Appendix 18-B

Brucejack Gold Mine Project: Wildlife Habitat Suitability Report

ERM

Pretium Resources Inc.

BRUCEJACK GOLD MINE PROJECT
Wildlife Habitat Suitability Report

PRETIVM

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BRUCEJACK GOLD MINE PROJECT
WILDLIFE HABITAT SUITABILITY REPORT

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Prepared for:

PRETIVM

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Executive Summary

Engineers and Scientists

Executive Summary

This report presents the habitat suitability mapping studies undertaken between 2010 and 2013 by Rescan Environmental Services Ltd. (Rescan) on behalf of Pretium Resources Inc. (Pretivm) for the proposed Brucejack Gold Mine Project (the Project). The Brucejack property is situated within the Sulphurets District in the Iskut River region, approximately 20 kilometres northwest of Bowser Lake and 65 kilometres north-northwest of the town of Stewart, British Columbia (BC).

Regional study area (RSA) habitat suitability mapping was conducted within approximately 378,300 ha (Table 1). Local study area (LSA) habitat suitability mapping was conducted within approximately 55,187 ha (Table 2). Habitat suitability models were developed for wildlife species that were selected because they were at risk and/or of cultural, economic, and biological importance in BC. Species and associated seasonal life requisite periods chosen for the Project were: moose (*Alces americanus*) early and late winter habitat; mountain goat (*Oreamnos americanus*) summer and winter habitat; grizzly bear (*Ursus arctos*) spring, summer, fall, and hibernating (denning) habitat; American marten (*Martes americana*) winter habitat; hoary marmot (*Marmota caligata*) growing season (combined spring, summer, and fall) habitat; and fisher (*Martes pennanti*) natal denning/black bear (*Ursus americanus*) hibernating (denning) habitat. 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, fisher/black bear denning habitat, and hoary marmot growing season habitat were rated using a 4-class rating. The mapping was based on models developed by Rescan for the Project and included field verification of initial assumptions.

Table 1. Summary of Habitat Suitability for Five Species in the Regional Study Area

Species and Season	Area of Modeled Habitat (ha) within the RSA											
	High	%[1]	Mod. High	%[1]	Mod	%[1]	Low	%[1]	Very Low	%[1]	Nil	%[1]
Moose												
Early Winter	9,831	2.7	46,929	12.7	89,672	24.4	20,786	5.6	25,181	6.8	175,720	47.7
Late Winter[2]	7,650	2.1	14,687	4.0	19,867	5.4	19,741	5.4	1,741	0.5	304,434	82.7
Mountain Goat[3]												
Winter	68,892	18.7	29,216	7.9	38,558	10.5	15,474	4.2	216,162 ha		58.7[6] %	
Summer	52,005	14.1	41,638	11.3	44,964	12.2	12,433	3.4	217,261 ha		59[6] %	
Grizzly Bear												
Spring	10,200	2.8	45,241	12.3	50,503	13.7	147,540	40.1	248	0.1	114,546	31.1
Summer	19,351	5.3	58,026	15.8	73,364	19.9	98,690	26.8	4,301	1.2	114,546	31.1
Fall	1,080	0.3	65,649	17.8	72,660	19.7	105,850	28.7	8,493	2.3	114,546	31.1
Marten												
Winter	69,735	18.9	nc	nc	2,814	0.8	2,658	0.7	nc	nc	293,070	79.6
Fisher/Black Bear												
Natal/Winter Denning	3,293	0.9	nc	nc	7,664	2.0	64,399	16.7	nc	nc	310,739	80.5

[1]Percent of Habitat in the RSA (moose, mountain goat, grizzly bear (excluding hibernating), and marten), [2] A total of 201,941 ha in the RSA (54.9%) were not rated for moose late winter habitat suitability, [3] Very low and nil are grouped together, nc - not calculated

Table 2. Summary of Habitat Suitability for Seven Species in the Local Study Area

Species and Season	Area of Modeled Habitat (ha) within the LSA											
	High	%[1]	Mod. High	%[1]	Mod	%[1]	Low	%[1]	Very Low	%[1]	Nil	%[1]
Moose												
Early Winter	1,315	3.4	5,772	14.9	10,828	27.9	3,797	9.8	4,225	10.9	12,926	33.3
Late Winter	1,084	2.8	1,857	4.8	2,335	6.0	2,908	7.5	615	1.6	30,064	77.4
Mountain Goat[2]												
Winter	5,419	13.9	1,546	4.0	4,449	11.4	836	2.2	26,614 ha		68.5[6] %	
Summer	4,089	10.5	4,482	11.5	6,347	16.3	2,181	5.6	21,764 ha		56[6] %	
Grizzly Bear												
Spring	1,702	4.4	6,838	17.6	5,776	14.9	15,140	39.0	44	0.1	9,361	24.1
Summer	975	2.5	7,353	18.9	10,784	27.8	9,941	25.6	447	1.1	9,361	24.1
Fall	514	1.3	8,420	21.7	9,562	24.6	9,796	25.2	1,210	3.1	9,361	24.1
Hibernating[3]	200	0.5	nc	nc	3,960	9.9	5,810	14.6	nc	nc	29,902	75.0
Marten												
Winter	8,652	22.3	nc	nc	668	1.7	386	1.0	nc	nc	29,156	75.0
Hoary Marmot												
Growing[4]	2,356	4.8	nc	nc	10,071	20.4	647	1.3	nc	nc	36,277	73.5
Fisher/Black Bear												
Natal/Winter Denning	856	2.3	nc	nc	1,011	2.6	7,799	20.1	nc	nc	29,157	75.0

[1] Percent of Habitat in LSA (hoary marmot and grizzly bear hibernating), [2]Very Low includes Nil Rated Habitat (i.e., Very Low/Nil), [3] A total of 5,315 ha (28% of LSA) was not rated for grizzly bear hibernating habitat suitability (Section 6.3), [4] A total of 8,924 ha (28% of LSA) was not rated for hoary marmot growing habitat suitability (Section 6.5), nc - not calculated

Moose are economically and socially important as a species for harvest by Aboriginal and non-Aboriginal hunters. Winter habitat modelling was conducted for moose to predict which habitats moose are likely to exploit during winter conditions when they are under the most physiological stress and forage resources required to sustain them are most limited (Safford 2004). The RSA contained both early and late winter habitat for moose. Within the LSA, most High rated moose habitat was in areas along the upper Bowser River and overlapped sections of the exploration access road. High and Moderately High rated early winter habitat was identified twice as much as late winter habitat within both study areas (Tables 1 and 2), reflecting the influence of habitat capability on the late model. Areas that provided suitable winter habitat were primarily within the eastern LSA and included low elevation riparian habitat such as Treaty Creek, Bell-Irving and Bowser Rivers and the Unuk Rivers. A relatively small area of High rated winter habitat associated with the Todedada wetland complexes was within the LSA and connected to other Moderately high patches that could likely provide connectivity between the valuable Bowser River floodplain and northern higher rated habitat areas along Treaty Creek. Proposed provincial moose winter range polygons overlapped high rated moose winter habitat in many areas, with substantial overlap along the Bell-Irving River, Treaty Creek and the Bowser River floodplain. A large portion of the available late winter habitat was rated as Nil for winter suitability due to lack of forage or deep snow pack and higher rated moose winter habitat was not identified near the proposed Brucejack Mine Site.

A key element of mountain goat habitat is suitable escape terrain (i.e., steep rocky topography). Because of the abundance of suitable, rocky escape terrain throughout the RSA, higher rated mountain goat habitats for both winter and summer were widely distributed across the study areas. Goat observations collected during baseline studies confirmed that higher rated habitat areas were often occupied (Rescan 2013c), and these areas also corresponded well to the proposed UWR polygons identified by the province. Roughly a quarter of the LSA was identified as Moderately High to Highly suitable winter (18%) and summer (22%) habitat (Table 2). Most of the higher rated habitats within LSA were identified near the proposed Brucejack Mine Site, within the central LSA north of the exploration access road and in the eastern LSA along Mount Anderson. Within the RSA valuable goat habitat areas were identified on Snowslide Range and Longview Range in the eastern RSA, mountains south of Treaty Creek, John Peak in the western RSA and in particularly dense groups for both seasons in the mountains between Sulphurets Creek and South Unuk River.

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 provincially blue listed. Habitat was mapped for grizzly based on the phenology of vegetation value with additional layers representing availability of animal protein (moose, salmon and hoary marmot). The diverse terrain across the study areas provided several areas with higher rated suitable habitat for spring, summer and fall. On average for all seasons, approximately a fifth of the habitat within the RSA and almost a quarter of the habitat within the LSA was rated as Moderately High to Highly suitable for grizzly bears. Most of the higher rated seasonal grizzly bear habitat areas within the LSA occurred near the exploration access road east of Knipple Glacier and in small patches along the proposed proposed Brucejack Transmission Line – South Option.

There was consistently higher quality habitat along the upper Bowser River in all seasons between the Knipple Glacier and Bowser Lake, reflecting the diversity of the plant community associated with floodplain, riparian and old burn habitat. An important habitat area was identified along Todedada Creek in low-mid elevations in the spring and summer reflecting the structural diversity associated with the wetlands in the area. Overlap with moose winter habitat, hoary marmot habitat and salmon spawning reaches identified important food habitat areas that provide additional seasonal dependant nutrition for bears.

Highly suitable grizzly bear habitat was distributed in patches across the RSA and LSA for the four seasons. High rated spring habitat was within the eastern portion of the RSA on mid-elevation slopes associated with the subalpine and alpine vegetation and within lower elevation riparian zones where herbaceous vegetation was abundant. High rated summer habitat was primarily located along the Unuk River and its drainages and within patches of low to mid-elevation slopes that could produce abundant berries. Important summer feeding areas based on marmot availability, were identified above the Bowser River floodplain and along Mount Anderson. High fall feeding habitat occurred along the Bell-Irving River and within the Bowser River floodplains and overlapped fall habitat supporting moose and salmon feeding opportunities along those rivers and additionally within the RSA along the Unuk River and Treaty Creek. Higher rated denning habitat was infrequently identified near the proposed Brucejack Mine Site, south of Berendon Glacier along the proposed Brucejack Transmission Line – South Option, on Mount Anderson, and along the exploration access road at the base of Knipple Glacier.

Marten habitat was assessed because of this species' economic and social contribution to local communities, as well as their biodiversity role for other wildlife species. Winter habitat was assessed because it is the limiting season and also the trapping season thus important from both a biological and socio-economic perspective. High rated winter habitat was extensively distributed throughout low elevation mature stands of the study areas along major river valleys, including: the Unuk, Bowser and Bell-Irving Rivers, and the Treaty, Scott, and Wildfire Creeks. High and Moderate rated habitat accounted for a quarter of the total RSA, reflecting the abundance of late seral stage conifer forest in the RSA. A quarter of the LSA was identified as Highly suitable winter habitat for marten. Most of the forest habitat along the eastern portion of the exploration access road was ranked High. Very little highly suitable habitat was mapped along the proposed Brucejack Transmission Line – South Option or near the proposed Brucejack Mine Site, where elevation and climate restricted forest growth.

Hoary marmots were selected as a species for habitat modelling because of their cultural significance and importance as a prey species for larger carnivores. Only the LSA was modelled for marmot due to the availability of soils data. Habitat was not rated for 28% of the LSA because it occurred in lower elevation forested habitat along river valleys. Of the modelled areas within the LSA, Higher rated (moderate and high), habitat was distributed across alpine areas in a quarter of the LSA. Moderate habitat areas were identified close to proposed infrastructure: adjacent to the proposed Brucejack Mine Site and patchily distributed along the exploration access road near the slopes of Mount Knipple and Mount Anderson. Those areas were verified to be occupied by marmot during the 2012 Brucejack baseline field studies. Relatively large areas of high elevation area supported barren rock and glaciers, conditions that could not support marmot habitat. This resulted in at least three quarters of the LSA classified as not suitable (i.e., of Nil suitability) for marmots.

A habitat suitability model was developed for the natal denning period for fisher and the hibernating period for black bears. A single model was designed because of the overlapping denning habitat requirements for both species: trees with sufficient diameter to permit denning within the boles, or in the case of black bears, root wads produced by large trees that they can dig under. Over three quarters of the forested habitat within the RSA and LSA was identified as unsuitable denning habitat for fisher and black bear. Functional habitat was found to occupy less than 5% of both the RSA and LSA. This reflected the conditions of the regional environment and directed classification at the most productive stands. Nil quality habitat encompassed most of the area surrounding the proposed Brucejack Mine Site and along the proposed Brucejack Transmission Line – South Option due to low forest productivity of this area. Highly suitable habitat was identified in patches along the Bowser River floodplain overlapping and near the exploration access road and in small amounts along the Bell-Irving River.

Acknowledgements

Engineers and Scientists

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Glossary and Abbreviations

Engineers and Scientists

Glossary 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.
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.
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.
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 (HSRs), 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 Nisg̱a'a Final Agreement (NFA; 2000).
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 BC. 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 - 3744 km^2 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.
Topography	The configuration of a surface, including its relief and the position of its natural and man-made features.
tpd	Tonne per day.
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.
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).
HSR	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

Engineers and Scientists

1. Introduction

1.1 WILDLIFE HABITAT SUITABILITY

Wildlife habitat suitability modelling was conducted between 2010 and 2013 for the Project. Habitat suitability models provide information about wildlife habitat that can be used during various components of project planning, including the description of the environmental setting and the assessment of potential environmental effects of the Project.

Wildlife suitability mapping is a relatively recent development for identifying and quantifying areas of 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. This spatial catalogue, or habitat map, identifies areas of suitable habitat for 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.

Data derived from ecosystem maps and other biophysical information are used to develop spatial inventories of wildlife habitat that can then be used for land management planning. Ecosystem mapping is the stratification of the landscape into similar units based upon ecological features such as terrain, soil, and vegetation communities. It provides information on the type and distribution of ecological units and can be used to determine wildlife habitat suitability.

Species selected for habitat suitability modelling the Project include those of conservation concern in British Columbia (BC), species of biological importance (e.g., possible indicators of ecosystem health, and/or species of particular economic or social importance (e.g., furbearers, game species) to regional governing agencies, residents of BC, or to Aboriginal peoples). Habitat suitability models were created in conjunction with Ecosystem Mapping (Rescan 2013a) for the following species and seasonal attributes: moose (*Alces americanus*) early and late winter habitat; mountain goat (*Oreamnos americanus*) summer and winter habitat; grizzly bear (*Ursus arctos*) spring, summer, fall, and denning habitat; American marten (*Martes americana*) winter habitat; hoary marmot (*Marmota caligata*) growing season (combined spring, summer, and fall) habitat; and fisher (*Martes pennanti*) natal denning/black bear (*Ursus americanus*) hibernating habitat. With the exception of the fisher/black bear denning model, all maps were based on habitat models initially developed for an overlapping study area for the KSM Project.

Field studies to identify wildlife species that inhabit the area of the proposed Project, including those of conservation concern, were undertaken independently of habitat suitability field studies. The results of these wildlife characterization studies are presented in a separate report (Rescan 2013c).

1.2 OBJECTIVES

The goal of the wildlife habitat suitability baseline modelling was to map the current distribution of wildlife habitat wildlife study areas defined for the Project. This information provides the basis for assessing potential direct and indirect effects of the Project on wildlife habitat (and subsequently to wildlife species), and for potential mitigation and management planning. The specific objectives of the wildlife habitat suitability study were to:

- conduct field inventories to identify habitats of representative wildlife species;
- identify important wildlife habitat features within the Project wildlife study areas; and
- generate habitat maps that represent the quality and spatial extent of suitable habitat available for select wildlife species within the Project wildlife study areas.

1.3 LEGAL FRAMEWORK

Land use as it pertains to wildlife is guided by: 1) Wildlife Legislation, which includes the relevant statute laws, such as Acts and associated regulations developed by provincial and federal administration; 2) Best Management Practices which are environmental guidelines and standards; and 3) Land Management Plans, which are guidelines developed by user groups and stakeholders to identify and integrate local resource values with development.

1.3.1 Legislation

Habitat suitability modelling, which provides a spatial representation of the quantity and quality of available wildlife habitat, is an important component of environmental impact assessments because wildlife, wildlife habitat, and wildlife habitat features are protected under several forms of federal and provincial legislation. Legislation applicable to the Project includes:

- BC *Wildlife Act* (1996b);
- BC *Forest and Range Practices Act* (2004);
- BC Order – Ungulate Winter Range (mountain goat) #U-6-002;
- BC *Water Act* (1988);
- Canada *Migratory Birds Convention Act* (1994); and
- Canada *Species at Risk Act* (2002).

Wildlife, wildlife habitat, and wildlife habitat features are protected under several forms of federal and provincial legislation (Table 4.1-1). The BC *Wildlife Act* (1996b) protects wildlife habitat features, such as nest sites, on a local scale. The *Wildlife Act* also affords protection to red- and blue-listed species in the province, whereby important habitat for 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 impact 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* (1996a) 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 extensive legislation surrounding the identification and protection of wildlife habitat within BC related to forestry activities. The BC FRPA is the regulatory authority for establishing Ungulate Winter Range (UWR), Wildlife Habitat Area (WHA), and Wildlife Habitat Feature (WHF) areas. In addition, the BC FRPA establishes General Wildlife Measures (GWMs), which are best management practices that should be implemented for the effective management of WHA and WHF areas. UWRs are areas that contain habitat necessary to meet the winter habitat requirements of particular ungulate species. WHAs are areas necessary to meet the habitat requirements of an Identified Wildlife species. WHFs are specific areas that are important to certain wildlife and may require special management, such as mineral licks, wallows, or nest sites of bald eagle, osprey, great blue heron, or bird species at risk (BC MWLAP 2004c). Mountain goat UWR #U-6-002 contains habitat polygons that overlap many areas of the RSA (BC MOE 2004). Preliminary WHAs for grizzly bear and UWRs for moose have also been identified within the RSA and were included as part of the grizzly bear and moose habitat suitability modelling.

In addition to legislation, the *Identified Wildlife Management Strategy* (IWMS) provides direction, policy, procedures, and guidelines for managing Identified Wildlife in BC (BC MWLAP 2004c). An Identified Wildlife Species is either at risk in the province or is regionally sensitive and requires special management attention.

1.3.2 Best Management Practices

Best management practice (BMP) guidelines and standards help to ensure that developments are designed and operated in an environmentally responsible manner. A "standard" is a regulatory requirement that must be followed or achieved in the design and completion of developments (BC MWLAP 2004d). "Best practice" is a recommended method or technique that should be followed to ensure that standards are met and effects are mitigated. Wildlife and wildlife habitat BMPs relevant to the Project include the following:

- Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia (BC MWLAP 2004a).
- Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia (BC MOE 2005).
- Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia (BC MOE 2006a).
- Wildlife Guidelines for Backcountry Tourism/Commercial Recreation (BC MOE 2006b).
- Management Plan for the Mountain Goat in British Columbia (MOE 2010).
- Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 (APLIC 2006).
- Wetlands Environmental Assessment Guideline (Milko 1998).
- Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia (WSP 2009).
- BC Resource Information Standards Committee (RISC) standards for conducting wildlife inventory protocol (RISC 2013).

1.3.3 Land Management Plans

Land Management Plans include Land Resource Management Plans (LRMPs) and Sustainable Resource Management Plans (SRMPs). These plans are collaborative stakeholder-based processes that integrate the various environmental, social, and economic values of the area while providing guidelines for regional resource development. The Project is within the Regional District of Kitimat-Stikine (RDKS), and contains extensive areas of Crown land and areas within the Cassiar Iskut Stikine (CIS) LRMP area (BC ILMB 2000) in the northwest of the RSA, and Nass South SRMP area (BC ILMB 2012) in the eastern portion of the RSA. The northwestern portion of the RSA falls within the General Management Direction (GMD) of the CIS 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). The RMZs are designated planning areas with unique biophysical characteristics, resource issues or resource management direction requirements (BC ILMB 2000). The Unuk River RMZ is the only RMZ within the RSA. The RSA also lies partially within the Nass Area as defined in the *Nisga'a Final Agreement*.

2. Project Description

Engineers and Scientists

2. Project Description

Pretium Resources Inc. (Pretivm) proposes to develop the Brucejack Gold Mine Project (the Project) as a 2,700 tonne per day (tpd) underground gold and silver mine. The Brucejack property is located at 56°28′20″ N latitude by 130°11′31″ W longitude, which is approximately 950 km northwest of Vancouver, 65 km north-northwest of Stewart, and 21 km south-southeast of the closed Eskay Creek Mine (Figure 2-1). The Project is located within the Kitimat-Stikine Regional District. Several First Nation and Treaty Nations have traditional territory within the general region of the Project, including the Skii km Lax Ha, Nisga'a Nation, the Tahltan Nation, the Gitxan First Nation, and the Gitanyow First Nation.

The mine site area will be located near Brucejack Lake. Vehicle access to the mine site will be via an existing exploration access road from Highway 37 that may require upgrades to support traffic during mine operations. A transmission line will connect the mine site to the provincial power grid near Stewart or along Highway 37. Two power options are currently under consideration.

The Project is located within the boundary range of the Coast Mountain Physiographic Belt, along the western margin of the Intermontane Tectonic Belt. The local terrain ranges from generally steep at higher elevations with substantial glacier cover in the western portion of the Project area, to relatively subdued topography in the eastern portion of the Project area towards the Bell-Irving River. The Brucejack mine site will be located above the tree line at an elevation of approximately 1,400 m above sea level (asl) in a mountainous area where surrounding peaks measure 2,200 m in elevation. The access and transmission corridors will span a range of elevations and ecosystems reaching a minimum elevation near the Bell-Irving River of 500 m asl. Sparse fir, spruce, and alder grow along the valley bottoms, with only scrub alpine spruce, juniper, alpine grass, moss, and heather covering the steep valley walls.

The general area of the Brucejack property has been the target of mineral exploration since the 1960s. In the 1980s Newhawk Gold Mines Ltd. conducted advanced exploration activities at the current site of the proposed Brucejack mine that included 5 km of underground development, construction of an access road along the Bowser River and Knipple Glacier, and resulted in the deposition of 60,000 m^3 of waste rock within Brucejack Lake.

Environmental baseline data was collected in the 1980s from Brucejack Lake and the surrounding vicinity to support a Stage I Impact Assessment for the Sulphurets Project proposed by Newhawk Gold Mines Ltd. In 2009, Silver Standard Resources Inc. initiated environmental baseline studies applicable to the currently proposed Project, which have been continued by Pretivm following its acquisition of the Project in 2010. The scope and scale of recent environmental baseline programs have varied since these programs began in 2009 as the development plan for the Project has evolved.

PROJECT # 1042-008-01 GIS # BJP-15-001 March 05 2013

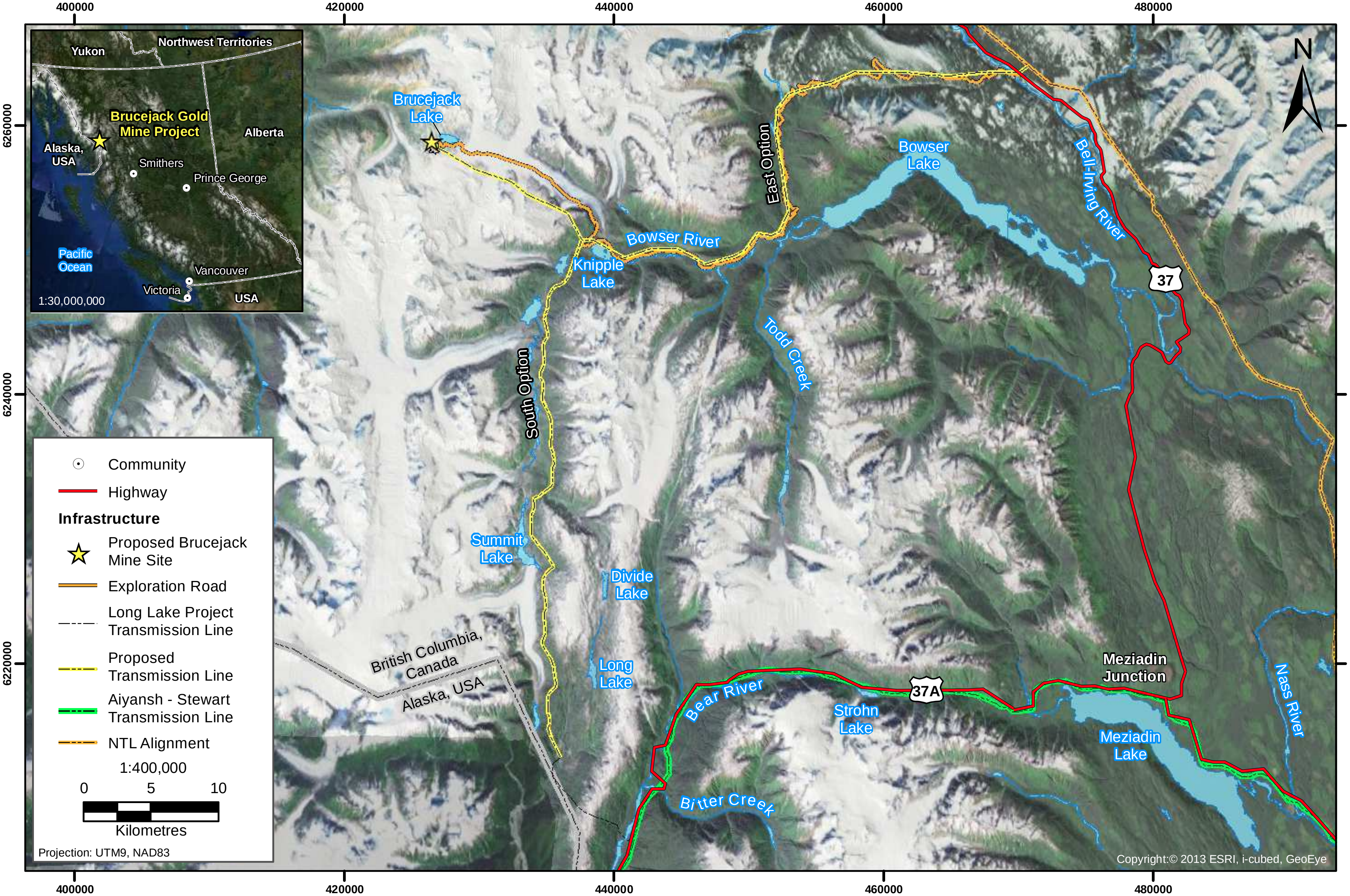

Figure 2-1

PRETIVM

Brucejack Gold Mine Project Overview

Figure 2-1

Rescan Engineers & Scientists

3. Methods

Engineers and Scientists

3. Methods

3.1 SPECIES SELECTION

Seven species were selected for habitat suitability modelling for the Brucejack habitat suitability modelling: moose, mountain goat, grizzly bear, American marten, hoary marmot, fisher, and black bear. Their seasonal life requisites and the rating scheme applied to their models are provided in Table 3.1-1.

Table 3.1-1. Focal Species and Habitats Rated

Species Rated	Season	Life Requisite[1]	Rating Scheme	Additional Modelling[2]
Moose	Early and Late Winter	LI (FD emphasis for 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	LI (FD emphasis for rating)	6 class	No
	Winter	HI	4 class	Yes
American Marten	Winter	LI	4 class	No
Hoary Marmot	Growing	LI	4 class	Yes
Black Bear	Winter	HI	4 class	No
Fisher	Winter	DE (Natal and maternal)	4 class	No

[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.

3.2 STUDY AREAS

Habitat suitability mapping was conducted within a regional study area (RSA), approximately 378,300 ha in size surrounding the Project, and a smaller local study area (LSA) within the RSA related specifically to the Project footprint (Figure 3.2-1). The LSA measures 55,187 ha in size and included proposed and existing Project infrastructure and areas that had the greatest potential to be influenced by the Project. 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 boundary for the RSA. Other ecological factors, such as the height of land or large waterways (which can act as barriers to movement), were also considered when delineating boundaries.

The study areas are located in the Meziadin Mountains and Southern Boundary Ranges ecosections within the Nass Ranges ecoregion and the Coast and Mountains ecoprovince. Elevations in the study areas 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. Wildlife is managed provincially by the BC Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO) Region 6 (Skeena Region), and the federal agency responsible for wildlife and species at risk in the area is the Pacific/Yukon division of Environment Canada. The Project study areas overlaps with three Wildlife Management Units (WMU) within Skeena Region 6: WMUs 6-16, 6-21, and minor portions of 6-17 (Figure 3.2-1). Nigunsaw Provincial Park, Border Lake Provincial Park, and Lava Forks Provincial Park are located in or within close proximity to the study areas.

