proposed TMF, plant site, Teigen Access Road, and associated facilities. The Mitchell-Teigen Corridor is glacier, rock, or alpine tundra and includes the 23 km long parallel tunnels between the Mitchell Creek and Teigen Creek valleys. The local study area used for habitat mapping covers 54,785 ha or 548 km^2.

The RSA was delineated to reflect the area anticipated to provide 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. Other ecological factors, such as height of land (which can act as a barrier to movement) were also considered when delineating boundaries. The RSA used for habitat suitability mapping is approximately 338,000 ha (3,380 km^2).

Ecologically, the RSA is divided into two distinct climatic regions. The western portion of the study area (including the Western LSA and Coulter Creek Access Corridor) represents moist coastal ecosystems, including Coastal Western Hemlock-Wet Maritime (CWHwm), Mountain Hemlock-Leeward Moist Maritime (MHmm2), and Coastal Mountain-heather Alpine-Undifferentiated Parkland (CMAunp) biogeoclimatic ecosystem classification (BEC) units. The eastern portion of the study area (including the Eastern LSA and Mitchell-Teigen Corridor) represents a transitional climate from coastal to interior ecosystems, including Engelmann Spruce – Subalpine Fir-Wet Very Cold (ESSFwv), Boreal Altai Fescue Alpine-Undifferentiated Parkland (BAFAunp), and Interior Cedar Hemlock- Very Wet Cold (ICHwc) BEC units. Elevations in the RSA range from approximately 240 m at the confluence of Sulphurets Creek and the Unuk River, to over 2,300 m at the peak of the Unuk Finger. Habitat types are diverse, with mature forests and wetlands at lower elevations, and shrubs/stunted trees and drier sparsely vegetated subalpine and alpine habitat at higher elevations.



SEABRIDGE GOLD

Wildlife Study Areas

FIGURE 1.5-1

Rescan

Provincial forests within the RSA are administered by the Ministry of Forests and Range. The Project overlaps two forest districts (Skeena Stikine and Kalum), as well as two timber supply areas (TSA; Cassiar and Nass). Wildlife is managed provincially by the Ministry of Environment (MOE) Region 6 (Skeena), and the Pacific/Yukon division of Environment Canada is the federal agency responsible for wildlife and species at risk in the area. The Project overlaps with three Wildlife Management Units (WMUs) within Skeena Region 6, including 6-16, 6-21, and minor portions of 6-17.

The western portion of the RSA is in the Cassiar Iskut-Stikine Land and Resource Management Plan (LRMP; BC ILMB 2000). A small part of the eastern portion of the RSA, including the Eastern LSA in the vicinity of the divide between Unuk River and Treaty Creek drainages, is within the Nass South Sustainable Resource Management Plan (SRMP; BC ILMB 2009). The RSA also lies partially within the Nass Area as defined in the Nisga'a Final Agreement.

There are three provincial parks in or within close proximity to the proposed Project, two of which are within the wildlife RSA. Ningunsaw Provincial Park and Border Lake Provincial Park are within 15 km and 25 km, respectively, of proposed Project infrastructure, and inside the RSA. Lava Forks Provincial Park is located outside of the westernmost part of the RSA, adjacent to the boundary.

1.6 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 potential mitigation and management planning. The specific objectives of the wildlife habitat suitability baseline study were to:

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

2. Background Information

2.1 WILDLIFE LEGISLATION

Wildlife is managed provincially by the Ministry of Environment Region 6 (Skeena), and 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* (1996a) protects wildlife habitat features, such as nest sites, on a local scale. The *Wildlife Act* 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* (1996b) affords protection to riparian areas and stipulates that all instream works must protect fish and wildlife habitat.

The BC *Forest and Range 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 and requires special management attention. The *Identified Wildlife Management Strategy* (IWMS) provides direction, policy, procedures, and guidelines for managing Identified Wildlife (BC MWLAP 2004b). 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 2004b). In addition, the 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 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 areas, 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

The Project area is situated within the Regional District of Kitimat-Stikine (RDKS), and contains extensive areas of Crown land and areas subject to the Cassiar Iskut-Stikine Land and Resource Management Plan (LRMP; BC ILMB 2000) and draft Nass South Sustainable Resource Management Plan (SRMP; BC ILMB 2009). 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. Regional plans or LRMPs (sub-regional plans) result in several main products including: broad land/coastal use zones delineated on a map; resource management objectives for land/coastal use zones; broad strategies for integrating resource use; socio-economic analysis; and plan monitoring, implementation, and interpretation mechanisms. SRMPs focus on similar issues and values as regional plans or LRMPs but at a more detailed level. For example, SRMPs are used to identify Old Growth Management Areas (OGMAs), a priority component of biodiversity planning, to address specific economic development issues such as agriculture or tourism developments, and to manage values such as spiritual and cultural resources as identified by Aboriginal groups.

The western portion of the RSA falls under 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. In addition to the GMD, there are objectives and strategies for area-specific Resource Management Zones (RMZs). One RMZ, the Unuk River RMZ, occurs within the RSA. A small part of the eastern portion of the RSA falls within the Nass South SRMP (draft). Wildlife-related management objectives of both the GMD and Unuk River RMZ of the Cassiar Iskut-Stikine LRMP, and the Nass South SRMP are described in Table 2.3-1.

Table 2.3-1. Wildlife Objectives of the Cassiar Iskut-Stikine LRMP and Nass South SRMP

Management Direction	Wildlife-Related Resource	Wildlife-Related Management Objectives
Cassiar Iskut-Stikine LRMP (BC ILMB 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 and Nass South SRMP (continued)

Management Direction	Wildlife-Related Resource	Wildlife-Related Management Objectives
Cassiar Iskut-Stikine LRMP (BC ILMB 2000) (continued)		
	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.

(continued)

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

Management Direction	Wildlife-Related Resource	Wildlife-Related Management Objectives
Cassiar Iskut-Stikine LRMP (BC ILMB 2000) (continued)		
	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 – Unuk River Zone	General	• Maintain high quality and quantity of grizzly bear habitat while allowing commercial timber harvesting and mineral exploration and development to occur.
Draft Nass South SRMP (BC ILMB 2009)		
Water Resources	Water	• Maintain ecological functioning of streams, rivers, wetland complexes and lakes, including those that do not support populations of fish. • Maintain the functional integrity of floodplains and alluvial fans.
Biodiversity Resources	Biodiversity	• Maintain or recruit structural attributes of old forests to support stand-level biodiversity.
Wildlife	Moose	• Maintain, enhance or restore moose winter range habitats. • Through access management, minimize mortality and disturbance to moose within and adjacent to the moose winter ranges identified.
	Mountain Goat	• Minimize adverse disturbance to goats within identified mountain goat winter range. • Minimize the number of roads within 500 m of winter range and 1000 m of canyon-dwelling goat winter range. • Minimize adverse disturbance to mountain goat winter range from helicopter logging activities.
	Grizzly Bear	• Preserved the highest value grizzly bear habitat. • Maintain the quality and effectiveness of grizzly bear foraging habitat. • Minimize human-bear conflicts. • Minimize long-term displacement of grizzly bears from industrial access development.
	Furbearers	• Minimize impact to known high value fisher and wolverine habitat.
	Northern Goshawk	• Maintain nesting and post-fledgling habitat at known goshawk nest areas, to support continued use and reproduction in those areas. • Maintain foraging habitat around known goshawk nest and post-fledgling areas.
	General Wildlife	• Maintain effectiveness of riparian habitats adjacent to wetlands.

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; Demarchi 2000; Demarchi and Johnson 2000) and North Nass Timber Supply Area (TSA; McElhanney 2007b, 2007a), in addition in areas to the northwest of the proposed Project (RTEC 2006a, 2006b). Numerous studies have also been conducted on mountain goats in the region (e.g., Keim 2004b, 2004a).

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 finding from this assessment was that 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 finding highlights the importance of migration corridors for moose in the region. Migration corridors are a type of key habitat features that cannot be identified through habitat suitability mapping alone and must be attained 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.

Based on mapping studies of moose winter range in the North Nass TSA, areas with the best winter forage for moose occurred on the floodplains and outflows of large rivers and at the toe of mountainous slopes with productive understory shrubs (McElhanney 2007b). This conclusion is supported by the results of moose surveys and habitat mapping for moose in other mining project areas (RTEC 2006d, 2006b) 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 snow pack was on the order of three metres or more (McElhanney 2007b). Snow depths such as these are known to restrict moose movement (Kelsall and Prescott 1971; Coady 1974; Doerr 1983). Typically, closed canopy forests are the only areas with low snow depths. However, some open canopy forest, such as those within the ICHvc BEC subzone, also have value for snow interception (McElhanney 2007b). While the canopy cover is less than 50%, trees may have much fuller crowns that create large tree wells underneath where moose can rest and find available forage within several meters (McElhanney 2007b).

2.3.2.2 Grizzly Bear

An assessment of the distribution, relative abundance, and seasonal habitat use of grizzly bears, as well as identification of high-use areas and movement patterns, was conducted in the nearby NWA 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 (COSEWIC 2002; BC MWLAP 2004a). Starting in low elevation river valleys and floodplains during spring, they progress slowly up avalanche chutes towards high alpine meadows where they remain through the late summer months, before returning to the valley bottoms once again in the fall (D.A. Blood 2002; BC MWLAP 2004a). During mapping of grizzly bear habitat in the North Nass TSA, McElhanney (2007a) determined that the highest value grizzly bear habitats across the spring, summer, and fall are on avalanche tracks within the ESSFvw BEC and floodplains and wetland habitat within the ICHvc and ICHmc BECs.

Access to salmon bearing streams in the late summer and fall is recognized as important for grizzly bears in the province. Salmon is an important dietary component for bears in the North Nass TSA and NWA, and access to salmon spawning habitat in the fall is important, particularly within the Hanna and Tintina Creek watersheds (Demarchi and Johnson 2000; McElhanney 2007a). In addition, over a two year DNA and stable isotope study in the Galore Creek Valley and surrounding areas, it was observed that grizzly bears in coastal habitats, which included the lower Stikine and Iskut River drainages, were highly reliant on salmon during all seasons (RTEC 2006a). During the spring, salmon constituted just under a quarter of the grizzlies' diet, and increased to over half of their diet during the summer and fall (RTEC 2006a). In addition, the largest movements of grizzly bears were by those bears moving towards fish bearing streams in the later summer and fall. However, it was found that salmon was not a 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 and plants.

2.3.2.3 Mountain Goat

Mountain goats tend to re-use core winter habitats over multiple years (Keim 2004b). Suitable mountain goat winter habitat has been identified near the proposed Project. Using GPS collared animals, winter movements, winter habitat selection, and core winter habitat use in the Taku River drainage (north of the Project) were determined (Keim 2004b), along with winter habitat suitability index models in the Bell II area (Keim 2004a). The results of these studies have led to the designation of approximately 78,649 ha of mountain goat UWR in and around the Bell II area (BC MOE 2008), portions of which overlap the RSA.

Mountain goat populations have also been monitored in areas to the northwest 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 population disbursement. The results of the surveys indicated that stable population of goats inhabited the area. In addition, selection of elevation did not appear to vary largely over the two year study, where goats were observed at roughly the same elevation in the winter as in the summer (RTEC 2006c). Although this trend was also observed during baseline studies for the KSM Project (see Rescan 2010e), it contrasts with what has been observed in several other studies, where goats typically move to lower elevations in the winter (Schoen and Kirchoff 1982; J.L. Fox, Smith, and Schoen 1989; Shackleton 1999).

3. Methods

3.1 HABITAT SUITABILITY MODELLING BACKGROUND

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 potential 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.

3.2 WILDLIFE HABITAT MODEL DEVELOPMENT

The development of habitat suitability models is a multi-step process, which includes gathering background information on focal wildlife species and summarizing this information in species accounts (Section 3.2.1), developing wildlife habitat ratings based on background information (Section 3.2.2), and then evaluating habitat models against current field conditions (Section 3.2.3). The initial development of habitat suitability models, including collection of field data and development of modelling assumptions, was conducted during 2008 and 2009. In late 2009 and early 2010, preliminary habitat models were developed based on model assumptions and were tested against field data to evaluate the model's ability to predict field conditions. A generalized approach is described here, while greater detail describing habitat mapping assumptions for individual wildlife species is included within each species section (Section 4).

3.2.1 Species Accounts

Species accounts were developed for the five species selected for habitat suitability mapping (Appendices 1 to 5). 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 development of species accounts was a desk-based exercise, accomplished by reviewing literature to identify important habitats (e.g., habitats most limiting to a wildlife species, such as winter range for ungulates) and biophysical components that constitute the habitat. Important 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 wildlife field studies can help identify features that can be used to predict important habitats prior to the development of models (i.e, Rescan 2010e).

Information on species biology and habitat selection in regional and provincial contexts was also included wherever possible (e.g., Section 2.3.2). Species accounts for focal species that were available on the provincial reports catalogue "Ecocat" (BC MOE 2010), were also consulted and modified for the ecology of the Project study area. This information helped guide the formulation of habitat suitability model algorithms and wildlife habitat ratings for each focal species.

3.2.2 Wildlife Habitat Ratings

The next step in model development is to identify suitable habitat used by each species. This step involves using standard ecosystem mapping products that identify and spatially define habitat across an area of interest (RIC 1999a). For the KSM Project, the results of Predictive Ecosystem Mapping (PEM) were used. The RSA 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 2008 and 2009 were utilized to guide and refine the PEM. Full details of the mapping process are provided in the KSM Project: 2009 Vegetation and Ecosystem Mapping Baseline Studies Report (Rescan 2010d).

The PEM product identified a variety of ecosystems ("ecosystem units") within the study area (Rescan 2010d); these are henceforth referred to as PEM ecosystem units. Following provincial standards, wildlife habitat ratings (WHRs) were then assigned to each PEM ecosystem unit as a way to characterize the suitability of that unit to support a wildlife species for a particular life requisite and season (RIC 1999a). Ratings were based on assumptions regarding the habitat requirements of the species and are defined in the species-habitat model. For the proposed KSM Project, these assumptions and algorithms are described in the relevant species chapter (Sections 4.2 to 4.6). For the grizzly bear hibernating model and the hoary marmot growing season model, no WHRs were developed (discussed below and in detail in Sections 4.4.2 [grizzly] and 4.6.2 [marmot]).

Wildlife habitat ratings (WHRs) were based primarily on the vegetation present in the area; however, a number of different aspects were considered, including the expected vegetation phenology schedules during a chronological season and vegetation structure. Plant or vegetation phenology refers to the developmental status or observed state of plants at a particular season or time of year (e.g., vegetation emergence, flowering, berry production). Chronological seasons refer to seasonal shifts that follow the calendar year. 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 1998b) is divided into seven classes ranging from un-vegetated areas (structural stage 1) to old-growth forest (structural stage 7). Each structural stage has different compositions of plant species; 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. Each structural stage may be useful for different sets of species throughout the chronological season. Canopy closure also has an important influence on habitat values. Canopy closure directs vegetation composition and production in the understory, which in turn influences the wildlife that will use the area. Structural stage and canopy closure often act in concert in influencing overall habitat value. 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).

Habitat of each identified focal species was evaluated for the specific seasons and life requisites outlined in Table 3.2-1. Following BC 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 3.2-2). In some cases, WHRs based on the ecosystem map product were combined with additional model algorithms so that abiotic features could also be included (Table 3.2-1). These features included the identification of capable winter topography for moose, suitable escape terrain and topography for mountain goat, and appropriate terrain characteristics for grizzly bear hibernating habitat and hoary marmot growing season habitat. The modelling techniques that were used for these species are discussed in further detail in the following sections.

Table 3.2-1. 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 rating)	6 class	Yes
Mountain Goat	Winter and Summer	LI (FD and SH emphasis for rating)	6 class	Yes
Grizzly Bear	Spring, Summer, and Fall	FD	6 class	No
	Winter	HI	4 class	Yes
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. Hibernating (HI) is a specific life requisite concerned with habitats with appropriate cover and thermal conditions for the winter season.
[2]. Additional modelling refers to the use of additional data (e.g., TRIM-based topography) to refine the habitat suitability model.

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 BC RISC Standards (RIC 1999a). The only exceptions were the hoary marmot growing season and grizzly bear hibernating models (Sections 4.4.2 and 4.6.2). Both WHRs and HSRs assigned to each ecosystem unit were based solely on the habitat contained within the RSA. That is to say, ratings were developed relative to one another within the study area and were not adjusted to the provincial "best" benchmarks (i.e., the best habitat for a given species across the entire province; RIC 1999a) outlined in the species account. For example, the highest value habitat for goats identified within the study area (i.e., HSR 1 habitat) may not translate to the percent of provincial best benchmarks outlined in Table 3.2-2.

3.2.3 Model Evaluation

Habitat models are limited by the accuracy of the knowledge of the species' habitat preferences used to develop the models and can only function as well as their ability to predict actual field conditions. Field testing verifies habitat suitability by evaluating a variety of habitats to see how well the model predicts actual field conditions (RIC 1999a). Field testing includes collection of data describing biophysical conditions as well as wildlife use of an area.

Table 3.2-2. Wildlife Habitat Rating (WHR) and Habitat Suitability Rating (HSR) Class Schemes[1]

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

[1] As described in RIC (1999a).
[2] % of best represents a conceptual framework 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. However, for the KSM Project, habitat ratings were not adjusted according to the provincial benchmarks.
[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.

Field assessments were conducted during the summer of 2008 and 2009 in conjunction with ecosystem and soils mapping (Rescan 2010d). At each field plot location, the wildlife surveyor rated the seasonal habitat for species selected for modelling according to a 6- or 4-class system (Table 3.2-2) using the Wildlife Habitat Assessment field cards (FS 882 (5) HRE 98/5). Field data were entered into the provincial data entry program VENUS (version 5.0).

To evaluate the species-habitat models, field ratings collected in 2008 and 2009 were compared to the wildlife habitat ratings[1] assigned to the final ecosystem map product for each focal species. This comparison was achieved by overlaying the location of field plots onto habitat suitability maps and analyzing each rating predicted at that location. The difference between the field and model WHR was calculated. An additional method of evaluation was performed for moose and mountain goat; observations of these species were overlaid with final suitability maps to assess whether wildlife presence corresponded with habitat quality.

There is 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 includes 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.

3.2.4 Model Confidence and Resolution

Habitat suitability maps presented in this baseline report provide an accurate representation of the distribution of wildlife habitat in the RSA at a landscape level of resolution. It is important to acknowledge that species habitat models are limited by the extent of the knowledge of a species, a species' use of habitat, and the ecosystems (RIC 1999a). In addition, PEM indicates the most likely distribution of these ecosystems rather than an exact representation of the distribution of ecosystems in the study area. Despite this limitation, the accuracy of the PEM is sufficient to evaluate the quantity and quality of wildlife habitat within the area at a landscape level.

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[1] This WHR is inclusive of any additional modelling inputs identified in Table 3.2-1 (e.g., identification of escape terrain and topography for goats).

4. Species Habitat Suitability Models

4.1 MOOSE

4.1.1 Background

Moose were selected as a candidate species for habitat suitability mapping in the study area because of their biological, social, and cultural significance. Moose are an important component of the regional biodiversity, and they are harvested by Aboriginal peoples, resident hunters, and non-resident hunters.

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 to maintain sustainable moose populations. Delineating Ungulate Winter Range (UWR), which conserves critical winter habitat, is one example of how inventory and habitat modelling efforts have been integrated for management of ungulate populations (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 during winter are limited and of reduced nutritional quality. Habitat suitability mapping for moose in this study focused on identifying habitats that may be used during the early and late winter periods. Snow depth in the early winter is not anticipated to limit the movements of moose, and moose may exploit a variety of habitats across the landscape. The snowpack during late winter, however, is expected to become prohibitively deep, potentially restricting moose movement. In response to deeper snowpacks, moose typically move to lower elevations, as observed in the Nass Wildlife Area (NWA; Demarchi 2000, 2003).

4.1.2 Moose Habitat Suitability Model Development

4.1.2.1 Model Rating Assumptions

Early Winter

An early winter habitat suitability model was developed to identify areas where moose are able to find preferred forage. The model represents periods when snowpack is not limiting movement, which occur when packed snow is less than one metre deep, or when snow may be deeper than one metre but less dense and easier for moose to travel through. The early winter model covers the time when snow begins to accumulate in October until snowpacks become limiting, which will vary on an annual basis.

In general, early winter habitat suitability ratings assigned to identified PEM ecosystem units were based on forage production. Specifically, areas that may produce abundant and preferred moose winter forage vegetation (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. For example, radio-collared moose in the NWA select areas with a greater availability of suitable forage within the winter home range (Demarchi 2000). During habitat suitability modelling of winter moose habitat in the NWA, 90% of the overall habitat suitability index value of the ecosystem unit was assigned to the feeding component of the model (Yazvenko, Searing, and Demarchi 2002).

In developing this model, the following general assumptions were made in 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 lower elevation BEC units (e.g., ESSF, ICH, CWH, and MH). High value habitat also included swamps and wetlands. Moderately High value habitat also included drier to mesic structural stage 3 vegetation within all BECs. 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 snow pack. 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 such as willow and was rated Moderately High. All the aforementioned areas were generally on topography with gentle or no 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 ESSF BEC. Moderate valued sites also included waterways and gravel bars, which are associated with riparian corridors that support a sparse to moderate distribution of 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.

These assumptions are based on current knowledge of moose habitat selection and use, which is outlined in the species account (Appendix 1). The early winter WHRs assigned to the PEM ecosystem units, based on these assumptions, are provided in Appendix 6.

Late Winter

The late winter habitat suitability model identifies the most important areas used by moose during more severe winter conditions, when deeper snow packs may become a major impediment to moose movement (Coady 1974; Dussault et al. 2005). Generally, dense snow packs greater than one metre deep were assumed to restrict moose movement within the study area. These snow depths tend to occur by December or January, with some annual variation. It is acknowledged that there may be times during the late winter when the “non-restrictive” snow conditions outlined in the early winter are present (e.g., shoulder periods or during the transition to spring), and the early winter model may be more applicable during these times than the late winter model.

Like the early winter model, habitat suitability ratings given to identified 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 snow pack as travel is easier in these areas (Demarchi 2000, 2003). Therefore, the late winter model also integrated topographic features to isolate areas with potentially shallower snow and more accessible forage. A topographic model was developed based on the local distribution of moose recorded during surveys in the winter of 2009 (Rescan 2010e). The areas identified by this model are referred to as “capable habitat” for moose in the late winter, described in detail in the following section.

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

- o High and Moderately High value habitat for the late winter included the same habitat as was identified during the early winter. However, some areas, including mixed coniferous and deciduous forest near valley bottoms and just above, were also rated as Moderately High.
- o Moderate value habitats for the late winter included the same habitat as were identified during the early winter.
- o 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.
- o Nil value habitat included areas not identified as capable from the topographic model.

These assumptions are based on current knowledge of moose habitat selection and use, which is outlined in the species account (Appendix 1). The late winter WHRs assigned to the PEM ecosystem units, based on these assumptions, are provided in Appendix 6.

