Terrestrial Ecosystem Mapping (TEM) with Wildlife Habitat Interpretations of the Besa-Prophet Area

Part 2: Wildlife Report

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- Richard Sims (Project Manager) coordinated and supervised the project. Bioterrain phototyping and ecosystem mapping was coordinated and completed by John Grods and Tim Janes.
- Christine Curry coordinated the GIS portion of the project. Andrew Dyk acquired and produced the merged satellite imagery and scanned and orthorectified the linework. Karen Warrendorf, York Law and Cari Kobialko provided GIS support for final edits, map legends, and final maps. Several R. A. Sims & Associates staff conducted the data input phases of the project, including York Law, Jeff Matheson, Libor Michalak, John Grods, Karen Warrendorf, Amy Tsang and Rachelle Robitaille.
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- Rachelle Robitaille facilitated the assembly of progress reports and the Final Report. John Grods edited the ecosystem unit description factsheets and the expanded ecosystem legend. Karen Warrendorf created the Study Area map. Richard Sims supervised and edited all reports.

EXECUTIVE SUMMARY

This project was conducted by R.A. Sims and Associates (578569BC Ltd.) on behalf of the BC Ministry of Environment, Lands and Parks' Oil and Gas Division. Phase 1 (1997-1998) of the two-year project was funded by Forest Renewal BC, and Phase II (1998-1999) was funded by the Muskwa-Kechika Fund.

This Final Report (composed of two separately bound documents, Part 1 – TEM and Part 2 – Wildlife) describes the Terrestrial Ecosystem Mapping (TEM) outputs, and related wildlife interpretations for the Besa/Prophet Study Area.

A range of baseline terrain, ecosystem and wildlife information was gathered and synthesized by this project. Principal goals were to:

1) Confirm (and as necessary adjust/refine) BCG zonal/subzonal/variant boundaries within the Study Area;
2) Refine Site Series classification units (ecosystem or map units) and their descriptions in particular within the SWB, Parkland and Alpine Zones;
3) Integrate the use of Landsat and SPOT TM into 1:50 000 TEM mapping methodologies; and,
4) Produce habitat suitability interpretations for a total of eleven wildlife species.

Part 1 of the Final Report provides, at the outset, an overview of the Study Area, including location, physical description, climate, vegetation, biogeoclimatic zones, disturbances and wildlife of the Study Area. It then summarizes the methodology followed in the field sampling, photo-interpretation, and GIS processing components of the project. Part 1 also includes definitions of the symbology and mapping conventions used in the bioterrain and ecosystem maps, and summarizes the digital databases that accompany the Final Report.

The BEC field guides for the Prince George Region (Delong *et al*. 1990, 1994, MacKinnon *et al*. 1990) provide basic descriptions only of mature and undisturbed ecosystems within the general geographic region. In these, information on non-forest and/or disturbed forest ecosystems is also lacking. Within Part 1 of the Final Report, considerably more detail is provided on the range of ecosystems that occur within the Study Area. The expanded legend and ecosystem descriptions provided here, include a range of information that is organized and presented in summary tables as well as a "factsheet" format. The ecosystem descriptions in Part 1 are complementary to the information provided within the TEM 1:50,000 map products. Also included is summarized data on disturbed and non-forest ecosystems that were field visited and sampled within the Study Area. It should be noted that information provided in the ecosystem "factsheets" is provisional, and can be further augmented, in future, should additional ecological data be gathered within or adjacent to the Study Area.

Part 2 of the Final Report (this document) deals with the TEM-related wildlife habitat interpretations undertaken for the Study Area. The primary purpose of the wildlife habitat interpretations is to provide habitat suitability mapping for eleven species (American marten, grizzly bear, black bear, mule deer, white-tailed deer, moose, elk, woodland caribou, bison, stone sheep, and mountain goat). In addition to habitat suitability mapping, this project provides a synthesis of known wildlife values for the Study Area, including the results of aerial surveys, wildlife habitat assessments and incidental observations.

Wildlife habitat suitability ratings define the relative importance of mapped ecological units to wildlife populations. For this project, we have developed species-habitat models that relate each species' life requisites to the attributes of the ecosystem units present in the Study Area. Each model is based on the scientific literature, previous studies in the region, our own field data collection and expert opinion. Ratings tables were generated using a linear model that contains the key attributes of an ecosystem unit. An automated approach using a relational database was used to assign ratings to each possible ecosystem unit in the Study Area. Polygon ratings were generated by "looking-up" the ecosystem unit in the ratings table. A GIS algorithm was then constructed to apply spatial adjustments to the polygon ratings.

Wildlife habitat mapping provides a basis to evaluate the effects of development on wildlife habitat. It identifies areas that provide regionally and/or Provincially significant habitat and places the loss or modification of habitat into a local and regional context. When combined with current known animal distributions, interpretations can also be made on potential avenues or opportunities for range expansion.

The following additional products accompany this Final Report (Parts 1 and 2):

- A folio of *TEM Manuscript Maps* (1:50,000 hard copy and mylar copy, and digital databases) with accompanying legend, and Ecosystem unit symbols for the entire Study Area;
- A *Plot Location Map* (1:250,000 scale, hard copy and digital database) showing locations of field sampling plots overlain on an imagery base of the Study Area;
- *Wildlife Habitat Interpretation Suitability Maps* for selected seasons for all 11 species produced as fully composed maps that can be printed on-demand; and,
- *Wildlife Habitat Interpretation Suitability Maps* for all rated seasons and uses for all 11 species in ArcView 3.0a that can be viewed on-demand.

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1.0 INTRODUCTION

This document is a report on wildlife habitat interpretations completed for an area in northeastern BC. These interpretations have been conducted in association with bioterrain and terrestrial ecosystem mapping (TEM). Fundamental ecosystem and wildlife information gathered by this TEM project will assist with operational planning activities by the Ministry of Environment, Lands, and Parks' (MELP) Oil and Gas Division, in the Fort St. John District, Omineca-Peace Region. Products from the Besa/Prophet TEM project will provide important baseline information for applying biodiversity conservation measures within an area known to have critical wildlife values.

The primary purpose of the wildlife habitat interpretations is to provide habitat suitability mapping for each of eleven species:

- American marten,
- Black bear,
- Grizzly bear,
- Moose,
- Rocky Mountain elk,
- Woodland caribou,
- Mule deer,
- White-tailed deer,
- Bison,
- Stone sheep, and
- Mountain goat

This list of species was selected because:

i. It includes all of the ungulate species present in the Study Area;

ii. Bison, which is not a year-round resident in the Study Area, is present in the Sikanni River drainage to the south and is predicted to expand its range into the Nevis River valley and northward;

iii. Bears are regionally important identified wildlife; and,

iv. Marten represents a different scale and mode of habitat use and is recognized as a species of management concern (both regionally and provincially).

In addition to habitat suitability mapping, this project provides a synthesis of known wildlife values for the Study Area, including the results of aerial surveys, wildlife habitat assessments and incidental observations.

Wildlife habitat mapping provides a basis to evaluate the effects of development on wildlife habitat. It identifies areas that provide regionally and/or Provincially significant habitat and places the loss or modification of habitat into a local and regional context. When combined with current known animal distributions, interpretations can also be made on potential avenues or opportunities for range expansion.

1.1 Background

Wildlife habitat suitability ratings define the relative importance of mapped ecological units to wildlife populations. In this project, we have developed species-habitat models that relate each species' life requisites to the attributes of the ecosystem units present in the Study Area. Each model is based on the scientific literature, previous studies in the region, our own field data collection and expert opinion. A GIS algorithm was constructed to apply the species-habitat model to the TEM spatial map database.

TEM uses traditional cartographic methods to stratify landscapes into map units (polygons) which are based on the relationships between ecological features such as climate, physiography, surficial material, bedrock geology, soil and vegetation. Ecosystems are mapped using a procedure that focuses on observable site and biological features assumed to determine the function and distribution of plant communities on the landscape (RIC, 1998b).

Our approach to ecosystem mapping in the Besa/Prophet Study Area used both air-photos and satellite imagery to delineate and classify ecosystems. Ecosystems were first delineated on air-photos (at 1:60,000 scale), which provided the best image detail for the study area but were dated (1986). The air-photo linework was then updated/revised using merged Landsat TM/SPOT satellite imagery, which provided recent land cover data, although at poorer resolution. In the intervening 11 years between the aerial photography and the acquisition of the satellite imagery, the study area underwent significant change, partly as result of natural vegetation succession and because of continued prescribed and natural fires which have removed forest and shrub cover. These changes have significant ramifications for wildlife habitat use and thus wildlife management prescriptions. The satellite imagery has provided the wildlife habitat interpretations with up-to-date ecosystem and bioterrain mapping on which to base the wildlife habitat models.

For a full description of the methodology used to generate the TEM maps, please see Part 1 of the Final Report.

2.0 STUDY AREA

The Besa/Prophet TEM Study Area is located in north central BC, northwest of Ft. St. John, and covers an area of approximately 306,000 hectares (Figure 2.1). The Study Area extends across five 1:50 000 NTS mapsheets (94F/9, 94G/5, 6, 11 and 12) and the following Landscape Units: Fort Nelson Landscape Units 29 and 30 and the Fort St. John Landscape Units 29 and 4. The area contains the Besa River, Richards Creek, Pocketknife Creek, Nevis Creek watersheds, and parts of the Prophet River watershed.

The Study Area lies within two Ecosections: the Muskwa Foothills (MUF) and the Eastern Muskwa Ranges (EMR). Both of these Ecosections are within the Northern Canadian Rocky Mountains Ecoregion of the Northern Boreal Mountains Ecoprovince.

2.1 Physiography

The Besa/Prophet Study Area lies within the Eastern System of the Canadian Cordillera and is underlain primarily by folded and faulted sedimentary rocks (Holland, 1976). The Study Area is composed of two physiographic zones: the Muskwa Ranges and the Rocky Mountain Foothills. The Muskwa Range extends from the Peace River north to the Liard rivers and from the Rocky Mountain Trench in the west to the Rocky Mountain Foothills in the east. On their eastern side, the Muskwa Ranges are eroded largely in Devonian and Permo-Carboniferous limestones. Longitudinal valleys of great length and width or characteristic of the Muskwa Ranges. They are eroded parallel to the structural trend along lines of faulting or along belts of softer, more easily eroded rock (Holland, 1976). The Rocky Mountain Foothills is entirely underlain by sedimentary rocks that are largely of Meoszoic age. The rocks are folded northerly to northwesterly and this results in prominently developed longitudinal ridges. Valleys are eroded along belts of soft rock and fault zones and are generally wide and flaring.

2.2 Vegetation

The Study Area is composed of four biogeoclimatic zones (Table 2.2.1). The Boreal White and Black Spruce zone (BWBS) occurs as an extension of the Great Plains (Alberta Plateau) into the northeastern corner of BC. The zone occupies the lower elevations of the main valleys west of the northern Rocky Mountains. The climate of this zone is characterised by short growing seasons, long, very cold winters with frequent outbursts of arctic air masses. Annual precipitation averages between 330 and 570 mm with 35-55% of this falling as snow. The ground freezes deeply for a large part of the year and discontinuous permafrost is common in the northeastern parts of the zone. The Spruce – Willow – Birch zone is the subalpine zone above the BWBS over most of its range and within the Besa/Prophet Study Area (DeLong *et al*., 1991).

White spruce, trembling aspen, lodgepole pine, black spruce, balsam poplar, tamarack, subalpine fir and paper birch are major tree species found in the BWBS. Forest fires are frequent, maintaining most of the forests in various structural stages (DeLong *et al.*, 1991). True climax forest are largely unknown in the BWBS as few stands have escaped fire for several hundred years (DeLong *et al.*, 1990).

The Fort Nelson Moist Warm BWBS (BWBSmw2) occurs between 300 and 1050 m and features aspen-white spruce forest on well-drained sites and black spruce forests (with some tamarack) commonly on very wet sites. (DeLong *et al.*, 1990). Lodgepole pine is relatively common, especially on wetter sites with black spruce or on well-drained, higher elevation sites. Balsam poplar, white spruce and often trembling aspen and paper birch are common on the floodplains of the major watercourses. Winter snow depths for this zone are approximately 185 cm (DeLong *et al.,* 1990).

The Spruce – Willow – Birch zone (SWB) is the most northerly subalpine zone in BC. The climate is characterised by long, cold winters and brief, cool summers. Winter cold spells can be broken by Chinooks. Mean annual precipitation is 460 to 700 mm, with 35-60% occurring as snowfall (Pojar and Stewart., 1991).

Lower elevation of the SWB are generally forested, consisting mainly of white spruce and subalpine fir. Higher up on slopes, subalpine fir dominates, especially on northern and eastern exposures. Black spruce, lodgepole pine and trembling aspen are relatively minor species, although all can be locally abundant. At high elevations (between 1600 and 1800 m), the SWB is characterised by a scub/parkland variant dominated by scrub birch (*Betula glandulosa*) and several species of willow (*Salix spp*.) (Pojar and Stewart, 1991).

Subzones of the SWB have not been well studied. The Besa-Prophet Study Area contains the Moist Cool SWB subzone (SWBmk) in addition to a scrub variant (SWBmks).

The third zone in the Besa/Prophet Study Area is Alpine Tundra (AT), occurring generally above 1800 m. The climate in this zone is cold, windy, snowy and characterised by low growing season temperatures and a very short frost-free period. Most precipitation falls as snow.

By definition, the AT is treeless. Alpine vegetation is dominated by shrubs, herb, bryophytes and lichens and many areas are dominated by rock, snow and ice. Common shrubs in the Study Area are scrub birch and various willows.

The site series expanded legend for the Study Area is contained in Appendix A. It forms the basis for the wildlife ratings tables.

Table 2.2.1 The four Biogeoclimatic Zones in the Besa/Prophet Study Area.

BEC Zone	Subzone/ Variant	Elevation (m)	Description
BWBS	mw2 – Fort Nelson moist warm	Up to 1050m	Climax zonal forests are comprised of White Spruce and Aspen with a dominantly stepmoss understory. Seral stands containing pine and aspen are very common.
SWB	mk – moist cool	1050 to 1600m	Zonal climax forests consist of mixed White Spruce and Sub-alpine fir forests, with bog birch and shrub willow present in the understory.
SWB	mks – moist cool scrub	1600 to 1800m	Characterized by lush forb-alpine grass communities, in association with shrub willow, scrub birch and krummholz vegetation (mostly Sub-alpine fir). (Fig. 3)
AT		Above 1800m	AT is an upper-elevation treeless area characterized by a harsh climate and a very short growing season. Zonal vegetation is dominated by lush mixed forbs and alpine grasses at lower elevations, while at higher elevations, conditions for growth are more limiting and support a less vigorous mix of sedges, dwarf shrubs, forbs and alpine grasses.

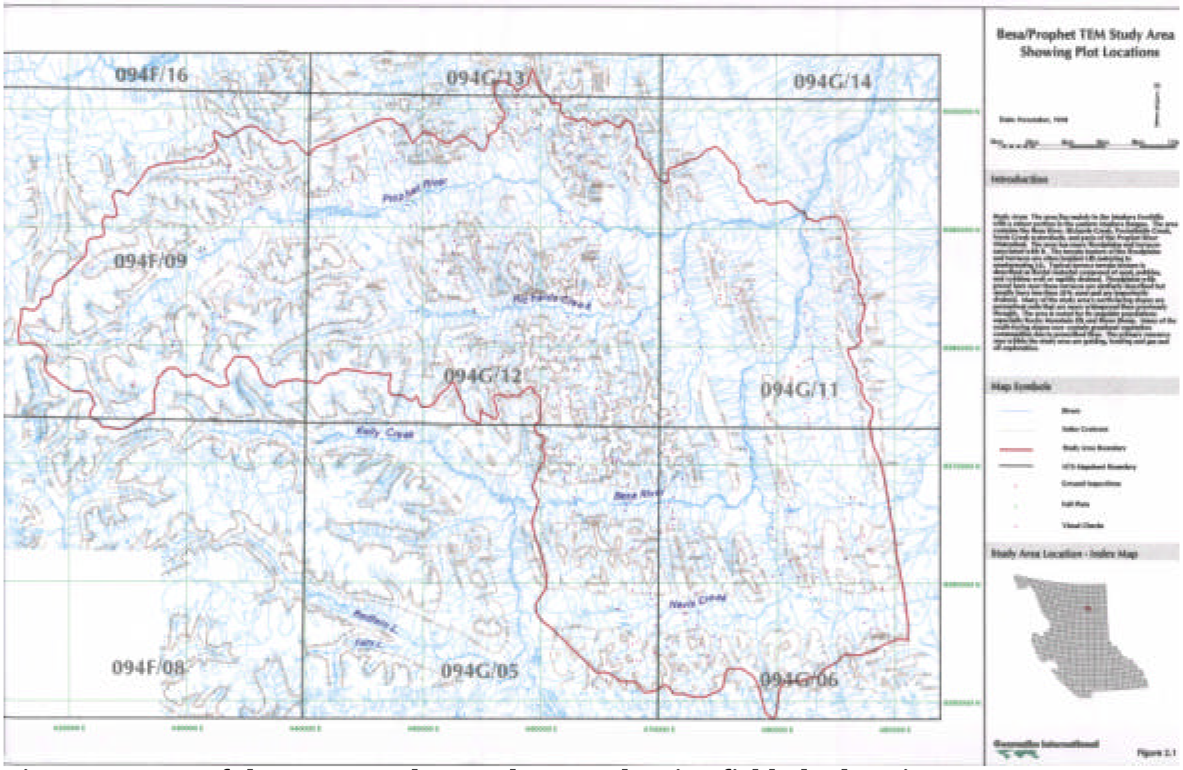

Figure 2.1 Map of the Besa/Prophet Study Area showing field plot locations.

2.3 Wildlife

The eastern slopes of the northern Rocky Mountains supports one of the largest intact predator-prey ecosystems in North America. Most of BC's ungulate species (all except for bighorn and Dall's sheep) are found in the Muskwa Foothills. The high ungulate diversity and abundance is mainly due to climate; the eastern slopes of the northern Rockies have low winter snowfalls and have frequent Chinooks that remove snow from windblown and south aspect areas.

The four biogeoclimatic zones present in the study have varying wildlife productivity and diversity and varying seasonal importance for wildlife.

BWBSmw2

The BWBSmw2 subzone occupies the relatively wide valley bottoms in the eastern edge of the Study Area and has the least snowfall of all the northern biogeoclimatic zones. A variety of different wetlands and forest types provide habitat for a ranges of species. This zone provides especially important winter range for caribou, rocky mountain elk and moose and for smaller numbers of mule and white-tailed deer (although deer are not abundant in the Study Area) (DeLong *et al.*, 1991). In other areas (e.g. the Sikanni River valley and southward), bison are found in the BWBS zone in both summer and winter. Stone sheep and mountain goat are also found in the BWBS wherever steep slopes provide escape terrain and where mineral licks are located. Snowshoe hares, lynx, deer mice, ermine, black and grizzly bears, and red squirrels are commonly found throughout the area. South-facing slopes provide warm, relatively snow-free habitats for all of the ungulate species and thus for many predators like wolves and wolverine.

In upland areas, forest fires have created a mosaic of uneven-aged stands in the BWBS. Conifers are often slow to re-establish in many burned areas and aspen and willow deciduous forests are common. These deciduous forests are very productive habitats for ungulates, birds and small mammals (DeLong *et al.*, 1991). Mature coniferous forests provide both security and good thermal protection in harsh winters.

In lowland areas, the BWBS contains numerous bogs, fens (Figure 2.3.1) (both of which are more common in the plateau to the east of the Study Area), floodplains and riparian areas. These productive habitats play important roles for a variety of wildlife, including moose who come to the lowlands for winter browse. The large number of snags associated with wet areas provide habitat for cavity-nesting/denning birds and small mammals such as three-toed woodpecker, red-breasted nuthatch, black-capped chickadee, boreal owl, boreal chickadee, red squirrel, American marten, fisher and lynx (DeLong *et al.*, 1991).

Because of the high population of passerines during the growing season, birds-of-prey, such as great horned owl, boreal owl, northern goshawk and northern harrier are also numerous.

SWBmk

The SWB zone has the harshest climate of all the forested subzones in British Columbia and this has a profound effect on wildlife. The zone is composed of a mosaic of mostly open-canopied coniferous and mixed forests, willow-birch shrublands, grasslands, rugged, steep slopes and some wetlands, riparian areas and floodplains (Pojar and Stewart, 1991a). Of the three zones present in the Study Area, the SWB is capable of supporting the highest diversity and density of ungulates.

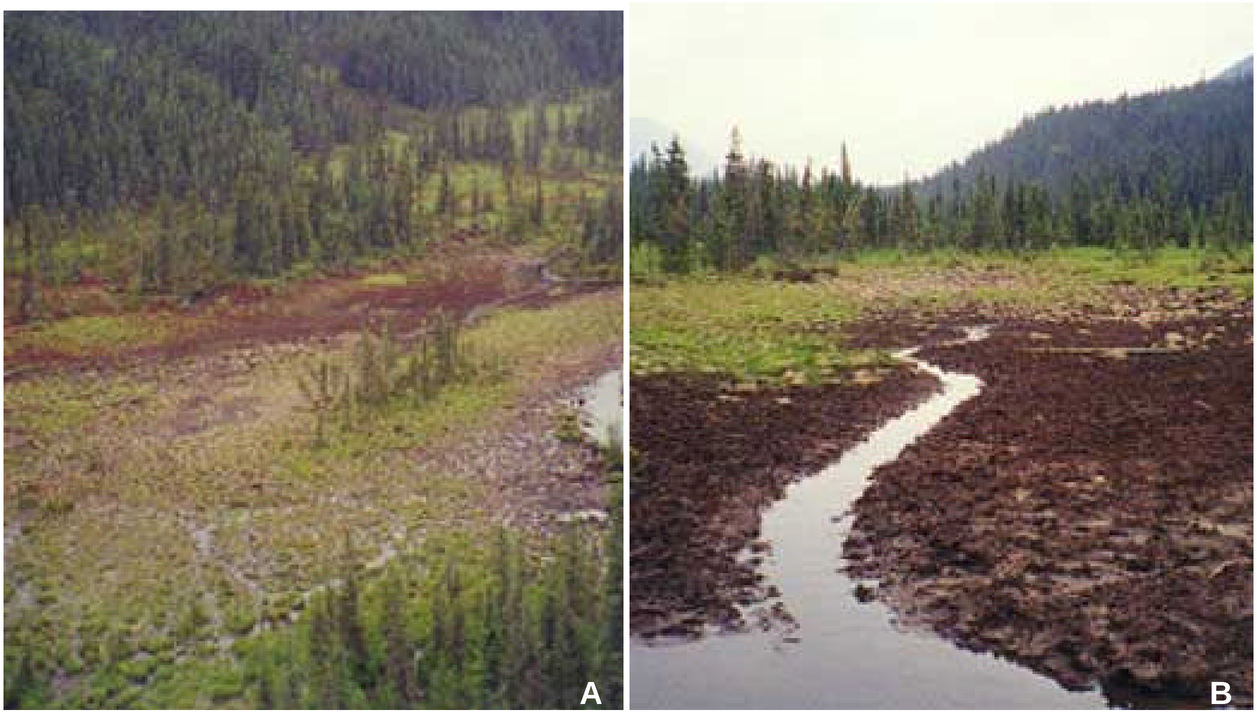

Figure 2.3.1. Aerial oblique view of a wet Open Fen (Photo A). A large number of animal tracks were observed crossing this small wetland (Photo B).

In the Study Area, natural and prescribed burning has been widespread in the SWB. On many sites, especially those that have burned repeatedly, conifers have been slow to return creating extensive grasslands and young stands of trembling aspen or willow (Figure 2.3.2). These areas provide high quality winter food for many ungulates, especially elk whose numbers have increased dramatically in recent years.

High elevation grassy southern aspects in the SWB are utilised by stone sheep and mountain goats year-round and by grizzly bear, deer, elk and caribou in the growing season. In winter, they are windswept and heated by the sun reducing snow levels and exposing food during this critical time of year. Steep, rocky upper slopes are important escape terrain for both Stone sheep and mountain goats, and golden eagles and gyrfalcons use this type of habitat for hunting.

Wetlands, riparian habitats and floodplains are not as abundant or as productive as in the BWBS but are used extensively by moose, bears, voles, ducks, songbirds, beaver, muskrat, various raptors like eagles and northern harriers, and large mammals like bison. Cold-air drainage and ponding create open, shrubby valley bottoms in many areas of the SWB. These habitats provide abundant browse year round although many areas are limited by snow depth in winter (Pojar and Stewart, 1991a).

Coniferous and mixed forests provide habitat for which species such as northern goshawk, northern hawk-owl, spruce grouse and three-toed woodpecker use this forest type extensively for foraging and nesting. Forested areas in the SWB also provide security and thermal protection in winter.

Figure 2.3.2. Natural and prescribed burns have created high quality foraging habitat on south-facing slopes, especially for elk. This location is in the SWBmk.

SWBmks

The scrub variant of the SWB occupies the intergrading area between the SWB zone and the non-forested AT. It is sparsely forested and much of the zone is characterised by herb (Figure 2.3.3), shrub and dwarf-shrub communities and by rugged, steep slopes. Mountain-tops in the foothills portion of the Study Area are predominantly SWBmks. Windblown portions of these areas have low snow depths providing habitat for large numbers of wintering caribou (Figure 2.3.4. These areas are especially important when snow depths are high at low elevations.

AT

Alpine tundra is found mostly in the western half of the Study Area, the Eastern Muskwa Ranges (EMR) Ecosection. Its harsh climate, rugged topography and low plant productivity result in low wildlife diversity and density. However, some wildlife species, such as mountain goat, pika, hoary marmot, willow and white-tailed ptarmigan, water pipits, caribou, stone sheep and rosy finch are well-adapted to the conditions found here (Pojar and Stewart, 1991b).

Grassland and scrub areas may be used extensively by ungulates during the summer months. In winter, these areas are utilised by goats, caribou and Stone sheep, which feed off lichens and dwarf shrubs, only where wind and solar radiation have reduced the snow depth. To the south of the Study Area, bison are also known to winter in both AT and SWBmks habitats. Grizzly bears use alpine meadows for food in the growing season.