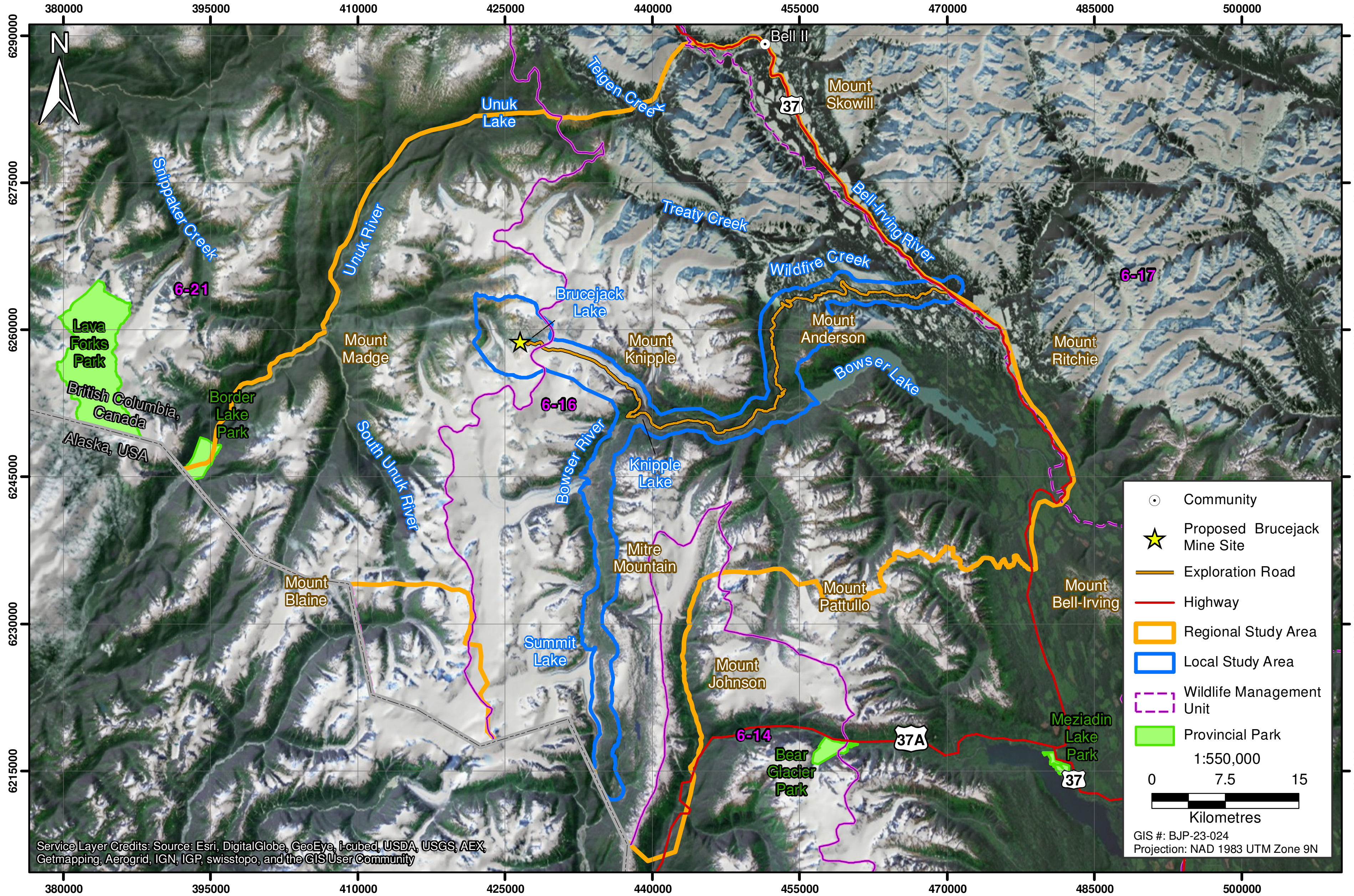

Figure 3.2-1

PRETIVM

Wildlife Regional Study Area and Local Study Area

Rescan Engineers & Scientists

Figure 3.2-1

Ecologically, the RSA is divided into two distinct climatic regions (Rescan 2013a). The western and southern portion is in moist coastal ecosystems represented by the biogeoclimatic ecosystem classification (BEC) units of Coastal Western Hemlock -Wet Maritime (CWHwm), Mountain Hemlock - Leeward Moist Maritime (MHmm2), and Coastal Mountain-heather Alpine - Undifferentiated Parkland (CMAunp). The eastern portion of the RSA encompasses a transitional zone from coastal to interior ecosystems that includes the BEC units of Engelmann Spruce – Subalpine Fir - Wet Very Cold (ESSFwv), Boreal Altai Fescue Alpine - Undifferentiated Parkland (BAFA), and Interior Cedar Hemlock - Very Wet Cold (ICHvc). Provincial forests within the RSA are administered by MFLNRO. The Project is located in the Skeena-Stikine and Kalum forest districts, and the Cassiar and Nass Timber Supply Areas (TSAs). The RSA is within areas of the CIS LRMP (BC ILMB 2000) and the Nass South SRMP (BC ILMB 2012).

3.3 MODEL DEVELOPMENT

The development of habitat suitability models is a three step process: 1) gathering background information on focal wildlife species and summarizing this information into species accounts; 2) developing assumptions and wildlife habitat ratings based on this background information; and 3) evaluating habitat models against current field conditions. The initial development of habitat suitability models, including collection of field data and development of modelling assumptions, was conducted between 2010 and 2011. In 2012, preliminary habitat models were developed based on model assumptions and were tested against field data to evaluate the model's accuracy. In 2013, the models were refined based on information used to designate provincial wildlife management areas and important wildlife habitat areas identified in regional land management plans. A generalized approach to habitat mapping is provided here, while greater detail about methodologies for each wildlife species is provided in their respective sections.

3.3.1 Species Accounts

Species accounts were developed for the seven species selected for habitat suitability mapping (Appendices 1 to 7). 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). Species accounts rely on available 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. Species accounts for focal species that were available on the provincial reports catalogue "Ecocat" (BC MOE 2010a) were also consulted and modified for the ecology of the Project study areas. Information on species biology and habitat selection is presented in regional and provincial contexts wherever possible. As regional conditions (e.g., climate, temperature, and snow fall) often influence wildlife use of an area, site specific wildlife field studies can identify features that can refine model development (Rescan 2013c). Collectively, this information guides the formulation of habitat suitability model algorithms and wildlife habitat ratings for each focal species.

3.3.2 Wildlife Habitat Ratings

Ranking the suitability of available habitat for each wildlife species involves the use of standard ecosystem mapping products that identify and spatially define habitat across an area of interest (RIC 1999a). For the Project, the results of Predictive Ecosystem Mapping (PEM) were used. PEM was modelled using inputs from Terrain Resource Information Management (TRIM) data, a Digital Elevation Model (DEM), and satellite imagery following the Predictive Ecosystem Mapping Standards (RIC 1999b). Field data collected in 2010 and 2012 were used to refine the PEM. Full details of the mapping process are provided in the *Brucejack Gold Mine Project 2012 Terrestrial Ecosystem Baseline Studies* (Rescan 2013a).

The PEM product identifies a series of distinct polygons or "ecosystem units" across the study area (Rescan 2013a). Wildlife habitat ratings (WHRs) are 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 for each species are based on assumptions about the habitat requirements of the species as outlined in the species accounts (Appendix 8).

Vegetation structure is a particularly important feature for wildlife, and there are two attributes of vegetation structure that influence the habitat value of any particular site: structural stage and canopy closure. The structural stage of an ecosystem unit is divided into seven classes ranging from un-vegetated areas (structural stage 1) to old-growth forest (structural stage 7; RIC 1998b). Each structural stage is characterized by different plant communities; structural stages (1 - 3) are defined by grasses, herbs, and shrubby habitats while structural stages (4 - 7) are typically forested habitats with varying degrees of understory cover. Each structural stage may be useful to different species during different times of the year. Canopy closure determines vegetation composition and production in the understory, which in turn influences wildlife use of the area. Structural stage and canopy closure often interact in determining overall habitat value.

WHRs are based primarily on vegetation composition; however, a number of different attributes can be considered, such as terrain features (slope, aspect, elevation) and vegetation structure. Habitat models can also be refined to reflect changes in climate or annual fluctuations in vegetation phenology by applying seasonal models to an earlier or later period.

WHRs were developed according to either a 6-class or a 4-class system (RIC 1999a), depending on the level of knowledge of the species and availability of relevant vegetation data (Table 3.3-1). The WHRs are then refined or weighted based on various abiotic habitat features to determine a final 4- or 6-class Habitat Suitability Rating (HSR) for each ecosystem unit found within the RSA. For example, these features may include capable winter topography for moose, suitable escape terrain for mountain goat, and certain terrain characteristics for grizzly bear dens. Often WHRs and HSRs are equivalent; however, the HSR is the value used for the final map product. HSRs in this study were assigned following BC RISC Standards (RIC 1999a), with the exception of the hoary marmot growing season and grizzly bear denning models, which were developed only for the LSA based on available soils information.

Table 3.3-1. 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 Brucejack 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.

The WHR and HSR values were assigned relative to what is available in the study areas and were not adjusted by comparison to provincial benchmarks (i.e., the best habitat for a given species across the entire province; RIC 1999a) as outlined in the species account. For example, the highest value habitat (i.e., HSR1) identified for goats may be the best available in the study area, but only considered moderate relative to what is available in the province and may not translate to the percent of provincial best benchmarks (Table 3.3-1). HSR values specific to a study area provide a more accurate reflection of the value of habitats to resident wildlife populations, and is therefore more applicable to land use planning for a particular region.

3.3.3 Model Evaluation

Habitat models are subject to the assumptions used to develop them, and their effectiveness for land use planning depends on how well the models represent field conditions. Field testing of habitat suitability enables an evaluation of a variety of habitats to see how well the models correspond to actual field conditions (RIC 1999a). Field assessments were conducted during the summer of 2012 (Appendix 9). At each field plot location, the habitat was rated for a particular species and season according to the 6- or 4-class system (Table 3.3-1) using Wildlife Habitat Assessment field cards (FS 882 (5) HRE 98/5). Vegetation was recorded on BC MNFLRO ground inspection forms (GIF), and any additional features of importance to wildlife were recorded that may explain any variation in modelled and field ratings. Field data were entered into the provincial data entry program VENUS (version 5.0).

To evaluate the habitat models, field ratings were compared to the final HSR values assigned to the ecosystem units for each focal species by overlaying field plot locations onto the habitat suitability maps. Any differences were highlighted for further assessment. In addition, direct wildlife observations of moose, mountain goat, and hoary marmot were overlain on the final suitability maps to assess how closely wildlife distributions corresponded with predicted habitat quality.

The higher the accuracy of habitat suitability models, the greater the utility of the models in land use planning. The target accuracy for this study was a minimum of 70% of field plots with the same HSR values that were generated in the habitat models, and at least 70% of moose, mountain goat, and marmot observations in habitat areas rated as moderate or higher. The models were developed to the provincial “High Reliability” standards for wildlife suitability models, which are described as models with detailed species-habitat relationship information that is based on reports and data collected within the region and having verified ratings (RIC 1999a). Discrepancies between field and model ratings could be the result of misidentification of ecosystem attributes (e.g., structural stage, canopy closure) and/or incorrect assumptions about habitat values. Exploring these discrepancies enable revisions to the final model algorithms. In addition, ratings are evaluated with slightly subjective wildlife habitat assessments so the interpretations of a rating category can vary. Therefore, the models developed for the Project were evaluated to within one HSR in order to accommodate for this subjectivity.

4. Moose Habitat Suitability Model

4. Moose Habitat Suitability Model

4.1 INTRODUCTION

Moose were selected for habitat suitability mapping because of their biological, social, and cultural significance. Moose are an important component of regional biodiversity, and they are harvested by Aboriginal peoples, resident hunters, and non-resident hunters. Moose also provide important prey and carrion to predators (e.g., grizzly bear, wolf, and wolverine) and healthy populations are key to functioning ecosystems in northwest BC.

Habitat suitability mapping for moose in this study focused on the early and late winter periods. The terms early and late refer to snowpack condition as opposed to a specific winter time frame. The early winter model represents winter conditions when snow pack is not limiting to movements; therefore, moose may exploit a wider variety of habitats for foraging. The late winter model refers to the period when snowpack will potentially restrict movements because it is prohibitively deep.

Winter is considered to be the most difficult season 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. In the North Nass TSA, areas with the best winter forage for moose occur on the floodplains and outflows of large rivers and at the toe of mountainous slopes with productive understory shrubs (McElhanney 2007b). This is consistent with results of moose surveys and habitat mapping reported in other mining project areas, including the neighbouring KSM Project (RTEC 2006d, 2006b, 2007; Rescan 2009). Other studies found 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 (M. W. Demarchi 2000). During habitat suitability modelling of winter moose habitat in the NWA, 90% of the overall habitat suitability rating (HSR) of the ecosystem unit was assigned to the feeding component of the model (B. S. Yazvenko, Searing, and Demarchi 2002).

Forests with adequate canopy cover to minimize snow depths (good snow interception) are also important for moose in the North Nass TSA, as the average winter snow pack was 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 Interior Cedar Hemlock very wet cold (ICHvc) BEC subzone, also provide adequate snow interception (McElhanney 2007b). While the canopy cover in ICHvc may be 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).

Population demographics and movement patterns of moose in the NWA were assessed from 1997 to 2000 using radio-telemetry and aerial surveys (M. W. Demarchi 2000). A significant portion (69%) of radio-collared moose in the NWA 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 key habitat features that cannot be readily identified through habitat suitability mapping alone and must be attained from additional studies. Snow depth significantly influences migration between winter and non-winter ranges (Demarchi (2000, 2003). Moose typically respond to increasing snowpack by moving to lower elevations where snow depths were shallower.

4.2 METHODS

4.2.1 Model Assumptions

4.2.1.1 Early Winter

The early winter model represents periods when snow depth is < 1 m deep, or when snow may be deeper than 1 m but less dense and easier for moose to travel through. The early winter model covers the period when snow begins to accumulate in October until snowpacks become limiting, which will vary on an annual basis. In general, early winter HSR values assigned to ecosystem units were based on forage production. Areas that may produce abundant and preferred moose winter forage (e.g., willow, red osier dogwood, aspen, scrub birch) were given higher HSR values.

Modelling assumptions are based on current knowledge of moose habitat selection and use, which is outlined in the species account (Appendix 1). The early winter WHR values based on these assumptions are provided in Appendix 8. The following general assumptions were made in the development of the early winter moose habitat model for the RSA:

- High and Moderately High value habitat (HSR 1 and 2) included:
  - Open areas of structural stage 3 (shrub) vegetation on moist to wet sites at lower elevation BEC units (e.g., ESSF, ICH, CWH, and MH).
  - High value habitat also included swamps and wetlands.
  - Moderately High value habitat 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.
  - Moderately High value habitat also included some open canopied structural stage 6 and 7 forests on wet nutrient rich sites, typically adjacent to floodplains and riparian areas that may provide access to winter forage such as willow.
  - All the aforementioned areas were generally on topography with gentle or no slopes.
- Moderate value habitats (HSR 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.
  - 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 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.
  - Lakes or ponds that would be frozen during winter but capable of providing some sparse amounts of rooted forage around the shores.
- Nil value habitat included areas of permanent ice or snow.

4.2.1.2 Late Winter

The late winter model identified the most important areas used by moose during more severe winter conditions, when deep snow may become an impediment to moose movement (Coady 1974; Dussault et al. 2005). Generally, snow depth > 1 m was assumed to restrict moose movement, which tends to occur by December or January, with some annual variation.

Like the early winter model, HSR values were primarily driven by the forage potential of the site; however, moose generally congregate at low elevations across the landscape during the late winter in response to increasing snow depths at higher elevations (M. W. 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 Project study areas and during baseline studies for the KSM Project. 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.

Modelling assumptions are based on current knowledge of moose habitat selection and use, which is outlined in the species account (Appendix 1). The late winter WHR values based on these assumptions are provided in Appendix 8. The following general assumptions were made in the development of the late winter moose habitat model for the RSA:

- High and Moderately High value habitat for the late winter included the same habitat as was identified during the early winter; however, some mixed coniferous and deciduous forest near valley bottoms were also rated as Moderately High.
- Moderate value habitats for the late winter included the same habitat as were identified during the early winter.
- Low and Very Low value habitat included areas that had relatively low winter forage, similar to that of the early winter model. It also included waterbodies where rooted forage around the shore of the wetlands may be sparsely available.
- Nil value habitat included areas of permanent ice or snow, or those areas not identified as capable from the topographic model.

4.2.2 Habitat Suitability Ratings

While the entire RSA 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 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” (RIC 1999a).

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 Brucejack Project (Rescan 2013a). 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 4.2-1). A small proportion of moose may be found on slightly steeper slopes and at higher elevations. To account for this, 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 forage less accessible).

Table 4.2-1. 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 HSR 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: HSR downgraded by one rating class for final rating (e.g., HSR 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

Final HSR values were adjusted for capable habitat (Table 4.2-1). 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 areas where moose can no longer travel through or burrow through the snow to access forage (Table 4.2-1). All habitats located in the alpine BEC zones (BAFA and CMA) were not included as capable habitat nor were they rated for late winter suitability. These areas are typically covered with very deep snow during the late winter and permanent snow or ice cover (e.g., glaciers) at the highest elevations.

Proposed provincially moose winter range (UWR) polygons were included on the suitability figures to supplement habitat suitability modeling with identification of areas previously identified as important for moose and to highlight areas within the RSA that may eventually have legislative protection.

4.3 RESULTS

4.3.1 Early Winter Habitat

Approximately 15.4% of the RSA was rated as High (HSR 1) to Moderately High (HSR 2) early winter habitat for moose, the majority of which occurred in the eastern LSA in and around the Bell-Irving and Bowser Rivers (Figure 4.3-1; Plate 4.3-1 and Plate 4.3-2; Table 4.3-1). A notable area of mixed high and moderately high moose early winter habitat that consisted of a large wetland complex bordering the Bell-Irving River and extending south to Surveyor Creek was also identified and was used by several groups of moose in 2011 (Rescan 2013c).

Table 4.3-1. 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	9,831	2.7	1,315	3.4	13.4
Moderately High	46,929	12.7	5,772	14.9	12.3
Moderate	89,672	24.4	10,828	27.9	12.1
Low	20,786	5.6	3,797	9.8	18.3
Very Low	25,181	6.8	4,225	10.9	16.8
Nil	175,720	47.7	12,926	33.3	7.4

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

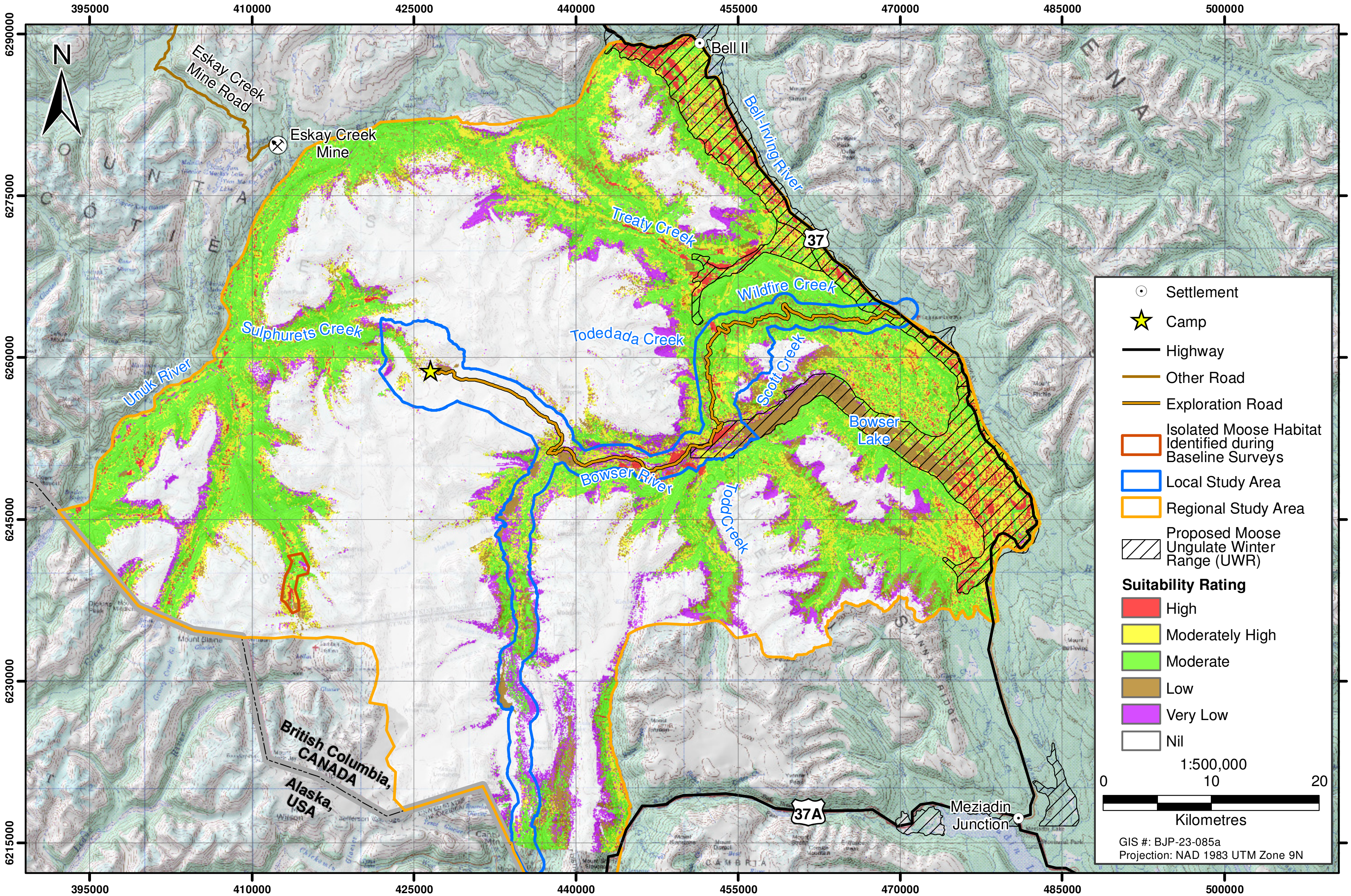

Figure 4.3-1

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Moose: Early Winter Habitat

Figure 4.3-1

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Plate 4.3-1. Highly suitable low elevation moose winter RSA habitat.

Plate 4.3-2. Early winter high elevation moose winter RSA habitat.

There were areas of high and moderately high early winter habitat within the RSA along Treaty Creek at and near the confluence of Todedada Creek and in the very northeast corner of the RSA along the Bell-Irving River. Connected patches of Moderately High early winter habitat stretched in a band across the east side of the RSA, consisting of timber harvested areas along Highway 37 and large wetlands. In the southern and western portions of the RSA, High and Moderately High early winter habitat areas were more sparsely distributed, and no significant sized polygons were identified; however, small pockets of mixed High to Moderately High rated habitat were mapped along the floodplains of the Unuk River and the South Unuk River. Those areas also had the highest observed density of moose in the winter of 2011 for the western portion of the RSA, but were less than half as dense as areas used in the eastern portion of the RSA (Rescan 2013c).

High and Moderately High suitable habitat accounted for 18.3% (16,918 ha) of the LSA (Table 4.3-1), including areas along the Bowser River between Bowser Lake and Knipple Lake (Figure 4.3-1). A small patch of HSR 1 early winter habitat was also identified within the Todedada wetland complexes adjacent to and north of the exploration access road. This small area may provide some connectivity between HSR 1 habitats located along Bowser River and Treaty Creek.

Moderate early winter habitat (HSR 3) represented the largest proportion of available habitat for moose within the RSA (89,672 ha or 24.4%; Table 4.3-1). These habitats were generally distributed along riparian corridors and associated floodplains of the Unuk River, South Unuk River, Treaty Creek, Surveyors Creek, Glacier Creek and the Sulphurets Creek (Figure 4.3-1). Moderate habitats did not have ideal composition and abundance of preferred winter forage, but were still able to produce browse in modest quantity and often supported conifer cover that provided value for security and predator avoidance. Similarly, a large proportion (27.9%), of moderate habitat is distributed throughout the LSA, particularly in patches throughout the western LSA along the exploration access road and concentrated along most of the lower elevation subalpine fir and Engelmann spruce forest north of Mount Anderson. Patchy distribution occurred along the very northern and southern sections of the proposed route for the proposed Brucejack Transmission Line – South Option.

Within the RSA, the remaining habitat was rated Low (5.6%), Very Low (6.8%), and Nil (47.7%; Table 4.3-1). The large extent of Nil habitat (175,720 ha) in the RSA was due to large tracts of steep mountainous terrain, very young seral forests such as those found along Highway 37 and along the Unuk River drainage, and large tracts of glacier areas that dominated the north, west and southern portions of the RSA (Figure 4.3-1). Similarly, large proportions of the LSA were rated as Nil (33.3%), Low (9.8%), and Very Low (10.9%) value habitat. A large proportion of the LSA encompasses Knipple Glacier and un-vegetated high elevation areas that surround the proposed Brucejack Mine Site.

4.3.2 Late Winter Habitat

A substantial portion of the RSA (201,941 ha or 54.9%) occurs within the BAFAunp and CMAunp BEC zones, including higher elevations along the majority of the proposed route for the proposed Brucejack Transmission Line – South Option and the proposed Brucejack Mine Site. These areas were considered Nil value habitat for moose in the late winter because they are at high elevations and are typically covered by very deep snow as well as permanent snowpack. The following summarizes modelling results for the remaining 46% of the RSA that was rated for late winter habitat suitability. Percentages are the proportion of each habitat suitability class within this smaller sampling unit.

High (HSR 1) and Moderately High (HSR 2) value habitats accounted for 6.1% (22,337 ha) of late winter habitat that was rated within the RSA (Table 4.3-2; Plates 4.3-3 and 4.3-4). Within the LSA, 7.6% was identified as higher rated habitat (Table 4.3-2). Proportionately, 26.8% of HSR 1 and HSR 2 habitats identified in the study areas occurred within the LSA (Table 4.3-2). These areas were primarily located along the Bowser River floodplain, which was identified as the Bowser River Moose Winter Range by the Nass SRMP (BC ILMB 2012). Substantial HSR 1 and 2 late winter habitat was associated with riparian vegetation along the Bell-Irving River along the eastern side of the RSA because of the presence of open cottonwoods stands and large concentrations of willow and red osier dogwood (Figure 4.3-2). Additional HSR 1 habitats were located in the lower reaches of the Bowser River near the confluence of the Bell-Irving River, which are within a proposed provincial UWR. High value habitats were also found along Treaty Creek, which was also identified as proposed provincial UWR and high quality winter range moose habitat in the Nass SRMP (BC ILMB 2012). Moderately High late winter habitat was largely distributed along the Unuk River in the western RSA.

Table 4.3-2. 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	7,650	2.1	1,084	2.8	14.2
Moderately High	14,687	4.0	1,857	4.8	12.6
Moderate	19,867	5.4	2,335	6.0	11.8
Low	19,741	5.4	2,908	7.5	14.7
Very Low	1,741	0.5	615	1.6	35.3
Nil	304,434	82.7	30,064	77.4	9.9

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

Plate 4.3-3. Moose in late winter range within the RSA along the South Unuk River, 2011.

Plate 4.3-4. Moose in high quality late winter habitat at west end of Bowser Lake, 2011.

Moderately suitable habitat (HSR 3) amounted to 5.4% of the modelled RSA and 6% of the LSA. Within the LSA, Moderate habitat was identified along Scott Creek and adjacent to higher rated habitat areas along the Bowser River floodplain. In the RSA, HSR 3 habitats occurred along the Unuk and South Unuk Rivers, along the northern portions of Scott Creek, in wetland complexes north of Bowser Lake, and adjacent to higher quality riparian areas of the Bell-Irving River (Figure 4.3-2).

Areas along the Bowser River floodplain at higher elevations or steeply sloped areas adjacent to high quality habitat accounted for most of the ecosystem units rated as Low (7.5%) and Very Low (1.6%) late winter habitat suitability for moose in the LSA (Table 4.3-2). There was almost no Very Low habitat within the RSA (0.5%). Low habitat within the RSA was also infrequent and located in small patches along the Unuk Rivers and Bowser Lake, represented by water bodies and topography that does not support suitable vegetation.

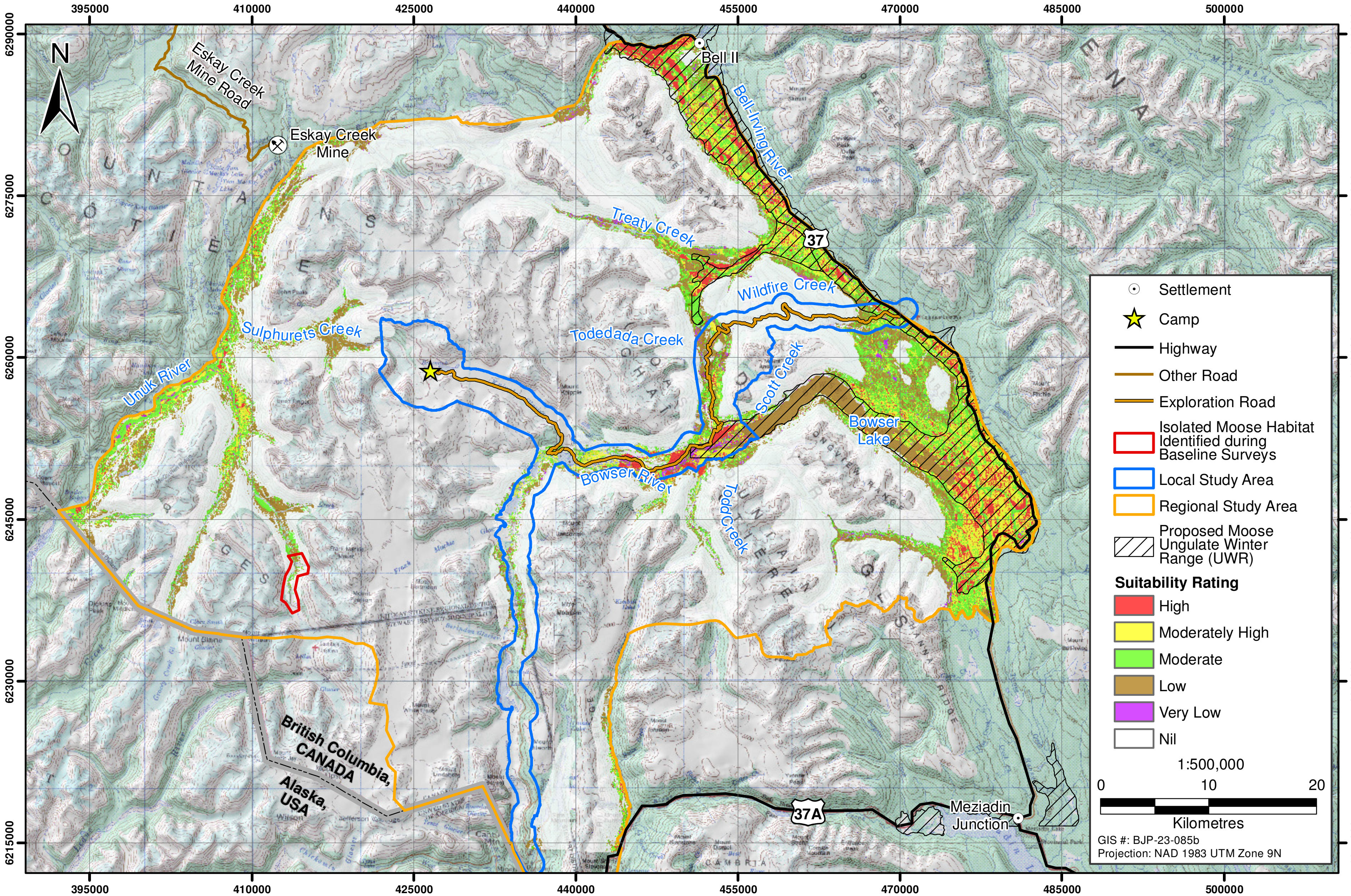

Figure 4.3-2

PRETIVM

Moose: Late Winter Habitat

Rescan Engineers & Scientists

Figure 4.3-2

The majority of ecosystem units rated in the RSA (82.7%) and LSA (77.4%) were classified as having Nil value for moose during late winter. Suitable late winter moose habitat was not identified near the proposed Brucejack Mine Site or along the proposed route for the proposed Brucejack Transmission Line – South Option.