4.1.2.2 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 is defined by RIC (1999a) 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". This definition was modified for moose to incorporate habitat types that are most able to provide their late winter life requisites, due to the limiting nature of winter habitat and its relative importance to moose.

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 KSM Project (Rescan 2010d). The most capable habitat included low elevation areas on gentle slopes (≤ 40%) below 450 m elevation within coastal BEC zones (CWH and MH) and below 600 m elevation within interior BEC zones (ICH and ESSF) (Table 4.1-1). The results of 2009 winter surveys, however, suggest that a small proportion of moose may be found on slightly steeper slopes and at higher elevations (Rescan 2010e). To account for this use, capable habitat was extended to include areas up to 750 m elevation and 60% slope, but it was assumed that this higher and steeper capable habitat would be of lower value to moose (e.g., snowpack in these areas may be deeper and thus forage less accessible). WHRs given to PEM ecosystem units were adjusted accordingly when assigning a final HSR (Table 4.1-1). All polygons (or portions thereof) that were above 750 m and/or greater than 60% slope were assigned a Nil value for late winter habitat, representing habitat where moose could no longer travel easily through the late winter snowpack nor burrow through the snow to access forage (Table 4.1-1). All habitat located within alpine BEC zones (BAFA and CMA) were not included within the definitions of capable habitat nor were they rated for late winter suitability. These areas would be covered with very deep snow during the late winter and at the highest elevations, permanent snow or ice cover (e.g., glaciers), and thus would be most similar to Nil rated habitat within the RSA.

4.1.3 Model Evaluation

The early winter habitat rating assumptions were evaluated 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 69% of the time (N=116). 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 69% of the time at 113 common locations.

Table 4.1-1. Elevation and Slope Adjustments to Capable Habitat and Associated Late Winter Habitat Suitability Rating for Moose

Coastal BEC Zones (CWH and MH)		Interior BEC Zones (ICH and ESSF)		
Elevation (m)	Slope (%)	Elevation (m)	Slope (%)	Associated HSR
0 - 450	0 - 40	0 - 600	0 - 40	Most Capable Habitat: HSR equivalent to WHR assigned to PEM ecosystem unit
0 - 450 451 - 750	41 - 60 0 - 60	0 - 600 601 - 750	41 - 60 0 - 60	Less Capable Habitat than above: WHR downgraded by one rating class for final rating (e.g., WHR 2 becomes HSR 3)
0 - 750 > 750	> 60 any	0 - 750 > 750	> 60 any	Not Capable Habitat: Automatically assigned a nil value (HSR 6) for late winter habitat

An additional model evaluation was conducted by overlaying moose group observations collected during the winter 2009 survey with the results of the late winter modelling. Of the 87 groups of moose that were observed within the modelled area, 47 (54%) were in habitats classified as High and Moderately High; and 78% of observations were located in habitats rated from High to Moderate (HSR 1, 2, and 3).

4.1.4 Results

4.1.4.1 Early Winter Habitat

Approximately 12% (40,637 ha) of the RSA is High (HSR 1) to Moderately High (HSR 2) rated early winter habitat for moose (Table 4.1-2). This total includes the LSA. High rated habitat was largely concentrated in the eastern RSA along the Bell-Irving River, the lower Treaty Creek drainage, and around Bowser Lake (Figure 4.1-1). Higher rated habitats in the eastern RSA tended to be located within areas of recent logging activity along Highway 37 or were concentrated within large wetland complexes, such as the confluence of Teigen Creek, Snowbank Creek, and the Bell-Irving River (Figure 4.1-1). In the western RSA, higher rated habitat was more sparely distributed. Small pockets of Moderately High rated habitat were mapped along the floodplains of the Unuk River. Some subalpine habitat in the western RSA, such as the area below Tom Mackay Lake, was rated High to Moderately High on account of the early seral stage vegetation that is available in those areas. A large amount of the RSA was rated Moderate (20%). These habitats were generally distributed across large tracts of land in the upper Unuk, Teigen, and Treaty Creek drainages, as well as in the southeast RSA between Treaty Creek and Bowser Lake (Figure 4.1-1). Moderate habitats 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, 23% was Low, 4% was Very Low, and 41% was Nil (Table 4.1-2). These areas tended to be either lower elevation young forests where limited forage is available, such as those along Highway 37 and along the Unuk River drainage, or higher elevation mountainous habitats that are sparsely vegetated or covered by glaciers (Figure 4.1-1).

High and Moderately High suitable habitat was mapped across 12% (6,204 ha) of the LSA, the majority of which occurred in the Eastern LSA within and around the proposed Tailing Management Facility and along the Teigen Creek Access Road (Figure 4.1-1). A small amount of HSR 1 and 2 habitat occurred within the Coulter Creek Access Corridor below Tom Mackay Lake (Figure 4.1-1). Of the High and Moderately High rated habitat mapped across the entire RSA, 11% and 20% occurs within the boundaries of the LSA, respectively (Table 4.1-2). Moderate habitat (HSR 3), totalling 25% of the LSA, was concentrated along most of the lower elevation subalpine fir and Engelmann spruce forest within the Eastern LSA; very little of the western, Mitchell-Teigen Corridor, or Coulter Creek Access Corridor LSA was identified as Moderately suitable. Relative to the entire area of Moderate habitat identified in the RSA, 19% was mapped within the LSA boundary (Table 4.1-2). The rest of the LSA was rated as Low

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(29%), Very Low (6%), and Nil (28%). These lower rated habitats were largely mapped within the Western LSA and along the Coulter Creek Access Corridor. The Mitchell-Teigen Corridor was primarily rated Nil on account of the high elevation and sparse distribution of vegetation (Figure 4.1-1).

Table 4.1-2. Early Winter Moose Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	21,557	6	2,410	5	11
Moderately High	19,080	6	3,794	7	20
Moderate	67,633	20	12,799	25	19
Low	76,141	23	14,926	29	20
Very Low	15,099	4	3,105	6	21
Nil	138,548	41	14,233	28	10

** Includes area of Local Study Area (LSA)*

4.1.4.2 Late Winter Habitat

In modelling late winter habitat, a substantial portion of the RSA (153,235 ha or 45%) occurs within the BAFAunp and CMAunp BEC zones and was not rated for suitability. These areas most likely represent Nil habitat for moose in the late winter, as they occur at too high an elevation and are covered by very deep snow as well as permanent snowpack. The following results summarize mapping of the remaining 55% of the RSA that was rated for late winter habitat suitability. Percentages therefore are the proportion of each habitat suitability class within this smaller RSA sampling unit.

High (HSR 1) and Moderately High (HSR 2) rated habitat accounts for 12% (20,928 ha) of the habitat in the RSA that was rated for late winter suitability (Table 4.1-3). This total includes HSR 1 and HSR 2 habitat found in the LSA. The HSR 1 and HSR 2 areas in the late winter model (Figure 4.1-2) were very similar to those identified in the early winter model (Figure 4.1-1), particularly those in the eastern RSA along Highway 37 from Bell II south to Bowser Lake. Moderately suitable habitat (HSR 3) accounted for 8% of the modelled RSA, and was distributed along the Unuk River in the western RSA and adjacent to higher rated habitat in the eastern RSA (e.g., around Bowser Lake). The majority of habitat was classified as Nil (72%). During aerial surveys in February 2009, five bull moose were observed in an isolated valley at high elevation (700 m) near the headwaters of the South Unuk River (Figure 4.1-1; Plate 4.1-1). This south facing valley received a Nil rating during habitat modelling on account of elevation; however, this valley may be of higher habitat quality, as bulls may have been using the wide open, isolated valley to avoid predators. In addition, hanging basins, particularly south facing ones, can provide forage in the winter; therefore, moose using this area could also find abundant browse.

A total of 38% (19,306 ha) of the LSA was within the BAFAunp and CMAunp BEC zones and was not rated for late winter suitability. The remaining habitat was rated (Table 4.1-3). The percentage of habitats within the LSA represents the proportion of rated habitat within the remaining 62% of the LSA.

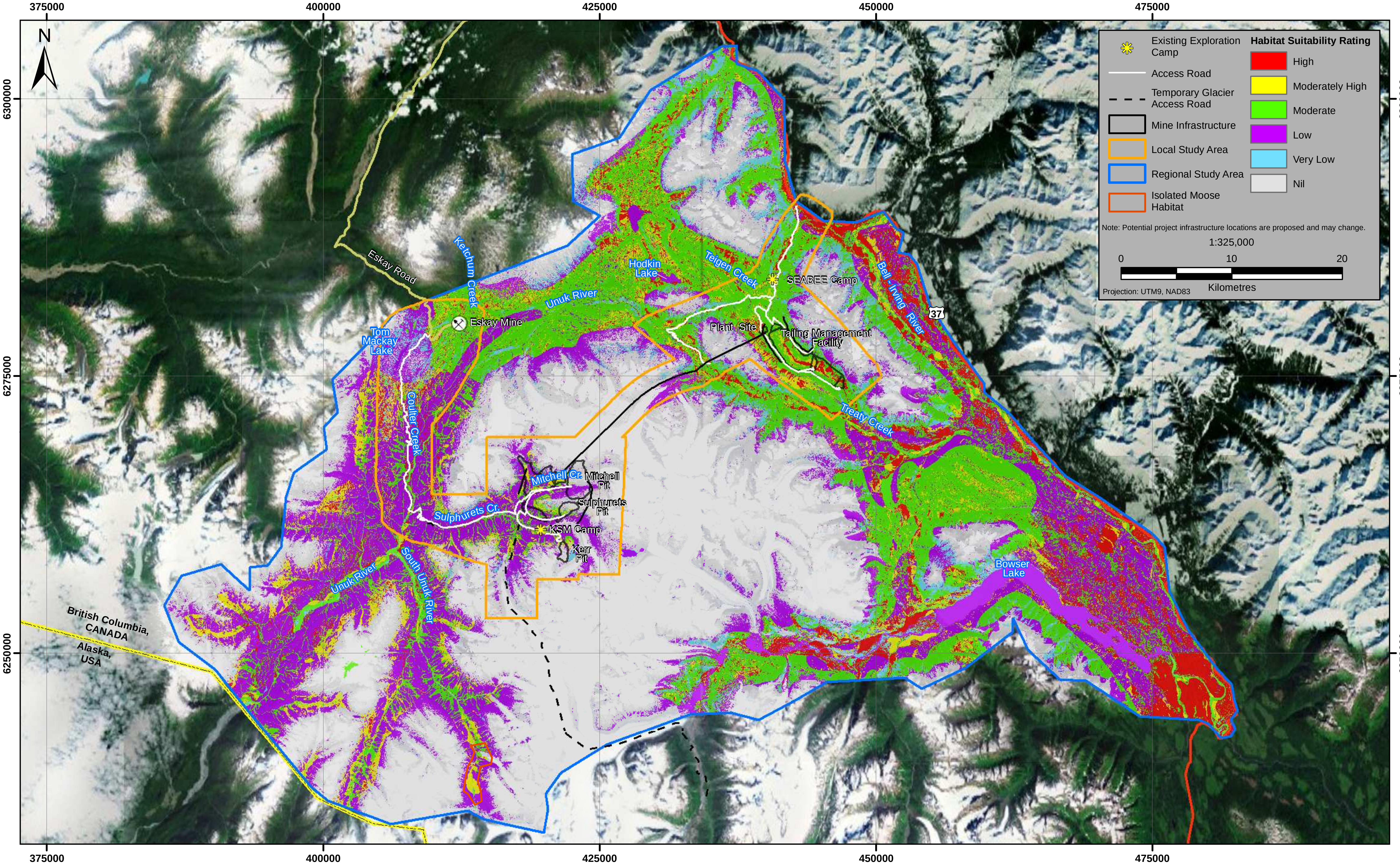
Table 4.1-3. Late Winter Moose Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	12,395	7	412	1	3
Moderately High	8,533	5	278	1	3
Moderate	14,483	8	1,279	4	9
Low	15,016	8	1,473	5	10
Very Low	1,930	1	219	1	11
Nil	132,465	72	28,299	89	21

** Includes area of Local Study Area (LSA)*

Plate 4.1-1. Isolated moose habitat within a valley (700 m elevation) at the headwaters of the South Unuk River.

Only a small proportion (2%) of the LSA was rated as High or Moderately High suitable late winter moose habitat. These higher rated habitats were primarily located in the Eastern LSA in the large wetland complex along Teigen Creek and the Bell-Irving River near Bell II (Figure 4.1-2). Proportionately, 3% of HSR 1 and HSR 2 habitats identified in the RSA occur within the LSA (Table 4.1-3). Very little habitat fell within the Moderate (4%), Low (5%), and Very Low (1%) suitability classes (Table 4.1-3); most of these habitats were mapped along the Coulter Creek Access Corridor and the Western LSA. The vast majority of the LSA was classified as Nil (89%). All of the proposed mine site and the Tailing Management Facility were rated as Nil for late winter suitability (Figure 4.1-2).



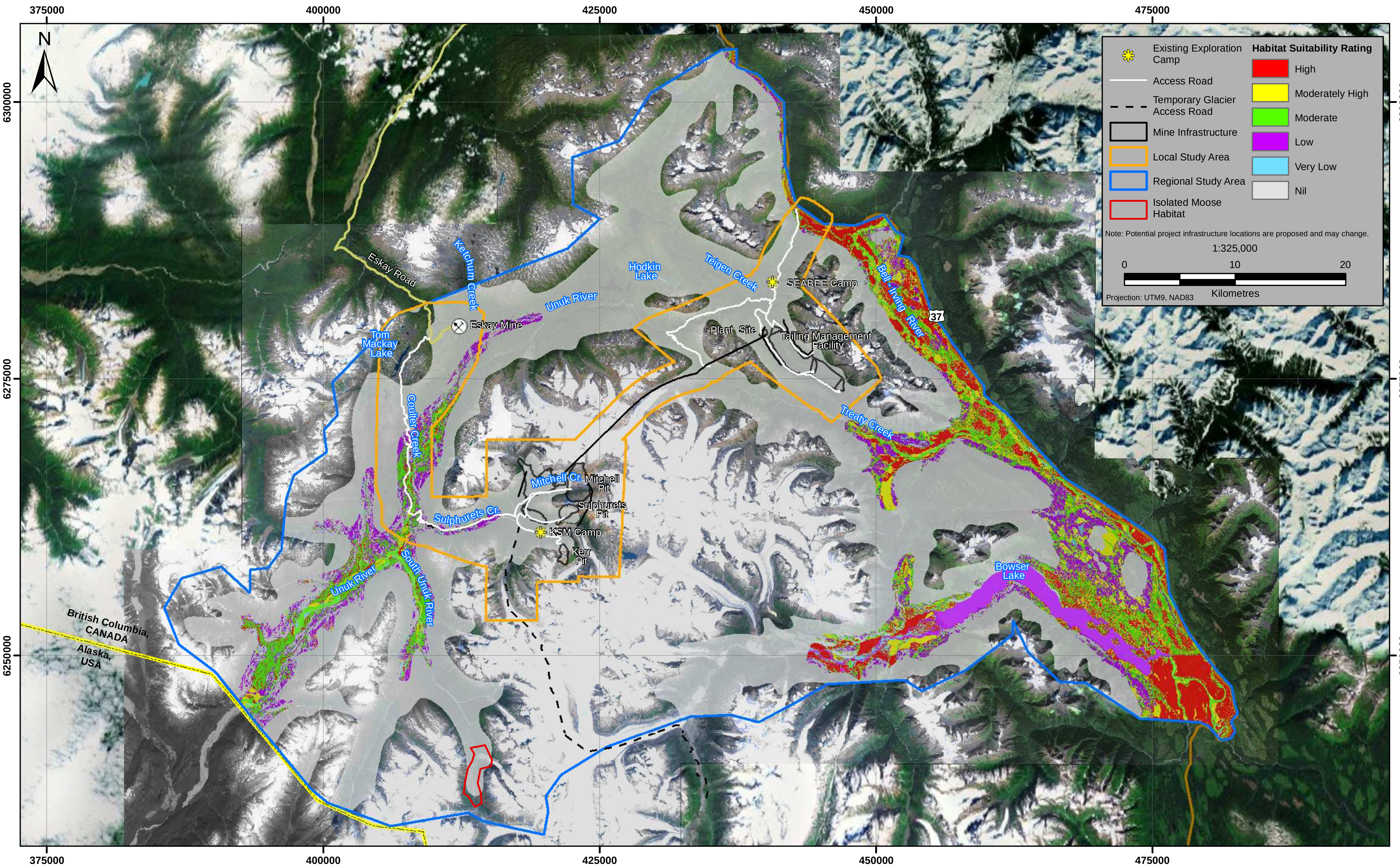
SEABRIDGE GOLD

Moose: Early Winter Habitat

FIGURE 4.1-1

Rescan

gis no. KSM-23-088 Job No. 0868-006-14-05 June 17, 2010



SEABRIDGE GOLD

FIGURE 4.1-2

Moose: Late Winter Habitat

Rescan

4.1.5 Discussion

The combination of vegetation and topography that received the highest habitat suitability ratings (High or Moderately High) can be described as “most suitable habitats” for moose. Overall, there is more High and Moderately High rated early winter habitat in the RSA as opposed to late winter habitat (Tables 4.1-2 and 4.1-3). Within the RSA, the wetland complex along the lower Teigen Creek drainage near Bell II and the large floodplains along the Bell-Irving and Bowser Rivers (Figures 4.1-1 and 4.1-2) were identified as the most suitable winter habitat. Within the LSA, there was very little higher rated late winter habitat and the most suitable early winter habitat was located in the wetlands within the proposed Tailing Management Facility and riparian areas along the length of Teigen Creek.

The RSA provided more early winter habitat than late winter habitat. There was less late winter habitat because a significant amount of the RSA (45%) is high elevation alpine habitat within BAFA and CMA BEC zones; this habitat is likely unusable for moose as there would be very deep snow in these areas during the late winter as well as permanent snow or ice cover (glaciers) at the highest elevations. In addition, a large portion (72%) of the remaining habitat was rated as Nil suitability (Table 4.1-3); these were areas where the topography suggests a prohibitively deep snowpack that would restrict moose movement. Therefore, there was a smaller amount of habitat within the RSA that was able to provide for the late winter forage requirements for moose (Tables 4.1-2 and 4.1-3). Within the RSA, the most suitable habitats that provided moose with preferred winter forage vegetation (e.g., willows and other woody browse) were centred around wetland-timber complexes and along floodplains of large rivers. Examples of these areas that rated highly in both the early and late winter were the wetland complex along the lower Teigen Creek drainage near Bell II and the large floodplains along the Bell-Irving and Bowser Rivers.

There were several areas within the LSA that were rated as higher suitability classes (HSR 1 or 2) for moose in the early winter, including the wetland habitat within the proposed Tailing Management Facility and riparian areas along the length of Teigen Creek. However, as snowpack increases in the late winter, these areas appear to become less suitable for moose as they were rated as Nil (Figures 4.1-1 and 4.1-2). Indeed, there were very few areas that were either Moderately High or Highly suitable late winter habitat for moose in the LSA.

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 during other seasons (for thermoregulation) and forage resources are more limited (Safford 2004). The importance of forage availability verses shelter/thermal requirements is based on winter conditions and the proximity of the two resources is important for moose during severe winter conditions. For example, forage availability for moose in the NWA is a better indicator of moose habitat preference than the availability of cover for snow interception (Demarchi 2000; Yazvenko, Searing, and Demarchi 2002). When snow depths increase, moose preferentially select habitat with abundant food resources interspersed with closed canopy forests for cover/shelter (Dussault et al. 2005).

Moose winter range has previously been identified in the RSA. High value habitat for moose was identified in the western RSA within the Cassiar Iskut-Stikine (CIS) LRMP (BC ILMB 2000) and in the eastern RSA within the north Nass TSA (McElhanney 2007b). Moose winter habitat within the CIS LRMP was mapped as a broad representation of moose winter range and considered forage, security, and/or thermal capabilities of habitats (i.e., habitat interspersion) (BC ILMB 2000), while moose winter range that accounts for habitat interspersion was mapped in the north Nass TSA (McElhanney 2007b). Therefore, high value habitats and moose winter range previously identified based on shelter and thermal requirements can be roughly compared with results of the winter habitat models produced in this report that were based solely on forage availability.

A small amount of high value habitat identified in the CIS LRMP occurs within the RSA along the lower Unuk River below the confluence with the South Unuk River (BC ILMB 2000), and within the north Nass TSA along the Bell-Irving River, Bowser Lake, and parts of Treaty Creek (McElhanney 2007b). These winter range polygons overlap with areas identified as Moderately High to Highly suitable in the RSA and on the edge of the Eastern LSA. Therefore, there is likely adequate cover and security habitat in proximity to these areas of Moderately High to Highly suitable foraging habitats. The moose winter range identified in the north Nass TSA (McElhanney 2007b) and in the eastern RSA of the current study was also an area where a large number of moose were observed during late winter surveys in 2009; 65 groups totalling 132 individuals, approximately 73% of all survey observations, were seen in this area (Rescan 2010e). Thus, the low elevation habitat in the far eastern RSA along the Bell-Irving River, Treaty Creek, and Bowser Lake appear to be some of the most important wintering habitat for moose in the region.

4.2 MOUNTAIN GOAT

4.2.1 Background

Mountain goat was 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 the CIS LRMP (BC ILMB 2000) and draft Nass South SRMP (BC ILMB 2009).

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. Goats are also vulnerable to noise and visual disturbance during the summer, particularly during the kidding period in June and July (S.D. Côté 1996; D. A. Blood 2000b; Goldstein et al. 2005).

4.2.2 Mountain Goat Habitat Suitability Model Development

4.2.2.1 Model Rating Assumptions

There were four main components of mountain goat habitat that were assumed to have the greatest influence on overall habitat value: escape terrain, forage availability and quality, elevation, and aspect. The following section provides a general description of the model rating assumptions that were used in the development of winter and summer models as based on the current knowledge of goat habitat selection in BC (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 for this study were 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. Habitats beyond 400 to 500 m of escape terrain were assumed to have very low to no value for goats, based on results from previous studies (e.g., J. L. Fox 1983).

Escape terrain was identified using a topographic model to isolate areas of steep, mountainous topography devoid of vegetation. Escape terrain was defined as areas with slopes from 40° to 70° and no vegetation (Plate 4.2-1). Both winter and summer habitat suitability is highly dependent on availability of escape terrain. Second to the availability of 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 advantage 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, with more southerly aspects enhancing habitat value because snow accumulation is lower and food can be found more readily (Wilson 2005).

Plate 4.2-1. Mountain goat escape terrain.

For summer habitat, goats move to higher elevations in response to progressing vegetation phenology to exploit the newly emerged high quality food sources. Areas with potential abundant high quality forage, particularly high protein early seral stage vegetation (e.g., grasses and herbs), were given the highest habitat values. However, a wider range of habitats was considered to have value for their forage potential in the summer than were considered during the winter, as goats are generalist herbivores and will tend to eat whatever is available (S. D. Côté and Festa-Bianchet 2003). For example, goats consume a large amount of shrubby vegetation during the summer, particularly the young leaves of willow and dwarf birch in habitats around the treeline (Laundré 1994). Therefore, habitat in proximity to escape terrain that could produce either herb or shrub vegetation, even in small quantities, had moderate summer value.