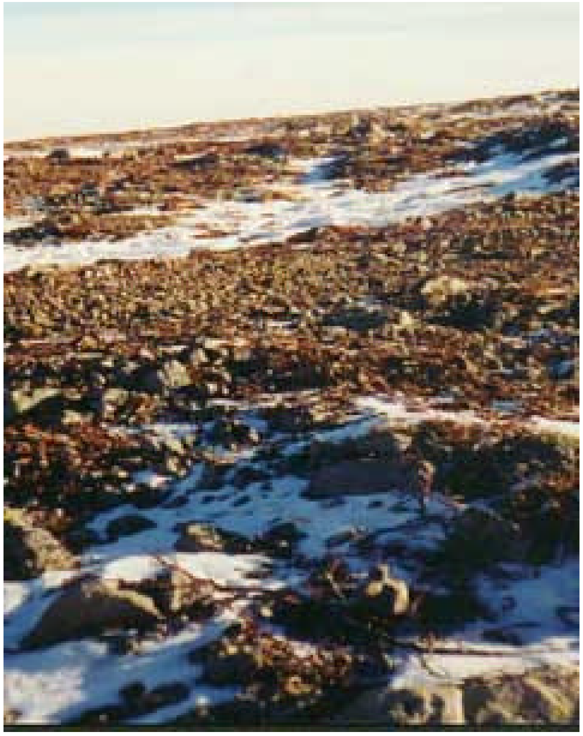

Figure 2.3.3. Photo A (left) illustrates a wind-swept alpine ridge where a herd of approximately thirty foraging caribou were observed. Photo B (right) shows the typical small patchy occurrences of *Cladina spp.* which forms more then half of a caribou's winter diet.

Figure 2.3.4. South-facing slopes in the SWBmks provide high quality habitat for elk, goat and sheep.

Other wildlife found seasonally in the AT include: snowshoe hare, voles, mule deer, black bear, wolverine, golden eagle, white-tailed ptarmigan, horned lark, golden eagle, golden-crowned sparrow and gyrfalcon (Pojar and Stewart, 1991b).

2.3.1 Wildlife Management Issues

The exceptional wildlife resources in the Besa/Prophet area give rise to a variety of ongoing wildlife management issues. Some of these issues include:

- Effects of prescribed burning;
- Effects of changing population numbers (e.g. increase in elk);
- Role of wolf predation;
- Role and effects of hunting;
- Effects of bison range expansion;
- Effects of feral horses on range quality;
- Effects of oil and gas development; and,
- Effects of seismic cut-line and road development.

2.3.2 Previous Surveys and Habitat Mapping

Previous activities related to wildlife mapping in and adjacent to the Study Area include:

- Aerial surveys (Resource Analysis Branch, 1968a; Resource Analysis Branch, 1968b; Resource Analysis Branch, 1969a; Resource Analysis Branch, 1969b);
- 1:250,000 scale overview wildlife capability mapping for northeastern BC (Habitat Inventory Section, 1994a);
- 1:250,000 scale habitat capability mapping of the Muskwa Foothills (Habitat Inventory Section, 1994b).

There are several recent or ongoing wildlife projects administered and/or conducted by the Ft. St. John Wildlife Section. Caribou, elk, Stone sheep and wolf have been radio-collared and monitored at various times in the past (Webster, pers.comm.). A geo-referenced database of all wildlife data is maintained by the Ft. St. John Wildlife Section. We have used this database in combination with our own wildlife survey data and observations to verify the habitat suitability ratings and to contrast available suitable habitat with currently occupied habitat for each species.

2.3.3 Harvest Records

Wildlife harvest records are available from Wildlife Protection Branch, MELP, Fort St. John. Appendix B contains hunter kill data for wildlife management unit 7-42. The boundaries of this management unit approximately corresponds to the Besa/Prophet Study Area except for the inclusion of the Boreal Plains and the Redfern-Keily Protected Area.

3.0 APPROACH AND METHODS

A framework for wildlife habitat mapping has been established by the Wildlife Interpretations Subcommittee (RIC, 1998a) and our methods conform to these standards. In this section, we describe our approach used to produce the wildlife habitat maps. Figure 3.1 shows the stages within distinct phases in the developmental process. Each of these phases are described below.

3.1 Development of Species Accounts and Preliminary Ratings

The first stage in the process involved defining each species' requirements for survival and the relationship between these requirements and habitat features and attributes present in the Study Area. This forms the basis for the species-habitat model.

We collected background wildlife information for both the Study Area and adjacent areas from the following sources:

- B.C. Conservation Data Centre (CDC);
- Primary literature from UBC and SFU libraries;
- Discussion with Ft. St. John MELP staff; and,
- Discussion with Wildlife Branch staff (MELP, Victoria).

In order to rate the suitability of a habitat for a given species, the life requisites of the species must be explicitly defined. Life requisites are the requirements of an animal for sustaining and perpetuating the species. These requirements are provided by the species' habitat and most commonly include food, security and thermal protection. Other life requisites may include denning, migrating and living. In our models, living encompasses all of a species life requisites and directly reflects where animals are likely to be found, assuming they are present in the Study Area.

Following the development of the species accounts, preliminary ratings were assigned to broad habitat categories present in the Study Area. This provided an indication of those areas that provide significant wildlife habitat and served to direct the locations of the field sampling.

3.2 Field Data Collection

The field data collection is divided into two periods: winter and summer. The winter data collection consisted of a reconnaissance level aerial survey to determine winter wildlife distribution and habitat use. During the summer field session, we completed wildlife habitat assessments in association with TEM full plots and ground inspections, recorded evidence of animal use, and recorded all incidental encounters with wildlife.

3.2.1 Winter

Between February 13th and 16th, 1998, four personnel from Geomatics International (Tim Janes, Jeff Matheson, Rachelle Robitaille and John Grods) and Andy Stewart (Wildlife Habitat Specialist with MELP, Victoria and the Wildlife Correlator for the project) conducted aerial wildlife surveys in the Besa/Prophet Study Area

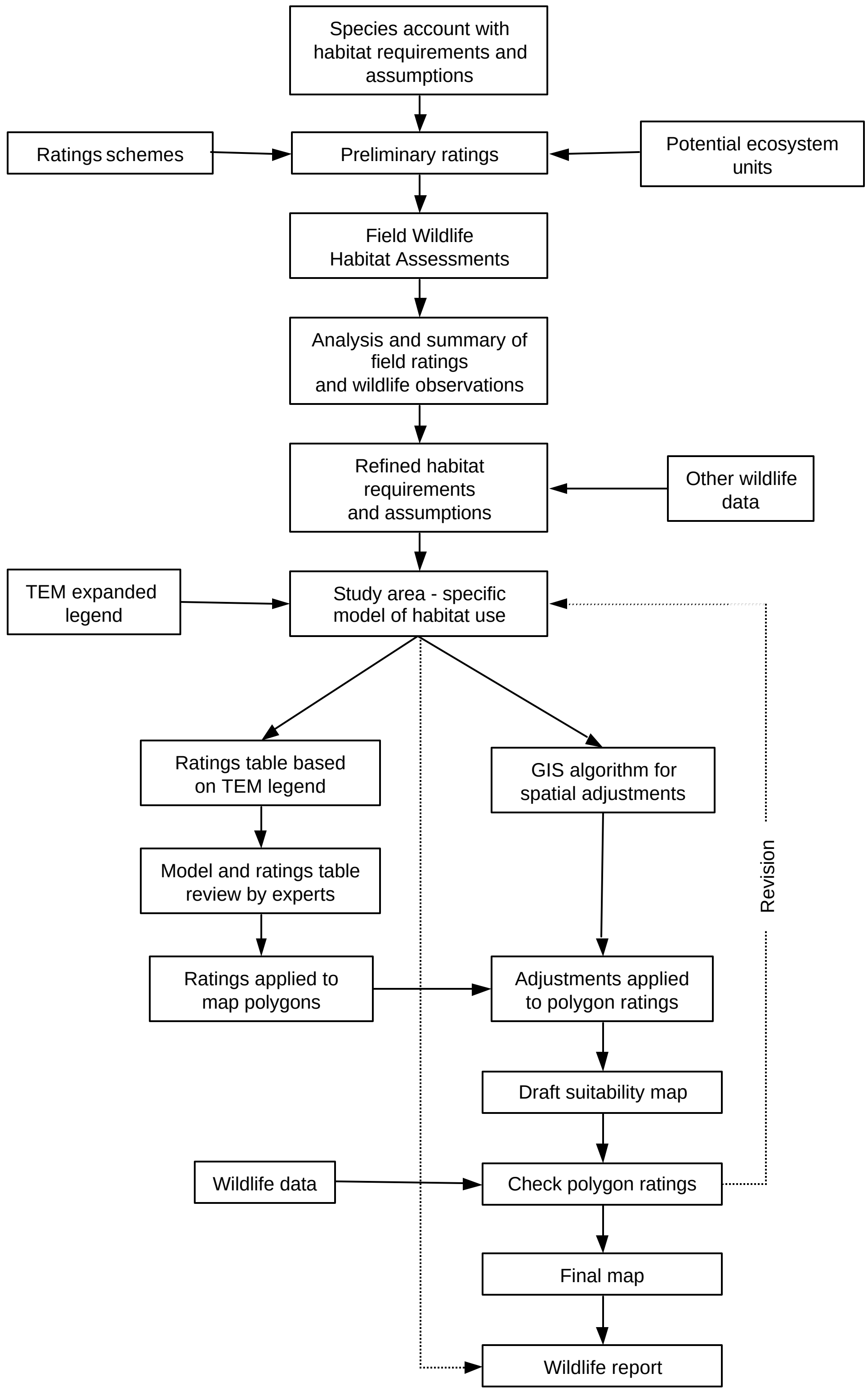

Figure 3.1 Developmental process for Besa/Prophet TEM wildlife habitat interpretations.

The survey methods followed the RIC standards for Aerial–Based Inventory Techniques for Selected Ungulates (RIC, 1997). We conducted a reconnaissance level survey by flying encounter transects in a Bell 206 Jet Ranger. We flew elevational contours in such a manner to cover the entire Study Area. All animals encountered were recorded and classified. Each survey period had three observers plus the pilot.

3.2.2 Summer

Summer field sampling was conducted from July 3rd to July 16th, 1998. We used two 3-person crews consisting of a soil scientist, a plant ecologist and a wildlife biologist to complete full plots, ground inspection plots, vistas and wildlife habitat assessments. The field effort was augmented for three days with additional expertise by the following Ministry of Environment correlators: Carmen Cadrin (Vegetation Ecologist), Bob Maxwell (Bioterrain Specialist) and Andy Stewart (Wildlife Habitat Specialist).

The purpose of the Wildlife Habitat Assessments (WHAs) was twofold: (1) to establish the relationship between a species' life requisites and the attributes of each ecosystem unit; and (2) to document signs of animal use.

A six-class habitat rating scheme was used to rate a habitat's potential to support a species for a given season and use relative to the best habitat in the province (Table 3.2.1). Ratings were assigned using a set of rating criteria developed from the species accounts and the preliminary ratings. The seasons and uses are listed in Table 3.4.1.

Table 3.2.1 The 6-class habitat rating scheme used to rate a habitat's potential to support a species for a given season and use relative to the best habitat in the province.

Code	Rating	Percent of Provincial Best
1	High	Equivalent (75-100% of best)
2	Moderately high	Slightly less (50-75% of best)
3	Moderate	Moderately less (25-50% of best)
4	Low	Substantially less (5-25% of best)
5	Very low	Much less (0-5% of best)
6	Nil	The habitat or attribute is absent

Sampling Design

The Wildlife Habitat Assessments generally followed the sampling strategy of the Ecosystem Field Plots (because the WHAs must be associated with either a Full Plot or a Ground Inspection Plot). To ensure that there was adequate representation of habitats for all of the eleven featured species, the selection of Ecosystem Field Plots was conducted in direct consultation with the wildlife habitat specialists.

WHAs were completed for each of the 31 Full Plots. As a subsample of the 102 Ground Inspection Plots, 69 WHAs were completed. The subsampling of WHAs were installed with Ground Inspection plots that represented a range of ecosystem conditions and in areas of suitable habitat. By only doing 70% of the Ground Inspection plots, the wildlife biologists were provided with sufficient time to complete the full WHA form and time to search the plots and adjacent habitat for signs of use by the

BRITISH COLUMBIA

WILDLIFE HABITAT ASSESSMENT

Proj. id. BP | Date 98 07 05 | N-hab. feature type R O dst. 3 | page 1 of 1

Plot no. 9800174 | Surveyor T. Janes

Species: 5-letter code	Hab use / Ssn: Sp. L.R.	Ssn	Plot type: FD	SH	TH	Com.	Plot-in-context: Habitat feature	Conf.	Distance (km)	F/C L.R.	Imp.	Habitat feature	Conf.	Distance (km)	F/C L.R.	Imp.	FD	SH	TH	Suit.	Com.
MMAAM	LI	A	3	6	/												3	6	/	6	
MURAR	LI	P	2	5	/												2	5	/	3	
MURAR	LI	S-F	4	5	/												4	5	/	4	
MURAM	LI	P	3	6	/												3	6	/	6	
MURAM	LI	S-F	4	6	/												4	6	/	6	
MALAL	LI	G	1	1	/												1	1	/	1	
MALAL	LI	W	1	2	/		FM	1	.0.3	F	2						1	1	/	1	
MODVI	LI	G	3	5	/												3	5	/	5	
MODHH	LI	G	3	5	/												3	5	/	5	
MODHH	LI	W	5	5	5												5	5	5	5	
MRATA	LI	P	1	2	/												1	2	/	2	
MRATA	LI	S-F	1	5	/												1	5	/	4	
MCEEL	LI	P	1	5	/												1	5	/	5	
MCEEL	LI	S-F	1	5	/												1	5	/	5	
MBIBI	LI	G	1	/	/												1	/	/	1	
MBIBI	LI	W	2	/	/												2	/	/	2	
MOVDS	LI	G	3	6	/												3	6	/	6	
MOVDS	LI	W	5	6													5	6	/	6	
MORAM	LI	G	3	6													3	6	/	6	

Comments / Notes: 57° 21' 40" Elev. 1340m
SS 26 123° 33' 49" SMR Hydric
site series is a new one ?

FS 882 (5) HRE 98/5

BRITISH COLUMBIA

WILDLIFE HABITAT ASSESSMENT

Project Id. B P. | Plot no. 9800174

Evidence of Use

Species	Inside plot: Sex	Life Stage	Activity	Des.	No.	Com.	Outside plot and inside ecosystem unit: Sex	Life Stage	Activity	Des.	No.	Sex	Life Stage	Activity	Des.	No.	Com.
MALAL	F	A	FE	S	1												
MALAL	U	U	FE	S	1	1											
MALAL	U	U	EX	Y	H												
MRATA	U	U	EX	Y	L	2											
MALAL	U	U	FE	Y	H	3											

Comments / Notes: 1 looks like a calf of the year, but not sure. 2 couldn't find any scat in the wetland its' self, but found some on the edge. 3 lots of Bet. gland. browsed.

Abbreviated Tree Attributes for Wildlife					
B.A.F.		Area		Min DBH	
No. of trees		No. dead		No. live	
Avg. DBH (cm)		Avg. length (m)			
Avg. lich load class		Comments			

Simple Coarse Woody Debris	Sampled										m of 30 m transect
Piece #	1	2	3	4	5	6	7	8	9	10	11
Decay class											
Diam. class											
Piece #	1	2	3	4	5	6	7	8	9	10	11
Decay class											
Diam. class											
Comments											

Management

Species (Sp. group)	Use	Ssn.	F/C LR(s)	Cap.	Mgmt. Tech.	M. Feat / Int	Comments / Notes

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Figure 3.2.1 A sample wildlife habitat assessment (WHA) form used to rate habitat suitability and to record evidence of their use for each of the eleven species.

eleven species. This number of WHAs was determined to be sufficient to develop a clear understanding of the relationship between the needs or life requisites of each species and the habitats available within the Study Areas.

Conduct of the Wildlife Habitat Assessments

Each WHA card (Figure 3.2.1) was linked to a accompanying Full Plot or Ground Inspection Plot by recording the project and plot number. When a site was visited in the field where a Full Plot or a Ground Inspection Plot was to be completed, the wildlife biologist within the crew recorded the BEC sub-zone, Site Series and structural stage on the WHA form. The wildlife biologist then walked the plot and visited adjacent habitats before assigning a rating for a particular use for each species. Signs of use by any of the eleven species was also recorded. Field notes were also taken to further describe the site or to record signs of use by non-target species.

At the end of each field day, the sampled plots were marked on a matrix of all site series and structural stages. This technique was used to monitor the distribution of samples across all combinations of available habitats within the Study Area. As appropriate, adjustments were made to the sampling plan to avoid over or under-sampling some wildlife habitat types.

A large number of incidental wildlife records were collected during the field session. Both target and non-target species were recorded as they were encountered. Locations of mineral licks and animal congregation areas were also recorded. These lists, combined with the plot data and other spatial wildlife data, will provide an important reference database during the construction of the wildlife models and will be used during the map verification phase of the project.

Compilation and Analysis of Field Ratings

Once the field surveys were completed, WHA and observational data were used to develop unique habitat-use algorithms that were applied to the TEM mapping. Field form data were transcribed to computer spreadsheet data files, and sorted/analyzed. These were then used in the development and refinement of the species model for each species being examined in the study.

3.3 Species-Habitat Models

The purpose of the species model is to document how the mapped ecosystems in the Study Area satisfy a species' requirements for survival. These requirements, referred to as life requisites, include a species' basic requirements for food, security and, for some, thermal protection, reproduction, denning and living. Living is a function of the spatial arrangement of food, security and thermal protection in the landscape and depicts where animals are likely to be found, assuming they are present in the area.

The procedure for the development of a species-habitat model involved the following steps:

1. The relationship between the mappable ecosystem attributes and the species' life requisites were explicitly defined (these are the assumptions);
2. A formal ratings table which assigns suitability ratings for each life requisite (food, security and thermal protection) to each ecosystem unit based on the assumptions was developed;
3. The adjustments needed to modify the ecosystem unit ratings to account for habitat requirements that are not inherent properties of the ecosystem unit (e.g. aspect, canopy closure or slope) were determined; and,

4. Rules for how the life requisites combine to produce suitable habitat for living, reproduction, denning, etc. were determined;

3.4 Rating Schemes and Map Themes

Polygon ratings for each season and life requisite are contained in the digital map database for each species. However, it is not possible to depict all of this information on printed maps. Table 3.4.1 summarizes the rating scheme and the map theme for each species.

For five of the eleven species (grizzly bear, black bear, bison, mountain goat and Stone sheep), the habitat maps depict the best seasonal rating. Therefore, the map shows the highest value for a polygon, regardless of when it might be used. For eight of the eleven species (all species except marten and grizzly and black bear), the availability of high quality winter habitat is an important determinant of their distribution and, therefore, the maps show winter habitat for living. Seasonal ratings that are not shown on the printed maps are on the accompanying CD-ROM (included as Appendix F). Maps of these ratings can be viewed in ArcView (version 3.0 or greater) using files also contained in Appendix F.

Spatial adjustments are used to calculate habitat suitability for living. These adjustments account for spatially separated life requisites. In all cases, the living rating is calculated using the food and security (or security/thermal) ratings within and adjacent to each polygon. Specific adjustments are described for each species in Section 4.

Table 3.4.1. Rating schemes and map themes for each of the eleven species.

Species	Rating Scheme [a]	Map Theme [a]	Spatially Adjusted?
American marten (MMAAM)	FD-W, SH-W, LI-W	LI-A	No
Grizzly bear (MURAR)	FD-P, FD-S [b], SH-G, LI-P, LI-S, LI-G	LI-G	Yes
Black bear (MURAM)	FD-P, FD-S [b], SH-G, LI-P, LI-S, LI-G	LI-G	Yes
Moose (MALAL)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W	LI-W	Yes
Elk (MCEEL)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W	LI-W	Yes
Caribou (MRATA)	FD-W, FD-P, FD-S	FD-W	No
Mule deer (MODHH)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W	LI-W	Yes
White-tailed deer (MODVI)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W	LI-W	Yes
Bison (MBIBI)	FD-G, W-FD	FD-W	No
Mountain goat (MORAM)	FD-G, FD-W, SH-A, LI-G, LI-W	LI-W	Yes
Stone sheep (MOVDS)	FD-G, FD-W, SH-A, LI-G, LI-W	LI-W	Yes

[a] Seasons: P- spring; S- summer; F- fall; G- growing; W- winter.
Uses: FD- food; SH- security; ST- security/thermal; LI- living.
[b] For grizzly bear, black bear and caribou, "S" includes both summer and fall.

3.5 Generation of the Ratings Table

Based on the models, the ratings table contains suitability ratings for each ecosystem unit (a combination of site series, structural stage and stand composition). The ratings table serves two purposes: it provides

- An individual rating for each ecosystem unit that reviewers can critique, if they have visited or are familiar with the units; and,

- A look-up table that instructs the GIS algorithm as to how to assign base ratings to map polygons.

We generated the ratings using a linear, additive model:

Rating = 1+[Ecosection]+[BEC Zone/Subzone/Variant]+[Site Series]+[Structural Stage] +[Stand Composition],

where each term in the model represent the influence of that attribute on habitat suitability. Each possible value for an attribute was given a degrading score relative the optimal value for the attribute. For example:

The optimal structural stages for American marten are mature and old forest. These stages have a degrading score of zero. A sub-optimal stage, such as pole/sapling, has a degrading score of minus three.

The degrading scores for Ecosection, BEC Zone/Subzone/Variant, site series, structural stage and stand composition are all scored in a similar manner. By summing all of the degrading scores for a single ecosystem unit, a base habitat suitability can be calculated. The degrading scores are listed in the model for each species.

To generate ratings for all ecosystem units, we used Microsoft Access, a relational database program. Figure 3.4.1 shows a sample screen capture of a database model for one of the species.

This automated approach to generating the ratings tables has several advantages:

1. Ratings for a large number of ecosystem units can be generated quickly and efficiently;
2. Revisions to the ratings table are fast (for example, if an assumption about structural stage habitat use changes, a new ratings table can be generated instantaneously for all occurrences of that structural stage);
3. Inconsistencies due to subjective evaluation are reduced; and,
4. Data entry errors are minimised.

Given the map scale, the size of the Study Area and the knowledge of species-specific habitat use in the Study Area, we have used a relatively simple model. However, complex models could potentially be used to generate ratings for a large number of ecosystem units in a cost-efficient manner.

The generation of the ratings table is described in more detail in Appendix F.

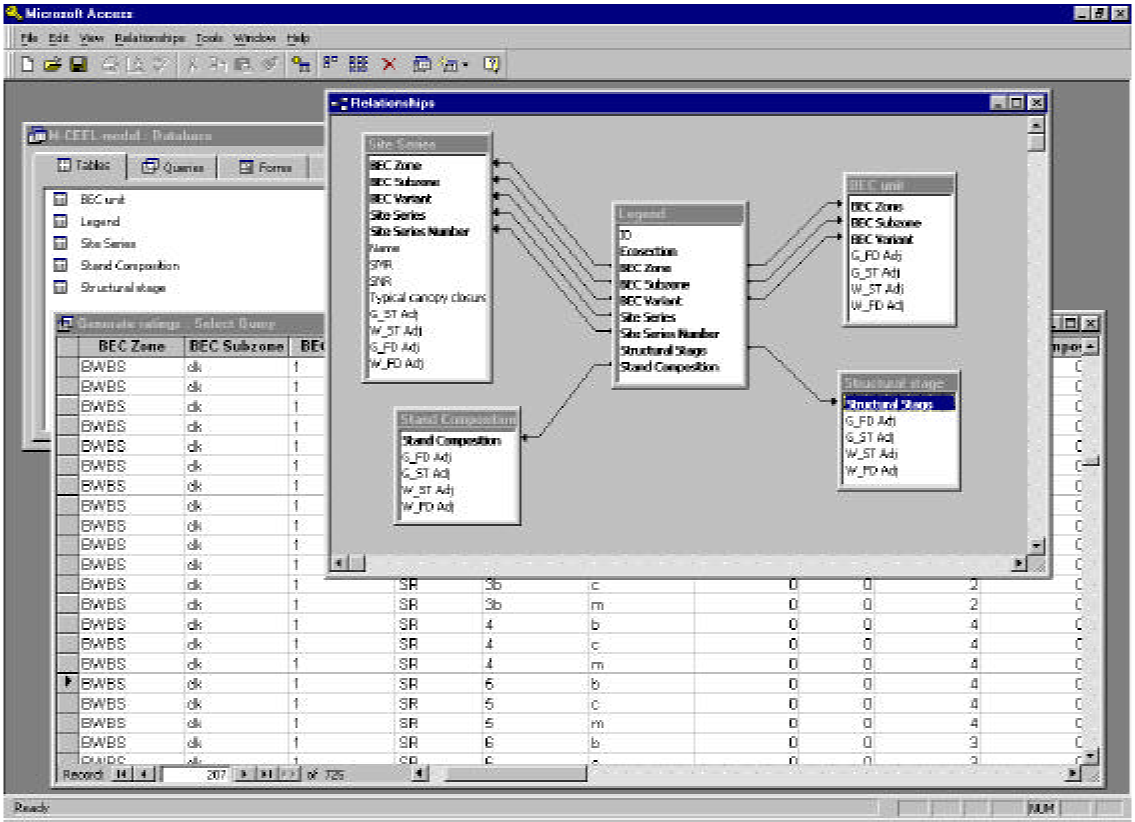

Figure 3.4.1 A screen capture of the relational database used to generate the ratings tables.

3.6 Polygon Ratings

The generation of the polygon suitability ratings involved several steps.

A. Ratings were assigned to each decile (ecosystem unit in a complex polygon) from the ratings table for each season and use (e.g., food and security for growing and winter) for each species.

B. Polygon-specific adjustments were applied to each decile rating. For example, a thermal rating in winter would be decreased if the decile contained a cool aspect. Other common adjustments included adjustments for steep slopes and various terrain types that afford security for some species (e.g. undulating terrain).

C. The polygon rating for each season and use was selected as the best rating of the first two deciles.

D. A GIS algorithm was used to generate habitat suitability ratings for living. The living rating reflects the expected use of a polygon if the species is present in the area. Since many of the target species have spatially separated life requisites (e.g. food and security are provided by different types of ecosystems), the availability of habitat in adjacent polygons is important.

For example, a polygon that provides food and no security would be rated low for living because of the lack of security. However, if security is provided in an adjacent polygon (within reasonable proximity, depending on the ecology of the species), both food and security are provided and the target polygon is thus rated higher for living.

The first three steps were performed using Microsoft Access. The remaining step was done in Arc/Info Version 7.1.

The generation of the polygon ratings is described in more detail in Appendix F.