Five bull moose were observed in a high elevation valley (700 m) near the headwaters of the South Unuk River where snowpack was exceptionally high (Plate 4.3-5) during 2011 baseline surveys for the Project (Rescan 2013c). This area was rated as Nil value for moose during baseline surveys for the KSM Project. The area has been highlighted on Figures 4.3-1 and 4.3-2 as "isolated moose habitat" as the area is relatively far from the more connected areas of identified moose winter range in the western and central portions of the RSA. It was not conducive to supporting cows or calves due to the high snowpack (1 – 2 m deep), which are the target group the models are intended to evaluate habitat for. Nevertheless, despite the elevation, the south facing valley may have higher habitat values for bulls. South-facing hanging basins on the leeward side can provide shallow snow depths and abundant winter forage, as illustrated in Plate 4.3-5.

Plate 4.3-5. Isolated moose habitat within a high elevation valley.

4.3.3 Provincial Proposed UWRs

Three proposed moose UWRs overlap with the RSA (shown on Figures 4.3-1 and 4.3-2), amounting to 26,825 ha of total area. High and Moderately High value habitats identified in the suitability models consistently overlapped the proposed UWRs for both early and late winter periods (Figures 4.3-1 and 4.3-2). The Bell-Irving River floodplain, Treaty Creek, and the Bowser River were highlighted and reinforced as important moose winter range areas.

4.3.4 Model Evaluation

In 2012, 100 field plots were completed within the RSA to evaluate the moose habitat models (Appendix 9). The evaluation of the early winter model indicated that 64% of field plots were assigned the same HSR value or were within one HSR value of what was predicted, while the late winter model had an accuracy of 78%. Further examination of the early winter model revealed that ecosystem units of structural stage one or two in the higher elevation BECs were overvalued for suitability, and were subsequently downgraded (Table 4.3-1). No modifications were made to the late winter model.

Moose observations collected during winter aerial surveys in 2011 (Rescan 2013c) were overlain on the late winter model to further evaluate model performance. The evaluation was restricted to interior ecosystem units as only seven moose groups were detected in coastal ecosystem units in the RSA. Of the 58 groups of moose observed in interior ecosystem units, 29 (50%) were in units classified as High and Moderately High value habitats, and 46 (79%) were located in HSR 1, 2, and 3 habitats. These results are comparable to baseline studies for the KSM Project that noted 47 (54%) moose groups were in High and Moderately High value habitats, and 78% were located across the top three habitat classes. These results supported the conclusion that further modifications to the late winter model were not required.

4.4 DISCUSSION

Habitat suitability modelling for moose focused on winter because it is typically the most difficult season for ungulates as they have a more sensitive energy balance and forage resources are limited (Safford 2004). Attaining winter browse while limiting energy expenditure are key for winter survival of moose. As snow depths increase, moose preferentially select habitat with abundant food resources interspersed with closed canopy forests for cover/shelter (Dussault et al. 2005). The most suitable habitats (HSR 1 and 2) that provided moose with preferred winter forage (e.g., willows, red osier dogwood, aspen and other woody browse) were found in wetland-timber complexes and along floodplains of large rivers (for example, Treaty Creek, the Bowser River, in frequent patches along the Bell-Irving with the largest continuous area at the north-western corner of the RSA, and in patchy distribution along the Unuk River). The most suitable early winter habitats were identified at the large floodplains along the Bell-Irving, the lower Bowser River from Bowser Lake to the Bell-Irving River, and the wetland complex along Treaty Creek near the confluence with Todedada Creek.

Overall, the extent of High and Moderately High rated early winter habitat was more than twice that identified for late winter because early winter habitat was not restricted by topographic conditions (i.e., capability) like late winter habitat. A substantial amount of the RSA (54.9%) is in high elevation alpine habitat within the BAFA and CMA BEC zones, which would be unusable by moose during late winter because of the very deep snow, permanent ice cover (glaciers) at the highest elevations, and no winter browse. As snow depths increase, ecosystem units assigned a high suitability rating for early winter become less suitable later in the winter for moose. There were few areas that were rated as High or Moderately High value late winter habitat for moose across the entire RSA, and in the LSA, higher rated habitat was limited to the central and eastern sections.

The Bowser River floodplains between Bowser Lake and Knipple Lake provide the most important winter range within the LSA, with interconnected patches of High to Moderately High rated winter habitats throughout. This area can provide moose with abundant winter forage and is at a lower elevation so receives less snow compared to other areas within the LSA (Rescan 2013c). A smaller area of High rated winter habitat in the LSA included the Todedada wetland complexes, which run adjacent to and north from the exploration access road and may connect patches of High winter habitat along Bowser River to other high value habitats along Treaty Creek. There is a wildlife trail through riparian areas and wetlands that connects the Treaty Creek watershed to the Bowser River floodplain (McElhanney 2011). There was little to no suitable habitat identified near the proposed Brucejack Mine Site or the proposed route for the proposed Brucejack Transmission Line – South Option.

The distribution of moose during late winter aerial surveys in 2011 was consistent with the distribution of modelled HSR 1, 2, and 3 habitats from this study. For example, substantial numbers of moose were observed along the Bowser River floodplain in the LSA and along the Bell-Irving riparian flats in the northwest corner of the RSA, both areas containing winter ecosystem units rated as High and Moderately High.

High value moose habitat was mapped for the Nass SRMP and the CIS LRMP (BC ILMB 2000; McElhanney 2007b, 2011). These areas were mapped as a broad representation of moose winter range and considered forage, security, and/or thermal capabilities of habitats (BC ILMB 2000; McElhanney 2007b). High value habitat areas mapped for the CIS LRMP were minimal and only identified along the northern portions of the Unuk River and the Bell-Irving River (BC ILMB 2000). The areas mapped for the Nass SRMP have been proposed as provincial UWRS and were identified in the eastern RSA along the Bell-Irving River, Bowser Lake, Bowser River and parts of Treaty Creek (McElhanney 2007b). These proposed winter range polygons overlapped areas rated as Moderately High to Highly suitable habitat in the RSA, which likely contain adequate cover and security habitat in proximity to suitable foraging habitats.

During studies conducted for the KSM Project in 2009, a total of 132 individual moose in 65 groups (73% of all observations) were observed during late winter surveys in proposed moose winter range (McElhanney 2007b) and in the eastern RSA. Moose were also observed to concentrate in these areas during winter 2011 (Rescan 2013c). These observations reinforce the value of low elevation winter habitat along the eastern boundary of the RSA, which includes the Bell-Irving River, areas associated with Treaty Creek and the Todedada Creek wetland complexes, and the Bowser River. These areas are also key for supporting species dependent on moose as prey or carrion (e.g., wolverine and wolves).

5. Mountain Goat Habitat Suitability Model

5. Mountain Goat Habitat Suitability Model

5.1 INTRODUCTION

Mapping habitat suitability for mountain goats in the study areas was conducted because of their contribution to regional biodiversity and their social and economic value associated with harvest. Goats were included as a species of management concern in the CIS LRMP (BC ILMB 2000) and Nass South SRMP (BC ILMB 2012). They also represent an important source of prey and carrion for large carnivores in the region.

Habitat suitability was modelled for both winter and summer seasons. Winter was modelled because it is generally considered one of the most stressful periods of the year for mountain goats due to limited food resources and severe climatic conditions. Summer was modelled because goats are vulnerable to noise and visual disturbance during the summer, particularly during the kidding period from May to June (Côté 1996; Blood 2000b; Goldstein et al. 2005; MOE 2010).

5.2 METHODS

5.2.1 Model Assumptions

Four features of mountain goat habitat were assumed to have the greatest influence on overall habitat value: escape terrain, forage availability and quality, elevation, and aspect (see species account, Appendix 2). Escape terrain is the most important component of mountain goat habitat, and therefore distance from escape terrain was assumed to have the greatest influence on habitat value. Both winter and summer habitat suitability is highly dependent on availability of escape terrain, defined as barren areas with slopes from 40° to 70° (BC MOE 2010b). Escape terrain was identified using a topographic model to isolate areas of steep, mountainous topography devoid of vegetation. Habitats in very close proximity to escape terrain had the highest habitat values, which steadily decreased 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 (Fox, Smith, and Schoen 1989; RTEC 2006c; BC MOE 2010b).

Secondary to escape terrain, model assumptions considered 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. Tree and shrub cover on steep, rocky ledges offer thermal advantage during sunny weather (solar radiation) and during inclement stormy weather by providing 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).

During summer, mountain goats move to higher elevations to exploit the newly emerged high quality vegetation. Areas with abundant early seral stage vegetation (e.g., grasses and herbs), were given the highest habitat values. A wider range of habitats was considered to have value for their forage potential in the summer because goats are generalist herbivores and will tend to eat whatever is available (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 or greater summer value. Higher elevation habitat also provides thermal relief during the warmest periods of summer.

Only vegetative potential was used to assign a WHR to each PEM ecosystem unit, that is, WHRs only addressed the feeding habitat life requisite (Appendix 2). Escape terrain, elevation, and aspect were taken into consideration in the modelling process to assign the final Habitat Suitability Rating (HSR) to PEM ecosystem units.

5.2.2 Habitat Suitability Ratings

5.2.2.1 Winter

The winter habitat suitability model was developed based on criteria previously developed in northwest BC for the Bell-Irving, Iskut, and Stikine River drainages, and applied to the overlapping study area associated with the KSM Project. Model development began with the topographic and vegetation features based on their importance for winter survival (Table 5.2-1), and was further modified by the identification of escape terrain (Table 5.2-2). 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 including work for the neighbouring KSM Project (RTEC 2006d, 2006c, 2008; Rescan 2009). The WHR values for the forage potential of identified PEM ecosystem units are provided in Appendix 8. See Appendix 2 for the species account life requisite parameters that were considered.

Table 5.2-1. Topographic and Vegetation Features for Modelling Mountain Goat Winter Habitat

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

Table 5.2-2. 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 5.2-3 summarizes the scores that were developed for each polygon based on sub-classes from each of the four primary features of goat habitat, and this score was then converted to a 6-class HSR rating scheme recognized by BC (RIC 1999a). HSR 5 and 6 were combined to represent areas which have little to no function for goats, termed Very Low/Nil suitability habitat.

Table 5.2-3. Cumulative Score and 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

5.2.2.2 Summer

Highly suitable summer habitat is found in areas that produce abundant, high quality forage. This habitat is generally associated with early seral stage vegetation, particularly high protein grasses and herbs. Escape terrain remains an essential habitat feature during the summer. The summer habitat suitability model was based on those developed for the Bell-Irving, Iskut, and Stikine River drainages and previously applied to the KSM Project with an overlapping RSA.

The steps to identify summer habitat for goats were similar to those used for the winter model and included an index score for sub-classes of topographic and vegetation features (Table 5.2-4). 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 5.2-5) for development of the habitat suitability map.

Table 5.2-4. Topographic and Vegetation Features for Modelling Mountain Goat Summer Habitat

Model Features	Score	Data Source
Distance to Escape Terrain (m)		Buffer around Escape Terrain (Table 4.2-1)
≤ 125	1	
126 - 235	2	
236 - 500	5	
≥ 501	12	
Elevation (m)		DEM information and TRIM data
≥ 1,851	1	
≤ 1,850	2	
Vegetation		Food rating assigned to PEM ecosystem units (Appendix 6)
HSR 1, 2, 3	1	
HSR 4, 5	3	
HSR 6	100	

Table 5.2-5. Cumulative Score and HSR for Mountain Goat Summer Habitat

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

5.3 RESULTS

5.3.1 Winter Habitat

Across the entire RSA, 98,108 ha (26.6%) were classified as Moderately High to Highly suitable winter habitat for mountain goats (Table 5.3-1; Figure 5.3-1; Plate 5.3-1). The higher rated habitats were distributed across most of the mountainous terrain of the RSA: the Snowslide Range in the north-eastern corner, Longview Range to the east, on various mountains south of Treaty Creek, on the west side around John Peak, and in particularly dense patches in the mountains between Sulphurets Creek and the South Unuk River (Rescan 2013c). Mount Anderson was identified as important winter habitat for mountain goats and although it is located within the RSA, it is just beyond the LSA boundary of the exploration access road. Goats were observed using Mount Anderson in large groups (> 10 goats) during the winter of 2011 (Rescan 2013c). More High habitat was identified for winter than summer within the LSA (Rescan 2013c).

Table 5.3-1. 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	68,892	18.7	5,419	13.9	7.9
Moderately High	29,216	7.9	1,546	4.0	5.3
Moderate	38,558	10.5	4,449	11.4	11.5
Low	15,474	4.2	836	2.2	5.4
Very Low/Nil	216,162	58.7	26,614	68.5	12.3

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

Plate 5.3-1. Suitable occupied winter mountain goat habitat within the Brucejack RSA.

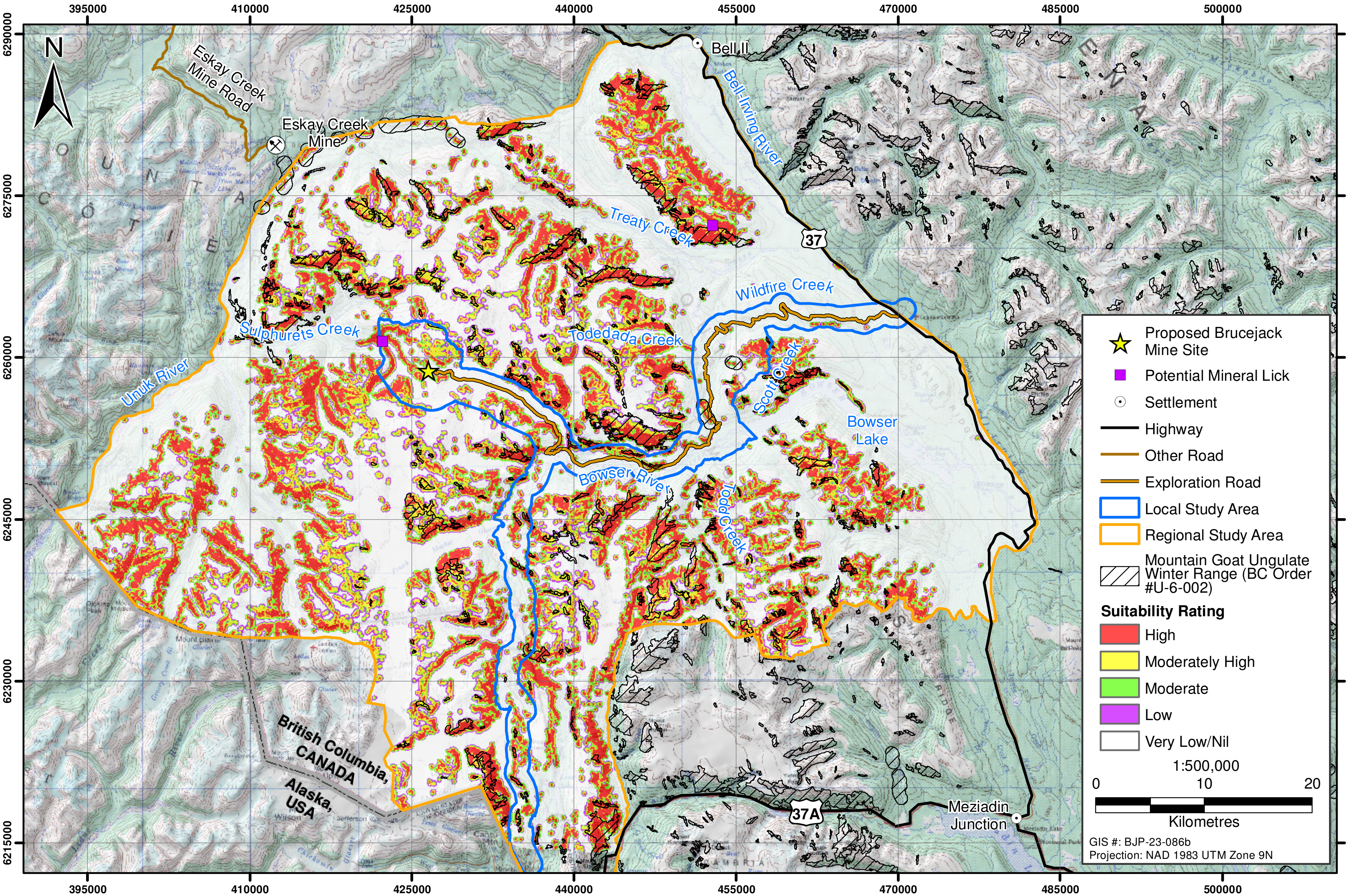

Figure 5.3-1

PRETIVM

Mountain Goat: Winter Habitat

Rescan Engineers & Scientists

Moderately High to Highly suitable mountain goat winter habitat was mapped across 6,965 ha (17.9%) of the LSA (Table 5.3-1). Moderately High to Highly suitable mountain goat winter habitat was found on the western sides of Mitre Mountain, Mount Dilworth, and Slate Mountain, which occur throughout the length of the LSA, including the area for the proposed Brucejack Transmission Line – South Option. A large proportion of the High rated habitat occurred at high elevation, south facing aspects within the western LSA overlapping the proposed mine site and in the central portion of the LSA on Knipple Mountain directly adjacent to the exploration access road (Figure 5.3-1). Groups of goats were observed west of the proposed Brucejack Mine Site and in the area along the exploration access road during the winter of 2011 (Rescan 2013c). The proportion of High and Moderately High rated winter habitat occurring within the LSA relative to the RSA was 7.9% and 5.3%, respectively (Table 5.3-1).

Moderate winter goat habitat was located at elevations just below the higher ranked habitats, which were rated lower primarily based on distance from escape terrain (Figure 5.3-1). Moderately suitable winter habitat amounted to 38,558 ha (10.5 %) of the RSA, and 4,449 ha (11.4%) of the LSA (Table 5.3-1). Mountain goats were not observed within the proposed Brucejack Transmission Line – South Option, which was predominantly rated as Very Low/Nil habitat. The area is adjacent to fairly consistent patches of High value habitat.

The remaining winter habitat fell within the lower suitability classes (HSR 4 and 5/6), which covered 231,636 ha (62.9%) of the RSA and 27,450 (68.5%) of the LSA (Table 5.3-1). Low rated mountain goat winter habitats generally surrounded Moderate to Highly suitable (HSR 1- 3) habitat while Very Low/Nil rated habitats were found at lower elevations along the river valleys within the RSA (Figure 5.3-1). Ecosystem units in the lower suitability classes (Low and Very Low/Nil) were often rated as such because of their distance from escape terrain rather than availability of forage.

5.3.2 Summer Habitat

Higher rated (high and moderately high), summer habitat for mountain goat were generally the same areas as higher rated winter habitats because the availability of escape terrain was important during both seasons (Figure 5.3-2; Plate 5.3-2). Overall, available high value (HSR 1 and HSR 2), summer habitat in the RSA was found on the Snowslide Range and the Longview Range in the east, on the mountains south of Treaty Creek, John Peak, Mount Anderson, and to the west on the mountains between Sulphurets Creek and South Unuk River (Rescan 2013c). Slightly less Moderately High to Highly suitable summer habitat in the RSA (93,643 ha or 25.4%) was identified compared to winter habitat (98,108 ha or 26.6%) due to changes in diet composition and availability of summer forage species (Table 5.3-2; Appendix 2).

Table 5.3-2. 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	52,005	14.1	4,089	10.5	7.9
Moderately High	41,638	11.3	4,482	11.5	10.8
Moderate	44,964	12.2	6,347	16.3	14.1
Low	12,433	3.4	2,181	5.6	17.5
Very Low/Nil	217,261	59.0	21,764	56.0	10.0

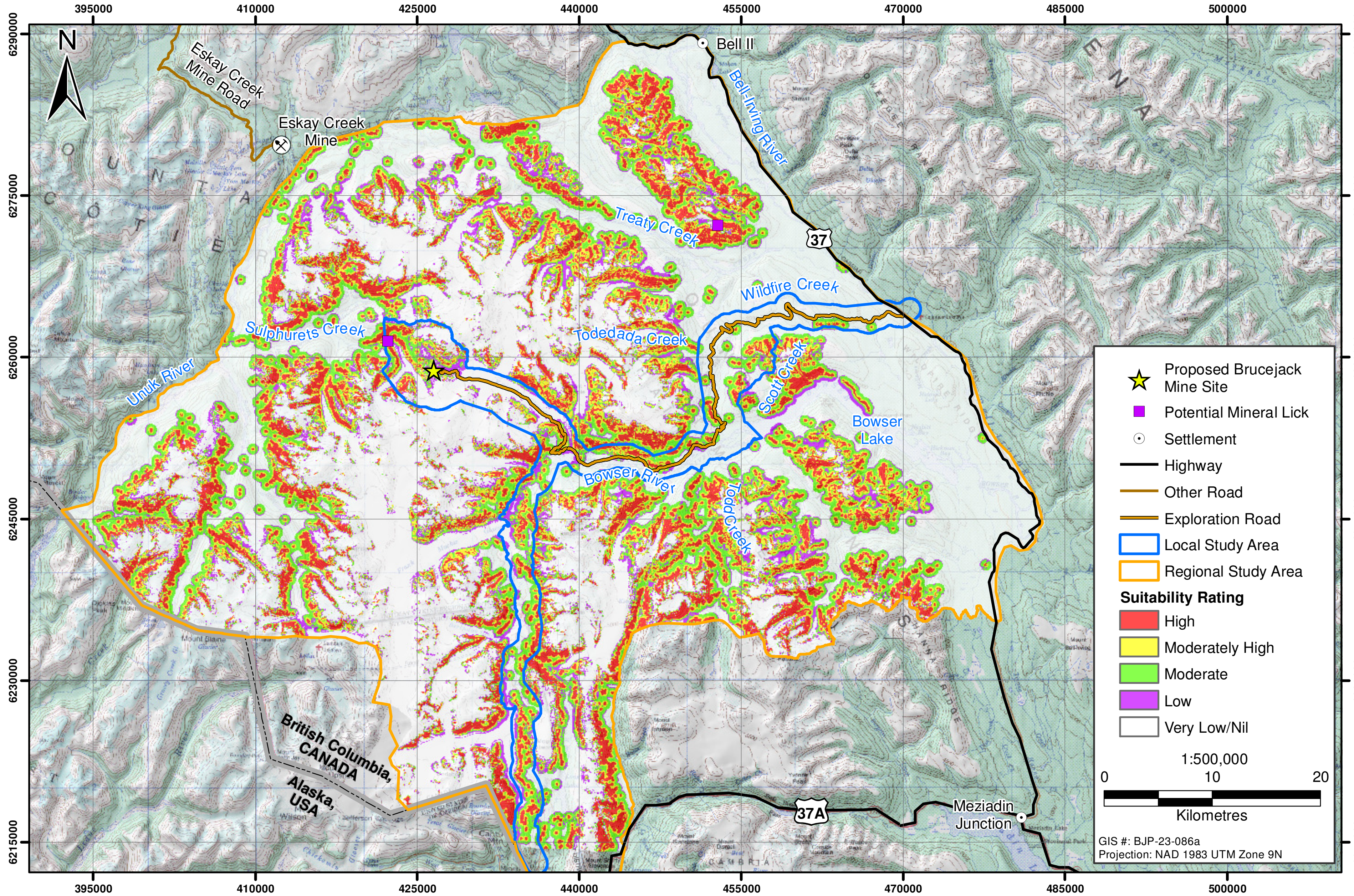

Figure 5.3-2

PRETIVM

Mountain Goat: Summer Habitat

Rescan Engineers & Scientists

Plate 5.3-2. Occupied HSR 1 rated summer mountain goat habitat comprised of suitable escape terrain within the RSA.

A total of 22% of the LSA was classified as Moderately High to Highly suitable mountain goat summer habitat, primarily in the central and western portions of the LSA (Figure 5.3-2). During the 2010 aerial surveys goats were observed in large groups (> 10 goats) on Mount Anderson near the exploration access road and west of the proposed Brucejack Mine Site (Rescan 2013c). Both of those areas were identified as a mix of Very High, High and Moderate habitat suitability (Figure 5.3-2). Patches of High and Moderately High habitat were identified directly along and adjacent to the proposed route for the proposed Brucejack Transmission Line – South Option. Goats were not observed using those areas during summer surveys in 2012 (Rescan 2013c). Of the High rated mountain goat summer habitat identified across the RSA, 7.9% occurred within the LSA.

Moderate rated summer habitat was generally located at elevations just below higher ranked suitable summer habitat and occupied 12.2% of the RSA (Figure 5.3-2, Table 5.3-2). A total of 6,347 ha of Moderate summer habitat were identified in the LSA, representing 14.1% of the total occurring across the RSA. This habitat filled in a large proportion of the area between the High and Moderately High habitat within the central LSA along the southern side of Mount Knipple and overlapped the exploration access road in that location. Moderate rated summer goat habitat was adjacent to the exploration access road in small patches from the central LSA to the eastern side (Figure 5.3-2). The lack of connectivity at those sites, however, likely result in less than moderate quality for actual use, and no goats were observed using the areas during 2010 field surveys (Rescan 2013c).

In general, almost the entire eastern and western boundary of the RSA was rated as Very Low/Nil because of the gentle topography in those areas. These habitat classes amounted to 229,694 ha of the RSA (Low = 3.4%; Very Low/Nil = 59%). Similar to the winter models, much of the RSA was unsuitable for mountain goats in the summer due to long distances from escape terrain. The RSA was largely made up of glacier covered habitat (116,644 ha, of which 3,281 ha was in the LSA), and the eastern portion of the RSA had many areas of gentle topography and long, low elevation riparian corridors and water bodies with no escape terrain.

Overall, both Low and Very Low/ Nil habitat areas were relatively similar for both seasons across both study areas (Figures 5.3-1 and 5.3-2). The lower rated habitat areas (HSR 4 and HSR 5/6) were largely near the eastern portion of the exploration access road, which was at low elevation and crossed through forest development and wetland complexes (Table 5.3-2).

5.3.3 Model Evaluation

Model ratings were not evaluated by comparison to field ratings (as was done for moose), because only a forage value rating was assigned to a PEM ecosystem unit which was predictive of vegetation. The model was developed with extensive inclusion of topographic data that would not be reflected in the field verifications making evaluation of a comprehensive product challenging. Rather, an evaluation was conducted by overlaying mountain goat group observations collected during the 2011 mountain goat surveys conducted for the Project (Rescan 2013c). Of the 80 groups observed during winter, 66 (82.5%) were observed within habitat classified as High, while 76 (95%) of the observations were within Moderate to High (HSR 1, 2 and 3) rated habitat. This was comparable to results from the KSM Project where 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. No modification was necessary for the model.

The summer model was evaluated against observation data from 2010 baseline surveys, which found that only 65% of groups (52 of 79 group observations) were within Moderate to High rated habitat (Rescan 2013a). It was found that 20 of the 79 group observations were in glacier/ice ecosystem units given a food rating of 6 (nil). The use of these areas was likely related to thermal regulation by mountain goats trying to cool down as conditions during the survey were very warm, approaching 30°C even at the highest elevation during the afternoon - an unusual occurrence for the region. Meteorological data from Terrace, BC show a record high temperature of 33.8°C on August 14, 2010 (Environment Canada 2013). Therefore, overall, ice and snow are not nil habitat 100% of the year as there is evidence for infrequent thermal relief.

Removal of groups associated with glaciers resulted in 89% of observations within Moderate to High rated habitat, consistent with the observations made for the KSM Project, which noted 92% of goat groups in HSR 1, 2 or 3 rated habitat. Under certain circumstances, use of habitat features that provide thermal relief can greatly influence habitat use by mountain goats; however, these are relatively rare conditions and did not warrant modification of the model parameters.

5.4 DISCUSSION

Overall, the RSA supports habitat that can provide annual life requisites for mountain goats. The abundant mountainous terrain distributed across the study areas had suitable High and Moderately High winter and summer habitat for mountain goats in many areas. The combination of vegetation and topography that received the highest habitat suitability ratings (High or Moderately High) represented areas in close proximity to escape terrain that support high quality winter forage. High quality winter forage includes rooted forage such as shrub and herb vegetation, as well as arboreal forage from conifer litter fall and arboreal lichen. Several of the higher suitability habitats were observed to be occupied by mountain goats, suggesting the importance of those habitats for the local population.

Within the RSA more than half of the habitat was rated as Very Low/Nil for both summer and winter use and almost a sixth of the RSA was rated High, the next most common suitable habitat type. The LSA largely consisted of Very Low/Nil habitat for goats and supported proportionately less High valued habitat than the RSA because gentle topography was selected for the exploration access route, which was adjacent to areas of highly suitable goat habitat.

Valuable goat habitat areas within the RSA that were identified by the HSR models and verified during field assessments (> 10 goats observed) included the Snowslide Range in the north-eastern corner, Longview Range on the eastern side, on various mountains south of Treaty Creek, on the west side around John Peak, and in particularly dense groups for both seasons in the mountains between Sulphurets Creek and South Unuk River (Rescan 2013c).

Within the LSA, two major areas were identified as Highly suitable for goats during winter and summer: high elevation areas overlapping and surrounding the north and west sides of the proposed Brucejack Mine Site and overlapping the exploration access road in the central portion of the LSA along the Knipple Mountain and associated ridges. Slightly less habitat was identified north of the proposed mine site for the summer, but overall there was more highly suitable habitat in the winter and additional connected areas were identified as moderate in the summer. The models were substantiated with field observations. Groups of goats were observed west of the proposed Brucejack Mine Site in the summer and the winter and the area along the exploration access road was used by goats during winter (Rescan 2013c). No goats were observed within the proposed Brucejack Transmission Line – South Option of the LSA.

An area of particular interest was Mount Anderson, north of Bowser Lake. Goats were detected on Mount Anderson just beyond the LSA boundary during 2011 winter field surveys and along the study area boundary during 2010 summer surveys. This range connects to areas within the LSA and is relatively close to the exploration access road.

The presence of escape terrain is the most important habitat feature for mountain goats. The majority of goats observed between 2010-2012 were distributed across High, Moderately High, and Moderately suitable habitats in the winter (61 of 68 groups) and summer (57 of 62 groups). These rating 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 (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 (M. W. 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 TSA, with 17,520 ha of mountain dwelling UWRs overlapping the Project RSA (BC MOE 2008). These areas require legislated management strategies that include work timing windows and set-back distances for road construction and flying (BC MOE 2008). High and Moderately High rated habitat overlapped a large proportion (> 80%) of the Provincial mountain dwelling UWR polygons. In total, 48% (97 observations) of goats observed during the 2011 and 2013 aerial surveys were within an UWR (Rescan 2013c). Many occupied areas, however, were not identified as a designated UWR and some of the most populated Survey Units had very little overlap with an UWR (Rescan 2013c).