The assumptions generalized above were used to assign WHRs to PEM ecosystem units, which were based solely on the vegetative potential of habitat. That is to say, WHRs only addressed the feeding habitat life requisite (Appendix 6). Assumptions based on the influence of escape terrain, elevation, and aspect were taken into consideration through the overall modelling process (Section 4.2.3.2) to assign the Habitat Suitability Rating (HSR) to PEM ecosystem units.

4.2.2.2 Methods

Winter

Mapping of suitable winter habitat for goats has been underway in the region for several years, and as such, there were several sources available that provided insight during model development. The winter habitat suitability model was developed based on the criteria developed by Rescan and RTEC for habitat suitability modelling in northwest BC, specifically within the Bell-Irving drainage. Model development first included the identification of escape terrain as defined in Table 4.2-1, and then subsequently scored certain topographic and vegetation features based on their importance as components of winter habitat (Table 4.2-2). Scoring criteria were developed and refined based on professional expertise and from review and evaluation of unpublished ungulate models for multiple projects in the northwest area of BC.

Table 4.2-1. Model Definition of Escape Terrain for Mountain Goat

Escape Terrain Attribute	Value	Value Source
Slope	40° - 70°	Digital Elevation Model (DEM) information and 1:20,000 Terrain Resource Information Management (TRIM) data
Vegetation	barren areas	Satellite Image Classification

Table 4.2-2. Topographic and Vegetation Features for Modelling Mountain Goat Winter Habitat

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 75	1	Buffer around Escape Terrain (Table 4.2-1)
76 - 125	2	
126 - 235	7	
≥ 236	12	
Aspect (°)		
Warm Southerly (145 - 240)	1	DEM information and TRIM data
Cool Northerly (240 -145)	2	
Elevation (m)		
≤ 1,630	1	DEM information and TRIM data
≥ 1,631	2	
Vegetation		
WHR 1, 2	1	Food rating assigned to PEM ecosystem units (Appendix 6)
WHR 3, 4	2	
WHR 5, 6	3	

The WHR value for the food rating of identified PEM ecosystem units is provided in Appendix 6. A score was developed for each polygon defined by the model and this score was converted to an HSR rating consistent with the 6-class rating scheme recognized by BC (Table 4.2-3; RIC 1999a). For the purposes of modelling goat winter habitat, 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 4.2-3. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Mountain Goat Winter Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999a)
4, 5, 6	1	High
7, 8, 9	2	Moderately-High
10, 11,12	3	Moderate
13, 14	4	Low
≥ 15	5/6	Very Low/Nil

Summer

In comparison to the amount of effort that has been directed at mapping winter habitat for mountain goats in northern BC (Section 2.3.1), relatively less effort has been directed at identifying suitable summer habitat. The summer habitat suitability model definitions were also based on those developed by Rescan and RTEC for modelling goat habitat in the Bell-Irving River drainage. As with winter habitat, escape terrain remains an essential habitat feature during the summer. Highly suitable habitat during the summer is represented by areas that produce abundant, high quality rooted forage. This habitat is generally associated with early seral stage vegetation, particularly high protein grasses and herbs.

The steps to identify summer habitat for goats were similar to those used for the winter model and included a score for topographic and vegetation features (Table 4.2-4). Scoring criteria were developed and refined based on professional expertise and from review and evaluation of unpublished ungulate models for multiple projects in northwest BC. The final score was transformed into a 6-class HSR rating scheme (Table 4.2-5) for development of the habitat suitability map.

Table 4.2-4. Topographic and Vegetation Features for Modelling Mountain Goat Summer Habitat

Model Features	Score	Data Source
Distance to Escape Terrain (m)		
≤ 125	1	Buffer around Escape Terrain (Table 4.2-1)
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 6)
WHR 4, 5	3	
WHR 6	100	

Table 4.2-5. Cumulative Score and Associated Habitat Suitability Rating (HSR) for Mountain Goat Summer Habitat

Cumulative Score from Habitat Model	Associated HSR	Provincial Rating Class (RIC 1999)
3, 4	1	High
5, 6	2	Moderately high
7, 8	3	Moderate
9 -14	4	Low
≥ 15	5/6	Very Low/Nil

4.2.3 Model Evaluation

The model assumptions were evaluated through the comparison of 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 70% of the time, based on the comparison of 135 field and model ratings at the same geographic location. Similar results were achieved for the summer model, where the model was either equal to or came within one rating class of field ratings 70% of the time (N=134).

An additional evaluation was conducted by overlaying mountain goat group observations collected during 2008 and 2009 surveys with the results of the winter and summer modelling. Of the 62 groups of mountain goats that were observed during summer surveys in 2008, 22 groups (36%) were observed in habitat classified as High, while 92% of all summer group observations were encompassed by habitat rated from High to Moderate (HSR 1, 2, and 3). During winter mountain goat surveys in 2009, 68 groups of goats were observed within the modelling area, and 58% of group observations were observed in High rated habitat (HSR 1) and 90% of all goat groups fell within habitat rated from High to Moderate.

4.2.4 Results

4.2.4.1 Winter Habitat

Across the entire RSA (including the LSA), 17% (58,511ha) was classified as Moderately High to Highly suitable winter habitat for mountain goats (Table 4.2-6). Results of habitat mapping within the LSA are discussed in the following paragraph. Moderately High to Highly suitable mountain goat winter habitats represent areas in close proximity to escape terrain that support high quality winter forage, including rooted forage such as shrub and herb vegetation, as well as arboreal forage from conifer litter fall and arboreal lichen. The higher rated habitats were distributed across most of the mountainous terrain of the RSA (Figure 4.2-1). Large blocks of Moderately High to Highly suitable winter habitat occurred in the eastern RSA along the Snowslide Range and in the western RSA around Johns Peak to the west of the proposed mine site (Figure 4.2-1). Moderately suitable winter habitat, totalling 7% of the RSA, was located at elevations just below the higher ranked habitats, which were rated lower primarily based on distance from escape terrain (Figure 4.2-1; Table 4.2-6). The remaining winter habitat fell within the lower suitability classes (HSR 4 and 5/6), which, combined across the entire RSA, covered roughly 256,488 ha or 76% of the RSA (Table 4.2-6). Low rated mountain goat winter habitats generally surrounded Moderate to Highly suitable (HSR 1- 3) habitat while Very Low/Nil rated habitats covered all lower elevation habitats along the river valleys within the RSA (Figure 4.2-1). Like Moderately suitable winter habitat, the habitats that fell in lower suitability classes (Low and Very Low/Nil) were more likely rated as such because of their distance from escape terrain than availability of forage.

Table 4.2-6. Mountain Goat Winter Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	33,861	10	5,650	10	17
Moderately High	24,650	7	2,821	5	11
Moderate	22,933	7	3,902	7	17
Low	14,699	4	1,554	3	11
Very Low/Nil	241,789	72	40,858	75	17

** Includes area of Local Study Area (LSA)*

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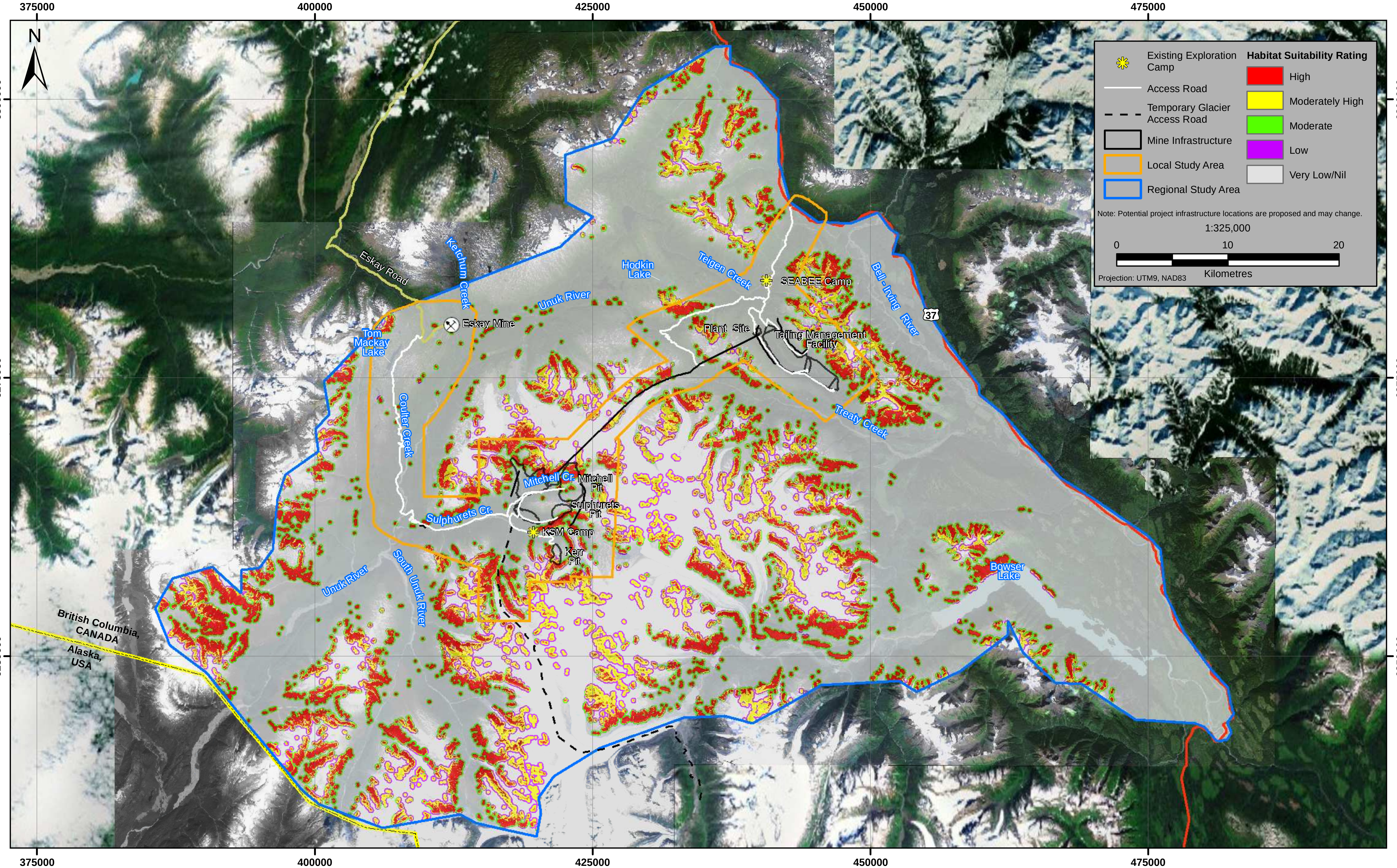


SEABRIDGE GOLD

FIGURE 4.2-1

Mountain Goat: Winter Habitat

Rescan

Moderately High to Highly suitable mountain goat winter habitat was mapped across 15% (8,471 ha) of the LSA (Table 4.2-6). Higher rated winter habitats occurred in the Western LSA surrounding the proposed mine site (Figure 4.2-2). The proportion of High and Moderately High rated winter habitat occurring within the boundaries of the LSA relative to what was mapped across the entire RSA was 17% and 11%, respectively (Table 4.2-6). A total of 7% of the LSA was classified as Moderately suitable winter habitat, and relative to the entire area of Moderately suitable winter habitat throughout the RSA, 17% occurred within the LSA boundaries (Table 4.2-6). The rest of the LSA was rated as Low (3%) and Very Low/Nil (75%).

4.2.4.2 Summer Habitat

The summer mountain goat habitats modelled within the higher suitability classes were generally situated in the same areas as higher rated winter habitats (Figure 4.2-2, Table 4.2-7) as the availability of escape terrain was important during both seasons. A larger amount of Moderately High to Highly suitable summer habitat was identified (76,718 ha or 23% of the RSA) compared to winter habitat, resulting from the assumption that goats may exploit areas further away from escape terrain in the summer (Appendix 2). Moderate rated summer habitats were generally located at elevations just below higher ranked suitable summer habitats and occupied 14% of the RSA (Figure 4.2-2, Table 4.2-7). The three lowest mountain goat summer habitat rating classes accounted for a 64% of the total RSA (Low = 12% of RSA; Very Low/Nil = 52% of RSA).

Table 4.2-7. Mountain Goat Summer Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	33,126	10	5,491	10	17
Moderately High	43,591	13	5,674	10	13
Moderate	47,221	14	8,277	15	18
Low	39,876	12	5,035	9	13
Very Low/Nil	174,116	52	30,308	55	17

A total of 20% of the LSA was identified as Moderately High to Highly suitable mountain goat summer habitat. The majority of this habitat occurred in the Western LSA (Figure 4.2-2; Table 4.2-7), similar to the results of winter modelling. Nearly one fifth of the Highly suitable mountain goat summer habitat identified across the RSA was mapped within the boundaries of the LSA (Table 4.2-7). Of the Moderately High rated mountain goat summer habitat identified across the RSA, 13% occurred within the boundaries of the LSA. Moderately suitable summer habitat accounted for 15% of the LSA, while Low rated habitat accounted for 9% and Very Low/Nil accounted for over half the entire LSA (Table 4.2-7).

4.2.5 Discussion

The combination of vegetation and topography that received the highest habitat suitability ratings (High or Moderately High) can be described as “most suitable habitats” for mountain goat. Overall, the RSA supports habitat that can provide all the annual life requisites for mountain goats. The most suitable year-round habitat occurred in the eastern RSA along the Snowslide Range and in the western RSA around John Peaks to the west of the proposed Mining Area. Within the LSA, suitable habitat was identified in the Western LSA near the proposed Mining Area and southeast of the Tailing Management Facility in the Eastern LSA.

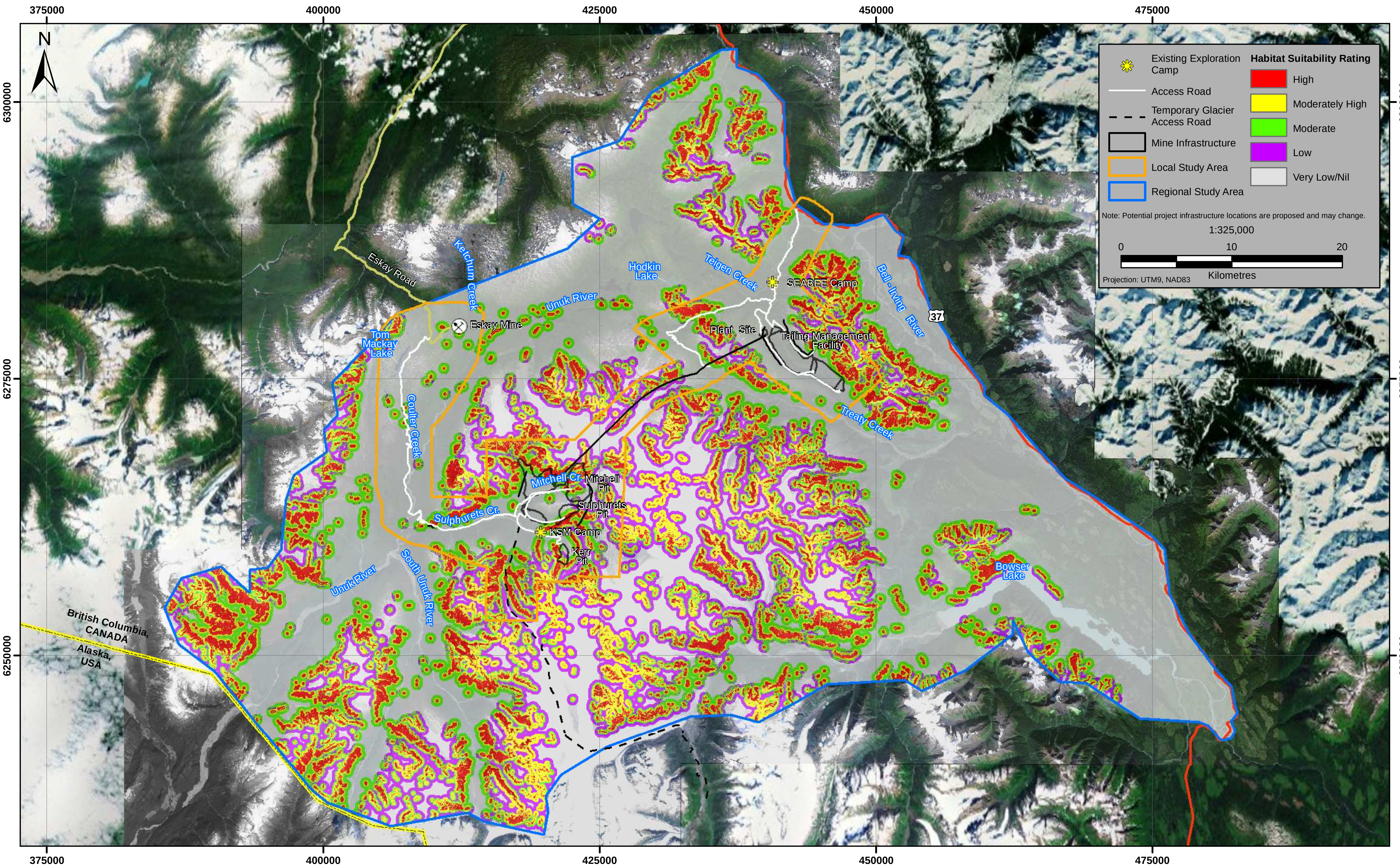
Within the RSA, roughly an eighth to a quarter was Moderately High to Highly suitable winter and summer habitat. The LSA supported between 15 to 20% of Moderately High to Highly suitable year round habitat for goats; the Western LSA surrounding the proposed Mining Area contained the largest quantity of HSR 1 and HSR 2 habitats for goats. Several of these higher suitability habitats were occupied by goats, suggesting an importance of those habitats for the local goat population.

The presence of escape terrain is the most important habitat feature for mountain goats. Overall, the majority of goats observed in 2008 and 2009 were distributed across Highly, Moderately High, and Moderately suitable habitats in the winter (61 of 68 groups) and summer (57 of 62 groups). These ratings classes (HSR 1 – 3) only occur 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 (J.L. 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 located in areas with open sightlines (for detecting predators) and in close proximity to suitable escape terrain (Tesky 1993). In addition, movements between seasonal ranges are generally along ridges in proximity to escape terrain (Demarchi, Johnson, and Searing 2000).

Mountain goat winter ranges have previously been modelled in areas that overlap the RSA. The BC Ministry of Environment (MOE) has designated 78,649 ha of Ungulate Winter Range (UWR) in the Nass Timber Supply Area (BC MOE 2008), some of which overlap the RSA. In addition, habitat mapping conducted in the Cassiar Iskut-Stikine LRMP area resulted in the identification of high value habitat for mountain goats, representing goat winter range (BC ILMB 2000). These winter range polygons from the CIS LRMP overlap the areas identified as Moderately High to Highly suitable mountain goat winter habitat in the RSA. The areas of most consistent overlap occur within the proposed Mining Area in the Western LSA, along the southern slopes of John Peaks above Sulphurets Creek in the Coulter Creek Access corridor, along the Snowslide Range and south-facing slopes above the Bowser River (west of Bowser Lake) in the eastern RSA (BC ILMB 2000; BC MOE 2008).

Two types of UWR overlap the RSA: Mountain Dwelling and Canyon/escarpment Dwelling, which occur at lower elevations (e.g., along Unuk River). The Mountain Dwelling and Canyon/escarpment UWRs overlapping the RSA were compared with the results of the current study. Within the 11,557 ha of Mountain Dwelling UWRs identified by BC MOE in the RSA, 56% of the habitat was identified as Highly suitable in the current study, and roughly 70% of the habitat was classified as High or Moderately High quality habitat. In addition, roughly 45% of the goat groups observed during the winter surveys in 2009 were observed in Mountain Dwelling UWRs (Rescan 2010e). Within the 2,368 ha of Canyon/escarpment Dwelling UWRs in the RSA, most of the habitat (79%) was rated as Very Low/Nil in the current study with less than 10% of habitat rated as Moderately High to Highly suitable habitat. No goats were observed in Canyon/escarpment Dwelling UWRs during the winter survey in 2009 (Rescan 2010e). Overall, the Mountain Dwelling UWRs identified by MOE were of similar habitat value to the results of the current report and were occupied by goats, while Canyon/escarpment Dwelling UWRs identified by MOE were modelled as lower habitat quality in the current report and were unoccupied.

Natal or kidding habitats were also mapped in the CIS LRMP and were generally smaller pockets of habitat located within high value winter habitat (BC ILMB 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 the small pockets of kidding habitat identified in the CIS LRMP (Figure 4.2-2; BC ILMB 2000).



SEABRIDGE GOLD

FIGURE 4.2-2

Mountain Goat: Summer Habitat

Rescan™

Mineral licks are also an important habitat feature for mountain goats, used primarily during the summer to compensate for mineral deficiencies or imbalances in goats' diet (Ayotte, Parker, and Gillingham 2008). One potential mineral lick was identified within the LSA during wildlife baseline studies in 2008 (Rescan 2010e). This potential lick, located above Sulphurets Lake, was surrounded by Moderately High rated summer habitat. In addition, goats were seen in the vicinity of these mineral licks during the summer. These areas likely receive annual use and are important for the local mountain goat population.

4.3 GRIZZLY BEAR

4.3.1 Background

Grizzly bears were selected as a candidate species for habitat suitability mapping in the study area because of their conservation status, and their social, economic, and biological importance. Grizzly bears are considered a species of special concern by COSEWIC and are blue-listed in BC (COSEWIC 2002; BC CDC 2010). In addition, grizzly bears are an Identified Wildlife element under the IWMS, which means that the species requires special conservation measures within BC. Grizzly bear populations are managed for harvest throughout BC and are a significant social and economical element for Aboriginal peoples, resident hunters, and non-resident hunters. Grizzly bears also play an important biological role within the ecosystem and are considered an umbrella species. Umbrella species are species that, due to their large home ranges and habitat requirements, afford protection to other species with similar or smaller homes range or life requisites if conservation measures are adequate to protect the umbrella species (Roberge and Angelstam 2004b).

4.3.2 Grizzly Bear Habitat Suitability Model Development

4.3.2.1 Model Rating Assumptions

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) as determined by vegetation phenology (Section 3.2.2). Wherever possible, seasonal forage preferences consistent with regional knowledge (MacHutchon and Mahon 2003) were incorporated into WHRs. In the case of the hibernating model, ratings were developed based on terrain and topographic features selected by denning grizzly bears (Appendix 3).