3.7 Model and Map Verification

Once models were complete, a review/verification process was followed:

- Review of the written model by species experts;
- Correlation with the provincial standards;
- Comparison of draft maps with wildlife distribution data; and,
- Model revision.

The revision process involved several iterations. This review process ensures that the assumptions are well supported and there is a high level of consistency among those who are developing wildlife habitat models in various parts of the province for the same or similar species.

4.0 FIELD DATA RESULTS

4.1 Winter Aerial Survey

The entire Study Area was flown over a four day period. The majority of the work was accomplished over two days due to perfect weather conditions. On each flight, there were three observers and the pilot (Doug Parrish of Bailey Helicopters, Ft. St. John).

In general, most of the ungulates were very dispersed, likely due to the below-average snow depth and coverage. Snow depth and coverage for the whole Muskwa area was below average accumulations (Webster, pers. comm). South-facing slopes were often bare, plateaus were wind-swept and, on average, valley floors had a mean snow depth of approximately 50 cm. The pilot, who had flown the study area numerous times in recent years, stated that the animals were more spread out than in other winters, and that the areas of "known high concentrations" did not appear. Overall, 1,180 ungulates were observed during the surveys. Table 4.1.1 lists the numbers of each species.

No mule deer or white-tailed deer were observed in the Study Area. Just south of the Study Area along the Sikanni River, bison were seen in the lowlands, but no bison were recorded within the Study Area. Ptarmigan were seen regularly during the survey.

4.2 Winter Ground-Based Wildlife Transects

Two and half days of ground-based wildlife transects were conducted in the BWBSmw2. Seismic lines were followed, and short traverses into wooded areas were covered on foot. As well, a small section of the Buckinghorse River was walked. Squirrel and snowshoe hare were the most common tracks observed. Some small mammal tracks such as voles, etc.. were also noted. In some instances, predator wing prints were also observed. Fisher and marten tracks were recorded along the Buckinghorse River. Wolverine tracks were seen following a creek in the NE portion of the Study Area, and in a mature forest in the same area, marten tracks were recorded along some woody debris. Moose tracks generally followed seismic lines; a few moose bedding sites were also encountered and recorded.

Snow depth measurements and snowpack profiles were taken at several locations throughout the Study Area. Snow depths varied greatly, ranging from no snow to 67 cm. During our field surveys, most of the south-facing slopes were essentially bare, and mountain plateaus were windswept and bare.

4.3 Wildlife Habitat Assessments

A total of 101 wildlife habitat assessments were completed during the summer field session. Table 4.3.1 lists the number of plots in each site series of each biogeoclimatic zone.

The wildlife habitat assessment ratings were summarised by ecosystem unit and used to construct the ratings tables for each species. Field notes recorded at each plot are presented in Appendix C.

Table 4.1.1 Species observed during the winter aerial survey in the Besa/Prophet TEM Study Area.

Common name	Scientific Name	Number observed	Comments
Moose	*Alces alces*	526	Seen throughout the Study Area and in all biogeoclimatic zones. Fewer tracks were noted in the SWB and higher elevations on north facing slopes and on very steep slopes
Rocky Mountain Elk	*Cervus elaphus*	308	Majority were recorded on south-facing slopes along the Prophet River and mostly in burned areas. Most elk occurrences were in the SWBmk and SWBmks. In some cases, elk and sheep were seen in the same areas.
Stone Sheep	*Ovis dalli stonei*	238	Observed mostly at and above treeline in the SWBmk, in the SWBmks and in grassy areas of the AT. Mostly near rounded bald mountain tops on south- or east-facing slopes. Sheep were observed on rockier terrain then the elk.
Mountain Goat	*Oreamnos americanus*	63	Majority of goats were recorded in AT in areas of little snow cover. More goats are likely present then were recorded due to their low “sight-ability” in snow covered areas. Some goats were seen in the SWBmk where escape terrain (i.e., cliffs) was nearby.
Caribou	*Rangifer tarandus*	45	Majority were observed on a windswept plateau on the east end of Mount Luckhurst. The low number of caribou observed may be due to the fact that they were hidden by trees in the BWBS and the SWB. This may also be indicative of declining population numbers from historically higher densities.
Wolf	*Canis lupus*	6	Wolves, wolf tracks and wolf kills were seen throughout the Study Area, except in the upper Prophet River area.
Wolverine	*Gulo gulo*	2	One was observed in a valley bottom alongside a river and the other was observed feeding on a moose carcass in the SWBmks zone.
Coyote	*Canis latrans*	2	Observed travelling near a ridge top in the SWBmks.
Northern Goshawk	*Accipiter gentilis*	1	Observed leaving a tree in the SWBmks
Hawk Owl	*Surnia ulula*	2	The hawk owls were observed in the BWBSmw2 and the SWBmk.
Bald Eagle	*Halleetus leucocephalus*	1	

Table 4.3.1 The number of wildlife habitat assessments completed during the summer field session.

BGC unit	Site Series	#
BWBSmw2	AM	2
BWBSmw2	SH	1
BWBSmw2	BL	1
SWBmk	BF	4
SWBmk	FA	1
SWBmk	FL	1
SWBmk	FS	1
SWBmk	FW	1
SWBmk	MA	1
SWBmk	SB	9
SWBmk	SC	6
SWBmk	SF	4
SWBmk	SH	6
SWBmk	SK	1
SWBmk	SL	4
SWBmk	SS	4
SWBmk	SW	9
SWBmk	TC	2
SWBmk	WH	2
SWBmk	WM	1
SWBmk	WS	2

BGC unit	Site Series	#
SWBmks	AD	2
SWBmks	BF	1
SWBmks	BV	4
SWBmks	FL	5
SWBmks	FW	4
SWBmks	MA	4
SWBmks	SB	2
SWBmks	SH	1
SWBmks	SK	1
SWBmks	SL	1
SWBmks	SS	1
SWBmks	WH	2
SWBmks	WM	1
AT	FW	1
AT	MA	5
AT	TA	2

4.4 Evidence of Use (Summer)

Evidence of use was found in or near almost all of the ground inspections and full plots. In this section, general relationships between evidence of use and plot attributes are described. Graphs are included for those species and attributes with a large number of samples. We have not included those records that were recorded outside the plot as these are often in a different ecosystem unit.

It must be noted that some trends may be caused by the distribution of samples. For example, high evidence of use in mesic sites may be due to high use but may also be because mesic sites are most common and thus sampled most.

Marten

There were no sightings or sign found of American marten within the study area. There are also no records of trapping within the study area although there has been sporadic trapping in the Muskwa drainage, which is adjacent to the north of the Prophet River basin

Grizzly bear

There were two grizzly bear sightings: one in the AT the other in the SWBmk. The bear in the AT was reported to be a female and was eating while travelling. The bear in the SWB was following a watercourse and was seen briefly from the air.

Black bear

Several black bears were observed. Most were recorded beside watercourses in the valley bottoms, although one was seen at high elevation in the SWBmks, far from forest cover. It should be noted there was a great deal of unknown bear sign (sign that could not be properly attributed exclusively to one species of bear) recorded on the wildlife forms. This included scat, diggings, logs torn apart and stripped trees.

Moose

Over 80% of the plots contained evidence of moose with all of the plots in the SWB containing sign. The greatest occurrence of sign was in the SWBmk. Structural stages low shrub (3a) and mature forest (06) and soil moisture regimes submesic to subhygric contained the most sign. More sign was likely present in the very wet sites than were actually found: feces are likely to decompose quickly in these environments. South and west aspects appeared to be used least and gentle slopes (8-33%) appeared to be used more than any other slope class.

Elk

The greatest proportion of plots with elk sign was the SWBmk. Most sign was found in early structural stages, however, abundant sign was found in mature forest indicating use of this habitat type, presumably for security and thermal protection. Site series that are submesic to sub-hydric were preferred. No distinct preference for aspect was observed.

Caribou

All of the 22 occurrences of caribou sign were in the SWBmk or SWBmks. Structural stages 2d and 3a had the majority of occurrences. There were no significant trends in the choice of aspect or in soil moisture regime. More than half of the occurrences were in very poor or poor soil nutrient regimes, which is consistent with their use of lichen dominated habitats in winter. Caribou sign was commonly found on north aspects slopes with permafrost soils. These habitats contained abundant grasses, forbs and lichen.

Mule Deer

Although mule and white-tailed deer sign are difficult to differentiate, four plots contained sign that was considered to belong to mule deer. All the occurrences were in BWBSmw2 and SWBmk (2 occurrences each).

White tail deer

There were six occurrences of sign that were thought to be white-tailed deer. Five of the occurrences were in the SWBmk while the remaining occurrence was in the BWBSmw2.

Bison

Bison or evidence of their presence were not found within the boundaries of the Study Area, however an interview with Mike Hammet (outfitter along the Sikhani river) revealed that bison were observed in 1998 at the head of Nevis Creek.

Mountain goat

Mountain goat sign was not found within any of the plots.

Stone sheep

Stone sheep sign was found in only eight plots. All of these occurrences were in the SWBmks in sparsely vegetated and herb structural stages. Almost all of the occurrences were on slopes less than 33%. These gentle slopes most likely represent feeding habitat rather than escape terrain.

4.5 Incidental Wildlife Observations

A total of 324 target species were recorded as incidental observations. These are sightings that were not associated with a plot—observed either in-transit or at a distance from a plot. Stone sheep, elk and moose were sighted more than any other species (Figure 4.5.1).

Appendix D.1 lists all of the target species incidental observations. A number of non-target species were also recorded during the field work. These are listed in Appendix D.2.

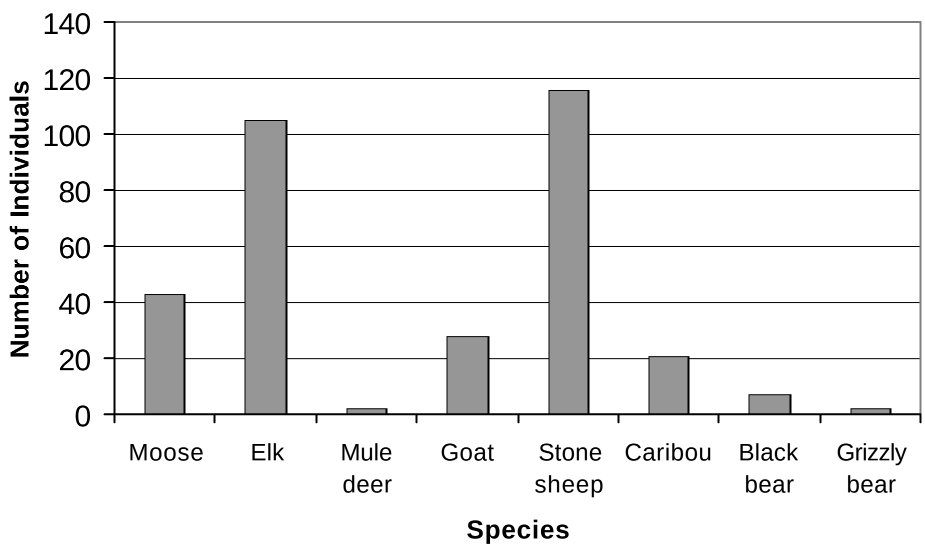

Figure 4.5.1 The number of incidental wildlife observations from the summer field work listed by species.

4.6 Wildlife Licks

During the field data collection, a number of licks were observed and recorded. Table 4.4.1 list the location of known licks within the Besa/Prophet Study Area. Interviews with knowledgeable locals revealed the location of other licks and these are also included.

Licks are areas where animals congregate, presumably for the purpose of obtaining mineral nutrients that are not available elsewhere. In many cases however, it is difficult to discern if wildlife are actually consuming the soil or if there are other reasons that individuals are congregating. These areas may function as suitable locations for wallowing, rutting, or in the case of the one lick that occurs at the outflow of a hot sulphur spring, it provides a snow-free area with access to open water.

Figures 4.6.1 shows a wet lick located along the Besa River valley bottom. Elk were viewed at this location and all of the tracks in the mud were elk. Figure 4.6.2 shows a dry lick located in the SWBmks above the Prophet River. Sheep and goat hair was found along the eroded edges.

Figure 4.6.1. A wet lick located along the Besa River valley bottom. The tracks in the mud belong to elk. This location is listed as the second lick in Table 4.6.1.

Figure 4.6.2. A dry lick located in the SWBmks on a ridge above the Prophet River. Goat and sheep hair was found along the eroded edges. This location is listed as the fourth lick in Table 4.6.1.

Table 4.6.1 Observed wildlife licks in the Besa/Prophet TEM Study Area.

Latitude	Longitude	Source[1]	Type[2]	Evidence of Animal Use	Notes
57°35'16''	123°45'27''	V	W	Rich with birds	Very muddy, wet lick , adjacent to plot 168 Sedge-fen in valley bottom Burned and unburned forest adjacent to plot Moderate use by unknown species, although likely elk and/or moose No evidence of soil consumption
57°40'35''	123°26'59''	V	D	Sheep hair caught of vegetation and on edge of eroded soil Possibly goat hair as well Possible soil consumption (small pockets with vague outlines of teeth marks)	Lick on top of ridge overlooking Besa River, Beside plot 392 Eroded and exposed soil on moderate slope Lick and plot are on NE aspect Excellent high elevation forage – abundant <u>Pao alpina</u> See Figure 4.6.2
57°28'18''	123°26'12''	V, A	W/D	Caribou and moose seen Elk tracks, goat or sheep tracks Sheep seen during winter survey Possible soil consumption Extremely well used	This is the Upper Prophet Hot Springs lick High accumulations of minerals Black bears were also observed near the hot springs
57°29'03''	123°22'59''	V	W	Very well-used lick along west-side of Besa River at base of slope Huge number of elk hoof prints Elk were seen from the air on initial fly-over Wolf tracks and wolf skeleton nearby in forest Located 200m east and down-slope of plot 98-00180	Smells like a barnyard Natural wetland with slowly flowing water meandering through floodplain Eroded, humocky banks Muddy patches with abundant elk prints Two mineral rich creeks on slope above wetland: one with a milky white precipitate and the second is a "red" creek See Figure 4.6.1
57°45'19''	123°27'58''	V	U	Unknown	Located 300m north of the co-ordinates given here Viewed from helicopter enroute
57°40'06''	123°55'08''	V	W	Unknown	Lick along south side of Prophet River Viewed from helicopter while enroute
57°40'09''	123°29'10''	A	U	A very well used stone sheep lick	Lick location supplied by Gary Vince
57°41'48''	123°18'07''	A	U	Information supplied indicated that this was a well used goat lick	Information supplied by Bryan Webster and Rob Woods of MELP.

Latitude	Longitude	Source[1]	Type[2]	Evidence of Animal Use	Notes
57°29'57''	123°18'31''	A	U	This is a Caribou lick.	Information supplied by Bryan Webster and Rob Woods of MELP.
57°35'11''	123°51'11''	A	U	This lick is used by both Moose and Elk	Information supplied by Bryan Webster and Rob Woods of MELP.
57°41'06''	123°53'20''	A	W	Primarily the sheep uses this lick.	Information supplied by Bryan Webster and Rob Woods of MELP.
57°21'20''	123°11'58''	A	U	This is a Moose lick.	Information supplied by Bryan Webster and Rob Woods of MELP.
57°27'59''	123°25'06''	V	U	Stone sheep were seen on several occasions in canyon.	Many of our sightings were up the Nevis canyon; canyon was were very steep and made of a very soft crumbly shale. Groups of stone sheep observed ranged from 1 to 20 animals. The majority of the sheep seen were ewe and lamb groups (and possibly some young males) but there no mature rams observed on any flights Although no direct evidence of a lick was found the sheep were very far from suitable escape terrain and therefore it is assumed that the sheep were drawn to this area for a good reason.
57°28'02''	123°17'16''	V	W	Observed lots of moose tracks and browse.	Looks like a large moose lick. Lick very close to plot # 9800181. Located in the middle of a wetland complex.
57°32'54''	123°40'00''	V	D	Several stone sheep were observed in the area of the lick.	This is a possible lick, black dirt was observed where the stone sheep were bedded down. The lick was approximately 800m from plot #9800320 at an Az of 334^0.
57°40'53''	123°54'36''	V	W	Lick looked to be the wheel spoke type, (a large trampled down area with some standing water with trails radiating out of the lick in a circular pattern)	This possible lick site was located in the middle of a wetland, but no animals were seen around it. It was likely a Moose lick.

[1]Source: V= Visited/viewed during 1998 TEM field work
A= Anecdotal report

[2]Type: W= Wet
D= Dry
U= Unknown

5.0 SPECIES-HABITAT MODELS

The species-habitat model serves several purposes:

- Describes the species' requirements for survival;
- Describes the relationship between the species' life requisites and spatial habitat attributes; and
- Defines a numerical relationship between a species' habitat requirement and the TEM database and other supplementary spatial data.

A ratings table is generated using the assumptions described in the model. The ratings table contains suitability ratings for food, security and thermal protection for each ecosystem unit that has been mapped in the study area. These ratings are then applied to the map database using a GIS algorithm. The ratings tables are contained in Appendix F.

Each species-habitat model follows a consistent, defined structure with the following sub-sections:

DISTRIBUTION, lists the provincial range, study are distribution and the provincial benchmark for the species;

ECOLOGY AND HABITAT REQUIREMENTS, describes the species requirements for survival;

LIFE REQUISITES/SEASONAL USE PATTERNS, describes the species' specific life requisites;

HABITAT USE AND ECOSYSTEM ATTRIBUTES, relates the life requisites to mappable ecosystem attributes, such as Ecosection, biogeoclimatic zone, site series, structural stage, stand composition, and proximity and spatial requirements;

HABITAT RATINGS, describes the rating scheme, modeling theme**,** and the numerical relationship between the habitat assumptions and the ecosystem attributes; and

REFERENCES.

5.1 American Marten (*Martes americana*)

SPECIES NAME: American marten
SCIENTIFIC NAME: *Martes americana*
SPECIES CODE: M-MAAM
STATUS: Not at risk (MELP, 1997; COSEWIC, 1998)

DISTRIBUTION

Provincial Range

American marten are found throughout mainland British Columbia, on Vancouver Island and on the Queen Charlotte Islands in addition to several smaller coastal islands (Nagorsen, 1990). They are generally split into two different forms: interior and coastal (Lofroth and Stevens, 1990).

Provincial Benchmark

Ecoprovince: Not established.
Ecoregion:
Ecosection:
Biogeoclimatic zone:
Broad Ecosystem Units:

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, and SWBmks
Elevational range: Valley bottom to subalpine scrub (~900m to 1500m).

ECOLOGY AND HABITAT REQUIREMENTS

Marten are generally associated with late-successional stands of mesic conifers, especially those with complex physical structure near the ground (Buskirk and Ruggiero, 1994). They may use younger forests and even open areas in the snow free seasons if good cover is provided nearby. The complex physical structure near the ground provides escape space/refuge sites; access to subnivean space where most prey are captured in winter; and protective thermal environments, especially in winter (Buskirk and Ruggiero, 1994). They require well insulated resting dens when not active. Dens are almost always subnivean and typically associated with coarse woody debris such as squirrel middens, stumps, snags, and the root masses of large trees (Lofroth and Steventon, 1990).

Marten diet varies by season. In summer, their diet includes bird's eggs and nestlings, insects, fish, fruit and young mammals. In winter, voles, mice, hares and squirrels dominate (Buskirk and Ruggiero, 1994). Marten hunt mostly on the ground, though they are good climbers and may chase squirrels or reach bird nests by climbing. Hunting is often done beneath the snow and fallen logs or rocks are used to access the subnivean spaces (Stevens and Lofts, 1988). Food is a significant factor limiting marten presence and distribution, especially in winter. Fluctuations in small mammal densities in Montana were believed to directly affect the carrying capacity for marten (Weckwerth and Hawley, 1962). However, large quantities of snow in winter with limited access routes to get at prey below deep snow may be more restrictive on marten winter densities than the actual density of prey present (Clark and Campbell, 1976). Thompson and Harested (1994) suggest that although marten have been reported to show some diet preferences, it is unlikely that the presence of individual prey species influences habitat selection.

Resting sites are very important to marten and include fallen trees, dense vegetation, natural cavities between rocks or stumps and in trees. The resting sites provide thermal shelter during inclement weather to reduce energy expenditure. Resting sites are often located near recent kills (Stevens and Lofts, 1988). In Wyoming, Clark and Campbell (1976) report that marten frequently select large (35 to 152.2 cm dbh), rotten Engelman spruce or sub-alpine fir snags as refuge sites.

Marten prefer coniferous stands with a closed canopy. Recorded canopy closure preferences vary widely; from as low as 20% to as high as 100%. Koehler and Hornocker (1977) report that habitat with less than 30% cover is utilised but movement about these areas may be restricted to edges. In Colorado, marten have been recorded searching for prey 0.8 to 3.2 km from forest cover from May to November (Streeter and Braun, 1968). In these cases, they were most commonly found in boulder fields looking for prey such as pikas (*Ochotona princeps*). Lefroth (1994) suggests that differences in canopy closure preferences must be interpreted in the context of the range of canopy closures that are available in the area.

There is little documentation on the requirements of natal den sites however logs, trees, rocks and snags account for the greatest number of reported dens (Buskirk and Ruggiero, 1994). The availability of natal sites may be related to structural complexity, often associated with old-growth forests.

Males generally have larger territories than females. A male's territory ranges from 0.9 km^2 to 17.9 km^2 and may overlap those of several females. The female home range may be from 0.5 km^2 to 8.5 km^2 (Stordeur, 1985). Home range size depends upon prey and habitat.

Marten home range does not shift among seasons although they do specialise in the higher quality portion of their range during winter (Buskirk and Ruggiero, 1994). Winter is considered the most critical season for marten when habitat requirements are most restrictive (Allen, 1982; Buskirk and Ruggiero, 1994; Lefroth and Steventon, 1990).

Little is known about landscape-scale marten habitat use. Attributes such as stand size, stand shape, area of interior, amount of edge, use of corridors and connectivity may be important in marten habitat selection but are almost completely unknown (Buskirk, 1992). Reports of minimum habitat size have been estimated in the western US to be approximately 2.59 km^2 for males. Based on this information, it is assumed that at least 2.59 km^2 of suitable habitat must be available before an area will be occupied by this species (Allen, 1982).

Marten are adversely affected by logging and by forest fires, both of which may remove overhead cover and coarse woody debris (Buskirk and Ruggiero, 1994; Strickland and Douglas, 1987; Thompson and Harestad, 1994).

LIFE REQUISITES/SEASONAL USE PATTERNS

Marten habitat requirements are divided into security, food, denning and living (Table 5.1.1).

Table 5.1.1 Marten seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Security	Winter	October to May
2.	Food	Winter	October to May
3.	Security	Growing	June to September
4.	Food	Winter	October to May
5.	Denning	Winter	March-April
6.	Living	Growing, Winter	June to September, October to May

Security

Security habitat (which provides cover) is required in all seasons, however, winter cover is considered the single most important factor determining habitat selection for marten (Allen, 1982; Buskirk and Ruggiero, 1994). If adequate winter cover is available, habitat requirements during other seasons may also be satisfied. For example, an area that provides suitable winter cover will also provide suitable summer cover, and suitable habitat for feeding, denning etc.. Habitat characteristics that relate to the provision of cover are therefore emphasised. Good security habitat is characterised by a coniferous canopy with canopy closure greater than 30% and high coarse woody debris.

Food

In winter, food availability is closely linked to security—those areas that provide good security provide access to subnivean spaces where prey are captured. Thus, habitat that provides security provides adequate feeding. During the growing season, marten may also use areas for feeding that are not suitable for winter cover.

Denning

Dens have been found in logs, trees, rocks and snags. We assume that natal den sites are provided in habitat with good security.

Living

Habitat that provides living contains both security and food. These requisites are often provided in the same habitat, however, marten will feed in areas with sub-optimal security if there is adequate security nearby in summer. In winter, marten habitat can only be as good as the security it provides.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

The distribution of marten in the MUF and EMR Ecosections is largely a function of the biogeoclimatic zones contained within. The EMR, which contains SWBmk, SWBmks and AT, generally lacks adequate canopy closure to support high numbers of marten. The presence of the BWBSmw2 sub-zone in the MUF Ecosection results is a greater availability of marten habitat.

Biogeoclimatic Zone

The BWBSmw2 zone, with its higher canopy closure and denser undergrowth, provides the highest quality marten habitat in the Study Area. The predominantly open canopy of the SWBmk zone severely limits its use by marten in winter, although it may provide food in summer if there is adequate cover nearby. The absence of forest cover in the SWBmks and AT precludes use by marten in winter although these zones may provide food in the growing season.

Site Series

In general, moister site series (soil moisture regimes [SMR] from sub-mesic to sub-hygric) provide better marten habitat than drier site series (very xeric to sub-xeric). Moister sites typically have higher canopy closure and denser shrub and herb layers, providing better cover and prey habitat. However, very wet sites (those with seepage water) (hygric to sub-hydric) typically have a lower canopy closure, are rated lower than moist sites. Mesic and moist sites are also likely to have higher coarse woody debris than both very wet and very dry sites. Lofroth (1994) found that marten avoided xeric habitat types and wetlands in a study in the Sub-Boreal Spruce Zone.

Site series with poor and very poor soil nutrient regimes (SNR) provide lower quality food and security habitat than sites with medium to very-rich SNRs.

Structural Stage

The habitat characteristics considered important for marten are often associated with the structural features present in advanced successional forests, such as overhead cover, especially near the ground; high volumes of coarse woody debris, especially of large diameter; and small-scale horizontal heterogeneity of vegetation (Allen, 1982; Buskirk and Ruggiero, 1994). Allen (1982) considers that early successional forests provide no marten habitat, mid-successional forests provide moderate marten habitat and mature or old growth forests provide optimum value. Lofroth (1994) found marten in the Sub-Boreal Spruce zone avoided young seral stages.

Younger structural stages generally cannot provide winter habitat because there is insufficient CWD to provide access to the sub-nivean spaces. Structural stages from young forest (05) to old growth (07) potentially provide habitat for year-round living. It is assumed that non-vegetated and herbaceous structural stages (01 and 02) do not represent marten habitat.

Stand Composition

Coniferous tree canopies provide optimal security for marten. Broadleaf and mixed canopies have low winter crown closure and thus provide poorer security, however, mature and old mixedwood stands do provide denning sites.

Canopy Closure

Sites with high canopy closure provide optimal security. For the most part, effect of canopy closure has been incorporated into the site series and stand composition assumptions described above.

