MACKENZIE:

WILDLIFE INTERPRETATIONS FOR THE KLAWLI MANAGEMENT UNIT NORTH-CENTRAL B.C.

by:
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1.0 INTRODUCTION

The project objectives were to classify, map (at a scale of 1:20,000), and describe the terrestrial ecosystem units (TEM) of the Klawli study area, and to interpret them with respect to their wildlife habitat values. The information is intended to provide a basis for future ecosystem and wildlife habitat management. This report contains the wildlife interpretation portion of the Klawli TEM project for Slocan Group, Mackenzie. Refer to *Terrestrial Ecosystem Mapping for the Klawli Landscape Unit* (Kesting and Teversham, 1999) for vegetation and soil information.

At the inception of this project, the list of wildlife species for which detailed habitat-based interpretations were to be made was comprised of the following nine species: Northern Goshawk (*Accipiter gentilis atricapillus*), Peregrine Falcon (*Falco peregrinus anatum*), Yellow-bellied Flycatcher (*Empidonax flaviventris*), Wolverine (*Gulo gulo luscus*), Lynx (*Lynx canadensis*), Marten (*Martes americana*), Fisher (*Martes pennanti*), Woodland Caribou (*Rangifer tarandus*), and Grizzly Bear (*Ursus arctos horribilis*). However, following further research and discussion, it was concluded that there was insufficiently detailed information on Peregrine Falcon and Yellow-bellied Flycatcher habitat use in North-Central B.C. to permit refinement of these species-habitat models at this time. Consequently, with the agreement of the contract monitor, these species were omitted from further consideration. The initial information compiled for these species is provided in Appendix 1 as it may provide some useful background for other studies. Although effort in the report has concentrated on the project species, a list of wildlife species observed during fieldwork has been included as Appendix 2. Table 1 summarizes the focal species, seasons, and life requisites rated for the Klawli project area.

Table 1: Species, Seasons, and Life Requisites Used for Habitat Ratings and Wildlife Interpretations for the Klawli Study Area – Mackenzie Forest District, B.C.

Species	Season	Life Requisites
Northern Goshawk	All	Food and Security
	Reproductive	Nest Habitat (Security/Thermal)
Lynx	All	Food and Security/Thermal Habitat
Wolverine (blue listed)	Growing	Food and Security Habitat
	Winter	Food and Security/Thermal Habitat
	Reproductive	Den Habitat (Security/Thermal)
Marten	Growing	Food and Security Habitat
	Winter	Food and Security/Thermal Habitat
	Reproductive	Den Habitat (Security/Thermal)
Fisher (blue listed)	Growing	Food and Security Habitat
	Winter	Food and Security/Thermal Habitat
	Reproductive	Den Habitat (Security/Thermal)
Grizzly Bear (blue listed)	Growing	Food and Security/Thermal Habitat
	Winter	Den Habitat (Hibernation)
Woodland Caribou (Wolverine Caribou Herd)	Early Winter	Food
	Spring	Food
	Summer	Food
	Fall	Food

1.1 Klawli Study Area Description

The Klawli study area is shown in Figure 1. The area lies west of Williston Lake, between the Rocky Mountains and the Coast Mountains. The village of Germansen Landing, north of the study area, is the closest settlement. The study area covers approximately 113,103 ha.

The Klawli study area falls within the Mackenzie Forest District. The Fort St. James Forest District borders the study area to the southwest. The study area is bordered to the northeast by the Germansen management unit, roughly along the height of land of the Germansen Range. The Wolverine and Manson management units border the study area on the northwest side, and the Gaffney landscape unit borders the study area on the western side along a mountainous divide. The southern boundary is formed by a mountainous divide that separates the Klawli study area from the Nation River watershed (with the exception of the Sylvester Creek drainage).

The northern portion of the study area is drained by the South Germansen and Manson Rivers. Klawli River (also known as Valleau Creek), Gillis Creek, Moosmoos Creek, and Tsaydaychi Creek drain the central portion of the study area, and Sylvester Creek drains the southeast corner of the area. Klawli and Tsaydaychi Lakes are located in the southwest part of the study area.

1.1.1 Relief

Topographic relief over the entire study area approaches 1000 m and ranges from the heights of Mount Germansen at 1926 m down to Klawli Lake at 997 m. In general, the northern half is higher in elevation than the southern portion and includes most of the high peaks, including Baldy Mountain (1796 m), Blackjack Mountain (1550 m), and Mount Gillis (1850 m). Most of the land that lies below 1200 m occurs within the southern half of the study area. Along the southeastern edge of the study area, Porcupine Mountain and Mount Sylvester rise to 1565 m and 1505 m respectively. Adade Yus Mountain rises to 1905 m along the southwestern border.

1.1.2 Ecological Classification

<u>Ecoregion Classification</u>

According to the Provincial Ecoregion Classification system, the Klawli study area falls within the Omineca Mountains Ecoregion of the Sub-boreal Interior Ecoprovince. Most of the study area falls within the Manson Plateau Ecosection (MAP), a rolling upland that lies south of the higher Omineca Mountains. The northern portion of the study area falls within the Southern Omineca Mountains Ecosection (SOM), which consists of rounded mountains and ridges separated by wide valleys. It has the driest climate in the Ecoregion.

<u>Biogeoclimatic Zone Classification</u>

Within the Biogeoclimatic Ecosystem Classification system (BEC), most of the study area lies in the Engelmann Spruce - Subalpine Fir (ESSF) biogeoclimatic zone, including the parkland areas at high elevation. Alpine Tundra (AT) is found at the highest elevations in the study area. The BWBS zone occurs at the northern end of the Klawli study area, while the Sub-Boreal Spruce (SBS) zone occurs in valleys of the southern part of the study area (Figure 1). The relative areas of each biogeoclimatic unit are shown in Table 2.

For detailed descriptions of the individual BEC zones and their associated ecosystem units, refer to *Terrestrial Ecosystem Mapping – Klawli Study Area* (Kesting and Teversham, 1999).

Table 2: Relative Area by Biogeoclimatic Unit.

Biogeoclimatic Unit	Area (Hectares)	Percentage of total area (%)
AT (Alpine Tundra)	306	0.27
ESSFmvp3 (Parkland)	3,059	2.70
ESSFmv3 (Engelmann Spruce – Subalpine Fir, Moist Very Cold Subzone, Omineca Variant)	100,218	88.57
BWBSdk1 (Boreal White and Black Spruce, Dry Cool Subzone, Stikine Variant)	910	0.80
SBSmk1 (Sub-boreal Spruce, Moist Cool Subzone, Mossvale Variant)	8,610	7.61
Totals	**113,103**	**100%**

INSERT FIGURE 1

Figure 1: Klawli Terrestrial Ecosystem Mapping (TEM) Project Area, North-Central B.C.: Biogeoclimatic Zone Boundaries and TEM Plot Locations (Full, Ground and Visual).

2.0 METHODOLOGY

The following sections describe the methods used in developing wildlife interpretations for the Klawli study area based on Terrestrial Ecosystem Mapping (TEM) completed for the area. Associated limitations are discussed.

2.1 Data Sources and Background Information

Black and white aerial photographs taken in 1994 (approximately 1:17,000 scale) were used to map the Klawli study area. Forest cover maps (1:50,000 scale), produced by the B.C. Ministry of Forests, were provided by Slocan Forest Products. 1:20,000 TRIM (Terrain Resource Information Mapping) data was obtained from Geographic Data B.C. Hugh Hamilton Ltd. modeled slope and aspect from the TRIM database and the resulting maps aided in distinguishing significant slopes and aspects. A fire history map (1:600,000) of the Mackenzie Region was provided by Slocan Forest Products and was useful in understanding the burn history of the study area. Slocan also provided development plans for the delineation of recent cut blocks. The area mapped by the Omineca Biophysical Mapping project (1:50,000 scale) overlapped part of the Klawli study area and provided information on ecosystem distribution in the area. The mapped area covers all or portions of the following 1:20,000 mapsheets: 93N027, 028, 029, 036, 037, 038, 039, 046, 047, 048, 049, 056, 057, 058, 066, 067, and 068.

2.1.1 Provincial Standards

Species-habitat model structure was based on *Standards for Wildlife Habitat Capability and Suitability Ratings in British Columbia* (RIC, 1998). Each species-habitat model is composed of a species account and habitat ratings. Scientific names, common names, and species codes were used as per Cannings and Harcombe (1990). In addition, as per the standards, the project was submitted to the Provincial Correlator (Calvin Tolkamp) for review before finalization.

2.1.2 Species Accounts

Species accounts provide background information on the species biology for the selected species and identify the habitat requirements for each life requisite and associated season of use that has been rated. The species accounts were developed using biological and habitat information published in the literature, personal knowledge, and discussions with species specialists. They were subsequently refined using additional data collected in the field. Local knowledge has also been incorporated into the accounts where applicable.

Information contained in the species accounts was greatly supplemented through personal communications with species specialists, local wildlife biologists, and trappers (see Acknowledgements). A literature review was completed to ensure that up-to-date reports were utilized, and that information applicable to the study area was incorporated.

In addition to published literature and local knowledge, the Conservation Data Centre (CDC) was contacted to request rare element occurrence records (i.e. red and blue-listed species) for the study area and immediate surroundings. This information was requested on both June 1998 and October 1999. The CDC staff spent a total of 0.5 hours searching their databases. No records were present for any rare elements (plant or animal). However, the CDC database is dynamic; records are added or amended on a daily basis and results reflect what was entered at the time of request.

2.1.3 Habitat Ratings

As part of the habitat Capability and Suitability (CAPSU) mapping process, ratings were assigned to each of the ecosystem units (EUs) (or habitats) mapped in the Klawli study area. An EU refers to each row in the ratings table, which consists of a site series and structural stage. A given EU may also contain modifiers for the structural stage and site (site modifiers).

Habitat ratings are values assigned to each ecosystem unit to express the capability[1] or suitability[2] of that unit to support a wildlife species for a particular life requisite and season (RIC, 1998). The ratings relate the habitat requirements described in the species accounts to the relevant ecosystem attributes. They do not take into account proximity of habitats to each other or proximity to landscape features such as lakes and rivers. In addition, they do not take into account non-habitat features, such as road traffic and predation. Site specific detail, such as distance of a polygon from a river, cannot be incorporated into the ratings, but ratings may be adjusted through the use of spatial analysis (GIS) tools such as ArcInfo. Appendix 3 includes a disc with the final habitat ratings tables in Microsoft Excel.

Ecosystem units were individually assessed for their value to each project species, based on the preliminary models, further refined by field observation and data collection. Assumptions about the habitat requirements for each species were developed and used in assigning the ratings.

Structural Stages

As required for capability ratings and mapping, all potential structural stages for each EU were rated, regardless of whether the structural stage occurred in the study area at the time of mapping (RIC, 1998).

For many of the rated structural stages no ecosystem information was available, because the structural stages did not occur within the study area (were not mapped). The Map Count column of the ratings table database indicates the number of times each EU was mapped. A reliability column was also included in the ratings table. Each row was assigned a scale of High, Moderate or Low based on available vegetation information and frequency of occurrence within the mapped area. Ecosystem units that were not mapped for the study area were assigned Low reliability. Units of highest reliability tend to be mesic EUs for which ample plot data was collected.

Site Modifiers

Each modifier was assessed for its influence on a given unit for each species and life requisite rated, in order to determine if the modified EU required a different habitat rating. In most cases, the modifiers do not have a significant influence (i.e. do not alter the life requisite value for that unit). Therefore, the original ratings for the unmodified EU (typical conditions) were applied. In cases where more than one modifier was used for a mapped unit, the combination was also assessed for its influence on the capability and suitability of the habitat. Table 3 lists the mapped modifiers rated for many of the EUs.

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[1] Capability is defined as *"the ability of the habitat, under optimal natural (seral) conditions, to provide the life requisites of a species, irrespective of its current habitat condition"* (RIC, 1998).

[2] Suitability is defined as *"the ability of the habitat, in its current condition, to provide the life requisites of a species"* (RIC, 1998).

Table 3: Ecosystem Site Modifiers Applied to TEM Mapping for the Klawli Project Area.

Modifier		Modifier		Modifier	
a	active floodplain	**k**	cool aspect	**v**	very shallow soils
c	coarse textured soils	**n**	fan	**w**	warm aspect
d	deep soil	**q**	very steep, cool aspect	**x**	drier than typical
g	gully	**r**	ridge	**y**	moister than typical
h	hummocky	**s**	shallow soils	**z**	very steep warm slopes >100%
j	gentle slopes	**t**	terrace		

2.1.4 Wildlife Maps and Digital Map Products

For mapping purposes, a wildlife ratings database was produced using Microsoft Excel 97 software. The ratings were then linked via look-up tables to the ecosystem database in ArcView 3.1 to illustrate wildlife values. The maps were coloured based on the first ecosystem label only, and no further refinements have been attempted at this stage. The primary ecosystem label is generally representative of the dominant vegetation type of the polygon, and therefore provides a good overview of habitat values in the study area.

Wildlife habitat suitability overview maps were produced in ArcView 3.1 for all focal species, seasons and life requisites rated (Figures 2-28). The digital files were submitted to the client for use with their spatial information base (GIS) for in-house map production and applications on an as need basis.

2.2 Fieldwork

Wildlife fieldwork was conducted in conjunction with the ecosystem mapping and bioterrain work during the summer field-sampling program. Detailed field sampling was designed by the project ecologists and wildlife biologists. Within the constraints of the project, every effort was made to cover the full range of EUs present within the study area, and to ensure collection of as much wildlife habitat information as possible.

Fieldwork for the Klawli project was carried out from July 29 to August 12, 1998. The wildlife field crew consisted of Dana Becker, *B.Sc.*, *R.P.Bio.*, and Tania Tripp, *B.Sc*. Ecologists Stephan Kesting, *M.Sc., R.P.Bio*, Jan Teversham, *M.A., R.P.Bio.*, and Ksenia Barton, *M.Sc., R.P.Bio*. conducted vegetation sampling, and Jason Hindson, *B.Sc*., and Pamela Williams, *B.Sc*., provided expertise in geomorphology and soil science. Fieldwork was helicopter-based, because road access into the study area was extremely limited. Full, ground and visual ecosystem verification plot coverage is illustrated in Figure 1.

2.2.1 Data Collected

Provincial Wildlife Habitat Assessment Forms (FS882 (5) HRE 98/5) were completed for all seven project species at the 60 full ecosystem plots and 223 ground inspection plots. Data from full and ground plots were entered in VENUS and GRAVITI (a government developed database management program for TEM and CAPSU projects). Information was exported into Excel to summarize the datasets because the wildlife report function was not operative at the time. Spreadsheets were analyzed in various ways for subsequent use in refining the habitat ratings.

Additional habitat attribute data was collected for this project, including information on wildlife trees and coarse woody debris. Supplementary information was also collected to add further detail on such aspects as arboreal lichen loading and ground lichen availability, which was used to assist habitat interpretations for caribou. For arboreal lichens, crude estimates were made of lichen loading by using abundant, moderate, sparse and nil categories. For ground lichens, although the vegetation forms give percentage cover estimates, there is no indication of depth and biomass, so lichen depths were noted where relevant to give a crude indication of terrestrial lichen biomass. Notes on phenology, additional adjacency information, or any other features of interest were also made.

2.3 Reliability and Data Limitations

For a variety of reasons, many inherent in the habitat mapping process, the habitat ratings table developed for this project should be regarded as a first approximation only. The standards use very broad rating schemes (2, 4 and 6-class) in order to boost the reliability of the assigned ratings (at the cost of precision). Regardless, based on information available for the area of study at this point in time, reliability of the ratings for the study area is probably low to moderate, at best, for most species. Species accounts discuss reliability as it pertains to the individual focal species (see species account Introduction sections).

Factors contributing to the uncertainties that exist are:

- Fieldwork is normally conducted during one visit over a period of time to a given study area. This results in a "snapshot" observation period of the area, usually in the spring or summer. However, ratings for other seasons such as winter are also made, but without the benefit of observing actual field conditions at the appropriate times. Numerous assumptions and educated guesses are thus involved in generating the ratings for other times of the year.
- In the field, habitat ratings for any given unit were often quite variable, reflecting site-specific differences, and possibly individual differences between field biologists. Although we try to control for the latter with regular in-house correlation, inevitably there are some differences in how individuals perceive - and rate - the environment. However, between-site variability cannot readily be controlled for and is especially common for mesic site series. As well, there is often only a single plot for a given unit that leads to the situation where the field results may be atypical. Therefore, the ratings may not truly represent more normal conditions for a given unit. Until there is a substantial database for every plot, structural stage, and modifier combination, these ratings may be misleading. The plot may or may not reflect typical conditions in the area, and more data is therefore needed to have confidence in the current ratings.
- Where seasons of use defined are very broad – as in the "growing season" – habitat values are effectively averaged out through the season, which in reality is often difficult to assess and may lead to under or over-rating of certain units in some situations.
- Winter ratings assume average winter conditions, but values can vary substantially from these during mild or severe winters. This could perhaps be accommodated by adding a number of adjustments to the species models to account for different conditions, but would require a lot of knowledge of local climatic conditions and their influence in the study area.

3.0 RESULTS AND INTERPRETATIONS

For each of the project species, important habitats within the Klawli study area are briefly identified. These summaries were made mainly through reviewing the ArcView map files for the study area by species, season, and life requisite. Some general trends and values stood out, and this section focuses simply on identifying those.

3.1 Habitat Availability

Table 4 summarizes the habitats (EUs) that occurred most frequently within each BEC subzone, based on coverage in hectares, within the Klawli TEM area. Table 4 serves as a reference source for the following focal species discussions. Appendix 4 provides a complete list of EU coverage (habitat availability) within the Klawli area.

3.2 Fieldwork Observations and ArcView Habitat Assessment

This section presents wildlife observations of interest made during fieldwork. Relevant observations on the project species are noted. However, many other species were directly or indirectly recorded during fieldwork, and these are listed in Appendix 2. A summary of wildlife use observed during fieldwork by species or species group is provided in Table 5.

The majority of mammal sign observed (mainly trails, scat and browsed vegetation) belonged to moose and caribou (48%). Deer use in the area was low to absent (less than 1% of recorded mammal observations). A number of well-worn wildlife trails were observed along ridgetops, valley bottoms, rivers, and through low passes between the foothills and adjacent drainages. The trail network is likely a result of frequent use by caribou and moose to travel between seasonal ranges and feeding sites. Carnivores such as bear, fox, and wolf will also use these routes for ease of travel and hunting.

Noteworthy bird observations included Peregrine Falcon and Swainson's Hawk, which are both red-listed for the province of B.C. The majority of bird observations were of grouse, ptarmigan, Gray Jays, and woodpeckers.

Table 4: Habitat Availability in the Klawli TEM Area (most frequently mapped habitat types).

BEC Zone	Map Label, Site Series, and Brief Description	Total Hectares	% of Study Area
AT	FW2b (High elevation grassy crest unit)	104	0.09
	TA (Talus slopes)	90	0.08
ESSFmvp3	FK3a (Fir krummholz)	942	0.83
	FW2b (High elevation grassy crest unit)	520	0.46
	TA (Talus slopes)	496	0.44
ESSFmv3	CS2b (Cottongrass and sphagnum dominated wetland)	2,531	2.24
	FH6 (07) (Moist fir forest with abundant horsetails)	2,202	1.95
	FO6 (04) (Rich, fresh subalpine fir forest with diverse shrubs and herbs)	1,780	1.57
	FR4 (01) (Mesic subalpine fir with abundant rhododendron understorey)	8,915	7.88
	FR5	10,865	9.60
	FR6	18,138	16.03
	FR7	3,940	3.48
	FV6 (00) (High elevation forest on rich, moist sites. Scattered subalpine fir with lush herbs)	3,423	3.03
	LC4 (02) (Dry lodgepole pine – abundant lichens)	11,866	10.49
	LC5	5,140	4.54
	WB3a (Willow, scrub birch and sedge dominated wetland)	3,103	2.74
BWBSdk1	LL4 (02) (Dry lodgepole pine with moss and lichen understorey)	302	0.27
	SS5 (05) (Dry forests dominated by Pl and soopolallie with few lichens)	101	0.09
SBSmk1	BH4 (06) (Pl and scrub birch stands adj. to wetlands)	875	0.77
	BH5	952	0.84
	LC4 (03) (Dry Pl - moss forest with sparse herbs and shrubs)	774	0.68
	LC5	951	0.84
	SB5 (01) (Pl or spruce forests with diverse herbs and shrubs, valley floor locations in the study area).	725	0.64
	SB6	865	0.76
	WB3a (Willow-dominated shrubby unit on floodplains)	605	0.53
TOTAL		**80,205**	**71%**
TOTAL ALL		113,103	100%

Table 5: The Number of Wildlife Use Observations Recorded by Species and Group Name During Fieldwork in the Klawli Project Area, 1998.

Species Name	Number of Observations*
Birds (see Appendix 2 for list)	189
Beaver (*Castor canadensis)*	8
Brown Lemming (*Lemmus sibiricus*)	2
Caribou (*Rangifer tarandus*)	78
Fox (*Vulpes vulpes*)	3
Grey Wolf (*Canis lupus*)	2
Grizzly Bear (*Ursus arctos horribilus*)	13
Hoary Marmot (*Marmota caligata*)	21
Marten (*Martes americana*)	1
Meadow Vole (*Microtus pennsylvanicus*)	8
Moose (*Alces alces*)	203
Mule Deer (*Odocoileus hemionus)*	2
Southern Red-backed Vole (*C. gapperi*)	1
Porcupine (*Erethizon dorsatum)*	20
Red Squirrel (*Tamiasciurus hudsonicus*)	91
River Otter (*Lontra canadensis*)	3
Snowshoe Hare (*Lepus americanus)*	36
Unidentified Small Mammal	64
Unidentified Ungulate Sign	36
Unidentified Bear Sign	17
Unidentified Vole	40
Total Mammal Observations	***649***
Total # of Wildlife Observations Noted	**838**

*Note: Observations can include visual, vocal (i.e. a bird song or call) or sign (tracks, trails, scat, feeding, antlers, dens, burrows, etc.).

3.2.1 Northern Goshawk (Yellow-listed)

Based on review of habitat values within the Klawli study area for Northern Goshawk, the overall suitability of the area is low to moderate throughout the year (Table 6). Mature forested mesic stands are abundant within the SBSmk1 and ESSFmv3, which provide foraging and security habitat throughout the year. Patches of high quality potential nesting habitat are dispersed throughout the ESSF mv3, SBSmk1, and BWBSdk1 subzones (Table 7). ArcView analysis indicated that the highest values are concentrated within the SBSmk1 subzone, along Moosmoos Creek, Klawli Lake, and southwest of Mt. Sylvester; as well as along the Manson and South Germansen Rivers to the north in the BWBSdk1 subzone (Figure 2-4). These areas should be the best within the study area to provide adequate food and security habitat throughout the year.

The subalpine parkland subzone (ESSF mvp3) contains some low food and security habitats, but is limited for potential use by this species. The AT zone has no suitability or capability for use by goshawks, due to the absence of security cover and perching structures (non-forested).

Table 6: Northern Goshawk Habitat Ratings Distribution within the Klawli TEM Area (based on the primary ecosystem unit map labels of 7,606 polygons).

Life Requisite	High	Moderate	Low	Nil
Food Habitat	81	2,523	4,289	713
Security and Thermal Habitat	128	2,096	2,852	2,530
Nesting Habitat	58	1,329	1,682	4,537

Table 7: High and Moderate Rated Ecosystem Units Mapped as the Primary Ecosystem Label for Northern Goshawk Habitat Within the Klawli TEM Area.

	SBSmk1	BWBSdk1	ESSFmv3	ESSFmvp3	AT
Food Habitat (High)	BH6-7, SO6-7, SH6	SC6-7, SM6	FD6, FH6, FO6, FO7, FV6	None	None
Food Habitat (Moderate)	BH4-5, LC5, SB6	SS5-7, SM5-7	FC6, FH5-7, FV6-7, LC5-7, FO5-6, FR5-7	None	None
Security (High)	BH6, SH6, SO6 & 7	SC7, SM6-7, SS6-7	FD6, FO6-7, FV7	None	None
Security (Moderate)	BH5, LC5, SB6, ST5C & M	SM5, SS5, SC6	BT7, FH6-7, FM6, FO5-6, FV6, FR6-7, LC4-5	None	None
Nesting (High)	SH6, SO6-7, ST6C	None	FD6-7, FO6-7	None	None
Nesting (Moderate)	BH6-7, LC6, SB6, SO5, ST5M & C	SC6-7, SM6-7, SS6, SS7	BT7, FH7, FO6, FR6-7, FV6-7, LC5-6	None	None

Note: Table 4 and Appendix 4 list the availability of these units.

All units of highest food, security, thermal, and nesting suitability and capability are listed in the ratings tables in Appendix 3.

According to nesting records from the Mackenzie Forest District goshawks frequently utilize deciduous components within mixed forest stands for nesting (refer to Section 4.4.3). This habitat type is limited within the study area to the spruce and pine-aspen (ST) unit of the SBS and ESSF, the SM unit (coniferous and deciduous forests) of the BWBSdk1subzone. However, mature coniferous forests are present throughout the area, and may provide suitable nesting habitat (Figure 4).