It was assumed that preferred grizzly bear spring vegetation included abundant grasses, sedges, and herbs (MacHutchon, Himmer, and Bryden 1993; McLellan and Hovey 1995). Preferred summer vegetation was dominated by early berry-producing shrubs (e.g., *vaccinium* spp, soopolalie) and late season herbs (e.g., fireweed, cow parsnip) (BC MWLAP 2004a). 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) (BC MWLAP 2004a). Sources of animal protein are also important during the growing season, such as winter weakened moose in the spring and access to salmon prior to hibernation in late summer and fall (Demarchi and Johnson 2000; RTEC 2006a). There are several salmon bearing waterways identified in the RSA, including the Unuk River, Teigen Creek, the Bell-Irving River, and Treaty Creek (Rescan 2010b). Areas where grizzly bears may supplement their vegetation diet were considered during the modelling process (Section 4.4.2.2). The assumptions used for the development of spring, summer, fall, and hibernating habitat model ratings for grizzly bears are detailed in the species account (Appendix 3) and are summarized below.

Spring Model Assumptions

Assumptions for grizzly bear foraging habitat 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 or open habitats capable of sustaining a berry crop over winter (e.g., crowberry) 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 to 7), open canopied 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 with poorly defined understory 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

Assumptions for grizzly bear foraging habitat in the summer were:

- High and Moderately High rated habitat included sites capable of producing abundant *Vaccinium* species, devils club, or other berry production. 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 the ESSF.
- Moderate rated habitat included sedge wetlands and riparian areas where high protein herb vegetation would be abundant in early summer within suitable microsites within these ecosystem units. These areas received moderate ratings as the length that the vegetation crop persists is somewhat less than those identified in High and Moderately High rated habitat, decreasing the overall value of sedge wetlands and riparian areas as the summer progresses. Areas where there is sparse cover of *Vaccinium* or other berry producing species also had moderate summer value, such as drier shrubby habitat within the ICH and ESSF, 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 bear, 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 in the above categories, and all barren and anthropogenic sites (e.g., glaciers, open water, roads).

Fall Model Assumptions

Assumptions for grizzly bear foraging habitat in the fall were:

- High and Moderately High rated habitat included areas that produce plant species of high value fall forage, 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 the 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 in the categories above, and areas that were barren or could not support plant growth (e.g., glaciers, open water, roads).

Hibernating (Denning) Habitat Assumptions

The primary focus of the hibernating (denning) model was to identify habitat at high elevation with the potential to support grizzly dens; it is not applicable to habitats below 1,100 m, the approximate elevation between forested sites and parkland/alpine. For the hibernating model, it was assumed that several terrain and topographic features, including soil surficial material, aspect, elevation, slope, and BEC zone, would influence the overall value of habitat for grizzly bear dens. Species biology and information on habitat selection used for the identification of suitable grizzly bear hibernating habitat are detailed in the species account (Appendix 3).

It was assumed that only a few types of soils, primarily those with morainal or colluvial surficial materials, had the most appropriate depth and structure for supporting grizzly dens. These soils are typically well drained and are cohesive enough to maintain the physical stability of the den during the winter, and have been selected by denning grizzly bears (Vroom, Herrero, and Ogilvie 1980; Nietfeld, Woolnough, and Hoskin 1985; Culling and Culling 2001). For habitat present on morainal or colluvial soils, the highest ratings were assigned to alpine areas with cooler aspects and moderate slopes, as these areas have a more persistent snowpack increasing the long-term stability of den sites over the winter. Alpine or subalpine parkland habitat with warm aspect on gentle or steep gradients rated lower.

4.3.2.2 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 using existing information from grizzly bear habitat use in the Skeena Region (MacHutchon and Mahon 2003). Appendix 6 includes the WHRs provided for PEM ecosystem units available in the study area, also representing the final HSRs for the model.

Access to sources of animal protein, such as ungulate carcasses and salmon, is important for grizzly bears during the growing season. Winter is considered the most stressful period of the year for moose (Section 4.2.2), and as a result, some animals are in very poor condition in the spring and die of natural causes (starvation) or are killed by wolves or grizzlies. The carrion from these kills supplement the spring diet of grizzly bears (D. A. Blood 2000a). Access to salmon bearing streams in the late summer and fall is important for grizzly bears in BC, including the north Nass TSA and NWA (Demarchi and Johnson 2000; McElhanney 2007a). Higher quality winter habitat for moose and salmon spawning streams were isolated and mapped. For moose, all HSR 1, 2, and 3 late winter habitat (Section 4.2.2) was mapped as a separate layer for presentation. For salmon, salmon-bearing rivers and stream reaches were identified and also mapped as a separate layer and included the area of the reach and a buffer of 50 m on either side (total of 100 m) to accommodate additional features (e.g., vegetation cover, buffer from disturbance) that may influence bears' use of this area.

The hibernating model included identifying areas with appropriate soil structure and topography to support grizzly bear dens (Table 4.3-1). High rated habitats included a very narrow range of soil and topographic features, while Moderate, Low, and Nil rated habitats included several combinations of features (Table 4.3-1). The hibernating model was restricted to the LSA (54,785 ha) and a small portion of habitat outside of the LSA boundary, as soil surficial material information was only available for this area. The total area modelled for grizzly bear hibernating habitat was approximately 69,670 ha.

Table 4.3-1. Terrain and Topographic Features for Modelling High Elevation Grizzly Bear Hibernating Habitat

HSR	Soil Surficial Material[1]	Aspect (°) [2]		Slope (°)[2]	Elevation (m)[2]	BEC[3]
H	Morainal/ Colluvial	Cooler	45 – 112.5	30 - 38	all	BAFA/CMA
M	Morainal/ Colluvial	Cooler	45 – 112.5	30 - 38	≥ 1100	ESSF/MH
	Morainal/ Colluvial	Warmer	112.5 - 45	30 - 38	all	BAFA/CMA
	Morainal/ Colluvial	Cooler	45 – 112.5	22 - 29	all	BAFA/CMA
	Morainal/ Colluvial	Cooler	45 - 112.5	39 - 40	all	BAFA/CMA
L	Morainal/ Colluvial	Warmer	112.5 - 45	30 - 38	≥ 1100	ESSF/MH
	Morainal/ Colluvial	Cooler	45 - 112.5	22 - 29	≥ 1100	ESSF/MH
	Morainal/ Colluvial	Cooler	45 – 112.5	39 - 40	≥ 1100	ESSF/MH
N	Morainal/ Colluvial	Cooler	45 - 112.5	< 22	≥ 1100	BAFA/CMA/ESSF/MH
	Morainal/ Colluvial	Cooler	45 - 112.5	> 40	≥ 1100	BAFA/CMA/ESSF/MH
	Morainal/ Colluvial	Warmer	112.5 - 45	< 30	≥ 1100	BAFA/CMA/ESSF/MH
	Morainal/ Colluvial	Warmer	112.5 - 45	> 39	≥ 1100	BAFA/CMA/ESSF/MH

Note: habitat below 1,100 m was not modelled as the aim of the model was to identify high elevation hibernating habitat.
Sources: 1 Terrain and Soils Mapping (Rescan 2010e), 2 Digital Elevation Model (DEM) information and 1:20,000 Terrain Resource Information Management (TRIM) data, 3 Terrestrial Ecosystem Mapping (TEM) (Rescan 2010f)

4.3.3 Model Evaluation

Field ratings were compared to theoretical model ratings to evaluate the model (Section 3.5.5). The resulting habitat models based on the rating assumptions were equal to field ratings or came within one rating class of field ratings 59% of the time for the spring model (N=133), 70% of the time for the summer model (N=134), and 65% of the time for the fall model (N=133). Hibernating habitat ratings were not collected during field surveys in 2008 and 2009.

4.3.4 Results

4.3.4.1 Spring Habitat

A total of 27% of the RSA, including the LSA, was identified as Moderately High to Highly suitable habitat for grizzly bears in the spring (Table 4.3-2). The results of habitat mapping within the LSA are discussed in the following paragraph. Spatially, these areas were distributed within mid-elevation habitat across the entire RSA, as well as low elevation riverine habitats around Bowser Lake in the southeastern RSA (Figure 4.3-1). Larger wetland areas also rated highly, such as those along the Bowser River (west of Bowser Lake), Todedada Creek, and within the proposed Tailing Management Facility within the LSA. Moderate rated habitats accounted for a quarter (26%) of the RSA and were distributed across riparian habitats along watersheds (e.g., Unuk, Bell-Irving, Treaty), and much of the forested habitat in the eastern RSA within the ICH BEC, where early spring vegetation (e.g., devil's club) is available. The three lowest habitat rating classes accounted for almost half of the RSA (Low = 23%; Very Low = 22%; Nil = 2%). Low and Very Low rated habitats were mainly located at high elevations, covering such areas as rocky, barren slopes and glaciers, while Nil rated habitat covered major areas of open water (e.g., Bowser Lake).

Table 4.3-2. Grizzly Bear Spring Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	15,515	5	2,697	5	17
Moderately High	74,862	22	14,289	26	19
Moderate	87,105	26	17,208	31	20
Low	79,048	23	13,174	24	17
Very Low	75,349	22	7,043	13	9
Nil	6,053	2	375	1	6

** Includes area of Local Study Area (LSA)*

Within the LSA, almost a third (31%) of the area was rated as Moderately High to Highly suitable spring grizzly bear habitat (Table 4.3-2), the majority of which occurred in the Coulter Creek Access Corridor below the Eskay Creek Mine and within the Eastern LSA on the slopes above the proposed Tailing Management Facility and Teigen Access Road (Figure 4.3.1). A total of 17% of the High rated habitat and 19% of the Moderately High rated habitat occurs within the boundaries of the LSA relative to what was mapped across the RSA (Table 4.3-2). Moderate rated habitat, totalling 31% of the LSA, was spread across the low elevation forests in the LSA; 20% of the Moderate rated habitat identified across the entire RSA occurred within the LSA. The remaining habitat fell within the lower suitability classes, of which 24% was classified as Low, 13% as Very Low, and 1% as Nil habitat (Table 4.3-2). Most of these lower rated habitats occurred in high elevation areas surrounding the proposed Mining Area within the Western RSA (Figure 4.3-1).

Areas with access to moose carrion during the spring were mapped as an additional layer with the spring habitat suitability rankings. A total of 48,552 ha of habitat was identified as Highly to Moderately suitable habitat for moose during the winter; therefore, these areas have been identified as habitat where grizzly bears can find moose carrion in early spring (Figure 4.3-1). The majority of high quality moose winter habitat overlapped Moderately rated grizzly bear spring habitat, based on vegetation content. Spatially, the areas where moose carrion may be available were broadly distributed across low elevation habitat in the eastern RSA along the Bell-Irving River and Highway 37 from Bell II to Bowser Lake, as well as along the lower Treaty Creek drainage (Figure 4.3-1). In the western RSA, the majority of lower elevation habitat along the Unuk River drainage had the potential to provide moose carrion. Only a small portion of these areas overlap the LSA, mainly in the Coulter Creek Access corridor (Figure 4.3-1). Therefore, the areas identified as having the potential to provide carrion from moose mortality are likely of higher overall spring habitat suitability for bears.

4.3.4.2 Summer Habitat

Much of the lower elevation habitat across the RSA was rated as Moderately High to Highly suitable summer habitat, occupying 38% of the total area of the RSA (Figure 4.3-2; Table 4.3-3). Of these higher rated summer grizzly bear habitats, a larger proportion was rated as Moderately High compared to High (Table 4.3-2). High rated habitats occurred in small pockets, particularly in the eastern RSA within some regenerating forests along Highway 37 (Figure 4.3-2). These high rated summer habitats were identified as the areas with the best potential to produce abundant summer berries such as *Vaccinium* spp.. A total of 15% of the RSA was rated as Moderate, distributed across mid elevation habitats throughout the RSA (Figure 4.3-2; Table 4.3-3). The remaining half of the RSA (48%) fell in the lower suitability classes and was rated as Low (22% of RSA), Very Low (24%), and Nil (4%). Like the spring habitat, much of the Low and Very Low rated summer grizzly bear habitat occurred in the alpine and areas covered with long lasting or permanent snow cover (Figure 4.3-2).

Table 4.3-3. Grizzly Bear Summer Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	14,929	4	2,080	4	14
Moderately High	114,380	34	21,671	40	19
Moderate	50,039	15	10,933	20	22
Low	73,050	22	12,109	22	17
Very Low	79,481	24	7,617	14	10
Nil	6,053	2	375	1	6

** Includes area of Local Study Area (LSA)*

Within the LSA, Moderately High to Highly suitable summer grizzly bear habitat was mapped across 44% (23,751 ha) of the area, most of which occurred in the Eastern LSA and Coulter Creek Access Corridor below the Eskay Creek Mine (Figure 4.3-2; Table 4.3-3). Of the High and Moderately High rated summer grizzly bear habitat mapped across the entire RSA, similar proportions occur within the boundaries of the LSA: 14% and 19% respectively (Table 4.3-3). Moderately suitable summer habitat totalled 20% of the LSA and relative to the entire area of Moderately suitable summer habitat identified in the RSA, 22% was mapped within the LSA boundaries (Table 4.3-3). The rest of the LSA was rated as Low (22%), Very Low (14%), and Nil (1%). The Mitchell-Teigen Corridor contained mostly Low and Very Low rated habitat as it is predominately glacier (Figure 4.3-2).

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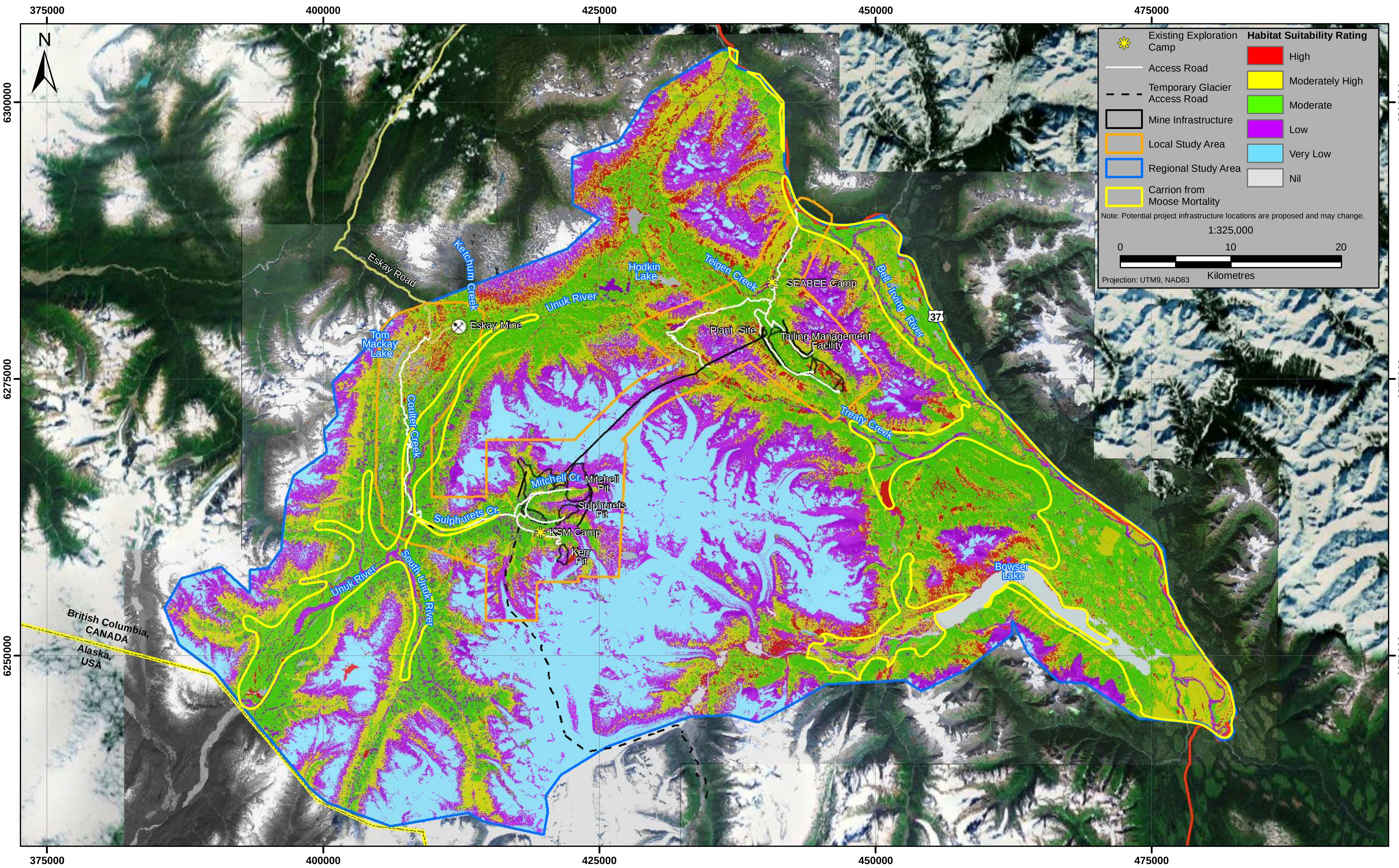
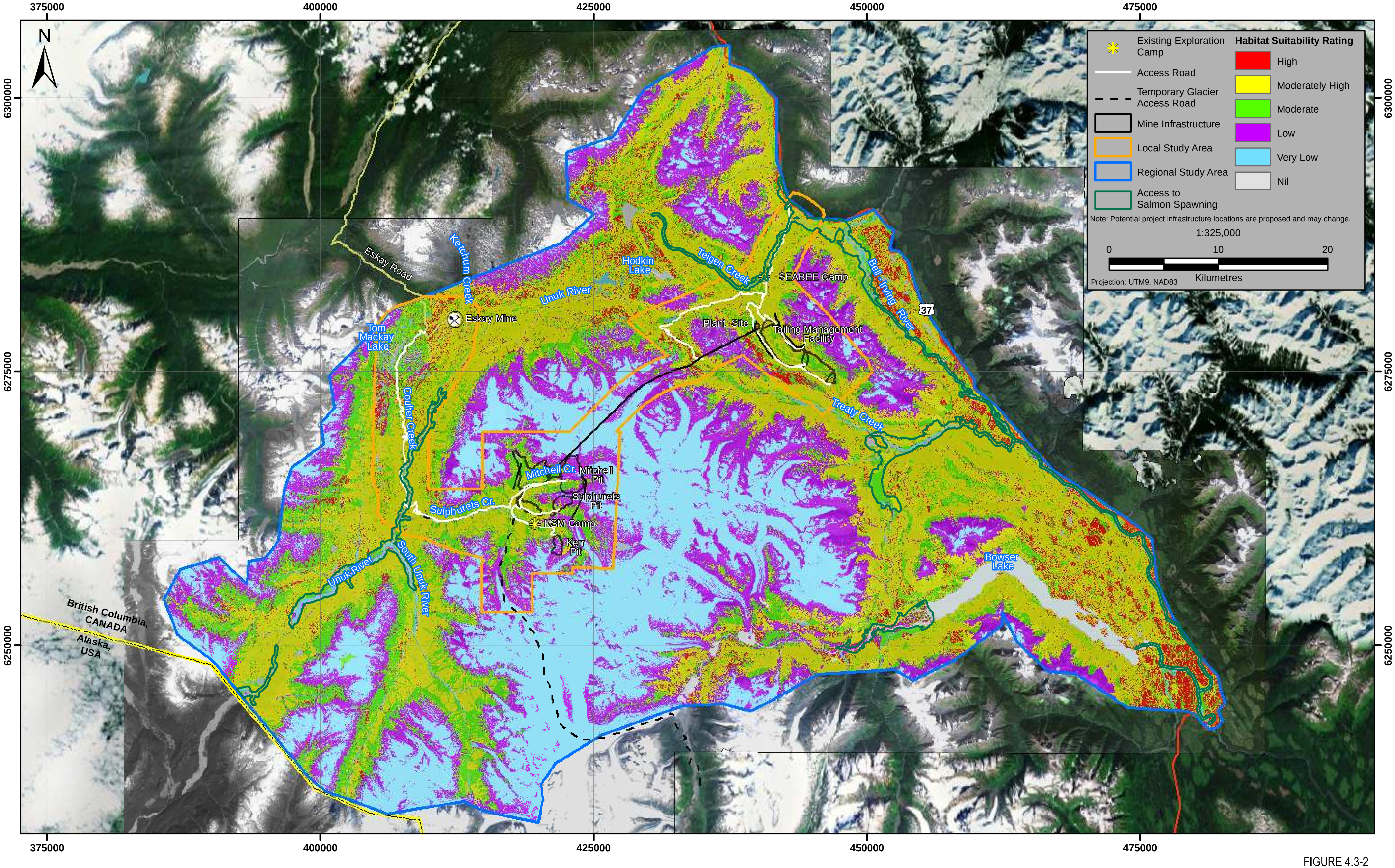


SEABRIDGE GOLD

FIGURE 4.3-1

Grizzly Bear: Spring Feeding Habitat

Rescan™



SEABRIDGE GOLD

FIGURE 4.3-2

Grizzly Bear: Summer Feeding Habitat

Rescan™

A total of 8,571 ha was identified as salmon spawning reaches in the RSA, surrounding major watercourses including the Unuk River, Teigen Creek, Treaty Creek, the Bell-Irving River, and the Bowser River east and west of Bowser Lake (Figure 4.3-2). These spawning reaches occurred in habitats that were rated between Moderate and High (HSR 1 – 3) based on vegetation content (Figure 4.3-2). Within the LSA, the Teigen Creek drainage in the Eastern LSA and the Unuk River in the Coulter Creek Access Corridor were identified as salmon spawning reaches. The grizzly bear DNA baseline study (Appendix 17.3) confirmed the use of the Unuk, Teigen, and Treaty drainages and their major tributaries by grizzly bears during the fall in 2009.

4.3.4.3 Fall Habitat

A small percentage of the RSA (<8%) was identified as Moderately High to Highly suitable fall grizzly bear habitat (Figure 4.3-3; Table 4.3-4). For the most part, these habitats were located in the eastern RSA along the Bell-Irving River below Bell II, along the Lower Treaty Creek drainage, and along the Bowser River on both side of Bowser Lake (Figure 4.3-3). Moderate rated fall grizzly bear habitats occupied a third (34.7%) of the RSA and were distributed across the lower elevations of the study area (Figure 4.3-3). The remaining fall grizzly bear habitat in the RSA was rated Low (32.1 % of RSA), Very Low (23.5 %) and Nil (1.8%) and similar to previous seasons, most of this habitat occurred in alpine areas (Figure 4.3-3; Table 4.3-4).

Table 4.3-4. Grizzly Bear Fall Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	1,138	0.3	19	0.03	2
Moderately High	25,394	7.5	4,659	8.50	18
Moderate	117,277	34.7	22,574	41.20	19
Low	108,590	32.1	19,542	35.67	18
Very Low	79,481	23.5	7,617	13.90	10
Nil	6,053	1.8	375	0.68	6

** Includes area of Local Study Area (LSA)*

There was very little Moderately High to Highly suitable fall habitat (<9%) identified in the LSA (Table 4.3-4). The small amount that did occur was located in the Coulter Creek Access Corridor just below the Eskay Creek Mine and in the Eastern LSA on the east facing slopes above the proposed Tailing Management Facility and along the lower Teigen Creek drainage (Figure 4.3-3). A very small proportion (2%) of the High rated fall grizzly bear habitat mapped across the entire RSA occurred within the boundaries of the LSA. Of the Moderately High rated habitat identified across the RSA, 18% of this habitat occurred within the boundaries of the LSA. Moderately suitable fall habitat accounted for over 40% of the LSA, and on a regional scale, 19% of the Moderately suitable fall habitat identified across the entire RSA was mapped within the LSA boundaries. The rest of the LSA was rated Low (35.67%), Very Low (13.9%), and Nil (0.68%).