Coarse Woody Debris

Coarse woody debris (CWD) is an important habitat attribute for marten, however, prediction of map units with high CWD is difficult. Late successional forests are most likely to contain the highest CWD (discussed above). As well, productive, mesic site series are likely to have higher CWD than both drier and wetter site series. The effect of CWD is therefore incorporated into the sites series and structural stage assumptions described above.

Proximity Effects

Marten use of a habitat is tied to the quality of habitat in adjacent areas. However, given the relatively small scale of the habitat mapping (1:50,000), proximity effects are not used in this model.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used to depict marten food (FD), security (SH) and living (LI) habitat in winter. The model depicts marten habitat in winter, when habitat is most limited. However, habitat used in winter is also used in summer and the ratings are essentially for year-round use. In the growing season, marten additionally feed in habitats with lower canopy closure and less coarse woody debris that are otherwise not suitable in winter.

The living rating encompasses all of the requirements necessary for survival and is a function of the spatial arrangement of food and security in the landscape. FD and SH ratings are rated for each ecosystem unit in the ratings table. LI ratings are generated using a GIS algorithm incorporating the FD and SH ratings and are therefore not included in the ratings table.

Food (FD) and Security (SH) Habitat Assumptions

The ratings table assigns a suitability rating for FD and SH to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between marten life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.1.2). For example, the optimal structural stage for marten security (old forest) has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 3, which would result in a maximum rating of 4 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Table 5.1.2 Marten security and food habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score	
			W_SH	W_FD
1. BEC Unit	**EMR**	SWBmk	-2	-2
		SWBmks	-5	-5
		AT	-3	-3
	MUF	BWBSmw2	0	0
		SWBmk	-2	-2
		SWBmks	-4	-4
		AT	-5	-5
2a. Site Series (SMR)		Xeric (1)	-2	-2
		Subxeric (2)	-1	-1
		Submesic (3)	0	0
		Mesic (4)	0	0
		Subhygric (5)	0	0
		Hygric (6)	-1	-1
		Subhydric (7)	-2	-2
		Hydric	-3	-3
2b. Site Series (SNR)		Very poor (A)	-1	-1
		Poor (B)	0	0
		Medium-very rich (C-E)	0	0
3. Structural Stage		Sparse (1a)	-5	-5
		Bryoid (1b)	-5	-5
		Forb-dominated (2a)	-5	-5
		Graminoid-dominated (2b)	-5	-5
		Dwarf-shrub dominated (2d)	-5	-5
		Low shrub (3a)	-4	-5
		Tall shrub (3b)	-4	-5
		Pole/sapling (4)	-3	-3
		Young forest (5)	-2	-2
		Mature forest (6)	0	0
		Old forest (7)	0	0
4. Stand Composition		Coniferous (C)	0	0
		Mixed (M)	-1	-1
		Broadleaf (B)	-2	-2

Polygon Food (FD) and Security (SH) Adjustments

There are no adjustments to the polygon food and security ratings.

Living (LI) Ratings Assumptions

The LI rating is a combination of the FD and SH ratings. Since a given habitat can generally only be as good as the most limiting life requisite, LI is calculated as the lower rating between the polygon FD and SH rating. Overall polygon ratings are generated using the best rating of any decile.

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5.2 Grizzly Bear (*Ursus arctos*)

SPECIES NAME: Grizzly bear
SCIENTIFIC NAME: *Ursus arctos*
SPECIES CODE: M-URAR
STATUS: Blue listed (MELP, 1997); Vulnerable (COSEWIC, 1998)

DISTRIBUTION

Provincial Range

Grizzly bears are found throughout most of mainland British Columbia. They have been extirpated from areas that are intensively farmed or urbanised, including the Lower Mainland, Thompson-Okanagan, Caribou and Peace River areas. Grizzlies are not found on the coastal islands of BC (Fuhr and Demarchi, 1990; Nagorsen 1994).

Provincial Benchmark

Ecoprovince: Not established.
Ecoregion:
Ecosection:
Biogeoclimatic zone:
Broad Ecosystem Units:

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2000m in elevation).

ECOLOGY AND HABITAT REQUIREMENTS

Grizzly bears are highly mobile omnivores with large spatial requirements. Grasslands and shrublands integrated with forests, subalpine meadows and forests, and alpine communities are typical grizzly habitat (Nietfeld *et al*., 1985). Their range encompass habitats that provide a sequence of abundant foods and alternate food sources.

Grizzlies feed on a wide variety of plants, switching during the year depending on availability and abundance (Fuhr and Demarchi, 1990). Grizzly diet in spring and early summer consists mainly of forbs, such as horsetail (*Equisetum sp*.), cow parsnip (*Heracleum lanatum*) and indian hellebore (*Veratrum viridae*) and grasses and sedges and other green vegetation (Stevens and Lofts, 1988). Moist fens and streamsides produce high densities of prime summer vegetation (Nietfeld *et al*., 1985). In late summer and fall, berries such as huckleberries, blueberries, soopolallie, and currants are an important component of their diet although roots, grasses and forbs continue to be consumed (Nietfeld *et al*., 1985).

Ridgetops , talus slopes, avalanche chutes, creek/river bottoms, fluvial and alluvial floodplains, and river/stream sides are seasonally important foraging areas (Craighead *et. al.*, 1982, Erickson, 1976). Riparian habitats provide aquatic vegetation types such as sedges and horse-tails (Craighead *et. al*., 1982, Martinka, 1976) and anthropogenic sites such as reclaimed well sites, pipelines and road sites are also utilised seasonally (Nagy, 1984). Most of the latter sites are subject to frequent or recent disturbances and therefore support early succession vegetation forms favoured by grizzly. In general, combinations of terrain and vegetation forming mosaics of forests, shrublands, grasslands and meadows, and riparian regions provide an interspersed array of habitats for the grizzly bear (Martinka, 1976). Grizzlies locate and learn to use specific locales where plant food are abundant; the most productive sites become centres of activity within the home range (Craighead *et. al.*, 1982).

Avalanche paths are key feeding habitats for grizzly but not all avalanche paths are used. Low use paths are often found in the mesic or drier classes while the high use paths are found in the sub-hygric or wetter classes. The lusher sites are often located on southwest aspects (Simpson, 1987). Other important feeding areas may include logged areas where food is potentially abundant (Simpson, 1987). In general, seral plant communities are important feeding habitat for grizzly bear (Humer and Herrero, 1983).

Animal matter such as ants, ground squirrels, and young, weak or old ungulates are also taken opportunistically. Animal protein sources may concentrate grizzly use on small areas such as fish spawning areas or rodent colonies (Fuhr and Demarchi, 1990).

In addition to suitable feeding areas, grizzlies require cover for security and bedding. Cover is generally provided in forested habitats. Simpson (1987) found that bedding sites averaged a canopy closure of 59% compared to an average of 28% for feeding areas. Simpson (1987) also noted that forest cover adjacent to avalanche paths was mainly composed of cedar (66%) followed by hemlock (26%) and spruce (8%). Security cover is most likely not a limiting factor in wilderness areas except in areas of resource development such as logging operations, and oil and gas exploration with associated road construction, all of which may increase hunting pressure (Nietfeld *et al*., 1985). Nietfeld *et al*. (1985) also report that adequate security cover to reduce visual contact by man is provided in vegetation and/or topography which hides 90% of a grizzly from view of a person 120m away. Habitats that provide cover should also have a diameter of at least 91m.

Grizzly den sites vary from alpine/subalpine talus slopes, shrubfields and krummholz areas to various timbered subalpine and lowland areas (Aune, 1994). Most dens are located to ensure an early and long-lasting snow cover for insulation. Dens tend to be located on slopes allowing for ease of digging, mostly ranging from 25-40°. Dens are usually located in areas were soils are well drained to prevent internal flooding and in soils cohesive enough to maintain the physical stability of the den during the first winter (Nietfeld *et al*., 1985).

Mountain valley bottoms and ridgetops serve as travel corridors throughout a grizzly's home range (Russel *et. al*.,1978, Zager *et. al.*, 1980). Corridors connect different habitat units, preventing isolation and enables bears to travel to key food sources (Jonkel, 1987). A corridor may not necessarily contain food, water, or denning habitat.

The major factor determining movement and home range size for grizzlies is the abundance and distribution of food (Macey, 1979). In areas where food and cover are abundant, grizzly home ranges can be as small as 24 km^2; where food resources are scattered, the ranges must be at least ten times larger to provide an adequate food base (LeFranc *et al*., 1987). Ranges vary greatly in area depending on the sex and age of the animal, seasonal and annual food availability, reproductive condition of females, as well as habitat type and population densities (Nietfeld *et al*., 1985).

LIFE REQUISITES/SEASONAL USE PATTERNS

In this model, grizzly life requisites are divided into food, security and denning (Table 5.2.1).

Table 5.2.1 Grizzly bear seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Food	Spring	June
2.	Food	Summer/Fall	July to September
3.	Security	Spring and Summer/Fall	June to September
4.	Denning	Winter	October to May
5.	Living	Spring and Summer/Fall	June to September

Food

The availability and abundance of food is considered the single most important factor determining habitat selection for grizzly. Optimal food is provided in mesic and wetter herbaceous and shrub communities adjacent to security habitat. Food habitats in spring are generally at low elevations with early green up. Food habitats in summer are at mid to high elevations with high plant productivity and high berry production.

Security

Security is provided by closed canopy forest and cover that can hide 90% of a grizzly from 120 m away and late successional stage areas that have a canopy closure greater than 50%. Security may also be provided by terrain that provides concealment, such as that provided by gullied, ridged or undulating topography. Security habitat provides two functions: (1) concealment and escape while feeding and, (2) concealment during movement or migration.

Denning

Dens are generally located at high elevations in areas of high snowfall and low snowmelt. Dens may be located in natural caves, hollows under the roots of trees or they may be excavated into the banks of steep slopes (Province of British Columbia, undated). Those dens that are excavated tend to be located on slopes mostly ranging from 55-90% (Nietfeld *et al*., 1985).

Living

Habitat that is used for general living contains food and security within 100m.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

The distribution of grizzly in the MUF and EMR Ecosections is largely a function of the biogeoclimatic zones contained within. The presence of the BWBSmw2 sub-zone in the MUF Ecosection results is a greater availability of higher quality spring habitat. On a provincial scale, Fuhr and Demarchi (1990) estimate that the MUF provide moderate to low grizzly habitat.

Biogeoclimatic Zone

Grizzly may be found in all of the sub-zones within the Study Area but is seasonally dependent. After den emergence, grizzlies descend to lower elevations (BWBSmw2) to access early green vegetation. With increasing late-spring and summer temperatures, grizzlies are able to access green vegetation at higher elevations (SWBmk and SWBmks). Fall use is concentrated in high berry producing areas in the BWBSmw2, SWBmk and SWBmks. Salmon are not considered to be diet items for grizzlies in the Study Area as none of the watercourses are salmon bearing.

Site Series

Moister sites (mesic to hygric) are rated higher than drier sites (very xeric to sub-mesic) for food as they have higher plant productivity for forage. Hydric and wetter sites have lower tree cover, thus providing less security. Sites with very poor soil nutrient regime (SNR) provided lower plant productivity for food.

Structural Stage

The optimal food and security habitats for grizzly lie at opposite ends of the successional scale– the best areas to find food are young structural stages while the best security habitat are present in more mature stages.

Structural stage 02 to 3b (herbaceous to tall shrub) primarily provide food habitat. The best food is provided in structural stages 02 and 3a (herbaceous and low shrub) where herbaceous plants and berry-producing shrubs can achieve their highest density. Structural stages 04 and 05 (pole sapling to young forest) provide poor food and security and are generally rated low for both. Structural stages 06 and 07 (mature forest to old forest) provide optimal security. Structural stage 01 (non-vegetated) provides no significant food or security.

Canopy Closure

Sites with high canopy closure provide optimal security. The effect of canopy closure has been incorporated into the site series assumptions described above.

Aspect

Warm southerly and westerly aspects (135-285 degrees) provide higher quality spring and summer feeding.

Terrain

Security may be provided by terrain that affords concealment, such as gullied, ridged or undulating topography. Therefore, non-forested areas that would normally provide no security, are rated higher than similar polygons lacking concealing topography.

Proximity Effects

While feeding, grizzlies require security in close proximity. Therefore, habitats that provide habitat for general living must have security within 100m.

Disturbance

Grizzly bears are affected by roads. McLennan and Shackleton (1988) found that grizzlies used habitat within 100m of primary, secondary and tertiary significantly less than expected. Avoidance of roads was independent of traffic volume, which suggests that even a few vehicles can displace bears. Habitats within 100 m of any road will be rated nil.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A six-class rating scheme is used to rate grizzly bear habitat for food (FD), security (SH) and living (LI) in the spring (P) and summer/fall (S). The LI rating is an integration of grizzly food and security requirements and more directly reflects where grizzly are likely to be found, assuming they are present in the area. A GIS algorithm uses the ratings for FD and SH and incorporates the spatial arrangement of ratings in adjacent polygons.

FD and SH are rated for each ecosystem unit in the ratings table. All ecosystem units are rated for spring and summer use. Denning habitat is not rated in this model as grizzly distribution is more dependent on the availability of adequate food and security than on the availability of den sites.

Food (FD) and Security (SH) Habitat Assumptions

The ratings table assigns a suitability rating for FD and SH to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between grizzly life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.2.2). For example, the optimal structural stage for security (old forest) has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 2, which would result in a maximum rating of 3 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Polygon Food (FD) and Security (SH) Adjustments

Adjustments are used to modify the ratings in order to account for habitat attributes that are not inherent features of the ecosystem unit.

Table 5.2.2 Grizzly bear food and security habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score		
			P_FD	S_FD	G_SH
1. BEC Unit	**EMR**	SWBmk1	-2	-2	0
		SWBmks1	-3	-2	0
		AT	-5	-2	-4
	MUF	BWBSmw2	-2	-2	0
		SWBmk1	-2	-2	0
		SWBmks1	-3	-2	0
		AT	-5	-2	-4
2a. Site Series (SMR)		Xeric	-2	-2	-1
		Subxeric	-1	-1	-1
		Submesic	0	0	0
		Mesic	0	0	0
		Subhygric	0	0	0
		Hygric	0	0	-1
		Subhydric	0	0	-2
		Hydric	0	0	-3
2b. Site Series (SNR)		Very poor	-1	-1	0
		Poor – very rich	0	0	0
3. Structural Stage		Sparse/Bryoid (1)	-4	-4	-5
		Sparse (1a)	-4	-4	-5
		Bryoid (1b)	-3	-3	-5
		Forb-dominated (2a)	0	0	-5
		Graminoid dom. (2b)	0	0	-5
		Dwarf shrub (2d)	0	0	-5
		Low shrub (3a)	0	0	-3
		Tall shrub (3b)	-1	-1	0
		Pole/sapling (4)	-3	-3	0
		Young forest (5)	-3	-3	0
		Mature forest (6)	-2	-2	0
		Old forest (7)	-2	-2	0
4. Stand Composition		Coniferous (C)	0	0	0
		Mixed (M)	0	0	0
		Broadleaf (B)	0	0	0

Table 5.2.3 Polygon-specific food and security ratings adjustments

Topic	Description
A. Aspect	Rate cool northerly and easterly aspects (285-135°) down 1 FD.
B. Disturbance	Rate polygons within 100m of any road 6 FD and 6 SH.
C. Terrain surface expression	Polygons lacking forest cover (structural stages 1a, 1b, 2, 3a and 3b) are rated up 2 SH for growing and winter if the surface expression is ridged (r), undulating (u) or hummocky (h).

Living (LI) Habitat Assumptions

The seasonal living ratings (spring and summer) are each equal to the limiting rating (lower rating) between the polygon FD rating and the best SH rating in all adjacent polygons, including the target polygon.

For complex polygons, the best ratings are selected from the first two deciles.

An overall rating for the growing season is also calculated. This is equal to the best seasonal living rating. This rating is shown on the printed maps.

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5.3 Black Bear (*Ursus americanus*)

SPECIES NAME: Black bear
SCIENTIFIC NAME: *Ursus americanus*
SPECIES CODE: M-URAM
STATUS: Not at risk (MELP, 1997; COSEWIC, 1998)

DISTRIBUTION

Ursus americanus is found throughout most of the North American continent.

Provincial Range

U. americanus inhabits the entire mainland, Vancouver Island, the Queen Charlotte Islands and the larger coastal islands. Hall (1981) reports five sub-species of black bear in BC. *U. a. cinnamomum* ranges across most of mainland British Columbia east of the coastal mountain ranges and is the sub-species present in the Besa/Prophet study Area (Nagorsen, 1990).

Provincial Benchmark

Ecoprovince: Not established.
Ecoregion:
Ecosection:
Biogeoclimatic zone:
Broad Ecosystem Units:

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2000m a.s.l.).

ECOLOGY AND HABITAT REQUIREMENTS

Black bears utilise a wide range of habitat types although they are generally associated with forested communities. Their ranges must include seasonal food sources, spring/summer/fall ranges or territories, bedding sites, travel routes and winter denning sites (Fish and Wildlife Branch, 1980). A mixed forest with a variety of tree and shrub species of varying ages provides the best habitat for black bear.

Black bears tend to concentrate on food resources within the forest, using these communities more than grizzlies, but also forage in lowland and alpine/subalpine wet meadows, avalanche shrubland, riparian and aquatic habitats such as rivers and streams (Aune, 1994; Jonkel and Cowan, 1971). Like grizzlies, they are omnivorous and utilise seasonally and locally abundant food. The bulk of their diet is vegetation and includes leaves, flowering parts, roots, bulbs, berries, nuts and fruits of grasses, forbs, shrubs and trees. Locally important plants for black bears include horsetails, bearberry (*Arctostaphylos urva-ursi*), blueberries and huckleberries (*Vacinium caespitosum, V. membranaceum and V. uligonosum*), and various graminoids *(Poa sp., Carex sp., Festuca, sp.*). They will also kill small mammals, fish and young ungulates in addition to eating carrion (Fish and Wildlife Branch, 1980; Banfield, 1974).

In spring, they forage for succulent vegetation in wet meadows, riparian inclusions, skunk cabbage swamps, avalanche chutes, and burns (Stevens and Lofts, 1988). During this period, they feed mainly on poplar catkins, spruce needles, newly emerging grasses and sedges, insects, ants, tree buds and carrion resulting from winter losses (Banfield, 1974; Kolenosky and Strathearn, 1987).

During the summer and fall months, black bears feed mainly on ripening fruit, cowparsnip and other forbs. In mountainous terrain, they will move to higher elevations, following green-up from spring to summer. Raine and Kansas (1990), studying in Banff, found ants to be a favoured summer food. In autumn, black bears forage in wild berry patches and aquatic habitats with spawning fish.
In many areas, black bears exist close to human settlements because of the extra food sources (refuse) which occur seasonally or throughout the year (Fish and Wildlife Branch, 1980). They may also feed in campgrounds, garbage dumps and orchards.

Albert *et al*.(1990) state that uneven-aged forests appear far superior to even-aged in meeting favourable bear habitat needs. In forests with mixed conifer or spruce-fir areas, small (<0.1ha) grouped selection tree plots are better than even aged stand composition because they tend to reduce horizontal and vertical cover throughout larger blocks of forest. An uneven-aged forest with small grassy openings is more suitable. Large trees (>25dbh) in these areas provide good cover and protection however, and stands with canopy cover less than 60% but with understorey vegetation up to six feet in height is sufficient to prevent bears from being seen by rivals for over 30m away (Albert *et. al*., 1990). Black bears will generally not move more than 100 m from adequate cover (Stevens and Lofts, 1988).

In fall, black bears select dens usually in a cave, rock crevice, hollow log, windthrown stump, or merely a mossy hollow under the low, sweeping branches of a spruce or fir (Banfield, 1974). In a study by Hayes and Pelton (1994), 66.6% of the bears studied used rock cavities for winter denning, and the remainder denned in excavations (12.5%), clearcuts (12.5%, open nests (4.2%) and tree cavities (4.2%).

Black and grizzly bear habitats overlap in many areas but differences in use are present. For example, grizzly bears will utilise a broader range of food resources available throughout a given environment while black bears concentrate on food resources within the forest (Herrero, 1978). Aune (1994) found that the mean elevation for black and grizzly bears increased from spring to fall but black bears were located at sites within the mid range of elevations more frequently than grizzly bears. Furthermore, Aune (1994) reports that grizzly bears use flat terrain with little discernible aspect more frequently than do black bears where as, black bears use the northeast, east, and southeast slopes more than did grizzly bears.

LIFE REQUISITES/SEASONAL USE PATTERNS

In this model, black bear life requisites are divided into food, security and denning (Table 5.3.1).

Table 5.3.1 Black bear seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Food	Spring	June
2.	Food	Summer/Fall	July to September
3.	Security	Spring and Summer/Fall	June to September
4.	Denning	Winter	October to May
5.	Living	Spring and Summer/Fall	June to September

Food

Areas with an abundance of food is considered the single most important factor determining habitat selection for black bear. Food habitats in spring are at low elevations with early green up. Food habitats in summer/fall are at mid to high elevations with high plant productivity and high berry production.

Security

Security is provided by a closed canopy forest and cover that can hide 90% of a black bear from 120 m away and late successional stage areas that have a canopy closure > than 50%. Security habitat provides two functions: (1) concealment and escape while feeding and, (2) concealment during movement or migration.

Denning

Dens are generally located in areas of high snowfall and low snowmelt with high vertical and horizontal cover on steep slopes, especially in the middle third of such slopes. Dens may be located in hollow trees, caves, rock crevices, fallen logs, or underground excavations (Stevens and Loft, 1988).

Living

Optimal black bear habitat contains a mosaic of suitable food and security areas, preferably within 100m of each other.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

Black bears are widely distributed throughout the interior of British Columbia and occur in the MUF and EMR Ecosections. Distribution in these two areas is largely a function of the biogeoclimatic zones contained within. The presence of the BWBSmw2 sub-zone in the MUF Ecosection results is a greater availability of good forest cover and early spring feeding areas. The EMR contains only the SWBmk, SWBmks and the AT and the SWB is characterised by a short growing season and relatively sparse forest cover with open canopies.

Based on overview capability mapping for the NE region (Habitat Inventory Section, 1994a), the Study Area provides up to moderate black bear habitat (corresponding to a rating of 3). Individual ratings for food and security may be higher.

Biogeoclimatic Zone

Black bears may be found in all of the sub-zones within the Study Area. After den emergence, black bears descend to lower elevations (BWBSmw2) to access early green vegetation. With increasing late-spring and summer temperatures, black bears are able to access green vegetation at higher elevations (SWBmk, and SWBmks).

Site Series

Moister site series (sub-mesic to sub-hygric) are rated higher than drier sites (very xeric to sub-xeric) for feeding as they have higher plant productivity and more robust vegetation. These sites also provide better security.

Structural Stage

Optimal security is provided in young to old forest (structural stages 5, 6 and 7). Optimal food habitat is provided in mature and old forests and in herbaceous and shrub (structural stages 02 and 3a). Structural stages 4 and 5 generally provide poor feeding and security.

Aspect

Warm southerly and westerly aspects (135-285º) provide higher quality spring and summer feeding.

Proximity Effects

Habitats that provide primarily food, must have security within 100m.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A six-class rating scheme is used to rate grizzly bear habitat for food (FD), security (SH) and living (LI) in the spring (P) and summer/fall (S). The LI rating is an integration of black bear food and security requirements and more directly reflects where bear are likely to be found, assuming they are present in the area. A GIS algorithm uses the ratings for FD and SH and incorporates the spatial arrangement of ratings in adjacent polygons.

Food (FD) and Security (SH) Habitat Assumptions

The ratings table assigns a suitability rating for FD and SH to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between black bear life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.3.2). For example, the optimal structural stage for security (old forest) has a degrading score of "0"– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 2, which would result in a maximum rating of 3 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Table 5.3.2 Black bear food and security habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score		
			P_FD	S_FD	G_SH
1. BEC Unit	**EMR**	SWBmk	-3	-2	-2
		SWBmks	-4	-3	-3
		AT	-5	-3	-5
	MUF	BWBSmw2	-2	-2	0
		SWBmk	-3	-2	-2

	SWBmks	-4	-3	-3
	AT	-5	-3	-5
2a. Site Series (SMR)	Xeric	-2	-2	-1
	Subxeric	-1	-1	-1
	Submesic	0	0	0
	Mesic	0	0	0
	Subhygric	0	0	0
	Hygric	0	0	-1
	Subhydric	0	0	-2
	Hydric	0	0	-3
2b. Site Series (SNR)	Very poor	-1	-1	0
	Poor – very rich	0	0	0
3. Structural Stage	Sparse/Bryoid (1)	-3	-3	-5
	Sparse (1a)	-3	-3	-5
	Bryoid (1b)	-3	-3	-5
	Forb-dominated (2a)	0	0	-5
	Graminoid dom. (2b)	0	0	-5
	Dwarf shrub (2d)	0	0	-5
	Low shrub (3a)	0	0	-4
	Tall shrub (3b)	-1	-1	-3
	Pole/sapling (4)	-2	-2	-2
	Young forest (5)	0	0	0
	Mature forest (6)	0	0	0
	Old forest (7)	0	0	0
4. Stand Composition	Coniferous (C)	0	0	0
	Mixed (M)	0	0	0
	Broadleaf (B)	0	0	0

Polygon Food (FD) and Security (SH) Adjustments

Adjustments are used to modify the ratings in order to account for habitat attributes that are not inherent features of the ecosystem unit.

Table 5.3.3 Polygon-specific food and security ratings adjustments for black bear.

Topic	Description
A. Aspect	Rate cool northerly and easterly aspects (285-135°) down 1 FD.
B. Terrain surface expression	Polygons lacking forest cover (structural stages 1a, 1b, 2, 3a and 3b) are rated up 2 SH for growing and winter if the surface expression is ridged (r), undulating (u) or hummocky (h).

Living (LI) Habitat Assumptions

The seasonal living ratings (spring and summer) are each equal to the limiting rating (lower rating) between the polygon FD rating and the best SH rating in all adjacent polygons, including the target polygon.

For complex polygons, the best ratings are selected from the first two deciles.

An overall rating for the growing season is also calculated. This is equal to the best seasonal living rating. This rating is shown on the printed maps.

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5.4 Moose (*Alces alces andersoni*)

SPECIES NAME: Moose
SCIENTIFIC NAME: *Alces alces andersoni*
SPECIES CODE: M-ALAA
STATUS: Not at risk (MELP, 1997; COSEWIC, 1998)

DISTRIBUTION

Moose are found across northern Europe and Asia from Scandinavia to the Pacific coast and across northern North America from Alaska to Newfoundland and Maine (Banfield, 1974).