During fieldwork, evidence of Northern Goshawks in the area included a visual of one at plot GS114 and 115, in the ESSFmv3 subzone (Mapsheet 93N058). Apparently, the bird was disturbed by the presence of field crew members, as it “jumped out of a tree in front of them”. The habitat type at the site was map unit Subalpine fir – White mountain heather (FM) structural stage 6 adjacent to FM3b. The bird was probably hunting when it was disturbed.

On July 29, at site GS7 in the ESSF mv3, a crew heard a goshawk juvenile begging call. The bird called four times with short breaks in-between before going silent. The area was assessed as having low to moderate suitability for nesting and foraging for goshawk, with some large pine trees located along the tops of the eskers suitable for nesting. Squirrel middens were present in the immediate area, with large ones in the gullies between eskers. Adjacent mature forest, riparian habitat (coniferous and mixed) would provide plentiful foraging opportunities (hare and grouse were observed). Site GS7 was located adjacent to Manson River near the Baldy Trail, southwest of Blackjack Mountain. (Mapsheet 93N068).

Figure 2. Food Habitat Suitability Ratings throughout the Year for Northern Goshawks in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 3. Security/Thermal Habitat Suitability Ratings throughout the Year for Northern Goshawks in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 4. Nesting Habitat (Security) Suitability Ratings Northern Goshawks in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

3.2.2 Swainson's Hawk (Red-listed)

Although the Swainson's Hawk was not a focal species for the Klawli project, noteworthy observations were made during fieldwork. Swainson's Hawks were not red-listed when fieldwork took place (status as of December 1, 1998).

On August 4, 1998, Tania Tripp and Jan Teversham spotted two Swainson's Hawks at the Northwest boundary of the study area 2 km north of Wudtsi Lake, located in the ESSF parkland variant (mvp3). The field crew was headed down slope from the top of an un-named mountain (1500 m elevation; Approx. UTM Coordinates = 6147000 N 382500 E) to a group of small lakes at 1200 m elevation. The surrounding habitat included open subalpine meadows interspersed with patches of subalpine fir trees. Some potential nest trees, >20 cm diameter at breast height (dbh) were noted downslope of plot GJ102. Small mammal sign was abundant in the meadows.

The pair was seen hovering and calling overhead. Both hawks had a completely dark colouration with no visible markings. The birds were also heard calling repeatedly for approximately 10 minutes, and stopped calling then started up again when the crew moved further downslope. Territorial behaviour was noted.

On August 7, 1998, Tania Tripp and Stephen Kesting observed what appeared to be another dark phase Swainson's Hawk at a different location (plot VS136). The site that the adult bird was first spotted in was a stand of Lodgepole pine-Cladina (mesic 02 site series of the ESSF) adjacent to a complex of wetlands. As soon as the helicopter took off, the bird started to call in an agitated pitch from the top of a pine tree. It appeared that the field crew had interrupted its lunch (a freshly killed, still warm, red-backed vole). The bird continued to call for 10-15 minutes, flying around above the crew and landing repeatedly on the same pine tree (near the vole). Suitable nesting habitat (mature forest, trees >20 cm dbh) was noted in the area. At plot VS144, two juvenile raptors started calling in return to the adult hawk (calling consisted of a juvenile begging call). They were calling from an adjacent forest stand (200-500 m away), and joined the initial one in flight above the field crew. At one point the adult hawk flew low (<15 feet) over the crew's heads (VS148 mature pine stand). These observations are indicative of a nesting territory. High meadow vole sign was noted in the area.

The above records were submitted to Syd Cannings (Senior Ornithologist at the MELP, Wildlife Branch in Victoria) for review. It is highly probable that the birds observed were Swainson's Hawks, because nesting records exist to the north in the Yukon and Alaska (Syd Cannings pers. comm.). Although Swainson's Hawks are associated with grassland habitat, the open alpine and parkland meadows may mimic grassland attributes, especially during small mammal population irruptions (Syd Cannings pers. comm.).

According to distribution maps in Fraser *et al.* (1999), there have been no breeding records to date in North-Central B.C. However, there is a recognized gap in the provincial knowledge base for raptor records, habitat use, and ecology for the area of study and surroundings. Inventory at these sites may confirm nesting by this species in the study area.

3.2.3 Peregrine Falcon (Red-listed)

The Peregrine Falcon subspecies (*Falco peregrinus anatum*) that occurs in the Mackenzie area is red-listed for the province. According to distribution maps in Fraser *et al.* (1999), the Mackenzie area is part of the former breeding range for this subspecies in B.C.

During fieldwork in the Klawli TEM area, an adult peregrine falcon was seen hunting marmots and other small mammals along a high elevation cirque in the ESSF parkland (mvp3) near plot GK174 (see Photo 1). It was also seen hunting along the flat parkland meadows (FW2b unit). The site was located on the Adade Yus Mountain range north of Klawdetelle Creek (southwest corner of Klawli study area). The area was one of the few within the Klawli TEM area that contained suitable nesting habitat (cliffs) for this species. During a flight over the Mt. Gillis area, nesting potential for peregrines was also noted, due to the presence of well-formed, extensive cliffs. Overall, the Klawli area contains little to no nesting habitat for peregrines other than at the above mentioned locations.

Photo 1. Adade Yus Mountain Range Area (photo taken from plot GK181, looking up at GK174).

3.2.4 Small Mammals

Overall, small mammals were observed to be abundant in the area, with especially high numbers of voles and lemmings at some sites. During discussion with small mammal specialist Dave Nagorsen, it was suggested that a population eruption might have occurred during our year of fieldwork. Small mammal observations (voles, lemmings, squirrels, marmots, and unidentified), made up 40% of all recorded mammal observations (see Table 5). It is hard to assess whether small mammal populations are always abundant in the area or whether it was an unusual year (eruption), because no previous small mammal population estimates or inventory have occurred within the Klawli or adjacent management units.

In contrast with other small mammals, snowshoe hare numbers were assessed as low for the sites surveyed. Snowshoe hare are believed to currently be at the low end of their population cycle, in addition to already occurring in low numbers in the area (Jim Tuck and Dennis Jones, pers. comm.). Of the 649 mammal observations recorded at full and ground ecosystem plots (not recorded for visuals), 36 observations from 27 sites were of snowshoe hare (5%). In the SBSmk1 hare sign was noted in young pine stands (stage 3b to 5), while in the BWBSdk1 hare pellets were noted in a SC6 floodplain forest unit. In the ESSFmv3 hare sign was noticed most frequently within the mesic FR map unit stages 4 and 5 (young mixed pine and fir stands). Sign (fecal pellets, bedding sites, and browsed vegetation) was also present in the mature FH7, FM6, FV7, and FO6 and 7 units. Throughout the ESSFmv3, where most hare use was observed, it was noted that rhododendron shrubs were the favoured forage species for hare (heavily browsed at 45-degree angle with pellets around the base of the shrubs). Browse was also noted on Sitka valerian, twisted stalk, willows, and young pine bark. In theory, units associated with rhododendron and units noted as of high food quality to hares should be of highest value for lynx within the area.

Hoary marmots were observed and heard around most of the high elevation survey sites (e.g. Mt. Gillis, Mt. Germansen, and Mt. Adade Yus). All marmot sign seen occurred in the ESSFmv3 and parkland subzones. The EUs (habitat types) that they were utilizing in the mv3 subzone included CFw3a (warm, vegetated talus slopes), CS2b, FW2b, TC2b, WB3b; use of parkland units included CFk3a, FV3b, FW2b, and MH2d. As marmots are thought to be an important prey item for wolverines during the growing season, especially for adult females with kits (Eric Lofroth, pers. comm.), these units were rated up to high for food.

Hoary marmot and brown lemming location records were provided to Dave Nagorsen at the Royal B.C. Museum, because records for the southwestern portion of the Williston Reservoir watershed did not exist in the museum's database. This information is important for production of accurate provincial distribution maps (Dave Nagorsen pers. comm.).

3.2.5 Lynx

No direct observations of lynx or evidence of use were noted during fieldwork. However lynx are elusive, and their sign is hard to detect (e.g. scat is often buried). In addition, lynx numbers are low in the Klawli area, which is likely a result of the current low snowshoe hare numbers in the area (Dennis Jones, Jim Tuck, pers. comm.). The best time of the year to detect lynx use of an area is during the winter through snow-tracking surveys.

Although no use was observed, lynx are expected to utilize habitats within the Klawli TEM area. Review of habitat suitability indicated moderate values for food and security, available extensively throughout the area, except for the AT and parkland (see Table 8). Moderate habitat consists predominately of FR 4 and 5 and LC4 units (Table 9).

A concentration of high quality habitats occurs in the centre of the study area, south of Baldy Mountain (Figures 5 and 6). The main habitat type is Lodgepole pine-Crowberry-Cladina (LC) stage 5. LC5 is abundant throughout the ESSFmv3 subzone (Table 4). The assessment assumes prey availability in these units, which will vary from year to year resulting in increased and decreased food habitat values. In actuality, values are likely much lower than illustrated, based on low snowshoe hare populations in the area.

Additional habitats of high quality are available at the southern end, around Klawli Lake, Gillis Creek, South Germansen River, and Tsaydaychi Lake (Figures 5 and 6).

Table 8: Habitat Ratings Distribution within the Klawli TEM Study Area (based on the primary ecosystem unit map labels of 7,606 polygons).

Life Requisite	High	Moderate	Low	Nil
Food Habitat - All Year	206	4,575	2,242	583
Security and Thermal Habitat - All Year	346	3,698	2,381	1,178

Table 9: High Rated Ecosystem Units Mapped as the Primary Label for Lynx Habitat within the Klawli TEM Area.

	SBSmk1	BWBSdk1	ESSFmv3	ESSFmvp3	AT
Food Habitat (High)	None	None	LC5, SO6, ST5M	None	None
Security (High)	BH5-7, SH6, SO6-7	SC6-7	FV7, LC5	None	None

Note: Table 4 and Appendix 4 for list the availability of these units.

Appendix 3 provides the ratings tables that contain all units of highest food, security and thermal suitability and capability within the Klawli area.

Figure 5. Food Habitat Suitability Ratings for Lynx throughout the Year in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 6. Security/Thermal Habitat Suitability Ratings for Lynx throughout the Year in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

3.2.6 Wolverine (Blue-listed)

As expected no wolverines were seen during TEM fieldwork in the Klawli. Wolverines are rarely seen, because they avoid humans and human habitated areas. No evidence of use was noted at any of the survey plots or during transects between plots. As with lynx, detection of wolverines in the area would be most probable during the winter, when their tracks are left in the snow.

Although not detected during fieldwork, the Klawli TEM area is considered to provide optimal habitat for wolverines, because many of the watersheds are intact and little human use occurs in the area (Photo 2). High elevation habitats with intact large areas for foraging and movement are available in the Klawli area. To date, human use within the Klawli area has been limited, with some forest harvesting in the southernmost section of the study area. A single historical recreational trail runs through the study area from Baldy Mountain south towards Mt. Sylvester and north towards the Manson River.

Lofroth *et al.* (1999) are currently using radio-telemetry to determine home range sizes, habitat use, and behaviour of wolverines in North-Central B.C. Using radiotelemetry, researchers have followed the movements of a number of wolverines, a few of which have travelled in and out of the Klawli study area (Eric Lofroth pers. comm.). One of the wolverines was a sub-adult female, which was tracked over a long distance from the south end of Mt. Gillis, to the northwestern portion of the Klawli TEM area by Mt. Germansen and Lake (Eric Lofroth pers. comm.). At this time, there is only one wolverine, a sub-adult male, being tracked by radiotelemetry in the Klawli area. This individual was captured north of Germansen Landing in November of 1998. It stayed in that area until June of 1999, at which time it moved south into to the Klawli TEM area (Tsaydaychi and Klawli Lake area) (Eric Lofroth pers. comm.).

Photo 2. Mount Germansen area near plot VS34 and ES35.

ArcView habitat availability analysis indicates that overall food habitat quality during the growing season (spring, summer, and fall) is low (Figure 7). Moderate and high quality food habitats are present, dispersed throughout the area. The concentration of high and moderate foraging habitat are located along the river and creek valleys, as well as in the upper elevation subalpine, where prey numbers are often concentrated.

Hoary marmots in the parkland subzone are of high value to adult female wolverines for food during the growing season (Eric Lofroth pers. comm.). Units where marmots are most likely to occur have been rated up to high for food requisites of wolverines (see Section 3.2.4).

During the late spring, summer, and fall months there are a number of other food sources in the area including ground nesting birds such as grouse and ptarmigan, small to mid-sized mammals including: snowshoe hare, red-backed voles, shrews, mice, and lemmings. All of the above mentioned food sources were observed during fieldwork, with high evidence of use by red-backed voles, hoary marmots, and lemmings.

Moose are the most common ungulates that occur in the area throughout the year, with highest concentrations in the southern section of the study area in the SBS and BWBS where Moosmoos Meadows and Creek are located. Other ungulates that use the area are caribou, mainly during the early winter, but also during the summer months. Wolverine in the area may utilize these food sources either through direct kills or as carrion (wolf kills).

Food habitat quality during the winter appears to be low to moderate throughout the Klawli TEM area (Table 10, Figure 8). As appropriate, the units where caribou are known to occur during the early winter have been rated moderate for food suitability in the winter for wolverines. Other prey species are also present in these areas. Table 11 lists the units of high quality presently mapped and illustrated in Figures 7 to 11.

Clustered high quality winter food depicted in the southeastern corner of the study area would probably not be used due to the nearby human disturbance (non-habitat features). In order to depict food habitat (i.e. areas where wolverines will feed), proximity of food to human disturbance would need to be assessed.

At present, moderate to high quality security habitat during the spring, summer and fall occurs throughout the study area (Figure 9). Concentrations of high quality security and thermal habitat are present around Mt. Germansen, Mt. Gillis, Baldy Mountain, Porcupine Mountain, Mt. Adade Yus, and Klawli Lake. These areas are likely valuable to adult female wolverines throughout the year for all life requisites. Moderate and high winter security and thermal habitat is also present in these areas during the winter (Figure 10).

Denning (reproductive) habitat for adult females appears to be limiting throughout most of the Klawli study area, restricted to higher elevation habitat. Potential denning habitat rated high was noted in the Mt. Germansen area. The Mt. Gillis, Porcupine Mountain, Mt. Germansen, Baldy Mountain, and Mt. Adade Yus areas are expected to contain some moderate to high denning habitat (Figure 11).

Table 10: Wolverine Habitat Ratings Distributions within the Klawli TEM Study Area (based on the primary ecosystem unit map labels of 7,606 polygons).

Life Requisite	High	Moderate	Low	Nil
Food Habitat - Growing Season	155	1,599	5,660	192
Security/Thermal Habitat – Growing	491	5,217	890	1,008
Food Habitat - Winter	122	1,996	4,545	943
Security/Thermal Habitat - Winter	255	4,000	1,662	1,689
Reproductive/Denning Habitat	57	619	2,229	4,701

Table 11: High Rated Ecosystem Units Mapped as the Primary Label for Wolverine Habitat within the Klawli TEM Area.

	SBSMK1	BWBSdk1	ESSFmv3	ESSFmvp3	AT
Food - Growing Season (High)	None	SC7	FD6-7, FO6-7, FV7, TAw1	CFw3a, ROw1, TAw1	TAw1
Food – Winter (High)	None	None	FD6-7, FO6-7, FV7	None	None
Security/Thermal Winter (High)	SO6-7	SM6-7	FH6-7, FV6-7	None	None
Reproductive-Denning (High)	None	None	FH7, FD7, FM7, FV7	FV6	None

Note: Table 4 and Appendix 4 list the availability of these units.

Appendix 3 provides the complete ratings tables which contain all units of highest food, security, thermal, and reproductive (denning) suitability and capability within the Klawli area.

Figure 7. Food Habitat Suitability Ratings for Wolverines during the Growing Season in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 8. Food Habitat Suitability Ratings for Wolverines during the Winter in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 9. Security Habitat Suitability Ratings for Wolverines during the Growing Season in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 10. Security/Thermal Habitat Suitability Ratings for Wolverines during the Winter in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 11. Den Habitat (Security/Thermal) Suitability Ratings for Wolverine during the Reproductive Season in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

3.2.7 Martens

Martens are expected to occur throughout the Klawli TEM study area. Martens have been actively trapped in the area for many years because they are common in the area (Dennis Jones pers. comm.). Sign of marten use during TEM fieldwork was positively identified at one site. It consisted of an observation of scat on top of a log near GJ135 in the ESSFmv3, map unit FC structural stage 6. The summer season is not ideal for detection of martens. As with other fur-bearers, snow tracking in the winter is one of the best methods for habitat use detection.

Overall suitability of the area according to current habitat availability appears to be low to moderate. The parkland and tundra units are rated of nil to low quality for the life requisites of martens (Table 12). Although low to moderate overall, there is still an abundant amount of moderate to high food and security and thermal habitat throughout the Klawli area (Figures 12-16).

Moderate winter food habitat is distributed throughout the area in clustered patches of moderate and high rated polygons (i.e. south of Moosmoos Creek, Manson River, South Germansen River, and Klawli Lake) (Figure 13). Squirrels and voles, prime prey items, are present in moderate to high numbers within the ESSFmv3, SBSmk1, and BWBSdk1.

Security and thermal habitat are also available extensively, with concentrated moderate and high values around Mt. Germansen, Baldy Mountain, Manson River, Mt. Gillis, Klawli Lake, and the majority of the southern portion of the study area (south of Moosmoos Creek) (Figure 14).

The limiting life requisite for use of the area by martens is denning habitat for birthing (Table 12). Lodgepole pine is the dominant tree species in the area, which is known to be of no value for denning. In addition, units with spruce and subalpine fir tend to have small diameters <30 cm dbh within the area. Also adding to low denning habitat quality is the lack of large, deciduous trees such as aspen, birch, and cottonwood. Units rated highest for reproductive habitat were those which would occur in the best growing sites, and have the largest diameter trees. These units consisted of old forest usually located along riparian zones or lakes such as site series FO and FV stages 6 and 7 in the ESSFmv3 (Figure 16). For information on denning requirements, refer to the species account for martens, section 7.4.3.

Table 12: Marten Habitat Ratings Distributions within the Klawli TEM Study Area (based on the primary ecosystem unit map labels of 7,606 polygons).

Life Requisite	High	Moderate	Low	Nil
Food Habitat - Growing Season	362	2,786	3,034	1,424
Security/Thermal Habitat – Growing	350	1,824	3,465	1,967
Food Habitat - Winter	138	1,402	2,929	3,137
Security/Thermal Habitat - Winter	125	1,442	2,867	3,172
Denning Habitat for Birthing	103	469	1,801	5,233

A number of the same ecosystem units are of high quality for all marten life requisites (Table 13). The largest expanses of high potential habitat include units FD, FH, FO, and FV stage 6 and 7 forested stands in the ESSFmv3. However, habitat within the SBS and BWBS are generally considered of higher quality due to the presence of deciduous components.

Table 13: High Rated Ecosystem Units Mapped as the Primary Label for Marten Habitat within the Klawli TEM Study Area.

	SBSMK1	BWBSdk1	ESSFmv3	ESSFmvp3	AT
Food - Growing Season (High)	SH6, SO6, ST5M	SC7, SM6-7, SS6-7	FD6-7, FH6-7, FM6-7, FO6-7, FV7, ST5M	None	None
Food - Winter (High)	SH6, SO6	SC7, SM6-7, SS6-7	FD6-7, FH6-7, FO6, FR6, FV6	None	None
Growing Security/Thermal (High)	BH6-7, SH6, SO6	SC7, SM6-7, SS6-7	FD6, FH6-7, FM6-7, FO6-7, FV7	None	None
Winter Security Thermal (High)	SH6, SO6-7	SC7, SM6-7, SS7	FD6-7, FH7, FO6-7, FR6, FV6-7	None	None
Reproductive Security (High)	BH6-7, SH6, SO6-7	None	FD6-7, FH6-7, FO7, FV7	None	None

Note: Table 4 and Appendix 4 list the availability of these units.

Appendix 3 provides the full ratings tables which contain all units of highest food, security, thermal, and reproductive (denning) suitability and capability within the Klawli area.

Figure 12. Food Habitat Suitability Ratings for Martens during the Growing Season in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 13. Food Habitat Suitability Ratings for Martens during the Winter in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 14. Security Habitat Suitability Ratings for Martens during the Growing Season in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 15. Security/Thermal Habitat Suitability Ratings for Martens during the Winter in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 16. Den Habitat (Security/Thermal) Suitability Ratings for Martens during the Reproductive Season in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

3.2.8 Fisher (Blue-listed)

Fisher numbers in the study area are thought to be low (Rich Weir and Dennis Jones pers. comm.). No fisher sign was recorded during the fieldwork (refer to Section 8.2.2 for potential distribution of fishers in the area of study).

Wildlife suitability maps for fishers indicate that food, security, thermal, and reproduction habitats are all limiting for this species within the Klawli area. Low values for all fisher life requisites predominate (Table 14) (Figures 17-21). The best potential habitat for fisher use in the area is located in the SBSmk1 subzone (Figure 1), which extends from Klawli Lake east along Moosmoos Creek and north towards the Squawfish Plateau area; as well as the BWBSdk1 habitat in the north along South Germansen and Manson Rivers. Habitats of highest quality in the area are listed in Table 15 (refer to the ratings tables in Appendix 3 for all units of highest food, security, thermal, and reproduction (denning) suitability and capability within the Klawli area).

Table 14: Fisher Habitat Ratings Distributions within the Klawli TEM Area (based on primary ecosystem unit map labels of 7,606 polygons).

Life Requisite	High	Moderate	Low	Nil
Food Habitat - Growing Season	49	768	5,497	1,292
Security/Thermal Habitat – Growing	49	880	5,160	1,517
Food Habitat - Winter	41	611	3,992	2,962
Security/Thermal Habitat – Winter	46	606	4,303	2,651
Denning Habitat for Birthing	None	29	1,350	6,227

Probably the most significant limiting factor to fisher use in the Klawli area is the lack of suitable reproductive habitat (>80% of polygons are rated of nil suitability), because this species has fairly exacting requirements for specific habitat features (Section 8.4.3). It is unlikely that habitat within the Klawli area will ever have greater than a low capability for fishers. High capability habitat is located in adjacent landscape units, where large cottonwoods are present (Rich Weir pers. comm.).

Table 15: High Rated Ecosystem Units Mapped as the Primary Label for Fisher Habitat within the Klawli TEM Area.

	SBSMK1	BWBSdk1	ESSFmv3	ESSFmvp3	AT
Food - Growing Season (High)	SH6, SO6-7	SC7, SS7	FH6-7, ST5M	None	None
Winter Food (High)	SH6, SO6-7	SC7, SS7	FHn7	None	None
Growing Security/Thermal (Moderate)	SH6, SO6-7	SC7, SS7	FH6-7, ST5M	None	None
Winter Security Thermal (High)	SH6, SO6-7	SC7, SS7	FHn7	None	None
Reproductive Security (High)	None	None	None	None	None

Note: Table 4 and Appendix 4 list the availability of these units.

Figure 17. Food Habitat Suitability Ratings during the Growing Season for Fishers in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 18. Food Habitat Suitability Ratings during the Winter for Fishers in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 19. Security Habitat Suitability Ratings during the Growing Season for Fishers in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 20. Security/Thermal Habitat Suitability Ratings for Fishers during the Winter in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 21. Den Habitat (Security/Thermal) Suitability Ratings for Fishers during the Reproductive Season in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

3.2.9 Grizzly Bear (Blue-listed)

Grizzly bears in the study area are believed to occur in low numbers. For grizzly bears, essential requirements that are likely to be the most limiting features in the study area are appropriate hibernating habitats and early green up spring food habitats. Security habitat for grizzlies (other than in relation to hibernating) while important, especially for females with cubs, is generally unlikely to be a limiting factor for grizzly bear use of an area or habitat type. Habitat use is generally dictated by food availability.

Present land use (harvesting, habitat fragmentation, road construction) is minimal throughout, which is optimal for grizzly bears (see species account Section 9.1 & 9.6.4). Human related mortality (hunting and poaching) and disturbance through human recreation are also expected to be minimal in the Klawli TEM area, due to the low development and human access.

Food habitat availability of moderate to moderately high quality for grizzly bears are clustered around Mt. Germansen, Baldy Mountain, Mt. Gillis, and Klawli Lake (Figure 22). Overall, food habitat within the Klawli TEM area is Low to Moderate. Early spring foraging habitat is likely limiting near denning sites (upper elevations), but lower elevations in the study area will provide suitable spring forage. Summer food is unlikely to be limiting in the area, because large areas of moderate summer food habitats are widely distributed. In the late summer and fall, the soopolallie units in the LC unit in the ESSFmv3 should provide soopolallie berries and crowberries. Other berry producing units that are important during the late summer and fall for grizzly bear forage include: SBS unit SB (01 site series, Spruce-Black huckleberry), and BWBS unit SS (05 site series, Spruce and Pine-Soopolallie).

Wildlife maps indicate that Moderate to moderately high quality security habitat is abundant across the study area (Figure 23). Table 17 summarizes the ecosystem units of highest potential for grizzly bear use in the Klawli area (refer to the ratings table in Appendix 3 for all units of highest food, security, thermal, and den suitability and capability within the Klawli area).