Salmon spawning rivers are important for grizzly bears in the fall (Demarchi and Johnson 2000). The 8,571 ha of spawning habitat identified in the RSA generally overlapped fall grizzly bear habitat classified as Moderately to Highly suitable (HSR 1 – 3). Spatially, spawning areas were distributed along the Unuk River, Teigen Creek, lower Treaty Creek, the Bell-Irving River, and the Bowser River east and west of Bowser Lake (Figure 4.3-3). These areas are important for grizzly bears in the fall where their vegetation diet is supplemented by animal protein.

4.3.4.4 Hibernating (Denning) Habitat

The grizzly bear hibernating model identified higher elevation habitat within the LSA (areas above 1,100m) that may be suitable for denning grizzly bears. A total of 26,036 ha, or nearly half (47%) of the LSA, fell below 1,100 m elevation and was therefore outside of the modelling area. Of the habitat within the LSA that was modelled, only 1.7% was identified as Highly suitable, and 10.8% as Moderately suitable hibernating habitat; the vast majority of habitat (87.5% of the LSA) fell in the lower suitability classes, rated as Low (5.7%) and Nil (81.8%; Table 4.3-5). Spatially, the majority of the Highly suitable hibernating habitat occurred in small pockets in the Western LSA along the slopes above Ted Morris Creek and McTagg Creek, and in the Eastern LSA on the small mountain between the proposed Tailing Management Facility and the Treaty Creek drainage (Figure 4.3-4). There did not appear to be any Highly suitable hibernating habitat within the footprint of the proposed pits and other infrastructure in the Western LSA. Moderately suitable hibernating habitat was well distributed in more alpine areas (BAFA and CMA) within the Western LSA and on the west facing slopes above the TMF (Figure 4.3-4). The Coulter Creek Access Corridor contained very little habitat rated for high elevation denning, as most of the corridor is below treeline.

The additional area outside the LSA that was modelled for grizzly bear hibernating habitat was located north of the Mitchell-Teigen Corridor and Western LSA and south of the Coulter Creek Access Corridor (Figure 4.3-4). Very small amounts of Highly (113 ha) and Moderately (793 ha) suitable hibernating habitat were identified by the model outside the LSA; these were generally distributed in the mountainous area to the north of the Mitchell-Teigen Corridor. More grizzly bear hibernating habitat modelled outside of the LSA fell in Low and Nil rating classes (Figure 4.3-4; Table 4.3-5).

Relative to the entire area within the LSA and portions of the RSA that was modelled for grizzly bear hibernating habitat (roughly 43,228 ha), the vast majority (85%) was rated as Nil. Only 1% of the entire modelled area was rated as High, while 9% was rated as Moderate and 3% was rated as Low.

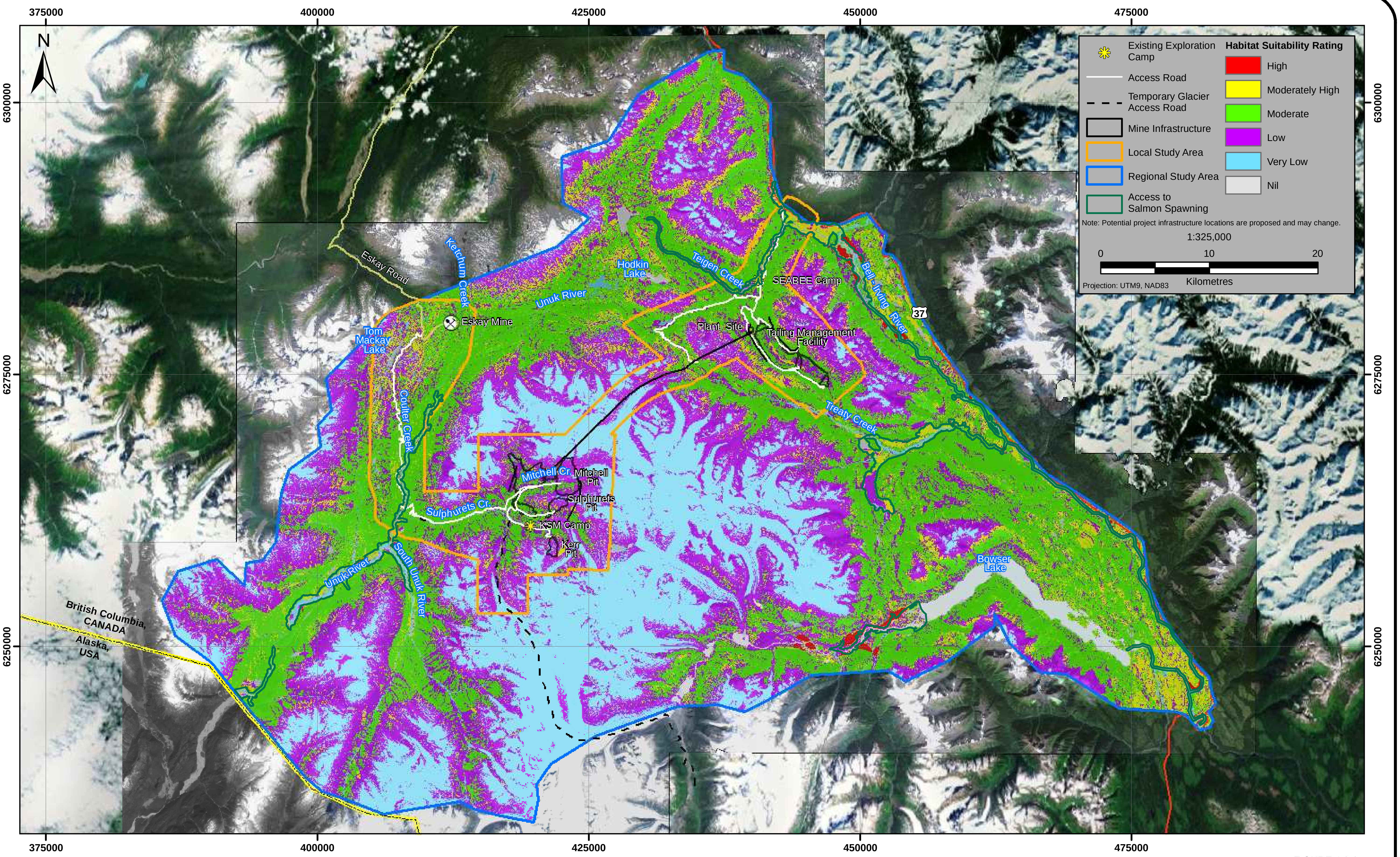
Table 4.3-5. Grizzly Bear Hibernating Habitat within the LSA and Additional Area outside the LSA

Habitat Suitability Rating	LSA		Additional Habitat Mapped Outside of LSA Boundaries*	Total Area of Mapped Habitat (ha)
	Area (ha)	% of Habitat in LSA		
High	476	1.7	113	589
Moderate	3,101	10.8	793	3,894
Low	1,641	5.7	169	1,810
Nil	23,530	81.8	12,515	36,045

** Additional soils information was available outside of the LSA boundaries, so the hibernating model was extended in these areas*

4.3.5 Discussion

The combination of vegetation and topography that received the highest habitat suitability ratings (High or Moderately High) can be described as “most suitable habitats” for grizzly bears. Overall, there was more High and Moderately High rated spring and summer habitat in the RSA and LSA as opposed to fall and denning habitat. Within the RSA, High rated spring habitat occurred at mid-elevation across the entire RSA, as well as at low elevation riverine areas around Lake), Todedada Creek, and within the footprint of the proposed Tailing Management Facility. High rated summer habitats occurred in small pockets, particularly in the eastern RSA within some regenerating forests along Highway 37. Within the LSA, the most suitable spring and summer habitats for grizzly bears were located in areas surrounding

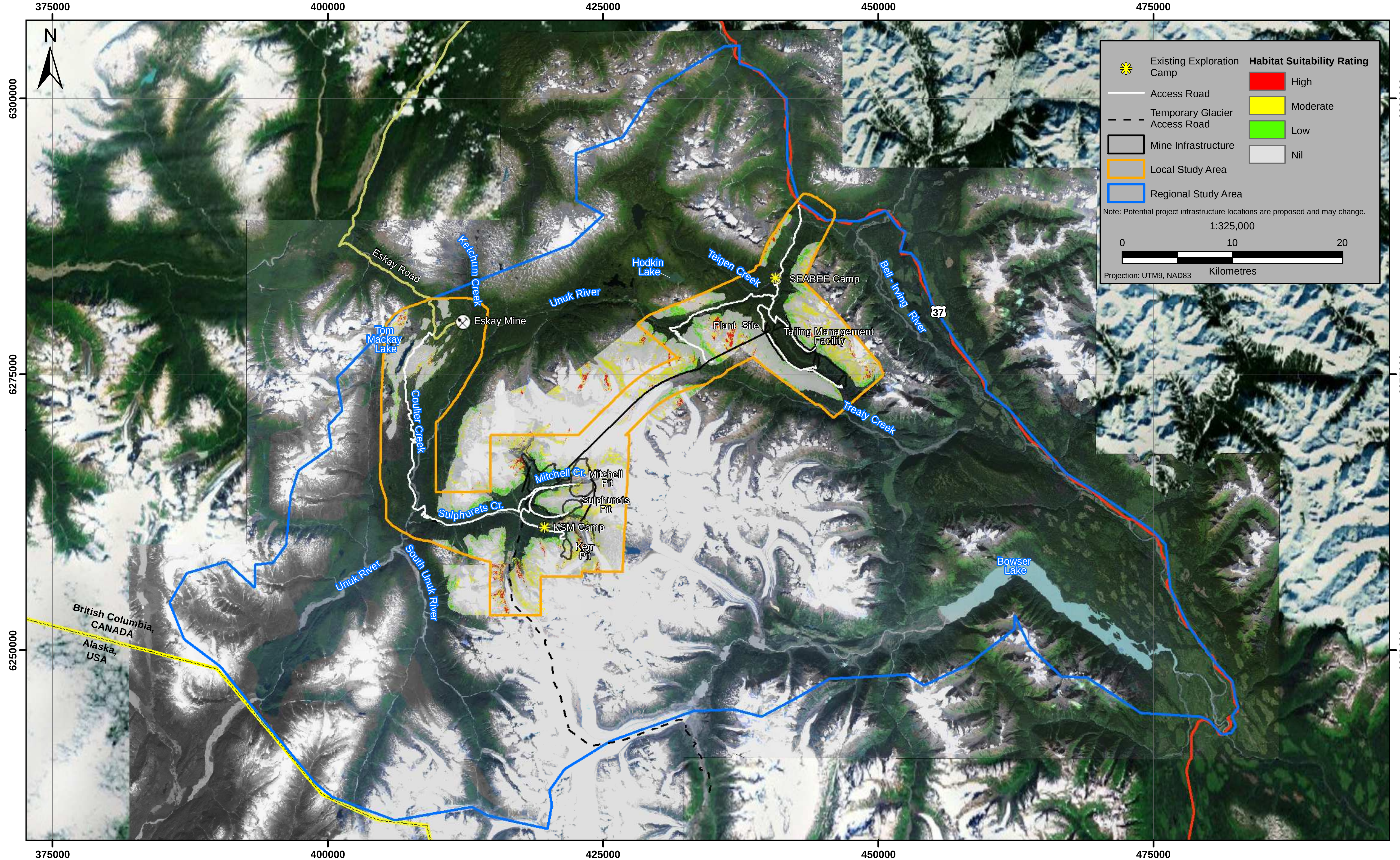


SEABRIDGE GOLD

FIGURE 4.3-3

Grizzly Bear: Fall Feeding Habitat

Rescan



SEABRIDGE GOLD

FIGURE 4.3-4

Grizzly Bear: Winter Hibernating Habitat

Rescan™

the Eskay Creek Mine in the Coulter Creek Access Corridor, and in the Eastern LSA near the proposed Tailing Management Facility. In the fall, the most suitable habitats for grizzly bears in the RSA occurred in the wetland-timber complex at the confluence of Teigen and Snowbank Creeks (also within the Eastern LSA), around Bell-Irving River near Bell II, and in the floodplain forests of the Bowser River west of Bowser Lake (Figure 4.3-3). Additional modelling of areas where grizzly bears can supplement their diet with animal protein suggest that the Unuk River drainage in the western RSA and the Bell-Irving, Treaty, and Bowser River drainages in the eastern RSA are valuable areas for bears to find winter weakened moose in the spring and spawning salmon in the summer and fall. Finally, a large patch of suitable winter hibernating habitat (HSR H and HSR M) occurred on the small mountain between the proposed Tailing Management Facility and the Treaty Creek drainage in the Eastern LSA.

The RSA supported between 27 and 38% of Moderately High to Highly suitable feeding habitat for grizzly bears during the spring and summer, and a relatively smaller amount (8% of the RSA) of higher rated fall feeding habitat (Tables 4.3-2 to 4.3-4). The combination of wetlands, riparian habitat, and avalanche chutes, contribute to the availability of early seral stage vegetation capable of providing abundant forage for bears during spring and summer. However, fall feeding habitats were more limited as there were fewer areas capable of producing large amounts of berries or early seral stage vegetation (e.g., herbs and shrubs) at that time of year.

In the LSA, there was also more Moderately High to Highly suitable spring and summer habitat compared to fall habitat. Most of the higher rated spring and summer habitats for grizzly bears occurring in the LSA were located in areas surrounding the Eskay Creek Mine in the Coulter Creek Access Corridor and the footprint of the proposed Tailing Management Facility in the Eastern LSA. These growing season habitat models were supplemented by additional modelling that identified areas where grizzly bears can supplement their vegetation diet with animal protein, specifically moose carrion in the spring and spawning salmon in the late summer and fall. This additional modelling suggested that the Unuk River drainage in the western RSA and the Bell-Irving River, Treaty Creek and Bowser River drainages in the eastern RSA are valuable areas for bears to find winter-weakened moose and spawning salmon.

Alpine areas within the LSA were also modelled to identify habitat with the best site characteristics to support grizzly bear dens. Less than an eighth of the alpine habitat that was modelled was Highly to Moderately suitable hibernating habitat for grizzly bears. The largest patch of higher rated habitat (HSR H and HSR M) occurred on the small mountain between the proposed Tailing Management Facility and the Treaty Creek drainage in the Eastern LSA. Grizzly bears may den below tree line; however, sufficient information is not available to develop a model for low elevation grizzly bear hibernating habitat.

Grizzly Bear habitat has previously been modelled in areas that overlap the RSA. High value habitat has been identified by the Cassiar Iskut-Stikine LRMP (BC ILMB 2000) and candidate Wildlife Habitat Areas (WHAs) have been identified in the north Nass TSA (McElhanney 2007a). High value habitat for grizzlies identified within the CIS LRMP occured in low elvation habitat along the entire Unuk River drainage (BC ILMB 2000). The most continuous patches of grizzly bear WHA in the north Nass TSA were distributed around the lower Teigen Creek draiange and the Bell-Irving River drainage from Bell II south to the Treaty Creek confluence (McElhanney 2007a). Habitat suitability modelling conducted for the KSM project identified similar areas as having higher habitat value for grizzly bears during the growing season. Areas of consistent overlap included the floodplains of the Bowser River west of Bowser Lake, and the large wetland-timber complex located at the confluence of the Teigen Creek, Snowbank Creek, and the Bell-Irving River around Bell II; these areas contained Moderately High to Highly suitable habitat in all seasons (spring through fall) and were identified as candidate WHAs (McElhanney 2007a). It should be noted that the scope of mapping conducted within the Cassiar Iskut-Stikine LRMP and by

McElhanney (2007a) differs from the mapping conducted in the current report; the two former sources integrated security and thermal considerations into habtiat models for the purposes of management. Therefore, there are expected differences in the boundaries of high value habitiat, Candidate WHAs, and higher rated habitat identified in the current report.

4.4 AMERICAN MARTEN

4.4.1 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 by licenced trappers in the Skeena Region (BC Stats 2005). Within the study area, marten accounted for 73% of the registered harvest from 1985 to 2007 (Rescan 2010e). 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 ILMB 2000). Considering their regional economic importance, marten were selected as a candidate species for habitat suitability mapping. Fisher (*Martes pennanti*) were also identified as a species of interest during issues scoping for the proposed Project (Rescan 2010 draft Application Information Requirements (AIR)). Fisher have similar winter habitat requirements to marten, although fisher exploit a wider range of habitats, such as intermediate and young pine stands, if prey such as porcupine are abundant. However, for the scope of the assessment, it was assumed that the habitat model produced for marten also identifies a considerable proportion of the suitable winter habitat for fisher.

Winter is considered the one of the most limiting times of year for marten. 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) have been identified as important components of winter habitat for marten (Steventon and Major 1982; Buskirk et al. 1989; Lofroth and Steventon 1990; Sherburne and Bissonette 1992; Takats et al. 1996). Areas with abundant CWD are high-quality hunting grounds for marten, as they provide subnivean spaces and habitat for their prey (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 CWD, canopy cover for snow interception is an important habitat feature for marten winter habitat (Koehler and Hornocker 1977). Canopy cover prevents excessive snow buildup in the understory, and therefore allows continued subnivean access throughout the winter.

4.4.2 American Marten Habitat Suitability Model Development

4.4.2.1 Model Rating Assumptions

Mature and structurally diverse conifer forests (structural stage 6 and 7 forests with large diameter trees and interlocking canopies) are a main feature of winter habitat for marten (Appendix 4). Habitat values are further enhanced by the presence of CWD, 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;
- 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 and

ESSF. Structural stage 4 and 5 conifer-dominated, closed canopy forests on mesic to moist sites were also rated Moderate.

- Low (L) rated habitat included Structural stage 4 and 5 floodplain forests, drier mature forests in the ICH not already rated in Moderate, as well as mesic parkland forests in the BAFA and CMA BECs.
- Nil (N) rated habitats included the remaining vegetation and areas of early seral stage vegetation (structural stages 1, 2, and 3), such as barren areas, lakes, wetlands, and rivers.

4.4.2.2 Methods

The preliminary WHRs developed from the model assumptions represent the final HSRs for ecosystem types present in the study area using a 4-class system. These habitat ratings are provided in Appendix 6.

4.4.3 Model Evaluation

Model assumptions were evaluated 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 76% of the time. This outcome was based on the comparison of 135 field and model ratings at the same location.

4.4.4 Results

The results of the habitat suitability modelling suggest that functional marten habitat, represented as High and Moderate rated habitat, occupies a quarter (25%) of the RSA and is widely distributed throughout lower elevation forested habitats (Figure 4.4-1; Table 4.4-1). This total includes the area of the LSA; results of habitat mapping within the LSA are discussed in the following paragraph. Of the top two ratings classes, proportionately more was rated as High than Moderate (Table 4.4-1). Much of the High rated habitat forms large continuous patches, especially in mature forests along the Unuk River watershed (Figure 4.4-1). Moderate rated habitats were primarily very small habitat patches surrounded by High rated habitat along the South Unuk River, Bell-Irving River, and floodplain of the Bowser River (west of Bowser Lake; Figure 4.4-1). The remaining three quarters (75%) of the RSA fell within the lower two rating classes, classified as Low (2%) and Nil (73%). Low rated habitat included all parkland/krummholtz type forested habitats located upslope of more suitable habitat (High and Moderate) as well as intermediate structural stage forests along major waterways (floodplain forests). Nil quality habitat constituted all the higher elevation alpine areas dominated by herb and shrub, and sparsely vegetated habitats that do not provide any cover for marten during the winter.

Table 4.4-1. American Marten Winter Habitat within the RSA and LSA

Habitat Suitability Rating	RSA		LSA		Proportion of Habitat in LSA Relative to the RSA (%)
	Area (ha)*	% of Habitat in RSA	Area (ha)	% of Habitat in LSA	
High	77,988	23	15,026	27	19
Moderate	6,980	2	1,227	2	18
Low	5,200	2	1,139	2	22
Nil	247,765	73	37,393	68	15

** Includes area of Local Study Area (LSA)*

Moderately to Highly suitable winter habitat for marten was mapped across 29% of the LSA and was distributed across lower elevation habitat in all parts of the LSA except for the Mitchell-Teigen Corridor

(Figure 4.4-1; Table 4.4-1). Of the High rated habitat mapped across the entire RSA, A total of 19% occurs within the boundaries of the LSA, while 18% of the total amount of Moderately High rated habitat occurs within the LSA (Table 4.3-1). The rest of the LSA was rated as Low (2%) and Nil (68%).

4.4.5 Discussion

The results of habitat suitability modelling indicate that the majority of the forested habitat within the RSA and LSA is Highly suitable winter habitat for marten (Figure 4.4-1). Within the RSA, continuous blocks of suitable habitat were distributed across low elevation habitat within all major watersheds, particularly in mature forests along the Unuk River watershed. Over a quarter of the LSA was identified as Highly suitable winter habitat for marten, with most of the forest habitat within the proposed Tailing Management Facility and low elevation older forests along the Coulter Creek Access Corridor ranked as Highly suitable.

In the RSA, High rated habitat formed large continuous blocks that were distributed across low elevation habitat within all major watersheds of the RSA. The remaining habitat in the RSA was primarily of Nil habitat quality for marten; there was very little of either Moderate or Low rated habitat. Moderate and Low rated habitat included younger structural stage forest. 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).