Provincial Range

Moose are widespread throughout the mainland of the province, excluding the coastal areas and the arid region centred in the Okanagan Valley. They are most abundant provincially in the central and northern portion of the province. Before 1900, moose were absent from most of the central and southern part of the province (Nagorsen, 1990).

Alces alces andersoni, one of three moose subspecies in the province (*A. a. americana, A. a. andersoni* and *A. a. shirasi*), ranges from northern Minnesota and Michigan to British Columbia, the Yukon Territory and NWT. It occupies regions east of the coastal mountain ranges except for the extreme northwest and southeast (Nagorsen 1990).

Provincial Benchmark

Ecoprovince: Boreal Plains
Ecoregion: Alberta Plateau
Ecosection: Peace Lowland (PEL)
Biogeoclimatic zone: BWBSmw2
Broad Ecosystem Units: Boreal White Spruce-Trembling Aspen in winter and White Spruce-Balsam Poplar Riparian in growing

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2100m in elevation).

ECOLOGY AND HABITAT REQUIREMENTS

Moose are generalist herbivores that feed on herbaceous plants, leaves and new growth of shrubs and trees in summer and twigs of woody vegetation during winter (Jackson *et al*., 1991). They occupy a range of habitat types within forested communities, favouring immature forest shrubland for food and dense, woody forest areas for cover (Nietfeld *et al*., 1985).

In winter, the most commonly consumed food is willow. Twigs of aspen, serviceberry, maple, birch, and red osier dogwood are also eaten in great quantities. Leaves and twigs of falsebox are a second favoured winter food, but this small shrub is usually buried deep under the snow. Conifers such as spruce and lodgepole pine will not sustain moose, although some types of fir and yew are eaten readily (Allen *et. al.*, 1987; Cushwa *et.al.*, 1976; Edwards, 1985; LeResche *et. al.*, 1974; Peterson, 1955; Pierce, 1984; Ritchie, 1978 and Spencer *et. al*., 1964). Bark may be stripped off larger trees, especially in late winter and early spring when food is in short supply (Nietfeld *et al*., 1985).

Depth, density and hardness of snow is an important factor limiting suitability and availability of certain habitat for moose in the critical winter months (Franzmann, 1978). Nietfeld *et al*. (1985) reports that moose in Alberta tend to avoid areas with greater than 65-75 cm of snow. Eastman (1977) found that moose move into forested habitats in mid-winter when snow depths approached 80cm. Collins and Helm (1997) found that lower shrubs became unavailable when snow depths exceeded 110 cm. Some moose may remain at higher elevations in late winter where thermal cover is reduced and wind action or temperature inversions reduce snow depth.

Floodplains are the mainstay habitat for moose during severe winters, particularly in areas where lack of recent disturbance in upland forests has led to a decline in browse availability (Simkin, 1975; Bishop and Rausch, 1975). Moose are attracted to uplands disturbed by recent fires, homestead or subdivision clearing and right-of-way construction (Collins and Helm, 1997).

During summer, moose diet includes many aquatics, forbs, grasses, and the foliage of many of the trees eaten in winter (Banfield, 1974). Moose are attracted to weedy lakes, marshes and sluggish streams where they can feed on aquatic vegetation (Nietfeld *et al*., 1985). In aquatic feeding, they may feed on sedges or horsetails in shallow water or on bur-reeds that float on the surface and may dive deeply for pondweeds or water lilies (MELP, undated).

Disturbances, such as fire and clearcutting, return forests to earlier successional stages that usually provide abundant browse. Burn areas generally provide the most suitable moose browse after 10-15 years, the length of time varying with the time of year of the burn and its intensity. LeResche and Davis (1974) estimated that the beneficial effects of fire on moose habitat lasts than 50 years with moose density peaking 20 to 25 years following a fire. Wolf and Zasada (1979) reported that aspen provided the most browse for moose 1 to 5 years after fire, while birch and willow provided the most 10 to 16 years after fire. MacCracken and Vierek (1990) report that following a spring fire, moose browse was abundant within two months. Discontinuous forest mosaic created by fire or timber harvest enhance “edge effect” increasing diversity of plant species favoured by moose and staggers plant maturation rate of various seral stages.

Dense, mature, coniferous forest is utilised as shelter from severe winter conditions, hot summer temperatures, as escape from harassment by insects and concealment from predators. Moose escape the summer heat by spending much of their time in the water, in cool timbered areas, or by retreating to high mountainous areas. Moose do not thrive in hot dry regions (MELP, undated). During summer, moose select tree muskegs and immature aspen stands greater than 10 m in height.

Boreal white spruce forests, white spruce-subalpine fir forests, wet interior white spruce forests, deciduous riparian forest, boreal spruce-trembling aspen mixed forests, trembling aspen forests, and birch-willow scrub parkland are important forest types. Other forested habitats such as Engelmann spruce-subalpine fir forests and Douglas fir-lodgepole pine forests are also used but mostly for cover. The mature forested habitats, wetland habitats, avalanche shrubland, and alpine/subalpine meadows with gentle terrain are important in the summer for food and general living (Stevens and Lofts, 1988). Eastman (1977) found that moose in north-central BC used partial cutovers and burns more than coniferous forest; deciduous forests and clearcuts were used least.

Moose generally make seasonal movements between winter and summer ranges, coinciding with spring thaw and freeze-up but they retain the same home range year after year (Nietfeld *et al*., 1985). In mountainous terrain, seasonal migrations are limited to up and down the mountain slopes and wintering in the valleys. Moose move into winter ranges before snow depths become limiting. Occasionally lone bulls winter high up on old avalanche slides where there has been thick regeneration of willows (Banfield, 1974).

Habitat sizes for the moose vary considerably with geographic location. On average, moose annual home range in northern Alberta and southern Alaska are approximately 568 – 638 km^2 (Novak *et al.*, 1987). In British Columbia, average seasonal moose ranges in summer are 218.9 ± 38 ha for males and 615.2 ±629.4 ha for females and in winter, 576.5 ± 365.8 ha for males and 596.2 ± 450.9 ha for females (Schwab, 1985, as cited in Stevens and Lofts, 1998).

LIFE REQUISITES/SEASONAL USE PATTERNS

In this model, moose life requisites are divided into food, security, thermal and living (Table 5.4.1).

Table 5.4.1 Moose seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Food	Winter	October to May
2.	Food	Growing	June to September
3.	Security/Thermal	Winter	October to May
4.	Security/Thermal	Growing	June to September
5.	Living	Winter, Growing	October to May, June to September

Food

Immature forest shrubland provides optimal food in winter. These areas, plus aquatic and wetland habitats provide optimal food in summer. Burn and clearcut areas generally provide high quality browse after 10-15 years. Young burned (70-year-old) aspen-white spruce-black spruce stands produce 10 times more forage than older stands (130 to 180 years old) (MacCracken and Viereck, 1990).

Security/Thermal

Security and thermal protection is provided by forest cover. In winter, dense, mature coniferous forest provides shelter from low temperatures and wind. Mature stands provide both thermal benefits and good snow interception because of their multi-layered structure and the deep, spreading crowns of the older trees. In summer, moose often use these thermal shelter areas to escape heat, although we assume that thermal habitat requirements are most important in winter. Ideal winter thermal habitat is composed of conifers taller than 6 m, with a canopy closure of 75 percent or greater (Allen *et. al.* 1987, Timmerman and McNichol, 1988, Krefting, 1974). Schwab and Pitt (1991) suggest that optimal canopy closure should be 70% in a mature forest and to escape winter wind chill factors and high summer temperatures.

Security may also be provided by concealing topography, such as that provided in gullied, ridged and hummocky terrain. We assume that water provides security for moose while feeding (i.e. open water and ponds).

Deep snow restricts movement and the availability of food, however, snow is not likely to be a limiting factor in the Study Area. Average maximum winter snowpacks for areas directly adjacent to the north of the Study Area are less the 80 cm with south aspects and windblown areas generally having less than 60 cm (Chilton, 1990).

Aerial surveys in the Study Area have shown moose utilising habitats with little or no nearby security in both summer and winter.

Living

Ideal moose habitat contains an interspersion of food and security/thermal habitat. We assume that food and security must be within 200m of each other.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

Moose are abundant in both the EMR and MUF Ecosections. The MUF provides moose habitat equal to the provincial benchmark (RIC, 1998a). Overall, the EMR provides less moose habitat than the MUF, due, in part, to the absence of the BWBS zone and other high quality low elevation wintering habitats.

Biogeoclimatic Zone

Moose potentially occur in all of the BGC zones and sub-zones in the Study Area. AT represents habitat in the growing season only.

Site Series

In general, moister site series (soil moisture regimes from mesic to subhydric) provide better moose habitat than drier site series (very xeric to sub-mesic). Moister sites typically have a higher canopy closure and denser shrub and herb layers, which provides good food and security/thermal protection.

Structural Stage

Early successional forests provide feeding habitat whereas young to mature forests provide good security and thermal protection. Older forests are important for food in winter as their high snow interception allows for easy access to food. Shrub structural stages provide optimal food but low security/thermal protection. Young to mature forests provide optimal thermal protection. Old-growth forests usually have low crown closure which allows good shrub growth but intercepts snow poorly and provides poor thermal protection.

Stand Composition

In the growing season, optimal food is found in broadleaf and mixed stands.

Aspect

Estimated snowpacks for areas directly adjacent to the north of the Study Area report lowest snow depths on south-facing aspects, which is a function of Chinook winds and solar radiation (Chilton, 1990). Eastman (1977) found that moose chose bedding sites on the upper slopes that faced south particularly when snow depths became restrictive at lower levels (80cm). Therefore, warm aspects are rated higher for food and security/thermal in winter.

Terrain

Terrain that provides concealment, such as that provided by gullied, ridged or undulating topography, provides security. Therefore, non-forested areas that would normally provide no security, are rated higher than similar polygons lacking concealing topography.

Proximity Effects

Habitats that provide food must have security/thermal protection within 200m.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used to rate moose habitat. Food (FD), security/thermal (ST) and living (LI) are rated for use in the growing and winter seasons. LI encompasses all of the requirements necessary for survival and is a function of the spatial arrangement of FD and ST in the landscape.

Food (FD) and Security/Thermal (ST) Habitat Assumptions

The ratings table assigns a suitability rating for FD and ST to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between moose life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.4.2). For example, the optimal structural stage for food (low shrub) has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Table 5.4.2 Moose food and security/thermal habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute	Value	Degrading Score			
		G_FD	G_ST	W_FD	W_ST
1. Ecosection	EMR	0	0	0	0
	MUF	0	0	0	0
2. BEC Unit	BWBSmw2	0	0	0	0
	SWBmk	0	0	-1	-1
	SWBmks	0	-2	-1	-2
	AT	-1	-5	-4	-5
3a. Site Series (SMR)	Xeric	-2	-2	-2	-2
	Subxeric	-1	-1	-1	-1
	Submesic	0	0	0	0
	Mesic	0	0	0	0
	Subhygric	0	0	0	0
	Hygric	0	0	0	-1
	Subhydric	0	-1	0	-2
	Hydric	0	-2	0	-3
3b. Site Series (SNR)	Very poor- Poor	-1	-1	-1	-1
	Medium-very rich	0	0	0	0
4. Structural Stage	Sparse (1a)	-5	-5	-5	-5
	Bryoid (1b)	-5	-5	-5	-5
	Herb (2)	-2	-5	-4	-5
	Low shrub (3a)	0	-5	0	-5
	Tall shrub (3b)	0	-2	0	-2
	Pole/sapling (4)	-4	0	-4	0
	Young forest (5)	-4	0	-4	0
	Mature forest (6)	-4	0	-3	0
	Old forest (7)	-4	0	-3	0
5. Stand Composition	Coniferous (C)	-1	0	0	0
	Mixed (M)	0	0	0	0
	Broadleaf (B)	0	0	0	0

Polygon Food (FD) and Security/Thermal (ST) Adjustments

Adjustments are used to modify the ratings in order to account for moose habitat attributes that are not inherent features of the ecosystem unit.

Table 5.4.3 Polygon-specific food and security/thermal ratings adjustments for moose.

Topic	Description
A. Aspect	Cool aspects (285-135°) down 1 ST in winter.
B. Terrain surface expression	Polygons lacking forest cover (structural stages 1a, 1b, 2, 3a and 3b) are rated up 2 ST for growing and winter if the surface expression is ridged (r), undulating (u) or hummocky (h).

Living (LI) Habitat Assumptions/Adjustments

Moose require habitat for both food and security/thermal. The LI rating incorporates the FD and ST ratings within the target polygon and the ratings in adjacent polygons.

They are also adjusted depending on the primary use of the polygon:

- Habitats used primarily for food may only be rated as good as the best security/thermal within 200 m of the target polygon.
- Habitats used primarily for security/thermal may only be rated as good as the best food within 200 m of the target polygon.

Specifically:

- If the FD rating is better than the ST rating, LI is equal to the best ST within 200m (including any decile of the target polygon) but not exceeding the FD rating of the target polygon.
- If the SH rating is better than the FD rating, LI is equal to the best FD within 200m (including any decile of the target polygon) but not exceeding the ST rating of the target polygon.

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5.5 Rocky Mountain Elk (*Cervus elaphus nelsoni*)

SPECIES NAME: Rocky mountain elk
SCIENTIFIC NAME: *Cervus elaphus nelsoni*
SPECIES CODES : M-CEEL
STATUS : Not at risk (MELP, 1997; COSEWIC, 1998)

DISTRIBUTION

Provincial Range

Rocky Mountain elk primarily occur in the Kootenays, the lower Peace River area and the Muskwa-Prophet River drainages on the eastern slope of the Rocky Mountains. Although Rocky Mountain elk were historically abundant and widely distributed in the Cariboo-Chilcotin and Thompson-Nicola areas, elk declined for unknown reasons and today only small, widely scattered herds remain in these areas.

Provincial Benchmark

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Mountains and Plateaus and Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF)
Biogeoclimatic zone: SWBmk
Broad Ecosystem Units: SM - Subalpine Meadow

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2000m in elevation).

The Besa-Prophet Study Area provides some of the best elk habitat in the province and elk are widespread and abundant. Population numbers have increased in recent years due to prescribed burning. Aerial surveys in the 1960s (e.g. Resource Analysis Branch, 1968a, 1968b, 1969a and 1969b) report no elk in the Study Area while recent surveys report large numbers (e.g. Wildlife Branch, 1995 and section 4.1 in this document).

ECOLOGY AND HABITAT REQUIREMENTS

Elk are habitat and diet generalists. They are good dispersers and rapidly exploit newly created habitats (Geist, 1982 in Singer and Norland, 1994). Elk require areas for food and cover, winter and summer and winter ranges (containing suitable food and cover), rutting, calving, migration routes and mineral licks (Fish and Wildlife Branch, 1981). Early successional stages and forest openings provide feeding habitat while forest cover provides security and thermal protection. They are often associated with the boundaries or ecotones between forest and non-forest ecosystems as this provide great abundance and diversity of forage with close proximity to cover (Skovlin, 1982).

Elk are often migratory, spending winters in low elevation ranges and summers in higher elevation upland areas. The migration movements are primarily a function of vegetation availability in relation to snow depth. In the growing season, elk are grazers, preferring early successional stages, including grasslands, parkland, avalanche tracts, clear-cuts, burns, roadsides and forest openings. Grasses and sedges are eaten extensively and will be used year-round, if available. Broad-leaved herbaceous plants are also used extensively (Nietfeld *et al*., 1985). Browse may be an important part of the summer diet, depending on the availability of grasses and forbs. (Fish and Wildlife Branch, 1981).

In winter, snow cover limits ground level forage and elk are forced to browse on deciduous trees and shrubs. Preferred winter browse species include Saskatoon (*Amalanchier alnifolia*), water birch (*Betula occidentalis*) and trembling aspen (*Betula tremuloides*) (Nietfeld *et al*., 1985). Conifers, with the exception of spruce, are also utilised. Snow-free areas associated with southerly aspects and periodic chinook weather provide the greatest access to forage in winter and spring (Carr, 1972).
In agricultural areas, cultivated crops may provide significant amounts of forage in fall and winter.

Snow depth is the factor most limiting to elk distribution and movement. Elk movements apparently begin to be restricted by snow depths in excess of 46 cm (Beall, 1974). Snow depth limits forage availability in winter, and at depths > 61 cm, browsing will replace grazing (Skovlin, 1982).

Seasonal use of aspect is determined largely by forage availability, thermal comfort factors, and cover type. Thermal forest cover on upper north-facing slopes provides the coolest habitat during the summer and the most succulent, high quality forage into autumn months (Skovlin, 1982; Nietfeld, *et al*., 1985). Skovlin (1982) states that many investigators have reported that elk prefer southern to southwestern exposures in winter and spring. South-facing aspects are seldom selected in summer. Sites which are protected by topography or dense vegetation are often sought out during the winter or early spring because these areas provide a refuge from strong winds, crusting or drifting snow.

Forest cover provides both cover and thermal protection. McNamee *et al*. (1981) characterised escape cover for elk as vegetation over 2 m with a stem density of between 50 and 2000 stems/ha while Black *et al*. (1976) states that vegetation capable of hiding 90% of an elk from a human at 61m as preferred. In winter, elk require thermal protection from low temperatures and is provided best in conifer stands with continuous closed canopies (Skovlin, 1982). Closely stocked stands of coniferous forest, 12 m or greater with high stem densities and an average canopy closure exceeding 70%, are used in winters characterised by very deep snow cover (Black *et al*. 1979; Skovlin, 1982).

Good interspersion and juxtaposition of food and cover components is important and is provided by irregular topography and parkland or forest/meadow vegetation cover (*Black et. al*., 1979). Valley and riparian habitats are important as travel corridors between high elevation summer range and low elevation winter range; stringer forest stands also provide protected travel lanes during migration (Black *et. al*., 1979).

Elk use gradually increases with increasing slope, to a maximum of 30-40%. The most frequently used slopes appear to be in the 15-30% class (Skovlin, 1982). A threshold in slope use appears between about 40-50%, after which elk use tends to diminish sharply (Nietfeld *et al*., 1985).

Rutting occurs in September through October and calves are generally born in late May or June (Fish and Wildlife Branch, 1981). Calving sites usually occur on transitional spring or fall ranges or even on upper elevation winter ranges. Site selection is extremely variable: some cows will select a very secluded area with high cover while others are much less selective (Skovlin, 1982).

Elk have a greater digestive capacity (larger rumen to body size ratio) than the smaller North American ungulates (such as mule deer and bighorn sheep) suggesting that elk may compete more successfully in poor range conditions (Collins and Urness, 1983 in Singer and Norland, 1994).

LIFE REQUISITES/SEASONAL USE PATTERNS

In this model, elk life requisites are divided into food, security/thermal and living (Table 5.5.1).

Table 5.5.1 Elk seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Food	Winter	October to May
2.	Security/Thermal	Winter	October to May
3.	Food	Growing	June to September
4.	Security/Thermal	Growing	June to September
5.	Living	Winter	October to May
6.	Living	Growing	June to September

Food

In winter, food availability in relation to snow is the most important factor limiting elk distribution. Snow-free areas associated with southerly aspects and periodic Chinook weather provide the greatest access to forage in the winter and spring. Winter feeding habitats are primarily low elevation grassy or shrubby openings in open stands of various timber types on warm south and west aspects. Low-elevation, recent burns provide particularly good food.

In the growing season, optimal feeding habitats are early successional stages, including grasslands, parkland, avalanche tracts, clear-cuts, burns, wetlands, riparian habitats, roadsides and forest openings, primarily at higher elevations.

Security/Thermal

Security and thermal protection are both provided by forested habitats. Security may be satisfied by vegetation over 2 m. This may occur in a variety of structural stages but those with a dense understory are optimal. Security may also be provided by concealing topography, such as that provided in gullied, ridged and hummocky terrain. Closed canopy coniferous stands provide thermal cover in winter. Dense vegetation over 12m in height with a canopy closure of greater than 70% is assumed to provide optimal thermal protection.

Living

Habitat that provides living in the growing season and in the winter are those areas containing food and security/thermal in close proximity. Black *et al*. (1979) reports that most elk occur within 183 m of cover. Areas that provide living habitat year-round have suitable summer and winter ranges.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

Elk are found in both the EMR and MUF Ecosections. The MUF is one of the two provincial benchmarks for this species (RIC, 1998a). Greater snow depths in the EMR results in poor winter habitat and thus fewer elk.

Biogeoclimatic Zone

Elk habitat may be found in all BGC Zones in the Study Area. The BWBSmw2 and SWBmk potentially provide the best habitat year-round. The SWBmks and AT provide habitat in the growing season provided there is adequate security nearby (forest cover or topography).

Site Series

A variety of site series with a range of soil moisture regimes produce good forage, however, moister areas (sub-mesic to mesic) tend to produce better forb diversity and quantity during the growing season and optimal thermal protection in winter. Both drier and wetter sites have lower canopy closure than the mesic sites and therefore provide poorer thermal protection.

Structural Stage

Younger structural stages generally provide the best feeding habitat where older, forested stages provide security and thermal habitat. Logged areas such as clearcuts increase forage production and species diversity.

Structural stages 02 (herbaceous) to 3a (herbaceous to low shrub) provide optimal food year-round. Structural stage 02 is rated lower in winter (because forbs and grasses may be inaccessible under the snowpack) unless located on a warm aspect slope. Structural stage 3b (tall shrub) provides moderate food habitat in both growing and winter. Structural stages 04 to 07 (pole sapling to old forest) provide no food in the growing season and low to moderate food in the winter.

Security habitat is provided in stages 04 (pole/sapling) to 07 (old forest). Optimal thermal habitat is provided in stages 05 (young forest) to 07 (old forest).

Fire areas encourage the development of favoured edge habitat and recently burned areas are often very productive.

Stand Composition

Conifer dominated canopies (>75%) provide optimal thermal protection in winter. Mixedwood and broadleaf habitats provide moderate and low levels of thermal habitat respectively and are thus rated lower.

Aspect

Estimated snowpacks for areas directly adjacent to the north of the Study Area report lowest snow depths on south-facing aspects, which is a function of Chinook winds and solar radiation (Chilton, 1990). Warm southerly and westerly aspects (135-285°) are rated higher for food in winter.

Terrain

Terrain that provides concealment, such as that provided by gullied, ridged or undulating topography, provides security. Therefore, non-forested areas that would normally provide no security, are rated higher than similar polygons lacking concealing topography.

Proximity

Habitats that provide food must be within 200m of habitats that provide security/thermal.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used to rate elk habitat. Food (FD), security/thermal (ST) and living (LI) are rated for use in the growing and winter seasons. LI encompasses all of the requirements necessary for survival and is a function of the spatial arrangement of FD and ST in the landscape.

Food (FD) and Security/Thermal (ST) Habitat Assumptions

The ratings table assigns a suitability rating for FD and ST to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between elk life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.5.2). For example, the optimal structural stage for food (low shrub) has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Food (FD) and Security/Thermal (ST) Habitat Adjustments

Adjustments are used to modify the ratings in order to account for elk habitat attributes that are not inherent features of the ecosystem unit.

Table 5.5.2 Elk food and security/thermal habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score			
			G_FD	G_ST	W_FD	W_ST
1. BEC Unit	**EMR**	SWBmk	0	0	-1	-1
		SWBmks	0	-1	-2	-2
		AT	-1	-5	-4	-5
	MUF	BWBSmw2	0	0	0	0
		SWBmk	0	0	0	-1
		SWBmks	0	-1	-2	-2
		AT	-1	-5	-3	-5
2a. Site Series (SMR)		Xeric	-2	-2	-2	-2
		Subxeric	-1	-1	-1	-1
		Submesic	0	0	0	0
		Mesic	0	0	0	0
		Subhygric	0	0	0	0
		Hygric	-1	-1	-1	-1
		Subhydric	-2	-2	-2	-2
		Hydric	-2	-2	-2	-2
2b. Site Series (SNR)		Very poor- poor	-1	-1	-1	-1
		Medium-very rich	0	0	0	0
3. Structural Stage		Sparse/Bryoid (1)	-5	-5	-5	-5
		Sparse (1a)	-5	-5	-5	-5
		Bryoid (1b)	-5	-5	-5	-5
		Herb (2)	0	-5	0	-5
		Forb-dominated (2a)	0	-5	0	-5
		Graminoid dom. (2b)	0	-5	0	-5
		Dwarf shrub (2d)	1	-5	-1	-5
		Low shrub (3a)	0	-5	0	-5
		Tall shrub (3b)	-2	-3	-2	-4
		Pole/sapling (4)	-4	-2	-4	-4
		Young forest (5)	-4	-1	-4	-2
		Mature forest (6)	-3	0	-2	0
		Old forest (7)	-3	0	-2	0
4. Stand Composition		Coniferous (C)	0	0	0	0
		Mixed (M)	0	0	0	-1
		Broadleaf (B)	0	0	0	-3

Table 5.6.3 Polygon-specific food and security/thermal ratings adjustments for elk.

Topic	Description
A. Aspect	Rate cool aspects (285-1135°) down 1 FD in winter.
B. Terrain surface expression	Polygons lacking forest cover (structural stages 1a, 1b, 2, 3a and 3b) are rated up 2 ST for growing and winter if the surface expression is ridged (r), undulating (u) or hummocky (h).

Living (LI) Habitat Assumptions

Elk require habitat for both food and security/thermal. The LI rating incorporates the FD and ST ratings within the target polygon and the ratings in adjacent polygons. They are also adjusted depending on the primary use of the polygon:

- Habitats used primarily for food may only be rated as good as the best security/thermal in or adjacent to the target polygon.
- Habitats used primarily for security/thermal may only be rated as good as the best food in or adjacent to the target polygon.

Specifically:

- If the FD rating is better than the ST rating, LI is equal to the best ST in all polygons directly adjacent to the target polygon (including any decile of the target polygon) but not exceeding the FD rating of the target polygon.
- If the ST rating is better than the FD rating, LI is equal to the best FD in all polygons directly adjacent to the target polygon (including any decile of the target polygon) but not exceeding the ST rating of the target polygon.