Den habitat availability is limiting within the Klawli area, with overall low to very low values (Figure 24). Isolated patches of moderate rated polygons occur, but there are few moderately high and no high quality sites based on primary ecosystem label analysis (Table 16). These results may be somewhat misleading, because there are likely many microsites within polygons that have higher potential than reflected in the values. It is expected that overall denning potential within the ESSFmvp3 parkland is moderate to moderately high, while the ESSFmv3 is low to moderate for the Klawli area. For this project, we have assumed that the low elevation BWBS and SBS units would be generally unsuitable for bear denning. Unfortunately, denning suitability is difficult to rate at the ecosystem level, because dens are often associated with microsite attributes. Research on habitat requirements for denning by bears in the area is required in order to increase the reliability of the ratings. In future, data gathered from the ongoing Parsnip Grizzly Research Project will aid in further refinement of the ratings.

Table 16: Grizzly Bear Habitat Ratings Distributions within the Klawli TEM Study Area (based on the primary ecosystem unit map labels of 7,606 polygons).

Life Requisite	High (1)	Moderately High (2)	Moderate (3)	Low (4)	Very Low (5)	Nil (6)
Food Habitat - Growing Season	19	1,364	911	3,333	1,832	147
Security/Thermal Habitat – Growing	None	1,929	3,954	698	813	212
Denning Habitat for Hibernation	None	3	139	2,059	2,406	2,999

Table 17: High Rated Ecosystem Units Mapped as the Primary Label for Grizzly Bear Habitat within the Klawli TEM Area.

Life Requisite	SBSmk1	BWBSdk1	ESSFmv3	ESSFmvp3	AT
Food Habitat - Growing Season (Rated 1 or 2)	SO5-7, SH6, ST5C, TC2b, WB3a-3b	CS2b, SC6-7, SS5, WF3b	BS3a, CS2b, FC6, FD3, FD6, FH7, FO6-7, FV6-7, SF2b, TC2b, VG2a, WB3a	FV3b, FW2b, VG2a	No 1 or 2 rated habitat
Security/Thermal Habitat – Growing (Rated 1 and 2)	Plentiful	Plentiful	Plentiful	Plentiful	Plentiful
Denning Habitat (Rated 1, 2 or 3)	None	None	LCw5-6, FRk4, FRg4, FV7, LCsw5	None based on primary label	None

Note: Table 4 and Appendix 4 list the availability of these units.

Little evidence of bear use was observed during fieldwork (5% of mammal obs. recorded at survey plots were of bear use). Occasional tracks were noted, but overall there were few confirmed observations of grizzly bear activity. Most bear sign, including wildlife trails, some feeding sign and scat, could not identified to species. Identified grizzly scats were observed at a few sites, but in general, evidence of use was quite low.

The highest concentration of grizzly sign observed during fieldwork was concentrated in an FH structural stage 7 forest stand (plot GS188) in the ESSFmv3 subzone (Photo 3). Over 30 old and 30 fresh piles of scat were counted. At the same site, two bedding areas were present, one large and one small impression in the horsetails. Feeding on horsetails was evident (sow and cub). In the adjacent ES189 plot within a moist oak fern, subalpine fir forest (FO) stage 6, fireweed had been browsed and scat was also present.

In the SBSmk1 (ES182), throughout a SM2b unit (hummocky, pine-sphagnum bog) chunks of moss were dug up around the bases of young Pl where moss mounds were present. It was apparent that a bear had been feeding on grubs (Photo 4).

At plot VS150 near a small un-named lake, foraging sign and large bear scats were noted (Photo 5). Adjacent to the wetland, a well-worn ridge trial with large overturned logs and rocks (Photo 6).

Photo 3. Overview of the wetland and forest habitat of concentrated use by grizzly bear sow and cub.

Photo 4. Bear feeding sign in wetland unit.

Photo 5. Wetland complex - bear use observed in the form of foraging and scat near plot VS150.

Photo 6. Wildlife path – use of ridges for travel (near plot VS150).

Figure 22. Food Habitat Suitability Ratings for Grizzly Bears During the Growing Season (Spring, Summer, and Fall) in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 23. Security Habitat Suitability Ratings for Grizzly Bears During the Growing Season (Spring, Summer, and Fall) in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 24. Den Habitat Suitability Ratings for Grizzly Bears in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

3.2.10 Woodland Caribou (Blue-listed)

The Wolverine Caribou Herd (WCH) inhabit the Klawli TEM area during the summer and early winter months (see species account Figures 29 and 30). During the rest of the year, they inhabit the core of their home range in the adjacent Germansen and Wolverine landscape units. Reproduction (birthing) was not rated for in this project because, with few exceptions, female caribou of the WCH give birth outside of the study area (refer to Section 10.2.2 & 10.3.4).

Within the study area (Klawli), travel corridors for summer and early winter access have been recognized, but not all migration routes are known (M. Wood pers. comm.). Some of the known routes include the South Germansen River corridor and the Gillis and Boulder Creek area. During early winter survey flights by Wood (1998) of the Wolverine Caribou Herd, they appeared to follow the river corridors closely of the South Germansen and Manson Rivers, and Gillis and Boulder Creeks (M. Wood pers. comm.). Alpine ridges are also used by caribou for travel and provide excellent visibility of approaching predators.

In contrast to the summer, the Klawli area receives high use by the WCH during the early winter, because the area contains valuable feeding grounds (mainly the Squawfish Plateau). Their repeated use of the area appears to be related to a few factors, one of which is the predominance of dry pine-lichen stands throughout the landscape. The area also consists of meadows and stream complexes, which are considered to be of importance for early winter feeding (Mari Wood pers. comm.).

Habitat ratings analysis, based on the primary ecosystem label, indicates that the majority of the Klawli TEM area is of low to very low quality for caribou food habitat (Table 18). However, there are still a high number of polygons rated Moderate and higher for the early winter (25% of polygons), summer (33%), and fall (21%). During the late winter, the Klawli area is of little to no value for caribou food habitat requirements due to deep snowpacks. Some EUs in the subalpine and alpine areas are assumed to be windblown allowing food access, but are a small percentage of the Klawli area (see Table 1). It is important to note that Table 18 is a summary by count, not area. Table 19 lists the habitat types of moderate to high quality for caribou food, and Table 4 indicates which of these units are most abundant (by area). Appendix 4 provides a complete summary of all mapped units and their area of coverage.

At present there are no ecosystem units, mapped as the primary ecosystem label, that have been assigned a rating of high (1) for food during the early spring or summer. Figure 26 illustrates the availability of early spring food habitat for caribou, which is low overall. The results are supported by the absence of caribou from the area during the spring. This is probably due to deep snowpacks and late spring green-up throughout the ESSFmv3 and SBSmk1 subzones in the area. Some warm aspect units may have decent food values, but as a whole, the area does not appear to be suitable for caribou during the early spring. See Table 19 for habitat rated the highest for the early spring season. Summer food values are higher than in the spring (Figure 27). During the fall, food habitat ratings closely parallel early winter values (Figure 28) (Table 19). The main difference in habitat use between the fall and early winter is that in the fall many sedges and grasses are still accessible. Terrestrial lichens are more heavily utilized during the early winter when other forage species are unavailable.

Figure 25 illustrates the availability of early winter food habitat in the Klawli area. Moderate to high quality food habitat ratings closely overlap with observations of early winter caribou use in the area by Terry and Wood (1999). Green dashed lines indicate the approximate boundary of the area in which the WCH have been observed through radio telemetry during the early winter (also see species account Figure 30).

Table 18: Caribou Habitat Ratings Distributions within the Klawli TEM Study Area (based on the primary ecosystem unit map labels of 7,606 polygons).

Life Requisite	High	Moderately High	Moderate	Low	Very Low	Nil
Food – Early Winter	84	642	1,206	945	4,448	281
Food – Early Spring	None	1	666	4,855	1,923	161
Food – Summer	None	766	1,771	4,607	302	160
Food - Fall	68	332	1,230	2,149	3,666	161

Table 19: High Rated Ecosystem Units Mapped as the Primary Label for Woodland Caribou Food Habitat within the Klawli TEM Area.

Life Requisite	SBSmk1	BWBSdk1	ESSFmv3	ESSFmvp3	AT
Early Winter Food Habitat - Rated 1 or 2	LC4-5	None	LCx5, LCx6, LC5-6, LCx4	None	None
Spring Food Habitat – Rated 2 or 3	LC5, SH6, SO5, SO7, ST4M, ST5M	BC5, CS2b, SM5-7	ST4B (one poly), FD4,6,7, FHn7, Foa5, LCx5, SB2c, SF2b, ST3B-4M-5M	TC2b, WB3a, MH2d, VG2a	FWw2b (one polygon)
Summer Food Habitat – Rated 2	LC5, SF2b, TC2b	CS2b, WF3b	CS2b, FD6-7, FH7, Foa5, SF2b, TC2b	TC2b, FW2b, VG2a	FW2b
Fall Food Habitat – Rated 1 or 2	Same as for Winter				

Note: Table 4 and Appendix 4 list the availability of these units.

As expected, during TEM fieldwork in the Klawli study area high caribou use at a number of sites and traverses was noted, especially in the Lodgepole pine-Crowberry-Cladina (LC) units of the ESSFmv3 and SBSmk1. The primary evidence of use consisted of numerous pellets and trails in dry pine forests of structural stage 4 and 5.

The Squawfish Plateau and Lake areas were observed to have the highest caribou use in the Klawli TEM area, with cratering, well-traveled trails, and winter pellets in abundance (Photos 7 and 8) (Table 20).

Single caribou were observed on two occasions during helicopter flights into the study area. Both were located in the higher elevation ESSF parkland and alpine, one near Mt. Gillis and another near Mt. Adade Yus. Caribou antlers were also observed, mainly in upper elevation parkland and AT areas.

Summary notes for Mt. Gillis recorded that the upper elevation AT and parkland had a high amount of caribou use – high scat, tracks, and trials. Antlers were also present near the top of Mt. Gillis, as well as in a FW2b unit. Numerous caribou scat were present along ridges (growing and winter season use).

Photo 7. Squawfish Plateau area, plot VJ262 showing heavy use by caribou for early winter feeding (terrestrial lichen cratering).

Photo 8. One of many well-used early winter caribou trails through the Squawfish Plateau area (near plot VJ262).

Table 20: Evidence of Caribou Use Recorded for the Klawli TEM Study Area.

Location Area	Ecosystem Plots	Comments
South Germansen River	ES19, GS20, VS22	BWBSdk1 subzone – Stage 4 dry pine-lichen with Bl regen. Caribou trails used during migration were noted. Winter pellets were noted at GS20.
	GJ11	Adult winter pellets (3 piles) noted in Pl-lichen stand.
Baldy Mountain	GJ16, GJ19, GJ22, VJ18	GJ19 and 22 low use trails through the CS2b cottongrass-moss fen and FC3. GJ16, travel and scat.
Mt. Germansen		Caribou use in the Mt. Germansen area was assessed as moderate to high during growing and winter seasons. Numerous tracks were present around lakes in the area, for access to water and possibly minerals. Excellent lichen growth was seen at Mt. Germansen, with average depths of 4 cm and some patches up to 7 cm. Caribou trails with light use evident were present along the Mtn. and along and down the ridges to glacial formed lakes. Winter and growing season scat were both numerous.
	GS32, VS34	Caribou winter pellets located on Mt. Germansen – good ridge travel, good lichen in some areas. Between plots noted high caribou habitat, excellent, thick ground lichen – trails, tracks (growing and winter pellets).
	ES39	Near ES39 caribou bones were located in a small rock outcrop along a creek. Caribou use, scat and travel sign along creeks was evident in the Mt. Germansen area.
	ES41	Wetland with wildlife trail, caribou growing season scat and tracks in the wetland patch (summer use).
	VS46, VS47	Winter pellets, excellent wildlife trail (well used). Same polygon pine-cladina stand stage 3b-5 mix with amazing Cladina patches, very deep >8 cm in some areas.
	Between GS49 and VS51	Very high number of winter and summer pellets (counted >15 piles over 200 m). Very high cover and food availability, moderate arboreal lichen as well. Adjacent creek, wetlands and lake. Can see where the caribou have eaten lichens (cratering).
	Between VS56 and VS57	Excellent carpets of lichen were present in the Pl 4 and 5 stand (average thickness of 6 cm), caribou pellets present. High cratering evidence at many sites.
	GS32	AT, FKw3a, trails across slope, growing season scat.
	ES31	AT, FW2b, grassy tundra on mountain top, winter pellets seen frequently.
	GS43 and 44	Pretty fresh tracks through wetland and plot <1 month old; caribou travel through this crummy short brushy forest (FM3b). Summer scat also present. GS44, SF2b, travelling through wetland to lake, at least 2-3 sets of recent tracks in the mud.
South of Mt. Germansen (93N056)	ES82 and VS84 plots noted	Browse on Arnica, it also looks like cratering occurs for lichens up here (mvp3, FKw3a upper krummholz). Trails along and across slope seen from the helicopter as left site, greater use lower down slope 100-200m.
Tsaydaychi Lake area	VK87	Caribou scat near open water patch surrounded by mature mesic forest. Low quality area for caribou. VK95 low for caribou all year, at best = 3 in early winter.
	GJ89, VJ93, GJ95, GJ85, VJ90, VJ92	GJ89, ESSFmv3, BS3a, skull and antlers located. Old wildlife trail present. Some old sign of feeding. GJ85, LC5, two piles of spring and summer scat, indistinct trail. GJ95 sign of old pellets in LC5 stand.

Table 20 (Con'td): Evidence of Caribou Use Recorded for the Klawli TEM Study Area.

Location Area	Ecosystem Plots	Comments
~3 km northeast of Klawli Lake, near Moosmoos Creek	GJ139, VJ140, GJ148, VJ143, VJ220, GJ223	GJ139, FR3, pellets and browsed lichen. VJ220 in the SBSmk1 had multiple tracks through the area (old trails), and some pellet groups (Mod #). GJ223 in the SBSmk1, LC5, winter scat at top of a slope. GJ148 had summer scat present within the STw3b.
Moosmoos Creek	GJ237	SBSmk1, LC4, sign of feeding, travelling and scat.
	GK204, GK207, GK208	GK204, SBSmk1, LC3b, sign of feeding on lichens. Heavy lichen disturbance as well as many trails (migratory route?) were noted at site GK207 in an LC5 stand.
Mt. Gillis	lat 55 28' 83'' long 124 21' 05"	On August 2, one adult caribou was spotted from the helicopter, southeast of Mt. Gillis, outside of the study area'
	GJ120, VJ122, VJ127	Excellent ridge travel noted. High caribou sign throughout the area. Upslope of VJ127 spotted high caribou sign.
	EJ121, VJ122	Travel paths moderate in the area, rich herbaceous meadows (VG2a), parkland habitat. Fresh tracks and growing season scat also present.
	EJ126, VJ127	Well-used rubbing tree site observed, with many small dead trees.
Adade Yus Mtn. Range (southwestern TEM boundary)	VK176, VK179, GK181, VK183, VK189	Caribou tracks through the cottongrass unit (2b). Caribou antlers located on rocky, talus slope (edge-upper slope of cirque) VK176. VK179 passed by caribou tracks and old spring or summer scat. GK181, high use by caribou, can see any approaching dangers; good grazing when snow is absent or shallow. Can access upper elevation for windswept lichen meadows. Trails throughout, old tracks, and scat. Heavy ungulate browse on fireweed and sitka valerian along a creek bed. VK183, FM, FV, and FK mix, good lichen loading. Between plots, noted 2 summer and 2 winter scat piles along a dry pine-clad slope. VK189 wetland well used by caribou, recent small and med-sized tracks present. Aircall spotted caribou antlers near krummholz by ridgetop of a cirque.
	GJ186, VJ185	Using avalanche track between alpine and swamps for travel (parkland, FV3b).
	GK188	Summer and winter scat in FR5 stand.
	GK181, 182	ESSFmv3, FWy2b, a number of well-worn trails were present as well as early spring or late spring scat. Heavy browse on willow (see photo), and moderate browse on triangle-leaved groundsel. No moose sign was noted in the area.
	GK174	Winter use evident through presence of a moderate amount of winter pellets.
	GS156 and GS158 (visual)	Single caribou spotted by Pamela and Stephan running along a ridgetop. Very distinct trails present along slope where animal was spotted.
	VS167, VS168	Antlers located at VS167.
Squawfish Lake Area	EJ60, EJ61, VJ59	Trail along bog, pine-lichen site.
	EJ51, VJ52, VJ53	ESSFmv3, EJ51, dry pine lichen site adjacent to meadow with sign of feeding and travel present summer and early winter use.
North of Squawfish Lake	GS142	Old wildlife trail through the pine-lichen stand (LC4).

Table 20 (cont'd): Evidence of Caribou Use Recorded for the Klawli TEM Study Area.

Location Area	Ecosystem Plots	Comments
Squawfish Plateau	VJ262, VJ263, VJ264	The area is a mixture of (transition zone) between SBSdk1 and ESSFmv3. VJ262, caribou winter pellets along Pl-Clad edge and sedge wetland. Single lane, well-used trail along a forest and wetland interface (see Photo 7 and 8). Excellent lichen on ground (4-6 cm deep), some sparse grass present. Adjacent grazing access when no to low snow pack. Good browse during summer. Massive cratering in same polygon (VJ262), and winter pellets high. Squawfish lake is approximately 6.0 km east of this area. Number one site seen during fieldwork for early winter feeding habitat use. Carex spp. also eaten (available in adjacent wetlands), adjacent dry grassy large meadows as well. VJ264, very hummocky, lichen abundant on raised area in centre (dry patch) winter pellets present.
	GJ264	Trails along wetland edge going through Pl-Clad stands (highway of trails visible from the air). Very high number of pellets along trails and throughout the Pl-Clad forest stands. Narrow trails approx. 1to 1.5 feet wide. Cratering seen throughout the area, as well as pellets (very concentrated use!). LC4 in the SBSmk1, old trail system, quite extensive and extremely well used. Moderate to high feeding sign. Many pellet groups.
	VJ270	VS270 (moved by heli to new area) well-worn caribou trail with plentiful scat. Well-used caribou trail.
	GJ271, VJ272	GJ271 in the SBSmk1 subzone, caribou antlers in a dry grass-herb meadow (TC2b) by river.
	GJ258, VJ259	Winter pellets.

Figure 25. Food Habitat Suitability Ratings During the Early Winter (Nov 1 to Dec 30) for Woodland Caribou in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 26. Food Habitat Potential for Woodland Caribou during the Early Spring in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 27. Food Habitat Suitability Ratings for Woodland Caribou During the Summer (June 16 to Sep 15) in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

Figure 28. Food Habitat Suitability Ratings for Woodland Caribou During the Fall/Rut (Sep 16 to Oct 30) in the Klawli Terrestrial Ecosystem Mapping Project Area, North-Central B.C.

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SPECIES-HABITAT MODELS

4.0 SPECIES - HABITAT MODEL FOR NORTHERN GOSHAWK

Common Name:	**Northern Goshawk ssp. *atricapillus***
Scientific Name:	*Accipiter gentilis atricapillus*
Species Code:	B-NOGO
B.C. Status:	Yellow listed
Identified Wildlife Status:	Yes (B.C. MELP, 1997)
COSEWIC Status:	Examined in 1995 and determined to be Not at Risk in Canada (COSEWIC, 1997)

4.1 Introduction

The Northern Goshawk is currently included as an Identified Wildlife Species in the *Identified Wildlife Management Strategy* (1997) for the *Forest Practices Code of British Columbia* (B.C. MELP, 1997), due to its association with older forest habitats. This species is considered to require special management precautions to prevent it from becoming threatened.

Northern Goshawk habitat ecology and diet have been well researched for most of British Columbia and North America. However, habitat use and inventory studies in central and northern B.C. are limited, in part due to limited access and remoteness. No studies have occurred within the Mackenzie Forest District, in which the Klawli study area is located. The closest inventory project was located in Ft. Nelson and Smithers. Regional information has been included in the species account as well as relevant literature from other parts of B.C. and western North America wherever applicable.

Although the broad habitat rating scheme (4-class) affords a broad margin for increased reliability, at this time, general habitat ratings for the Northern Goshawk are predicted to have a low to moderate reliability. This is because no model verification has been done to confirm habitat use within the study area and habitat information is limited in this part of the province.

4.2 Distribution

Goshawks occur throughout the Northern Hemisphere Temperate Zone from Siberia through Northern Asia and into Europe from Scandinavia to the Mediterranean (Peterson, 1990; Beier, 1997). The North American populations, consisting of three subspecies (*A. g. atricapillus*, *A. g. langi* and *A. g. apache*), breed from Alaska across Canada and the northern United States including New England, and northern Michigan, Wisconsin, and Minnesota and south along the western mountain ranges into Mexico (Beier, 1997). The Northern Goshawk (*A. g. atricapillus*) is the most widespread of the three North American subspecies, with *A. g. langi* occupying coastal areas and islands of the Pacific Northwest and *A. g. apache* in the southern U.S.A. and into Mexico (Johnsgard, 1990).

4.2.1 Provincial Range

Two subspecies of the goshawk occur in British Columbia. This species account focuses on the habits of the *Accipiter gentilis atricapillus* subspecies, because this is the subspecies found within the Mackenzie region (Northern Goshawk). The *Accipiter gentilis langi* subspecies, commonly called the Queen Charlotte Goshawk, occurs on Vancouver Island and the Queen Charlotte Islands. It is Red listed within B.C. (B.C. MELP, 1996; B.C. Conservation Data Centre (CDC), 1997), and is considered vulnerable in Canada by COSEWIC (1997).

The *A. g. atricapillus* subspecies occurs throughout the mainland and is not currently considered at risk in B.C. (Yellow-listed) (B.C. Ministry of Environment, 1995). Northern Goshawks are found in all forested mainland ecosections in British Columbia (B.C. MELP, 1997) preferring coniferous and deciduous forests, especially in mountainous areas, and forest edges. The Northern Goshawk occurs in all biogeoclimatic zones within B.C., with the exception of the Alpine Tundra (AT) zone (Tripp, 1996; B.C. MELP, 1997).

Within the Mackenzie Forest District, in which the Klawli study area is located, there have been six separate nesting territories located over the last four years through field crews of local forest companies (Table 4). This is a moderate to high number of records to obtain solely based on incidental observations. To date no goshawk specific inventory programs have occurred within the Mackenzie FD.

The Mugaha Banding Station located near Mackenzie monitors bird occurrences and numbers in the area, including Northern Goshawk. The observation records are during the migratory and post-breeding dispersal season, when the banding station is active. Dates of goshawk records (all single bird observations) include: Sept 19 and 28 (1996), July 29 (1997), August 25 and September 16 and 17 (1998), and Sept 1 (1999) (Vi Lambie pers. comm.).

4.2.2 Potential Study Area Distribution

The Northern Goshawk is expected to occur within all of the ecoregions, ecosections, and biogeoclimatic zones found within the Klawli study area or North-Central B.C. (Mackenzie Forest District), except within the AT zone. The non-forested upper elevations of the ESSF zone (parkland variant) may be used for hunting during fall dispersal, but likely receive limited use. Expected goshawk occurrence by subzone and variant is summarized in Table 21.

Table 21: Expected Northern Goshawk Occurrence within the 5 Ecosection - BEC Variant Combinations Found Within the Klawli Study Area, Mackenzie Forest District.

Ecoprovince	Ecoregions	Ecosections	BEC Variants	Expected Occurrence
Sub-Boreal Interior	Omineca Mountains	Manson Plateau (MAP)	AT	x
			ESSFmv3	•?
			ESSFmvp3	?
			SBSmk1	•
		Southern Omineca Mountains (SOM)	BWBSdk1	•

Legend: • = occurs in the variant; •? = probably occurs in the variant; ? = unlikely to occur in the variant; x = essentially absent

4.2.3 Elevational Range

Northern Goshawks will use areas with forest cover from the valley bottoms to the upper slopes of the ESSF where adequate forest cover is available. Nesting sites located within the area of the province in which the Klawli is located (i.e. Mackenzie Forest District) have occurred at relatively low elevations (under 3000 ft/900 m) (Jim Tuck pers. comm.). As the Klawli TEM area contains predominately upper elevation habitat (ESSF parkland and ESSFmv3), this may be a limiting factor for goshawk use of the area. In general, the northern half of the study area is higher in elevation than the southern portion and includes most of the high peaks, including Baldy Mountain (1796 m), Blackjack Mountain (1550 m), and Mount Gillis

(1850 m). Most of the land that lies below 1200 m occurs within the southern half of the study area, where nesting habitat is likely more suitable.

4.3 Ecology and Habitat Requirements

Northern Goshawks are generally associated with mature and oldgrowth forests for nesting and postfledgling security habitat requirements (Towry, 1984; Russell *et al.,* 1994). These forests also provide the structural diversity used by prey species such as red squirrels (*Tamiasciurus hudsonicus*) and other small mammals. While hunting, the goshawk is a habitat generalist using a diversity of forest types (Reynolds *et al.,* 1992).

Although Northern Goshawk populations are considered non-migratory, winter habitat use is not well documented and little is known about winter foraging patterns. Northern Goshawks are known to respond to reduced prey availability in the winter by moving southward, or into lower elevations (Tripp, 1996; Reynolds, 1992).