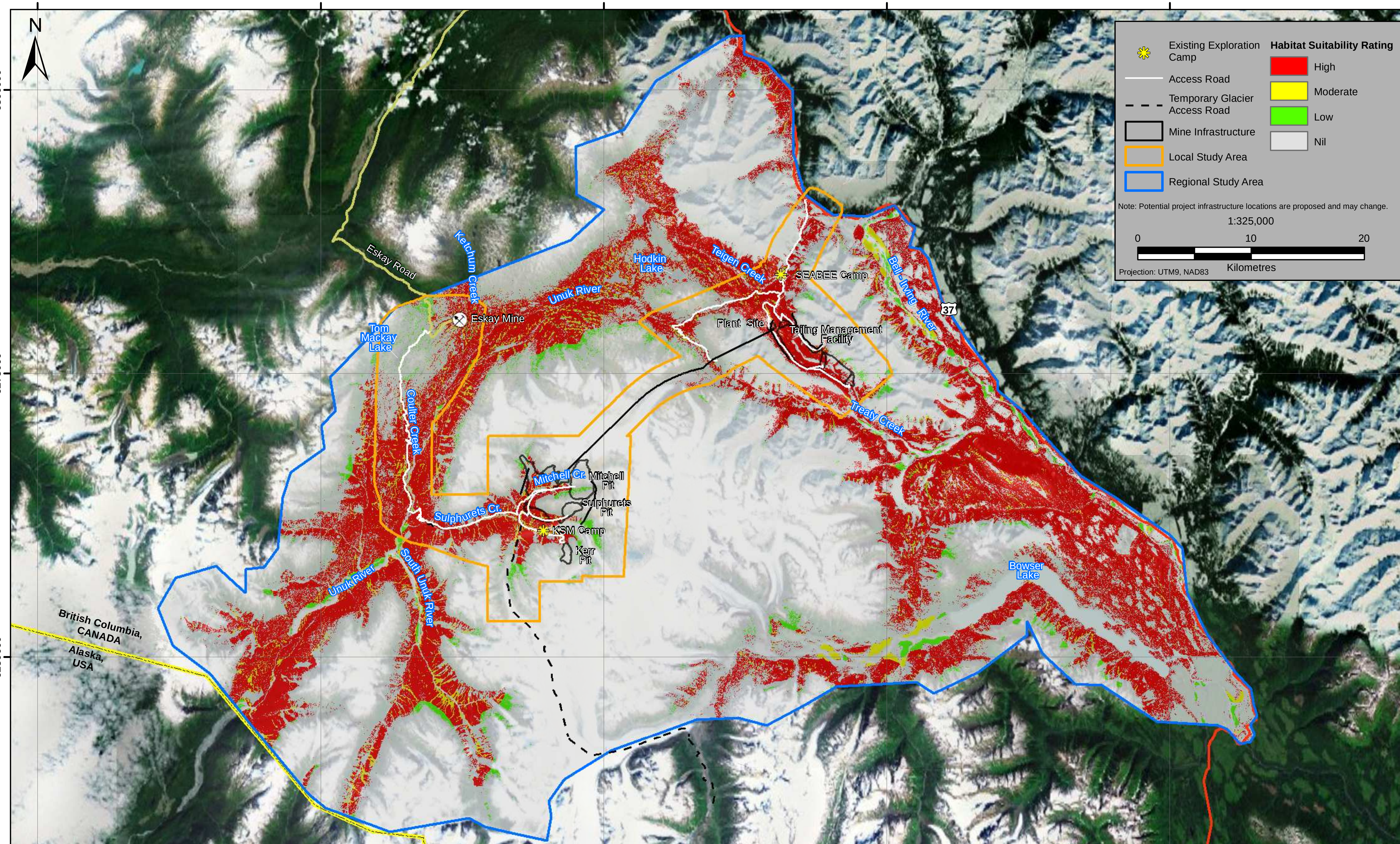
Over a quarter of the LSA was identified as Highly suitable winter habitat for marten. Most of the forest habitat within the footprint of the proposed Tailing Management Facility was Highly suitable for marten, as well as low elevation older forests along the Coulter Creek Access Corridor. As marten are often associated with late successional, canopied coniferous forests throughout most of their range (Payer and Harrison 2003), most of the higher elevation habitat within the Western LSA surrounding the proposed Mining Area and along the Mitchell-Teigen Corridor were rated as Nil.

High value habitat for marten has been identified within the Cassiar Iskut-Stikine LRMP (BC ILMB 2000), which overlaps the western RSA. High value habitat is represented as areas with the potential to provide abundant cover vegetation and small mammal prey populations, as well as areas with subnivean access in the winter (BC ILMB 2000). There was a relatively small amount of high value habitat identified in the CIS LRMP that overlapped the RSA, all of which occurred in the northern RSA along Highway 37 within Ningunsaw Provincial Park. This area was also identified as Highly suitable for marten in the current study, which confirms the importance of this area for marten (Figure 4.4-1; BC ILMB 2000).

4.5 HOARY MARMOT

4.5.1 Background

Hoary marmots have been identified as a species of cultural significance by Aboriginal peoples and they are an important prey species for carnivores such as grizzly bears and golden eagles. Due to their cultural significance and importance as a prey species, marmots were selected as a candidate species for habitat modelling. 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 1998a). Modelling focused on identifying suitable growing season habitat (combined spring, summer, and fall habitat) since marmots are only active during snow-free months.



SEABRIDGE GOLD

American Marten: Winter Habitat

FIGURE 4.4-1

Rescan

4.5.2 Hoary Marmot Habitat Suitability Model Development

4.5.2.1 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 uphold the structural integrity of burrows over time (Armitage 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 in which marmots can acquire nutrient resources during the growing season. To account for all of these differences, a growing habitat model was developed using multiple inputs, including digital topographic data, and ecosystem and soils mapping products (Rescan 2010d, 2010c), 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 5). Based on the results of ground surveys conducted at hoary marmot burrows in the study area in 2009 (Rescan 2010e), the soil type with the most appropriate structure for burrows was assumed to be 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 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. 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. For this reason, the model was only applied within higher elevation BEC zones (i.e., ESSF, MH, CMA, and BAFA).

4.5.2.2 Methods

The hoary marmot growing season habitat model included identifying 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 4.5-1. The model was only applied to habitat within the ESSF, MH, CMA, and BAFA BEC zones.

The hoary marmot model was restricted to the LSA (54,785 ha), as soil surficial material information was only available for this area. A small portion of habitat outside of the LSA boundary, totalling approximately 14,885 ha, also had soils information and was included in the hoary marmot model. The total modelled area for hoary marmot growing season habitat was approximately 69,670 ha.

4.5.3 Model Evaluation

Model assumptions were evaluated by comparing field ratings to theoretical model ratings; however, field ratings for hoary marmot were only collected during 2008 and few field plots were located within the modelled area. The final growing season habitat model was either equal to field ratings or came within one rating class of field ratings 69% of the time, based on the comparison of 67 field and model ratings at the same location.

An additional evaluation of the model was conducted by overlaying locations of active hoary marmot colonies observed during surveys in 2009 with the results of the growing season modelling. Of the 76 colonies that were observed within the modelled area, 15 (19%) were observed in habitat classified as High, while 70% of all colonies were encompassed by habitat rated from High to Moderate.

Table 4.5-1. Soil, Topographic, and Vegetation Features for Modelling Hoary Marmot Growing Habitat in the ESSF, MH, CMA, and BAFA BECs

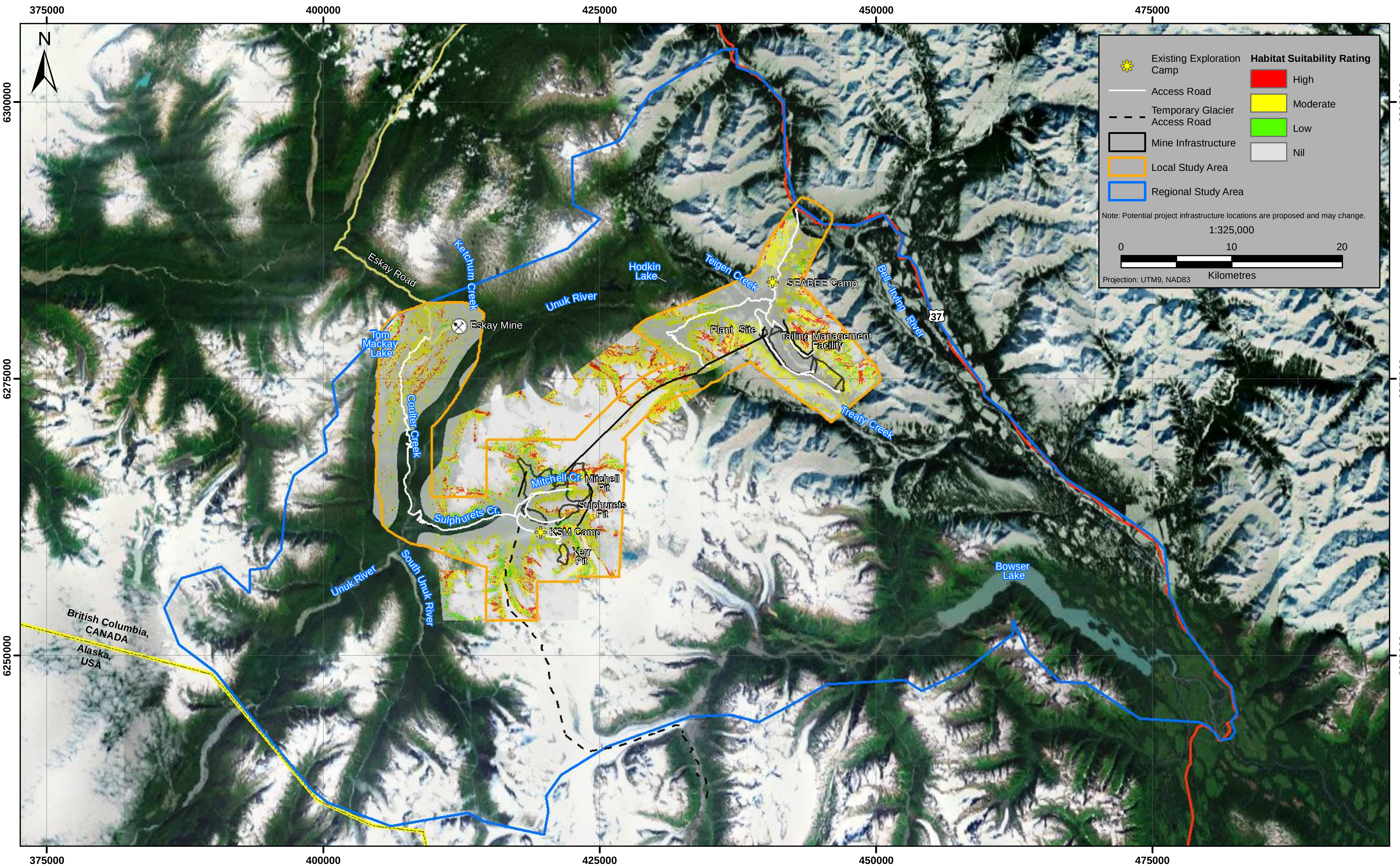
	Soil and Topographic Features				Vegetation Features	
HSR	Soil Surficial Material[1]	Slope (%)[2]	Aspect (°)[2]		PEM Site Series[3]	Structural Stage[3]
H	Morainal/ Colluvial	25-60	Warm	67.5 – 292.5	Herbaceous Meadow (AM), Barren (BA), Dry Herb (DH), Escape Terrain (ET), Herb-dominated Avalanche Track on moderate slopes (GTm), Heather Heath (MP), and Wetter Herb (VW)	≤ 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), Shrub-dominated Avalanche Track on moderate slopes (Avm), Shrub-dominated Avalanche Track on steep slopes (AVs), Drier Shrub/Herb (DS), Krummholz (KH), Parkland forest / woodland (PK), Mesic Shrub/Herb (VF), and Wetter Shrub/Herb (VS)	≤ 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 (Rescan 2010c), [2] Digital Elevation Model (DEM) information and 1:20,000 Terrain Resource Information Management (TRIM) data, [3] Predictive Ecosystem Mapping (PEM) (Rescan 2010d)

4.5.4 Results

A total of 10% of the LSA (5,684 ha) fell within lower elevation BEC zones (CWH and ICH) and was subsequently not modelled for marmot growing season suitability. The following results represent the remaining 90% of the LSA rated for suitability. Percentages express the proportion of habitat within each suitability class within the LSA that was rated.

The results of the habitat suitability modelling indicated that almost a third (31%) of the LSA modelled for suitability was Highly suitable and Moderately suitable growing season habitat for marmots (Figure 4.5-1; Table 4.5-1). Higher suitability habitats (High and Moderate) were well distributed across the alpine in the Western and Eastern LSA, as well as in the Coulter Creek Access Corridor below Eskay Creek Mine and the eastern end of the Mitchell-Teigen Corridor (Figure 4.5-1). The remainder of the LSA was rated in the lower suitability classes (Low and Nil), most of which was Nil habitat (66%).



SEABRIDGE GOLD

FIGURE 4.5-1

Hoary Marmot: Growing Season Habitat

Rescan™

The additional area outside the LSA that was modelled for hoary marmot growing season habitat was located north of the Mitchell-Teigen Corridor and Western LSA and south of the Coulter Creek Access Corridor. Of the habitat modelled outside the LSA, the majority of the habitat was rated as Nil (11,547 ha; Figure 4.5-1; Table 4.5-1). However, small pockets (668 ha) of Highly suitable habitat were modelled, mainly on the mountainous area to the north of the Mitchell-Teigen Corridor, and 2,388 ha of Moderately suitable habitat was modelled, which was largely distributed in the same area as High rated habitat described above and along the west facing slopes of the Unuk River drainage (Figure 4.5-1; Table 4.5-1).

Relative to the entire area within the LSA and portions of the RSA that were modelled for hoary marmots growing season habitat (roughly 63,986 ha), a total of 5% was ranked as Highly suitable and 24% was Moderately suitable. The remaining habitat was rated as Low (3%) and Nil (68%).

4.5.5 Discussion

Within the LSA, almost a third of the habitat that was modelled for hoary marmots was identified as Highly to Moderately suitable growing season habitat (Figure 4.5-1; Table 4.5-2). In relation to proposed infrastructure, higher suitability (High and Moderate) habitats were patchily distributed across the proposed Mining Area in the Western LSA; however, most proposed infrastructure contained little to no functional hoary marmot growing season habitat.

Table 4.5-2. Hoary Marmot Growing Season Habitat within the LSA and Additional Area outside the LSA

Habitat Suitability Rating	LSA		Additional Habitat Mapped Outside of LSA Boundaries*	Total Area of Mapped Habitat (ha)
	Area (ha)*	% of Habitat in LSA		
High	2,494	5	668	3,162
Moderate	12,859	26	2,388	15,247
Low	1,480	3	282	1,761
Nil	32,269	66	11,547	43,816

5. Summary

Habitat suitability modelling conducted for the KSM Project included the following species and seasons/attributes: moose (*Alces alces*) early and late winter habitat; mountain goat (*Oreamnos americanus*) summer and winter habitat; grizzly bear (*Ursus arctos*) spring, summer, fall, and hibernating habitat; American marten (*Martes americana*) winter habitat; and hoary marmot (*Marmota caligata*) growing season habitat (Table 5-1).

Table 5-1. Summary of Habitat Suitability Modelling for Five Species in the RSA and LSA

Species and Season	Area of Modelled Habitat (ha)											
	High	%[1]	Mod. High	%[1]	Moderate	%[1]	Low	%[1]	Very Low	%[1]	Nil	%[1]
RSA												
Moose												
Early Winter	21,557	6	19,080	6	67,633	20	76,141	23	15,099	4	138,548	41
Late Winter[2]	12,395	7	8,533	5	14,483	8	15,016	8	1,930	1	132,465	72
Mountain Goat[3]												
Winter	33,861	10	24,650	7	22,933	7	14,699	4	241,789	72	-	-
Summer	33,126	10	43,591	13	47,221	14	39,876	12	174,116	52	-	-
Grizzly Bear												
Spring	15,515	5	74,862	22	87,105	26	79,048	23	75,349	22	6,053	2
Summer	14,929	4	114,380	34	50,039	15	73,050	22	79,481	24	6,053	2
Fall	1,138	< 1	25,394	8	117,277	35	108,590	32	79,481	24	6,053	2
Marten												
Winter	77,988	23			6,980	2	5,200	2			247,765	73
LSA												
Moose												
Early Winter	2,410	5	3,794	7	12,799	25	14,926	29	3,105	6	14,233	28
Late Winter[2]	412	1	278	1	1,279	4	1,473	5	219	1	28,299	89
Mountain Goat[3]												
Winter	5,650	10	2,821	5	3,902	7	1,554	3	40,858	75	-	-
Summer	5,491	10	5,674	10	8,277	15	5,035	9	30,308	55	-	-
Grizzly Bear												
Spring	2,697	5	14,289	26	17,208	31	13,174	24	7,043	13	375	1
Summer	2,080	4	21,671	40	10,933	20	12,109	22	7,617	14	375	1
Fall	19	< 1	4,659	9	22,574	41	19,542	36	7,617	14	375	1
Hibernating[4]	476	2			3,101	11	1,641	6			23,530	82
Marten												
Winter	15,026	27			1,227	2	1,139	2			37,393	68
Hoary Marmot												
Growing[5]	2,494	5			12,859	26	1,480	3			32,269	66

[1] Percent of Habitat in the RSA (moose, mountain goat, grizzly bear (excluding hibernating), and marten) and Percent of Habitat in LSA (hoary marmot and grizzly bear hibernating)
[2] A total of 153,235 ha in the RSA (45%) were not rated for moose late winter habitat suitability. Within the LSA, there were 19,306 ha (38% of LSA) not rated (see Section 4.2.4 for more details).
[3] Very Low includes Nil Rated Habitat (i.e., Very Low/Nil)
[4] A total of 26,036 (48% of LSA) was not rated for grizzly bear hibernating habitat suitability (Section 4.4.4).
[5] A total of 5,684 (10% of LSA) was not rated for hoary marmot growing habitat suitability (Section 4.6.4).

The suitability mapping conducted for the Project identified areas of relative importance for selected species across the entire RSA. For example, the combination of wetland, riparian corridors, and mature forests within these areas provided good forage habitat for moose and grizzly bears in the RSA and LSA. In particular, the large wetland-timber complex along the lower Teigen Creek drainage near Bell II are important for moose in the early and late winter, and for grizzly bears in the spring, summer, and fall. Large tracts of low elevation mature forests within all watersheds of the RSA and LSA rated highly for American marten, as they provided the best forest structure for accessing prey populations during the winter. The RSA and LSA also support a large quantity of alpine habitat, which provided suitable habitats for goats, denning grizzly bears, and hoary marmots, particularly the small mountain between the proposed Tailing Management Facility and the Treaty Creek drainage in the Eastern LSA.

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Appendix 1

Species Account for Moose

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Appendix 1 – Species Account for Moose

Name:	*Alces alces* or *Alces americanus*	
Species Code:	M-ALAL/M-ALAM	
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 broadly distributed across the majority of the province but are most abundant within interior regions such as the central and sub-boreal mountains, the northern boreal mountains, and the boreal plains of northeastern BC (Blood 2000). Northern BC is home to over 70% of the provincial population, with other moderate to plentiful populations located in the Cariboo-Chilcotin, Thompson-Okanagan, and Kootenay regions (Blood 2000). Moose are absent from Vancouver Island and Haida Gwaii and are generally not found in coastal areas of BC. However, there is evidence to suggest that some animals travel down to the ocean within several inlets along the Coast Range (Blood 2000) and that low density populations currently subsist in coastal areas of central and northern BC (Darimont et al. 2005).

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 BC. were likely low or non-existent prior to the late 1800's and have increased significantly since then, moving from northeastern BC. 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:** Coast and Mountains, Sub-Boreal Interior
- **Ecoregions:** Boundary Ranges; Northern Skeena Mountains, Nass Ranges

- **Ecosections:** Meziadin Mountains, Northern Skeena Mountains, Nass Basin, Southern Boundary Ranges
- **Biogeoclimatic Zones:** Boreal Altai Fescue Alpine (BAFAunp), Coastal Western Hemlock (CWHwm), Coastal Mountain-heather Alpine (CMAunp), Engelmann Spruce-Subalpine Fir (ESSFwv), Interior Cedar Hemlock (ICHvc), Mountain Hemlock (MHmm2).
- **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, Bennett, and Corbett 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, Hebert, and Halko 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, Ovaska, and Jakimchuk 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, Ovaska, and Jakimchuk 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; M. W. Demarchi and Bunnell 1993, 1995).

Moose migrate seasonally from high elevations in the summer, to elevations below 1,300 m in the winter (Sopuck, Ovaska, and Jakimchuk 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, Bishop, and Coady 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, Bishop, and Coady 1974; Peek, Urich, and Mackie 1976; Eastman 1977; MacCracken, Ballenberghe, and Peek 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 (Eastman 1974; Peek 1974; Peek, Urich, and Mackie 1976; Doer 1983; MacCracken, Ballenberghe, and Peek 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).

Reproduction

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, Ovaska, and Jakimchuk 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, Ballenberghe, and Peek 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, Ovaska, and Jakimchuk 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

The specific life requisite that will be evaluated for moose will be *living* for the early and late winter; habitats for the early and late winter are rated separately. In relation to food/cover life requisites included within the specific *living* life requisite, the *feeding habitat* (FD) portion will account for most of the value of habitat over *security habitat* (SH) and *thermal habitat* (TH). Food/cover life requisites 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

Trees and Shrubs	
Balsam fir (*Abies balsamea*)	Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*)
Balsam (*Abies* spp.)	Trembling aspen (*Populus tremuloides*)
Douglas maple (*Acer glabrum*)	Cherry (*Prunus* spp.)
Sitka alter (*Alnus crispa*)	Cascades rhododendron (*Rhododendron albiflorum*)
Saskatoon (*Amelanchier alnifolia*)	Scouler willow (*S. scouleriana*)
Bog birch (*Betula glandulosa*)	Willow (*Salix* spp.)
Paper birch (*Betula papyrifera*)	Elderberry (*Sambucus* spp.)
Swamp birch (*Betula pumila*)	Western mountain ash (*Sorbus scopulina*)
Birch (*Betula* spp.)	Mountain ash (*Sorbus* spp.)
Red osier dogwood (*C. stolonifera*)	Western Pacific yew (*Taxus brevifolia*)
Hazelnut (*Corylus californica*)	Western red cedar (*Thuja plicata*)
Black twinberry/bearberry honeysuckle (*Lonicera involucrate*)	Highbush cranberry/Lowbush cranberry (*Viburnum edule*)
Myrtle pachistema/Falsebox (*Pachistima myrsinities*)	
Forbs	
Clematis (*Clematis* spp.)	Skunk cabbage (*Lysichtiton kamtschaktkense*)
Bunchberry dwarf dogwood (*Cornus canadensis*)	Claspleaf twistedstalk (*Streptopus amplexifolius*)
Fireweed (*Epilobium angustifolium*)	
Aquatic Vegetation	
Water arum (*Calla palustris*)	Robinson pondweed (*P. robbinsii*)
Yellow waterlily (*Nuphar lutea* ssp. *polysepala*)	Pondweed (*Potamogenton* spp.)
Large-leaf pondweed (*P. amplifolius*)	Burreed (*Sparganium* spp.)
Grassleaf pondweed (*P. gramineus*)	Horsetail (*Equisetum* spp.)
Floating-leaf pondweed (*P. natans*)	Water horsetail (*E. fluviatile*)
Richardson pondweed *(P. richardsonii*)	
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 (Peek 1974; Blood 2000). 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 Jordon 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, Chavez, and Paloheimo 1984). Therefore, Adair, Jordon, and Tillma (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 highbush cranberry (*Viburnum edule*), trembling aspen, Saskatoon (*Amelanchier albiflorum*), and black twinberry (*Lonicera involucrata*).