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5.6 Woodland Caribou (*Rangifer tarandus caribou*)

SPECIES NAME: Woodland caribou
SCIENTIFIC NAME: *Rangifer tarandus caribou*
SPECIES CODE: M-RATA
STATUS: STATUS: Northern ecotype is not-listed by MELP (1997); Vulnerable (COSEWIC, 1998)

DISTRIBUTION

Provincial Range

Woodland caribou (*Rangifer tarandus caribou*) are associated with the boreal forest region of Canada. They are distributed across the northern portion of British Columbia and extend as far south as Tweedsmuir Provincial Park and the southern Kootenays (Nagorsen, 1990). Mainland populations have been reduced since historical times and small relic herds exist at the southern periphery of its range in the province (Stevenson and Hatler, 1985)

Provincial Benchmark

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Mountains and Plateaus
Ecosection: Stikine Plateau (STP)
Biogeoclimatic zone: SWBun/AT in winter and AT in growing
Broad Ecosystem Units: LP/6 – Lodgepole Pine/AG – Alpine Grassland in winter and AM - Alpine Meadow in growing

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2100m in elevation).

ECOLOGY AND HABITAT REQUIREMENTS

Caribou in British Columbia belong to the woodland subspecies (*Rangifer tarandus caribou*), but can be further divided into two ecotypes, mountain ecotype and northern ecotype (Stevenson and Hatler, 1985). Mountain caribou are found in southeastern BC and spend much of the year at high elevations in subalpine forest and alpine habitats. Deep snow prevents them from cratering for terrestrial forage in winter so they rely primarily on arboreal lichens for winter food. Northern Caribou are found in the northern and west-central areas of the province. They generally inhabit mountainous areas in summer, and use low elevation pine forests or windswept alpine areas during winter. The low snow depths in those habitats during winter allow them to crater for terrestrial lichens (Seip and Cichowski, 1996). In the Besa/Prophet TEM Study Area, all caribou are the northern ecotype, although, a portion of their winter diet may include arboreal lichens.

Caribou habitat selection is largely a function of (1) food availability in relation to snow depth and (2) predator avoidance (Bergerud *et al*., 1984; Bergerud, 1992). Both of these factors generally result in seasonal elevational migratory patterns. Because of the seasonal and annual variability of climate (particularly snow depth) and regional patterns of predator density, multiple habitat types may be occupied and will vary from year to year.

Published accounts of caribou habitat use in the Besa/Prophet Study Area are few. However, aerial surveys (such as Resource Analysis Branch, 1968a, 1968b, 1969a and 1969b; Wildlife Branch, 1995 and the survey conducted for this study) and personal communications with regional experts provide a picture of caribou ecology and habitat requirements in this area.

The density of caribou populations in BC appears to be related to their ability to become spatially separated from their predators (Seip and Cichowski, 1996). This is achieved by separating themselves from other ungulate prey, thereby reducing themselves from the risk of predation. This may be a particularly important consideration in the Besa/Prophet area due to the significant density of wolves in this part of the province (Elliot, 1984). In the Study Area, the majority of wolf caribou kills are found during calving (Webster, pers. comm.).

In winter, caribou remain where lower snow depths allow access to terrestrial lichen, primarily *Cladina spp*., *Cladonia spp.* and *Cetraria spp*,. In Jasper, these species, comprise approximately 60-82% of the winter diet, particularly where snow depth is less than 62 cm, the threshold depth for cratering (Sentar, 1994). The remainder of the winter diet items include shrubs, horsetails, grasses and sedges. Arboreal lichens such as *Bryoria spp., Alectoria spp,* and *Usnea spp.* may be important in years when snowfall is particularly high and terrestrial lichens are less accessible.

Lichen availability is strongly controlled by snow depth. In normal snowfall years, which are characterised by low snow depths due to low precipitation and frequent Chinooks (Chilton, 1990), the majority of caribou are found at low elevations in black spruce and open pine forests (Webster, pers comm.). The low snow depths allow ease of movement and access to relatively abundant lichens.

When snow is deep and crusting, caribou utilise high elevation, windswept slopes (as was observed in the winter 1998 aerial surveys). These high elevations support caribou year-round and provide escape from the higher predator densities present at lower elevations and have lower snow depths in windblown areas.

Caribou may also be found on frozen lakes and rivers. Caribou are able to see approaching predators and move quickly on crushed snow, particularly in the late winter (Darby *et. al*. 1989). In some areas, young successional forests, including cutovers, are not generally used, possibly due to increased predation risk, reduced food availability, or unfavourable snow conditions (Cummings and Beange, 1993).

In spring (May/June), and generally in snow-free periods, caribou distribute themselves across the landscape, and group size tends to be smaller than in winter. New green vegetation in bogs, riparian areas, and open meadows are sought out during this period (Hatler 1986). Use of habitats such as south-facing deciduous hillsides, aspen stands and meadows that become snow-free earlier than heavily timbered areas is common in other areas of BC (Wood, 1994). Caribou may remain at higher elevations in spring to escape high predator densities despite the availability of early green vegetation at lower elevations, as is the case in Jasper NP (Sentar, 1994). In high snowfall areas, spring elevations are related to snow depths, with animals moving up valleys until snow depths reach 50-60 cm (Sentar, 1994).

Females often ascend to spring/summer ranges for calving before males. Calving areas are usually at high elevation in subalpine or parkland habitats. In these areas, females are dispersed from moose and other wolf prey (Bergerud *et al*., 1983).

Summer diet is more diverse than in winter and consists of forbs, deciduous leaves, lichens, fungi, grasses and sedges. In Jasper, summer northern caribou diet is composed of forbs, shrubs and graminoids and continues to include terrestrial lichens.

Summer range is primarily upper elevation spruce/fir forests and sub-alpine/alpine areas. They disperse into areas where wolves and alternative prey species such as moose, as well as other caribou are scarce (Bergerud and Page, 1987).

Winter lichen availability is critical to evaluating caribou habitat. Highest densities are associated with mature forests as lichen is very slow growing. The most suitable growing sites tend to be drier, with low nutrient availability and where productivity of other plants is low (Coxson *et al*., 1998; Sentar, 1994; Seip, 1996). Coxson *et al*. (1998) also reports higher terrestrial lichen cover on crest and upper slopes of the landscape. Other factors which influence the distribution and abundance of terrestrial lichen are the severity of initial perturbation (e.g. fire), and site conditions. Lichen productivity may decline in mature forests as gaps in the canopy close in with understory trees (often spruce and fir) and *Cladina spp*. are replaced by feathermoss and other ground plants (Coxson *et al*., 1998; Schaefer and Pruitt, 1991).

Caribou require extensive areas of mature coniferous forest for cover and lichen production and fire removes these essential habitats. Caribou avoid recently burned areas and these affect their movements and fragment their range (Nietfeld *et al*., 1985). They may continue to use burned areas, feeding on lichens in unburned patches, for about five years until fire-killed trees fall and obstruct movement (Schaefer and Pruitt, 1991).

Rutting occurs in the fall and rutting areas are usually found in or close to summer habitats (Wood, 1994; Sentar, 1994). They select open habitats, including open peatlands, tundra, or alpine tundra, for the autumn rut (Banfield 1974).

LIFE REQUISITES/SEASONAL USE PATTERNS

Woodland caribou habitat requirements is divided into food, security and reproduction (Table 5.6.1).

Table 5.6.1 Mountain caribou seasonal life requisites

Rank	Life Requisite	Season	Months
1.	Food	Winter	October-May
2.	Security	Year-round	Year-round
3.	Reproduction	Spring	May/June
4.	Food	Spring	June
5.	Food	Summer/Fall	July-September

Food

Suitable feeding habitat is an important determinant of caribou distribution and underlies much of their seasonal movements. Feeding habitat has been described in detail above with habitat supporting lichen being most important.

Security

Habitats that have low wolf density have optimal security. These are areas that have low moose and elk densities, especially in early summer during calving. These areas are at high elevations and at low elevations in forest stands with continuous forest cover.

The quality of security habitat is a complex interaction between wolves, caribou and other ungulates. This level of detail is beyond the scope of this project and security is therefore not modelled.

Reproduction

Calving areas are usually at high elevation in subalpine or parkland habitats. In these areas, females are dispersed from moose and other wolf prey (Bergerud *et al*., 1983). Reproduction habitat is strongly tied to the quality of security habitat. Since security habitat is not modelled, reproduction habitat cannot be identified.

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

The MUF Ecosection provides caribou habitat that is equal to the provincial benchmark (RIC, 1998a). The EMR Ecosection generally provides less suitable terrain and we assume provides up to moderately high caribou habitat relative to the provincial benchmark.

Biogeoclimatic zone

Northern ecotype caribou generally spend winters at low elevations in normal snowfall years and high elevations in high snowfall winters and in summer and fall. Optimal spring food is provided at lower elevations where early green-up occurs.

In the Besa/Prophet Study Area, normal snowfall winter habitat is provided best in the BWBSmw2 where terrestrial lichens are most abundant. In high snowfall winters, the SWBmks and AT are optimal. In spring, caribou move to low elevations in both the BWBSmw2 and SWBmk following the retreating snow. By summer they are again found in SWBmks and AT.

Site Series

Moister site series (sub-mesic to sub-hygric) provide better spring and summer/fall forage than drier sites. Drier sites with low nutrient availability and where productivity of other plants is low provide optimal terrestrial lichen and thus rated highest for winter use.

Structural Stage

Since lichen is very slow growing, mature and old forests will have the greatest cumulative lichen densities. However, non-vegetated/sparse, herb and low shrub habitat in the SWBmk, SWBmks and AT are important during high snowfall years. In spring, northern caribou seek out early-greening plants and will utilise herb and low shrub stages in addition to mature and old forest. Tall shrub, pole/sapling and young forest provide low-level feeding habitat year-round. In summer/fall, caribou may be found in a variety of structural stages, from herb to old forest.

Stand Composition

In winter, mixed and broadleaf stands have a lower probability of containing terrestrial lichen than conifer stands.

Aspect

Warm aspects have lower snow depths and thus more accessible vegetation. Therefore, warm aspects will be rated higher than cool aspects for food in winter.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used rate habitat suitability for food (FD) and security (SH) in three seasons: winter (W), spring (P) and summer/fall (S).

Food ratings are assigned to polygons using the ratings table. Security ratings will be assigned to polygons using a sub-model incorporating the moose and elk habitat suitability ratings.

As described above, caribou habitat use varies depending on winter snow depths. This model shows optimal habitat for both normal and high snowfall years.

Food (FD) Habitat Use Assumptions

The ratings table assigns a suitability rating for FD to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between caribou life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.6.2). For example, an optimal structural stage for food has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Food (FD) Habitat Adjustments

Adjustments are used to modify the ratings in order to account for caribou habitat requirements that are not inherent features of the ecosystem unit. There is one adjustment:

- Cool aspects (135 – 285^{o}) rated down one for FD in winter

Table 5.6.2 Caribou food habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score		
			W_FD	P_FD	S_FD
2. BEC Unit	**EMR**	SWBmk	-2	0	-2
		SWBmks	-2	-1	0
		AT	-2	-2	0
	MUF	BWBSmw2	0	0	-3
		SWBmk	-2	0	-2
		SWBmks	0	-1	0
		AT	0	-2	0
3a. Site Series (SMR)		Xeric	0	-1	-1
		Subxeric	0	0	0
		Submesic	0	0	0
		Mesic	0	0	0
		Subhygric	0	0	0
		Hygric	0	0	-1
		Subhydric	0	-1	-2
		Hydric	0	-2	-2
3b. Site Series (SNR)		Very poor- poor	0	-1	-1
		Medium-very rich	0	0	0
4. Structural Stage		Sparse/Bryoid (1)	0	-3	0
		Sparse (1a)	0	-3	0
		Bryoid (1b)	0	0	0
		Forb-dominated (2a)	0	0	0
		Graminoid dom. (2b)	0	0	0
		Dwarf shrub (2d)	0	0	0
		Low shrub (3a)	0	0	0
		Tall shrub (3b)	-3	-3	-3
		Pole/sapling (4)	-4	-4	-4
		Young forest (5)	-1	-2	-2
		Mature forest (6)	0	-1	-1
		Old forest (7)	0	-1	-1
5. Stand Composition		Coniferous (C)	0	0	0
		Mixed (M)	0	0	0
		Broadleaf (B)	0	0	0

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5.7 Mule Deer (*Odocoileus hemionus hemionus*)

SPECIES NAME: Mule deer
SCIENTIFIC NAME: *Odocoileus hemionus hemionus*
SPECIES CODE: M-ODHH
STATUS: Not at risk (MELP, 1997; COSEWIC, 1998)

DISTRIBUTION

Mule deer (*Odocoileus hemionus*) are distributed across western North America from northern Mexico to the southern Yukon Territory and Mackenzie District, NWT (Banfield, 1974). Interior mule deer (*O. hemionus hemionus*) range across the Great Plains and western Cordillera of North America (Nagorsen, 1990).

Provincial Range

Mule deer are distributed through much of the province east of the Coast Mountains to the Alberta border. They are most common in the southern interior and in the Peace River area of BC (Stevens and Lofts 1988)

Three subspecies of mule deer are found in BC. The largest of the three is *O.h. hemionus* and has the widest distribution, found as far north as the Liard River Valley and throughout the interior of the province as far west as the coastal mountains. In the extreme northwest, discontinuous populations are found in the Stikine River and Atlin Lake regions (Nagorsen, 1991).

Provincial Benchmark

Ecoprovince: Southern Interior Mountains
Ecoregion: Columbia Mountains and Highlands
Ecosection: Eastern Purcell Mountains (EPM)
Biogeoclimatic zone: IDFdm in winter; ESSFdk in growing
Broad Ecosystem Units: DF/1 – Interior Douglas-Fir Forest in winter; SM – Subalpine Meadow in growing

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Eastern Muskwa Ranges (EMR), Muskwa Foothills (MUF)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2000m in elevation).

ECOLOGY AND HABITAT REQUIREMENTS

Mule deer are very broadly adapted and occur in a large array of habitat types. In BC, they commonly utilise open coniferous forest, early seral stages and forest edges, burns, logged areas aspen parkland, sub-climax brush, meadows, subalpine parkland and often in steep broken terrain and in river valleys. Unbroken areas of climax boreal forest and open grassland devoid of shrubs and trees limit use by mule deer (Nietfeld *et al*., 1985).

In mountainous areas, mule deer are migratory. Summers are often spent at higher elevations and ranges consist of a diverse mixture of coniferous forest, meadows, aspen woodlands, alpine parkland and often alpine tundra. In winter, they seek regions of lower snowfall, usually at lower elevation. Preferred winter range has abundant forage on recently disturbed moisture receiving areas, interspersed with stands having mature canopy (Stevens and Lofts, 1988). These wintering areas can be critically important in regions of high snowfall.

In foothill and mountainous regions, mule deer winter at the highest elevation that snow will allow and will descend to lower elevations as snow depth increases and becomes restricting (Nietfeld *et al*., 1985). Snow depths of 20-30 cm may impede mule movements (Loveless, 1978, cited in Stevens and Lofts, 1988; Telfer, 1970) while depths of more than about 50 cm precludes use of an area. (Armleder, 1981; Loveless, 1978, cited in Stevens and Lofts, 1988). In the absence of snow, some mule deer will also utilise high elevations in winter (Wallmo and Regelin, 1978). The southern exposures with low snow depths are most heavily utilised in the late winter and early spring (Nietfeld *et al.,* 1985).

Mule deer feed on forbs, shrubs, trees, grasses and fungi with the use of each group dependent on season and availability (Stevens and Lofts, 1988). In summer, new leaves of shrubs and forbs are used extensively (Nietfeld *et al*., 1985). In autumn, shrubby vegetation is most important though forbs may make up 25 per cent of the diet in some areas. Their winter diet is composed of twigs of evergreens, deciduous saplings, nuts, lichens and shrubs. Among their favourite winter foods in some areas are Douglas fir, western red cedar, Oregon yew, trailing blackberry and huckleberry, salal, aspen, willow, red-osier dogwood, serviceberry, bitterbrush, mountain juniper, and sagebrush. In spring, grasses are heavily utilised (Banfield, 1974; Forsyth, 1985).

Riparian and wetland zones are heavily used because of their palatable vegetation. Optimum mule deer habitat in some areas has open water within 0.8 km of any point; heaviest use of an area occurs within 300 m of water but free water is less important in areas of succulent forage (Nietfeld *et al*., 1985).

Mule deer rut is in mid-October to December and fawns are born in June. Optimum fawning habitat is forest with 50% canopy closure, with low shrubs or small trees from 0.6 to 1.8 m and with food nearby (Stevens and Lofts, 1988).

In many areas, mule and white-tailed deer ranges overlap. Prescott (1974) lists some of the differences between these two deer: mule deer prefer open grassland/parkland types; mule deer range farther north and higher in elevation and can tolerate longer and more severe winters; white-tailed deer tend to winter in dense, coniferous forest types; mule deer use the subalpine zone in winter and white-tailed do not; and mule deer are often forced out by settlement and agriculture while white-tailed deer adapt and exploit agricultural crops for winter food.

LIFE REQUISITES/SEASONAL USE PATTERNS

Mule deer habitat requirements are divided into thermal, security and food (Table 5.7.1).

Table 5.7.1 Mule deer seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Food	Winter	October to May
2.	Thermal/Security	Winter	October to May
3.	Security	Growing	June to September
4.	Food	Summer/Fall	July to September
5.	Living	All seasons	June to September, October to May

Thermal

Optimal thermal protection is provided in closed canopy forest. Stands should have coniferous trees or shrubs greater than 1.5 m tall and with greater than 76% canopy closure (Nietfeld *et al*. 1985). In areas of severe climactic conditions, mule deer require climax forest for thermal protection (Armleder *et al*., 1994). Optimum size of mule deer thermal cover is 0.8-2.0 ha with a minimum width of 91 m (Nietfeld *et al*., 1985)

Security

Security is provided by rugged terrain (to outmanoeuvre predators) and by forest cover.

Food

They are broadly adapted and may find found in a variety of habitats but prefer open coniferous forest and early seral stages. Winter range includes spruce-subalpine fir, trembling aspen forests; preferred winter range has abundant forage on recently disturbed moisture receiving sites, interspersed with mature canopy. They tend to summer at higher elevations, usually in moister areas, subalpine parkland, alpine/subalpine wet meadows and alpine tundra feeding on forbs, shrubs, trees, grasses and fungi while in winter food consist of woody browse.

In forested areas, mule deer show a heavy use of natural openings with adjacent escape cover. For optimum use, openings should be 10.5 ha and have no point farther than 180 m from the edge of cover (Nietfeld *et al*. 1985).

Living

Interspersion of food and cover is essential to mule deer. Therefore, habitat that provides living contains a mosaic of food, security and thermal habitat. Food habitat must be within 180 m of security (Nietfeld *et al*. 1985).

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

Based on overview capability mapping for the NE region (Habitat Inventory Section, 1994a), the Study Area provides up to moderate mule deer habitat (corresponding to a rating of 3). Individual ratings for food and security/thermal may be higher. The MUF provides better mule deer habitat than the EMR.

Biogeoclimatic Zone

Mule deer potentially occur in all of the BGC zones and sub-zones in the Study Area. In high snowdepth years, the AT would provide habitat in the growing season only.

Site Series

In general, moister site series (soil moisture regimes from sub-mesic to hygric) provide better mule deer habitat than drier site series (very xeric to sub-xeric). Moister sites typically have a higher canopy closure and denser shrub and herb layers, which provides good thermal cover and natural openings which provide feeding habitat. However, very wet sites (hygric to sub hygric) typically have a lower canopy closure but provide good feeding.

Structural Stage

Optimal habitat for food is found in early seral stages (herb to tall shrub), in forest openings and in mature stands (mature and old forest) with high understory growth. Pole/sapling and young forest provide low food but good security and moderate thermal protection. Mature stands usually provide both thermal benefits and good snow interception because of their multilayered structure and the deep, spreading crowns of the older trees. Old growth forests generally do not provide good thermal habitat because they usually have low crown closure which intercepts snow poorly.

Stand Composition

Coniferous stand types provide better security/thermal protection than mixed and broadleaf stands in winter.

Aspect

Estimated snowpacks for areas directly adjacent to the north of the Study Area report lowest snow depths on south-facing aspects, which is a function of Chinook winds and solar radiation (Chilton, 1990). Warm southerly and westerly aspects (135-285°) are rated higher for food in winter.

Terrain

Terrain that provides concealment, such as that provided by gullied, ridged or undulating topography, provides security. Therefore, non-forested areas that would normally provide no security, are rated higher than similar polygons lacking concealing topography.

Proximity Effects

Habitats that provide food must have security/thermal protection within 180 m.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used to rate mule deer habitat. Food (FD), security/thermal (ST) and living (LI) are rated for use in the growing and winter seasons. LI encompasses all of the requirements necessary for survival and is a function of the spatial arrangement of FD and ST in the landscape.

Food (FD) and Security/Thermal (ST) Habitat Use Assumptions

The ratings table assigns a suitability rating for FD and ST to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between mule deer life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.7.2). For example, an optimal structural stage for food (e.g. low shrub) has a degrading score of "0"– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Polygon Food (FD), Security/Thermal (ST) Adjustments

Adjustments are used to modify the ratings in order to account for the species' habitat attributes that are not inherently a feature of the ecosystem unit. There are two adjustments (see Table 5.7.3).

Living (LI) Habitat Use Assumptions

Mule deer require habitat for food in proximity to security/thermal (within approximately 150m). The LI rating incorporates the FD and ST ratings within the target polygon and the ratings in adjacent polygons.

The LI rating is equal to the limiting rating between FD and ST. They are also adjusted depending on the primary use of the polygon:

- Habitats used primarily for food may only be rated as high as the best security/thermal in or directly adjacent to the target polygon.
- Habitats used primarily for security/thermal may only be rated as good as the best food in or directly adjacent to the target polygon.

Specifically:

- If the FD rating is better than the ST rating, LI is equal to the best ST in all polygons directly adjacent to the target polygon (including any decile of the target polygon) but not exceeding the FD rating of the target polygon.
- If the ST rating is better than the FD rating, LI is equal to the best FD in all polygons directly adjacent to the target polygon (including any decile of the target polygon) but not exceeding the ST rating of the target polygon.

Table 5.7.2 Mule Deer food and security/thermal habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score			
			G_FD	G_ST	W_FD	W_ST
1. BEC Unit	**EMR**	SWBmk	-2	-1	-3	-2
		SWBmks	-2	-2	-4	-4
		AT	0	-5	-4	-5
	MUF	BWBSmw2	-2	0	-2	0
		SWBmk	-2	-1	-2	-2
		SWBmks	-2	-2	-3	-3
		AT	0	-5	-4	-5
2a. Site Series (SMR)		Xeric	-2	-2	-2	-2
		Subxeric	-1	-1	-1	-1
		Submesic	0	0	0	0
		Mesic	0	0	0	0
		Subhygric	0	0	0	0
		Hygric	0	0	0	0
		Subhydric	-1	-1	-1	-1
		Hydric	-2	-2	-2	-2
2b. Site Series (SNR)		Very poor- poor	-1	-1	-1	-1
		Medium-very rich	0	0	0	0
3. Structural Stage		Sparse/Bryoid (1)	-3	-3	-3	-3
		Sparse (1a)	-3	-3	-3	-3
		Bryoid (1b)	-3	-3	-3	-3
		Forb-dominated (2a)	0	-3	0	-3
		Graminoid dom. (2b)	0	-3	0	-3
		Dwarf shrub (2d)	0	-3	0	-3
		Low shrub (3a)	0	-3	0	-3
		Tall shrub (3b)	0	-2	0	-2
		Pole/sapling (4)	-1	0	-1	-1
		Young forest (5)	-1	0	-1	-1
		Mature forest (6)	0	0	0	0
		Old forest (7)	0	0	0	0
4. Stand Composition		Coniferous (C)	0	0	0	0
		Mixed (M)	0	0	0	-1
		Broadleaf (B)	0	0	0	-2

Table 5.7.3 Polygon-specific food and security/thermal ratings adjustments for mule deer.

Topic	Description
A. Aspect	Rate cool aspects (285-1135°) down 1 FD in winter.
B. Terrain surface expression	Polygons lacking forest cover (structural stages 1a, 1b, 2, 3a and 3b) are rated up 2 ST for growing and winter if the surface expression is ridged (r), undulating (u) or hummocky (h).

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5.8 White-tailed Deer (*Odocoileus virginianus*)

SPECIES NAME: White-tailed Deer
SCIENTIFIC NAME: *Odocoileus virginianus*
SPECIES CODE: M-ODVI
STATUS: Not at risk (MELP, 1997; COSEWIC, 1998)

DISTRIBUTION

Provincial Range

White-tailed deer is distributed in two disjunct regions in British Columbia: the Peace River area and the southeastern portion of the province, particularly the lower valleys of the Kootenay Columbia, Kettle, and Okanagan Rivers.

Provincial Benchmark

Ecoprovince: Southern Interior Mountains
Ecoregion: Southern rocky Mountain Trench
Ecosection: East Kootenay Trench (EKT)
Biogeoclimatic zone: PPdh in winter; IDFdm in growing
Broad Ecosystem Units: DP/1 – Douglas-fir-Ponderosa Pine in winter; DF/1 – Interior Douglas-fir Forest in growing

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2000m in elevation).

ECOLOGY AND HABITAT REQUIREMENTS

In northeastern BC, white-tailed deer are at their northwestern limit of their range. As in other northern areas, their distribution is strongly controlled by snow cover. In mountainous areas they prefer lower altitudes in winter; higher slopes and ridge tops in summer (Nietfeld *et al*., 1985). They prefer an interspersion of habitat types, using trees and shrubs for security and forest openings and meadows for food.

White-tailed deer are primarily browsers. In Alberta, white-tails were found to consume 60% browse, 26% forbs, 6% grasses and the remaining unknown (Wishart, 1985). In snow-free periods, their habitat use is strongly dependent up the presence of digestible forage. Their summer diet consists mainly of grasses, fruits, forbs and green foliage of shrubs and saplings, needles of evergreens and mushrooms (Forsyth, 1985). Preferred foraging areas are small openings (1-3 ha.) in coniferous forests, trembling aspen forests, and deciduous riparian forests (Stevens and Lofts, 1988).

Cold weather conditions and deep snow force white-tailed deer to migrate to winter ranges. If winters are severe and snow depths exceed 50 cm, deer will aggregate in dense stands of conifer and mixed-wood (Nietfeld *et al*., 1985). During periods of mild weather and moderate snow conditions or where winters are less severe, white-tailed deer select more open-canopied habitats with more optimum forage conditions (Pauley *et al*., 1993). Winter diet consists mainly of buds and twigs of shrubs and saplings as well as needles of evergreens (Forsyth, 1985). South-facing slopes are important feeding areas in winter (Nietfeld *et al*., 1985).