UWR polygons have not been designated on the west side of the proposed Brucejack Mine Site, despite that area having HSR 1 value and confirmed occupancy in 2011 (Rescan 2013c). UWR polygons that were within the western LSA just northeast of the proposed mine site were not found to be occupied during baseline surveys and were rated as Moderately High (Rescan 2013c). Within the central LSA and directly adjacent to it, UWR polygons were rated as Highly suitable and found to be occupied during the winter of 2011 (McElhanney 2011; Rescan 2013c). All goats (N= 14), observed in that area were within an UWR (Rescan 2013c). The area parallels the exploration access road near Knipple Glacier, north of the Bowser River. Mount Anderson UWRs were relatively close to the eastern LSA boundary and rated as HSR 1. Twelve goats were observed on Mount Anderson during the winter, four of which were within an UWR polygon. Goats were not observed within the LSA along the proposed Brucejack Transmission Line – South Option; however, they were observed within HSR 1 habitat directly adjacent to the designated UWR areas and just outside of the LSA boundary (Rescan 2013c).

Habitat mapping was conducted in the CIS LRMP area that resulted in the identification of high value winter range for mountain goats (BC ILMB 2000). CIS LRMP high value areas overlapped High rated habitat mapped on the Snowslide Range and in the western RSA along southern slopes of John Peak above Sulphurets Creek (BC ILMB 2000; BC MOE 2008). Most of the RSA and all of the LSA were not within the LRMP boundary. Natal and 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). Of particular note were kidding areas identified on John Peak and within the LSA west of the proposed Brucejack Mine Site.

A potential mineral lick was identified within the LSA near the proposed Brucejack Mine Site above Sulphurets Lake within Moderately High summer habitat and connected to High rated habitat (Rescan 2013c). Goats were observed near the mineral lick during the summer of 2008. Another mineral lick was identified in the RSA between Treaty Creek and the Bell-Irving River. Mineral licks receive annual use and are important for the local mountain goat population. They are used primarily during the summer to compensate for mineral deficiencies or imbalances in goats’ diets (Ayotte, Parker, and Gillingham 2008).

6. Grizzly Bear Habitat Suitability Model

Engineers and Scientists

6. Grizzly Bear Habitat Suitability Model

6.1 INTRODUCTION

Grizzly bears were selected as a candidate species for habitat suitability mapping in the study areas 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; COSEWIC 2012; BC CDC 2013a). Grizzly bears are an Identified Wildlife Species 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 significant for their social and economic importance to First Nations, resident hunters, and non-resident hunters. Grizzly bears play an important biological role within the ecosystem as top predators. From a conservation perspective, the grizzly bear is considered an umbrella species, which means that due to their large home ranges and habitat requirements, conservation measures for grizzly bears also afford protection to other species with similar or smaller home ranges or life requisites (Roberge and Angelstam 2004b).

Habitat models were developed for grizzly bears for spring, summer and fall and the winter hibernating period. The first three models represent the diverse habitat selection and foraging strategies that grizzly bears use over a large landscape as available vegetation and protein sources change and direct habitat selection throughout the year. The hibernating model is reliant, however, on landscape features that will den construction, stability and thermal regulation.

6.2 METHODS

Forage potential was the main consideration for assigning HSR values to PEM ecosystem units (e.g., availability, forage quality, and biomass). For example, spring habitat in the alpine is dependent on when vegetation is greening up and available, rather than buried under snow as it would be during the same time period at lower elevations. Regional information regarding seasonal forage preferences was incorporated into the grizzly bear suitability ratings wherever possible (A.G. MacHutchon and Mahon 2003). In the case of the denning model, ratings were developed based primarily on terrain and topographic features (Appendix 3).

The spring, summer and fall models were developed with a six class rating system, whereas the denning model was developed with a four class system due to the limitations of available vegetation and soil data for the model. The denning model was also restricted to the LSA and a small portion of habitat outside of the LSA boundary because data on soil surficial material was only available for these areas. The total area modelled for grizzly bear denning habitat was 39,872 ha.

Proposed Provincial wildlife habitat areas (WHAs) were retrieved in February of 2013 from MFLNRO (Len Vanderstar, Ecosystem Biologist, pers. com). These areas have not yet been officially designated, however, they were included on the grizzly bear suitability maps because they are intended to evolve into regulated areas with legislative protection in the future and represent high quality grizzly bear habitat. Grizzly bear WHAs are developed considering multi-season use and connectivity between seasonal habitats for movement and access to animal protein as well as thermal and security cover features (BC MFLNRO 2013).

Areas where grizzly bears may supplement their diet with ungulate, marmot and fish protein were considered during the modelling process (M. W. Demarchi and Johnson 2000; RTEC 2006a).

These layers were not incorporated into the final model ratings but identified important areas where available protein sources overlapped highly suitable habitat. Moose data was presented on the spring feeding habitat map and marmot data was presented on the summer feeding habitat map.

HSR 1 and 2 late winter moose habitats were included on spring suitability maps because grizzly bears will supplement their diet with ungulate carcasses that have died in the winter or kill the winter-weakened animals (Blood 2000a). High value marmot habitat was identified on summer suitability maps (Munro et al. 2006). Salmon-bearing rivers and stream reaches were included with a 50 buffer to either side (total of 100 m) to accommodate additional features (e.g., vegetation cover, buffer from disturbance) that may influence use of these areas by grizzly bears (M. W. Demarchi and Johnson 2000; McElhanney 2007a). There are several salmon bearing waterways identified in the RSA, including Unuk River, Bowser River, Bell-Irving River, and Treaty Creek (Rescan 2013b).

6.2.1 Model Assumptions

The habitat suitability models were consistent with the regional standard and used forage as the preliminary driving factor in the ratings (S. B. Yazvenko, Searing G. F., and W. 2002). Grizzly bear habitat use was determined by the distribution of food resources that were predominantly vegetative, protein sources were added later as a secondary layer of data. Temporal and spatial habitat selection is driven by relative abundance and availability of food sources, plant phenology, individual preference for foods, and the physiological state of the bear (S. B. Yazvenko, Searing G. F., and W. 2002).

Preferred spring forage for grizzly bears included abundant grasses, sedges, and herbs (A. G. 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 2004b). Fall vegetation had substantial overlap with summer forage, and 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 2004b).

Cover is also an important grizzly bear habitat feature. Thermal and security cover values were incorporated in the seasonal models for grizzly bear during the preliminary WHR ratings. In some areas Highly suitable grizzly bear summer habitat has a conflicting relationship with cover parameters in alpine areas above tree line, reducing the value of those important habitat areas within the suitability model (S. B. Yazvenko, Searing G. F., and W. 2002). Therefore, wherever possible, the lower habitat categories were modified after preliminary ratings were developed to reflect higher selection probabilities associated with cover.

Grizzly bears may den below tree line; however, sufficient information was not available to develop a model for low elevation grizzly bear denning habitat. It was assumed that large trees and areas under the root wads of wind thrown trees would support grizzly dens at lower elevations; therefore, the fisher natal denning/black bear denning model can be used as an approximation to represent forested areas that may also provide denning opportunities for grizzly bears.

The assumptions used for the development of spring, summer, fall, and denning habitat suitability model ratings for grizzly bears are detailed in the species account (Appendix 3) and are summarized below.

6.2.1.1 Spring Model Assumptions

Spring habitat suitability for grizzly bears was rated based on the following assumptions:

- High and Moderately High rated habitat included:

  - Sites capable of producing an abundance of preferred forage, including grasses and herbs. These habitats were typically associated with structural stage 2 (herb) and 3 (shrub) vegetation on nutrient rich and moist sites (e.g., wetlands, avalanche chutes) in all BEC zones.
  - Open canopied mature (structural stage 6 and 7) forest capable of early berry production.
  - Open habitats capable of sustaining a berry crop over winter (e.g., crowberry).
- Moderate rated habitat included:
  - Less productive sites of structural stage 2 and 3 vegetation, typically those with dry to mesic moisture regimes.
  - Advanced structural stages (5 to 7) with 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. These forests tended to be present in wetter areas.
  - Rivers and associated riparian areas.
- 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 understory plant growth.
  - 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).
- 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.

6.2.1.2 Summer Model Assumptions

Summer habitat suitability for grizzly bears was rated based on the following assumptions:

- High and Moderately High rated habitat included:
  - Sites capable of producing abundant *Vaccinium* species, devils club, or other berries. These habitats were characterized as structural stage 2 and 3 vegetation on mesic to wet sites (e.g., wetlands, shrubby areas, and avalanche chutes) in all BEC zones.
  - 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. 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 with patchy distribution of *Vaccinium* sp. or other berry species, 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 bears, or were anticipated to have low forage value (e.g., dried grass) in summer.
  - Forested areas with poor berry and herb production in the understory, including closed canopy mature forests in most BEC zones, and both open and closed canopy mature forests

at the lower slopes of mountains or toes of slopes, characterized as boggy or swampy areas with poorly drained soils.

- Very Low and Nil value habitat included:
  - Structural stage 4 and 5 forests with closed canopies not otherwise rated in the above categories, and all barren and anthropogenic sites (e.g., glaciers, open water, roads).

6.2.1.3 Fall Model Assumptions

Fall habitat suitability for grizzly bears was rated based on the following assumptions:

- 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 (e.g., Arctic lupine, cow parsnip). These habitats included open structural stage 2 and 3 vegetation on suitable sites and very open canopies of mature forests upslope of valley bottoms.
- Moderate rated habitat included:
  - Areas that could produce preferred plant forage, but not in high abundance, or could produce abundant forage of marginal value. These habitats included open-to-moderately closed canopies of 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 understory plant growth resulting in very little forage production.
  - Rivers and adjacent riparian areas (which were later highlighted on the maps as important feeding habitat if they were salmon bearing).
  - Dry herb vegetation and marshes that have limited forage production.
- 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).

6.2.1.4 Denning Habitat Assumptions

The primary focus in developing the denning model for grizzly bears was to identify habitats at high elevation with appropriate cover and substrate to support dens (Table 6.2-1). The grizzly bear denning model, assumed that several terrain and topographic features would influence the overall value of habitat for grizzly bear dens, including soil surficial material, aspect, elevation, slope, and BEC zone. High rated habitats included a very narrow range of soil and topographic features, while Moderate, Low, and Nil rated habitats included several combinations of aspect, slope, elevation and biogeoclimatic features (Table 6.2-1). Information on grizzly bear ecology and habitat selection used to identify suitable grizzly bear denning habitat is detailed in the species account (Appendix 3).

It was assumed that only certain soils, primarily those with morainal or colluvial surficial materials, had the most appropriate depth and structure for supporting grizzly bear dens. These soils are typically well drained and are cohesive enough to maintain the physical stability of the den during the winter (Vroom, Herrero, and Ogilvie 1980; Nietfeld, Woolnough, and Hoskin 1985; Culling and Culling 2001). For areas on morainal or colluvial soils, the highest ratings for denning potential 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 on warmer aspect and gentle or steep gradients were rated lower.

Table 6.2-1. Terrain and Topographic Features for Modelling High Elevation Grizzly Bear Denning Habitat

HSR	Soil Surficial Material[1]	Aspect (°) [2]		Slope (°)[2]	Elevation (m)[2]	BEC[3]
H	Morainal/ Colluvial	Cooler	30 - 120	28 - 38	all	BAFA/CMA
M	Morainal/ Colluvial	Cooler	30 - 120	28 - 38	≥ 1100	ESSF/MH
	Morainal/ Colluvial	Warmer	120 - 30	28 - 38	all	BAFA/CMA
	Morainal/ Colluvial	Cooler	30 - 120	20 - 28	all	BAFA/CMA
	Morainal/ Colluvial	Cooler	30 - 120	38 - 40	all	BAFA/CMA
L	Morainal/ Colluvial	Warmer	120 - 30	28 - 38	≥ 1100	ESSF/MH
	Morainal/ Colluvial	Cooler	30 - 120	20 - 28	≥ 1100	ESSF/MH
	Morainal/ Colluvial	Cooler	30 - 120	38 - 40	≥ 1100	ESSF/MH
N	Morainal/ Colluvial	Cooler	30 - 120	< 20	≥ 1100	BAFA/CMA/ESSF/MH
	Morainal/ Colluvial	Cooler	30 - 120	> 40	≥ 1100	BAFA/CMA/ESSF/MH
	Morainal/ Colluvial	Warmer	120 - 30	< 28	≥ 1100	BAFA/CMA/ESSF/MH
	Morainal/ Colluvial	Warmer	120 - 30	> 38	≥ 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 2013a), [2] Digital Elevation Model (DEM) information and 1:20,000 Terrain Resource Information Management (TRIM) data, [3] Terrestrial Ecosystem Mapping (TEM; (Rescan 2013a)

Grizzly bears will also den on warm southerly aspects to have early access to spring forage; however the denning model assumed that the insulative qualities to denning would be higher. The warmer aspects were rated as moderately suitable, which are still considered a highly suitable and functional habitat rating in the four class system.

The model does not include habitats below 1,100 m, the approximate transition between forested sites and parkland/alpine. Potential low elevation (below tree line) denning sites for grizzly bears are captured by models developed for fisher and black bear denning.

6.2.2 Model Evaluation

Model ratings were compared to field ratings to evaluate model accuracy. In 2012, 101 field plots were evaluated during the summer.

6.3 RESULTS

6.3.1 Spring Habitat

Elevation gradients are important components of habitat suitability for grizzly bears in different seasons. In general, suitable habitat in the RSA occurred at lower elevations earlier in the year with an increasing use of higher elevation terrain throughout the summer and fall. Low elevation use consisted of riparian zones and extensive forested ecosystems that can provide a wide diversity of plant communities, including areas with early spring growth (Plates 6.3-1 and 6.3-2) and berry producing areas that mature and persist from early summer well into fall. Mid-elevation habitat between approximately 1000 m and 1500 m was representative of the parkland variants of ESSF and MH, as well as alpine habitat associated with the BAFA and CMA (Plate 6.3-3). Mid-elevation habitat was dominated by herb and shrub plant species on slopes and avalanche chutes, which provide important food in the growing season. High elevation terrain above approximately 1500 m within the RSA was predominantly un-vegetated and consisted of rock, exposed soils and glaciers and therefore provided little forage for grizzly bears.

*Plate 6.3-1. Spring forage: devils club (*Oplopanax horridus*).*

*Plate 6.3-2. Spring forage: horsetail (*Equisetum hyemale*).*

Plate 6.3-3. Highly suitable mid-elevation sub-alpine habitat within the RSA.

The RSA had extensive amounts of Moderately High to High quality spring grizzly bear habitat (15.1%; Table 6.3-1), with most of the habitat found in the central to eastern portions of the RSA (Figure 6.3-1). These areas were distributed within mid-elevation habitat, as well as in low elevation riverine and wetland habitats near Bowser Lake and Treaty Creek (Figure 6.3-1). Higher quality habitat in the LSA was distributed in patches along the Bell-Irving River floodplain and in patches along the eastern portion of the exploration access road near Scott Creek and Wildfire Creek areas. Small patches of Moderately High to High quality habitat also existed along the proposed Brucejack Transmission Line – South Option.

Moderate rated habitats accounted for 13.7% of the RSA (Table 6.3-1). Moderate habitat was distributed broadly across mid to low elevation habitats including riparian zones and forested habitat in the eastern RSA within the ICH BEC zone where early spring vegetation is available.

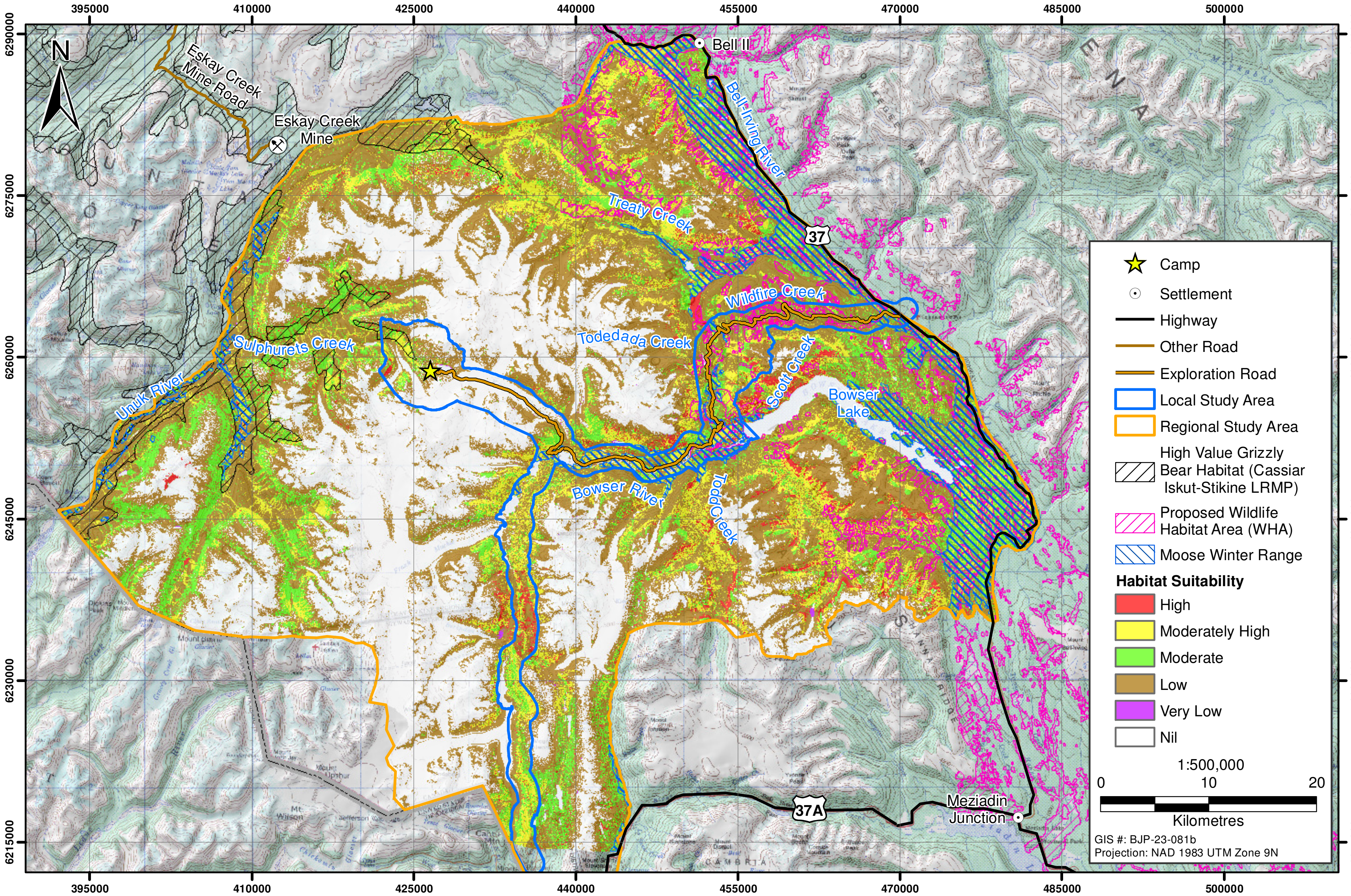

Figure 6.3-1

PRETIVM

Grizzly Bear: Spring Feeding Habitat

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Figure 6.3-1

Table 6.3-1. 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	10,200	2.8	1,702	4.4	16.7
Moderately High	45,241	12.3	6,838	17.6	15.1
Moderate	50,503	13.7	5,776	14.9	11.4
Low	147,540	40.1	15,140	39.0	10.3
Very Low	248	0.1	44	0.1	17.9
Nil	114,546	31.1	9,361	24.1	8.2

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

The three lowest habitat rating classes accounted for more than half of the RSA (Low = 40.1%; Very Low = 0.1%; Nil = 31.1%; Table 6.3-1). Low and Very Low rated habitats were mainly located on mid-elevation slopes but also occurred in higher elevations in the south eastern corner of the RSA which would be covered with snow in the spring. Nil rated habitat occurred in alpine areas with long lasting or permanent snow cover and large areas of open water such as Bowser Lake.

Within the LSA, 22% was rated as Moderately High to Highly suitable spring grizzly bear habitat (Table 6.3-1), and was largely associated with the Bowser River Valley and the Scott Creek area along the exploration access road (Figure 6.3-1). Pockets of Moderately High to High rated habitat were identified along the proposed route for the proposed Brucejack Transmission Line – South Option and in small patches near the proposed Brucejack Mine Site. Thirty percent of the total available Moderately High and High rated habitat occurred within the LSA (Table 6.3-1). Moderate rated habitat, (14.9% of the LSA), was distributed across low elevation forests (Table 6.3-1). The remaining ecosystem units were ranked in the lower suitability classes of Low (39.0%), Very Low (0.1%), and Nil (24.1%) habitat (Table 6.3-1). Most of these lower rated habitats occurred in high elevation areas surrounding the proposed Brucejack Mine Site and along the proposed Brucejack Transmission Line – South Option where there are areas of permanent or long lasting snow cover (Figure 6.3-1).

A total of 22,337 ha of the RSA and 2,598 ha of the LSA Moderately High to Highly suitable spring grizzly bear habitat overlapped with HSR 1 and HSR 2 late winter moose habitat within lower elevations. Specifically, this habitat occurred along the Bell-Irving River and Highway 37 from Bell II to Bowser Lake, within riparian and wetland habitats near lower Treaty Creek and the Bowser River, and along the Unuk River and its drainages (Figure 6.3-1).

6.3.2 Summer Habitat

Extensive areas of Moderately High to High rated summer grizzly bear habitat were identified within the western portion and at low to mid elevations in the eastern half of the RSA (Figure 6.3-2). Within the LSA, Moderate to High rated habitat was generally confined to areas between Knipple Glacier and the Bell-Irving River along the Bowser River Valley, Scott Creek and Wildfire Creek, which includes the exploration access road (Figure 6.3-2).

High rated summer habitats were defined as having the capacity to produce abundant summer berries such as *Vaccinium membranaceum* and *Shepherdia Canadensis* (Plate 6.3-4). High quality summer grizzly bear habitat accounted for 5.3% of the RSA and occurred predominantly at low elevations in the western portion of the RSA along the Unuk River and its drainages (Figure 6.3-2; Table 6.3-2). A total of 15.8% of the RSA was rated as Moderately High and occurred between mid to low elevation habitat, mostly along the Bell-Irving River, Treaty Creek, and upper Bowser River (Figure 6.3-2).

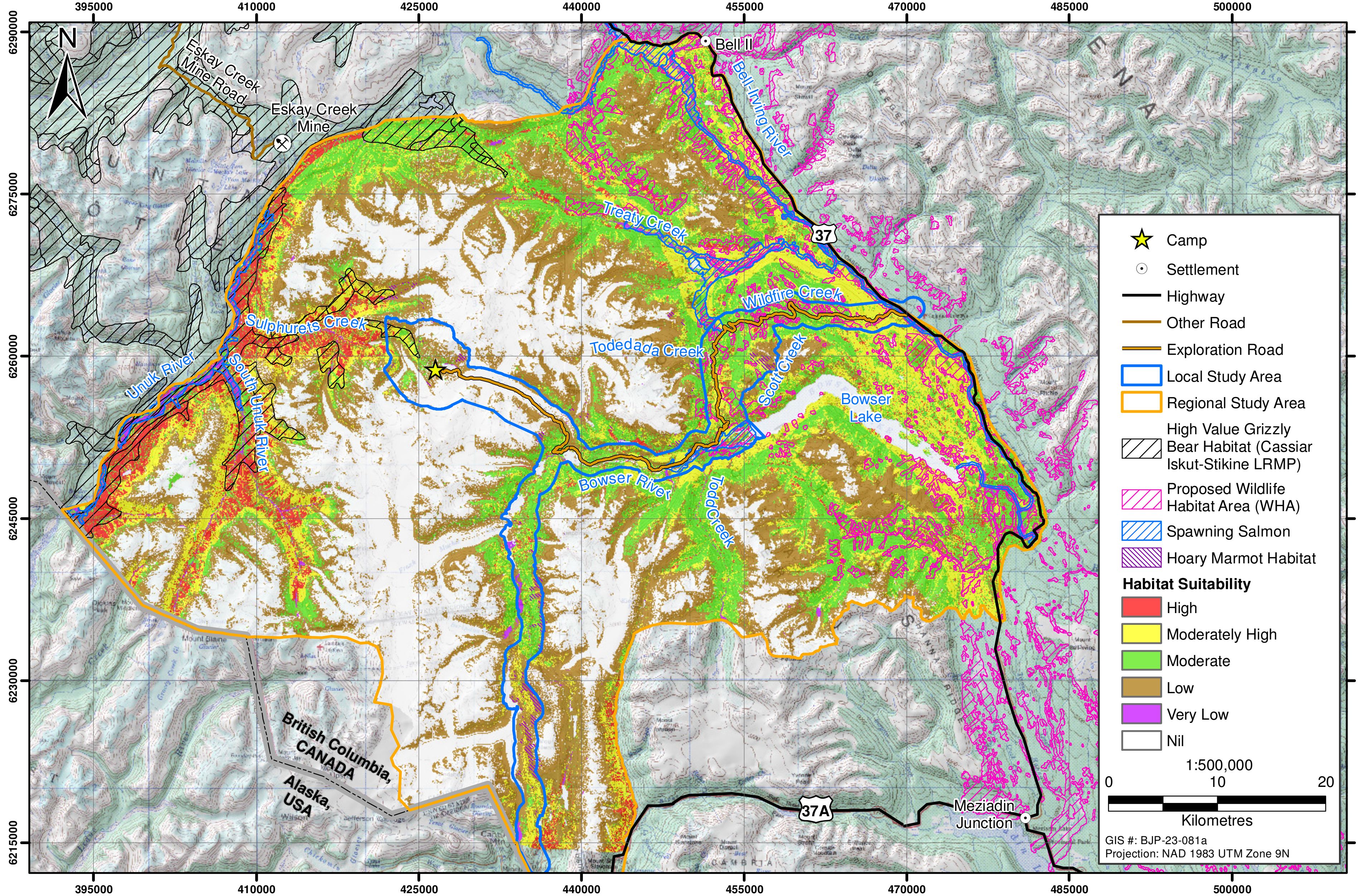

Figure 6.3-2

PRETIVM

Grizzly Bear: Summer Feeding Habitat

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*Plate 6.3-4. Highly suitable grizzly bear summer forage: soopolallie (*Shepherdia canadensis*) within the RSA.*

Table 6.3-2. 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	19,351	5.3	975	2.5	5.0
Moderately High	58,026	15.8	7,353	18.9	12.7
Moderate	73,364	19.9	10,784	27.8	14.7
Low	98,690	26.8	9,941	25.6	10.1
Very Low	4,301	1.2	447	1.1	10.4
Nil	114,546	31.1	9,361	24.1	8.2

A total of 19.9% of the RSA was rated as Moderate, and was distributed across mid-elevation habitat throughout the RSA (Figure 6.3-2; Table 6.3-2). The remaining half of the RSA (59.1%) fell in the lower suitability classes of Low (26.8% of RSA), Very Low (1.2%), and Nil (31.1%; Table 6.3-2). Similar to spring habitat, much of the Low and Very Low rated summer grizzly bear habitat occurred in high elevation zones and Nil habitat in areas of long lasting or permanent snow cover (Figure 6.3-2).

Moderately High to Highly suitable summer grizzly bear habitat amounted to 21.4% of the LSA, most of which occurred along the exploration access road in the eastern portion and Bowser River habitat west of Bowser Lake (Figure 6.3-2; Table 6.3-2). Seventeen percent of the total available High and Moderately High habitat occurred within the LSA (Table 6.3-2). Moderately suitable summer habitat totalled 27.8% of the LSA, and 14.7% occurring within the LSA relative to the RSA. The Moderately rated habitat primarily occurred along the exploration access road between the Bell-Irving River and Knipple Glacier, as well as in pockets along the proposed Brucejack Transmission Line – South Option. The rest of the LSA was rated as Low (25.6%), Very Low (1.1%), and Nil (24.1%). The majority of Lower rated habitats occurred along the proposed Brucejack Transmission Line – South Option and the area surrounding the proposed Brucejack Mine Site (Figure 6.3-2).

Additional protein habitat areas were identified in conjunction with grizzly bear summer habitat. Salmon spawning areas were identified within the LSA (2,598 ha) and the RSA (8,461 ha; Plate 6.3-5). Moderately High to Highly suitable grizzly bear summer habitat overlapped salmon sources along the Unuk, Bell-Irving, and Bowser rivers, and along Treaty Creek (Figure 6.3-2). Highly suitable hoary marmot habitat was identified within the LSA (12,427 ha). Overlap between higher rated grizzly and hoary marmot habitat occurred west of Bowser Lake and within a small pocket of the far western portion of the LSA (Figure 6.3-2).

*Plate 6.3-5. Highly suitable summer grizzly bear forage: sockeye salmon (*Oncorhynchus nerka*) within the RSA at Unuk River.*

6.3.3 Fall Habitat

High quality fall grizzly bear habitat occurred in small patches throughout the RSA, and primarily along the exploration access road west of Bowser Lake in the LSA (Figure 6.3-3; Plate 6.3-6; Plate 6.3-7). Significant amounts of Moderately High rated habitat occur across the RSA and LSA where regenerating forests provided an increase in suitable forage vegetation cover.

A total of 18.1% of the RSA was identified as Moderately High to Highly suitable fall grizzly bear habitat (Table 6.3-3). For the most part, these habitats were located in the eastern RSA along the Bell-Irving River below Bell II, along the Unuk River, and along Bowser River on both sides of Bowser Lake. Moderately rated fall grizzly bear habitats occupied 19.7% of the RSA and were distributed across mid-elevations.