During the fall rutting period (late September to early October), moose generally select open wetland and shrubland habitat types or early seral stage burns and cutblocks (Lent 1974; Peek, Urich, and

Mackie 1976; MacCracken, Ballenberghe, and Peek 1997). Use of closed canopy forests also can be found in areas where hunting of moose occurs, possibly in response to this activity (Peek, Urich, and Mackie 1976; Tomm, Beck Jr, and Hudson 1981; Schwab 1985). Male moose tend to aggregate more during the rut than females (Lent 1974), and have been shown to have smaller seasonal home ranges during this time (Cederlund and Sand 1994).

Winter

The most important winter food for moose is willow, as it is both palatable and abundantly available (B.C. MoE 1979; Ritcey Undated). The winter diet is close to 100% trees and shrubs, with the occasional consumption of frozen sedges if they can be found (Schwartz, Hubbert, and Franzmann 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 red cedar (*Thuja plicata*) regeneration, *Vaccinium* spp., and alder (*Alnus* sp.) are also important winter food sources (Peek 1974; Petticrew and Munro 1979; Ritcey Undated). 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 elevation riparian communities, especially along dynamic riverine systems, where much of the riparian vegetation is in a sub-climax seral stage (LeResche, Bishop, and Coady 1974; Van Drimmelin 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 BC (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, Probert, and Van Beek (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 (Bechtold 1996; Klaus and Schmid 1998). 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, Ballenberghe, and Peek 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 (Schwab 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.

Two seasons will be rated for moose: Early and Late Winter.

Table 2. Monthly Life Requisites for Moose

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

** Seasons defined for Sub-boreal Interior and Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC 1999b)*

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).

Table 3. Predictive Ecosystem Mapping (PEM) Relationships for Each Life Requisite for Moose

Life Requisite	PEM Attribute
Food Habitat	• Site: site disturbance, elevation, slope, aspect, structural stage • Vegetation: Percent cover by layer, species list by layer, cover for each species for each layer
Security Habitat	• Site: elevation, slope, aspect, structural stage • Vegetation: total percent cover, percent cover by layer • Mensuration: tree species, diameter at breast height, height
Thermal Habitat	• Site: elevation, slope, aspect, structural stage • 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 1999a) (Table 4).

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

Provincial "Best" Benchmark during the Winter

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

Winter Provincial Benchmark(s) provided for Ecoprovinces occurring within the RSA

Ecoprovince:	Coast and Mountains	Sub-boreal Interior
Ecosection:	Nass Basin (NAB)	Boundary Ranges (BRR)
Biogeoclimatic Zone (BEC):	ICHmc	SBSmk
Broad Ecosystem Unit (BEU):	Boreal White Spruce-Trembling Aspen (structural stage 2-3)	Boreal White Spruce-Trembling Aspen (structural stage 2-3)
Ecosection Rating against Provincial Best (% of Provincial Best):	3 (26-50%)	1 (76-100%)
BEU Rating against Provincial Best (% of Provincial Best):	3 (26-50%)	1 (76-100%)

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 3 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.
8. Capable winter habitat (based on observational data from winter flights) is restricted to portions of CWH, ESSF, MH, and ICH BECs within the study area, based on criteria outlined in Table 5. Areas falling outside of this criteria will not be ranked (BAFA and CMA BECs).

Table 5. Elevation and Slope Adjustments to Capable Habitat and Associated Late Winter Habitat Suitability Rating for Moose

Coastal BEC Zones (CWH and MH)		Interior BEC Zones (ICH and ESSF)		
Elevation (m)	**Slope (%)**	**Elevation (m)**	**Slope (%)**	**Associated HSR**
0 - 450	0 - 40	0 - 600	0 - 40	Most Capable Habitat: HSR equivalent to WHR assigned to PEM ecosystem unit
0 - 450 451 - 750	41 - 60 0 - 60	0 - 600 601 - 750	41 - 60 0 - 60	Less Capable Habitat than above: WHR downgraded by one rating class for final rating (e.g.,, WHR 2 becomes HSR 3)
0 - 750 > 750	> 60 any	0 - 750 > 750	> 60 any	Not Capable Habitat: Automatically assigned a nil value (HSR 6) for late winter habitat

<u>Ratings Adjustments</u>

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.

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Appendix 2

Species Account for Mountain Goat

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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)**

DISTRIBUTION

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 (Blood 2000). Populations exist in the Cassiar Mountains in north-central BC, the Cariboo Mountains of the upper Fraser River system, the Purcell, Selkirk and Monashee Mountains of south-east BC and the Coast Mountains from the lower Fraser River to the extreme north-west portion of the province (Blood 2000; Mountain Goat Management Team 2010).

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, Moorhead, and Olson 1986). Mountain goats generally occur in mountainous terrain at >1,500 m. Some sub-populations are also known to use canyons and forested rocky habitats year-round (Turney et al. 2001; Mahon and Turney 2002).

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 (Blood 2000), a slight decrease from the 1977 population estimate of 63,000 (Macgregor 1977).

Project Area

- **Ecoprovince:** Coast and Mountains, Sub-Boreal Interior
- **Ecoregions:** Boundary Ranges; Northern Skeena Mountains, Nass Ranges
- **Ecosections:** Meziadin Mountains, Northern Skeena Mountains, Nass Basin, Southern Boundary Ranges

- **Biogeoclimatic Zones:** Boreal Altai Fescue Alpine (BAFAunp), Coastal Western Hemlock (CWHwm), Coastal Mountain-heather Alpine (CMAunp), Engelmann Spruce-Subalpine Fir (ESSFwv), Interior Cedar Hemlock (ICHvc), Mountain Hemlock (MHmm2).
- **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 (Fox, Smith, and Schoen 1989; BC 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). Areas with abundant food supply and little escape terrain are generally not utilized by mountain goats (Herbert 1967; Chadwick 1973; Russell 1974; B. L. Smith 1977; Fox 1978; Schoen and Kirchoff 1982).

Habitat Use and Home Range

Mountain goats may migrate a few kilometres between winter-spring and summer ranges, but many seasonal migrations are just local shifts in elevation (Blood 2000). Winters are spent on well ledged or fractured cliffs, and very steep terrain with interspersed vegetation with low snow accumulation. These habitats are usually on steep south to southwest aspects with slopes exceeding 40° 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 (Blood 2000). Studies have also observed that adult male ranges tend to be much larger than those of adult females, especially during the fall rut (Chadwick 1973; Thompson 1980; C.A. Smith and Raedeke 1982).

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 (Casebeer, Rognrud, and Brandborg 1950; Herbert 1967; Foster 1982; Fox, Smith, and Schoen 1989). Foraging takes place in a variety of habitat types ranging from alpine tundra, alpine grass-herb communities, sub-alpine meadows and sub-alpine shrub and early seral stage forests (Chadwick 1973; Russell 1974; Fox 1978; Foster 1982; Fox, Smith, and Schoen 1989). During summer months, goats often use areas of lush herbaceous forage in alpine grasslands, meadows, and grassy slide-rock slopes of the BAFA (AT) and ESSF parklands. Timbered areas and avalanche tracks 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).

Reproduction

The life span of the mountain goat is variable but estimated at approximately 12 years. Full maturity is reached at 4 years of age, while female sexual maturity first occurs at 2.5 years of age (Blood 2000; Côté and Festa-Bianchet 2001b). Males are capable of procreating at that age, but are generally out-dominated by older males. Studies in Colorado and Washington (Bailey 1991; Festa-Bianchet, Urquhart, and Smith 1994) reported that kid production was common among 3-year-olds and rare among 2-year-olds. Côté and Festa-Bianchet (2001a) found that kid production was significantly influenced by both age and social rank of the female and that females may not give birth every year.

The mating season, or rut, peaks in late November and early December. Mountain goats are polygamous during this time. After a gestation period of six months, nannies (mothers), retire to secluded, precipitous ledges to give birth to kids in late May or early June. Generally one kid is born, although twins are common, and they will stay with their mothers in nursery groups for up to two years (Macgregor 1977). 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. Groups of more than 40 animals have been reported in some areas (e.g., Von Elsner-Schak 1986; Varley 1996). Billies are less social, occurring singly or in groups of two to four animals. Males and females live apart except during breeding (Holmes 1988; Tesky 1993; Varley 1996; Blood 2000).

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.

<u>Feeding Habitat (FD)</u>

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 winter, feeding occurs on steep, south-facing rocky areas and in some cases forested or scrub forest areas nearby (Chadwick 1973; B. L. Smith 1977; J.W. Schoen and M.D. Kirchoff 1982). 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 (Chadwick 1973; Thompson 1980; Stevens 1983). Foster and Rahs (1981) estimate the average winter food diet of mountain goats to be 80-95% shrubs and trees, 0% forbs, and 15% grasses.

Use of forested habitats in winter is dependent on the availability of nearby escape terrain, snow condition and snow depth. In the interior, when snow levels are high, mountain goats will tend to stay on steep, snow-shedding terrain or in areas where the wind keeps the snow from accumulating (Herbert 1967; B. L. Smith 1977). In coastal areas, mountain goats will use south-facing timbered habitats below and adjacent to escape terrain, foraging on plant species such as *Vaccinium* spp, bunchberry, sedges, tree lichens and mosses (Foster 1982; C. A. Smith 1986; Fox and Smith 1988; Fox, Smith, and Schoen 1989). This difference in use of forested terrain in winter appears to be related to the difficulty in moving in the deep, wet snow found in coastal areas as opposed to the drier snow found in interior areas.

Summer diet is more varied with a higher proportion of forbs (35-70%), grasses (22-62%) and sedges (Foster and Rahs 1981). Travel to find feeding areas is greatest during the summer when movements of a couple of kilometres are common (Chadwick 1973). Habitats used include krummholz-parkland, avalanche tracks, alpine and sub-alpine meadows, cliffs, rocky outcrops, snowfields, sub-alpine parkland and sub-alpine forests (Thompson 1980; Foster 1982; Schoen and Kirchoff 1982; Stevens 1983). Plants commonly used during the summer include shrubs (*e.g.*, willows and soopolallie), grasses, sedges and herbaceous plants (Chadwick 1973; Thompson 1980).

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

Trees and Shrubs	
Mountain Heath (*Phyllodoce aleutica*)	Western service berry (*Amelanchier alnifolia*)
Moosewood (*Viburnum edule*)	Common juniper (*Juniperus communis*)
Highbush cranberry/ Lowbush cranberry (*Viburnum pauciflorum*)	Sitka spruce (*Picea crispa*)
Sitka alter (*Alnus crispa*)	Quaking aspen (*Populus temuloides*)
Scrub birch (*Betula glandulosa*)	Black cottonwood (*Populus trichocarpa*)
Hazelnut (*Corylus californica*)	Willow (*Salix* spp.)
Alpine fir (*Abies lasiocarpa*)	Scouler willow (*Salix scouleriana*)
Western red cedar (*Thuja plicata*)	Western and mountain hemlock (*Tsuga* spp.)
Forbs	
Lupine (*Lupine* spp.)	Mountain bluebell (*Mertensia* spp.)
Bunchberry dogwood (*Cornus canadensis*)	Polemonium (*Polemonium* spp.)
Red osier dogwood (*Cornus stolonifera*)	Kinnikinnick (*Arctostaphylos uva-ursi*)
Foamflower (*Tiarella trifoliate*)	
Ferns	
Alpine lady fern (*Athyrium alpestre*)	Maindenhair spleenwort (*Asplenium trichomanes*)
Oak fern (*Gymnocarpium dryopteris*)	
Moss and Lichens	
Lichen (*Cetraria* spp.)	Moss (*Hedwigia ciliate*)
Lichen (*Cladina* spp.)	Moss (*Hylocomium* spp.)
Moss (*Dicranum* spp.)	
Grasses and sedges	
Wheatgrass (*Agropyron* spp.)	Bluegrass (*Poa* spp.)
Bentgrass (*Agrostis scarbra*)	Grass (Gramineae)
Reedgrass (*Calamagrostis* spp.)	Sedge (*Carex* spp.)
Fescue (*Festuca* spp.)	

(Foster and Rahs 1981; Fox, Raedeke, and Smith 1982)

Mountain goats, like many other ungulates, seek out mineral supplementation in the form of natural (mineral) salt licks. Mountain goats will travel further from their normal habitats than any other ungulate to obtain minerals (Herbert 1967). Mountain goats will use mineral licks that are in unfavourable habitats and will travel through forests to obtain minerals (Herbert 1967; Turney, Blume, and Mahon 1999, 2000; Turney et al. 2001). Mineral licks are used once they become snow-free in the spring until snowfall in late fall, early winter (Herbert 1967; Thompson 1980; Turney, Blume, and Mahon 1999, 2000; Turney et al. 2001). These salt licks are described as critical for both maintaining sodium levels as well as balancing stomach acidity (Bechtold 1996; Klaus and Schmid 1998). 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 (Côté 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. Festa-Bianchet, Urquhart, and Smith (1994) found that the major cause of death for mountain goats in their first four years was predation by grey wolf, grizzly bear and cougar, with most of the deaths occurring in the fall. For mountain goats in their second year and goats greater than eight years old, the primary causes of mortality reported by Smith (1986) were predation by grey wolf and bear and other natural causes. Mountain goats between two and eight years of age appeared relatively invulnerable to predation and other natural causes of death, but died primarily as a result of hunting. Other causes of mountain goat mortality include predation by species such as the golden eagle, bobcat, wolverine, and coyote, diseases and parasites, falls and avalanches, and winter weather (Chadwick 1973; Macgregor 1977; Festa-Bianchet, Urquhart, and Smith 1994; Blood 2000). Several source suggest that the availability of suitable winter habitat is a major determinant of mountain goat survival (Macgregor 1977; Blood 2000).

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, Kirchoff, and Walmo 1980; J. L. Fox, K. J. Raedeke, and C. A. Smith 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, Johnson, and Searing 2000).

Thermal Habitat (TH)

During the winter, the selection of south-facing habitats and areas under forest canopy is common for both coastal and interior mountain goats (B. L. Smith 1977; J.L. Fox 1978; Foster 1982; Schoen and Kirchoff 1982). 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 (Demarchi, Johnson, and Searing 2000; Côté and Festa-Bianchet 2003).

North 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. The primary life requisites that will be rated are *security habitat* (SH) and *feeding habitat* (FD), in conjunction with the specific life requisite *living* (LI).

The two seasons for which ratings will be applied to are:

- Summer Season: feeding (FD) in high elevation habitats (e.g., BAFA, CMA) but also may include spring range use and security habitat (SH) for kidding.
- Winter: feeding on shrubs and forbs on wind-blown or exposed rocky or alpine slopes (e.g., BAFA, CMA).

Table 2. Monthly Life Requisites for Mountain Goats

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

**Seasons defined for 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. Predictive Ecosystem Mapping (PEM) Relationships for Each Life Requisite for Mountain Goats

Life Requisite	PEM 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 "Best" Benchmark(s) during the Winter

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

Winter Provincial Benchmark(s) provided for Ecoprovinces occurring within the RSA

Ecoprovince:	Sub-boreal Interior
Ecosection:	Southern Skeena Mountains(SSM)
Biogeoclimatic Zone:	ESSFmc
Broad Ecosystem Unit:	Engleman Spruce-Subalpine Fir/RO-Rock
Ecosection Rating against Provincial Best (% of Provincial Best):	2 (51 - 75%)
BEU Rating against Provincial Best (% of Provincial Best):	2 (51 - 75%)

Provincial "Best" Benchmark(s) during the Summer

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

Summer Provincial Benchmark(s) provided for Ecoprovinces occurring within the RSA

Ecoprovince:	Sub-boreal Interior
Ecosection:	Southern Skeena Mountains (SSM)
Biogeoclimatic Zone:	AT
Broad Ecosystem Unit:	Alpine Meadow
Ecosection Rating against Provincial Best (% of Provincial Best):	2 (51 - 75%)
BEU Rating against Provincial Best (% of Provincial Best):	1 (76-100%)

Habitats: Mature to old-growth forests, subalpine parkland and seepage areas complexed with cliffs, rock bluffs, talus slopes, and avalanche tracks, on steep (greater than 80% 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.

Rating Assumptions

1. PEM 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, kid-rearing areas are similar to summer habitat and can be identified analogously to 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. South facing aspect will be ranked marginally higher than north facing aspects in the winter.
8. Thermal cover in winter includes conifer vegetation providing snow interception and oblique cover. This habitat also may 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 PEM product to determine the suitability of habitat based on its distance from escape terrain.

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Appendix 3

Species Account for Grizzly Bear

Appendix 3 – 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, Heard, and Austin 2004). This number indicated a slight increase in the population from the previous year's estimate of 13,800 (Hamilton and Austin 2004), 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 (Blood 2002).

Project Area

- **Ecoprovince:** Coast and Mountains, Sub-Boreal Interior
- **Ecoregions:** Boundary Ranges; Northern Skeena Mountains, Nass Ranges
- **Ecosections:** Meziadin Mountains, Northern Skeena Mountains, Nass Basin, Southern Boundary Ranges
- **Biogeoclimatic Zones:** Boreal Altai Fescue Alpine (BAFAunp), Coastal Western Hemlock (CWHwm), Coastal Mountain-heather Alpine (CMAunp), Engelmann Spruce-Subalpine Fir (ESSFwv), Interior Cedar Hemlock (ICHvc), Mountain Hemlock (MHmm2).
- **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 (BC MWLAP 2004).

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 (BC MWLAP 2004).

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 (BC MWLAP 2004).

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, Himmer, and Bryden 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; Demarchi and Johnson 2000).

Reproduction

Breeding occurs between the end of April and end of June (Mundy and Flook 1973), 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 (Aune 1985; McLellan 1989). 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 (BC MWLAP 2004).

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, Himmer, and Bryden (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 (J. J. Craighead, Varney, and Craighead 1974; McLellan and Shackleton 1989; Eberhardt, Blanchard, and Knight 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 (J. J. Craighead, Sumner, and Mitchell 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 (BC MWLAP 2004). Grizzly bears dig dens at or near the treeline, and below the ridge crest where mid-winter thaws are unlikely (Vroom, Herrero, and Ogilvie 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 (F. C. Craighead and Craighead 1972; Vroom, Herrero, and Ogilvie 1977; BC MWLAP 2004).

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 (Blood 2002). Dens may be clustered in areas that have favourable environmental conditions (Vroom, Herrero, and Ogilvie 1977; Blood 2002).

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 (Blood 2002). McLoughlin, Cluff, and Messier (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.

Early Spring

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

Trees and Shrubs	
Alpine fir (*Abies lasiocarpa*)	Buckthorn (*Rhamnus alnifolia*)
Saskatoon (*Amelanchier alnifolia*)	Black gooseberry (*Ribes lacustre*)
Western service berry (*Amelanchier alnifolia*)	Red raspberry (*Rubus idaeus*)
Kinnikinnick (*Arctostaphylos uva-ursi*)	Salmonberry (*Rubus spectabilis*)
Red-osier dogwood (*C. stolonifera*)	Scouler willow (*S. scouleriana*)
Bunchberry dogwood (*Cornus canadensis*)	Sitka mountain ash (*S. sitchensis*)
Crowberry (*Empetrum nigrum*)	Willow (*Salix* spp.)
Black twinberry (*Lonicera involucrata*)	Red elderberry (*Sambucus racemosa*)
Devil’s club (*Oploplanax horridus*)	Soopolallie (*Shepherdia canadensis*)
Bog cranberry (*Oxycoccus oxycoccos*)	Western mountain ash (*Sorbus scopulina*)
White spruce (*Picea glauca*)	Highbush cranberry/Lowbush cranberry (*V. pauciflorum*)
Quaking aspen (*Populus temuloides*)	Dwarf blueberry (*Vaccinium caespitosum*)
Black cottonwood (*Populus trichocarpa*)	Huckleberry (*Vaccinium* spp.)
Northern gooseberry (*R. oxyacanthoides*)	Moosewood (*Viburnum edule*)

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

Forbs	
Angelica (*Angelica lucida*)	Sweet cicely (*Osmorhiza* sp.)
Asters (*Aster* sp.)	Colts foot (*Petasites* spp.)
Vetch (*Astragalus* spp.)	Rose hips (*Rosa* spp.)
Fireweed (*Epilobium angustifolium*)	Solomon's seal (*Smilacina stellata*)
Cow parsnip (*Heracleum lanatum*)	Dandelion (*Taraxacum spp*.)
Peavine (*Lathyrus* spp.)	White Clover (*Trifolium repens*)
Desert-parsley (*Lomatium* spp.)	Clover (*Trifolium* spp.)
Skunk Cabbage (*Lysichiton americanum*)	Stinging nettle (*Urtica dioica*)
Ferns	
Alpine lady fern (*Athyrium alpestre*)	Spiny wood fern (*Dryopteris expansa*)
Grasses and sedges	
Bromes (*Bromus* spp.)	Grass (*Gramineae* spp.)
Sedges (*Carex* spp.)	Bluegrass (*Poa* spp.)
Tufted hairgrass (*Deschampsia caespitose*)	Spike trisetum (*Trisetum spicatum*)
Horestails (*Equiseum* spp.)	
Other food sources	
Moose (*Alces alces*)	Mule deer (*Odocoileus hemionus*)
White sucker (*Castomomus commersoni*)	Salmonids (*Oncorhynchus* spp.)
Ants (Formicidae)	Mountain goats (*Oreamnos americanus*)
Marmots (*Marmota* spp.)	Caribou (*Rangifer tarandus*)
Voles (*Microtus* spp.)	Wasps (Vespidae)

Source: Fuhr and Demarchi (1990); Beaudry, Martin, and Paczkowski (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 (J. J. Craighead, Sumner, and Scaggs 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.

Seasons of Use

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.

Four seasons will be rated for Grizzly Bears: Feeding in the Spring, Summer, Fall, and Hibernating in the Winter.

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	Spring
Food , Security, Thermal	June	Spring/Summer
Food , Security, Thermal	July	Summer
Food , Security, Thermal	August	Summer
Food , Security, Thermal	September	Fall
Food , Security, Thermal	October	Fall/Winter
Hibernating	November	Winter
Hibernating	December	Winter

** Seasons defined for Sub-boreal Interior and Coast and Mountains Ecoprovinces 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. Predictive Ecosystem Mapping (PEM) Relationships for Each Life Requisite of Grizzly Bears

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

Provincial "Best" Benchmark(s) (based on habitat capability mapping (BC MOE 2000))

Area:	Coastal BC	Interior BC
Ecoprovince:	Coast and Mountains	Southern Interior Mountains
Ecosection:	Kitimat Ranges (KIR)	Border Ranges (BRR)
Biogeoclimatic Zone:	CWHvm1	ESSFdk; MSdk
Broad Ecosystem Unit:	Coastal Western Hemlock-wet maritime	Engleman Spruce Subalpine Fir dry cool; Montane Spruce dry cool

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

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

Provincial Benchmark(s) provided for Ecoprovinces occurring within the RSA

Provincial benchmarks for grizzly bear in the Sub-boreal Interior Ecoprovince has not been formally established.