In spring, white-tailed deer often disperse to valley bottoms at low to middle elevations and large riparian zones (Stevens and Lofts, 1988) for early green vegetation. Grass and forb consumption in this period is usually high (Wishart, 1984; Nietfeld *et al*., 1985).

In the east Kootenays winter home ranges are less that 2.79 km^2 and summer home ranges were less than 2.0 km^2. Size is generally dependent on the quality of available food and cover (Stevens and Lofts 1988).

Logging creates earlier stages of vegetation succession which favours forage production. However, cutting patterns must be small and irregular to enhance the interspersion of food, cover and edge habitat (Nietfeld *et al*. 1985). Fire similarly acts to increase forage production.

In many areas, mule and white-tailed deer ranges overlap. Prescott (1974) lists some of the differences between these two deer: mule deer prefer open grassland/parkland types; mule deer range farther north and higher in elevation and can tolerate longer and more severe winters; white-tailed deer tend to winter in dense, coniferous forest types; mule deer use the subalpine zone in winter and white-tailed do not; and mule deer are often forced out by settlement and agriculture while white-tailed deer adapt and exploit agricultural crops for winter food.

LIFE REQUISITES/SEASONAL USE PATTERNS

In this model, white-tailed deer habitat requirements are divided into thermal, food and security (Table 5.8.1).

Table 5.8.1 White-tailed deer seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Food	Winter	October to May
2.	Thermal	Winter	October to May
3.	Security	Growing	June to September
4.	Food	Growing	June to September
5.	Living	All seasons	All months

Food

Year-round, food is found in small openings in forested habitats and in a variety of other habitats in early successional stages, such as riparian areas, clearcuts and burns. South facing slopes are important feeding areas in winter and spring since they have the least snow. White-tailed deer have a heavy use of natural openings with adjacent escape cover; for optimum use, openings should be 10.5 ha and have no point farther than 180 m from the edge of cover (Nietfeld *et al*. 1985).

Thermal

Telfer (1970) reports that winter thermal cover should be composed of coniferous trees and shrubs greater than 1.5 m tall, have a canopy closure of greater than 75% and be at least pole-sapling stage. Valley slopes and eroded, hummocky terrain also provide important thermal cover in winter although topography cannot substitute for the thermal value of vegetation, only increase its value (Nietfeld, *et al*. 1985). Optimal size of stands for thermal cover is 0.8-2.0 ha (Nietfeld *et al*. 1985)
.

Security

Security is provided by trees and shrubs and by terrain that provides concealment (e.g. gullied, ridged and undulating topography).

Living

Habitat that provides living contains food and security/thermal protection in close proximity. Edge or ecotonal areas associated with transition zones between treed and non-treed areas bring suitable food and cover types into close association (Wishart, 1979). Small openings in forested areas plus the presence of fresh water ponds, streams and rivers enhances interspersion of food and cover, and increases habitat quality (Nietfeld *et al*., 1985). Most use of land occurs within 180 m of the edge between cover and feeding areas (Nietfeld, *et al*. 1985).

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Ecosection

Based on overview capability mapping for the NE region (Habitat Inventory Section, 1994a), the Study Area provides up to low white-tailed deer habitat (corresponding to a rating of 4). Individual ratings for food and security/thermal may be higher. Deep snow in the EMR Ecosection results in very low white-tailed deer habitat.

Biogeoclimatic Zone

White-tailed deer potentially occur in all of the BGC zones and sub-zones in the Study Area. The SWBmk and SWBmks generally provide growing season habitat only; however they may provide low level winter habitat in low snowfall years. AT represents food habitat in the growing season only.

Site Series

In general, moister site series (soil moisture regimes from sub-mesic to hygric) provide better deer habitat than drier site series (very xeric to sub-xeric) in each of the BGC sub-zones present in the Study Area. Moister sites typically have a higher canopy closure and denser shrub and herb layer, which provides good thermal cover and natural openings providing feeding habitat. However, very wet sites (hygric to sub hygric) typically have a lower canopy closure but provide good feeding areas if cover is within 180 m.

Structural Stage

Optimal food is found in herb and shrub stages and in mature and old forests will small openings. Optimal winter thermal habitat is provided in dense stands of closed canopy conifers. Mature stands usually provide both thermal benefits and good snow interception because of their multilayered structure and the deep, spreading crowns of the older trees. Understory shrub growth can also be quite high in these forests.

Stand Composition

Coniferous stand types provide better security/thermal protection than mixed and broadleaf stands in winter.

Aspect

South-facing slopes are preferred in spring and winter. Estimated snowpacks for areas directly adjacent to the north of the Study Area report lowest snow depths on south-facing aspects, which is a function of Chinook winds and solar radiation (Chilton, 1990). Warm southerly and westerly aspects (135-285°) are therefore rated higher for food in winter.

Terrain

Terrain that provides concealment, such as that provided by gullied, ridged or undulating topography, provides security and thermal protection. Therefore, non-forested areas that would normally provide no security, are rated higher than similar polygons lacking this type of topography.

Proximity Effects

Optimal white-tailed deer habitat contains an interspersion of food and security/thermal. Habitats that provide food must have security/thermal protection within 150 m.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used to rate white-tailed deer habitat. Food (FD), security/thermal (ST) and living (LI) are rated for use in the growing and winter seasons. LI encompasses all of the requirements necessary for survival and is a function of the spatial arrangement of FD and ST in the landscape.

Food (FD), and Security/Thermal (ST) Habitat Use Assumptions

The ratings table assigns a suitability rating for FD and ST to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between white-tailed deer life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.8.2). For example, the optimal structural stage for food (low shrub) has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is

Table 5.8.2 White-tailed deer food and security/thermal habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score			
			G_FD	G_ST	W_FD	W_ST
1. BEC Unit	**EMR**	SWBmk	-3	-1	-5	-5
		SWBmks	-3	-2	-5	-5
		AT	-3	-5	-5	-5
	MUF	BWBSmw2	-2	-1	-2	-2
		SWBmk	-2	-1	-3	-3
		SWBmks	-2	-2	-4	-4
		AT	-2	-5	-5	-5
2a. Site Series (SMR)		Xeric	-2	-2	-2	-2
		Subxeric	-1	-1	-1	-1
		Submesic	0	0	0	0
		Mesic	0	0	0	0
		Subhygric	0	0	0	0
		Hygric	0	0	0	0
		Subhydric	-1	-1	-1	-1
		Hydric	-2	-2	-2	-2
2b. Site Series (SNR)		Very poor- poor	-1	-1	-1	-1
		Medium-very rich	0	0	0	0
3. Structural Stage		Sparse/Bryoid (1)	-2	-2	-2	-2
		Sparse (1a)	-2	-2	-2	-2
		Bryoid (1b)	-2	-2	-2	-2
		Forb-dominated (2a)	0	-2	-2	-2
		Graminoid dom. (2b)	0	-2	-2	-2
		Dwarf shrub (2d)	0	-2	-2	-2
		Low shrub (3a)	0	-2	-2	-2
		Tall shrub (3b)	-1	-1	-1	-1
		Pole/sapling (4)	-1	-1	-1	-1
		Young forest (5)	0	0	0	0
		Mature forest (6)	0	0	0	0
		Old forest (7)	0	0	0	0
4. Stand Composition		Coniferous (C)	0	0	0	0
		Mixed (M)	0	0	0	-1
		Broadleaf (B)	0	0	0	-2

calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Polygon Food (FD), Security/Thermal (ST) Adjustments

Adjustments are used to modify the ratings in order to account for the species' habitat attributes that are not inherently a feature of the ecosystem unit. There are two adjustments (see Table 4.8.3).

Table 5.8.3 Polygon-specific food and security/thermal ratings adjustments for mule deer.

Topic	Description
A. Aspect	Rate cool aspects (285-1135°) down 1 FD in winter.
B. Terrain surface expression	Polygons lacking forest cover (structural stages 1a, 1b, 2, 3a and 3b) are rated up 2 ST for growing and winter if the surface expression is ridged (r), undulating (u) or hummocky (h).

Living (LI) Habitat Use Assumptions

White-tailed deer require habitat for food in proximity to security/thermal. The LI rating incorporates the FD and ST ratings within the target polygon and the ratings in adjacent polygons.

The LI rating is equal to the limiting rating between FD and ST. They are also adjusted depending on the primary use of the polygon:

- Habitats used primarily for food may only be rated as high as the best security/thermal in or directly adjacent to the target polygon.
- Habitats used primarily for security/thermal may only be rated as good as the best food in or directly adjacent to the target polygon.

Specifically:

- If the FD rating is better than the ST rating, LI is equal to the best ST in all polygons directly adjacent to the target polygon (including any decile of the target polygon) but not exceeding the FD rating of the target polygon.
- If the ST rating is better than the FD rating, LI is equal to the best FD in all polygons directly adjacent to the target polygon (including any decile of the target polygon) but not exceeding the ST rating of the target polygon.

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5.9 Bison (*Bison bison*)

SPECIES NAME: Bison
SCIENTIFIC NAME: *Bison bison*
SPECIES CODE: M-BIBI
STATUS: *Bison bison athabascae* is red listed and *B.b. bison* is blue listed (MELP, 1997); *B. b. athabascae* is threatened (COSEWIC, 1998)

DISTRIBUTION

Two North American subspecies of modern bison are currently recognised: *Bison bison bison* (plains bison) and *B. b. athabascae* (wood bison). Detailed comparisons of wood and plains bison are difficult to make because of the disappearance of most wild populations of both forms followed by the hybridisation of remnant populations. Historical accounts generally agree that, compared to plains bison, the wood bison was larger, darker, hardier, more fleet and wary, and lived in smaller bands (Meagher, 1978).

Plains bison occurred throughout the prairies of central North America and also occurred in the hardwood forests of eastern United States. Now they are mostly found in semi-domesticated herds in many national parks and reserves (Banfield, 1974). There has been integration of the two races but pure forms can still be seen in some areas, including the Pink Mountain area of BC (Nagorsen, 1990).

Provincial Range

Both bison subspecies occur in northeastern British Columbia (Nagorsen, 1990). Plains bison were introduced to the Pink Mountain area in 1971 from Elk Island National Park. This is the population now present as far north as the Sikanni River and potentially into the Nevis Creek valley. Wood bison reported from various northeastern localities (e.g. Fort Nelson, Kotcho Lake) probably originated from those introduced to Nahanni Butte, Northwest Territories, in 1980.

Provincial Benchmark

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF)
Biogeoclimatic zone: SWBdk
Broad Ecosystem Units: BA/1 – Boreal White Spruce-Trembling Aspen in winter; SM – Subalpine Meadow in growing

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2100m in elevation).

Bison are resident in the Sikanni River valley, located directly adjacent to the south of the Study Area. These bison have also been reported during summer at the head of the Nevis Creek valley near the boundary of the Study Area. Their general absence from Nevis Creek northward is likely due to factors other than the absence of suitable habitat.

ECOLOGY AND HABITAT REQUIREMENTS

Bison habitat varies from open, arid plains, to open forests, grasslands and meadows, river valleys, and mountainous areas (Forsyth, 1985). Their habitat use is dependent on food availability during each season and they select habitats that provide optimal protein (Larter and Gates, 1990). Optimal habitats for food are open grasslands with high grass and sedge cover but bison use forested areas when available.

Bison are predominantly grazers and grasses and sedges are their main diet in most places, although they will also consume horsetails, rushes, lichens, shrubs and berries (Banfield, 1974). Selection of individual diet items varies among geographical areas and is mostly a function of relative forage availability (Larter and Gates, 1991). Plains bison and wood bison inhabiting Wood Buffalo National Park predominately consume grasses or a combination of grasses and sedges. Bison in Yellowstone National Park eat sedges almost exclusively (Meagher, 1978). Plains bison inhabiting riparian willow communities use browse, mostly in an opportunistic manner and will not abandon habitats providing higher sedge and grass biomass to do so. Larter and Gates (1991) report that summer browsing included up to 33% of wood bison diet in the Mackenzie Bison Sanctuary, NWT. They also found high consumption of lichen, comprising up to 40% of their diet in fall. In all areas presently inhabited by bison, snow or open water is available at all times and apparently used daily (Meagher, 1978).

Bison diet also varies by season. In the Mackenzie Bison Sanctuary, winter diet is composed almost exclusively of sedges. In spring and early summer, their diet includes a diverse mix of sedges, grasses and shrubs. In late summer and fall, lichen and forbs become more dominant (Larter and Gates, 1990).

Bison herds that spend summers at higher elevations in the mountains often move down to river valleys in winter, although lone bulls regularly winter high in mountain passes. In November and May, the bison in Wood Buffalo National Park undertake considerable migrations from the wooded hills to the Peace River valley (Banfield, 1974).

Bison are extremely winter hardy. They can forage in several feet of loose snow (Meagher, 1978). In fact, the main factor in habitat selection in winter may be snow hardness and not snow depth. Reynolds *et al.* (1987) found that snow hardness was the principle factor influencing choice of feeding sites. Some habitats may also provide important thermal protection. Warmer areas (e.g. south aspects) with less snow provide a margin for survival for bison in the harshest wintering areas (Meagher, 1978).

Wintering bison in the Sikanni and Halfway River valleys are regularly found in subalpine and alpine habitats in winter. The low snow depths in the Muskwa Foothills allows for good access to forage at all elevations and seasons.

Primary bison habitat is in non-forested areas. Cairns and Telfer (1980) observed strong selection by bison for upland grassland areas in the boreal forest. Similarly, Hudson and Frank (1987) found bison mostly on grassy upland meadows and little use of poplar forests. Forested habitats, however, may be used extensively. During severe winter conditions, forested areas and topographical variations may provide some degree of shelter. These areas may be especially important during periods of crusted or dense, deep snow. Forested habitats are also used for shade, to escape insect pests and the trees are used for scraping. Extensive forests that provide little forage may be traversed from one foraging area to another (Meagher, 1978). In some areas, conifer forests provide the highest lichen biomass for fall feeding. Recent burns provide abundant forage for bison. Pearson *et al.*.(1995) found these areas used most in mid- to late-winter.

LIFE REQUISITES/SEASONAL USE PATTERNS

The availability of food is the primary factor determining bison habitat use and distribution (Table 5.9.1).

Table 5.9.1 Bison seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Food	Winter	October to May
2.	Food	Growing	June to September

Food

Optimal food is found in grassland and herbaceous communities. In winter, open conifer forest are also used. There appear to be few topographical limitations for bison.

KEY HABITAT REQUIREMENTS/ATTRIBUTES

Ecosection

The MUF Ecosection is the provincial benchmark for Bison. The colder climate and higher snow depths in the EMR results in lower quality and availability of winter range than the MUF.

Biogeoclimatic Zone

Bison are known to use all of the zones present in the Study Area. In the SWBmk, the combination of valley bottom riparian plains, open forest cover, and the herb and shrubland communities produced by massive cold-air ponding (e.g. *Betula glandulosa – Festuca altaica* association and others) combine to provide excellent bison habitat year-round. The SWBmks and AT are also used extensively in all seasons.

Site Series

Suitable forage is found in sites with various moisture and nutrient regimes. Wet sites (subhydric to hydric) are used less than drier sites.

Structural Stage

Early successional stages provide optimal food habitat for Bison. Mature forested stands provide good snow interception because of their multilayered structure and the deep, spreading crowns of the older trees. Patch forest communities are favoured because of the clear areas between stands.

Stand Composition

Broadleaf and mixed stands provide more forage than coniferous stands in the BWBSmw2 and SWBmk.

Aspect

Estimated snowpacks for areas directly adjacent to the north of the Study Area report lowest snow depths on south-facing aspects, which is a function of Chinook winds and solar radiation (Chilton, 1990). Warm southerly and westerly aspects (135-285°; site modifier “w”) are therefore rated higher for food in winter.

HABITAT RATINGS

Rating Scheme/Modelling Theme

Bison habitat is rated for food (FD) in the growing and winter seasons. The availability of food is the primary factor responsible for determining habitat use by bison and the model is therefore based entirely on this life requisite.

Food (FD) Habitat Use Assumptions

The ratings table assigns a suitability rating for FD to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between bison life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.9.2). For example, the optimal structural stage for food (herbaceous) has a degrading score of "0"– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of -4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Polygon Food (FD) Adjustments

Adjustments are used to modify the ratings in order to account for bison habitat attributes that are not inherent features of the ecosystem unit. There is one adjustment:

- Cool aspects rated down 2 FD in winter.

Table 5.9.2 Bison food habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score	
			G_FD	W_FD
1. BEC Unit	EMR	SWBmk	0	-2
		SWBmks	0	-2
		AT	-1	-3
	MUF	BWBSmw2	0	0
		SWBmk	0	0
		SWBmks	0	0
		AT	-1	-1
2a. Site Series (SMR)		Xeric	-2	-2
		Subxeric	-1	-1
		Submesic	0	0
		Mesic	0	0
		Subhygric	0	0
		Hygric	0	0
		Subhydric	-1	-1
		Hydric	-2	-2
2b. Site Series (SNR)		Very poor- poor	-1	-1
		Medium-very rich	0	0
3. Structural Stage		Sparse/Bryoid (1)	-4	-4
		Sparse (1a)	-4	-4
		Bryoid (1b)	-4	-4
		Forb-dominated (2a)	0	0
		Graminoid dom. (2b)	0	0
		Dwarf shrub (2d)	0	0
		Low shrub (3a)	0	0
		Tall shrub (3b)	-2	-2
		Pole/sapling (4)	-2	-2
		Young forest (5)	-2	-2
		Mature forest (6)	-1	0
		Old forest (7)	-1	0
4. Stand Composition		Coniferous (C)	-1[a]	-1[a]
		Mixed (M)	0	0
		Broadleaf (B)	0	0

[a] Only if BEC Unit is BWBSmw2, and SWBmk.

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5.10 Mountain Goat (*Oreamnos americanus*)

SPECIES NAME: Mountain goat
SCIENTIFIC NAME: *Oreamnos americanus*
SPECIES CODE: M-ORAM
STATUS: Not at risk (MELP, 1997; COSEWIC, 1998)

DISTRIBUTION

Provincial Range

Mountain goats are found throughout the Cordilleran region of western Canada and occupy the mainland portion of the province, except for the central interior (Banfield, 1974; Nagorsen, 1990). In BC the mountain goat is divided on the basis of distribution and appearance of cranial characteristics into three subspecies: those north of the Peace and Skeena Rivers are classified as *Oreamnos americanus columbianus;* those of the Crowsnest Pass in the East Kootenays fall into the *O. a. missoulae* race; and those throughout the remainder of BC are classified as *O. a. americanus* (Wright undated).

Provincial Benchmark

Ecoprovince: Southern Interior Mountains
Ecoregion: Western Continental Ranges
Ecosection: Southern Park Ranges (SPK)
Biogeoclimatic zone: ESSFdk in winter; AT in growing
Broad Ecosystem Units: SF/6 – White Spruce-Subalpine Fir/RO – Rock in winter; AM – Alpine meadow in growing

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2600m in elevation).

ECOLOGY AND HABITAT REQUIREMENTS

Mountain goats are associated with mountainous, high elevation terrain although they may be found in a variety of habitats ranging from coastal forests through to subalpine and alpine areas. Two mountain goat ecotypes are generally considered: coastal and interior (Hebert and Turnbull, 1977; Chadwick, 1983). The largest differences between these ecotypes appears to be diet and winter habitat use. The feature common to all mountain goat areas is precipitous topography which functions as escape terrain and provides snow shedding capability, especially important in high snowfall areas (Fish and Wildlife Branch, 1979).

Optimum habitat for mountain goats contains feeding areas interspersed with escape terrain. Goats in the interior are predominantly grazers (Herbert and Turnbull, 1977) and their diet includes grasses, sedges, rushes, forbs, shrubs, lichen and conifers (Fish and Wildlife Branch, 1979). Varley (undated), studying in Wyoming and Montana, found most feeding mountain goats used slopes between 16 and 60^{o} and nearly all feeding goats were within 50m of escape terrain. Haynes (undated), also studying in Wyoming, found nearly all goats within 400m of cliffs.

The availability of suitable winter range is generally a limiting factor. Goats will move long distances to low elevation ranges where snow depths are less and forage is accessible; however, they will also winter on high, steep cliffs where wind action is greatest, escape terrain is available and both shrubs and conifers are present. Nietfeld *et al*. (1985) reports that goats in Alberta generally descend to where snow depths are less than 45cm. Adams *et al*. (1980) reports that on Colorado winter ranges, goats preferred areas without persistent or melt-crusted snow where cliffs were interspersed with tundra treeline or with shrubs or sparse coniferous habitats below the treeline. Smith (1977), studying in western Montana, found greatest use of southern exposure, lower elevations and cliff terrain when winter snow depths were greatest. Goats in many areas also find winter forage and thermal protection in open mature forests (MOF and BCE, 1997). Winter ranges are typically south and west-facing slopes (Fish and Wildlife Branch, 1979; Poole and Mowat, 1997). During severe weather, caves, overhanging ledges and the sheltered side of cliffs provide refuge (Soper, 1982).

Summer goat ranges are extensive and only limited by the availability of escape terrain (Phelps *et al*., 1985). North and east-facing slopes are often preferred as they have the greatest supply of snow and water, providing continuously green, succulent forage (Nietfeld *et al*., 1985; Varley, undated). Goats will frequently travel to mineral licks (if available) and these may be used extensively in summer and fall after feeding on low sodium forage in spring and early summer (Phelps *et al*., 1983).

Seasonal migrations between summer and winter ranges are not pronounced and movements are often contained within a single, contiguous range. However, goat populations that utilise mineral licks may move long distances through a variety of habitats including closed canopy forest.

Rutting season occurs in November and early December and kids are born in late May or early June. Natal areas are often in the most rugged portion of the goat’s range and are located in a sheltered spot, such as a cave or overhang (Fish and Wildlife Branch, 1979).

Aside from hunting, human activities have had little effect on mountain goats because of the remote nature of their habitat. However, goats have been found to abandon areas undergoing logging activity. Road construction and traffic is also a disturbance (Nietfeld *et al*., 1985).

LIFE REQUISITES/SEASONAL USE PATTERNS

In this model, mountain goat life requisites and divided into security, food, reproduction and living (Table 5.10.1).

Table 5.10.1 Mountain goat seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Security	All seasons	Year-round
2.	Food	Winter	October-April
3.	Food	Growing	May-September
4.	Reproduction	Growing	May-September
5.	Living	Growing and winter	May-September October-April

Security

Steep slopes provide security (or escape terrain). In Alberta, 50% of goats reported have been on slopes greater than 100% (Nietfeld *et al*., 1985). Haynes (undated) found that Wyoming goats used terrain greater than 78% as their primary habitat and preferred slopes greater than 100%. Chadwick (1983) found goats on slopes greater than 90% more than seventy percent of the time. Slope requirements greater than 100% are poorly documented however cliffs approaching vertical are known to be used preferentially.

Food

Summer feeding areas are at high elevations and may occur wherever escape cover nearby. Winter feeding areas include wind-swept ridges, steep cliffs and high elevation, open forests.

Reproduction

Both rutting and natal areas occur within a goat's normal territory. Natal areas are often located in the most rugged portion of the territory but is not significantly different from the habitat required at other times of the year. Habitat for reproduction is not rated in this model and is included here only for completeness.

Living

Habitat that provides living contains security and food in close proximity. MOF and BCE (1997) and Haynes (undated) report that goats are rarely more than 400 m from escape terrain where
Varley (undated) found most feeding mountain goats within 50m of escape terrain. For this model, we assume that food habitat within 400m of escape terrain has adequate security.

KEY HABITAT REQUIREMENTS/ATTRIBUTES

Ecosection

Mountain goat occur in both the EMR and MUF Ecosections. Based on overview capability mapping for the NE region (Habitat Inventory Section, 1994a), the Study Area provides up to moderate mountain goat habitat (corresponding to a rating of 3). Individual ratings for food and security/thermal may be higher.

Biogeoclimatic Zone

Mountain goat habitat occurs in the AT, SWBmk and SWBmks. Goats may also be present in the BWBSmw2 if they are travelling to or are at a mineral lick. However, since this zone does not provide significant goat habitat, it is rated low. Goat use in the SWBmk is highest in winter when goats may descend to seek out lower snow depths.

Site Series

Mesic and moister site series (soil moisture regimes sub-mesic to sub-hygric) provide better feeding habitat than drier.

Structural Stage

Goats in the interior are most often found in non-forested habitat. Structural stage 02 (herb) provides optimal foraging and structural stages 01 (non-vegetated/sparse), 03 (shrub/herb) and 3a (low shrub) provide the next best. Structural stages 3b (tall shrub), 04 (pole/sapling) and 05 (young forest) generally provide little feeding habitat with one exception– structural stage 3b in the SWBmks are usually composed of open, often krummholz forest that provides suitable forage. In winter, structural stages 06 and 07 (mature forest and old-growth forest respectively) provide low-level feeding in the SWBmk and better quality winter feeding in the SWBmks.

Slope

Slopes greater than 100% provide the best escape terrain. Slopes between 80 and 100% provide moderate escape terrain and slopes less than 80% provide little. Polygons classified as cliff (CL) provide optimal escape terrain.

Proximity effects

Areas used for feeding must be adjacent to escape terrain. It is assumed that feeding habitat less than 400m from escape terrain provides the security. Areas located greater than 400m from escape terrain are not likely to be used by goats for feeding. Feeding habitat may only be rated as high as its security rating or the adjacent security rating.

Aspect

Winter ranges are typically on south and west-facing slopes as these have the lowest snow depths (Chilton, 1990). North and east-facing slopes are often preferred in summer as they have the greatest supply of snow and water, providing continuously green, succulent forage. Therefore, warm aspects (135-285°) are rated down for feeding and security in the growing season and cool aspects (285-135°) are rated down one for feeding in winter.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used to rate mountain goat habitat for food (FD), security (SH) and living (LI) in growing and winter.

FD ratings are defined in the ratings table. SH ratings are not found in the ratings table because slope is not an inherent feature of the ecosystem units. LI encompasses all of the requirements necessary for survival and is a function of the spatial arrangement of FD and SH in the landscape. The LI ratings are generated using a GIS algorithm.