4.4 Habitat Use (Life Requisites and Seasons)

Little is known about winter food availability and possible migration during the winter months within Northern B.C. Therefore, it would be of low reliability to differentiate between growing and winter season habitat values. As a result, habitat use was based on an all year suitability rating for providing food, security, and thermal requisites. Since there is more available literature on security habitat requirements for nesting, the reproductive season was rated separately. Rated life requisites are described in detail in the following sections.

Table 22: Summary of Rated Life Requisites and Seasons for Northern Goshawk in the Klawli Study Area.

Rated Life Requisites and Seasons	Code	Months of Use
All year - Food Habitat All year - Security and Thermal Habitat	A_FD A_ST	All
Reproducing (eggs) - Security habitat for nesting	RE_SH	April to September

4.4.1 Food Habitat

The Northern Goshawk is one of three main species of forest hawks in B.C. (the Accipiters – Sharp-shinned Hawk, Cooper's Hawk and Northern Goshawk). The shape of their wings and tail enable highly skilled manoeuvring between trees in pursuit of prey. As goshawks are adapted to foraging in forested habitats, habitat selection may be influenced more by prey availability (as determined by vegetation structure) than by prey abundance (Beier and Drennan, 1997; Reynolds *et al.,* 1992).

Variation among the diets of goshawks between areas and between seasons of use has been observed (Reynolds *et al.*, 1992). Their diets appear to reflect the abundance and availability of birds and mammals in different study areas (Reynolds *et al.*, 1992). Various studies have shown that they prey on small- to medium-sized birds and mammals. Diets have been found to include birds such as American Crow, Varied Thrush, grouse, woodpecker, sapsucker, Steller's Jay, Gray Jay, ptarmigan, Northern Flicker and mammals including hares, squirrels, and chipmunks (Doyle and Smith, 1994; Johnsgard, 1990; Reynolds *et al.*, 1992). Prey items are usually associated with mature and oldgrowth forests or forest edges (Beier and Drennan, 1997; Reynolds *et al.*, 1992).

In central and northern B.C., snowshoe hare and grouse are likely the key prey utilized (Bennett *et al.*, 1998). Doyle and Smith (1994) found that goshawks in the Southwest Yukon had greater breeding success as hare populations increased, and declined when the hare population crashed following the 10-year cycle. The response of goshawks in the more restrictive climate and habitat of the north to prey cycling is likely more dramatic than in the southern regions where alternate food sources are available year round.

In the Mackenzie Forest District, key prey items observed include Northern Flicker, Three-toed Woodpecker, Red Squirrel and grouse. Snowshoe hare are not as abundant in this part of the province as in neighbouring areas such as the Peace River, which is likely why little evidence of hare kills have been noted (Jim Tuck pers. comm.). In the Kispiox FD study, red squirrel were the main prey of goshawks early in the breeding season, switching to birds (primarily jays, thrushes and woodpeckers) during the post-fledgling period (Doyle and Mahon, 1997).

Food sources are an important influence of use in a habitat, area or region (Beier, 1997). Goshawks have been shown to select foraging sites with higher canopy closure, greater tree density, and greater density of trees > 40.6 cm dbh (Beier, 1997; Beier and Drennan, 1997). Goshawks are also opportunistic hunters and thus utilize habitats accordingly (Reynolds *et al.,* 1992). If necessary, goshawks will forage over large areas to obtain food. Studies from the states have shown that foraging areas are approximately 800 to 970 ha in size (Russell *et al.,* 1994), and encompass the nesting and post-fledgling areas. Nesting ranges can encompass up to 2,400 hectares, consisting of a nest area, post fledgling family area and foraging areas (Reynolds *et al.,* 1992). Other home range studies from the states are provided in Table 23.

Table 23: Estimates of Mean Home Rang Size Among Northern Goshawk Studies in North America (Adapted from Reynolds, 1983 and Reynolds *et al.*, 1992).

Location	Mean Size (Ha*)	Source
Alaska	4,142	McGowan, 1975
California, E	900	Hargis *et al.*, 1994
California, N	3,100	Austin, 1993
Colorado	2,463	Reynolds, 1983
Minnesota	1,979	Eng and Gullion, 1962
New Mexico	1,146	Kennedy, 1990
Oregon	2,750	Reynolds *et al.*, 1978

* 1 Ha = 2.471 acres

4.4.2 Security and Thermal Habitat

In general, goshawks avoid large openings, possibly avoiding predation from Great Horned Owls and others. Security habitat consists of forested habitat with open understorey for ease of flight, perching branches located below the main canopy (usually the first set of live branches). A deciduous forest component may provide additional security by adding visual cover from predators during nesting and resting during the spring and summer months.

Thermal and security habitats are closely linked and overlap in habitat use and requirements (multi-storied forests with canopy coverage). During winter Northern Goshawks are under greater thermal and hunting stress; temperatures are low, most avian prey have migrated, and most mammalian prey hibernate or are using subnivean habitat (Beier and Drennan, 1997; Reynolds *et al.*, 1992). Within the Klawli study area, thermal stress would be highest during the winter months, because temperatures become very cold and snow is present throughout the winter. In theory, forests with higher canopy coverage would provide the best thermal protection from the elements. However, where forest canopies are too dense, as with young stands, they will not be available for shelter due to difficulty in flying within dense stands.

4.4.3 Nesting Habitat (Security)

Nest areas are used from March until September for courtship, breeding, nesting, and fledging. Breeding and brood-rearing season extends from April to September. Clutches of 3-4 eggs are laid in early to mid-April and incubated for 30-32 days. Chicks fledge at approximately 35-45 days of age. After fledging chicks will stay near the nest for 30-50 days and remain dependent upon parents for food up to 80 days after fledging (Campbell *et al.*, 1990; Crocker-Bedford, D. C. 1990; Johnsgard, 1990; Tripp, 1996).

Goshawks require mature forest canopy cover with low density of shrub growth in the understorey for nesting. Nest areas are usually located in stands of large old trees with dense canopy cover (approximately 30 acres) contain two to four alternate nests (Reynolds *et al.,* 1992). The topography and vegetative structure of nest sites are relatively consistent (Hayward and Escano, 1989) allowing for specific management of forested habitat to meet the requirements of the goshawk (Lilieholm *et al.,* 1993). Nesting density appears to be closely associated with open understories and dense overstories (Crocker-Bedford, 1990) with water and large forest openings within approximately 1 km and nest sites tend to be on gently sloping (less than 60%) northerly aspects (Hayward and Escano, 1989; Tripp, 1996). Forest type and productivity will influence the canopy density and the tree age of nest sites selected (Russell et. al. 1994).

Within the Mackenzie Forest District, a few active Northern Goshawk nests have been located (Table 24). Most of the nests have been located in deciduous trees, mainly aspen and birch. A commonality between all records is the use of a fork-like structure in the tree as support for the stick nest. Although most nests located to date have been found in deciduous trees, the forest stands in which the trees were located were all coniferous dominant – mature, mixed stands (Jim Tuck pers. comm. and Christie Butt pers. comm.).

Table 24: Northern Goshawk Nesting Records within the Mackenzie Forest District.

Location/ Record	BEC Zone	Stand Description	Tree Species	Tree Size cm dbh	Year(s) Active
Gagnon Creek Jim Tuck (MELP)	SBS wk2	Mature mixed	Birch	approx. 30	1997, 1998
Ospika River Jim Tuck (MELP)	SBS mk2	Mature mixed	Spruce	40-50cm	1996, 1997
Manson Creek Jim Tuck (MELP)	BWBS dk1	Mature mixed	Aspen	approx. 30	1999
Westin Creek Christie Butt Donahue FP Ltd.	SBS mk2	Mature mixed	Aspen	20-30cm	1999
Chunamon Christie Butt	SBS mk2	Mature mixed	Aspen	20-30cm	1999

In Fort Nelson B.C., adjacent to the north-east of the Mackenzie Forest District, Bennett *et al.* (1998) inventoried 110 stick nests in the forest district, the majority of which (77.8%) were located in mature or old deciduous stands. The majority of stick nests located in deciduous trees occurred in trembling aspen (average dbh 42.3 cm). White spruce was the next most common tree species for stick nests, and averaged 5-20% canopy cover – very open stands. A limited number of stick nests were also located in balsam fir, balsam poplar, lodgepole pine, and paper birch. The canopy of all tree species averaged 45% closure (ranging 20-70%), while the shrub layer (woody vegetation <10 m in height) was also dense at the nest sites averaging 49% (range 10-85%) (Bennett *et al.*, 1998). None of the stick nests surveyed were active, and therefore some may have belonged to other species (i.e. ravens and red-tailed hawk). However, goshawk nests are often easily differentiated from typical raven or red-tailed hawk nests in that they are below the main canopy and the structure is usually of different shape and construction (Jim Tuck pers. comm.). One factor, which may have skewed the results towards nest detection in deciduous habitat, was the ease of visibility in deciduous forests versus coniferous stands, especially during aerial surveys.

In the Kispiox Forest District of B.C., most nest areas were located in mesic, age class 8 or 9 hemlock dominated forest, with moderate to high crown closure and sparse herb and shrub development in the understorey (Doyle and Mahon, 1997). Of the 23 nests located, within 12 nesting areas, 20 were in western hemlock and three were built in amabilis fir (Doyle and Mahon, 1997). These findings are quite different than observations from the Mackenzie FD and Fort Nelson survey, where deciduous trees are predominately used for nesting. This contrast is to be expected based on the very different habitat types present in the Kispiox FD (i.e. ICH and CWH biogeoclimatic zones).

The post fledging-family areas (PFA) range from 120 to 240+ acres surrounding the nest area used by the goshawk family for hiding cover, and prey species used for learning hunting skills (Reynolds *et al.,* 1992). The PFA may include a variety of forest types and conditions with patches of dense trees, a developed herbaceous and/or shrubby understorey, and attributes important for prey species including, snags, downed logs, small openings (Reynolds *et al.,* 1992, Russell *et al.,* 1994). Research in the Kispiox Forest District observed that juvenile goshawks stayed within 400 m of the nest for a 4-6 week period after fledging (Doyle and Mahon, 1997).

4.4.4 Seasons of Use

Northern Goshawks are active throughout the year and a few likely over winter in the Mackenzie area. However, goshawks within the Mackenzie Forest District likely migrate south where prey is more abundant during the winter months. Goshawks have been seen around Mackenzie during the winter where they have been seen taking advantage of bird feeder locations as hunting posts, but winter sightings are rare (pers. comm. Jim Tuck). Table 25 summarizes the rated life requisites for the Northern Goshawk for each month of the year.

Table 25: Monthly Life Requisites for the Northern Goshawk in the Klawli Study Area.

Month	Season*	Rated Life Requisites
January	Winter	food and security/thermal
February	Winter	food and security/thermal
March	Winter	food and security/thermal
April	Winter	food and security/thermal Nesting - security
May	Growing	food and security Nest security (Reproducing)
June	Growing	food and security Nest security (Reproducing)
July	Growing	food and security Nest security (Reproducing)
August	Growing	food and security Nest security (Reproducing)
September	Growing	food and security Nest security (Reproducing)
October	Growing	food and security
November	Winter	food and security/thermal
December	Winter	food and security/thermal

*Seasons defined for the Sub-Boreal Interior Ecoprovince per the Chart of Seasons by Ecoprovince (RIC, 1998; Appendix B).

4.5 Ecosystem Attributes

A number of relationships between habitat use and ecosystem attributes can be determined for goshawks based on current literature and local knowledge. Often the habitats used most frequently are associated with specific stand structure such as mature stands for security cover during reproduction, tree species (deciduous trees for nest foundation), and aspect (often warm aspect sites). Table 26 lists which ecosystem attributes are considered in the habitat ratings tables.

Table 26: Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Northern Goshawk.

Life Requisite	Ecosystem Attribute
Food	site: elevation, structural stage, site disturbance vegetation: open understorey other: abundant CWD, available snags and perches, water and small openings for hunting, interspersion of habitat types for prey species.
Security and Thermal	site: elevation, structural stage vegetation: % cover by layer, species list by layer, canopy cover mensuration: tree species, dbh, height structural stage: stage 4-7, mainly mature forest
Reproducing by Eggs (Nest Security)	site: elevation, >30 acres, <60% slope, water and small openings w/in 1 km vegetation: % cover by layer, species list by layer, tree species, open understorey mensuration: dbh, height structural stage: 6-7, some potential in stage 5 for some units other: abundant CWD, available snags and perches

4.6 Development of the Habitat Ratings

Habitat ratings were developed through collection of habitat data within the study area over a two-week period, supported by personal communications with local biologists, and species experts, and supplemented with a current literature review.

4.6.1 Rating Scheme

A 4-class rating scheme of high (H), moderate (M), low (L) and nil (N) is employed, as suggested by RIC (1998) for use with the Northern Goshawk at the 1:20,000 map scale. This rating scheme requires an intermediate knowledge of habitat use and is defined in Table 27.

Table 27: Habitat Capability and Suitability 4-Class Rating Scheme (from RIC, 1998)

% of Provincial	Rating	Code
100% - 76%	High	H
75% - 26%	Moderate	M
25% - 1%	Low	L
0%	Nil	N

This rating scheme is used when assigning habitat ratings to the ecosystem units present within the Klawli study area. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for the Northern Goshawk as previously outlined in Table 25.

4.6.2 Provincial Benchmark

A provincial standard (best in B.C.) has not been identified for the Northern Goshawk at the present time. Northern Goshawks are distributed throughout forested habitat of mainland British Columbia (Campbell *et al.*, 1990). In theory, goshawks would be most abundant where prey was easily accessible throughout the year and mature and old-growth forest was available for nesting and security cover. To date, there have been few studies to determine goshawk distribution and population size in B.C. Studies that have been completed or are underway have focused on presence/not detected and habitat use. A Northern Goshawk study in the Kispiox Forest District, northwestern B.C., estimated the population density in the district to be 1.5 pairs per 100 km^2 (Doyle and Mahon, 1997).

4.6.3 Ratings Assumptions

The assumptions for the seasonal habitat requirements for the Northern Goshawk were refined during the 1998 field season. Further study is needed to validate and refine these ratings. The following assumptions have been made:

Life Requisite and Season	Assumption(s)
Food Habitat All Year FD_A	**Structural Stages** • Young seral stages (1, 2 and 3a) provide some hunting opportunities where mature forests are located adjacent to them for security and hunting perches. • Structural stage 3b and 4 are of the least value to goshawks for hunting because the regeneration is too dense for flight. • Mature and old successional stage forests (stages 5 to 7) associated with open understorey, abundant CWD, and perch availability (large branches in the understorey and snags), have the highest suitability for foraging habitat. **Site** • Forested units with small openings for hunting, units adjacent to wetlands and meadows for hunting along edge habitat with forest for cover. **Biogeoclimatic Zones** • The SBS, BWBS and ESSFmv3 zones have higher quality food habitat than the ESSFmvp3 subzone because of the presence of forested units and favoured prey base such as hare, squirrels, grouse, and passerines. • The AT zone is of Nil suitability for foraging habitat due to the lack of security cover (absence of trees).
Security and Thermal Habitat All Year ST_A	**Structural Stages** • Structural stages 1 to 3 provide no security or thermal habitat values. • Some 3b stunted forests – bog and open forest units or krummholz – provide tree patches for perching (i.e. unit BS 3b in the ESSFmv3 stunted black spruce), but are not rated above low suitability. • Some forested site series of structural stages 4 and 5 provide low to moderate potential security habitat during foraging or travelling. • Forest units with closed canopies and open understories were rated highest for providing security/thermal requisites. These sites are usually of structural stage 6 and 7 (stage 7 being the oldest stands).
Nest Security Habitat for Reproducing SH_RE	**Structural Stages** • Structural stages 2, 3, and 4 have nil suitability for nesting requirements. • Structural stage 5 stands can provide up to moderate nest habitat quality for some units, but in general are of low suitability. • Structural stages 6 and 7 were assumed to offer the highest quality habitat for goshawk nest sites because these forests offer security habitat and contain the structural diversity required by prey species. **Tree Size** • Trees greater than 20 cm dbh. **Site** • Nesting habitat availability and forage accessible to nest site limit goshawk use in any given study area. • Moist sites with better growing conditions are rated higher for STRE (e.g. riparian and floodplain forested units).

4.6.4 Rating Adjustment Considerations

Ratings adjustment considerations for Northern Goshawk habitat use include polygon size (small size downrated), landscape unit contexts, and adjacency to rivers and lakes (e.g. polygons located further than 5 km from these features rated lower, with the assumption that closer is better). A spatial analysis, using GIS software such as ArcInfo, could help to more accurately select the areas of highest quality based on ratings adjustments for the above mentioned landscape features.

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5.0 SPECIES – HABITAT MODEL FOR LYNX

Common Name:	**Lynx**
Scientific Name:	*Lynx canadensis*
Species Code:	M-LYCA
B.C. Status:	Yellow listed, not a species at risk in British Columbia
Identified Wildlife Status:	None
COSEWIC Status:	Not applicable

5.1 Introduction

Lynx populations are not considered to be at risk in British Columbia. However, there has been little to no research done on lynx within B.C. Most of what we do know about their ecology is based on literature from outside of the province. Trapping records and trapper questionnaires are one of the only and therefore most valuable sources of data available on lynx population sizes and habitat use within B.C. Currently lynx are managed as Class 2 fur-bearers because they are not present on most registered traplines in manageable numbers, and are vulnerable to overharvest (B.C. Ministry of Environment, 1991).

In addition to its economic importance in the fur trade market, this species serves an important role as a top predator. Managing responsibly for lynx habitat is closely tied to providing habitat for their prey (e.g. snowshoe hare, grouse, ptarmigan, and various small mammals). Lynx distribution within B.C. clearly reflects the presence/absence of their preferred habitat and prey species.

At this time, habitat ratings for the lynx are predicted to have a low to moderate reliability because no model verification has been done in the study area. Due to the lack of literature available on lynx for B.C., supplemental sources were referenced for production of this account, and include relevant literature predominately from Northwestern North America.

5.2 Distribution

Lynx occur across the boreal forests of North America from Alaska to Newfoundland. Their range also extends south into the northern portions of the western mountains, where environmental conditions at high elevations support boreal forest habitats similar to those found in northern regions (Koehler and Aubry, 1994).

5.2.1 Provincial Range

In B.C. lynx are year round residents in most biogeoclimatic zones except for in the CDF, MH and BG zones. Lynx are generally absent from the wetter and coastal forests of the Coast Mountains and in the Georgia Depression (Koehler and Aubry, 1994; Hatler, 1988; Shelford and Olson, 1935). Extensive literature supports that lynx distribution and abundance is tied to that of the snowshoe hare.

Lynx densities range from near extirpation to 10-20 per 100 km^2 during population peaks (Koehler and Aubry, 1994). These fluctuations are a function of the densities of the primary prey species, the snowshoe hare (following its 10-year cycle with a 1-2 year lag) and its associated habitat features (Brand *et al.*, 1976; Koehler and Aubry, 1994; Hatler, 1988; Nellis *et al.*, 1972; Mowat *et al.*, 1996). In Alberta, a snow-tracking study showed that lynx densities increased from 2.1 to 7.5 per 100 km^2 because hare numbers increased (Nellis *et al.*, 1972). Currently in B.C., lynx are thought to be on the low end of the 10-year cycle (Jim Tuck, Dennis Jones, pers. comm.).

5.2.2 Distribution in Project Area

Lynx are expected to occur within all of the biogeoclimatic zones present within the Klawli study area, but are essentially absent from the AT, as summarised in Table 28. According to trappers in the area, lynx are not abundant in the Klawli area and surroundings. A survey in 1992 of trappers in the Williston Lake watershed found that 17% of those surveyed felt that lynx were extremely scarce, 52% said scarce, 4% didn't know, 13% said not present and only 13% said that they were common (Becker, 1992). Dennis Jones (pers. comm. trapper in the northern section of the study area) caught up to 11 along one line during the peak of the population cycle (i.e. 1982/83), but averages 1 to 2 a year. Trappers have indicated that a lot of the habitat in the Williston lake watershed is not appropriate for lynx (Becker, 1992). Lending support to these observations, overall opinion is that snowshoe hare are not as common in the area as they are in the Peace River region to the east (Jim Tuck, pers. comm.).

Research from elsewhere predicts that the next peak for lynx population numbers will occur during 2002/03, based on peaks occurring in the third year of each decade (MELP, 1989). If populations within the study area follow trends seen elsewhere, then hare numbers should currently be low, as reported. Some trappers from the Williston Lake watershed considered it to be a cycle peak at the time of the questionnaire in 1992 (Becker, 1992). This may be an indicator that lynx in the area are on a similar cycle to those observed elsewhere.

Table 28: Expected Lynx Occurrence within the BEC Zone, Subzone and Variant Combinations Found within the Klawli Study Area.

Ecoprovince	Ecoregions	Ecosections	BEC Variants	Expected Occurrence
Sub-Boreal Interior	Omineca Mountains	Manson Plateau (MAP)	AT	x
			ESSFmv3	•
			ESSFmvp3	•?
			SBSmk1	•
		Southern Omineca Mountains (SOM)	BWBSdk1	•

Legend: • = occurs in the variant; •? = probably occurs in the variant; ? = unlikely to occur in the variant; x = essentially absent

5.2.3 Elevational Range

Topographic relief over the entire study area averages 1000 m, and ranges from the heights of Mount Germansen at 1926 m down to Klawli Lake at 997 m. Most of the land that lies below 1200 m occurs within the southern half of the study area. Suitable habitat is abundant throughout the study area, not limited by elevation. However, the higher elevation AT and ESSF parkland zones are of lower quality to lynx because of the lack of forest cover for security/thermal requirements, especially in the winter.

5.3 Ecology and Habitat Requirements

Lynx ecology and habitat requirements have been well studied outside of B.C. Much of this information is considered directly applicable to B.C. populations based on observations and trapping records. Lynx require a landscape mosaic of early seral habitats, which support the critical prey base of the snowshoe hare, and climax forest habitats; used for denning and resting security/thermal habitat (Hatler, 1988). Both, mid-successional vegetation stages such as those produced by fire, and alpine shrub thickets are the habitats of the greatest importance to the lynx nutritional requirements; and are critical as food refuges for lynx during low hare cycles (Koehler and Aubry, 1994; Hatler, 1988).

Lynx cover large areas of these habitat types, with home ranges normally 16-20 km^2 in size; but can vary from 12 to 243 km^2 (MELP, 1989). A recent study in the Southern Canadian Rocky Mountains recorded large annual home ranges of 341 and 239 km^2 for resident males and females respectively (n=6) (Apps, 1999). During times of low snowshoe hare, lynx have to cover larger areas and longer distances in order to meet their nutritional needs. Ward and Krebs (1985) found that lynx home ranges increased three-fold (from 13.2 to 39.2 km^2) following declines in hare populations

In light of the diversity of home ranges and dispersal patterns for lynx, Poole (1994) states that, "Comparisons of home-range size among studies must be conducted cautiously because of the variety of habitats, field techniques, calculation methods and sample sizes involved".

5.4 Habitat Use (Life Requisites and Seasons)

There is little documented difference in food and shelter requirements between growing and winter months. In addition, there is inadequate information available on seasonal variations among habitat use by lynx. Therefore, ecosystem units were not rated separately for the growing and winter seasons. Instead, ratings covering the entire year were assigned to habitats within the study area. Life requisites rated include food, and a combined security and thermal rating, as summarised in Table 29. These life requisites are detailed further in the following sections. Although not rated for, additional information on lynx reproduction and natal dens has been included in the species account in order to provide a better overview of lynx biology.

Table 29: Summary of Rated Life Requisites and Seasons for Lynx in the Klawli study area.

Rated Life Requisites and Seasons	Code	Months of Use
Food - All year Security and thermal - All year	FD_A ST_A	All

5.4.1 Food Habitat

Studies specific to lynx food habits and corresponding foraging habitat requisites are lacking for British Columbia (Hatler, 1988). It is assumed that the food requirements of the lynx in British Columbia are similar to those documented in Alberta, the Northwest Territories and the Northern United States.

According to Hatler (1988), all studies found that hare was the number one ranking prey species. In one year a single lynx will eat about 170 hares (MELP, 1989). Van Zyll de Jong (1966) completed a study of food frequency in diets for lynx in Alberta and the Northwest Territories during a peak in lynx population as hare populations began to decline. He found that, "snowshoe hare was the most common in the winter (72%) and in the summer (52%); microtines were important in both seasons-10% in winter and 31% in summer (22% *Microtus* sp. and 9% *Clethrionomys* sp.); other mammals eaten included red squirrel, two species of ground squirrel, beaver, and deer; birds occurrence was 23% in winter (10% grouse and 13%

unidentified) and in 35% of the summer samples (4% grouse, 4% Gray Partridge, 9% duck, and 17% unidentified" (Van Zyll de Jong, 1966).

A more recent study on lynx diet, in the Southern Canadian Rocky Mountains, recorded a diverse winter diet consisting of hares (52%), red squirrels (30%), northern flying squirrels (5%), grouse (3%), martens (3%), and voles (3%) (n = 137 kills sample size) (Apps, 1999).

Hatler (1988) also suggests that ungulates may be used as prey and carrion during hare lows. However, Koehler and Aubry (1994) found that importance of ungulates to the lynx diet was insignificant.