Table 6.3-3. 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	1,080	0.3	514	1.3	47.5
Moderately High	65,649	17.8	8,420	21.7	12.8
Moderate	72,660	19.7	9,562	24.6	13.2
Low	105,850	28.7	9,796	25.2	9.3
Very Low	8,493	2.3	1,210	3.1	14.2
Nil	114,546	31.1	9,361	24.1	8.2

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

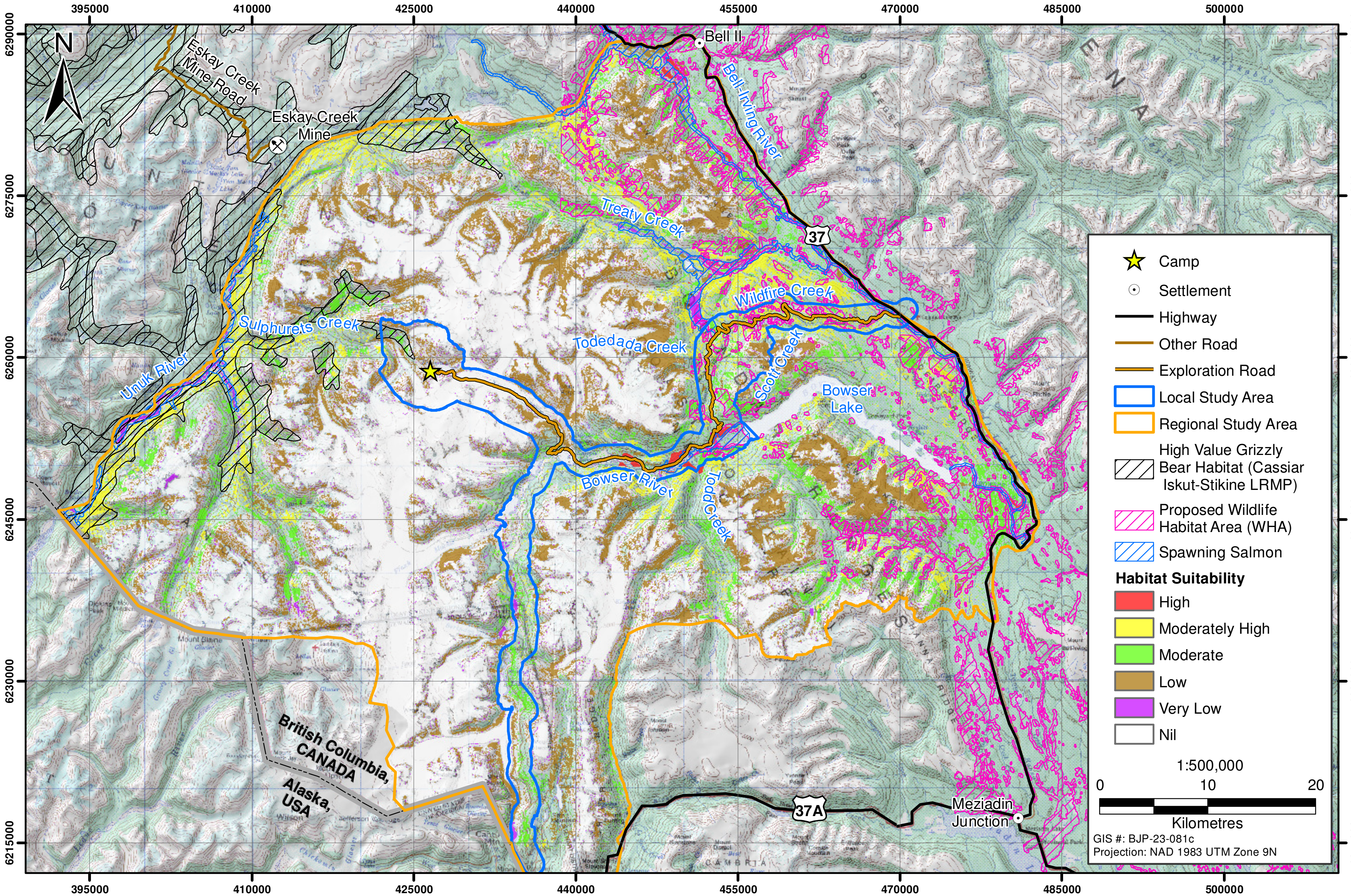

Figure 6.3-3

PRETIVM

Grizzly Bear: Fall Feeding Habitat

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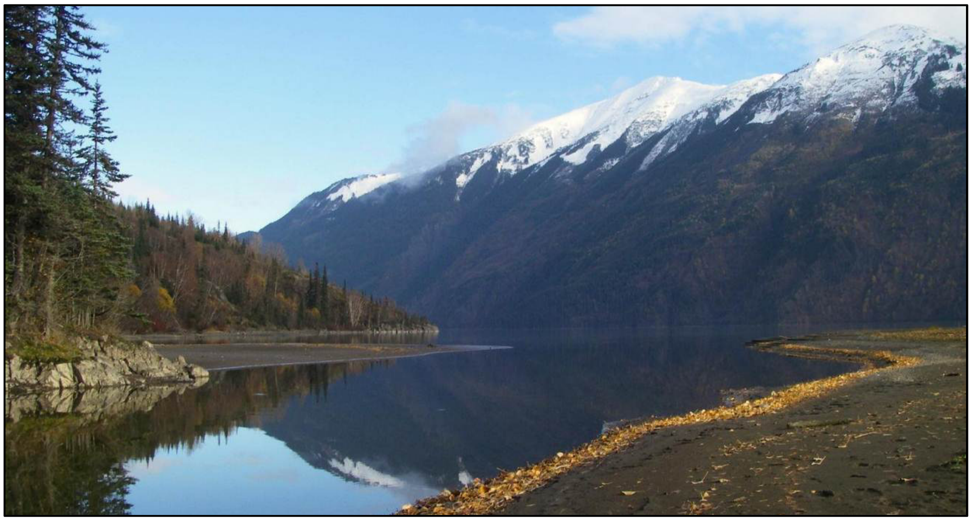

Plate 6.3-6. Highly suitable fall grizzly bear habitat at Bowser Lake near the Bowser River inlet within the LSA.

Plate 6.3-7. Grizzly bear tracks observed in 2012 within Highly suitable fall grizzly bear habitat along the Bowser River.

The remaining fall grizzly bear habitat within the RSA was rated as Low (28.7%), Very Low (2.3%), and Nil (31.1%). Low and Very Low rated habitat occurred in mid to high elevation terrain, and Nil rated habitat occurred in places with long lasting or permanent snow cover. A substantial portion of the proposed Brucejack Transmission Line – South Option and near the proposed Brucejack Mine Site area had Lower rated habitat.

A very high proportion of the total available High rated fall grizzly bear habitat was identified within the LSA (47.5%; Table 6.3-3). Although relatively low amounts of high fall habitat were identified for fall grizzly bear, those areas frequently overlapped the exploration access road west of Bowser Lake (Figure 6.3-3). Moderately High rated habitat was patchily distributed along the upper Bowser River and within the eastern portion of the LSA. Moderately suitable habitat was primarily identified along the proposed Brucejack Transmission Line – South Option and in patches at the toe of Mount Anderson. The rest of the LSA was rated Low (25.2%), Very Low (3.1%), and Nil (24.1%), and occurred along the proposed Brucejack Transmission Line – South Option and west of the Knipple Glacier (Figure 6.3-3).

Fall salmon spawning areas were included on the grizzly bear fall feeding maps as a secondary layer. A total of 8,461 ha within the RSA and 2,598 ha in the LSA were identified as suitable salmon spawning habitat. These areas overlapped with Moderately High to Highly suitable fall grizzly bear habitat along the Unuk, Bell-Irving, and Bowser rivers (Figure 6.3-3). Of particular note was spawning salmon habitat along the Bowser River because it was directly adjacent to higher rated (HSR 1 and HSR 2) modelled habitat making this location a very valuable feeding area for grizzly bears in the fall. The lower Salmon River south of the RSA is important for spawning salmon (and grizzly bear); however, the reach within the LSA has not been confirmed as salmon bearing so this location was not identified as spawning salmon habitat on Figure 6.3-3.

6.3.4 Hibernating (Denning) Habitat

Grizzly bear denning habitat was modelled for the LSA (Figure 6.3-4). Highly suitable denning habitat was identified in 0.5% of the LSA (Plate 6.3-8) and Moderately suitable habitat in 9.9% of the LSA (Table 6.3-4). The remaining (89.6%) was rated as Low to Nil (Table 6.3-4). A total of 15,315 ha (28%) of the LSA fell below 1,100 m elevation and was not included in the denning model.

Table 6.3-4. Grizzly Bear Hibernating Habitat within the LSA

Habitat Suitability Rating	LSA	
	Area (ha)	**% of Habitat in LSA**
High	200	0.5
Moderate	3,960	9.9
Low	5,810	14.6
Nil	29,902	75.0

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

Plate 6.3-8. Highly suitable Grizzly bear denning within the LSA.

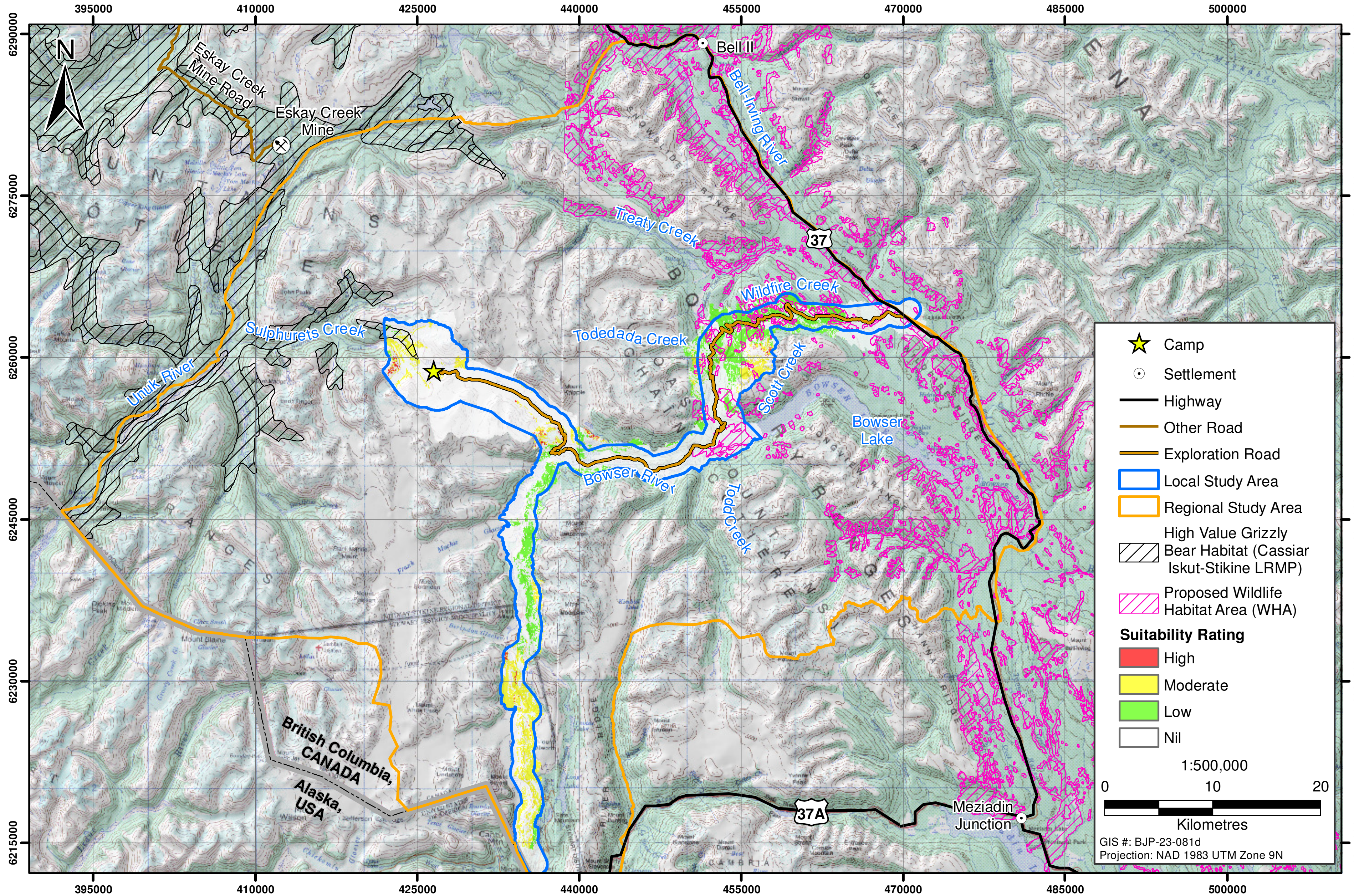

Figure 6.3-4

PRETIVM

Grizzy Bear: Winter Denning Habitat

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Highly suitable denning habitat was found adjacent to larger areas of moderately suitable habitat in small patches in the LSA. Specifically, high quality denning habitat was identified near the proposed Brucejack Mine Site along the western edge of the LSA, on both sides of the exploration access road near the end of Knipple Glacier, along the proposed Brucejack Transmission Line – South Option just south of Berenden Glacier, and in small scattered patches along the north-western side of Mount Anderson (Figure 6.3-4). Moderately suitable denning habitat was more widely available, and located throughout the same locations as highly suitable habitat, but also included areas along the southern portion of the proposed Brucejack Transmission Line – South Option. The northern portion of the proposed Brucejack Transmission Line – South Option was rated as low quality grizzly bear denning habitat. Other low rated areas were found along the exploration access road in the eastern portion of the LSA following Scott Creek, Wildfire Creek, and the southern extent of the Todedada wetlands.

6.3.5 Model Evaluation

Field plots confirmed that the spring model was within one HSR classification 68% of the time. A review of the data suggested that model accuracy was influenced by the classification of PEM ecosystem units as barren when in fact they supported herb vegetation that could be used by grizzly bears. This occurred for 5 of 17 alpine plots. This vegetation classification issue in PEM was not consistent, so the habitat model could not be modified. The summer model was within one HSR classification 82% of the time; therefore, no modifications were made. The fall model was within one HSR classification 68% of the time associated with the same issue encountered in the spring model. Areas identified as barren were actually vegetated and capable of producing herbs (roots and tubers) or low spreading berries (e.g., crowberry or small *Vaccinium*). It was also found that wetter sites were ranked too high at 18 plots, so the model was modified by down-grading the suitability of these sites accordingly (e.g., swamps of structural stage 3 and wetter shrub/herb structural stage 3 were decreased by one suitability rating).

Initial field review revealed that little denning habitat had been predicted from the model. Wildlife biologists worked with GIS technicians to determine the source of error which limited the modeling result and the issues were deemed to be technical in nature stemming from the internal GIS programming. The algorithms were not changed but the model was rerun and evaluated with the field plots that were sampled within the area modeled for grizzly denning. The updated model revealed that 77% of field plots matched the model ratings and 90% were within 1 HSR rating. The map was deemed adequate for predicting grizzly bear denning habitat.

Proposed Provincial WHAs identified for grizzly bear were predominantly located on the eastern side of the RSA with some areas extending into the central portions of the LSA along the exploration access road and over high rated habitat within the Bowser River floodplain. The WHAs overlapped Bell-Irving River, Bowser Rivers, Treaty Creek, Scott Creek, Wildfire Creek and Surveyors Creek in continuous patches. Overall, based on seasonal suitability ratings the polygons appear to be most functional for summer grizzly bear use, particularly around Treaty Creek and the Bell-Irving River and with slightly less suitability but still moderately high ratings at those locations during the spring and fall as well as at Surveyors Creek.

High Value grizzly bear CIS LRMP habitat and proposed Provincial WHAs are included on all of the grizzly bear figures (Figures 6.3-1 to 6.3-2). CIS LRMP grizzly bear habit was identified along the Unuk and South Unuk Rivers and Sulphurets and Mitchell Creeks, which are located at the western edge of the RSA. Those areas were primarily rated moderate to low in the spring, moderately high to high with portions containing confirmed salmon spawning streams in the summer, and again having salmon spawning areas along the Unuk River in the fall but the habitat was rated lower as mostly moderate to moderately high. The denning habitat was only modelled for the LSA so only a very small area of the

CIS LRMP high value grizzly bear habitat overlapped modelled high quality habitat, which was identified relatively near the proposed Brucejack Mine Site along Sulphurets creek and in conjunction with moderate rated habitat.

6.4 DISCUSSION

Overall, the RSA provides suitable habitat that can support all the life requisites for grizzly bears. The diverse terrain across the study area provided several zones with Moderately High and Highly suitable habitat across all seasons. The combination of wetlands, riparian habitat, and avalanche chutes contributes to the availability of early seral stage vegetation capable of providing abundant forage for bears. High value areas at subalpine and alpine elevations for spring herb forage were also suitable in the fall because these plant communities often produce roots and tubers that are eaten by grizzly bears when the herbaceous vegetation senesces. In several of these higher suitability habitats, grizzly bears were found during field surveys, supporting the conclusion that these habitats are important to grizzly bears.

On average, approximately a fifth of the habitat within the RSA and almost a quarter of the habitat in the LSA was rated as Moderately High to Highly suitable habitat for grizzly bears. A large proportion of the RSA had Moderately High suitable habitat for grizzly bears in similar areas to LRMP and provincially identified High rated habitat. There was a greater amount of High rated habitat rated for spring and summer feeding and greater amount of Moderately High rated habitat identified for summer and fall feeding.

High rated spring habitat mainly occurred within the eastern portion of the RSA on mid-elevation slopes, with some habitat along lower elevation riparian zones where herbaceous vegetation would be abundant. High rated summer habitat occurred along the Unuk River and its drainages and within patches on low to mid-elevation slopes across the RSA, including open zonal forests with abundant *Vaccinium*, as well as old burns and cut blocks supporting berry producing shrubs. In the fall, High rated grizzly bear habitat in the RSA mostly occurred along the Bell-Irving River and within the floodplain forests along the Bowser River Valley west of Bowser Lake where riparian forests have shrubs that produce persistent berries, such as red osier dogwood or high brush cranberry.

In the LSA, similar amounts of Moderately High to High quality habitat occurred in the spring, summer and fall models. Most of the higher rated habitats for grizzly bears that occurred in the LSA were located east of Knipple Glacier and in small patches along the proposed Brucejack Transmission Line – South Option. More specifically, higher quality habitat occurred along and near the exploration access road from highway 37 to Knipple Glacier and along Todedada Creek. These areas supported suitable vegetation forage whereas the area west of Knipple Lake was dominated by glacier and rock. There was consistently higher quality habitat along the upper Bowser River in all seasons between the Knipple Glacier and Bowser Lake, reflecting the diversity of the plant community associated with floodplain and riparian habitat. In the summer and fall, the eastern portion of the LSA near the Bell-Irving River contains large patches of higher quality habitat and bears were identified in the eastern LSA during 2011 field surveys (Rescan 2013c). An important zone of high quality habitat was also found along Todedada Creek at low to mid elevations in the spring and summer reflecting the structural diversity associated with the wetlands in that area.

Areas above treeline in the LSA were modelled to identify the best site characteristics to support grizzly bear dens. A tenth of the alpine habitat that was modelled was rated Moderate to High for providing grizzly bear hibernating habitat. The largest area of higher rated habitat (HSR M and HSR H) occurred along the proposed Brucejack Transmission Line – South Option. Important hibernating habitat was also identified in the western LSA and on Mount Anderson in the eastern LSA. Higher quality habitat existed in several patches near the proposed Brucejack Mine Site, some of which overlapped with High Value grizzly bear habitat identified in the CIS LRMP (BC ILMB 2000).

Additional modelling of areas where grizzly bears can supplement their diet with animal protein suggested that the Unuk River drainage in the western RSA and the Bell-Irving, Treaty, and Bowser River drainages in the eastern RSA, are valuable feeding areas where grizzly bears can find moose carrion or moose in poor condition in the spring, and spawning salmon in the summer and fall. Habitat suitability modelling for marmot (see Section 8.3), suggested that there are considerable areas that may support marmot colonies at mid-elevation, which enhance the value of summer habitat for grizzly bears.

Grizzly bear habitat has previously been modelled in areas that overlap the RSA. High value habitat was identified in the CIS LRMP (BC ILMB 2000), candidate provincial WHAs were identified in the north Nass TSA (McElhanney 2007a), and baseline mapping was conducted for the KSM Project. The grizzly bear model and previously mapped areas had consistent overlap along the floodplains of the Bowser River west of Bowser Lake, which contained Moderately High to Highly suitable habitat in all seasons (McElhanney 2007a). The proposed Provincial WHAs appear to be most functional for summer grizzly bear use, particularly around Treaty Creek and the Bell-Irving River. High value habitat for grizzlies identified within the CIS LRMP occured in low elevation habitat along the entire Unuk River drainage (BC ILMB 2000).

7. American Marten

7. American Marten

7.1 INTRODUCTION

Furbearers, especially marten, are important economic and cultural resources within the RSA. BC MOE harvest data showed that marten accounted for 73% of the registered fur-bearers harvested by licenced trappers between 1985 and 2003 (BC Stats 2005). Initiatives within the CIS LRMP have emphasized provisions for managing furbearer populations as a sustainable resource (BC ILMB 2000). Marten were selected as a candidate species for habitat suitability mapping because of their regional economic importance and dependence on mature forest stand structure values which help to identify important habitat for other wildlife species.

Winter is considered one of the most limiting times of year for marten, and is the period when they are actively trapped for fur; therefore, habitat suitability modelling focused on identifying suitable winter habitat for marten.

7.2 METHODS

7.2.1 Model 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. Habitat values are further enhanced by the presence of CWD, which provides cover and access points for marten to seek out prey under the snow. Coarse woody debris (CWD), snags, rootballs, or other structures that facilitate movement beneath the snow (subnivean), have been identified as important components of winter habitat for marten. These characteristics provide predatory cover and are high-quality hunting grounds (Steventon and Major 1982; Buskirk et al. 1989; Lofroth and Steventon 1990; Sherburne and Bissonette 1992; Buskirk and Powell 1994; Sherburne and Bissonette 1994; Takats et al. 1996). Subnivean spaces are also used for resting during harsh winter conditions (Wilbert, Buskirk, and Gerow 2000). Sufficient canopy cover for snow interception prevents excessive snow build-up in the understory, allowing subnivean access throughout the winter (Koehler and Hornocker 1977). 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; and
- Nil (N) rated habitats included the remaining areas of early seral stage vegetation (structural stages 1, 2, and 3), such as barren areas, lakes, wetlands, and rivers.

The final HSRs developed from the model assumptions use a 4-class rating system. Additional marten life requisite information is provided in the species account available in Appendix 4. The habitat ratings are provided in Appendix 8.

7.3 RESULTS

7.3.1 Winter Habitat

Functional marten habitat, represented as High and Moderate rated habitat, amounted to approximately 20% of the RSA (Table 7.3-1). Nearly all the functional marten habitat was rated as High, totalling 69,735 ha that were widely distributed throughout lower elevation forested habitats (Table 7.3-1; Plates 7.3-1 and 7.3-2; Figure 7.3-1). Much of the High rated habitat areas were large continuous mature and old growth conifer stands (Plate 7.3-1). Moderate rated habitat areas were primarily small patches of low elevation, mature, riparian stands (< 1%) along the South Unuk River, Bell-Irving River, Scott and Wildfire Creeks, and along the Bowser River. Many of the moderately suitable areas were adjacent to High rated habitat (Figure 7.3-1).

Table 7.3-1. 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	69,735	18.9	8,652	22.3	12.4
Moderate	2,814	0.8	668	1.7	23.7
Low	2,658	0.7	386	1.0	14.5
Nil	293,070	79.6	29,156	75.0	9.9

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

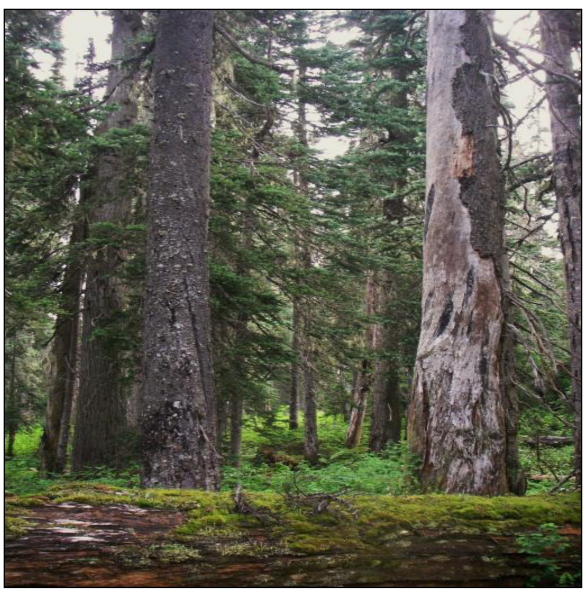

Plate 7.3-1. Highly suitable Marten habitat within forested areas of the RSA.

Plate 7.3-2. Highly suitable Marten habitat within harvested areas of the eastern RSA.

Within the LSA, High value habitat overlapped the eastern portion of the exploration access road along the Wildfire and Scott Creek drainages (Figure 7.3-1). This habitat was represented by valley bottoms of ICH forests and riparian habitat that provide important stand structure and diversity for prey species abundance and protection from predators. Nearly a quarter of the total available Moderate habitat occurred within the central LSA, along the exploration access road and within the Bowser River floodplain (Table 7.3-1; Figure 7.3-1).

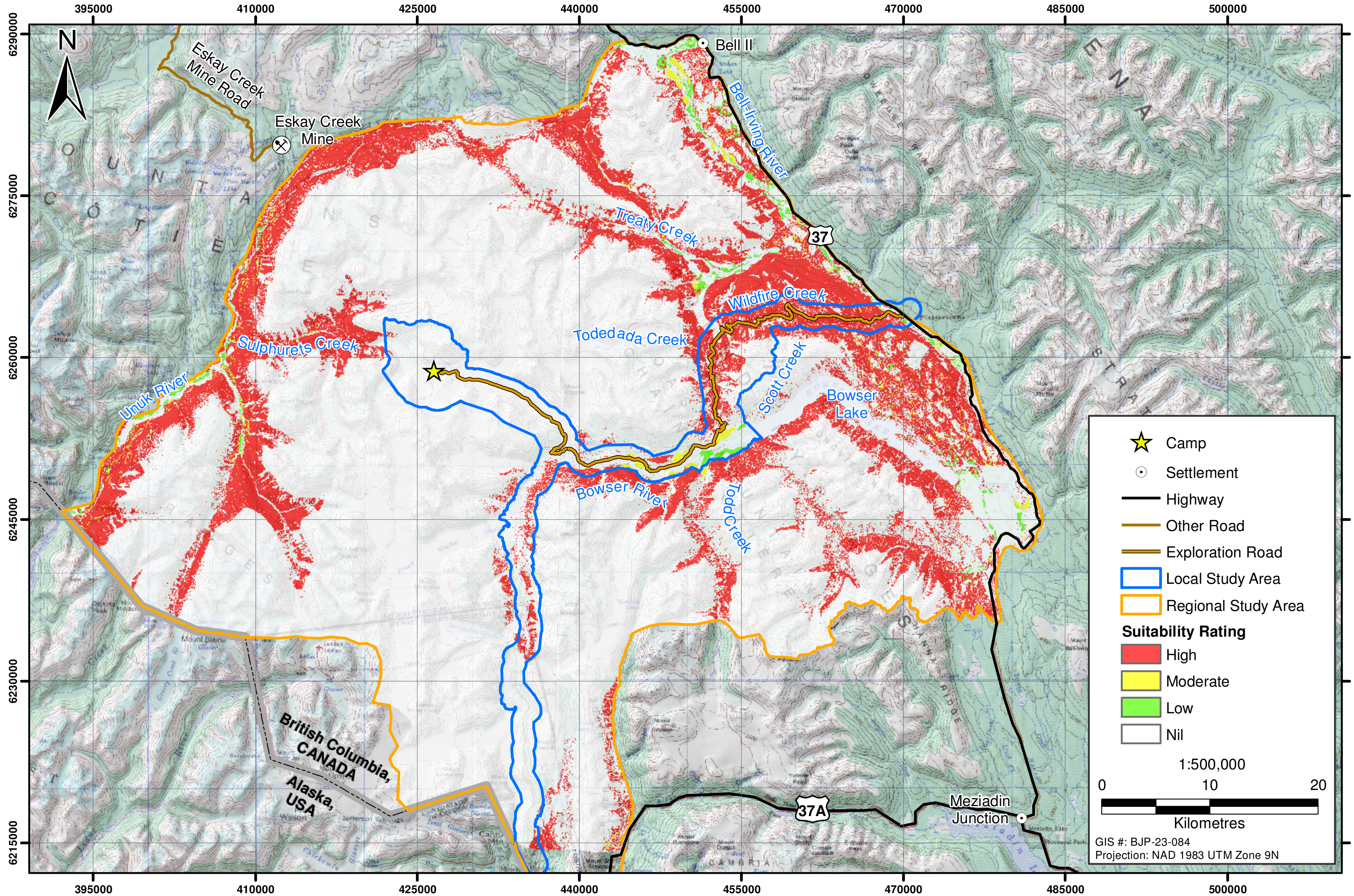

Figure 7.3-1

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American Marten: Winter Habitat

Figure 7.3-1

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Over 80% of the RSA was classified as containing Low (0.7%) and Nil (79.6%) value habitat for marten (Table 7.3-1; Figure 7.3-1). These lower rated habitat areas do not provide adequate forage or cover (e.g., glaciated tracts, barren areas, herb or shrub dominated areas), and consisted of natural openings that lack large CWD (e.g., lakes, wetlands and alpine areas above treeline). Low rated habitat was relatively rare and included younger stands of deciduous forests along floodplains and parkland forests. Low rated habitat was patchily distributed along waterways such as the Bowser, Unuk, South Unuk, Bell-Irving Rivers and Treaty Creek (Figure 7.3-1). An isolated patch of low quality marten winter habitat was identified south of the exploration access road along the south side of the Bowser River. The proposed Brucejack Mine Site, the western portion of the exploration access road and most of the proposed Brucejack Transmission Line – South Option were rated as Nil for winter marten suitability.

7.3.2 Model Evaluation

Model assumptions were evaluated by comparing field ratings from 101 field plots to theoretical model ratings. Field plots were distributed throughout the RSA and sampled during July and August 2012. The marten winter habitat model was either equal to field ratings or came within one rating class of field ratings 85% of the time. It was concluded that no modifications to the model were necessary.

7.4 DISCUSSION

Most of the habitat within the RSA was primarily rated as having Nil winter suitability for marten (80%). The higher elevation ecosystem units within the LSA were identified as providing Nil winter habitat for marten due to an absence of forested areas.

The majority of the forested areas within the RSA and LSA were identified as having Highly suitable winter habitat for marten. The study areas were largely within an undisturbed landscape that supported mature forests and areas with structural diversity that can provide suitable hunting and predator avoidance characteristics. Within the RSA, highly suitable habitat was distributed in continuous areas across lower elevations within all the major watersheds: the Unuk, Bowser and Bell-Irving Rivers, and the Treaty, Scott, and Wildfire Creeks. Nearly a quarter of the LSA was identified as Highly suitable winter habitat for marten and many areas were mapped along the eastern portion of the exploration access road. Only trace amounts of highly suitable habitat was mapped along the proposed Brucejack Transmission Line – South Option. Highly suitable marten habitat was not identified near the proposed Brucejack Mine Site, which was rated as Nil quality due to the lack of vegetation.

A relatively small area was identified as Moderately suitable winter marten habitat within younger structural stage forests. Younger forests that 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 so potentially these areas could be re-evaluated for a higher rating (Poole et al. 2004).