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, Hann, and Jonkel 1985).
2. Areas in close proximity and accessibility to salmon spawning streams will be considered during the modelling process.
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 and 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 PEM 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 will incorporate:

1. Proximity to high value moose winter habitat and salmon spawning reaches.

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Appendix 4

Species Account for American Marten

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Appendix 4 – Species Account for American 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:** Coast and Mountains, Sub-Boreal Interior
- **Ecoregions:** Boundary Ranges; Northern Skeena Mountains, Nass Ranges
- **Ecosections:** Meziadin Mountains, Northern Skeena Mountains, Nass Basin, Southern Boundary Ranges
- **Biogeoclimatic Zones:** Boreal Altai Fescue Alpine (BAFAunp), Coastal Western Hemlock (CWHwm), Coastal Mountain-heather Alpine (CMAunp), Engelmann Spruce-Subalpine Fir (ESSFwv), Interior Cedar Hemlock (ICHvc), Mountain Hemlock (MHmm2).
- **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 (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, Barrett, and Zielinski 1983; Buskirk and Powell 1994).

Fall / Winter

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, Fisher, and Mair (1983) found voles to be the major winter food source of marten in the boreal forest of the Northwest Territories. A study by Koehler, Blakesley, and Koehler (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, Barrett, and Zielinski 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 (BC 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	Growing (Spring)
Living	June	Growing (Spring/Summer)
Living	July	Growing (Summer)
Living	August	Growing (Summer)
Living	September	Growing (Fall)
Living	October	Growing (Fall)
Living	November	Winter
Living	December	Winter

** Seasons defined for Sub-boreal Interior 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).

<u>Ratings</u>

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).

Table 2. Predictive Ecosystem Mapping (PEM) Relationships for Each Life Requisite for Marten

Life Requisite	PEM 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

Provincial "Best" Benchmark during the Winter

Ecoprovince: Southern Interior Mountains
Ecosection: East Purcell Mountains (EPM)
Biogeoclimatic Zone (BEC): ESSFdk
Broad Ecosystem Unit (BEU): Engelmann Spruce-Subalpine Fir dry cool

Winter Provincial Benchmark(s) provided for Ecoprovinces occurring within the RSA

Provincial benchmarks for marten in the Sub-boreal Interior or Coast and Mountains Ecoprovinces has not been formally established.

<u>Ratings Assumptions</u>

1. Drier subzones generally rate lower. 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.

<u>Ratings Adjustments Considerations</u>

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

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Appendix 5

Species Account for Hoary Marmot

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Appendix 5 – 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:** Coast and Mountains, Sub-Boreal Interior
- **Ecoregions:** Boundary Ranges; Northern Skeena Mountains, Nass Ranges
- **Ecosections:** Meziadin Mountains, Northern Skeena Mountains, Nass Basin, Southern Boundary Ranges
- **Biogeoclimatic Zones:** Boreal Altai Fescue Alpine (BAFAunp), Coastal Western Hemlock (CWHwm), Coastal Mountain-heather Alpine (CMAunp), Engelmann Spruce-Subalpine Fir (ESSFwv), Interior Cedar Hemlock (ICHvc), Mountain Hemlock (MHmm2).
- **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. Gestation takes about 30 days; hoary marmots use their dens as a nest for young, which are usually born in late July. 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)

Feeding Habitat

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 / Living	April	Winter/ Growing (Spring)
Living	May	Growing (Spring)
Living	June	Growing (Spring/Summer)
Living	July	Growing (Summer)
Living	August	Growing (Summer)
Living	September	Growing (Fall)
Living / Hibernating	October	Growing (Fall) / Winter
Hibernating	November	Winter
Hibernating	December	Winter

** Seasons defined for Sub-boreal Interior and Coast and Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince (RIC 1999)*

One season will be rated for Hoary Marmot: *living* during the growing season.

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. Predictive Ecosystem Mapping (PEM) Relationships for Each Life Requisite for Hoary Marmot

Life Requisite	PEM 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 (25-60% slope, 67.5 – 292.5° 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 in structural stage 3 vegetation will be rated down one.
4. Very shallow soils or soils with coarser fragments, as well as all lower elevation habitat below the treeline will rate nil.

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.

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Appendix 6

Predictive Ecosystem Mapping (PEM) Wildlife Habitat Rating (WHR) Table

SEABRIDGE GOLD

Rescan™ Engineers and Scientists

Appendix 6. Predictive Ecosystem Mapping (PEM) Wildlife Habitat Rating (WHR) Table

BEC unit	Site_S	SiteS_MapCode	SiteS_Unit_Name	GenEcoType	StStage	M-ALAL LI-WE	M-ALAL LI-WL	M-ORAM FD-S	M-ORAM FD-W	M-URAR FD-P	M-URAR FD-S	M-URAR FD-F	M-MAAM-LI W
BAFAunp	00	AM	Herb meadow	Mesic Herb	2	5	99	1	2	1	2	2	N
BAFAunp	00	BA	Barren	sparsely vegetated	1	6	99	5	4	4	4	4	N
BAFAunp	00	DH	Dry herb	Drier Herb	2	5	99	1	2	2	2	2	N
BAFAunp	00	DS	Drier Shrub/Herb	Drier Shrub/Herb	3	4	99	2	1	3	3	2	N
BAFAunp	00	ET	Escape Terrain	sparsely vegetated	1	6	99	3	3	4	4	4	N
BAFAunp	00	GI	Glacier/ice or permanent snow	non-vegetated	n/a	6	99	5	5	5	5	5	N
BAFAunp	00	KH	Krummholz	Parkland Forest/Krummholz	3	4	99	2	1	3	3	3	L
BAFAunp	00	LA	TRIM lake	non-vegetated	n/a	4	99	5	5	6	6	6	N
BAFAunp	00	MP	Heather heath	Mesic Herb	2	5	99	3	2	2	3	2	N
BAFAunp	00	RI	TRIM river	non-vegetated	n/a	3	99	4	4	4	5	5	N
BAFAunp	00	VF	Mesic Shrub/Herb	Mesic Shrub/Herb	3	4	99	1	2	2	3	4	N
BAFAunp	00	VS	Wetter Shrub/Herb	Wetter Shrub/Herb	3	4	99	1	2	2	2	3	N
BAFAunp	00	VW	Wetter Herb	Wetter Herb	2	5	99	1	3	1	1	2	N
BAFAunp	00	WA	Water	non-vegetated	n/a	5	99	6	5	5	5	5	N
BAFAunp	00	Wm	TRIM marsh	Wetland Shrub/Herb	2	3	99	3	2	1	3	4	N
CMAunp	00	AM	Herb meadow	Mesic Herb	2	5	99	1	2	1	2	2	N
CMAunp	00	BA	Barren	sparsely vegetated	1	6	99	5	4	4	4	4	N
CMAunp	00	DH	Dry herb	Drier Herb	2	5	99	1	2	2	2	2	N
CMAunp	00	DS	Drier Shrub/Herb	Drier Shrub/Herb	3	4	99	2	1	3	3	2	N
CMAunp	00	ET	Escape Terrain	sparsely vegetated	1	6	99	3	3	4	4	4	N
CMAunp	00	GI	Glacier/ice or permanent snow	non-vegetated	n/a	6	99	5	5	5	5	5	N
CMAunp	00	KH	Krummholz	Parkland Forest/Krummholz	3	4	99	2	1	3	3	3	L
CMAunp	00	LA	TRIM lake	non-vegetated	n/a	4	99	5	5	6	6	6	N
CMAunp	00	MP	Heather heath	Mesic Herb	2	5	99	3	2	2	3	2	N
CMAunp	00	RI	TRIM river	non-vegetated	n/a	3	99	4	4	4	5	5	N
CMAunp	00	VF	Mesic Shrub/Herb	Mesic Shrub/Herb	3	4	99	1	2	2	3	4	N
CMAunp	00	VS	Wetter Shrub/Herb	Wetter Shrub/Herb	3	4	99	1	2	2	2	3	N
CMAunp	00	VW	Wetter Herb	Wetter Herb	2	5	99	1	3	1	1	2	N
CMAunp	00	WA	Water	non-vegetated	n/a	5	99	6	5	5	5	5	N
CMAunp	00	Wm	TRIM marsh	Wetland Shrub/Herb	2	3	99	3	2	1	3	4	N
CWHwm	00	AVs	Avalanche Track - shrub dominated - steep slope	Avalanche Track	3	4	4	1	2	2	3	3	N
CWHwm	00	BA	Barren	sparsely vegetated	1	5	5	5	4	4	4	4	N
CWHwm	00	DS	Drier Shrub/Herb	Drier Shrub/Herb	3	1	1	2	2	3	1	2	N
CWHwm	00	GTm	Avalanche Track - herb dominated - moderate slope	Avalanche Track	2	3	3	1	3	1	2	3	N
CWHwm	00	GTs	Avalanche Track - herb dominated - steep slope	Avalanche Track	2	5	5	1	3	1	2	3	N
CWHwm	00	GW	Herb wetland	Wetland Shrub/Herb	2	2	2	2	3	1	2	2	N
CWHwm	00	LA	TRIM lake	non-vegetated	n/a	4	4	5	5	6	6	6	N
CWHwm	00	RI	TRIM river	non-vegetated	n/a	3	3	4	4	4	5	5	N
CWHwm	00	VF	Mesic Shrub/Herb	Mesic Shrub/Herb	3	1	1	2	2	3	1	2	N
CWHwm	00	VS	Wetter Shrub/Herb	Wetter Shrub/Herb	3	1	1	2	2	3	2	2	N
CWHwm	00	VW	Wetter Herb	Wetter Herb	2	3	2	3	2	1	3	4	N
CWHwm	00	WA	Water	non-vegetated	n/a	5	5	6	5	5	5	5	N
CWHwm	00	WE	Wetland Shrub/Herb	Wetland Shrub/Herb	3	1	1	3	2	2	2	2	N
CWHwm	00	Wm	TRIM marsh	Wetland Shrub/Herb	2	3	2	3	2	1	3	4	N
CWHwm	00	Ws	TRIM swamp	wetter forest	3	2	2	3	2	3	2	2	N
CWHwm	01/03	HB / SO	HwSs - Blueberry / SsHw - Oak fern	Mesic Forest	6/7	4	3	3	1	3	2	3	H
CWHwm	02	HM	HwSs - Step moss	Drier Forest	6/7	4	4	4	2	4	2	3	H
CWHwm	04	SD	SsHw - Devil's club	Moist Forest	6/7	3	3	3	1	3	2	3	H
CWHwm	05	SS	Ss - Salmonberry	Floodplain Forest	6/7	3	2	3	1	3	2	3	H
CWHwm	06	CD	Act - Red-osier dogwood	Floodplain Forest	6/7	1	1	3	1	2	2	1	M
CWHwm	06/07	CD/CW	Act - Red-osier dogwood / Act - Willow	Floodplain Forest	4	2	2	3	1	3	3	2	L
CWHwm	06/07	CD/CW	Act - Red-osier dogwood / Act - Willow	Floodplain Forest	5	2	2	3	1	3	3	2	L
CWHwm	06/07	CD/CW	Act - Red-osier dogwood / Act - Willow	Floodplain Forest	6	1	1	3	1	2	2	1	M
CWHwm	07	CW	Act - Willow	Floodplain Forest	6/7	1	1	3	1	2	3	3	M
CWHwm	08	HS	Hw - Sphagnum	wetter forest	6/7	3	3	2	1	2	2	2	M
CWHwm	09/10	SC / LS	Ss - Skunk cabbage / Pl - Sphagnum	Wetland Forest	6/7	3	3	3	2	1	2	2	M
ESSFwv	00	AM	Herb meadow	Mesic Herb	2	3	99	1	3	1	2	3	N
ESSFwv	00	Avm	Avalanche Shrub mod slope	Avalanche Track	3	3	99	2	2	2	2	3	N
ESSFwv	00	AVs	Avalanche Shrub steep slope	Avalanche Track	3	5	99	1	2	2	2	3	N

Appendix 6. Predictive Ecosystem Mapping (PEM) Wildlife Habitat Rating (WHR) Table

BEC unit	Site_S	SiteS_MapCode	SiteS_Unit_Name	GenEcoType	StStage	M-ALAL LI-WE	M-ALAL LI-WL	M-ORAM FD-S	M-ORAM FD-W	M-URAR FD-P	M-URAR FD-S	M-URAR FD-F	M-MAAM-LI W
ESSFwv	00	BA	Barren	sparsely vegetated	1	4	99	4	4	4	4	4	N
ESSFwv	00	ET	Escape Terrain	sparsely vegetated	1	6	99	3	3	4	4	4	N
ESSFwv	00	FP	unknown floodplain	Floodplain Forest	4	2	99	3	2	3	4	4	N
ESSFwv	00	GI	Glacier/ice or permanent snow	non-vegetated	n/a	6	99	5	5	5	5	5	N
ESSFwv	00	GTm	Avalanche Herb mod slope	Avalanche Track	2	3	99	1	3	1	2	3	N
ESSFwv	00	GTs	Avalanche Herb steep slope	Avalanche Track	2	5	99	1	3	1	2	3	N
ESSFwv	00	GW	Herb wetland	Wetland Shrub/Herb	2	2	99	3	3	1	3	4	N
ESSFwv	00	LA	TRIM lake	non-vegetated	n/a	4	99	5	5	6	6	6	N
ESSFwv	00	MP	Heather heath	Mesic Herb	2	4	99	2	3	2	4	2	N
ESSFwv	00	PK	Parkland Forest/Woodland	Parkland Forest/Krummholz	3	3	99	2	2	3	3	3	N
ESSFwv	00	RI	TRIM river	non-vegetated	n/a	3	99	4	4	4	5	5	N
ESSFwv	00	VF	Mesic Shrub/Herb	Mesic Shrub/Herb	3	2	99	2	2	2	1	2	N
ESSFwv	00	VS	Wetter Shrub/Herb	Wetter Shrub/Herb	3	1	99	2	2	1	3	4	N
ESSFwv	00	VW	Wetter Herb	Wetter Herb	2	3	99	2	3	1	2	3	N
ESSFwv	00	WA	Water	non-vegetated	n/a	5	99	6	5	5	5	5	N
ESSFwv	00	WE	Wetland Shrub/Herb	Wetland Shrub/Herb	3	1	99	2	2	1	3	4	N
ESSFwv	00	Wm	TRIM marsh	Wetland Shrub/Herb	2	3	99	3	2	1	3	4	N
ESSFwv	00	Ws	TRIM swamp	wetter forest	3	1	99	3	2	3	2	2	N
ESSFwv	01	FA	BlHm - Azalea	Mesic Forest	6/7	3	99	3	1	3	2	3	H
ESSFwv	02	LC	BlPl - Cladonia	Drier Forest	6/7	4	99	3	3	2	4	2	L
ESSFwv	03	FF	BlHm - Feathermoss	Drier Forest	6/7	4	99	3	1	2	2	3	M
ESSFwv	04	MH	BlHm - Heron's-bill	Mesic forest	6/7	3	99	3	1	3	2	3	M
ESSFwv	05	FO	Bl - Oak fern - Heron's-bill	Mesic Forest	6/7	3	99	3	1	3	2	3	H
ESSFwv	06	FD	Bl - Devil's club - Lady fern	wetter forest	6/7	3	99	3	1	2	2	3	H
ESSFwv	07	FV	Bl - Valerian - Sickle moss	wetter forest	6/7	3	99	3	1	2	3	3	H
ESSFwv	08	FH	Bl - Horsetail - Glow moss	wetter forest	6/7	2	99	3	1	2	3	4	H
ESSFwv	09	FL	Bl - Lady fern - Horsetail	Wetland Forest	6/7	2	99	3	1	2	3	4	H
ICHvc	00	AM	Herb meadow	Mesic Herb	2	4	4	1	3	1	3	4	N
ICHvc	00	Avm	Avalanche Track - shrub dominated - moderate slope	Avalanche Track	3	2	2	2	2	2	3	4	N
ICHvc	00	AVs	Avalanche Track - shrub dominated - steep slope	Avalanche Track	3	4	4	1	2	2	3	4	N
ICHvc	00	BA	Barren	sparsely vegetated	1	5	5	4	4	4	4	4	N
ICHvc	00	DH	Dry herb	Drier Herb	2	3	3	1	3	1	3	4	N
ICHvc	00	DS	Drier Shrub/Herb	Drier Shrub/Herb	3	2	2	2	2	3	1	2	H
ICHvc	00	ET	Escape Terrain	sparsely vegetated	1	6	6	3	3	4	4	4	N
ICHvc	00	GTm	Avalanche Track - herb dominated - moderate slope	Avalanche Track	2	3	3	1	3	1	2	3	N
ICHvc	00	GTs	Avalanche Track - herb dominated - steep slope	Avalanche Track	2	5	5	1	3	1	2	3	N
ICHvc	00	GW	Herb wetland	Wetland Shrub/Herb	2	3	3	3	3	1	3	4	N
ICHvc	00	LA	TRIM lake	non-vegetated	n/a	4	4	5	5	6	6	6	N
ICHvc	00	RI	TRIM river	non-vegetated	n/a	3	3	4	4	4	5	5	N
ICHvc	00	VF	Mesic Shrub/Herb	Mesic Shrub/Herb	3	1	1	1	2	2	1	2	N
ICHvc	00	VS	Wetter Shrub/Herb	Wetter Shrub/Herb	3	1	1	2	2	2	2	3	N
ICHvc	00	VW	Wetter Herb	Wetter Herb	2	3	2	1	3	1	3	3	N
ICHvc	00	WA	Water	non-vegetated	n/a	5	5	6	5	5	5	5	N
ICHvc	00	WE	TRIM wetland	Wetland Shrub/Herb	2/3	1	1	2	2	2	3	4	N
ICHvc	00	WE	Wetland Shrub/Herb	Wetland Shrub/Herb	3	1	1	3	2	2	3	4	N
ICHvc	00	Wm	TRIM marsh	Wetland Shrub/Herb	2	3	2	3	2	1	3	4	N
ICHvc	00	Ws	TRIM swamp	wetter forest	3	1	1	3	2	3	2	2	N
ICHvc	01	HD	HwBl - Devil's club	Mesic Forest	6/7	4	3	3	1	3	2	3	H
ICHvc	02	HM	Hw - Step moss	Drier Forest	6/7	4	4	4	1	4	2	3	M
ICHvc	03	SD	Sx - Devil's club	Moist Forest	6/7	3	2	3	1	3	2	3	H
ICHvc	04/05	DD /CD	Sx - Devil's club - Dogwood / ActSx - Dogwood	Floodplain Forest	4	2	2	3	1	3	3	3	L
ICHvc	04/05	DD /CD	Sx - Devil's club - Dogwood / ActSx - Dogwood	Floodplain Forest	5	2	2	3	1	3	3	3	L
ICHvc	04/05	DD /CD	Sx - Devil's club - Dogwood / ActSx - Dogwood	Floodplain Forest	6	1	1	3	1	2	2	1	M
ICHvc	04/05	DD /CD	Sx - Devil's club - Dogwood / ActSx - Dogwood	Floodplain Forest	6/7	3	1	3	1	3	2	3	H
ICHvc	06	SH	Sx - Horsetail	Wetland Forest	6/7	4	3	3	1	3	3	4	H
MHmm2	00	AM	Herb meadow	Mesic Herb	2	2	99	1	3	2	3	4	N
MHmm2	00	Avm	Avalanche Track - shrub dominated - moderate slope	Avalanche Track	3	2	99	2	2	2	3	4	N
MHmm2	00	AVs	Avalanche Track - shrub dominated - steep slope	Avalanche Track	3	4	99	1	2	2	3	4	N
MHmm2	00	BA	Barren	sparsely vegetated	1	5	99	5	4	4	4	4	N

Appendix 6. Predictive Ecosystem Mapping (PEM) Wildlife Habitat Rating (WHR) Table

BEC unit	Site_S	SiteS_MapCode	SiteS_Unit_Name	GenEcoType	StStage	M-ALAL LI-WE	M-ALAL LI-WL	M-ORAM FD-S	M-ORAM FD-W	M-URAR FD-P	M-URAR FD-S	M-URAR FD-F	M-MAAM-LI W
MHmm2	00	DH	Dry herb	Drier Herb	2	3	99	1	2	2	3	4	N
MHmm2	00	DS	Drier Shrub/Herb	Drier Shrub/Herb	3	2	99	2	2	3	1	2	N
MHmm2	00	ET	Escape Terrain	sparsely vegetated	1	6	99	3	3	4	4	4	N
MHmm2	00	GI	Glacier/ice or permanent snow	non-vegetated	n/a	6	99	5	5	5	5	5	N
MHmm2	00	GTm	Avalanche Track - herb dominated - moderate slope	Avalanche Track	2	3	99	1	3	1	2	2	N
MHmm2	00	GTs	Avalanche Track - herb dominated - steep slope	Avalanche Track	2	5	99	1	3	1	2	2	N
MHmm2	00	GW	Herb wetland	Wetland Shrub/Herb	2	3	99	2	3	1	3	4	N
MHmm2	00	LA	TRIM lake	non-vegetated	n/a	4	99	5	5	6	6	6	N
MHmm2	00	MP	Heather heath	Mesic Herb	2	5	99	3	2	3	4	3	N
MHmm2	00	PK	Parkland forest / woodland	Parkland Forest/Krummholz	3	3	99	3	2	3	2	3	N
MHmm2	00	RI	TRIM river	non-vegetated	n/a	3	99	4	4	4	5	5	N
MHmm2	00	VF	Mesic Shrub/Herb	Mesic Shrub/Herb	3	1	99	2	2	3	1	2	N
MHmm2	00	VS	Wetter Shrub/Herb	Wetter Shrub/Herb	3	2	99	2	2	3	2	3	N
MHmm2	00	VW	Wetter Herb	Wetter Herb	2	3	99	1	3	1	3	4	N
MHmm2	00	WA	Water	non-vegetated	n/a	5	99	6	5	5	5	5	N
MHmm2	00	WE	Wetland Shrub/Herb	Wetland Shrub/Herb	3	2	99	3	2	2	3	4	N
MHmm2	00	Wm	TRIM marsh	Wetland Shrub/Herb	2	3	99	3	2	1	3	4	N
MHmm2	01	MB	HmBa - Blueberry	Mesic Forest	6/7	4	99	3	1	3	2	3	H
MHmm2	02	MM	HmBa - Mountain-heather	Drier Forest	6/7	4	99	4	1	4	2	3	H
MHmm2	03	MO	BaHm - Oak fern	Mesic Forest	6/7	4	99	3	1	3	2	3	H
MHmm2	04	AB	HmBa - Bramble	Moist Forest	6/7	3	99	3	1	4	2	3	H
MHmm2	05	MT	BaHm - Twistedstalk	Moist Forest	6/7	3	99	3	1	4	2	3	H
MHmm2	06	MD	HmYc - Deer-cabbage	wetter forest	6/7	3	99	3	1	3	3	4	M
MHmm2	07	YH	YcHm - Hellebore	wetter forest	6/7	3	99	3	1	3	3	4	M
MHmm2	08/09	YS /YC	HmYc - Sphagnum / YcHm - Skunk cabbage	Wetland Forest	6/7	3	99	3	1	2	3	4	M