Lynx are known to favour hunting in habitats where snowshoe hare are plentiful (Koehler and Aubry, 1994). Hares will tend to use more open habitat types in the summer in response to availability of herbaceous forage (Livaitus *et al.,* 1985). Snowshoe hare require woody seedling and saplings for food and shrub cover for security, usually provided by early successional forests. Early successional stages resulting from fire, timber harvesting, windthrow and disease are utilised by snowshoe hare beginning 10 years after the event, but most optimally at 22 years (Koehler and Aubry, 1994; Koehler and Brittell, 1990). As succession progresses canopy shade reduces herbaceous understorey and hare use declines rapidly (Koehler and Aubry, 1994; Koehler and Brittell, 1990). Low conifer branches, coarse woody debris (CWD), low and high shrub cover, rocks and small trees offer the dense physical structure required by snowshoe hare (Livaitis *et al.*, 1985).

Conifer-dominated stands are preferred when in close association with small openings (2-4 ha in size), and mature mixed-wood forests are not selected (Quinn and Parker, 1987). Shelford and Olson (1935) found that, "though the lynx may live and die in the climax forest, it depends upon the subclimax for its food."

5.4.2 Security and Thermal Habitat

Security cover is important for lynx during reproduction, hunting and travelling. Lynx will avoid large open areas (>100 m in width), and are known to avoid roads and wetter areas such as bogs (Hatler, 1988). Conifer stands provide greater concealment from predators, lighter snowpacks, and warmer temperatures during winter than deciduous stands (Fuller and Heisey, 1986).

Travel areas require canopy cover with coniferous or deciduous vegetation greater than 2 m in height adjacent to foraging habitat. Optimal interspersion of mature forest cover within the landscape is not known (Hatler, 1988). Lynx prefer travelling on ridges and saddles (Koehler and Aubry, 1994, Koehler and Brittell, 1990).

Snow tracking evidence reported in the literature suggests that lynx do not return to specific resting sites. Instead they will bed down along daily hunting trails in areas that offer some mature forest cover (cover requirements determined by severity of weather) (Hatler, 1988; Van Zyll de Jong, 1966; Nellis and Keith, 1968; Brand *et al.*, 1976). Lynx requirements for older forest types seem to be a function of denning requirements (thermal and security) and need for protection from precipitation (Hatler, 1988; Koehler and Aubry, 1994).

The same habitats that provide security for lynx are assumed to also provide thermal attributes during the winter. As such, a combined security and thermal value has been assigned to each ecosystem unit in the Klawli TEM area for the All Year ratings.

5.4.3 Reproduction (Natal Dens)

Although not rated for in this study, natal den habitats for reproduction (live birth) are an important life requisite for lynx. All references detailing information on natal den sites suggest that the presence of large debris and forest cover characteristic of oldgrowth forests are preferred habitat characteristics as they offer important thermal and security protection for litters (Koehler and Aubry, 1994). It can be assumed that EUs rated high for security and thermal all year also have the potential to be high for denning habitat.

Other important habitat attributes for denning include proximity to foraging habitat, distance from human disturbance, and stands a minimum of 1 ha in size. Lynx also require travel corridors between den sites to move kittens when prey availability changes (Koehler and Aubry, 1994). Some identified den sites include dens in windthrow or large piles of woody debris, and dry remote islands surrounded by wet spruce bogs in old spruce forests (Hatler, 1988). Towry (1984) suggests that lynx may also use caves or rock crevices for denning.

Mowat *et al.* (1996) found litter sizes to range from 1 to 7 for adults and 3 to 5 for yearlings. Birthing occurred in May and June with the occasional birth into July after a gestation of approximately 60-65 days (Koehler and Aubry, 1994; Mowat *et al.*, 1996). Kittens typically remain with the mother until they are 9 to 10 months of age (Koehler and Aubry, 1994). Although females are capable of becoming pregnant at 10 months during peak hare availability (Brand *et al.*, 1976), animals reach reproductive maturity at 22 months (Koehler and Aubry, 1994). During declines in hare populations, lynx recruitment will fall (Poole, 1994; Nellis *et al.*, 1972). Mowat *et al.* (1996) found that recruitment of lynx went from a peak in 1990 to zero reproductive output in 1992, two years after declines in hare populations were observed. An increase in kitten mortality is also concurrent to declines in hare populations (Koehler and Aubry, 1994; Poole, 1994).

5.4.4 Seasons of Use

Lynx are present within the study area throughout the year. Table 30 summarizes the rated life requisites for lynx for each month of the year.

Table 30: Monthly Rated Life Requisites for Lynx in the Klawli Study Area.

Month	Season*	Rated Life Requisites
January	Winter	Food, Security and Thermal
February	Winter	Food, Security and Thermal
March	Winter	Food, Security and Thermal
April	Winter	Food, Security and Thermal
May	Growing	Food, Security and Thermal
June	Growing	Food, Security and Thermal (females using natal dens)
July	Growing	Food, Security and Thermal (females using natal dens)
August	Growing	Food, Security and Thermal
September	Growing	Food, Security and Thermal
October	Growing	Food, Security and Thermal
November	Winter	Food, Security and Thermal
December	Winter	Food, Security and Thermal

*Seasons defined for the Sub-Boreal Interior Ecoprovince per the Chart of Seasons by Ecoprovince (RIC, 1998; Appendix B).

5.5 Ecosystem Attributes

A number of relationships between habitat use and ecosystem attributes can be determined for lynx based on current literature. Often the habitats used most frequently are associated with specific vegetation cover (e.g. favoured browse species of snowshoe hare), and/or structural stages (e.g. mature stands for security cover during reproduction). Table 31 lists which ecosystem attributes are considered in the habitat ratings tables.

Table 31: Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Lynx.

Life Requisite	Ecosystem Attribute	Non-ecosystem attribute
Food	structural stage: young forest advanced regeneration site: elevation, structural stage, site disturbance vegetation: % cover by layer, species list by layer, cover for each species for each layer	• Size of opening
Security and Thermal	structural stage: old forest (structural stage 6-7) closed canopy with large diameter CWD site: slope, aspect, elevation, structural stage vegetation: % cover by layer, % cover of shrub over 2 m in height, bedding areas require some canopy closure. mensuration: tree species, large dbh trees, height	• proximity to forage • distance from human disturbance • Size of stand

5.6 Development of the Habitat Ratings

Habitat ratings were developed through collection of habitat data within the study area over a two week period, and supported by personal communications with local biologists, local trappers, and supplemented with a current literature review.

5.6.1 Rating Scheme

A 4-class rating scheme of high (H), moderate (M), low (L) and nil (N) is employed due to the intermediate level of knowledge of lynx habitat use in B.C. This rating scheme is suggested by RIC (1998) for use with lynx at the 1:20,000 map scale and is defined in Table 32.

Table 32: Habitat Capability and Suitability 4-Class Rating Scheme (from RIC, 1998).

% of Provincial Best	Rating	Code
100% - 76%	High	H
75% - 26%	Moderate	M
25% - 1%	Low	L
0%	Nil	N

This rating scheme was used when assigning habitat ratings to the ecosystem units present within the Wolverine Range study area. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for lynx as previously outlined in Table 30.

5.6.2 Provincial Benchmark

A provincial standard (best in B.C.) for lynx has not been determined. Lynx are distributed throughout the mainland of B.C., with higher densities likely from central B.C. northward, where favoured habitat (lodgepole pine forests naturally disturbed by fire) and prey (snowshoe hare) are prevalent. The Omineca-Peace region is reported to produce the greatest numbers of lynx in the province, based on trapping records (MELP, 1989).

5.6.3 Ratings Assumptions

The following assumptions have been made in assigning habitat values to terrestrial ecosystem units for the Klawli project area:

Life Requisite and Season	Assumptions
Food Habitat **All Year** **FD_A**	High rated habitat assumes that prey is available. Good snowshoe hare habitat is good lynx foraging habitat. **Structural Stages** • Lodgepole pine stands stages 3b to 5 are of high foraging quality because snowshoe hare are associated with these dense coniferous stands (Koehler, 1987). • Non-forested units (structural stage 2), low shrub, higher shrub (3a and b), which provide cover while stalking prey, are important hunting habitat for lynx. **Site Disturbance** • Old burn sites (greater than 10 years of age) are often very productive for snowshoe hares because they promote the growth of deciduous shrubs. **Stand Characteristics** • Forested units with shrubby opening provide ideal hunting habitat. • Forested units with open canopies are of higher suitability due to promotion of shrub layer growth for snowshoe hare. • Units with a deciduous (aspen, birch or alder), willow, and/or a young conifer component are rated high for food potential. • Young pine and fir stands are rated higher than spruce stands for lynx food suitability. **Biogeoclimatic zones** • Lynx use the ESSF, SBS and SWB habitat types, predominately successional stage 3, and mixed forests with uneven age classes (Becker, 1992). • The AT is rated of no value (Nil) due to the general lack of prey.
Security and Thermal Habitat **All Year** **ST_A**	**Structural Stages** • Mature coniferous forests (stage 5 to 7) provide overhead cover for resting sites in the winter and for protection of kittens in their natal dens. Forest cover is especially important for denning and resting sites. Dens are usually found within these forests types, located in hollow trees, tangled thickets, under logs, stumps and fallen timber (Koehler and Aubry, 1994). These stands will have more openings interspersed and therefore will be of higher quality - provide access to prey and resting sites with thermal and security cover. • Stages 5 coniferous forests have up to moderate potential for security/thermal requirements, while 6 and 7 will be of highest quality. This assumes that CWD is present for cover. **Site and Stand** • Avoid xeric sites and open meadows (Koehler, 1987). • Mature spruce-subalpine fir forests are considered the preferred denning habitat, with a high number of downed logs (Koehler, 1987). **Biogeoclimatic Zone** • The AT is rated of Nil suitability/capability for lynx due to the lack of appropriate security and thermal habitat.

5.6.4 Limitations

One of the greatest limitations for habitat mapping of lynx is the lack of ecological information applicable to B.C. Much of the literature produced in B.C. assumes that ecology and habitat requirements are similar to other areas. In addition, the studies that are available from other areas are not standardised among methodology used, study duration and intensity, age, sex, nutritional status, stage of the lynx-hare cycle, and sample size. Many of the studies done on lynx do not have large enough sample sizes; thus, ecology and habitat use is extrapolated. In addition, habitat studies have been located opportunistically rather than in areas significant to lynx biologically (Ward and Krebs, 1985; Hatler, 1988). Food habits, denning requirements and habitat use should be identified before habitat relationships can be reliably determined for the study area and elsewhere in B.C.

5.6.5 Rating Adjustment Considerations

Depending on the question(s) to address, a more detailed spatial analysis may be required. As lynx are known to avoid areas used by humans, ratings adjustments for distance to areas near roads, settlements and recreational facilities may be necessary in order to determine the areas of greatest suitability. Additional ratings adjustments could be conducted for polygons with openings between 2-4 hectares that occur adjacent to mature forest. These polygons, selected through GIS spatial analysis, would be rated of higher quality for lynx (landscape level suitability). Another ratings adjustment to consider includes the downgrading of habitat ratings for herbicide and pesticide treated areas. Both post-logging treatments are considered to reduce abundance of prey, which can result in alienating lynx from the affected area (Ritchie and Sullivan, 1989). Ratings adjustments should result in a more accurate assessment of habitat suitability for habitat management planning.

5.7 References

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6.0 SPECIES – HABITAT MODEL FOR WOLVERINE

Common Name:	**Wolverine ssp. *luscus***
Scientific Name:	*Gulo gulo luscus*
Species Code:	M_GUGU
B.C. Status:	Blue listed (B.C. MELP, 1996; B.C. CDC, 1997)
Identified Wildlife Status:	None
COSEWIC Status:	Western populations were designated as vulnerable in Canada, following a review in 1989 (COSEWIC, 1997).

6.1 Introduction

Wolverines are the largest terrestrial member of the mustelid (weasel) family. They typically reside in large undisturbed wilderness areas, frequenting wooded and mountainous areas where food and security habitats are widely available. Their main predators are wolves, but during the mating season, male wolverines may also kill one another (Lofroth *et al.*, Draft 1999). Wolverine populations have declined in the continental U.S. and Eastern Canada (Banci, 1994), due to a number of different factors including habitat loss, over-harvesting and changes in the prey base (Lofroth, 1996). Low reproductive rates, poor juvenile survival, lack of population estimates and ecological information, and large space requirements support the decision to designate wolverines as vulnerable wildlife in B.C. (Blue-listed). Within the hunting regulations it is managed as a Class 2 fur-bearer, because it is not present on most registered traplines in manageable numbers, and is vulnerable to overharvest (B.C. Ministry of Environment, 1991).

Habitat ecology and diet of wolverines have not been well researched within British Columbia. Ongoing research is currently taking place in the Williston Reservoir study area near Mackenzie (North-Central B.C.), as well as in Revelstoke (south-eastern B.C.). These studies are part of an initiative to increase the knowledge base of wolverine ecology in B.C. The information gained will provide a base from which to develop responsible management plans for this species. The research is a joint effort of the Ministry of Environment, Lands and Parks, Ministry of Forests FRBC, forest industry and local universities. Eric Lofroth provided recent information from the DRAFT report for the Williston Reservoir study for inclusion in the species account. Other regional information, and relevant literature from B.C. and western North America have been included where relevant. At this time, general habitat ratings for wolverines are predicted to have a moderate reliability, because some detailed habitat information is available for the study area (i.e. use of biogeoclimatic zones, subzones, variants and structural stages that are directly applicable to the mapped study area).

6.2 Distribution

Wolverines occur across the boreal and tundra zones of Eurasia. In North America, wolverines have been found from the 38th parallel northwards (Banci, 1994), with populations less abundant in the east (Van Zyll de Jong, 1975). In Canada, evidence suggests that wolverines never occurred in Nova Scotia or Prince Edward Island and disappeared from New Brunswick after the middle of the 19th century (Banci, 1994). However, they are present over much of the remaining forested areas of Canada, especially the Northern Territory, the Yukon Territory and western provinces (Hash, 1987).

6.2.1 Provincial Range

Wolverines are found in low densities throughout the boreal forest, tundra and western mountains of British Columbia (Lofroth, 1996). There are two subspecies of wolverine identified within B.C. The subspecies *Gulo gulo vancouverensis* is identified in the literature to be morphologically different from *Gulo gulo* (Banci, 1982). This subspecies occurs on Vancouver Island and is Red-listed within B.C. (B.C. MELP, 1996; B.C. CDC, 1997). Although some discrepancies in classification exist, the British Columbia mainland wolverines (the subspecies that is found in the study area) are identified as *Gulo gulo luscus* by Banfield (1974).

Although wolverines occur throughout the mainland, they are not found in southern agricultural areas and are not likely to be found in the Thompson-Okanagan Highlands ecoprovince (Banci, 1994).

The Northern Boreal Forest ecoprovince (northern B.C.) is of high value to wolverines, because the area offers abundant ungulates for food in association with mountainous terrain including extensive alpine and subalpine habitats with wide plateaus, valleys and lowlands containing important forested habitats (Banci, 1994). Population densities range from one per 40 to one per 800 km^2 per wolverine, depending on food availability (Banci, 1994).

6.2.2 Distribution in Project Area

Wolverines occur within all of the ecoregions, ecosections and biogeoclimatic zones found within the Klawli study area, in the Mackenzie Forest District, as summarized in Table 33. Research in the area and adjacent areas have recorded wolverine use in all of the subzone variants mapped for this project. Records of a female wolverine at Klawli Lake were obtained during ongoing tracking in the area (Eric Lofroth, pers. comm.).

Table 33: Expected Wolverine Occurrence within the Ecosection and BEC Variant Combinations Found within the Klawli Study Area.

Ecoprovince	Ecoregions	Ecosections	BEC Variants	Expected Occurrence
Sub-Boreal Interior	Omineca Mountains	Manson Plateau (MAP)	AT	•
			ESSFmv3	•
			ESSFmvp3	•
			SBSmk1	•
		Southern Omineca Mountains (SOM)	BWBSdk1	•

Legend: • = occurs in the variant

6.2.3 Elevational Range

Wolverines have been found in studies in British Columbia, the Yukon, Alaska, and Montana to use areas ranging from lowland valleys to high alpine environments. Research near the Klawli study area indicates that female adult wolverines utilize the high elevation Alpine Tundra (AT) and Engelmann Spruce Subalpine Fir (ESSF) biogeoclimatic zones more frequently throughout the year than males or subadults (Lofroth *et al.*, Draft 1999). The lower elevation Sub-Boreal Spruce (SBS) and Boreal Black and White Spruce (BWBS) zones are utilized more frequently by adult males and subadults, with the BWBS used most frequently by subadult males (Lofroth *et al.*, Draft 1999). The research also showed that adult males travel into the upper elevation habitat during the mating season, where the adult females are located. At this time, referred to as Season 2, sub-adult females are also found in the higher elevation habitat, but subadult males are not (Lofroth et. al., Draft 1999).

Mean monthly elevations ranged from a low of 700 m to a high of 1587 m, with the lowest elevations recorded during the cold and snowy months (mid-November to mid-February) (Lofroth *et al.*, Draft 1999). Highest elevations were recorded from late May to late August (the mating season) (Lofroth *et al.*, Draft 1999).

6.3 Ecology and Habitat Requirements

Habitat requirements are best described as a function of large undisturbed wilderness areas, availability of food and avoidance of predators (wolves) (Banci, 1994; Banci, 1982; Hatler, 1989; Lofroth, 1999). Forage (FD) availability and security/thermal (ST) habitat are important year round. Security habitat for adult females is particularly important during birthing (reproduction).

Generally, studies within Canada and Alaska suggest that wolverines use a wide range of habitats and can be found in muskeg, foothills and mountains (Hatler, 1989). Home range sizes are large covering 600 km^2 for males (females maintain smaller home ranges) and travelling distances of up to 20-30 km per day (Hatler, 1989). Home ranges of adult wolverines range from as low as 158 km^2 to as large as 900 km^2 (Lofroth *et al.*, Draft 1999). Mean home ranges were much larger for males than females and subadult home ranges are larger than adult home ranges; with subadult home ranges as much as ten times the size of adults. As well, home ranges of most adult females were relatively small and all enclosed a significant portion of high elevation habitat (Lofroth *et al.*, Draft 1999). Movement observations showed coverage in distance from 2 to 5 km on a daily or weekly basis to very large movement of more than 100 km (Lofroth *et al.*, Draft 1999).

6.3.1 Migration

Generally, wolverines have seasonally vertical migrations, moving to the higher elevations in the spring and summer and seeking out the lower ungulate ranges in the winter (Gardner, 1985 and Lofroth, 1996). However, in the study area, wolverines have been noted to utilize caribou carrion and (dependent on snow conditions) will go to high elevation forests adjacent to the alpine (Lofroth *et al.*, Draft 1999). Wolverines will cover large distances during seasonal migrations. Riparian habitat, ridge tops and timbered corridors between cutblocks likely all serve as important migratory habitat along routes.

6.4 Habitat Use (Life Requisites and Seasons)

In South-Central Alaska wolverines were found to use spruce types for courting and hunting, along with shrub, alpine tundra, rock and ice in the summer while tall shrub and deciduous forests was only used for travel (Gardner, 1985). Hatler (1989) notes that there is as yet no evidence that wolverines select for particular forest cover types, although spruce and fir forests are often used for resting and foraging in the winter. Research in North-Central B.C. also found that wolverines utilized a wide range of habitat types, with females using early and late successional habitats primarily while male activity was predominantly within late successional habitats (Lofroth *et al.*, Draft 1999). Relatively little use is made of mid-successional habitats by any wolverines (Lofroth *et al.*, Draft 1999).

Wolverines habitat use for the study area has been broken down into two seasons - growing and winter. Life requisites that are rated for wolverines include food, security, combined security and thermal, and reproduction as summarized in Table 34.

Table 34: Summary of Rated Life Requisites and Seasons for Wolverines in the Klawli Study Area.

Rated Life Requisites and Seasons	Code	Months of Use
Growing season - food Growing season – security	FD_G ST_G	May to October
Winter season - food Winter season – security and thermal	FD_W ST_W	November to April
Reproducing (birthing) – security and thermal	ST_RB	February to June

6.4.1 Food Habitat

Being generalists and using a large variety of food sources, wolverines are not very susceptible to fluctuations in prey species such as the snowshoe hare (Erlinge, 1986). Food availability is likely the most important factor determining habitat requirements and use patterns of wolverines.

<u>Growing Season</u>

Moose and caribou are important in diet during the spring and summer months, but less so than during the winter. Other foods consumed when available include: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), beaver (*Castor canadensis*), red squirrel (*Tamiasciurus hudsonicus*), ground squirrel (*Spermophile* sp.), hoary marmot (*Marmota caligata*), deer mice (*Peromyscus maniculatus*), jumping mice (*Zapus princeps*), and ground nesting birds (ptarmigan, grouse and waterfowl) (Lofroth, 1999 and Hatler, 1989). Summer foods also include other small rodents, bird's eggs, wasp nests, and berries (Ewer, 1973).

Hornhocker and Hash (1981) found that stands of mature or intermediate timber were selected for foraging, particularly when they contained edges and ecotonal area around cliffs, slides, blowdowns, meadows, basins, and wetlands. Near the study area, wolverines appear to select for early (stage 2) and late successional stages (5-7) with relatively little use of mid-successional habitats (stage 4) (Lofroth *et al.*, Draft 1999). Some use of stage 1 habitat also occurs, especially by adult females in the upper elevation habitat. Use of stages 3a and 3b by wolverines is very limited (0-5% of all observations in the Williston Reservoir study by Lofroth *et al.* (1999)).

<u>Winter</u>

Literature indicates that food sources are seasonal with reliance on ungulate carrion increasing in the winter (Ewer, 1973). Access to winter food is considered to be the most limiting life requisite (Lofroth, 1996). Habitat where ungulates are likely to congregate such as wetland-forest complexes for Moose are of highest suitability for food potential in the winter. Moose carrion was the major scavenged item observed in the area (Lofroth *et al.*, Draft 1999). Caribou were also scavenged as well as killed directly. Both moose and caribou are accessible within the Klawli study area during most of the year, with caribou leaving the area after the early winter (Mari Wood pers. comm.).

6.4.2 Security and Thermal Habitat

Like many other species, wolverines have security and thermal requirements that aid in their survival during the various seasons. Many of these habitat needs are the same throughout the year.

Growing Season

During the growing season, thermal habitat is not considered to be a primary life requisite for wolverines. Heat shelter is unlikely to be a factor for this species in the area of study or elsewhere in B.C. There is no supporting literature for this either way, but security and food habitat are known to by key life requisites for occupation of an area by this species. Therefore, the habitat ratings for the growing season focus on security habitat only (denoted as SH in the ratings table).

Wolverines will travel across large openings reluctantly (Hornocker and Hash, 1981). Therefore, areas with large openings such as clearcuts will have low suitability values for wolverines, with higher capability for future mature forested stands. Structural stages 5, 6 and 7 will have higher value due to existence of forest cover, higher stand diversity, and interspersed openings. Early to mid-successional stages (1 to 4) of the SBS and BWBS were found to have significantly less use throughout the year than other successional stages near the study area (Lofroth *et al.*, Draft 1999). Habitat use by all age and sex classes in the lower elevation zones (SBS and BWBS) are primarily within successional stages 5, 6 and 7 (Lofroth *et al.*, Draft 1999). Late successional stage habitat (stage 6) is preferred in the ESSF, with stage 5 and early successional stage 2 secondary but widely used by all age classes (Lofroth *et al.*, Draft 1999). Herb and shrub-dominated habitats are frequently used by wolverines while in the AT zone (stages 1 and 2). Stage 3a habitat in the AT zone was used significantly less (Lofroth *et al.*, Draft 1999).

Little information is available on denning or resting security habitat requirements. Hornocker and Hash (1981) and Hash (1987) indicate that they require cover and rock outcrops for bedding. Resting wolverines will bed along travel routes in snow caves or cavities, under trees and on open outcrops (Hatler, 1989 and Hornhocker and Hash, 1981).

Winter

As during the growing season, structural stages 5, 6 and 7 will have higher value due to existence of forest cover, higher stand diversity, and interspersed openings which provide a source of security from predators as well as thermal cover. As the same habitat is likely to provide both security and thermal values, the ratings for winter reflect a combined security and thermal habitat value (denoted at ST in the ratings table).

Results interpreted by Lofroth *et al.* (Draft 1999) are that as proximity to human activity increases the importance of forested cover (presumably as security cover) increases.

During the winter, subnivean habitat, units with high concentrations of CWD, may provide important thermal cover conditions as well as denning and resting opportunities. These units (older successional stages) are rated highest for security/thermal values. Shrub dominated habitat in avalanche tracks of the ESSF were also found to be used during the winter (stage 2). Non-natal dens and bedding sites consist of tunnels dug in the snow.

6.4.3 Reproduction (Security and Thermal Habitat for Denning)

The mating season occurs over a three month period from late May through to late August, with delayed implantation occurring in winter (Lofroth *et al.*, Draft 1999). Females do not produce young every year (Hornhocker and Hash, 1981; Krott, 1960). Birth occurs within natal dens during the late winter to early spring with litter sizes averaging 3, but ranging from 1 up to 6 kits (Hatler, 1989; Rausch and Pearson, 1972; Wright and Rausch, 1985). A strong relationship has been observed between nutrition and productivity (Hatler, 1989; Rausch and Pearson, 1972). Nursing and weaning occur during mid-February to late May, with females providing for the young throughout the late spring and summer months (Lofroth *et al.*, Draft

1999). Young may be kept for up to two years with the mother, with sexual maturity for females around 4 years of age (Krott, 1960).