Very little Low rated habitat was identified within the Project study areas. Low quality habitat was identified along the Bowser River floodplain and adjacent to the central portion of the exploration access road.

A relatively small amount of High value habitat identified in the CIS LRMP occurred in the north-western corner of the RSA along Highway 37 within Ningunsaw Provincial Park (BC ILMB 2000). This area was also identified as Highly suitable for marten in the current study, which confirms its importance for marten. The maintenance of continuous suitable habitat in interior forests and development of harvest guidelines have been identified as valuable components for marten management (BC ILMB 2000).

The Provincial Fur Harvest Database was examined for the reported marten harvest from registered traplines located in the study areas (Rescan 2013c). Marten accounted for the majority of reported trapper harvest amongst all species (73%) between 1985 and 2009 (Rescan 2013c). All traplines with available harvest data overlapped with large areas of High rated marten winter habitat because those areas were forested and so suitable for trapping multiple mustalid species. In addition, many incidental marten images were collected from remote cameras within or adjacent to highly suitable marten habitat (Rescan 2013c).

Suitable marten habitat includes features that are important to a myriad of other wildlife species. The attributes that define high quality marten habitat are characteristics that support forest dwelling breeding birds, small mammals, and other arboreal furbearers such as red squirrel, ermine, and fisher. The status of marten populations and marten habitat could therefore serve as an indicator of ecological integrity for mature forest stands which are a valuable wildlife habitat type.

8. Hoary Marmot

8. Hoary Marmot

8.1 INTRODUCTION

Hoary marmots have been identified as a species of cultural significance by First Nations and they are an important prey species for carnivores such as grizzly bears, wolverine and golden eagles and were therefore included as a candidate species for habitat modelling. The hoary marmot is a relatively sedentary species, 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.

8.2 METHODS

8.2.1 Model Assumptions

For the marmot model, preliminary WHRs based on vegetation were not assigned to PEM ecosystem units because of the importance of soils, aspects, or slopes, which may differ in overall habitat value for marmots. For example, because 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 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 season habitat model was developed using multiple inputs (Table 8.2-1), including digital topographic data, and ecosystem and soils mapping products which were then combined to assign the final HSR to PEM ecosystem units. Information on species ecology and habitat selection used for the identification of suitable hoary marmot growing season habitat is provided in the species account (Appendix 5).

Soils with morainal or colluvial surficial materials were assumed to be the most appropriate to provide sufficient structure for burrows, which was supported by field surveys conducted at hoary marmot burrows during baseline studies for the Brucejack Project (Rescan 2013c). For areas on morainal or colluvial soils, the highest habitat ratings were assigned to those that could produce an abundance of highly favoured plant forage, including grasses and herbs (structural stage 1 or 2) across all moisture regimes. Preference was given to warmer aspects and relatively gentle topography because these areas may be snow-free for the longest periods during the growing season. Areas of relatively flat or steep topography, as well as those supporting mixed herb and shrub vegetation on appropriate soil types, received Moderate and Low habitat ratings.

Habitat that did not have the appropriate substrate for supporting marmot burrows automatically received a Nil habitat rating. Forested areas of Structural Stage 4 or greater were assumed to have no habitat value because marmots generally live in open alpine areas. For this reason, the model was only applied to higher elevation BEC zones (i.e., ESSF, MH, CMA, and BAFA) above treeline (approximately > 1,100 m). The hoary marmot model was generally restricted to the LSA, as soil surficial material information required was only available for this area. Additional areas adjacent to but outside of the LSA boundary totalling approximately 17,509 ha were incorporated into the model because of available ecosystem and soils data.

Table 8.2-1. Marmot Growing Habitat Modelling Features of ESSF, MH, CMA, and BAFA BEC Zones

HSR	Soil and Topographic Features: Soil Material[1]	Slope (%)[2]	Aspect (°)[2]		Vegetation Features: 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 2013a), [2] Digital Elevation Model (DEM) information and 1:20,000 Terrain Resource Information Management (TRIM) data, [3] Predictive Ecosystem Mapping (PEM)

8.3 RESULTS

Soils and vegetation suitable for supporting marmot during the growing season was identified between 1,100 m to 1,500 m. Areas above this range were too rocky, or un-vegetated, while areas below tended to be forested.

Only a small proportion of the LSA (4.8%) was rated as high quality marmot habitat (Figure 8.3-1; Table 8.3-1). A total of 2,356 ha were identified as high quality marmot habitat, including areas northwest of the proposed Brucejack Mine Site (primarily along the western boundary of the LSA), along the south facing slopes of Mount Knipple in the central LSA, above Bowser River and the exploration access road, and along Mount Anderson (Table 8.3-1; Plates 8.3-1 and 8.3-2; Figure 8.3-1). These results were consistent with findings from 2012 baseline studies, where almost all marmot observations within the LSA were at those same locations (Rescan 2013c). The highest density of marmot observations occurred along Mount Anderson (Rescan 2013c).

Table 8.3-1. Hoary Marmot Growing Season Habitat within the LSA

Habitat Suitability Rating	LSA: Area (ha)	% of Habitat in LSA
High	2,356	4.8
Moderate	10,071	20.4
Low	647	1.3
Nil	36,277	73.5

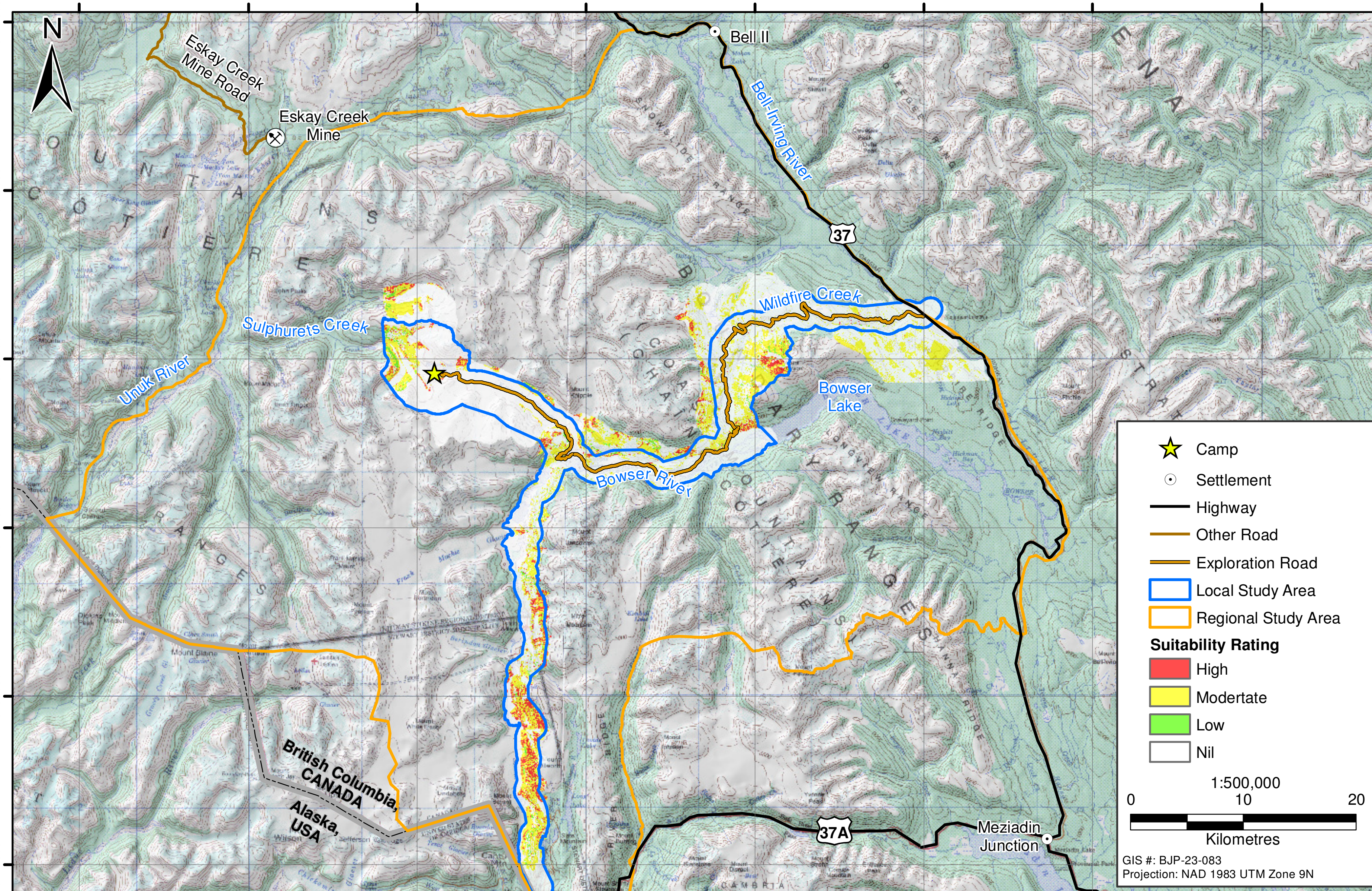

Figure 8.3-1

PRETIVM

Hoary Marmot: Growing Season Habitat

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Plate 8.3-1. A hoary marmot den within highly suitable habitat north of the exploration access road along Mount Knipple.

Plate 8.3-2. Highly suitable hoary marmot growing habitat within the LSA along Mount Anderson.

Moderate rated habitat occurred adjacent to High quality habitat in larger patches, representing a more significant proportion of the LSA (20.4%). The largest concentration of Moderate habitat occurred directly adjacent to and along ridges northwest of the proposed Brucejack Mine Site (Figure 8.3-1). Multiple marmot colonies were also identified near the proposed Brucejack Mine Site during field surveys, indicating that this area is possibly a higher suitability for marmot than the model has indicated (Rescan 2013c).

Minimal Low quality habitat was identified (647 ha), likely due to the constraint of ≥ 90% slope (Table 8.3-1). Surprisingly, an area that was rated as low quality by the marmot suitability model was found to have high a density of marmot colonies on Mount Knipple north of the exploration access road (Rescan 2013c). This area had a mosaic of surface bedrock and pockets of soil, supporting small colonies with lower densities than areas such as Mt Anderson where habitat was rated High. The mixed conditions were at resolution that could not be detected by the vegetation mapping photo interpretation inputs, resulting in an average habitat rating of Low that resulted from a matrix of Nil and Moderate/High habitat quality.

Nearly three quarters of the LSA was rated as Nil (73%) for marmots (Table 8.3-1). These sites were covered by glaciers or low elevation areas such as riparian, wetland and harvested blocks.

8.3.1 Model Evaluation

During 2012, 81 field plots were established across the RSA and 79% of the plots were found to be within one HSR class predicted by the model. Aerial surveys conducted within the LSA located 164 colonies (Rescan 2013c). These colonies were rated for habitat suitability during the survey and a sample of 18 colonies was assessed on the ground to determine if aerial survey results could adequately predict ground conditions. Three were within one HSR class, and 15 (83%) had identical ratings. This suggested that habitat ratings assigned from aerial surveys could be used to evaluate the habitat model.

Of the 164 colonies observed in the LSA, 128 (78%) were classified within one HSR of the rating predicted by the habitat model. Most of the differences were due to the model underestimating the robustness of the vegetation (i.e., field conditions supported richer vegetation than was predicted). As a result, the field value was underestimated 55% of the time while only 16% was overestimated. No changes to the model were recommended because both evaluation methods yielded greater than 78% correspondence, suggesting the model was adequate.

8.4 DISCUSSION

Higher rated habitats (moderate and high) were identified within a quarter of the LSA. Most suitable habitat was rated as Moderate. Nearly 5% of the LSA area was rated High and was identified near the proposed Brucejack Mine Site and along the exploration access road. These areas of High rated habitat were found to support active colonies during baseline field studies (Rescan 2013c).

Habitat value appeared to be influenced by continuity of habitat, a feature not included in this model. Areas with extensive High or Moderate suitability habitat (e.g., Mount Anderson), tended to have greater density of marmots than areas that were less contiguous (i.e., above Knipple Glacier). Large areas of contiguous habitat support colony expansion and dispersal of individuals to other adjacent areas of suitable habitat. Large contiguous habitat tended to have deeper soils and additional characteristics that provide protection from predators that could excavate burrows (e.g., bears and wolverine), supporting colony resilience. Whereas smaller more isolated burrows in lower quality habitat were often unoccupied likely as a result of re-colonization into available less suitable habitat (Rescan 2013c).

Large areas of marmot habitat have high food value for predators such as grizzly bear, wolverine, and golden eagles. The extent of marmot colonies serves as an indicator of high quality richly vegetated habitat on deep, gentle soils that is also favoured by other alpine species such as grassland breeding birds, voles, and lemmings.

9. Fisher and Black Bear

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9. Fisher and Black Bear

9.1 BACKGROUND

Fisher and black bear habitat models focused on identifying areas suitable for providing denning habitat for fisher and black bears. Both species den in forested areas and are dependent on trees with sufficient diameter to permit denning within the boles. These species were selected as model vectors because of their shared habitat requirements enabling a single model to represent valuable habitat for two species.

9.1.1 Fisher

The fisher is a valuable British Columbian furbearer. Fisher are currently blue listed in BC (BC CDC 2013b). Maintaining stand structure and connectivity along riparian systems has been identified within the CIS LRMP as an important management consideration to support fisher populations (BC ILMB 2000). Habitat degradation has been noted as a key factor in the decline of fisher in the Province largely because suitable trees and mature forest stands are harvested to manage the mountain pine beetle epidemic (BC CDC 2013b; CDC 2013). Fisher avoid large openings, including roads, due to predator exposure (BC ILMB 2009; Rescan 2013c).

The Project RSA is at the edge of fisher distribution in BC (Weir 2003). They were a minor contribution to the fur harvest within the RSA (three individuals in 24 years) according to the BC Fur Harvest Database (Rescan 2013c), although this can be attributed to the closed season for fisher in Region 6. Therefore monitoring of this species is not recommended due to its rare occurrence within the region. Nevertheless, they do exist within the RSA. During field inventories in the winter of 2012, fisher were observed at the confluence of the Bell-Irving River and Treaty Creek (Rescan 2013c), and identifying important habitat areas is critical to maintaining fisher presence within the regional landscape.

Fisher are carnivores and feed on a wide range of live prey (red squirrel, snowshoe hare, voles, mice, grouse and porcupines) as well as carrion. As a result, they exploit a diversity of forested habitats. Fisher require cavities in large trees for giving birth and rearing young during winter and early spring (Weir and Almuedo 2010). Some examples of suitable trees include black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) with diameters over 90 cm, balsam poplar (*Populus balsamifera* ssp. *balsamifera*) with diameters over 50 cm, trembling aspen (*Populus tremuloides*) with diameters over 40 cm, and conifer including lodgepole pine (*Pinus contorta)* with diameters greater than 35 cm (Weir and Almuedo 2010). While large cottonwood and balsam poplar are associated with low elevation riparian habitat, mesic and submesic sites can also produce trees with suitable diameter to support fisher dens. Appendix 7 includes a more detailed account of fisher habitat requirements.

9.1.2 Black Bear

Black bear are the most common bear species in North America, and are distributed all over BC with an estimated population of 120,000 to 160,000 (D. N. Demarchi 1999). Black Bears were detected frequently throughout the RSA during grizzly bear inventories (Rescan 2013b). They are not a species of concern as they are provincially yellow listed and federally listed as not at risk (BC CDC 2013a). Black bears are provincially classified as a game animal and a furbearer because of their harvest by First Nations, BC residents and international hunters. Black bears were modelled because of their economic value and they are a culturally important species.

Black bear exploit a wide range of habitats, from valley bottoms to alpine areas to meet their life requisites. Black bears den in cavities of large diameter old-growth trees or in areas associated with large root wads that trap early snow that maximizes insulation. In northwest BC, black bears den from November to April and their dens are generally below treeline. Denning habitat is key for survival of the species, and disturbance within 1,000 m of a den may result in physiological stress to denning bears (Linnell et al. 2000).

In the central interior of BC black bears have been found denning in excavated dens, rock dens and tree dens in about equal proportions (Hodder and Rea 2005). Interior dens were found to be in areas of deep loam soils associated with zonal site series at mid elevation, rock dens in the driest sites at higher elevations, and treed dens associated with riparian sites at the lowest elevations where the largest trees occurred (Hodder and Rea 2005). Given the extensive area of land base that have suitable soils, it is very difficult to predict the location of excavated and rock dens (Hodder and Rea 2005). In the southeast Kootenays of British Columbia, black bears have been observed denning in black cottonwood trees with trunks greater than 85 cm (Van Damme et al. 2007) and on Vancouver Island 28% of monitored black bear dens were re-used in subsequent winters (Davis 1996). Appendix 7 provides greater detail for black bear denning habitat requirements.

9.2 METHODS

9.2.1 Model Assumptions

The fisher and black bear denning model was developed based on the assumption that stands capable of containing the largest diameter trees, either deciduous or conifer, would have the greatest value for denning. These forests included the lowest elevation and more moist and nutrient rich sites, particularly those that could support large black cottonwood stands. The generalized assumptions for the ratings used in the model were:

- High (H) rated habitat included:
  - Rich and wet stands associated with floodplains at the lowest elevations (ICH and CWH BEC) that support structural stage 6 and 7 (mature and old growth) hybrid spruce conifer forest; or
  - Structural stage 5 (over mature) black cottonwood dominated riparian forest.
- Moderate (M) rated habitat included:
  - Moist and medium to rich sites with structural stage 6 and 7 conifer at low elevations.
  - Structural stage 4 cottonwood dominated sites at low elevations.
  - Riparian habitat at higher elevations (ESSF and MH BEC) with structural stage 6 and 7 conifer or structural stage 5 deciduous.
- Low (L) rated habitat included the mesic and drier sites at low elevation dominated by structural stage 6 and 7 conifer vegetation.
- Nil (N) valued habitat included all high elevation sites (BAFA and CMA as well as parkland variants of the ESSF and MH) and all early structural stage 5 or lower vegetation except as noted above.

The preliminary WHRs developed from the model assumptions represent the final HSRs for ecosystem types present in the RSA using a 4-class system. These habitat ratings are provided in Appendix 8.

9.3 RESULTS

High and Moderate rated ecosystem units were infrequent, and distributed in patches throughout lower elevation riparian forested habitats and within the eastern area of the LSA in historical timber harvest areas (Plates 9.3-1 and 9.3-2; Figure 9.3-1). The habitat suitability model suggested that functional (Highly and Moderately suitable), fisher and black bear denning habitat amounted to only 3% of the RSA (Table 9.3-1). This habitat occurred in low elevation riparian areas associated with the larger watercourses including the Bell-Irving River, Treaty Creek, Unuk River and upper and lower Bowser River.

Plate 9.3-1. A Highly suitable fisher or black bear deciduous denning tree within the RSA.

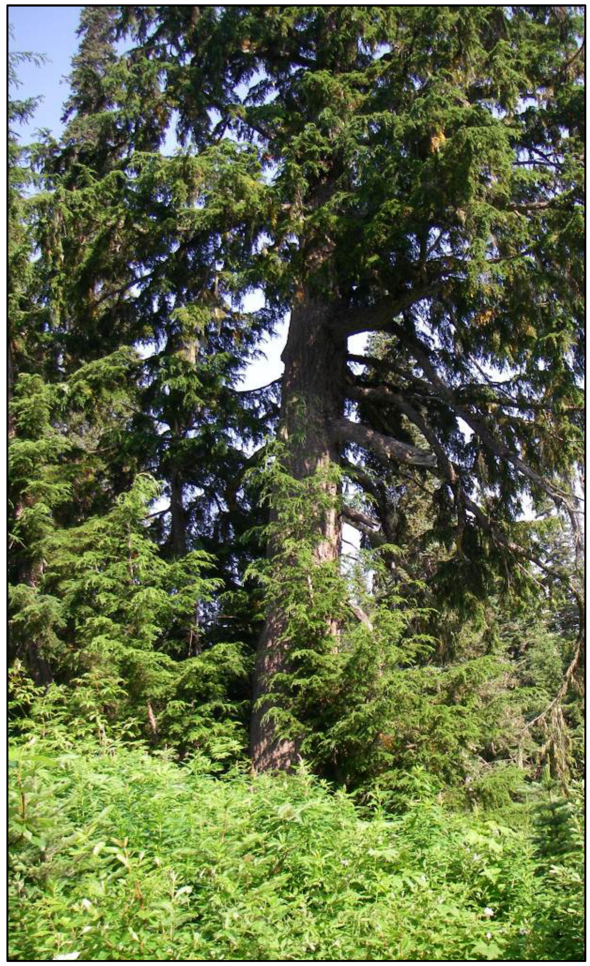

Plate 9.3-2. A Highly suitable black bear conifer denning tree within the RSA.

Table 9.3-1. Fisher and Black Bear Denning 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	3,628	1.0	884	2.9	24.4
Moderate	7,623	2.1	814	2.6	10.7
Low	62,915	17.1	5,902	19.0	9.4
Nil	294,315	80.0	23,396	75.5	8.0

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

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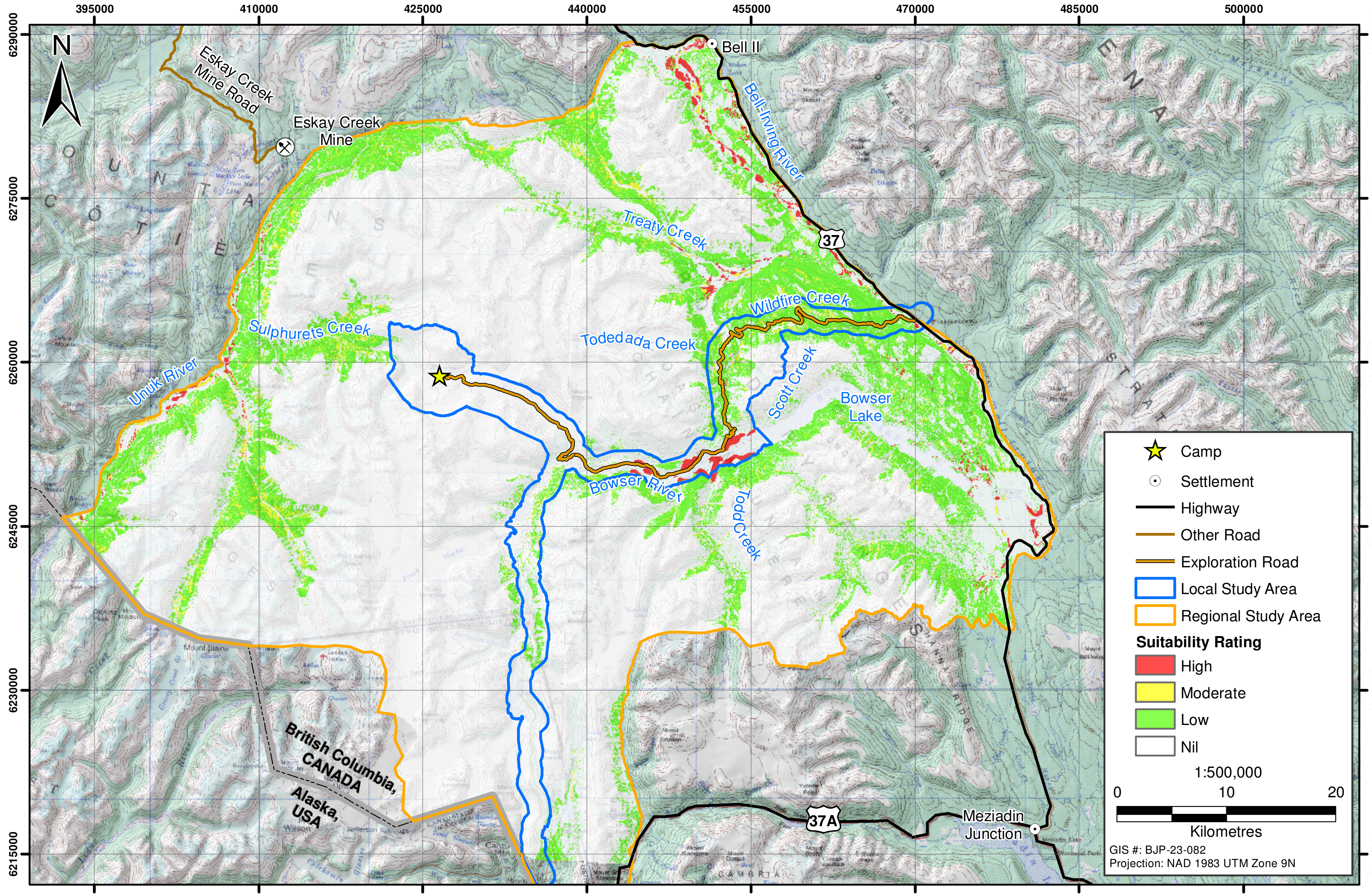

Figure 9.3-1

PRETIVM

Fisher and Black Bear: Denning Habitat

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Only 2.9% of the LSA was rated as High quality denning habitat and only 2.6% was rated as Moderate. These areas were found along the floodplains of the Bowser River and were relatively substantial compared to other high rated areas, and consisted of almost all the high rated habitat within the LSA. The HSR 1 habitat along the Bowser River floodplain overlapped sections of the exploration access road and so would be the most sensitive location for fisher and black bear denning. Proportionally, the LSA provided a much larger area of high quality denning habitat than the RSA.

Low and Nil rated habitat amounted to 97.1% of the RSA 94.5% of the LSA for black bear/fisher denning. Low rated habitat was distributed across the RSA along riparian corridors and included large areas of forest at low and mid elevations (Figure 9.3-1). Nearly 20% of ecosystem units in the LSA were rated Low, slightly higher than was identified in the RSA. Three quarters of the available habitat was rated as having Nil suitability for fisher/black bear denning in the LSA and this included areas around the proposed Brucejack Mine Site and along the proposed Brucejack Transmission Line – South Option due to a lack of appropriate forest stands.

9.4 DISCUSSION

Habitat was available in the RSA and the LSA that could support denning by fisher and black bears; however, due to the specific features that made habitat suitable for denning, higher rated areas were restricted to a limited distribution. Functional fisher and black bear denning habitat was found to occupy less than 6% of both the RSA and LSA throughout lower elevation stands of mature riparian forest. High rated habitat was associated with larger watercourse and was most prominent along the Bowser River floodplain, which overlapped portions of the exploration access road within the LSA. Patches of high rated habitat were also identified within the RSA along the Bell-Irving River, Unuk River and Treaty Creek.

Low rated habitat was distributed across the RSA along riparian corridors and associated wetland complexes, representing 19% of the LSA. A larger amount of Low value denning habitat was identified within the LSA than the RSA. These areas were represented by the wide distribution of zonal structural stage 6 and 7 across the RSA, which have soils that may be used by bears for den excavation, but had lower probability of large diameter trees that could be used by fisher or black bears for denning.

The models indicated that the majority of forested habitat within the RSA and LSA provided unsuitable denning habitat for fisher and black bears. Over three quarters of available habitat was identified as Nil value for denning. Nil value ecosystem units were distributed throughout higher elevation alpine and glacier areas that were dominated by herb and shrub, or sparsely vegetated. These areas included most of the area surrounding the proposed Brucejack Mine Site and along the proposed Brucejack Transmission Line – South Option. These areas do not provide suitable large diameter trees preferred for fisher and black bear dens.

Stands identified as capable denning sites for fisher and black bear also provide habitat to other species with similar requirements, such as bat day and natal roosts, cavity nesting waterfowl, and riparian dependant raptors. Valuable Highly suitable habitat, therefore, is also similiarly limited across the RSA for some of the life requisites of these species groups.

10. Summary

10. Summary

Habitat suitability modelling conducted for the Brucejack Goldmine Project included the following seven species and associated seasonal attributes: moose early and late winter habitat; mountain goat summer and winter habitat; grizzly bear spring, summer, fall, and hibernating habitat; American marten winter habitat; hoary marmot growing season habitat, and fisher/black bear natal denning/hibernating habitat (Table 10-1).

Table 10-1. Focal Species and Habitat Rating Scheme

Species	Season	Life Requisite[1]	Rating Scheme
Moose	Early and Late Winter	Living (Food emphasis)	6 class
Mountain Goat	Winter and Summer	Living (Food and Shelter emphasis)	6 class
Grizzly Bear	Spring, Summer, and Fall	Food	6 class
	Winter	Hibernating	4 class
Marten	Winter	Living	4 class
Hoary Marmot	Growing	Living	4 class
Black Bear	Winter	Denning	4 class
Fisher	Winter	Denning	4 class

[1] Life requisites are supplied by the species' habitat (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.

The development of the habitat models varied between six and four class rating schemes, according to the level of knowledge of the species and available vegetation data (Table 10-1). The six class scheme was used for the ungulates (moose and mountain goat) and grizzly bear whereas the four class scheme was used for marten, hoary marmot, and the black bear/fisher denning model.

The suitability mapping conducted for the Project identified areas of relative importance for selected species across the RSA. For example, the combination of wetland, riparian corridors, and mature forests provided good forage habitat for moose and grizzly bears in the RSA and LSA. 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 support a large quantity of alpine habitat, which provided suitable habitats for goats, denning grizzly bears, and hoary marmots. Alpine areas occurred throughout the RSA and in particular within the LSA, important alpine habitat was identified near the proposed Brucejack Mine Site, within the central LSA north of Bowser River and along Mount Anderson.

Winter habitat modelling was conducted for moose to predict which habitats moose will exploit during severe winter conditions. High quality moose winter habitat was identified within the central LSA along sections of the exploration access road. An area of High rated winter habitat associated with the Todedada wetland complexes was within the LSA that could provide connectivity between the Bowser River floodplain and northern Higher rated habitat areas along Treaty Creek, which have also been proposed for provincial UWR areas. Within the RSA High quality winter range was identified in low elevation riparian habitat such as Bell-Irving, Bowser and the Unuk Rivers. A large portion of the available late winter habitat was rated as Nil for winter suitability and Higher rated moose winter habitat was not identified near the proposed Brucejack Mine Site.

High rated mountain goat habitat was evenly distributed in patches throughout the study areas and higher rated areas were confirmed as occupied during baseline studies (Rescan 2013c). Roughly a quarter of the LSA was identified as Moderately High to Highly suitable winter (18%) and summer (22%) habitat (Table 10-2). Within the LSA, Higher rated habitat surrounded the proposed Brucejack Mine Site, was north of the exploration access road, and along Mount Anderson. Within the RSA valuable goat habitat areas were identified at: Snowslide Range and Longview Range in the eastern RSA, mountains south of Treaty Creek, John Peaks in the western RSA and for both seasons in the mountains between Sulphurets Creek and South Unuk River.