Food (FD) Habitat Use Assumptions

The ratings table assigns a suitability rating for FD to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between mountain goat life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.10.2). For example, the optimal structural stage for food (herb) has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Table 5.10.2 Mountain goat food habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score	
			G_FD	W_FD
1. BEC Unit	**EMR**	SWBmk	-2	-3
		SWBmks	-2	-3
		AT	-2	-3
	MUF	BWBSmw2	-2	-3
		SWBmk	-2	-2
		SWBmks	-2	-2
		AT	-2	-2
2a. Site Series (SMR)		Xeric	-1	-1
		Subxeric	0	0
		Submesic	0	0
		Mesic	0	0
		Subhygric	0	0
		Hygric	0	0
		Subhydric	-1	-1
		Hydric	-2	-2
2b. Site Series (SNR)		Very poor- poor	0	0
		Medium-very rich	0	0
3. Structural Stage		Sparse/Bryoid (1)	0	-1
		Sparse (1a)	0	-1
		Bryoid (1b)	0	-1
		Forb-dominated (2a)	0	-1
		Graminoid dom. (2b)	0	-1
		Dwarf shrub (2d)	0	-1
		Low shrub (3a)	0	-1
		Tall shrub (3b)	-2	-2
		Pole/sapling (4)	-2 (0)[a]	-2 (0)[a]
		Young forest (5)	-2 (0)[a]	-2 (0)[a]
		Mature forest (6)	-2 (0)[a]	-2 (0)[a]
		Old forest (7)	-2 (0)[a]	-2 (0)[a]
4. Stand Composition		Coniferous (C)	0	0
		Mixed (M)	0	0
		Broadleaf (B)	0	0

[a] Conditional rating: if zone is SWBmks, then down-rating adjustment equals 0.

Food (FD) Habitat Use Adjustments

Adjustments are used to modify the ratings in order to account for the species' habitat attributes that are not inherent features of the ecosystem unit.

Table 5.10.3 Polygon-specific food ratings adjustments for mountain goat.

Topic	Description
A. Aspect	Warm aspects (135-285°) rated down 1 FD in growing. Cool aspects (285-135°) rated down 1 FD in winter.
B. Slope	Slopes greater than 100% are rated up 1 FD in winter.

Security Habitat (SH) Use Assumptions

Security habitat is rated using the presence of cliffs (ecosysem code CL) and the terrain surface expression codes:

- Polygons classified as cliff (CL) rated 1 SH.
- Slopes greater than 78% (surface expression code "s") rated 3 SH.
- Slopes <80% (all other surface expression codes) rated 6 SH.

Living (LI) Habitat Use Assumptions

The LI rating is a combination of the FD and SH rating and is generated using a GIS algorithm. Since a given habitat can generally only be as good as the most limiting life requisite, LI is calculated as the lower rating between the polygon FD rating and the best SH rating in all polygons within 400m.

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5.11 Stone Sheep (*Ovis dalli stonei*)

SPECIES NAME: Stone sheep
SCIENTIFIC NAME: *Ovis dalli stonei*
SPECIES CODE: M-OVDS
STATUS: Blue listed (MELP, 1997); not at risk (COSEWIC, 1998)

DISTRIBUTION

Provincial Range

In BC, Stone sheep are found from the Yukon border to just south of the Peace Arm of Williston Reservoir (Nagorsen 1990).

Provincial Benchmark

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF)
Biogeoclimatic zone: SWBmk in winter; AT in growing
Broad Ecosystem Units: BA/1 – Boreal White Spruce-Trembling Aspen/RO – Rock in winter; SM – Subalpine Meadow in growing

Project Study Area

Ecoprovince: Northern Boreal Mountains
Ecoregion: Northern Canadian Rocky Mountains
Ecosection: Muskwa Foothills (MUF), Eastern Muskwa Ranges (EMR)
Biogeoclimatic zone: BWBSmw2, SWBmk, SWBmks, and AT.
Elevational range: Valley bottom to alpine tundra (~ 900m to 2000m in elevation).

ECOLOGY AND HABITAT REQUIREMENTS

The world population of Stone sheep inhabits mountainous areas of northern British Columbia and the southern Yukon (Seip, 1983; MELP, 1978). Populations occur on the Yukon and Stikine plateaus, the Skeena, Cassiar and Omenica Mountains from the Pine River to the Liard River, and the Boundary Ranges of the Coast Mountains (Fish and Wildlife Branch, 1978). Good sheep habitat is described as narrow linear ridges, talus slopes and nearly vertical cliffs interspersed with gently sloping saddles and alpine meadows with abundant vegetation (Seip 1983). They eat primarily grasses and sedges, but also supplement their diet with several kinds of herbs in the summer and woody plants in the winter (Banfield, 1977).

Stone sheep generally have two distinct ranges: summer and winter with corresponding spring and fall migrations (Chapman and Feldhamer, 1982). During summer, they inhabit alpine slopes and plateaus, moving higher with the green-up of succulent grasses and forbs (Scotter and Ulrich, 1995, Seip 1983) and always on or adjacent to precipitous terrain.

In winter, snow cover limits the availability of forage and Stone sheep select habitats that have less snow, either at lower elevations or in wind-blown areas. They are known to use lower, drier, southern-facing slopes (Banfield, 1977) however, they commonly use mountain peaks and ridges at elevations up to 2200m, as documented by Seip (1983). They may also move up and utilise the often sparse vegetation of the upper slopes as wind clears the snow off after storm events (Luckhurst, 1973). Seip (1983) found that in the Yedhe, Delano, and Racing River areas, stone sheep were using mountain peaks and ridges as winter range. These were at elevations between 1500 to 2200 m and the primary characteristic of these areas appeared to be their tendency to be blown free of snow. The average snow depth used by the sheep was 16.5cm and the depth where they ceased digging for food was 32.4 cm (Seip 1983). Much of their time during winter is spent on the south or west facing slopes and ridges below 1,700 m (Luckhurst, 1973).

Luckhurst (1973) studied Stone sheep in the Nevis Creek area. He reports that sheep in the northern foothills depend almost exclusively on alpine vegetation. In summer, the most commonly used feeding habitat was in the *Calamagrostis-Hierochloe*, *Betula-Vaccinium vitis-idaea* and *Festuca-Dryas* communities. Use of these areas in winter was severely limited by snow cover.

In winter, greatest use was found in the *Elymus-Agrpyron*, *Elymus-Festuca,* and *Dryas-Festuca* communities. During critical periods in the winter and again in spring, sheep relied heavily on the *Elymus-Agropyron* community. This community occupied only 20% of the winter range area.

Specific requirements for escape terrain are not well documented for Stone sheep. Bighorn sheep (*Ovis canadensis*) escape terrain has been much better characterised and we assume that escape terrain requirements are similar between the two species. Van Dyke *et al.*.(1983), in a review of California bighorn sheep (*O. canadensis californiana*) escape areas, reports that steep broken cliffs with traversible terraces are most desirable; where steep cliffs are lacking, steep slopes and talus are used. Escape terrain must be higher than 8 m and larger than 0.16 ha but must be larger than 2 ha to suffice as lambing habitat. Van Dyke *et al*. (1983) also reports that optimal bighorn foraging habitat lies within 1 km of suitable escape terrain and few bighorns forage more than 1.6 km from escape terrain. Smith *et al*. (1991) report more restrictive distances: generally only 300 m but as much as 500 m if escape terrain is available on more than one side.

Although cliffs contain only sparse vegetation, they may be important for feeding in winter as the steep slopes readily shed snow and are often warmer, thus providing easier access to forage (Van Dyke *et al.,* 1983).

The breeding season extends from about mid-November to mid-December, and the gestation last about 175 days, with lambing in May. Pregnant ewes leave the band and go to the most rugged place in there summer range to give birth (Scotter and Ulrich, 1995, Seip 1983, Chapman, and Feldhamer. 1982).

Mineral licks appear to be an important habitat requirement of Stone sheep, and may be a means of replenishing mineral reserves depleted during the winter (Scotter and Ulrich, 1995, Seip 1983). Luckhurst (1973) found Stone sheep frequently visiting mineral licks from late spring to early fall. Mineral licks have a major influence on movements and distribution in certain seasons.

Luckhurst (1973) found interspecific competition for forage to be low in the Nevis Creek drainage however, he suggests that it may occur with elk in other areas. Given the widespread increase in elk number in recent years, this is likely the case.

LIFE REQUISITES/SEASONAL USE PATTERNS

In this model, Stone sheep life requisites are divided into security, food, reproduction, migration and living (Table 5.11.1).

Table 5.11.1 Stone sheep seasonal life requisites.

Rank	Life Requisite	Season	Months
1.	Security	All seasons	Year-round
2.	Food	Winter	October-May
3.	Food	Growing	June-September
4.	Reproduction	Growing	June-September
5.	Living	Year-round	Year-round

Security

In general, Stone sheep are restricted to semi-open, precipitous terrain with rocky slopes, ridges, cliffs or rugged canyons. Specific Stone sheep security requirements must be inferred from those requirements documented for California and Rocky Mountain bighorn sheep. We assume that optimal security habitat is provided by slopes greater than 60°, moderately high security provided by slopes between 40 and 60°, moderately low between 30 and 40° and no security provided in polygons with slopes less than 30°.

Food

Optimal food in the growing season is found above treeline in herbaceous and low shrub communities adjacent to escape terrain. Optimal plant communities are *Calamagrostis-Hierochloe*, *Betula-Vaccinium vitis-idaea* and *Festuca-Dryas* communities.

Optimal winter food is found on south aspect slopes and on wind-swept ridges, both with low snow cover. Optimal plant communities are *Elymus-Agrpyron*, *Elymus-Festuca*, and *Dryas-Festuca* communities.

Reproduction

Stone sheep lambing habitat is usually part of their winter range or as an intermediate between winter and summer range (Chapman and Feldhamer, 1982). Preferred lambing habitat is in the most precipitous, inaccessible cliffs near forage, and generally has a dry, southern exposure (reviewed by Chapman and Feldhamer, 1982; Seip, 1983; Scotter and Ulrich, 1995)

Living

Habitat that provides general living requirements includes habitats that provide food in close proximity to habitat that provides security. We assume that optimal foraging habitat occurs within 500 m of security habitat.

KEY HABITAT REQUIREMENTS/ATTRIBUTES

Ecosection

Stone sheep are abundant in both the MUF and EMR Ecosections. The MUF Ecosection is the provincial benchmark (RIC, 1998a).

Biogeoclimatic Zone

Stone sheep habitat occurs in the AT, SWBmk and SWBmks. They may also be present in the BWBSmw2 if they are travelling to or are at a mineral lick. However, since this zone does not provide significant Stone sheep habitat, it is generally rated low.

The AT primarily provides habitat in the growing season however, wind-blown cliffs and ridges with south and west facing aspects may also provide suitable winter habitat. The SWBmks provides sheep habitat year-round. Sheep use in the SWBmks is highest in winter when sheep may descend to seek out lower snow depths on wind-blown south or west facing ridges.

Site Series

Mesic and moister site series (soil moisture regimes sub-mesic to sub-hygric) generally provide better feeding habitat than drier site series.

The vegetation communities described by Luckhurst (1978) as used most by Stone sheep in the Nevis Creek area are found in the FL – Fescue-Lichen and MA – Avens-Lupine site series in winter and the BV – Birch-Vaccinium, FL – Fescue-Lichen and AD – Arnica-Daisy in the growing season.

Structural Stage

Stone sheep are most often found in areas consisting of few trees, some low-growing shrubs and either natural or burned grasslands (reviewed by Chapman, and Feldhamer 1982). Structural stage 02 (herb) provides optimal foraging and structural stages 01 (non-vegetated/sparse), 03 (shrub/herb) and 3a (low shrub) provide the next best. Structural stages 3b (tall shrub), 04 (pole/sapling) and 05 (young forest) generally provide little feeding habitat with one exception– structural stage 3b in the ESSFmvp4 and SWBmkp1 are usually composed of open, often krummholz forest that provides suitable forage. In winter, structural stages 06 and 07 (mature forest and old-growth forest respectively) provide low-level feeding in the SWBmk and better quality winter feeding in the SWBmks.

Slope

We assume that optimal security habitat is provided by terrain units with surface expressions moderately steep (60-78%) and steep (>78%). Moderate security is provided by terrain units with the surface expression moderate slope (35-60%). No security is provided by slopes less than 36%.

Aspect

Winter ranges are typically on south and west-facing slopes as these have the lowest snow depths (Chilton, 1990). Therefore, cool aspect slopes are down in winter.

Proximity effects

Areas used for feeding must be adjacent to escape terrain. We assume that optimal foraging habitat occurs within 500 m of security habitat.

HABITAT RATINGS

Rating Scheme/Modelling Theme

A 6-class rating scheme is used to rate Stone sheep habitat for food (FD), security (SH) and living (LI) in growing (G) and winter (W).

This model considers only three of many possible life requisites that could be considered for Stone sheep. However, we assume that food, security and living represent the most important and if these are satisfied, other life requisites are also satisfied.

The living rating encompasses all of the requirements necessary for survival and is a function of the spatial arrangement of FD and SH in the landscape.

Food (FD) Habitat Use Assumptions

The ratings table assigns a suitability rating for FD to each ecosystem unit. An ecosystem unit is a combination of site series and structural stage. The relationship between Stone sheep life requisites and the ecosystem attributes are defined by a degrading score relative to the optimal value for the attribute (Table 5.11.2). For example, the optimal structural stage for food (herbaceous) has a degrading score of “0”– no degrading effect. However, a sub-optimal structural stage (such as pole-sapling) has a degrading score of 4, which would result in a maximum rating of 5 on a scale of 1 to 6. By summing the degrading scores over all of the ecosystem attributes, a final rating is calculated. See Section 3.5 and Appendix F for a full description of the methodology used to generate the ratings table.

Polygon Food (FD) Habitat Use Adjustments

Adjustments are used to modify the ratings in order to account for Stone sheep habitat attributes that are not inherent features of the ecosystem unit. There is one adjustment:

- Cool aspects (285-135°) rated down 1for FD in winter.

Security Habitat (SH) Assumptions

Security habitat is rated using the presence of cliffs (ecosystem code CL) and the terrain surface expression codes:

- Polygons classified as cliff (CL) rated 1 SH;
- Slopes greater than 78% (surface expression code “s”) rated 2 SH.
- Moderately steep (“k”, 60-78% slope) rated 4 SH;
- All other slopes rated 6 SH.

Table 5.11.2 Stone sheep food habitat use assumptions. Each number represents a degradation score. A rating for an ecosystem unit is generated by summing the degradation scores over all attributes. See Section 3.5 and Appendix F for a full description of the ratings approach.

Attribute		Value	Degrading Score	
			G_FD	W_FD
1. BEC Unit	EMR	SWBmk	0	-1
		SWBmks	0	-1
		AT	0	-1
	MUF	BWBSmw2	-1	-1
		SWBmk	0	0
		SWBmks	0	0
		AT	0	0
2a. Site Series (SMR)		Xeric	-1	-1
		Subxeric	0	0
		Submesic	0	0
		Mesic	0	0
		Subhygric	0	0
		Hygric	0	0
		Subhydric	-1	-1
		Hydric	-2	-2
2b. Site Series (SNR)		Very poor- poor	0	0
		Medium-very rich	0	0
3. Structural Stage		Sparse/Bryoid (1)	0	0
		Sparse (1a)	0	0
		Bryoid (1b)	0	0
		Forb-dominated (2a)	0	0
		Graminoid dom. (2b)	0	0
		Dwarf shrub (2d)	0	0
		Low shrub (3a)	0	0
		Tall shrub (3b)	-4	-4
		Pole/sapling (4)	-4 (0)[a]	-4 (-1)[a]
		Young forest (5)	-4 (0)[a]	-4 (-1)[a]
		Mature forest (6)	-4 (0)[a]	-4 (-1)[a]
		Old forest (7)	-4 (0)[a]	-4 (-1)[a]
4. Stand Composition		Coniferous (C)	0	0
		Mixed (M)	0	0
		Broadleaf (B)	0	0

[a] Conditional rating: if zone is SWBmks, then down-rating adjustment equals 0.

Living (LI) Habitat Assumptions

The LI rating is a combination of the FD and SH rating and is generated using a GIS algorithm. Since a given habitat can generally only be as good as the most limiting life requisite, LI is calculated as the lower rating between the polygon FD rating and the best SH rating within 500m.

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6.0 WILDLIFE HABITAT MAPS

This section provides brief descriptions to accompany the folded overview map contained in Appendix G. The overview map shows habitat suitability ratings for one season and use for each of the eleven species (Table 6.1). Maps of other seasons and life requisites can be viewed using ArcView 3.0 and the files that are contained on the accompanying CD-ROM (Appendix H).

Table 6.1 (which is a repeat of the table in Section 3.4) lists the rating schemes and map themes for each of the eleven species. The rating scheme refers to suitability ratings that have been calculated for individual seasons and life requisites. The map theme refers to the individual season and life requisite that was selected for the printed maps, since not all seasons and life requisites can be displayed. For all species, these ratings are for seasons and uses that are most limiting. These are the ratings that are displayed on the composite map (Appendix G).

As described in earlier sections, the living rating (LI) is calculated from individual food and security (or security/thermal) ratings for each season. Another rating, called "best seasonal" has also been calculated. This was calculated by selecting the best rating from each of the seasonal living ratings. A map of these ratings therefore shows the highest value of a habitat regardless of when it occurs.

Table 6.1. Rating schemes and map themes for each of the eleven species.

Species	Rating Scheme [a]	Map Theme [a]	Spatially Adjusted?
American marten (MMAAM)	FD-W, SH-W, LI-W	LI-A	No
Grizzly bear (MURAR)	FD-P, FD-S [b], SH-G, LI-P, LI-S, LI-G, Best seasonal living	LI-G	Yes
Black bear (MURAM)	FD-P, FD-S [b], SH-G, LI-P, LI-S, LI-G, Best seasonal living	LI-G	Yes
Moose (MALAL)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W, Best seasonal living	LI-W	Yes
Elk (MCEEL)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W, Best seasonal living	LI-W	Yes
Caribou (MRATA)	FD-W, FD-P, FD-S, Best seasonal food	FD-W	No
Mule deer (MODHH)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W, Best seasonal living	LI-W	Yes
White-tailed deer (MODVI)	FD-G, ST-G, FD-W, ST-W, LI-G, LI-W, Best seasonal living	LI-W	Yes
Bison (MBIBI)	FD-G, W-FD, Best seasonal food	FD-W	No
Stone sheep (MOVDS)	FD-G, FD-W, SH-A, LI-G, LI-W, Best seasonal living	LI-W	Yes
Mountain goat (MORAM)	FD-G, FD-W, SH-A, LI-G, LI-W, Best seasonal living	LI-W	Yes

[a] Seasons: P- spring; S- summer; F- fall; G- growing; W- winter.
Uses: FD- food; SH- security; ST- security/thermal; LI- living.
[b] For grizzly bear, black bear and caribou, "S" includes both summer and fall.

There are several issues that users must be aware of when using the habitat mapping.

1. Highly rated habitats are areas where animals are likely to occur, if they are present in the area. This may or may not correspond to areas with high animal use (areas that are currently occupied). There are many reasons why animals may not occupy suitable habitat:

   - Interspecific competition (an area is already occupied by another species);
   - Annual variability;
   - Predation (high predator densities);
   - Social interactions (social interactions can cause subdominant individuals to inhabit lower quality areas, potentially resulting in even higher animal densities than in higher quality habitat (RIC, 1998a));
   - Disease;
   - Human disturbance; or
   - Factors that determine distribution that are currently unknown.

   Since animal distribution is dynamic, areas that are unoccupied now may become occupied at a future time through natural range expansion, loss of currently occupied habitat or other factors. This is where the strength of habitat mapping lies: by understanding both current distribution and the availability of suitable habitat, predictions about future habitat occupancy can be made.

2. Most of the TEM polygons are complexes of two or three ecosystem units. Since only one of these ecosystems may be of value for a specific season and use, the exact location of an important habitat may be difficult to determine. To determine exact location (sub-polygon accuracy), a site-visit or photo-interpretation using high-quality recent photos is required.

3. The maps represent the state of the terrain and vegetation as it was observed in 1998 (through site visits, air-photos from 1986 and satellite imagery from 1997). Changes to vegetation (through man-made modifications or through natural succession) will continue to have an influence on the distribution and dynamics of wildlife habitat.

4. The mapping is based on models that are applied to the TEM data in a uniform fashion. Point features, such as mineral licks, are not depicted and are therefore not incorporated into the model. Consequently, animals may be found in areas that are otherwise not suitable (e.g., there is no food or security).

Marten

Marten habitat is restricted to the valley bottoms and lower slopes where forest cover is most dense. The generally sparse and open nature of forests in the SWB zone results in low availability of good quality marten habitat. High quality habitat is found in the eastern portion of the study area where the BWBSmw2 fingers into the main valley bottoms. The dense forest in this boreal zone provides good overhead cover for security and snow interception.

The map shows habitat that is suitable for year-round living. However, marten habitat is most limiting in winter and the model is therefore based on winter habitat requirements. Suitable winter habitat also provides suitable habitat in the growing season. When not restricted by snow cover, marten may also be found foraging in areas with low overhead cover, if prey are abundant.

It is assumed that those habitats that provide suitable food and security also provide habitat for denning. However, the availability of den sites can only be determined by site visits.

Grizzly Bear

Grizzly bear habitat use is strongly controlled by food availability. In spring, grizzly habitat occurs at lower elevations in habitats with early green vegetation, such as grasslands and riparian areas. In summer and fall, optimal food is found at higher elevations in grasslands, meadows, avalanche chutes, alpine communities and shrublands. While feeding, grizzlies require security in close proximity. This is provided by shrub and forest cover and by topography that provides concealment (e.g. undulating terrain). Although dense forest provides little food, it is still used as cover for travelling and bedding.

Grizzly bears are generally not abundant in the Study Area relative to others parts of the Province. However, moderate level grizzly bear habitat (the maximum for the Study Area) is found throughout the area.

Black Bear

Black bears are generally associated with forested communities but will utilise a wide variety of habitats including subalpine/alpine meadows, avalanche shrubland, riparian areas and aquatic habitats. The majority of black bear habitat, however, is located along the lower slopes and valley bottoms where forest cover is greatest, especially in the MUF Ecosection.

Moose

Moose are very abundant and widely distributed in the Study Area. There are few areas where moose are not likely to be found, at least during one season. The shrubby nature of the SWB provides abundant browse in both summer and winter. Wetlands in the valley bottoms also provide high quality food year-round. Security is provided by concealing topography and by forest cover, however, moose do not appear to be dependent on forest cover for security in this area. Forest cover does provide thermal protection during periods of extreme cold. Moose habitat is generally not found at the highest elevations as rocky mountain-tops and windswept plateaus provide little food. Deeper snow depths in the EMR Ecosection (the western portion of the Study Area) results in lower habitat suitability than in the MUF.

Elk

Elk are very abundant in the Study Area. The grassy and shrubby nature of the SWB zone provides abundant food. Natural and prescribed burns have also increased the availability of food in recent years. Since snow cover is usually not deep (due to low precipitation and frequent winter chinooks) food is readily available in winter, especially on warm aspects. Elk are often migratory, however, they can be found at almost any elevation in the Study Area in winter. Deeper snow depths in the EMR Ecosection (the western portion of the Study Area) results in generally lower habitat suitability than in the MUF.

Caribou

Caribou habitat selection is largely a function of food availability and predator avoidance. For this project, we have modelled food availability. In the growing season, caribou food is found in upper elevation spruce forests and sub-alpine/alpine areas. In winter, caribou rely heavily on terrestrial lichen and they remain where lower snow depths allow access. In forested areas, highest lichen densities are associated with mature forests as lichen is very slow growing. When snow is deep at low elevations, caribou utilise high elevation, windswept slopes and ridges where terrestrial lichen is exposed.

Caribou habitat use is strongly influenced by predator distribution and density. Habitats that have high security are those with few moose and elk, which are the primary ungulate prey for wolves. To avoid both wolves and their prey, caribou often utilise high elevation habitats (especially important for females during calving) and use dense, continuous forest cover.

Mule deer

Mule deer are broadly adapted and occur in a variety of habitat types. In winter, however, they are primarily associated with mature coniferous forests that provides security and thermal protection. In the Besa/Prophet Study Area, suitable wintering habitat is limited and mule deer densities are generally low to moderate. In the growing season, mule deer also utilise grasslands, meadows, avalanche tracks, clear-cuts, burns, wetlands and riparian habitats for food. Mule deer are generally found in more rugged terrain and at higher elevations in summer than are white-tailed deer.

White-tailed deer

In the Besa/Prophet Study Area, suitable white-tailed deer wintering habitat is limited and as a result, their densities are low. In winter, they migrate to areas of lower snow depth with good thermal protection. Optimal thermal protection is provided by coniferous trees and shrubs with dense canopy cover. This type of habitat is severely limited in the SWB zone. Deep snow and the lack of good forest cover in the EMR Ecosection excludes deer from this area in winter. In the growing season, white-tailed deer are found feeding in grasslands, meadows, avalanche chutes, burns, wetlands, riparian habitats and forest openings. Security, which is provided by trees and shrubs and by concealing terrain, is always nearby.

Bison

Bison are extremely winter hardy and can forage in several feet of loose snow. In the Besa/Prophet Area, suitable winter habitat occurs at all elevations, including both high-elevation subalpine/alpine communities and low-elevation open forests. Bison are not resident in the Besa/Prophet Area, despite the apparent availability of high quality habitat. Bison are resident in the Sikanni River valley, located directly adjacent to the south. These bison have also been reported during summer at the head of the Nevis Creek valley near the boundary of the Study Area.

Stone sheep

Stone sheep are almost always associated with steep or precipitous terrain. This generally occurs at high elevations along ridges and mountain tops. However, steep bluffs and cliffs do exist at low elevations, particularly along rivers, and these can be seen in several areas on the habitat map.

Optimal habitats contain steep rocky slopes and cliffs interspersed with grasslands, meadows or low shrub communities with abundant vegetation. In winter, snow cover limits the availability of forage and Stone sheep select habitats that have less snow, either at lower elevations, on warmer exposures or in wind-blown areas. Most Stone sheep habitat is found in the MUF Ecosection. Deeper snowfalls reduce the availability of food in the EMR Ecosection.

Mountain goat

Mountain goats are almost always associated with steep or precipitous terrain. Their habitat use differs from Stone sheep by their higher use of near-vertical cliffs. Summer feeding areas are at high elevations and may occur wherever food and escape cover are nearby. In winter, deep snow can obscure forage and goats seek out wind-swept ridges, steep cliffs and open forests that have lower snow depths. Similar to Stone sheep, most mountain goat habitat is found in the MUF Ecosection.

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