Lofroth (1996) observed that natal dens in the northern interior occurred in association with coarse woody debris, forest cover and snow cover. Natal dens have also been found in ravines, snow caves, beneath rock or boulders, logjams and covered tree routes (Hatler, 1989). Snow insulation may be important for thermal protection during natal denning (Hatler, 1989). Adult females used high elevation habitats during the incubation and birthing season (February to late May) for maternal den sites (Lofroth *et al.*, Draft 1999).

Local research documented that all maternal dens were located in the ESSFmv3 subzone variant (Lofroth *et al.*, Draft 1999). Three were in dry forested sites – typically a dense coniferous forest with shrub-dominated understories, which include plant communities that may progress through seral pine to a varied climax of Engelmann spruce and subalpine fir. The other two dens were in dry parkland – typically a high elevation mosaic of stunted tree clumps and herb or dwarf shrub-dominated openings, occurring above the closed forest and below alpine (IWMS, 1999). Dens were associated with logs or piles of CWD. One den was associated with a large rock. All dens were between 1550 and 1775 m elevation. Dens were located in variable seral stages including herb, pole sapling, mature and old. Dens were also located on variable slopes (5 to 49%), with a wide variation of aspects (Lofroth *et al.*, Draft 1999).

During the mating season, the majority of habitat use by adult males and females occur in the upper elevation AT and ESSF zones. Adult wolverines were located in the herb/shrub and fir parkland habitats in these zones during this time significantly more so than in lower elevation areas (Lofroth *et al.*, Draft 1999). Most locations are within late successional stage habitats (particularly mature and oldgrowth) (Lofroth *et al.*, Draft 1999). Overhead cover and structural features of forested stands may be important for natal and maternal dens (Lofroth *et al.*, Draft 1999).

6.4.4 Seasons of Use

Wolverines are active throughout the year. Table 35 summarizes the rated life requisites (column 2) for wolverines for each month of the year for the study area (Sub-Boreal Interior Ecoprovince). Local research by Lofroth *et al.* (draft 1999) identified four seasons of activity for wolverines in their study area. "The seasons of activity are periods of the year where behaviour and habitat use may be consistent and influenced by biological imperatives, such as breeding, and weather phenomena" (Lofroth *et al.*, 1999).

The following are season definitions for Table 19, column 3 from Lofroth *et al.* (1999):

- Season 1: during this period female wolverines are whelping kits and involved in nursing and weaning; snow conditions during this time vary from crusted snow as a result of daily melts and overnight freezing temperatures to valley bottoms barren of snow in the latter part of the season.
- Season 2: during this period, female wolverines are provisioning young; this is the mating season for wolverines.
- Season 3: during this period, kits are dispersing and snow begins to appear in the high elevation habitats.
- Season 4: this period is one of cold temperatures (as a rule) and large snowfalls resulting in deep, soft snow which potentially impedes movement.

Table 35: Monthly Life Requisites for Wolverines in the Klawli Study Area.

Month	Broad Season*	Season*	Season**	Rated Life Requisites
January	Winter	Winter	4	Food, Security and Thermal
February	Winter	Winter	4 (up until mid-Feb.) 1 (starting mid-Feb.)	Food, Security and Thermal
March	Winter	Winter	1	Food, Security and Thermal, and Reproduction
April	Winter	Winter/Early Spring	1	Food, Security and Thermal, and Reproduction
May	Growing	Spring	1 (til the end of May) 2 (starting end of May)	Food, Security, and Reproduction
June	Growing	Spring	2	Food and Security
July	Growing	Summer	2	Food and Security
August	Growing	Summer	2	Food and Security
September	Growing	Fall	3	Food and Security
October	Growing	Fall	3	Food and Security
November	Winter	Winter	3	Food, Security and Thermal
December	Winter	Winter	3 (early December) 4 (Early to mid Dec.)	Food, Security and Thermal

*Seasons defined for the Sub-Boreal Interior Ecoprovince per the Chart of Seasons by Ecoprovince (RIC, 1998; Appendix B). **Seasons as observed by Lofroth *et al.* (draft 1999) – may vary from year to year according to weather conditions.

6.5 Ecosystem Attributes

A number of relationships between habitat use and ecosystem attributes can be determined for wolverines based on local research and current literature. Often the habitats used most frequently are associated with specific elevations, stand structure and age class, vegetation cover, units of high quality for prey species (e.g. parkland units containing marmot colonies), various structural elements such as CWD and large boulders. Table 36 lists which ecosystem attributes are considered in the habitat ratings tables.

Table 36: Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Wolverines.

Life Requisite	Ecosystem Attribute
Food	site: elevation, structural stage, site disturbance soil and terrain: bedrock, terrain texture, flooding regime vegetation: % cover by layer, species list by layer, Diverse habitat types from swamps to alpine; ungulate winter ranges
Security and Thermal	site: elevation, structural stage vegetation: % cover by layer, species list by layer mensuration: tree species, dbh, height other: large diameter (>20cm) coarse woody debris, and rock outcrops
Reproducing by birthing (Security and Thermal)	site: elevation, structural stage soil and terrain: terrain texture other: coarse woody debris; other structural elements such as large boulders, large debris piles

6.6 Development of the Habitat Ratings

Habitat ratings were developed through collection of habitat data within the study area over a two-week period, supported by personal communications with local biologists, local trappers, and species experts, and supplemented with a current literature review.

6.6.1 Rating Scheme

A 4-class rating scheme of high (H), moderate (M), low (L) and nil (N) is employed, as suggested by RIC (1998) for use with wolverines at the 1:20,000 map scale. This rating scheme requires an intermediate knowledge of habitat use and is defined in Table 37.

Table 37: Habitat Capability and Suitability 4-Class Rating Scheme (from RIC, 1998).

% of Provincial Best	Rating	Code
100% - 76%	High	H
75% - 26%	Moderate	M
25% - 1%	Low	L
0%	Nil	N

The four class rating scheme was used when assigning habitat ratings to the ecosystem units present within the Wolverines Range study area. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for wolverines as previously outlined in Table 35.

6.6.2 Provincial Benchmark

No provincial benchmark has been defined for wolverines, because no provincial population estimate exists for this species. However, according to Banci (1982) it was observed that the Fort Nelson area appeared to be the centre of wolverines population in western Canada because 40% of the 1979 provincial population occurred in the Omineca Peace area. According to Banci (1994), the two ecoprovinces of the greatest quality to the wolverines are the Shining Mountains and the Northern Boreal Forests (see 6.2.1). Becker (1992) also identified the mountainous areas of the Omineca Peace and Skeena Sub-Regions along with the Kootenay Region to have the highest production of wolverines in the province. Personal communications with trappers local to the study area also indicate that concentrations are highest in the Omineca Peace area, with high yields (10 year average of 4 a year, with as high as 6 in one winter) over short trapping lines (738T003) (Dennis Jones pers. comm., Oct. 1999).

6.6.3 Ratings Assumptions

The following assumptions have been made in assigning habitat values to terrestrial ecosystem units for the Klawli project area:

Life Requisite and Season	**Assumptions**
Food Habitat During the Growing Season FD_G	Structural Stages • Some use of stages 1, especially by adult females in the upper elevation habitat. • Some use of stages 3a and 3b by wolverines is assumed, but very limited (0-5% of all observations in the Williston Reservoir study by Lofroth *et al.* (Draft 1999). • Wolverine appear to select for early (stage 2) and late successional stages (5-7) with relatively little use of mid-successional habitats (stage 4) (Lofroth *et al.*, Draft 1999). **Biogeoclimatic Zones and Elevation** • Wolverine feed heavily on marmots where available; therefore rock outcrop units (RO) and talus (TA) in the AT and ESSF are rated highest during the growing season for food within the study area (highest concentration of potential food source for adult females). • All elevations within the study area provide potential food habitat for wolverines according to local research (Lofroth *et al.*, Draft 1999). **Other** • Habitat of high quality for ground nesting birds, snowshoe hare and small mammals such as voles and mice are rated of high food suitability for wolverines – assuming that the prey is present and accessible.
Food Habitat During the Winter FD_W	• Access to winter food is considered to be most limiting (Lofroth, 1996). • Habitat with access to ungulate winter ranges will be of higher quality in the winter for wolverines. • Habitat where ungulates are likely to congregate such as wetland-forest complexes for Moose are rated highest for food potential in the winter. Caribou are present in the early winter in the study area. Moose carrion was the major scavenged item in local research (Lofroth *et al.*, Draft 1999). Caribou were also scavenged as well as killed directly.
Security Habitat During the Growing Season SH_G	**Structural Stages** • Structural stages 5, 6 and 7 will be of higher quality and therefore have higher value, due to existence of forest cover, higher stand diversity, and interspersed openings. **Structural Stages and BEC Zones** • Areas with large openings such as clearcuts will have low value for wolverines. • Late successional stage habitat (stage 6) is preferred security habitat, with earlier successional stages secondary but still widely used (Lofroth *et al.*, Draft 1999). • Habitat use by all age and sex classes in the lower elevation zones (SBS and BWBS) are primarily within successional stages 5, 6 and 7 (Lofroth *et al.*, Draft 1999). • Herb and shrub-dominated habitats are frequently used by wolverines while in the AT zone (stages 1 and 2). Stage 3a habitat is used significantly less (Lofroth *et al.*, Draft 1999).

Life Requisite and Season	Assumptions
Security and Thermal Habitat During the Winter ST_W	**Structural Stages** • Same as above ST-G for stages 5, 6 and 7. • Subnivean habitat, units with high concentrations of CWD, may provide important thermal cover conditions as well as denning and resting opportunities. These units (older successional stages) are rated highest for security/thermal values. **Structural Stages and -BEC Zones** • See ST_G assumptions above regarding large openings. • Shrub dominated habitat in avalanche tracks of the ESSF are used during the winter (stage 2).
Security and Thermal Habitat During the Reproductive Season ST_RB	**Structural Stages and BEC Zones** • High elevation structural stages 6 and 7 provide suitable SH for natal dens within the study area, because these units likely contain CWD in addition to tree cover. Rock outcrops also offer suitable sites. Stage 2 and 4 parkland in the ESSFmv3 are also suitable for denning (Lofroth *et al.*, Draft 1999). Dens are often subnivean, located under fallen trees, CWD and blowdown. • Overhead cover and structural features of forested stands may be important for natal and maternal dens (Lofroth *et al.*, Draft 1999). • Within the study area, the ESSFmv3 subzone variant is of highest quality for natal denning ST. Units associated with logs or piles of CWD, or large rocks are of high potential. Herb, pole-sapling, mature and old seral stages may all be utilized for denning sites. • High elevation zone (AT and ESSF) are of higher suitability than the SBS and BWBS (rated up to low). **Site (Slope and Aspect)** • No obvious patterns exist between slopes or aspects and location of denning sites in research conducted adjacent to the Klawli (Lofroth *et al.*, 1999). It is our assumption that there are no obvious patterns.

6.6.4 Limitations

During the 1990s, our knowledge of wolverines ecology in B.C. has increased substantially. However, information on demographics, population dynamics, movements, habitat use, foraging and food habits and reproduction are still limited. Habitat use and denning requirements should continue to be investigated in order to determine reliable habitat relationships for development of habitat ratings.

According to Lofroth *et al.* (Draft 1999), wolverines inhabit areas with adequate year-round food supplies in large, sparsely inhabited wilderness areas, rather than in terms of particular types of topography or plant associations. The approach of capability/suitability mapping is to attempt to connect habitat values to plant associations. Therefore, wolverines are not an ideal animal for this methodology. A landscape level habitat suitability approach would be better suited for this species.

As research continues, the relationships between wolverines and their habitat are becoming clearer. This information will provide a valuable source of habitat use for future CAPSU projects. We are not far from being able to rate wolverines habitat at a more detailed level (e.g. winter, spring, summer and fall) as well as with higher confidence (i.e. six-scale) (Eric Lofroth, pers. comm.).

6.6.5 Rating Adjustment Considerations

Depending on the question(s) to address, a more detailed spatial analysis may be required in order to more accurately assess habitat suitability for wolverines. One of the ratings adjustments of primary importance for wolverine habitat assessment is the downgrading of habitat adjacent to human development, or facilities. This is an important consideration for management of habitat for this species.

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7.0 SPECIES – HABITAT MODEL FOR MARTEN

Common Name:	**Marten**
Scientific Name:	*Martes americana*
Species Code:	M-MAAM
B.C. Status:	Yellow-listed
Identified Wildlife Status:	None
COSEWIC Status:	Not applicable for western populations

Martens are managed as a Class 1 species because they are present on individual traplines in manageable numbers (B.C. Ministry of Environment, 1991).

7.1 Introduction

Although martens are likely the most researched North American terrestrial weasel (family Mustilidae), they have not been well researched in British Columbia. Most studies on ecology, habitat requirements, and food preferences of martens were undertaken in the United States and Eastern Canada. Although habitat use by martens vary regionally in accordance with ecological variation, habitat quality, prey availability, and prey abundance, some aspects of marten ecology can be extrapolated from the literature (Thompson and Colgan, 1990).

Within B.C., Quick (1955) completed a study on martens in northern B.C. (Quick, 1955), but was limited to describing diet preferences of martens in the winter. Research that is more recent was completed in the B.C. interior by Penner (1981), Lofroth and Steventon (1990) and Lofroth (1993). As part of an ongoing fisher research project in the Mackenzie Forest District (1997-2000), information on incidental captures of martens during live trapping has been recorded. A number of martens have been captured this way and are considered to be abundant throughout the district; about 8.37 captures per 100 trap nights (Weir, 1997).

As information on martens in B.C. is limited, relevant literature from North America have been included. At this time, general habitat ratings for martens are predicted to have a moderate reliability because adequate literature on habitat use is available. However, reliability is not high because no model verification has been conducted to confirm habitat use within the Klawli study area.

7.2 Distribution

Martens were historically found throughout the mature and oldgrowth forests of North America. Marten populations have been significantly reduced over the past 100 years as a result of habitat loss (primarily logging) and over-exploitation (Clark *et al.,* 1989 cited in Becker, 1992). However, distribution of martens in northwestern North America over the past decade has remained relatively stable, with a recent recovery by populations in Alberta (Gibilisco, 1994).

7.2.1 Provincial Range

Martens are widespread throughout British Columbia, typically confined to the forested biotypes (Stordeur, 1986). According to Hagmeier (1956), martens occur throughout the following biotic areas of British Columbia: Caribou Parklands, Columbia Forests, Subalpine Forest, Boreal Forest, Peace River Parklands, Coast Forest, Queen Charlotte Islands, and Vancouver Island. Martens are generally separated into interior and coastal forms (Lofroth and Steventon, 1990). This species account is limited to interior forest populations, because coastal martens may have different requirements due to variation in climatic conditions and habitat.

7.2.2 Distribution in Project Area

Martens were considered plentiful to common but slowly decreasing in population due to habitat alterations throughout the Williston reservoir watershed (encompassed by the Mackenzie Forest District) according to a survey of trappers in 1992 (Becker, 1992). Distribution of martens within the Klawli project area (south-west quadrant of the Williston reservoir) is expected to be widespread and of moderate to high numbers. Martens are expected to occur within all of the lower elevation habitat subzones of the study area, because appropriate habitat and prey are present. Discussions with local biologist Richard Weir and trapper Dennis Jones indicate that the Williston area contains prime marten habitat. Trapping records reflect the overall high numbers of martens throughout the area. Occurrence within the ecoregions, ecosections, and biogeoclimatic zones of the study area is summarised in Table 38.

Table 38: Expected Marten Occurrence within the BEC Zones, Subzones and Variant of the Klawli Project Area, Mackenzie Forest District, B.C.

Ecoprovince	Ecoregions	Ecosections	BEC Variants	Expected Occurrence
Sub-Boreal Interior	Omineca Mountains	Manson Plateau (MAP)	AT	x
			ESSFmv3	•
			ESSFmvp3	?
			SBSmk1	•
		Southern Omineca Mountains (SOM)	BWBSdk1	•

Legend: • = occurs in the variant; •? = probably occurs in the variant; ? = unlikely to occur in the variant; x = essentially absent

7.2.3 Elevational Range

Within the study area, martens are found from the valley bottoms and plateaus of the SBS and BWBS zones up to the ESSF (1200-2100 m). Generally, martens are not found in the AT zone or in the upper elevation ESSFmvp3 (parkland variant) due to lack of forested security habitat and harsher winter climate.

7.3 Ecology and Habitat Requirements

Across most of North America, martens are associated with late seral stages and uneven-aged stands of coniferous or mixed wood forests (Soutiere, 1979; Snyder and Bissonette, 1987; Spencer *et al.,* 1983; Stevenson and Major, 1982; Weckworth and Hawley, 1962). They are also known to tolerate a variety of forest habitats if specific security and foraging habitat requirements are met (Strickland and Douglas, 1987). Martens have been found to decline with removal of forested habitat, increased human access, and unrestricted trapping (Clarke *et al.,* 1987 cited in Becker, 1992). Hargis and Bissonette (1997) determined that forested areas with more than 25% removal were not used by martens, and there were no increases in densities with increases in prey abundance, concurrent to low levels of fragmentation. Steventon and Major (1982) found that martens avoided clearcuts in the winter and used them less than expected (in proportion to availability) in the summer, foraging for berries when available. Many ecology studies have found that martens do not use clearcuts for 15 to 40 years post-harvesting (Soutiere, 1979; Snyder and Bissonette, 1987; Slough, 1988; Thompson, 1994). Thompson (1994) found that in Ontario densities of martens in uncut forests were 90% higher than those of martens in harvested forests. Lofroth (1993) found that male martens use “unsuitable” stands by selecting patches of suitable habitat within the larger matrix of poor habitat.

Martens generally prefer spruce-fir sites to lodgepole pine sites (Buskirk *et al.,* 1989; Corn and Raphael, 1992). A winter survey by Penner (1981) in the Liard River Valley of B.C. found that martens preferred spruce forest and burned areas with tall, deciduous shrub and pole-sized aspen. They generally avoided burns with lodgepole pine regeneration, floodplain deciduous and coniferous forests, and habitats with no cover. Also, in the Liard River Valley, but in the Yukon Territory, martens showed a distinct preference for white spruce dominated cover types as did the red squirrel and snowshoe hare (Slough, 1988). Martens were also found to be moderately abundant in the widespread upland pine forests (Slough, 1988).

Home range size of martens vary significantly among geographic areas and between sexes (Buskirk and McDonald, 1989; Soutiere, 1979; Weckworth and Hawley, 1962), and reflect habitat quality (Soutiere, 1979). Females have smaller home ranges than males (Baker, 1992), which may reflect sexual dimorphism (males are heavier than females) (Table 39).

Table 39: Home Range Sizes of Male and Female Martens from Various Studies in Western North America.

Location	Female Range	Male Range	Reference
Alaska	3.7 km^2	6.8 km^2	Buskirk, 1983, cited in Thompson and Colgan, 1987
Interior of British Columbia	0.8 – 8.4 km^2	2.0 – 15.72 km^2	Lofroth and Steventon, 1990
Quesnel, B.C.	1.0 - 5.6 km^2	1.0 - 5.6 km^2	Keystone Wildlife Research, 1995
Yukon	2.1 km^2	5.9 km^2	Archibald and Jessup, 1984, cited in Thompson and Colgan, 1987

7.4 Habitat Use (Life Requisites and Seasons)

Martens use habitat within the Klawli project area throughout the year. Life requisites for martens include water, food, foraging sites, resting and maternal den sites, security cover, and a good interspersion of habitat types providing these requisites (Lofroth and Banci, 1991). Habitat use ratings were divided into two seasons, growing and winter, based on different seasonal life requisites. Table 40 summarizes the life requisites rated for martens.

Table 40: Summary of Rated Life Requisites and Seasons for Martens in the Klawli Project Area, Mackenzie Forest District, B.C.

Rated Life Requisites and Seasons	Code	Months of Use
Food - Growing season Security - Growing season	FD_G SH_G	May-October
Food - Winter Security and Thermal - Winter	FD_W ST_W	November-April
Security and Thermal - Reproducing by birthing	ST_RB	March-May

7.4.1 Food Habitat

Martens are opportunistic foragers and consume a variety of prey, although most studies suggest that they are microtine specialists (mice and voles) (Buskirk and MacDonald, 1984; Koehler and Hornocker, 1977; Quick, 1955; Weckwerth and Hawley, 1962). Although there is geographical variation in diets, studies have repeatedly found that martens use voles more than any other single food item (Buskirk and MacDonald, 1984; Cowan and Mackay, 1950; Koehler and Hornocker, 1977; Soutiere, 1979; Quick, 1955; Weckworth and Hawley, 1962).

Diet choice is also highly dependent upon prey availability and abundance; which limits the amount of use a given area will receive (Thompson and Colgan, 1990; Weckworth and Hawley (1962). Thompson and Colgan (1987), in north central Ontario, found that low prey availability resulted in reduced population densities, enlarged home ranges, and poor condition of adult females.

Small mammal populations are greater in areas with good security and thermal cover. These are generally productive sites with abundant low shrub and herb layer and abundant CWD. Keisker (1996) suggests that CWD from decay classes 1, 2 and 3 offers the best subnivean habitat by providing small, concealed spaces required for prey species. Koehler and Hornocker (1977) found that mesic habitat types supported the greatest number of rodents concurrent to the greatest number of understorey plant species. This suggests that mesic sites should be significant for foraging for prey year round. Lofroth and Banci (1991) found that the best foraging habitats in the SBS biogeoclimatic zone contain >100m^3/ha of CWD at least 20 cm in diameter, 5 m^2/ha basal area of snags at least 20 cm in diameter, and at least 30% canopy closure.

<u>Growing Season</u>

Diets choices vary between the growing and winter seasons. Martens have a diverse summer diet of mammals, eggs, birds, fish, insects and carrion (Buskirk and Ruggiero, 1994). Berries are foraged when available especially *Vaccinium* sp. and *Rubus* sp. (Buskirk and Ruggiero, 1994), and Saskatoon (Thompson and Colgan, 1990). Thompson and Colgan (1990) observed an increased occurrence of insects and berries and reduced use of snowshoe hare in the summer.

Habitat use also varies between the summer and winter, with use of more open habitat (e.g. structural stages 3a and 3b) where prey availability is high and accessible during the growing season (no subnivean access in the winter). Koehler and Hornocker (1977) found that open meadows and burns might be used in the summer if adequate cover is available for accessing berries and insects. During the growing season, foraging habitat is less limiting than in the winter, when fewer food choices and habitat are accessible.

<u>Winter</u>

A study by Koehler *et al.,* (1990) on the use of different successional stages by martens in the winter confirmed previous findings that martens did not forage in younger successional stages but selected older-aged stands with higher occurrences of voles.

A crucial component of winter food habitat for martens is availability of access points to subnivean (under snow) spaces where the majority of hunting occurs (Lofroth and Steventon, 1990; Sherburne and Bissonette, 1994). Corn and Raphael (1992) found that martens used existing openings to gain access created by CWD at low snow depths and by lower branches of live trees in deeper snow. In the south central Yukon Territory, martens were also found to gain access to the subnivean using tree trunks, deadfall, and saplings (Northern Biomes Ltd., 1983). Decayed stumps and trees of large diameter may also provide access (Steventon and Major, 1982; Hargis and McCollough, 1984).

Quick (1955) identified the winter diet of martens in northern B.C. as including (in order of importance) red backed vole, deer mouse, red squirrel, snowshoe hare, bird (sp. unknown), grouse, shrew, and porcupine. Douglass *et al.* (1983) also found voles to be the major winter food source of martens in the boreal forest of the Northwest Territories. Squirrels and/or hares become more important in late winter and early spring (Buskirk and Ruggiero, 1994; Buskirk and MacDonald, 1984; Northern Biomes Ltd., 1983). In the western interior of Alaska, Paragi and Wholecheese (1994) observed a marten attack and kill a goshawk during the winter.

7.4.2 Security and Thermal Habitat

<u>Growing Season</u>

Martens will avoid areas with little or no canopy cover and generally prefer a coniferous canopy cover of 30% to 80% (Lofroth and Banci, 1991; Lofroth and Steventon, 1990; Spencer *et al.,* 1983). However, they will avoid stands that are so dense as to suppress herbaceous cover (Spencer *et al.,* 1983). Martens seldom venture more than 10 to 100 m from forest cover, using forest edges for security while hunting along clearcut openings (Hargis and McCollough, 1984; Spencer *et al.,* 1983; Slough, 1988; Lofroth and Steventon, 1990).

Overhead cover (especially near the ground) is needed as security cover to provide protection from both avian (e.g. Great Horned Owl) and terrestrial predators (e.g. coyote, fox and Lynx) (Buskirk and Ruggiero, 1994; Thompson, 1994; Brainerd, 1990). Martens also require trees of pole size or bigger to climb to escape predation.