Table 10-2. Summary of Habitat Suitability Modelling for Five Species in the RSA and LSA

Species and Season	Area of Modeled Habitat (ha)											
	High	%[1]	Mod. High	%[1]	Moderate	%[1]	Low	%[1]	Very Low	%[1]	Nil	%[1]
RSA												
Moose												
Early Winter	9,831	2.7	46,929	12.7	89,672	24.4	20,786	5.6	25,181	6.8	175,720	47.7
Late Winter[2]	7,650	2.1	14,687	4.0	19,867	5.4	19,741	5.4	1,741	0.5	304,434	82.7
Mountain Goat[3]												
Winter	68,892	18.7	29,216	7.9	38,558	10.5	15,474	4.2	216,162[6] ha		58.7[6] %	
Summer	52,005	14.1	41,638	11.3	44,964	12.2	12,433	3.4	217,261[6] ha		59[6] %	
Grizzly Bear												
Spring	10,200	2.8	45,241	12.3	50,503	13.7	147,540	40.1	248	0.1	114,546	31.1
Summer	19,351	5.3	58,026	15.8	73,364	19.9	98,690	26.8	4,301	1.2	114,546	31.1
Fall	1,080	0.3	65,649	17.8	72,660	19.7	105,850	28.7	8,493	2.3	114,546	31.1
Marten												
Winter	69,735	18.9	*nc*	*nc*	2,814	0.8	2,658	0.7	*nc*	*nc*	293,070	79.6
Fisher/Black Bear												
Natal/Winter Denning	3,293	0.9	*nc*	*nc*	7,664	2.0	64,399	16.7	*nc*	*nc*	310,739	80.5
LSA												
Moose												
Early Winter	1,315	3.4	5,772	14.9	10,828	27.9	3,797	9.8	4,225	10.9	12,926	33.3
Late Winter[2]	1,084	2.8	1,857	4.8	2,335	6.0	2,908	7.5	615	1.6	30,064	77.4
Mountain Goat[3]												
Winter	5,419	13.9	1,546	4.0	4,449	11.4	836	2.2	26,614[6] ha		68.5[6] %	
Summer	4,089	10.5	4,482	11.5	6,347	16.3	2,181	5.6	21,764[6] ha		56[6] %	
Grizzly Bear												
Spring	1,702	4.4	6,838	17.6	5,776	14.9	15,140	39.0	44	0.1	9,361	24.1
Summer	975	2.5	7,353	18.9	10,784	27.8	9,941	25.6	447	1.1	9,361	24.1
Fall	514	1.3	8,420	21.7	9,562	24.6	9,796	25.2	1,210	3.1	9,361	24.1
Hibernating[4]	200	0.5	*nc*	*nc*	3,960	9.9	5,810	14.6	*nc*	*nc*	29,902	75.0

(continued)

Table 10-2. Summary of Habitat Suitability Modelling for Five Species in the RSA and LSA (completed)

Species and Season	Area of Modeled Habitat (ha)											
	High	%[1]	Mod. High	%[1]	Moderate	%[1]	Low	%[1]	Very Low	%[1]	Nil	%[1]
LSA *(cont'd)*												
Marten												
Winter	8,652	22.3	*nc*	*nc*	668	1.7	386	1.0	*nc*	*nc*	29,156	75.0
Hoary Marmot												
Growing[5]	2,356	4.8	*nc*	*nc*	10,071	20.4	647	1.3	*nc*	*nc*	36,277	73.5
Fisher/Black Bear												
Natal/Winter Denning	856	2.3	*nc*	*nc*	1,011	2.6	7,799	20.1	*nc*	*nc*	29,157	75.0

[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 201,941 ha (54.9%) were not rated for moose late winter habitat suitability.*
[3] *Very Low includes Nil Rated Habitat (i.e., Very Low/Nil)*
[4] *A total of* 5,315 ha (28% of LSA) *was not rated for grizzly bear hibernating habitat suitability*
[5] *A total of 8,924 ha (28% of LSA) was not rated for hoary marmot growing habitat suitability*
[6] *Very low and nil are grouped together*
nc - not calculated

Moderately High to Highly suitable grizzly bear habitat was identified for all seasons within approximately a fifth of the RSA and almost a quarter of the LSA. Most of the higher rated seasonal grizzly bear habitats areas within the LSA occurred near the exploration access road east of Knipple Glacier along the Bowser River and Wildfire Creek Valleys, in small patches along the proposed Brucejack Transmission Line – South Option and along Todedada Creek. Within the RSA, more spring feeding habitat was identified than summer habitat. High rated spring habitat was primarily distributed throughout the eastern portion of the RSA on mid-elevation slopes and within lower elevation riparian zones and High rated summer habitat was primarily located along the Unuk River and its drainages and within patches of low to mid-elevation slopes. High rated fall feeding habitat occurred along the Bell-Irving River and within the floodplains of the Bowser River west of Bowser Lake. Just over 10% of the habitat assessed in the LSA was rated as Moderate to Highly suitable grizzly bear hibernating habitat. Although infrequent, High and Moderately suitable denning habitat was identified near the proposed Brucejack Mine Site along the western edge of the LSA, on both sides of the exploration access road near the end of Knipple Glacier, along the proposed Brucejack Transmission Line – South Option just south of Berenden Glacier and in small scattered patches along the northwestern side of Mount Anderson and south of the exploration access road. Important fall habitat supporting moose and salmon feeding opportunities were identified along the Unuk River drainage in the western RSA and in the eastern RSA along Bell-Irving River, Treaty Creek, and Bowser River drainages. Important summer feeding areas based on marmot availability were also identified above the Bowser River floodplain and along Mount Anderson.

High rated winter marten habitat was extensively distributed throughout low elevation mature and old growth conifer forests of the study areas along major river valleys, including: the Unuk, Bowser and Bell-Irving Rivers, and the Treaty, Scott, and Wildfire Creeks. High and Moderate rated habitat accounted for a quarter of the total RSA. A quarter of the LSA was identified as Highly suitable winter habitat for marten. Most of the forest habitat along the eastern portion of the exploration access road was ranked High but very little Highly suitable habitat was mapped along the proposed Brucejack Transmission Line – South Option or near the proposed Brucejack Mine Site.

The LSA was modelled for hoary marmot. A quarter of the LSA was found to have Higher rated (moderate and high) habitat distributed across suitable alpine areas. Moderate habitat areas were identified close to proposed infrastructure including areas adjacent to the proposed Brucejack Mine Site and patchily distributed along the exploration access road along the slopes of Mount Knipple and Mount Anderson. Those areas were verified as occupied during the 2012 Brucejack baseline field studies (2013 Baseline ref). Three quarters of the LSA that was modelled was rated as Nil suitability for marmots. Portion of the LSA (28%), were not evaluated because they occurred in lower elevation forested habitat along the major river valleys.

Over three quarters of the forested habitat within the RSA and LSA was modelled as unsuitable denning habitat for fisher and black bear and functional habitat was found to occupy less than 5% of both the RSA and LSA. Nil quality habitat encompassed most of the area surrounding the proposed Brucejack Mine Site and along the proposed Brucejack Transmission Line – South Option, with High value habitat only identified along the Bowser River floodplain overlapping and near the exploration access road and patchily distributed along the Bell-Irving. Fisher were detected in areas that were rated as High quality habitat (Rescan 2013c).

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Engineers and Scientists

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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Appendix 1

Species Account for Moose

Engineers and Scientists

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); and
- **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*)	Myrtle pachistema/Falsebox (*Pachistima myrsinities*)
Balsam (*Abies* spp.)	Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*)
Douglas maple (*Acer glabrum*)	Trembling aspen (*Populus tremuloides*)
Sitka alter (*Alnus crispa*)	Cherry (*Prunus* spp.)
Saskatoon (*Amelanchier alnifolia*)	Cascades rhododendron (*Rhododendron albiflorum*)
Bog birch (*Betula glandulosa*)	Scouler willow (*S. scouleriana*)
Paper birch (*Betula papyrifera*)	Willow (*Salix* spp.)
Swamp birch (*Betula pumila*)	Elderberry (*Sambucus* spp.)
Birch (*Betula* spp.)	Western mountain ash (*Sorbus scopulina*)
Red osier dogwood (*C. stolonifera*)	Mountain ash (*Sorbus* spp.)
Hazelnut (*Corylus californica*)	Western Pacific yew (*Taxus brevifolia*)
Black twinberry/bearberry honeysuckle (*Lonicera involucrate*)	Western red cedar (*Thuja plicata*)
	Highbush cranberry/Lowbush cranberry (*Viburnum edule*)
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 (October - Dececmber) 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).

<u>Security Habitat (SH)</u>

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).

<u>Thermal Habitat (TH)</u>

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.

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 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)*

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; Tables 4 to 6).

Table 4. Summary of General Habitat Attributes for Moose

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

Table 5. 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)

Table 6. 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%)

<u>Ratings Assumptions</u>

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 7. Areas falling outside of this criteria will not be ranked (BAFA and CMA BECs).

Table 7. 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

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); and
- **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.

Feeding Habitat (FD)

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

Mountain goats feed on a variety of plant foods (Table 1). Grasses, sedges, rushes, ferns, forbs, lichens, shrubs and conifers are important in different seasons. During 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.

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)

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).

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).

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)*

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).

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; Tables 4 to 7).

Table 4. 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

Table 5. 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%)

Table 6. 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

Table 7. 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); and
- **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.

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

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).

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).

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*)
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).

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.

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 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)*

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; Table 4).

Table 4. 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.

<u>Ratings Assumptions</u>

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.

<u>Ratings Adjustments</u>

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

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); and
- **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).

Ratings

There is an intermediate level of knowledge of the habitat requirements of martens in British Columbia, which warrants a 4-class rating scheme (RIC 1999; Table 3).

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

Table 3. 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.

Ratings Assumptions

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.

Ratings Adjustments Considerations

Habitat capability and suitability maps may incorporate:

1. Conifer forests of young age that function as later seral forest may be upgraded; and
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); and
- **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

Species Account for Fisher

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Appendix 6. Species Account for Fisher

Name	*Martes pennanti*	
Species Code	M-MAPE	
Status*	**Global:**	G5 – Secure. Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.
	Provincial:	S2S3 – Imperiled/Vulnerable. Imperiled province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the province.
	COSEWIC:	Not listed.
	BC List:	**B**lue-listed. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. "Class 2" furbearer ("not present on most registered traplines in manageable numbers, and vulnerable to overharvest")
	Identified Wildlife:	Not listed.

**References (BC CDC 2013)*

DISTRIBUTION

Provincial Range

Fisher are found at low densities throughout the province of British Columbia with the exception of the coastal islands, including Vancouver Island (Banci 1989). They are a non-migratory, year-round resident. They are only found in North America, however their present distribution is reduced from their range prior to European colonization due to intense harvesting of furs in the early 20th century. This reduction has mostly occurred in the United States, although at a local level, fishers have also been extirpated from residential, industrial, and agricultural areas in British Columbia as well (Powell, 1982 in Banci 1989).

Elevational Range

Fisher generally inhabit middle-range elevations, and do not change elevation between seasons (Banci 1989). Deep snow conditions commonly found at higher elevations throughout a large part of the year apparently create difficulties in mobility (R. A. Powell and Zielinski 1994; Krohn, Zielinski, and Boone 1997). Lower elevation coastal forests are also rarely used due to heavy snow accumulations and predominantly warm conditions, which prevent the formation of a supportive crust on top of the snow pack.

Provincial Context

The latest population estimates give a range of 1,113 to 2,759 (based on two density scenarios), with 1,454 to 2,236 being the most likely range (Weir 2003). This was an extrapolation from a study in the Williston area of north-central British Columbia, where late winter densities of 1 fisher per 146 km^2 were recorded (Weir, Harestad, and Corbould 2004). It was also estimated that 40 to 116 fishers may occur within protected areas in British Columbia at the end of winter (Weir 2003). There is insufficient information at this time to analyse the population trend in British Columbia over the past 10 years.

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); and
- **Project Map Scale:** 1:20,000.

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

The fisher is closely related to the American marten (*Martes americana*) and more distantly related to the other members of the *Mustelidae* family (wolverines, weasels, otters, badger, and mink). They grow to be 33 - 40" from nose to tail, with males weighing 6 to 12 pounds (2.7 - 5.4 kg) and females weighing 3 to 7 pounds (1.4 - 3.2 kg; R. A. Powell 1982). They are a solitary animal that has peak activity patterns around sunrise and sunset, however, they may be active at any time throughout the day and night (Banci 1989). They are a generalist predator and prefer habitats that are considered to possess a high degree of diversity and interspersion that support a diverse prey base. Fisher have the capacity to take advantage of a variety of foods depending on their relative abundance (S. M. Arthur, Krohn, and Gilbert 1989; Banci 1989; S. M. Powell, Scanlon, and Fuller 1997).

Fisher occur primarily in forested landscapes and often prefer late successional forests over young seral stages (Jones and Garton 1994; Weir and Harestad 1997). It appears that fisher in western coniferous forests may rely on the ecological processes and structure associated with old-growth stands to fulfill many of their life requisites (Ruggiero et al. 1994; Weir and Harestad 1997). In the winter, fisher attempt to avoid areas of deep snow and will use forests with high canopy structure that intercepts much of the snowfall (Raine 1983; S. M. Arthur, Krohn, and Gilbert 1989). This is in contrast to their close relative, the marten, whose smaller body size and relatively large feet allow for easy winter travel.

Both males and females are sexually mature at one year of age; however, females don't usually give birth until their second year due to delayed implantation (Banci 1989; R. A. Powell and Zielinski 1994; Frost and Krohn 1997). Spring is when mating occurs (just after the females give birth) but implantation occurs the following fall, depending on the fitness level of the female. Young are born from January to May (R. A. Powell 1982), with most births occurring from March to April (Banci 1989). Females will have between 1 and 4 kits each year (most commonly 2-3; R. A. Powell 1982; Banci 1989). The young normally remain with their mother through the following winter, but most establish their own territories within the first year (Stephan M. Arthur, Paragi, and Krohn 1993).

Fishers use dens for reproduction, as well as for security, thermal protection, and resting. In British Columbia, most of the natal dens found have been located in large-diameter, declining cottonwood trees. Reproductive dens were found to have very specific habitat requirements. Denning primarily occurs in live but "declining" trees with some kind of damage that has created rotting within the heart of the tree. Boles that are greater than 40 cm in diameter are needed to provide for a cavity of at least 30 cm diameter within. In addition to this only certain tree species are selected based on the biogeoclimatic zone in which they are located and are as follows:

- SBS and MS: Black cottonwood ≥ 90 cm dbh;
- BWBS: Trembling aspen ≥ 40 cm dbh;
- Balsam poplar ≥ 50 cm dbh;
- SBPS: Trembling aspen ≥ 40 cm dbh;
- Lodgepole pine ≥ 35 cm dbh; and
- IDF: Douglas-fir ≥ 60 cm dbh.

In south-central British Columbia, Weir (1995) also found that fisher selected trees of a large diameter; the average diameter at breast height was observed to be 103 cm and the average height of the dens being 25.9 m up the tree bole. Banci (1989) however, found natal dens to be between 7 and 12 m from the ground. Stands chosen for natal dens also tended to have a larger proportion of large coarse woody debris (> 20 cm) than adjacent stands (Weir 1995). Large diameter cottonwoods may be a critical habitat component for fisher natal dens in south-central and north-central B.C. (Weir 1999). Due to the fisher's diverse diet, specific habitat selection may be more dependent upon the availability of resting and denning sites than on forage opportunities (R. A. Powell and Zielinski 1994). Limiting habitat for fishers may be maternal denning habitat that is in close proximity to feeding habitat.

Fishers are generalist feeders and have a diverse diet, which consists mainly of small- to medium-sized mammals, birds, and carrion. Some preferred food items include snowshoe hare, porcupines, squirrels, mice, shrews, various fruits, and moose and deer in the form of carrion (S. M. Arthur, Krohn, and Gilbert 1989; Martin 1994; S. M. Powell, Scanlon, and Fuller 1997). Fisher are the only predator that commonly prey upon porcupines, which can make up an important portion of their diet. However, Weir (1995) found that fishers in British Columbia tend to use porcupine less than in other study areas. Throughout most of the fisher's range, snowshoe hares are probably the primary food source (Kuehn 1989). Two studies in Manitoba found snowshoe hares to constitute 70% and 84.3% of fisher diets (Raine 1987). Fisher populations in British Columbia however, are not as dependent on hare populations as some studies done in eastern Canada suggest (Kuehn 1989). In south-central British Columbia, snowshoe hares made up 31.4% of fisher diets and were recorded as the most frequently used species of prey (Weir 1995). Fishers will switch prey based on availability (Banci 1989) and can therefore compensate for the decrease in population of any one prey species by focusing on others (Kuehn 1989; Weir 1995). The general diet of marten overlaps considerably with that of the fisher, and it is possible that competition between the two species may occur (de Vos 1952). Fisher diets do not exhibit large seasonal differences; however, there is an increased use of plant material (fruits and nuts) during summertime (R. A. Powell and Zielinski 1994).

Fisher are non-migratory with the same home range being used throughout the year. Home range sizes are 20 to 34 km^2 for adult males and 15 to 19 km^2 for adult females (Banci 1989). Home ranges within each sex do not overlap, however male and female ranges generally do (S.M. Arthur 1987; Cannings et al. 1999). Weir (1999) found that in north-central British Columbia, the home range size of one adult male fisher was 281.8 km^2 with a core area of 60.1 km^2. This compared with 49.9 km^2 (10.1 km^2 core area) for females. It was also found that the home range size of females was smaller in the summer versus the winter, the home range size of females with kits was smaller than that of females without kits, and reproducing females who had summer ranges that included extensive floodplain ecosystems had smaller home ranges than the female whose summer home range did not include these ecosystems (Weir 1999).

Fisher generally select late succession forests over young seral stages (Jones and Garton 1994; Weir and Harestad 1997). They also tend to avoid non-forested areas (Jones and Garton 1994; R. A. Powell and Zielinski 1994; Thomasma, Drummer, and Peterson 1994; Weir 1995) as well as mixed-selectively logged stands (Buck et al. 1994; Weir 1995; Lieffers and Woodard 1997). It is believed that the diverse structure of old-growth stands provide the majority of the security, thermal, and feeding requirements of the fisher (Ruggiero et al., 1994 in Weir and Harestad 1997). This structure generally includes relatively closed canopy forests, although apparently at least some of that canopy may be deciduous (RIC 1997). Fisher tend to also select denning sites that possess a larger proportion of large coarse woody debris (> 20 cm) than adjacent stands (Weir 1995) which is also an attribute of later succession forests. Coarse woody debris in decay classes 1, 2, and 3 are the most important for resting and denning sites (Keisker 2000). In the winter, fishers tend to select for spruce stands with an aspen component and use coarse woody debris for thermal protection when temperatures are low (Weir 1995). Dens used as day resting sites are diverse and predominantly arboreal (in witch's brooms, tree cavities, squirrel nests, and raptor nests) but may also include snow dens, dens under boulders, hollow logs, and burrows (Banci 1989).

HABITAT USE – LIFE REQUISITES

The life requisite that is rated in this model for fisher is **Denning** (natal and maternal) during the **winter** season. The emphasis was on identifying stands that were most likely to support trees of sufficient diameter and decay structure to support natal and maternal dens.

Denning – Winter

Fisher use many different structures for fulfilling their security and thermal requirements in the winter season. This includes subnivean burrows, snow dens, hollow logs, tree cavities, large branches, and witch's brooms for resting dens (R. A. Powell 1977; Weir 1999). In British Columbia, Weir (2003) recorded fishers using branch rest structures most frequently (57.0%), followed by cavity (19.8%), coarse woody debris (18.6%), and ground rest structures (4.6%). Fisher will typically focus on old-growth forest types that are conifer dominant with some deciduous component to provide the required structure for resting den sites. This includes over-mature trees or snags to provide cavities, large branches, and witch's brooms; a high level of coarse woody debris to provide hollow logs and create snow dens; and high canopy closure for snow interception for ease of travel. Reproductive (natal and maternal) denning structures are very important to fisher and Weir and Almeudo (2010) identifies that fisher need cavities in large trees for giving birth and rearing young during winter and early spring. Some examples of suitable trees provided by Weir and Almeudo (2010) include black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) with diameters over 90 cm, balsam poplar (*Populus balsamifera* ssp. *balsamifera*) with diameters over 50 cm, trembling aspen (*Populus tremuloides*) with diameters over 40 cm, and conifer including lodgepole pine, (*Pinus contorta)* with diameters greater than 35 cm. While large cottonwood and balsam poplar are associated with low elevation riparian habitat, mesic and submesic sites can also produce trees with suitable diameter to support fisher dens

Powell (1977) found that all resting den sites in winter were temporary and were not used for more than one day. Temperature is an important factor in the selection of rest sites (R. A. Powell and Zielinski 1994). Taylor and Buskirk (1994) studied the thermal properties of branch, cavity, and coarse woody debris sites in Wyoming and found that the warmest microclimates were provided by coarse woody debris sites and were generally used when temperatures dropped below -5°C, especially when associated with high wind speeds. Deeper snow packs (> 15 cm) also increased the insulation values of these sites (Taylor and Buskirk 1994). In British Columbia, Weir (2003) found that fisher used subnivean coarse woody debris structures exclusively when temperatures were below -15°C. In the absence of restrictive thermoregulatory demands, fisher probably select arboreal resting sites due to the increased protection from predators provided by an elevated vantage point while also having the additional advantage of improving detection of potential prey (Raphael and Jones 1997).

Habitat Requirements Summary

The following summary of the key habitat requirements for natal and maternal denning of fisher (Table 1) is based on the assumption that fisher habitat use in the Brucejack area is similar to that reported for this species in other areas of British Columbia and other populations in North America (as summarized in the previous sections of this report; Table 2).

Table 1. Summary of Habitat Requirements for Fisher in the Brucejack Project Area

Life Requisite	Season	Specific Attributes Required	Preferred Structural Stages
Natal and Maternal Denning	Winter	• Mature and old growth cotton wood dominant stands (e.g. riparian forest) with potential to support cottonwood stems greater than 50 cm • Deciduous or mixed stands that are likely to have aspen with diameters over 40 cm • Mature and old growth conifer dominant forests that can produce stems of pine, spruce or fir greater than 35cm	7, 6, and 5 (if deciduous dominant)

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ratings

Detailed knowledge of winter fisher habitat use for satisfying feeding, security, and thermal life requisites is moderate; therefore, a four-class scheme using ratings of **1 = High, Moderately High, 2 = Moderate, 3 = Low,** and **4 = Nil** (RIC 1999) was applied to the ecosystems for the life requisite of living during the winter season.

No adjustments were made beyond the classification of ecosystem units (Table 2).

Table 2. Ratings Adjustments and Considerations

		Structural Stage						
BEC Variant	**Site Series Code**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
ICHvc	01	4	4	4	4	4	3	3
	02	4	4	4	4	4	3	3
	03	4	4	4	4	4	3	3
	04	4	4	4	4	1	1	1
	05	4	4	4	2	1	1	1
	06	4	4	4	4	4	2	2
	51	4	4	4	4	4	4	4
	52	4	4	4	4	4	4	4
CWHwm	01	4	4	4	4	4	3	3
	02	4	4	4	4	4	3	3
	03	4	4	4	4	4	3	3
	04	4	4	4	4	4	4	4
	05	4	4	4	4	1	1	1
	06	4	4	4	4	1	1	1
	07	4	4	4	2	1	1	1

(continued)

Table 2. Ratings Adjustments and Considerations (completed)

		Structural Stage						
BEC Variant	**Site Series Code**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
CWHwm (cont'd)	08	4	4	4	4	4	2	2
	09	4	4	4	4	4	2	2
	10	4	4	4	4	4	4	4
	31	4	4	4	4	4	4	4
	Wf01	4	4	4	4	4	4	4
	00	4	4	4	4	4	4	4
	00	4	4	4	4	4	4	4
	00	4	4	4	4	4	4	4
	00	4	4	4	4	4	4	4
ESSFwv	01	4	4	4	4	4	3	3
	02	4	4	4	4	4	3	3
	04	4	4	4	4	4	3	3
	05	4	4	4	4	4		
	06	4	4	4	4	4	2	2
	07	4	4	4	4	4	2	2
	08	4	4	4	4	4	3	3
	09	4	4	4	4	4	2	2
MHmm2	01/04	4	4	4	4	4	3	3
	02	4	4	4	4	4	3	3
	03	4	4	4	4	4	3	3
	05	4	4	4	4	4	2	2
	06	4	4	4	4	4	2	2
	07	4	4	4	4	4	4	4
	08	4	4	4	4	4	3	3
	09	4	4	4	4	4	2	2
BAFA								
CMA								

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Appendix 7

Species Account for Black Bear

Engineers and Scientists

Appendix 7. Species Account for Black Bear

Name **Species Code**	*Ursus americanus* M-URAM	
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 at Risk. The species has been evaluated and found to be not at risk.
	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 2013)*

DISTRIBUTION

Provincial Range

Black bears occur commonly throughout their range. Populations in BC are stable, and currently, approximately 140 000 - 160 000 black bears occur in BC (T. Hamilton, pers. comm.). Black bears occur from sea level in coastal estuaries, up to high elevation alpine meadows; and are present in every biogeoclimatic zone in the province. The highest coastal concentrations of black bears occur in the Kitimat Range (KIR) and Nass Ranges (NAR) ecosections, whereas, the Chilcotin and Okanagan areas have low densities. Relative densities of black bear are lower on southern Vancouver Island due to the preponderance of closed canopy second growth forest and human settlements.

Elevational Range

Black bears are widespread throughout a variety of habitats from Sea-Level to Alpine.

Provincial Context

Black bears inhabit all forested regions of British Columbia. They can be found within all biogeoclimatic zones and occupy a wide variety of habitats ranging from coastal estuaries to alpine meadows.

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); and
- **Project Map Scale:** 1:20,000.

ECOLOGY AND KEY HABITAT REQUIREMENTS

General

Black bears prefer forested and shrubby areas, but use wet meadows, high tidelands, ridgetops, burned areas, riparian areas and avalanche chutes (Pelton 1972). They prefer mesic over xeric sites and timbered over open areas (Unsworth, Beecham, and Irby 1989). Black bears are very adaptable and inhabit a wide variety of plant communities. In the Northwest black bears are found in spruce-western red cedar-hemlock forests as well as pine and fir forests (Pelton 2003).

Black bears are omnivorous and opportunistic in their feeding habits. Green leafy material forms the bulk of their diet, especially in late spring and early summer. They also feed on insects, fruits, berries, fish, garbage, carrion, and small mammals. Occasionally, black bears will prey on young/small deer.

During periods of inactivity, black bears periodically utilize bed sites in forest habitat with thick understudy vegetation. These sites are often a simple shallow depression in the forest leaf litter, but may become deeper with use.

Home Range

Seasonal movement of black bears within a geographic area are influenced by the juxtaposition or availability of seasonally important food resources or habitat components, breeding activity, reproductive status of individuals and availability of denning habitat (Rogers 1977). Black bears make extensive seasonal movements to areas of food abundance such as spring green-up sites, spawning areas, berry patches and garbage dumps (Rogers 1977; Modafferi 1978). In particular, these extensive movements occur to and from winter den sites and during the late summer and fall when foraging activities increase (Pelton 2003). Migrating black bears will use movement corridors such as game trails, human trails, open edges, shorelines, ridges, creek beds, snow filled avalanche chutes, logging roads, sandbars or rivers (Stevens and Lofts 1988). Generally, adult males have the largest home ranges, which may be several times as large as those of females and overlap more than those of females (Young and Ruff 1982). Females have well-defined home ranges of between 12 and 50 km^2. Male black bears, especially subadults, have much larger home ranges, sometimes traveling 50 km or more to a preferred food source or winter denning site (Rogers 1977).

Reproduction

Breeding occurs in May and June (Stevens and Lofts 1988). Gestation is 6 to 7 months long with one to three cubs being born from late November through February. Birth and early maternal care occurs in the winter den. The cubs remain with their mother for 1 to 2 years. Hollow trees or fallen logs are used for hibernating habitat.

HABITAT USE – LIFE REQUISITES

The life requisite that will be rated for black bear is hibernating, which are described in detail below.

Hibernating Habitat (HI)

Suitable dens for black bears are warm, dry and secure. Black bears hibernate between October and May. However, black bears in coastal habitats may not enter their dens until late November or early December, emerging in April. Some coastal black bears, given suitable climate regimes, don’t enter dens. Typically dens are underground and in locations that catch early snow and maximize the snow’s insulative qualities. Cavities in old-growth structures, including large old trees, stumps, root bolls and logs having a diameter greater than 85 cm are suitable dens. Yellow cedar and western red cedar are important hibernating sites, although sites are likely based on den structure, rather than tree species. Hibernating in second growth forest stands is limited by suitable denning locations.

Seasons of Use

Black bears require different feeding, security and thermal habitat differently throughout the year. Table 1 summarizes the life requisites black bear for each month of the year for the Coast and Mountains ecoprovince.

Table 1. Monthly Life Requisites for Black Bear

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

HABITAT USE AND ECOSYSTEM ATTRIBUTES

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

Table 2. Predictive Ecosystem Mapping (PEM) Relationships for the Denning Life Requisite for Black Bear

Life Requisite	PEM Attribute
Hibernating (HI)	• site - site series, site disturbance, elevation, slope, aspect • soil - terrain classification, rooting depth, rooting zone particle size, root

Based on the habitat requirements identified in this species account and the location of the project (i.e., Coast and Mountains Ecoprovince), the Winter (Denning) season will be rated for black bear.

<u>Ratings</u>

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; Tables 3 and 4).

Table 3. Summary of Hibernating Habitat Attributes for Black Bears

Habitat Use	Specific Attributes for Suitable Black Bear Habitat	Structural Stage
Hibernating Habitat	• deep, fine-textured soils • dry, moisture-shedding site • higher elevation, steep slope site • old-growth coastal forests, with large diameter tress and coarse woody debris.	6,7

Table 4. 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
Habitats	skunk cabbage, floodplains, wetlands, estuaries/beaches; the highest densities of black bears are associated with extensive areas of early seral stages complexed with salmon bearing streams, marine beach habitats, and forested ecosystem units for security/thermal cover.	

Ratings Assumptions

1. Ecosystem units with tree species composition of mixed conifer/deciduous species, and/or mature shrub cover (e.g., > 35%), and/or high canopy closure (e.g., > 50%) or any equivalent combination will be rated class 1 security/thermal habitat for black bears across all seasons.
2. High elevation ecosystem units on steep slopes, with dry stable, fine-textured soil conditions will be rated class 1 for hibernating habitat.
3. In coastal ecosystems, black bear hibernating habitat can occur in the old-growth forests with, for example, large diameter trees which offer hollow boles, and/or large diameter downed hollow, coarse woody debris.
4. Black bear habitat use is strongly influenced by intraspecific social interactions and the presence and activities of people.
5. Although it is recognized that other factors such as predation, disease, intra/inter specific competition and hunting influence black bear population growth and distribution, this model does not include these factors.