Security habitat for resting sites are often associated with large woody debris, cavities in decayed logs, squirrel middens, snags, stumps, logs, and canopy cover (Buskirk, 1984; Buskirk *et al.,* 1989; Spencer, 1987). Keisker (1996) suggests that although martens use a wide range of wildlife trees (Classes 2 to 7, with 1 being the least decayed), they will select trees in the older wildlife tree classes for resting and denning. They also show preference for resting sites in large branches available in black cottonwood trees and to a lesser extent lodgepole pine and aspen. Non-winter resting sites include witches broom in hybrid white spruce and lodgepole pine (Keisker, 1996).

A close association between martens and red squirrels was found in south-central Alaska where martens primarily used active middens as resting sites (Buskirk, 1984). Spencer (1987) observed a similar relationship between martens and decayed log cavities used as middens by Douglas' squirrels.

<u>Winter</u>

Winter security habitat requirements are much the same as during the growing season, but thermal habitat may play a more important role during the winter. Important security habitat is likely to also supply thermal needs (e.g. forest cover for snow interception and/or large woody debris for resting), therefore the ratings are presented as a combined security and thermal value (depicted as ST in the ratings table).

Sites used during periods of severe winter temperatures were found to be selected based on their thermal properties (Buskirk *et al.,* 1989). Winter resting sites are characterised as subnivean sites partially or completely surrounded by coarse woody debris. During winter in the central Rocky Mountains, Buskirk *et al.,* (1989) found martens primarily used subnivean resting sites where coarse woody debris was available to provide thermal cover. Spencer (1987) found that subnivean sites were used exclusively under continuous snow conditions. Above ground sites (often arboreal) are used in the summer, but may also be used during warmer winter weather, early spring (Buskirk *et al.*, 1989).

7.4.3 Reproduction (Natal and Maternal Denning Security and Thermal Habitat)

Breeding takes place from late June to early August, with the peak of activity in July (Stordeur, 1986). During March and April, martens give birth in dens to 1 to 6 (average of 3) kits (Stordeur, 1986). The young emerge from the dens at about 50 days of age, although they may be moved among dens before this (Buskirk and Ruggiero, 1994).

Martens use two types of dens: natal dens (where parturition occurs) and maternal dens (different dens where young are raised) (Buskirk and Ruggiero, 1994). Females will generally change den sites when kits become mobile (Lofroth and Banci, 1991). Little information exists on requirements for maternal den sites, although it is suggested that sheltered sites in snags and woody debris provide appropriate maternal denning sites (Lofroth and Banci, 1991). According to Buskirk and Ruggiero (1994), natal and maternal dens are commonly found in trees, logs, and snags associated with large structures that are characteristic of late-successional forest. The same authors also report that natal dens are found in habitats with more developed old-growth characteristics compared to those of maternal den sites, and that structurally complex forested habitat will be used more frequently for natal denning. During the whelping period, above ground dens may be required to protect kits from wet spring ground conditions (Wynne and Sherburne, 1984). Structural stage 6 and 7 forests (with 7 the oldest structural stage class) are probably the only habitats that will consistently provide large trees and structures with suitable natal and maternal den attributes.

7.4.4 Seasons of Use

Table 41 summarizes the rated life requisites for martens for each month of the year within the Klawli project area.

Table 41: Monthly Rated Life Requisites for Martens in the Klawli Project Area.

Month	Season*	Rated Life Requisites
January	Winter	Food, Security and Thermal
February	Winter	Food, Security and Thermal
March	Winter	Food, Security and Thermal Reproducing – security and thermal (natal dens)
April	Winter	Food, Security and Thermal Reproducing – security and thermal (natal dens)
May	Growing	Food, Security, and Reproducing – security (natal dens)
June	Growing	Food, Security, and Reproducing – security (natal dens)
July	Growing	Food, Security, and Reproducing – security (natal dens)
August	Growing	Food and Security
September	Growing	Food and Security
October	Growing	Food and Security
November	Winter	Food, Security and Thermal
December	Winter	Food, Security and Thermal

*Seasons defined for the Sub-Boreal Interior Ecoprovince per the Chart of Seasons by Ecoprovince (RIC, 1998; Appendix B).

7.5 Ecosystem Attributes

A number of relationships between habitat use and ecosystem attributes can be determined for martens based on extensive research throughout North America and local knowledge of biologists and trappers. Often the habitats used most frequently are associated with specific elevations, stand structure and age class, vegetation cover, etc. Table 42 lists which ecosystem attributes are considered in the habitat ratings tables.

Table 42: Terrestrial Ecosystem Mapping (TEM) Relationships for Each Life Requisite for Martens.

Life Requisite	Ecosystem Attribute
Food	Structural stages: 5, 6, and 7 Structural elements: volume of CWD Stand type: mixed wood, and coniferous forests, spruce-fir stands, some lodgepole pine use Vegetation: % cover shrubs and trees, berry shrub component, canopy cover Site: slope, aspect
Security and Thermal	Structural stages: 5, 6, and 7 Structural elements: size and volume of CWD (>20 cm diameter and 100m^3/ha), CWD quality (class of decay), cavities in large trees Vegetation: % cover of shrubs and trees (>30% canopy closure)
Reproduction	Structural stages: Older forested stands (stage 6 and 7) Stand type: coniferous and mixed forests Structural elements: large diameter coniferous and deciduous live and dead (snags) trees

7.6 Development of the Habitat Ratings

Habitat ratings were developed through collection of habitat data within the study area over a two-week period, supported by personal communications with local biologists, local trappers, and species experts, and supplemented with a current literature review.

7.6.1 Rating Scheme

A 4-class rating scheme of high (H), moderate (M), low (L), and nil (N) was used when assigning habitat ratings to the ecosystem units present within the Klawli project area. The broader 4-class was used due to the intermediate level of knowledge of habitat use by martens in B.C. This rating scheme is suggested by RIC (1998) for use with martens at the 1:20,000 map scale and is defined in Table 43. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for martens as previously outlined in Table 41.

Table 43: Habitat Capability and Suitability 4-Class Rating Scheme (from RIC, 1998).

% of Provincial Best	Rating	Code
100% - 76%	High	H
75% - 26%	Moderate	M
25% - 1%	Low	L
0%	Nil	N

7.6.2 Provincial Benchmark

A provincial benchmark has not yet been established for martens, because they are widespread throughout the province. Stordeur (1986) established a high density rating for martens for the BWBS and SBS biogeoclimatic zones, a moderate density rating in the ESSF zone, and martens were considered absent in the AT zone. High value habitats (rated 1) should be present within the BWBS and SBS zones of the study area.

7.6.3 Ratings Assumptions

The following assumptions have been made in assigning habitat values to terrestrial ecosystem units for the Klawli project area:

Life Requisite and Season	Assumptions
Food Habitat During the Growing Season FD_G	Values are reflective of food presence and are assumed accessible by martens. Abundance of prey items increases the quality of habitats and areas for martens (assumed to be mainly small mammals) have high food values for martens. **<u>Structural Stage</u>** ▪ Stage 1 ecosystems do not generally support marten prey and are therefore given nil or low food ratings. ▪ Stage 2 units, meadows and burns, generally have poor suitability for foraging by martens due to the lack of security cover, but may be utilized when prey is abundant. ▪ If sufficient shrub cover exists, martens may forage farther into stage 3, 3a, and 3b shrubby burns and clearcuts. ▪ In the growing season, structural stages 6 and 7 presumably provide optimal food habitat, and stages 4 and 5 have low to moderate values. **<u>Vegetation Characteristics</u>** ▪ Units that produce good berry crops will also have moderate food values in the growing season, because martens will often forage on berries in the late summer and fall. ▪ Abundant low shrub and herb layer and abundant CWD. **<u>Moisture and Nutrient Regime</u>** ▪ Submesic to subhygric moisture regimes with abundant shrub cover provides the most suitable habitat for small mammals (Lofroth and Banci, 1991). Dryer sites are not productive enough to provide good habitat for small mammals; and wetter sites, although productive, may have surface and sub-surface water present reducing availability of subterranean habitats (Lofroth and Banci, 1991). ▪ Use of riparian zones for foraging (Baker, 1992). **<u>Slope</u>** ▪ Aggregates of CWD are commonly found in steep-sloped, upper level riparian areas (toe position) through the process of natural downhill movement of windthrow and earthflow (Buskirk *et al.*, 1989). **<u>Elevation</u>** ▪ Ecosystems in the AT and ESSFmv3p zones generally have no food value (rated nil) during the growing season due to a lack of forest cover at these higher elevations. All ecosystem units in these zones are given nil values for food with the exception of a few shrubby units in the ESSFmvp that may have some limited food value during the growing season.

Life Requisite and Season	**Assumptions**
Food Habitat During the Winter FD_W	The present model assumes martens are using a winter subnivean prey source, and alternate food sources (hares and carrion) have not been taken into account. **Structural Stage** • Stage 1 ecosystems have no value (rated nil), because they do not generally support marten prey and are inaccessible in winter. • In a winter of average snowfall, prey is assumed to be present yet not accessible to martens in younger structural stages (2 to 4) due to an absence of access points from CWD and lack of security cover. These structural stages are therefore given nil to low food values. • Stage 5 has some food value (generally rated low quality). • Oldgrowth and mature structural stages have the highest winter food values. They have the most large size CWD, stumps, snags, and large trees, which increases the access to subnivean hunting. **Vegetation Characteristics** • Small mammal populations are greater in areas with good security and thermal cover. These are generally productive sites with abundant low shrub and herb layers and abundant CWD. **Structural Elements** • CWD is required to provide access points to subnivean hunting for martens. **Moisture and Nutrient Regime** • Same as requirements for food in the growing season. **Elevation** • Ecosystem units in the AT and ESSFmvp zones have no food value (rated nil) in the winter due to deep snow depths and a lack of ST habitat at these higher elevations.
Security Habitat During the Growing Season SH_G	**Structural Stage** • Due to the lack of overhead cover (not security or thermal cover) in structural stages 1 and 2, they are given ratings of nil for SH habitat. • Some stage 3, 3a, and 3b units with dense overhead shrub cover can provide low to moderate SH values during the growing season, but generally are of poor suitability. • Stages 4 and 5 have lower SH values than stage 6 and 7. • In the growing season, structural stages 6 and 7 are presumed to provide optimal SH habitat. They have the greatest amount of large size CWD, stumps, snags, and large trees, which increase the number of potential available resting and denning sites, and availability of security and thermal cover. **Vegetation Characteristics** • Martens will avoid open areas and generally prefer a coniferous canopy cover of 21-60% (Lofroth, 1993). Therefore ecosystems with <30% canopy closure are given low SH habitat ratings. • In general, habitats with low levels of coniferous composition receive low SH values. • Ecosystems with abundant low shrub layers and CWD afford more security habitat and therefore receive higher ratings. **Elevation** • Due to a lack of tree cover at these higher elevations, all ecosystem units in the AT and ESSFmvp zones are given nil values for SH habitat in the growing season with the exception of a few shrubby units in the ESSFmvp that may have some limited SH value.

Life Requisite and Season	**Assumptions**
Security and Thermal Habitat During the Winter ST_W	**Structural Stage** • Martens generally avoid habitats that lack overhead cover (Hargis and McCollough, 1984; Spencer *et al.,* 1983; Lofroth and Steventon, 1990). Structural stages 1 and 2 are therefore given ratings of nil for ST quality. • Stages 3, 3a, and 3b have poor values in the winter because subnivean access points are limited, there is a lack of den sites, and thermal cover is lacking. They are therefore rated low at best. • Stages 4 and 5 will have lower ST values than stages 6 and 7. • In the winter season, structural stages 6 and 7 are presumed to provide optimal ST habitat. **Structural Elements** • Martens require at least pole size or bigger trees to escape predation, because smaller trees will not provide adequate security cover. **Vegetation Characteristics** • See above security assumptions during the growing season for veg. • Coniferous trees provide more canopy closure than deciduous trees during winter and thereby provide better thermal protection and security cover from aerial predators. Habitats with low levels of coniferous composition receive low ST values. **Elevation** • All ecosystem units in the AT and ESSFmvp zones are given nil values for ST habitat in the winter due to deep snow depths and a lack of tree cover at these higher elevations.
Security/Thermal Habitat for Reproduction (Natal and Maternal denning) ST_RB	**Structural Stage** • Structural stages 6 and 7 are the only stages that will consistently provide large, suitable trees and structures required for natal and maternal dens within the study area (rated M to H). • Structural stages 1 to 5 are given nil values for reproducing. **Vegetation Characteristics** • Coniferous or mixed forests that supply large diameter trees are given the highest habitat ratings for potential natal denning. **Nutrient and Moisture Regime** • Ecosystem units with the greatest potential to produce large diameter coniferous and deciduous trees (medium to very rich sites) are given the highest reproducing ratings. **Elevation** • High elevation sites in the AT and ESSFmvp zones do not support large trees needed for reproducing. Therefore, all ecosystem units in these zones are given nil value for reproducing.

7.6.4 Limitations

The species-habitat model assumes information on ecology of martens from other regions of B.C. and North America is applicable to the study area. It also assumes that access to subnivean prey is limiting. They are, however, generalists and opportunistic foragers.

7.6.5 Rating Adjustment Considerations

Martens will presumably avoid travelling across large open areas. Landscape fragmentation will thus reduce the quality of habitats, because highly fragmented areas will have little connectivity between mature habitats, making travelling between units difficult. In addition, logging and post logging practices can alienate martens from traditional habitat and reduce abundance of prey (herbicide and pesticide treatments) (Ritchie and Sullivan, 1989). Forest fragmentation, removing more than 25% of cover, will also reduce suitability for martens (Hargis and Bissonette, 1997).

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8.0 SPECIES – HABITAT MODEL FOR FISHER

Common Name:	**Fisher**
Scientific Name:	*Martes pennanti*
Species Code:	M-MAPE
B.C. Status:	Blue-listed (B.C. MELP, 1996; B.C. CDC, 1997)
Identified Wildlife Status:	Yes (B.C. MELP, 1997)
COSEWIC Status:	Not applicable

8.1 Introduction

In British Columbia, the fisher is considered to be vulnerable to over-harvest because it is not present on most registered traplines in manageable numbers, and is therefore managed as a Class 2 fur-bearer (B.C. Ministry of Environment, 1991). Fishers are blue-listed (vulnerable status) in B.C. by the Ministry of Environment, Wildlife Branch because of suspected population declines. Consequently it has been identified as a species of management concern and has recently been included as an Identified Wildlife Species in the *Identified Wildlife Management Strategy* (1998) for the *Forest Practices Code of British Columbia.*

Most of the research regarding this species has been conducted in the eastern half of North America. Some studies have taken place in the west, however, predominantly in the United States. Research on fisher in B.C. has increased over the last decade due to the reported decrease in numbers and lack of information for B.C. fisher ecology. In B.C., Weir (1995 and 1998) examined the diet, spatial organization, and habitat relationships of fishers in the Williams Lake area, south central (1995) and northwest of Mackenzie, in North-Central B.C. (1998). The later study is currently ongoing as part of a 5 year research project. Information from it is considered directly applicable to this species-habitat model, because the Klawli project area contains similar habitat and many of the same subzones and variants. In addition to using local information, supplemental literature sources from western North America have been included where applicable.

At this time, general habitat ratings for the fisher are predicted to have a low to moderate reliability. No model verification has been done to confirm levels of use (i.e. inventory) within the ecosystem units and structural stages mapped for the Klawli project area.

8.2 Distribution

Fishers only occur in North America (Douglas and Strickland, 1987), where they range through most of the Canadian Provinces, from B.C. east to Nova Scotia. They extend north into the southern Yukon and southern Northwest Territories, and extend south into parts of the western and eastern United States. They are largely absent from the central United States, and do not occur in Alaska.

8.2.1 Provincial Range

Fishers are generally thought to be well distributed across British Columbia, occurring in most ecoprovinces and biogeoclimatic zones, with the exception of the coastal islands and the southern portions of the Southern Interior and Southern Interior Mountains Ecoprovinces. However, detailed distribution is not known and could be quite patchy. Further inventory is required to confirm suspected ranges (RIC, 1997).

Fishers are found at low densities throughout the boreal forests of British Columbia, where they reach the northern extent of their range in the province (Banci, 1989). However, fishers also occur within the southeast corner of the Yukon where they are also believed to be rare (Hagmeier, 1956; Penner, 1981; Slough, 1985). Banci (1989) roughly estimates a density of >1 fisher/200km^2 in B.C., but emphasizes that information is insufficient to estimate densities and populations sizes.

8.2.2 Distribution in the Project Area

Within British Columbia, fisher are considered to be uncommon to common yearlong in the dry, cool BWBS; absent in the moist ESSF and in the wet parkland ESSF, and are considered uncommon to common yearlong in the moist, cool SBS (Weir, pers. comm.). Fisher occurrence within the ecoregions, ecosections, and biogeoclimatic zones of the Klawli study area are summarised in Table 44.

According to a 1992 trapper questionnaire of the Williston Reservoir watershed, fishers are considered to be extremely scarce in the area, and low trapping occurrences indicate that populations are not changing (Becker, 1992). Current research in the area by Weir (1998) has inventoried fisher habitat use within three of the same subzones present within the Klawli study area. Weir's results to date (ongoing 5-year project) were assumed to reflect presence/absence and habitat selection for the same subzones within the Klawli, because no other local research has been completed to date.

Table 44: Expected Fisher Occurrence within the BEC Zones, Subzones and Variant Combinations Found within the Klawli Project Area, Mackenzie FD, B.C.

Ecoprovince	Ecoregions	Ecosections	BEC Variants	Expected Occurrence
Sub-Boreal Interior	Omineca Mountains	Manson Plateau (MAP)	AT	x
			ESSFmvp3	x
			ESSFmv3	x
			SBSmk1	•
		Southern Omineca Mountains (SOM)	BWBSdk1	•

Legend: • = occurs in the variant; •? = probably occurs in the variant; ? = unlikely to occur in the variant; x = essentially absent

8.2.3 Elevational Range

Generally, fishers occur at the lower range of elevations; seasonal movements between different elevations do not often occur (Banci, 1989). Within the study area, fishers are likely to occur in the valley country of the SBS and BWBS, preferring areas of higher canopy closure which are more often associated with lowland forest (Powell, 1982). Trappers reported fishers to most commonly use the ESSF and SBS successional stage 5 habitat types in the Williston reservoir area (Becker, 1992). Fishers are not found in the AT zone due to the lack of forested security cover and prey.

8.3 Ecology and Habitat Requirements

Fishers occur primarily in forested landscapes and often prefer late succession forest to younger seral stages (Jones and Garton, 1994, in Weir and Harestad, 1997). It appears that fishers in western coniferous forests may rely on the structures and ecological process associated with late successional stands to fulfill many of their life requirements (Ruggiero *et al.,* 1994).

During periods of deep snow accumulations fishers will avoid traveling through open areas and soft snow, and will use forests with snow interception (Arthur *et al.,* 1989; Raine, 1983). The types of forests that provide snow interception are generally mature coniferous stands.

Fisher establish home ranges that are used all year, but that may vary seasonally (i.e., larger in the summer and smaller in the winter) Weir (1995). Home range sizes for male fishers are usually larger than for females, because fishers are sexually dimorphic; the males are usually significantly larger than the females, and require a larger area to maintain their body condition (Weir, 1995). Home ranges within the sexes do not overlap, but male and female ranges do overlap. Fishers intrasexual home ranges do not usually overlap, whereas intersexual home ranges do overlap (Weir, 1995). The size of home ranges for male and female fishers varies between studies, likely a reflection of habitat and prey availability (see Table 45). In North-Central B.C., research by Weir (1998) has recorded larger home range sizes than found elsewhere. However, the limited sample size and variation in resource distribution between regions may in part explain the significant variation.

Table 45: Annual Home Range Sizes of Male and Female Fisher From Various Studies in British Columbia.

Location	Male Range	Female Range	Reference
British Columbia	20-34 km^2	15-19 km^2	Banci, 1989
North-Central B.C. (Williston Reservoir Area)	*281.8 km^2	**43.9 km^2	Weir, 1999
Quesnel, B.C.	15-35 km^2	15-35 km^2	Keystone, 1995
Williams Lake, B.C.	46.5 km^2	26.4 km^2	Weir, 1995 Weir and Harestad, 1997

*= sample size of 1; ** = sample size of 5

8.4 Habitat Use (Life Requisites and Seasons)

In general, fishers prefer a diversity of forest types with a high degree of interspersion (Arthur *et al.,* 1989; Banci, 1989). Fishers use multi-aged stands interspersed with openings, wetlands, edges, or ecotones (Banci, 1989; Powell and Zielinski, 1994). Riparian forests are also important habitat for fishers (Buck *et al.,* 1994; Powell and Zeilinski, 1994), because they tend to select for old-growth habitat elements in riparian stands (Weir, 1995). In the Mackenzie area, high fisher use has also been found in areas with cottonwoods and kettle lake systems (Weir pers. comm., Oct. 1999; Weir, 1999).

A high degree of stand diversity is optimal for fisher habitat. Important stand characteristics include tree height and shape; opening size; associated understorey vegetation; volume, piece size and decay class of coarse woody debris (CWD); density and decay class of snags; and layering of cover (Buskirk and Powell, 1994; Weir, 1995; Weir, 1999). This complexity in forest structure and the associated prey may be essential features in habitat preferences of fishers (Buskirk and Powell, 1994).

Fisher habitat use for the study area is broken down into two seasons – growing and winter. Life requisites that are rated for the fisher include food, security, combined security and thermal, and reproduction (natal and maternal denning security and thermal habitat) as summarised in Table 46.

Table 46: Summary of Rated Life Requisites and Seasons for Fisher in the Klawli Study Area, Mackenzie FD, B.C.

Rated Life Requisites and Seasons	Code	Months of Use
Food - Growing season Security - Growing season	FD_G SH_G	May-October
Food - Winter Security and Thermal - Winter	FD_W ST_W	November-April
Security and Thermal - Den Habitat for Reproducing by birthing	ST_RB	March-May (Natal dens) May-July (Maternal dens)

8.4.1 Food Habitat

Fishers forage in habitat that provides food and cover for their prey (Weir, 1995). Low conifer branches, CWD, abundant low and high shrub cover, rocks, and small trees offer the dense physical structure required by snowshoe hare (Livaitis *et al.,* 1985) which are selected by fishers (Buskirk and Powell, 1994; Powell, 1982; Weir, 1995). Prey availability is the most important factor determining selection of foraging habitat by fishers.

Fishers are generalist feeders, and have diverse diets dominated by snowshoe hare, porcupine, red squirrels, small mammals (particularly red-backed voles), and birds (Banci, 1989; Weir, 1995). Fisher diet and habitat use varies regionally (Douglas and Strickland, 1987), but throughout most of the fishers' range, snowshoe hares are probably the primary food source (Kuehn, 1989). Although literature indicates that fisher numbers may be largely reflective of hare abundance in many areas, Weir (1995) suggests that fisher diets in B.C. may not be as dependent on hare as those in more eastern regions. This is supported by findings of Kuehn (1989). Fishers will switch prey in response to availability (Banci, 1989), and they can thus compensate for decreases in populations of their primary prey by switching to more available prey items (Kuehn, 1989; Weir, 1995). In south central B.C., fishers also tended to use porcupine less than is documented in other study areas, and to use moose carrion rather than deer carrion (Weir, 1995).

As there is an extreme sexual dimorphism in fishers, the smaller females tend to use smaller prey items than males (Holmes and Powell, 1994; Weir, 1995).

<u>Growing Season</u>

There is an increased use of plant material, especially fruits and nuts, during the summer (Powell and Zielinski, 1994).

Although fishers are most often associated with relatively unfragmented, late-successional forests (Powell and Zielinski, 1994), they may be able to utilize earlier successional stages of forest for hunting in the summer (Banci, 1989).

<u>Winter</u>

Winter food values closely reflect security/thermal values. During times of little snow, or when a heavy crust is present, fishers are able to travel extensively and may utilize most site series for hunting.

During the winter, fishers are not limited by access to subnivean hunting or resting sites as the majority, if not all, foraging occurs above the snow (Buskirk and Powell, 1994; Raine, 1983). Stands with no coarse woody debris are avoided and in winter stands with >50 m^3/ha of CWD >20 cm in diameter not resting on the ground, are preferred (Weir, 1995).

8.4.2 Security and Thermal Habitat

Growing Season

Fishers avoid non-forested areas (Jones and Garton, 1994; Powell and Zielinski, 1994; Thomasma *et al.,* 1994; Weir, 1995) and mixed, selectively logged stands (Weir, 1995). Kelsall *et al.* (1977) found fishers to be virtually absent from recently burned or logged stands, but were observed to utilize second-growth stands more than martens. Fishers are generally believed to require closed-canopy habitats, although a portion of the canopy may be comprised of deciduous species (RIC, 1997). Fishers selected sites with >20% canopy closure in south central B.C. (Weir, 1995) and >50% in Michigan (Thomasma *et al.,* 1994); 21% to 41% of the canopy may be deciduous (Weir, 1995). Fishers selected for trees >27 cm diameter at breast height in Michigan (Thomasma *et al.,* 1994).

Resting sites can be quite diverse, including snow dens, hollow logs, holes in the ground, tree cavities, snags, and downed logs (Banci, 1989). Tree species used for resting in the Williams Lake area included aspen, cottonwood, Douglas-fir, and spruce (Weir, 1995). Spruce trees infected with spruce broom rust appear to be important rest sites during all parts of the year (Weir, 1995, 1999). Keisker (1996) suggests that CWD in early decay classes are the most important for resting and denning sites.