Ratings Adjustments

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

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

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Appendix 8

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

Engineers and Scientists

Appendix 8. Predicitive 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-URAR LI-DE	M-MAAM LI-W	M-MACA LI-G	M-URAM LI-DE	M-MAP LI-DE
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		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			

Appendix 8. Predicitive 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-URAR LI-DE	M-MAAM LI-W	M-MACA LI-G	M-URAM LI-DE	M-MAP LI-DE
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			
ESSFwv	00	BA	Barren	sparsely vegetated	1	4	99	4	4	4	4	4		N			

Appendix 8. Predicitive 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-URAR LI-DE	M-MAAM LI-W	M-MACA LI-G	M-URAM LI-DE	M-MAP LI-DE
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			

Appendix 8. Predicitive 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-URAR LI-DE	M-MAAM LI-W	M-MACA LI-G	M-URAM LI-DE	M-MAP LI-DE
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			
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			

Appendix 8. Predicitive 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-URAR LI-DE	M-MAAM LI-W	M-MACA LI-G	M-URAM LI-DE	M-MAP LI-DE
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			

Appendix 9

2012 Habitat Suitability Field Evaluation Data

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Engineers and Scientists

Appendix 9. 2012 Habitat Suitability Field Evaluation Data

Field Data																Draft Models					
Plot	Grizzly Bear Living Spring	Grizzly Bear Living Summer	Grizzly Bear Living fall	Grizzly Bear Denning	Fisher Denning	Marten Living Winter	Moose Early winter	Moose Late Winter	Mountain Goat Summer	Mountain Goat Winter	Hoary Marmot Living General	Northing	Easting	Date	ALTITUDE	Fisher Denning MAPE	Hoary Marmot CACA	American Marten Winter MAAM	Grizzly Bear Denning URAR	Grizzly Bear Fall URAR	Grizzly Bear Summer URAR
1	1	3	3	n	n	n	3	3	1	2	n	6263731	469422	24-JUL-12 14:23	457	4	6	2	0	2	2
2	2	2	2	n	m	h	2	2	2	1	n	6263664	469652	24-JUL-12 15:26	438	4	6	2	0	2	2
3	3	2	3	n	l	h	3	4	3	2	n	6263694	469603	24-JUL-12 16:03	0	4	6	2	0	2	2
7	3	3	4	n	m	h	4	3	2	1	n	6262768	468674	25-JUL-12 07:50	652	4	6	2	0	2	2
8	1	2	3	n	n	n	3	2	1	2	n	6262310	468814	25-JUL-12 08:47	689	6	4	6	0	3	3
9	3	4	5	n	m	m	4	3/4	4	3	n	6262018	468099	25-JUL-12 09:47	711	4	6	2	0	2	2
10	1	2	2	n	n	n	3	2	1	2	n	6261823	468125	25-JUL-12 10:35	682	4	6	2	0	2	2
11	3	3	4	n	m	h	4	3	3	1	n	6261603	468119	25-JUL-12 11:19	708	4	6	2	0	2	2
12	1	2	3	n	n	n	3	2	1	2	n	6261246	468142	25-JUL-12 12:11	690	6	4	6	0	3	3
13	2	4	5	n	n	n	4	3	3	2	n	6260928	468332	25-JUL-12 12:51	695	6	6	6	0	5	3
14	3	2	3	n	m	h	4	3	2	2	n	6260976	468398	25-JUL-12 13:24	658	6	6	6	0	5	3
15	3	2	2	n	m/l	h	4	3	2	2	n	6259699	468839	25-JUL-12 14:32	630	4	6	2	0	2	2
16	1	2	3	n	n	n	3	2	1	2	n	6258607	469166	25-JUL-12 15:15	680	6	0	6	0	2	1
17	1	2	2	m	n	n	6	6	1	3	h	6259577	456344	26-JUL-12 07:55	1476	6	2	6	0	2	2
18	2	3	3	m	n	n	6	6	2	2	h	6259742	456640	26-JUL-12 08:44	1594	6	4	6	0	4	4
19	4	4	4	m	n	n	6	6	4	3	m/l	6259919	456695	26-JUL-12 09:33	1657	6	2	6	0	3	4
20	5	5	5	l	n	n	6	6	5	5	n	6260006	456806	26-JUL-12 09:58	1694	6	4	6	0	4	4
21	4	4	4	m	n	n	6	6	4	2	l	6259635	456599	26-JUL-12 10:23	1556	6	2	6	0	3	4
22	1	2	1	m	n	n	6	6	1	2	h	6259549	456507	26-JUL-12 11:00	1505	6	2	6	0	2	2
23	1	2	2	l	n	n	6	6	1	2	h	6259336	456135	26-JUL-12 11:47	1374	6	2	6	0	3	2
24	4	2	3	m	n	l	5	6	3	1	n	6259256	456086	26-JUL-12 12:36	1341	6	2	6	0	2	2
25	2	3	3	n	n	n	2	6	2	2	l	6259523	455933	26-JUL-12 13:17	1345	6	2	6	0	2	2
26	1	2	2	m	n	n	6	6	1	3	n	6254460	441762	27-JUL-12 10:49	1420	6	4	6	0	4	3
27	2	3	2	l	n	n	6	6	1	3	h	6254508	441969	27-JUL-12 11:57	1507	6	4	6	0	4	3
28	3	4	2	l	n	n	6	6	3	2	m	6254666	442021	27-JUL-12 12:53	1579	6	4	6	0	4	4
29	2	3	3	l	n	n	5	6	2	3	m	6256285	437373	27-JUL-12 13:41	1365	6	4	6	0	4	3
30	2	3	3	l	n	n	5	6	2	3	m	6256464	437412	27-JUL-12 14:11	1381	6	2	6	0	2	2
31	3	2	2	m	n	n	5	6	3	2	m	6256209	437415	27-JUL-12 15:01	1326	6	2	6	0	3	2
32	4	4	4	l/n	n	n	6	6	4	3	l	6256158	437648	27-JUL-12 15:59	1336	6	4	6	0	4	4
33												6256106	437601	27-JUL-12 16:25	1302	6	4	6	0	4	3
34	3	4	4	n	n	n	2	2	3	2	n	6263884	468362	29-JUL-12 13:17	516	6	0	6	0	4	4
35	2	3	4	n	l	h	4	3	4	2	n	6263532	468596	29-JUL-12 13:54	564	4	6	2	0	2	2
36	1	1	2	n	n	n	3	3	2	1	n	6260084	466798	29-JUL-12 15:18	684	6	4	6	0	3	3
37	2	4	5	n	n	n	4	3	3	2	n	6257934	466796	29-JUL-12 16:06	695	6	0	6	0	2	1
38	1	3	5	n	n	n	4	3/4	1	3	n	6257984	466819	29-JUL-12 16:29	715	6	0	6	0	2	1
39	2	3	2	n	h	l	1	1	4	2	n	6253316	452923	30-JUL-12 07:51	421	2	0	3	0	1	2
40	4	4	2	n	h	l	1	1	4	2	n	6253221	452945	30-JUL-12 08:39	403	2	0	3	0	1	2
41	3	2	2	n	n	n	1	1	3	2	n	6253371	453255	30-JUL-12 09:12	390	6	0	6	0	4	3
42	2	2	3	n	h	m	3	2	4	2	n	6253349	453267	30-JUL-12 09:37	394	6	0	6	0	4	3
43	4	2	3	n	n	m	3	3	4	2	n	6253519	453196	30-JUL-12 10:28	449	6	0	6	0	4	4
44	4	3	3	n	l	l	3	3	4	2	n	6253915	453615	30-JUL-12 11:31	469	6	2	6	0	2	2
45	4	4	4	n	l	m	3	3	4	2	n	6253930	453596	30-JUL-12 12:07	501	6	4	6	0	3	3
46	4	3	4	n	l	m	3	3	4	1	n	6254017	453141	30-JUL-12 13:19	521	6	4	6	0	3	3
47	2	3	5	n	n	n	4	4	3	4	n	6254877	452574	30-JUL-12 14:11	618	6	0	6	0	4	4
48	1	3	5	n	n	n	1	1	2	2	n	6254814	452609	30-JUL-12 14:45	620	3	6	3	0	3	3
49	3	4	5	n	n	n	4	4	4	3	n	6255576	452567	30-JUL-12 15:25	636	4	6	2	0	2	2
50	3	4	5	n	l/n	m	4	3	4	2	n	6256123	452739	30-JUL-12 16:03	626	4	6	2	0	2	2
51	2	3	5	n	n	n	1	1	2	2	n	6262658	452819	31-JUL-12 07:40	615	6	6	6	0	2	2
52	1	3	5	n	n	n	3	3	2	3	n	6262712	452891	31-JUL-12 08:01	614	6	6	6	0	2	2
53	2	3	5	n	n	n	1	1	2	2	n	6262885	452669	31-JUL-12 08:27	613	6	6	6	0	2	2
54	1	3	5	n	n	n	4	3	3	4	n	6262887	452464	31-JUL-12 08:51	620	6	6	6	0	2	2
55	4	4	4	n	n	n	3	3	4	3	n	6262896	452345	31-JUL-12 09:24	612	4	6	2	0	2	3
56	4	3	4	m	n	n	6	6	4	1	m	6264212	448519	31-JUL-12 10:26	1463	6	0	6	0	4	4
57	2	3	2	l	n	n	6	6	2	3	h	6264078	448497	31-JUL-12 10:57	1429	6	4	6	0	3	2

Appendix 9. 2012 Habitat Suitability Field Evaluation Data

Field Data																Draft Models					
Plot	Grizzly Bear Living Spring	Grizzly Bear Living Summer	Grizzly Bear Living fall	Grizzly Bear Denning	Fisher Denning	Marten Living Winter	Moose Early winter	Moose Late Winter	Mountain Goat Summer	Mountain Goat Winter	Hoary Marmot Living General	Northing	Easting	Date	ALTITUDE	Fisher Denning MAPE	Hoary Marmot CACA	American Marten Winter MAAM	Grizzly Bear Denning URAR	Grizzly Bear Fall URAR	Grizzly Bear Summer URAR
58	4	5	5	h	n	n	6	6	4	2	l	6264344	448471	31-JUL-12 11:37	1507	6	0	6	0	4	4
59	2	3	2	m	n	n	6	6	3	2	l/m	6264548	448494	31-JUL-12 12:07	1524	6	4	6	0	3	2
60	2	3	2	n	m	n	1	1	2	2	n	6250615	445473	31-JUL-12 13:01	434	6	0	6	0	4	4
61	3	1	2	n	n	n	3	2	2	1	n	6250542	445623	31-JUL-12 13:42	433	6	2	6	0	2	3
62	4	2	2	n	n	n	2	2	4	2	n	6249631	446389	31-JUL-12 14:54	414	6	0	6	-9999	4	4
63	1	3	5	n	n	n	4	4	2	4	n	6263245	457092	01-AUG-12 07:37	983	6	6	6	0	5	3
64	2	3	5	n	n	n	1	1	2	2	n	6263295	457060	01-AUG-12 08:03	983	6	6	6	0	5	3
65	4	3	3	n	m	h	3	4	3	1	n	6263170	457355	01-AUG-12 08:36	993	3	6	2	0	4	4
66	3	4	4	n	n	l	3	3	3	1	n	6263451	457383	01-AUG-12 09:14	995	4	6	2	0	2	3
67	2	3	5	n	n	n	1	3	2	2	n	6263241	457639	01-AUG-12 09:45	994	6	6	6	0	5	3
68	2	3	5	n	n	n	3	4	2	3	n	6263162	457771	01-AUG-12 10:14	994	6	6	6	0	5	3
69	5	2	4	n	n	n	3/4	2/3	3	2	n	6250558	449706	01-AUG-12 10:35	396	6	0	6	0	4	4
70	4	3	4	n	n	n	3	2	4	2	n	6251349	450331	01-AUG-12 11:31	396	6	4	6	0	3	3
71	4	2	3	n	h	m	2	2	2	1	n	6251552	450392	01-AUG-12 12:03	399	2	0	3	0	1	2
72	1	3	5	n	n	n	1/2	1/2	2	3	n	6265691	450923	01-AUG-12 13:16	596	6	6	6	0	5	3
73	2	3	5	n	n	n	1	1	2	2	n	6265612	450641	01-AUG-12 13:46	592	6	6	6	0	5	3
74	3	3	5	n	n	n	4/5	4/5	3	2	n	6265596	450524	01-AUG-12 14:17	599	6	4	6	0	4	4
75	2	2	3	n	m	h	4	3	2	1	n	6265781	450582	01-AUG-12 15:11	610	4	6	2	0	2	2
76	2	3	5	n	n	n	4	4/3	2	3	n	6265529	450848	01-AUG-12 15:58	586	6	6	6	0	5	3
77	1	2	2	1	n	n	6	6	1	3	m	6259487	449971	02-AUG-12 08:21	1404	6	4	6	0	4	4
78	4	3	3	m	n	n	6	6	3	2	l	6259314	450069	02-AUG-12 09:05	1345	6	6	6	0	6	6
79	2	2	2	m	n	n	5	6	2	1	m	6259330	450155	02-AUG-12 09:34	1307	6	4	6	0	4	4
80	1	2	2	l	n	n	6	6	1	3	h	6258285	459546	02-AUG-12 10:31	1474	6	3	6	0	3	2
81	2	3	2	l	n	n	6/5	6	1	3	h	6258158	459307	02-AUG-12 11:13	1449	6	3	6	0	3	2
82	1	2	2	m	n	n	6	6	1	3	h	6258420	459056	02-AUG-12 12:03	1529	6	2	6	0	2	2
83	2	3	2	l/n	n	n	6	6	3	3	l/m	6258395	459473	02-AUG-12 12:41	1516	6	0	6	0	4	4
84	1	2	2	l	n	n	6	6	1	3	h	6256513	456296	02-AUG-12 13:35	1450	6	3	6	0	3	2
85	2	2	2	m	n	n	6	6	1	3	h	6256318	456145	02-AUG-12 14:08	1421	6	2	6	0	2	2
86	4	5	5	l	n	n	5	6	4	2	n	6256406	456236	02-AUG-12 14:46	1450	6	2	6	0	3	3
87	1	2	2	m	n	n	6	6	1	3	h	6256660	456575	02-AUG-12 15:27	1379	6	2	6	0	3	3
88	3	2	3	n	l/m	h	3	3	3	1	n	6263902	469922	03-AUG-12 08:03	484	4	6	2	0	2	2
89	3	4	5	n	n	n	1/2	1/2	3	2	n	6263381	470602	03-AUG-12 08:31	451	6	4	6	0	3	3
90	3	2	3	n	n	n	1	1	2	2	n	6263033	471039	03-AUG-12 08:51	470	6	2	6	0	2	2
91	2	2	2	n	n	n	2	2	1	2	n	6256982	476342	03-AUG-12 09:23	442	6	2	6	-9999	2	2
92	3	4	3	n	l	h	1	1	3	1	n	6250406	479598	03-AUG-12 09:52	430	6	0	6	-9999	2	1
93	2	2	2	n	n	n	1	2/1	2	2	n	6243546	481019	03-AUG-12 10:33	365	6	0	6	-9999	4	3
94	3	3	2	n	h	l	1	1	2	2	n	6242835	481608	03-AUG-12 11:06	355	6	2	6	-9999	2	2
95	4	5	5	n	n	n	3	3	4	3	n	6243071	481198	03-AUG-12 11:34	387	6	0	6	-9999	4	4
96	2	3	3	n	n	n	5	6	1	1	l	6225431	434794	06-SEPT-12	1137	6	0	6	0	3	3
97	4	5	5	l	n	n	5	6	4	2	m/l	6225426	434859	06-SEPT-12	1165	6	0	6	0	4	4
98	4	3	3	l	n	n	6	6	4	1	n/l	6225473	434882	06-SEPT-12	1171	6	0	6	0	3	3
99	5	5	5	n	n	n	6	6	5	4	n	6225465	434958	06-SEPT-12	1201	6	0	6	0	4	4
100	1	2	2	l	n	n	6	6	1	3	h	6225412	435049	06-SEPT-12	1241	6	0	6	0	2	2
101	4	3	2	m	n	m/l	5	6	3	1	n	6227302	435320	06-SEPT-12	970	6	0	6	0	3	3
102	3	2	2	n	n	l	5	6	3	1	l	6227696	435122	06-SEPT-12	944	6	0	6	0	3	3
103	2	3	3	l	n	n	1	6	3	1	l	6233249	433510	06-SEPT-12	876	6	0	6	0	3	3
104	2	5	5	n	n	n	1	3	4	1	n	6235737	434663	06-SEPT-12	657	6	0	6	0	3	2

Appendix 9. 2012 Habitat Suitability Field Evaluation Data

Draft Models																	
Plot	Grizzly Bear Spring URAR	Moose Late Winter ALAL	Moose Early Winter ALAL	Mountain Goat Winter ORAM	Mountain Goat Summer ORAM	PEM Code	Area_ha	BEC_Label	BEC_Zone_N	Zone	Subzone	Site_S	Site_MC_S	Site Unit	StrctStage	GenEcoType	ALTITUDE
1	3	2	2	5	5	9018	936.5	ICHvc	5000	ICH	vc	00	BA	Barren	1	sparsely vegetated	457
2	3	2	2	5	5	5031	2904.2	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	438
3	3	2	2	5	5	9023	1881.2	ICHvc	5000	ICH	vc	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	0
7	4	4	3	5	5	5011	6897.0	ICHvc	5000	ICH	vc	01	HD	HwBl - Devil's club	6/7	Mesic Forest	652
8	3	3	2	5	5	9015	7002.7	ICHvc	5000	ICH	vc	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	689
9	3	3	2	5	5	5032	564.5	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	711
10	4	4	3	5	5	5011	6897.0	ICHvc	5000	ICH	vc	01	HD	HwBl - Devil's club	6/7	Mesic Forest	682
11	4	4	3	5	5	5011	6897.0	ICHvc	5000	ICH	vc	01	HD	HwBl - Devil's club	6/7	Mesic Forest	708
12	3	3	2	5	5	9021	257.7	ICHvc	5000	ICH	vc	00	AM	Herb meadow	2	Mesic Herb	690
13	1	4	3	5	5	409015	159.0	ICHvc	5000	ICH	vc	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	695
14	1	4	3	5	5	5031	2904.2	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	658
15	4	4	3	5	5	5012	5942.5	ICHvc	5000	ICH	vc	01	HD	HwBl - Devil's club	6/7	Mesic Forest	630
16	2	2	1	5	5	9023	1881.2	ICHvc	5000	ICH	vc	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	680
17	1	-9999	5	5	3	1004	1283.2	BAFAunp	1000	BAFA	unp	00	AM	Herb meadow	2	Mesic Herb	1476
18	4	-9999	6	5	4	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1594
19	2	-9999	5	5	3	1009	2002.3	BAFAunp	1000	BAFA	unp	00	MP	Heather heath	2	Mesic Herb	1657
20	4	-9999	6	5	4	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1694
21	2	-9999	5	5	3	1009	2002.3	BAFAunp	1000	BAFA	unp	00	MP	Heather heath	2	Mesic Herb	1556
22	1	-9999	5	5	3	1004	1283.2	BAFAunp	1000	BAFA	unp	00	AM	Herb meadow	2	Mesic Herb	1505
23	1	-9999	4	5	3	1006	567.2	BAFAunp	1000	BAFA	unp	00	VW	Wetter Herb	2	Wetter Herb	1374
24	1	-9999	5	5	3	1003	4017.5	BAFAunp	1000	BAFA	unp	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	1341
25	1	-9999	5	5	3	1004	1283.2	BAFAunp	1000	BAFA	unp	00	AM	Herb meadow	2	Mesic Herb	1345
26	3	-9999	2	3	2	1004	1283.2	BAFAunp	1000	BAFA	unp	00	AM	Herb meadow	2	Mesic Herb	1420
27	3	-9999	2	1	1	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1507
28	4	-9999	6	1	2	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1579
29	3	-9999	2	1	1	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1365
30	1	-9999	5	1	1	1003	4017.5	BAFAunp	1000	BAFA	unp	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	1381
31	1	-9999	4	1	1	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1326
32	4	-9999	6	3	3	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1336
33	3	-9999	2	1	1	1002	1734.3	BAFAunp	1000	BAFA	unp	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	1302
34	4	5	5	5	5	9018	936.5	ICHvc	5000	ICH	vc	00	BA	Barren	1	sparsely vegetated	516
35	4	3	3	5	5	5011	6897.0	ICHvc	5000	ICH	vc	01	HD	HwBl - Devil's club	6/7	Mesic Forest	564
36	3	3	2	5	5	9015	7002.7	ICHvc	5000	ICH	vc	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	684
37	2	2	1	5	5	9016	945.0	ICHvc	5000	ICH	vc	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	695
38	2	2	1	5	5	9015	7002.7	ICHvc	5000	ICH	vc	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	715
39	2	2	1	5	5	9024	2367.6	ICHvc	5000	ICH	vc	00	Avm	Avalanche Track - shrub dominated - moderate slope	3	Avalanche Track	421
40	2	1	1	5	5	669017	123.4	ICHvc	5000	ICH	vc	04/05	DD /CD	Sx - Devil's club - Dogwood / ActSx - Dogwood	6	Floodplain Forest	403
41	2	1	1	5	5	5033	1178.4	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	390
42	2	1	1	5	5	5033	1178.4	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	394
43	4	5	5	5	5	9018	936.5	ICHvc	5000	ICH	vc	00	BA	Barren	1	sparsely vegetated	449
44	1	3	3	5	5	9015	7002.7	ICHvc	5000	ICH	vc	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	469
45	3	2	2	5	5	9024	2367.6	ICHvc	5000	ICH	vc	00	Avm	Avalanche Track - shrub dominated - moderate slope	3	Avalanche Track	501
46	3	2	2	5	5	5012	5942.5	ICHvc	5000	ICH	vc	01	HD	HwBl - Devil's club	6/7	Mesic Forest	521
47	4	6	5	5	4	9016	945.0	ICHvc	5000	ICH	vc	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	618
48	2	3	2	5	3	5031	2904.2	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	620
49	4	4	3	5	5	5031	2904.2	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	636
50	3	3	2	5	5	5031	2904.2	ICHvc	5000	ICH	vc	03	SD	Sx - Devil's club	6/7	Moist Forest	626
51	3	2	1	5	5	509032	196.1	ESSFwv	4000	ESSF	wv	00	Ws	TRIM swamp	3	wetter forest	615
52	3	2	1	5	5	509032	196.1	ESSFwv	4000	ESSF	wv	00	Ws	TRIM swamp	3	wetter forest	614
53	3	2	1	5	5	509032	196.1	ESSFwv	4000	ESSF	wv	00	Ws	TRIM swamp	3	wetter forest	613
54	3	2	1	5	5	509032	196.1	ESSFwv	4000	ESSF	wv	00	Ws	TRIM swamp	3	wetter forest	620
55	4	4	3	5	5	9032	1962.9	ESSFwv	4000	ESSF	wv	00	WE	Wetland Shrub/Herb	3	Wetland Shrub/Herb	612
56	4	6	4	5	5	9034	6432.1	ESSFwv	4000	ESSF	wv	00	BA	Barren	1	sparsely vegetated	1463
57	1	6	5	5	5	9045	1141.3	ESSFwv	4000	ESSF	wv	00	GTs	Avalanche Herb steep slope	2	Avalanche Track	1429

Appendix 9. 2012 Habitat Suitability Field Evaluation Data

Draft Models																	
Plot	Grizzly Bear Spring URAR	Moose Late Winter ALAL	Moose Early Winter ALAL	Mountain Goat Winter ORAM	Mountain Goat Summer ORAM	PEM Code	Area_ha	BEC_Label	BEC_Zone_N	Zone	Subzone	Site_S	Site_MC_S	Site Unit	StrctStage	GenEcoType	ALTITUDE
58	4	6	4	5	4	9034	6432.1	ESSFwv	4000	ESSF	wv	00	BA	Barren	1	sparsely vegetated	1507
59	3	6	3	5	3	9038	995.8	ESSFwv	4000	ESSF	wv	00	MP	Heather Heath	2	Mesic Herb	1524
60	4	5	5	5	4	9016	945.0	ICHvc	5000	ICH	vc	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	434
61	1	6	5	5	3	9026	318.1	ICHvc	5000	ICH	vc	00	GTm	Avalanche Track - herb dominated - moderate slope	2	Avalanche Track	433
62	4	5	5	5	4	9018	936.5	ICHvc	5000	ICH	vc	00	BA	Barren	1	sparsely vegetated	414
63	1	6	4	5	5	409032	286.7	ESSFwv	4000	ESSF	wv	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	983
64	1	6	4	5	5	409032	286.7	ESSFwv	4000	ESSF	wv	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	983
65	3	6	3	5	5	4011	23474.0	ESSFwv	4000	ESSF	wv	01	FA	BlHm - Azalea	6/7	Mesic Forest	993
66	4	6	3	5	5	4011	23474.0	ESSFwv	4000	ESSF	wv	01	FA	BlHm - Azalea	6/7	Mesic Forest	995
67	1	6	4	5	5	409032	286.7	ESSFwv	4000	ESSF	wv	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	994
68	1	6	4	5	5	409032	286.7	ESSFwv	4000	ESSF	wv	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	994
69	4	5	5	5	5	9018	936.5	ICHvc	5000	ICH	vc	00	BA	Barren	1	sparsely vegetated	396
70	3	2	2	5	5	669018	54.2	ICHvc	5000	ICH	vc	04/05	DD /CD	Sx - Devil's club - Dogwood / ActSx - Dogwood	6	Floodplain Forest	396
71	2	1	1	5	3	669015	323.7	ICHvc	5000	ICH	vc	04/05	DD /CD	Sx - Devil's club - Dogwood / ActSx - Dogwood	6	Floodplain Forest	399
72	1	3	3	5	5	409020	28.4	ICHvc	5000	ICH	vc	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	596
73	1	3	3	5	5	409017	158.5	ICHvc	5000	ICH	vc	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	592
74	3	3	2	5	5	9024	2367.6	ICHvc	5000	ICH	vc	00	Avm	Avalanche Track - shrub dominated - moderate slope	3	Avalanche Track	599
75	4	4	3	5	5	5011	6897.0	ICHvc	5000	ICH	vc	01	HD	HwBl - Devil's club	6/7	Mesic Forest	610
76	1	3	3	5	5	409092	29.8	ICHvc	5000	ICH	vc	00	Wm	TRIM marsh	2	Wetland Shrub/Herb	586
77	4	-9999	6	1	2	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1404
78	6	-9999	6	2	5	1008	40782.4	BAFAunp	1000	BAFA	unp	00	GI	Glacier/ice or permanent snow	n/a	non-vegetated	1345
79	4	-9999	6	3	3	1007	25449.6	BAFAunp	1000	BAFA	unp	00	BA	Barren	1	sparsely vegetated	1307
80	1	6	3	3	2	9038	995.8	ESSFwv	4000	ESSF	wv	00	MP	Heather Heath	2	Mesic Herb	1474
81	1	6	3	3	2	9044	1587.6	ESSFwv	4000	ESSF	wv	00	GTm	Avalanche Herb mod slope	2	Avalanche Track	1449
82	1	-9999	5	1	1	1004	1283.2	BAFAunp	1000	BAFA	unp	00	AM	Herb meadow	2	Mesic Herb	1529
83	4	6	4	3	3	9034	6432.1	ESSFwv	4000	ESSF	wv	00	BA	Barren	1	sparsely vegetated	1516
84	1	6	3	5	3	9034	6432.1	ESSFwv	4000	ESSF	wv	00	BA	Barren	1	sparsely vegetated	1450
85	1	-9999	5	5	3	1004	1283.2	BAFAunp	1000	BAFA	unp	00	AM	Herb meadow	2	Mesic Herb	1421
86	3	6	4	5	3	9038	995.8	ESSFwv	4000	ESSF	wv	00	MP	Heather Heath	2	Mesic Herb	1450
87	1	6	2	5	5	9037	506.4	ESSFwv	4000	ESSF	wv	00	AM	Herb meadow	2	Mesic Herb	1379
88	4	3	3	5	5	9015	7002.7	ICHvc	5000	ICH	vc	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	484
89	3	2	2	5	5	9023	1881.2	ICHvc	5000	ICH	vc	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	451
90	1	3	3	5	5	9017	993.3	ICHvc	5000	ICH	vc	00	WE	Wetland Shrub/Herb	3	Wetland Shrub/Herb	470
91	1	3	3	5	5	9015	7002.7	ICHvc	5000	ICH	vc	00	VF	Mesic Shrub/Herb	3	Mesic Shrub/Herb	442
92	2	1	1	5	0	-9999	0.0										430
93	2	1	1	5	5	9017	993.3	ICHvc	5000	ICH	vc	00	WE	Wetland Shrub/Herb	3	Wetland Shrub/Herb	365
94	1	3	3	5	5	9023	1881.2	ICHvc	5000	ICH	vc	00	VS	Wetter Shrub/Herb	3	Wetter Shrub/Herb	355
95	4	5	5	5	5	9018	936.5	ICHvc	5000	ICH	vc	00	BA	Barren	1	sparsely vegetated	387
96	4	-999	5	3	2	2009		CMAunp	2000	CMA	unp	00	MP	Heather heath	2	Mesic Herb	1137
97	4	-999	6	3	3	2007		CMAunp	2000	CMA	unp	00	BA	Barren	1	sparsely vegetated	1165
98	4	-999	5	5	3	2009		CMAunp	2000	CMA	unp	00	MP	Heather heath	2	Mesic Herb	1171
99	4	-999	6	5	3	2012		CMAunp	2000	CMA	unp	00	ET	Escape Terrain	1	sparsely vegetated	1201
100	4	-999	5	5	3	2005		CMAunp	2000	CMA	unp	00	DH	dry herb	2	Drier Herb	1241
101	2	-999	3	1	1	1010		BAFAunp	1000	BAFA	unp	00	KH	Krummholz	3	Parkland Forest/Krummholz	970
102	2	-999	3	5	5	1010		BAFAunp	1000	BAFA	unp	00	KH	Krummholz	3	Parkland Forest/Krummholz	944
103	2	-999	3	5	3	1010		BAFAunp	1000	BAFA	unp	00	KH	Krummholz	3	Parkland Forest/Krummholz	876
104	3	3	2	5	5	9032		ESSFwv	4000	ESSF	wv	00	WE	Wetland Shrub/Herb	3	Wetland Shrub/Herb	657