Winter

As with the growing season, fishers are believed to require closed-canopy habitats for security cover (see above growing season security habitat description). In the winter, thermal habitat also becomes an important life requisite. Fishers have been observed to select for spruce stands with deciduous components, and to use CWD and slash piles for security as well as thermal protection (Weir, 1995). Fishers tend to select single, large (>30 cm diameter) pieces of early decay class debris for resting during periods of extreme cold (Weir, 1995).

8.4.3 Reproduction (Natal and Maternal Den Security Habitat)

Generally, fishers may give birth as early as January but more commonly in March to April, having 1 to 4 (average of 2 to 3) kits (Banci, 1989; Powell, 1982). Breeding takes place soon after parturition, with the breeding season from late February to mid-April (Banci, 1989). Similar to other mustelids, fishers go through delayed implantation in their reproductive process (Powell, 1982). After a short gestation period (approximately 30 days; Powell, 1982), the kits are born and become independent at four to five months of age (Powell and Zielinski, 1994). Female fishers become sexually mature and can begin breeding at the age of one, but usually have their first litter when they are two years of age (Powell and Zielinski, 1994).

Most information on natal dens (where parturition occurs) and maternal dens (dens where young are raised) comes from eastern North America. Fisher kits are generally moved from natal to maternal dens when they are about 8 to 10 weeks old (Powell and Zielinski, 1994). In south central B.C., Weir (1995) found females moved their kits to different maternal den trees 4 to 6 weeks following parturition. Female fishers use 1 to 3 dens per litter, and will move dens if disturbed (Paragi, 1990, cited in Powell and Zielinski, 1994).

Den requirements include thermal protection for kits and security from predators (Banci, 1989). In general, tree cavities are used almost exclusively for natal and maternal dens, and large, dead or living trees are needed to provide suitable den sites (Powell and Zielinski, 1994). Most natal dens found have been in hardwoods – most commonly aspen (Powell and Zielinski, 1994). In south central B.C., Weir (1995) found fishers whelped exclusively in large cottonwood trees (mean diameter 103 cm, n=5) that contained heart rot and branch-hole cavities. These trees were relatively rare, and were frequently found in riparian and riparian-associated habitats (Weir, 1995 and 1998). Dens were located an average of 25.9 m above the ground (Weir, 1995). Weir (pers. comm.) suggested that large diameter cottonwoods could be significant, even possibly limiting, for natal denning and whelping in the North-Central interior (Weir, 1995). Structural stage 6 and 7 forests are probably the only habitats that will consistently provide large trees with suitable den attributes, unless they are left during forest harvesting (isolated patches).

In North-Central B.C. (Williston reservoir area), Weir (1998) located 8 natal dens of 6 females and 4 maternal dens of 3 fishers. He recorded fishers denning exclusively in large diameter declining black cottonwood or balsam poplar trees (Weir, 1999). Unique decay characteristics and classes, as well as large diameters supplied the suitable elements for rearing kits (Weir, 1999).

8.4.4 Seasons of Use

Table 47 summarizes the rated life requisites for fisher for each month of the year within the Klawli study area.

Table 47: Monthly Rated Life Requisites for Fisher in the Klawli study area.

Month	Season*	Rated Life Requisites
January	Winter	Food, Security and Thermal
February	Winter	Food, Security and Thermal
March	Winter	Food, Security and Thermal Reproduction - Security and Thermal (natal dens)
April	Winter	Food, Security and Thermal Reproduction - Security and Thermal (natal dens)
May	Growing	Food and Security Reproduction - Security and Thermal (natal and maternal dens)
June	Growing	Food and Security Reproduction - Security and Thermal (natal and maternal dens)
July	Growing	Food and Security
August	Growing	Food and Security
September	Growing	Food and Security
October	Growing	Food and Security
November	Winter	Food, Security and Thermal
December	Winter	Food, Security and Thermal

*Seasons defined for the Sub-Boreal Interior Ecoprovince per the Chart of Seasons by Ecoprovince (RIC, 1998; Appendix B).

8.5 Ecosystem Attributes

A number of relationships between habitat use and ecosystem attributes can be determined for fisher based on current literature/research and local biologist and trapper knowledge. Often the habitats used most frequently are associated with specific stand structure, age class, vegetation cover, etc. Table 48 lists which ecosystem attributes are considered in the habitat ratings tables.

Table 48: Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Fisher.

Life Requisite	Ecosystem Attribute
Food	Structural stages: 4, 5, 6, and 7 Structural elements: volume of CWD(>50 m^3/ha) Stand type: mixed, and coniferous forests, spruce-fir stands, some lodgepole pine use Vegetation: abundant shrub/ground cover, % cover shrubs and trees, canopy cover Site: slope, aspect
Security and Thermal	Structural stages: 4, 5, 6, and 7 Structural elements: size and volume of CWD (>20 cm dbh), CWD quality (class of decay), cavities in large trees for resting Vegetation: % cover of shrubs and trees (>20% canopy closure)
Reproduction	Structural stages: Older forested stands (stage 6 and 7) Stand type: coniferous and mixed forests Structural elements: large diameter (>100 cm dbh) cottonwood trees, or other tree spp. e.g. aspen

8.6 Development of the Habitat Ratings

Habitat ratings were developed through collection of habitat data within the study area over a two-week period, supported by personal communications with local biologists, local trappers, and species experts, and supplemented with a current literature review.

8.6.1 Rating Scheme

A 4-class rating scheme of high (H), moderate (M), low (L), and nil (N) is employed due to the intermediate level of knowledge of fisher habitat use in B.C. This rating scheme is suggested by RIC (1998) for use with fisher at the 1:20,000 map scale and is defined in Table 49.

Table 49: Habitat Capability and Suitability 4-Class Rating Scheme (from RIC, 1998).

% of Provincial Best	Rating	Code
100% - 76%	High	H
75% - 26%	Moderate	M
25% - 1%	Low	L
0%	Nil	N

This rating scheme is used when assigning habitat ratings to the ecosystem units present within the Klawli study area. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for the fisher, as previously outlined in Table 47.

8.6.2 Provincial Benchmark

A provincial benchmark has not yet been established for fisher. According to Weir (pers. comm.), fisher abundance in B.C. is likely highest in the SBS and BWBS zones of the North-Central lowland plateau located within the Omineca-Peace region. From 1985 to 1989, The greatest numbers of fisher have been harvested from the Cariboo and Omineca-Peace regions (B.C. Ministry of Environment, 1990).

8.6.3 Ratings Assumptions

Each combination of ecosystem unit and structural stage was individually assessed for its ability to meet the seasonal requirements for food, security, and reproduction. As fishers are generalist hunters and may use prey in relation to availability, it is relatively difficult to assess habitat in terms of food quality. Habitat assessments for food values are therefore extremely generalized. The following assumptions were made:

Life Requisite and Season	**Assumptions**
Food Habitat During the Growing Season FD_G	During the growing season, most forested units within the study area have some foraging values because fisher prey can be found in a variety of seral stages and forest types during that time. **Structural Stage** • Fishers avoid non-forested areas; therefore, structural stages 1 and 2 are given poor foraging and security/thermal values in both the winter and growing seasons. • Stage 3, 3a, and 3b units may receive some low use for hunting in summer when some overhead cover from brush and saplings is provided and mature stands are adjacent. Values can be relatively high at times – especially in dense spruce, birch, aspen, cottonwood, pine regen. • Stage 4 and 5 can also provide moderate to high values because they often provide excellent food sites for snowshoe hare (a favored prey species) as well as moderate habitat for some other small mammals. • Structural stage 6 and 7 habitats provide optimal foraging attributes, because small mammal prey populations are greater in areas with good security and thermal cover. **Structural Elements** • Fishers forage in habitat that provides food and cover for their prey, primarily snowshoe hares, squirrels, and small mammals (Weir, 1995). CWD, abundant low and high shrub cover, rocks, and small trees offer the dense physical structure required by snowshoe hare, which are selected by fishers. **Vegetation Characteristics** • Edges and ecotones between units have high foraging value, because they are usually very diverse and should have good abundance of several different prey items. **Soil Moisture and Nutrient Regime** • Riparian and riparian-associated units provide many of the attributes that support abundant small mammals populations, and receive high foraging ratings. **Elevation** • Ecosystems in the AT and ESSFmvp zones generally have nil or low food value during the growing season due to a lack of security habitat at these higher elevations. All ecosystem units in these zones are given nil values for food.

Life Requisite and Season	Assumptions
Food Habitat During the Winter FD_W	Winter food values closely reflect security/thermal values. **Structural Stage** • Same as during the growing season. • In an average winter, prey is assumed present, yet often not accessible to fishers in these younger structural stages (1 to 4) due to restrictive snow depths. Therefore, these structural stages will be rated low or nil. **Structural Elements** • As for the growing season, forest stands with greater structural diversity have higher food values due to presence of more prey and more opportunities for hunting. **Vegetation Characteristics** • Same as requirements for food in the growing season. **Soil Moisture and Nutrient Regime** • Same as requirements for food in the growing season. **Elevation** • Ecosystem units in the AT and ESSFmvp3 zones have no food value (rated nil) in the winter due to the lack of food.
Security Habitat During the Growing Season SH_G	**Structural Stage** • Fishers avoid non-forested areas, because they lack security/thermal cover. Therefore, structural stages 1 and 2 are given nil and security/thermal values in both the winter and growing seasons. • Some stage 3 units with dense overhead shrub cover can provide moderate security/thermal values during the growing season. • Stage 5 forests are generally less structurally complex and will have lower security/thermal values, and stage 4 generally have poor values. • In both the growing and winter seasons, structural stage 6 and 7 provide optimal security/thermal habitat. **Structural Elements** • Structurally complex habitats with abundant shrub layers and CWD will enhance security and thermal values for fishers and are given higher ratings. **Vegetation Characteristics** • Stands with <20% canopy closure receive low security/thermal ratings because fishers selected for sites with >20% canopy closure in south central B.C. (Weir, 1995). • Units with large spruce trees may support resting sites and are rated up to moderate. **Elevation** • Due to the lack of suitable forested habitat, all units in the AT are given nil values for security/thermal.

Life Requisite and Season	Assumptions
Security/Thermal Habitat During the Winter ST_W	**Structural Stage** • See growing season assumptions. • Structural stages 1 to 4 are rated as having minimal security habitat value in a winter of average snowfall. • In the winter, excessive snow depth may restrict fisher movements (Raine, 1983). During severe winters, mature (stage 5 and 6), closed canopy, coniferous-dominated stands are probably important habitat for travelling by fishers, providing thermal cover and relatively shallow snow depths that will not hinder fisher movement. **Structural Elements** • Stands with no CWD are avoided. In winter, stands with >50 m3/ha of CWD >20 cm in diameter, which is not resting on the ground, are preferred (Weir, 1995). **Vegetation Characteristics** • See growing season assumptions for security habitat. **Elevation** • All ecosystem units in the AT and ESSFmvp zones are given nil values for ST habitat in the winter due to deep snow depths and a lack of tree cover at these higher elevations. • Habitats at lower elevations are rated up to high in winter.
Security and Thermal Habitat for Reproduction (natal and maternal dens) ST_RB	**Structural Stage** • Structural stages 6 and 7 are the only stages that will consistently provide suitable trees for natal and maternal dens within the study area, because they are limited to structures such as large trees, CWD, and snags found in late-successional forests (Powell and Zielinski, 1994). **Structural Elements** • Stands with no CWD are avoided. **Vegetation Characteristics** • Units that supply large diameter (>100 cm dbh) cottonwood and aspen are given the highest reproducing ratings. **Soil Moisture and Nutrient Regime** • Riparian units often have a deciduous component and are rated up to high (Subhygric-rich site series rated high, mesic rich rated medium). **Elevation** • High elevation sites in the AT and ESSFmvp zones do not support large trees, which provide security/thermal habitat needed for reproducing, and are therefore given a value of nil.

8.6.4 Limitations

Fisher-prey relationships are not well known in North-Central B.C. As prey availability and abundance may be an important factor influencing fisher habitat use, continued research on fisher prey in North-Central B.C. is important to habitat ratings. Food habits, denning requirements, and habitat use should be further identified before habitat relationships can be reliably determined.

8.6.5 Rating Adjustment Considerations

Landscape fragmentation will reduce the quality of habitats. Fishers generally avoid non-forested or open areas with little overhead cover when travelling (Powell and Zielinski, 1994;

Weir, 1995); and highly fragmented areas will have little connectivity between mature habitats, making travelling between units difficult.

In the aspen parklands of Alberta, fishers were found to prefer continuous forests and were rarely found in stands less than 100 ha in size (Badry *et al.,* 1997). Therefore, stand size may also be an important factor in determining habitat quality, with small patches of forest having reduced value.

Post logging practices (herbicide and pesticide treatments) can also reduce abundance of prey for fishers (Ritchie and Sullivan, 1989), also resulting in reduced habitat ratings.

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9.0 SPECIES – HABITAT MODEL FOR GRIZZLY BEAR

Common Name:	**Grizzly Bear**
Scientific Name:	*Ursus arctos horribilis*
Species Code:	M-URAR
B.C. Status:	Blue-listed (B.C. Conservation Data Centre, 1999)
Identified Wildlife Status:	Yes (B.C. MELP, 1997)
COSEWIC Status:	Designated as vulnerable in Canada, following a review by Banci (1991) (COSEWIC, 1997).

9.1 Introduction

Grizzly bears are one of the largest terrestrial carnivores in the world. Like other large terrestrial carnivores, grizzlies are a top predator in the food chain and require large expanses of habitat. As apex predators with conservative reproduction and low resilience to human disturbance (Weaver *et al.,* 1996; Hamilton, 1989), grizzlies are considered to be indicators of ecosystem health.

Grizzly bear requirements for large expanses of continuous wilderness containing abundant food make them very susceptible to habitat fragmentation and human encroachment (B.C. MELP, 1999; Gibeau *et al.,* 1996). Population recovery or resilience is inhibited by a late age of first reproduction, long inter-litter periods, and a low survival rate for cubs (Wielgus, 1986; Miller *et al.,* 1982).

Within North America, British Columbia has some of the best habitat available for grizzly bears. Alaska, the Yukon, and Northwest Territories, and British Columbia currently have the largest populations of grizzly bears in North America. Within B.C., the highest quality habitat for interior grizzly bears is located in the southeastern section of the province (the Southern Interior Mountains Ecoprovince). The study area for this project is located to the north in the Sub-Boreal Interior Ecoprovince; which contains moderate to moderately high habitat values for grizzly bear (RIC, 1998a).

Within the study area, the Klawli management unit study area, located immediately south of Germansen Lake in the Mackenzie Forest District of North-Central B.C., no specific grizzly bear habitat studies or inventories have occurred. However, research is currently taking place around the Parsnip River area (Parsnip Grizzly Project, an on-going study since 1997), which is located south-east of the study area, and south-east of Mackenzie (Mamo *et al.*, 1998). The Parsnip Grizzly Project is aimed at obtaining much needed information on grizzly bear population status, seasonal habitat use patterns and critical habitat types, home ranges, and food habits for North-Central B.C. Preliminary results from this study were made available for this project. Due to the paucity of grizzly bear ecological data for the Williston Reservoir area, the information from the Parsnip study has been referenced.

The information presented in this species account has been largely extrapolated from other regions, because there is little documentation of grizzly bear habitat associations for this part of British Columbia. At this time, general habitat ratings for grizzly bear for the Klawli study area are predicted to have a moderate reliability. Before more reliable ratings of habitat quality can be developed, data are required on the seasonal food habits and habitat selection of grizzly bears in this region.

9.2 Distribution

Grizzly bears are found throughout Eurasia and North America. The Eurasian brown bear is considered to be the same species as the North American brown bear (*Ursus arctos*) (Jonkel, 1987). Historically, grizzly bears were widespread throughout most of central and western North America. The traditional range of the grizzly bear has been dramatically reduced during the last century, especially since European settlers arrived (Banci, 1991). Presently this species occurs in the western United States (Alaska, Wyoming, Idaho, Montana, and Washington) and in northern and western Canada (Alberta, British Columbia, Northwest Territories, and Yukon Territory) (Lefranc *et al.,* 1987).

9.2.1 Provincial Range

Grizzly bears inhabit most of the province except Vancouver Island, the Queen Charlotte Islands, smaller coastal islands, the lower mainland and portions of the south-central interior. Only one subspecies, *U. arctos horribilis*, is recognized for the province of British Columbia (Nagorsen, 1990).

Grizzly bears inhabit most of the mainland portion of British Columbia except areas that have been urbanized, intensively farmed, or used for ranching (Hamilton, 1989). The latter includes the lower mainland, Thompson-Okanagan, Cariboo, and Peace River areas (Fuhr and Demarchi, 1990). The British Columbia population of grizzly bears is estimated at 10,000 to 13,000 bears (B.C. MELP, 1997; Fuhr and Demarchi, 1990). Fox (1987) estimates that approximately 9,000 or 72% of the provincial grizzly bear population is found throughout the Northern Region: 4,700 in the Skeena, 1,500 in the Omineca, and approximately 2,800 in the Peace sub-region.

The British Columbia grizzly bear population can be described as two distinct ecotypes; coastal and northern interior (Hamilton, 1997). Coastal mountain studies indicate that grizzly bear habitat occurs predominantly below tree line, concentrating on ecosystems associated with important salmon rivers (Banner *et al.,* 1985). The northern interior grizzly bear ecotype occurs where there are no salmon bearing watersheds. These bears use a range of habitat types from forested valleys to alpine and subalpine ecosystems (Banner *et al.,* 1985; Mosquin and Suchal, 1977). Some important findings from coastal studies have been included in this summary, yet the habits of the interior grizzly bear are the focus of the account.

Population estimates for bears are available in a number of different studies across western Canada, but none specific to the area of study (Table 50).

Table 50: Grizzly Bear Population Estimates from North American Studies.

Location	Density	Reference Source
Northern Yukon	48 km^2 per bear	Pearson, 1976
Kluane National Park - Yukon	22.8-27.2 km^2 per bear	Pearson, 1975
Mackenzie Mountains - Yukon	86 km^2 per bear	Miller *et al.,* 1982
Southern Interior B.C.- Flathead drainage	10-15.6 km^2 per bear	McLellan, 1984
Mackenzie, B.C.	moderate (1 bear/64-192 km^2) to plentiful (>1 bear/64 km^2)	Fuhr and Demarchi, 1990
Jasper National Park, B.C.	85.5-101.6 km^2 per bear	Russell *et al.,* 1979

9.2.2 Distribution in Project Area

Grizzlies are expected to occur at some time during the year within all of the ecoregions, ecosections, and biogeoclimatic zone, subzone, and variant combinations found within the Klawli study area, as summarized in Table 51. The general consensus for the Klawli area is that there are few grizzly bears there. Dennis Jones, local woodsman and trapper within the Klawli area for the last 25 years, has observed that more grizzly bears have been moving into the area since logging has started (Jones, pers. comm.). During fieldwork, very little bear sign was observed. However, in a few isolated sites, sign was high (see section 3.5.1 for details). No inventory of grizzly bear use and numbers in the Klawli area has occurred.

Table 51: Expected Grizzly Bear Occurrence within the BEC Zones, Subzones and Variant Combinations Found within the Klawli Project Area.

Ecoprovince	Ecoregions	Ecosections	BEC Variants	Expected Occurrence
Sub-Boreal Interior	Omineca Mountains	Manson Plateau (MAP)	AT	•
			ESSFmv3	•
			ESSFmvp3	•
			SBSmk1	•
		Southern Omineca Mountains (SOM)	BWBSdk1	•

Legend: • = occurs in the variant

9.2.3 Elevational Range

Topographic relief over the entire study area averages 1000 m, and ranges from the heights of Mount Germansen at 1926 m down to Klawli Lake at 997 m. Most of the land that lies below 1200 m occurs within the southern half of the study area.

The Klawli study area contains a wide range of habitat, from the low plateaus and valley country of the SBS and BWBS to alpine tundra (AT) at the highest elevations. Suitable year round habitat is present and accessible throughout the study area, not limited by elevation.

Grizzlies are known to exhibit seasonal elevational migrations to optimize food availability. In the early spring, bears follow the phenology of the high-value early herbs and move into the higher elevations with early green-up usually near denning sites. Bears move to lower elevations in the early summer as berries ripen, then gradually move back to higher elevations as the summer progresses, using later ripening berries and other foods to put on fat stores required for winter survival (RIC, 1998b).

9.3 Ecology and Habitat Requirements

Grizzly bears require extensive areas of land (Nietfeld *et al.,* 1985), and use a diverse range of ecosystem types to meet their life requisites (Hamilton, 1989). In B.C. they use a variety of habitats, from coastal estuaries to alpine meadows (RIC, 1998b). In each of these different biomes, the grizzly encounters, “grossly varying conditions not only in terms of availability of food but also in terms of denning sites and other physical requirements for its existence and successful reproduction” (Pearson, 1977). As indicated by habitat use, forage patterns follow seasonal food availability.

Social interactions between individuals are important factors determining habitat use (B.C. MELP, 1999). Although discussed briefly here, for clarification of the ecology of the grizzly bear, they are not included in the ratings tables, because they are considered non-habitat features.

9.3.1 Home Ranges

Home range size and location is influenced by sex, age, and reproductive status of the animals. Size and location of home ranges also vary with population density and habitat quality (Nagy and Gunson, 1990).

Adult male grizzly bears are the most mobile of the sex and age groups (Pearson, 1975; Miller *et al.,* 1982), and male home ranges are larger than those of females or sub-adults. Adult females show more fidelity to specific home ranges. Although female ranges do not commonly overlap (except those of mothers and daughters), sub-adult and adult male ranges commonly overlap female ranges. Table 52 summarizes some of the findings from home range studies in western North America.

Table 52: Grizzly Bear Home Range Size Results from Western North American Studies.

Location	Adult Males	Adult Females	Reference
Interior ecosystems	other estimates suggest 1000 km^2 to 2000 km^2		Gibeau *et al.,* 1996 Russell *et al.,* 1979
Jasper	916 km^2		Lefranc *et al.,* 1987
Mackenzie Mountains, Northwest Territories		265 km^2	Miller *et al.,* 1982
North-Central Interior, B.C. - Parsnip River area	mean = 978.3 km^2	mean = 66.9 km^2	Mamo *et al.*, 1998 – preliminary results
Northern Interior, Yukon and B.C.	averaged about 287 km^2	73-86 km^2	Pearson, 1975 and 1976
Western Canada	100 to 1300 km^2	20 to 430 km^2	Banci, 1991

9.3.2 Migration

Grizzly bears have daily and seasonal migration patterns. Specific information on grizzly migration routes in the study area is not available. The scale of migration varies regionally. Daily migrations may follow streambeds, trails, open edges, ridges, and roads. Seasonal migrations, moving from lower to higher elevations in spring to late summer, back to lower elevations in the summer, and returning to higher elevations for late-summer feeding and denning, may require the use of high elevation passes to move from one drainage to another. As seasonal migrations follow the phenological development of forage species, see “Feeding” under “Life Requisites”, above for specific information on seasonal habitat use.

9.3.3 Sexual Segregation

Sexual segregation among grizzly bears forces females to use higher elevations, different aspects, and steeper slopes when males move into female ranges (Weilgus and Bunnell, 1994). Compression of male home ranges may indirectly lead to displacement of females from more high quality food sources. It is suggested that females move into less productive habitat in order to avoid adult males, particularly in the fall when males converge on highly productive berry patches (Weilgus and Bunnell, 1994).

9.4 Habitat Use (Life Requisites and Seasons)

Grizzly bear habitat use for the study area is separated into two seasons – growing and winter. Grizzly bear life requisites that were rated included den habitat (hibernation), food, and security, as summarized in Table 53. Reproductive (birthing) habitat is assumed to be the same as hibernating habitat, because young are born in the winter dens.

At the inception of the project a two season rating scheme for habitat use was considered to be most appropriate for the Klawli area, because little information was available on grizzly use in North-Central B.C., and few bears were expected to occur within the study area. However, in order to provide a more detailed review of grizzly bear biology and habitat use, spring, summer, and fall food habitat have been discussed separately. As well, although not rated, general details for reproduction and migration have also been summarized.

Table 53: Summary of Rated Life Requisites and Seasons for Grizzly Bears in the Wolverine Range Study Area.

Rated Life Requisites and Seasons	Code	Months of Use
Food - Growing season	FD_G	May-October
Security - Growing season	ST_G	May-October
Security and Thermal - Den Habitat for Hibernation	ST_HI	November-April

9.4.1 Food Habitat

Grizzly bears are omnivorous and have a diverse diet, including vegetation, berries, carrion, small and large mammals, fish, and insects. Food habitat use varies seasonally (Miller *et al.,* 1982; Pearson, 1975), and season of use varies regionally according to different provincial ecotypes (Fuhr and Demarchi, 1990). Vegetation phenology of a particular area also influences food use by bears; the bears will seek out the highest quality food sources according to emergence and maturation of plants (Fuhr and Demarchi, 1990; Miller *et al.,* 1982).

In a literature review, Nagy and Gunson (1990) found that the general foraging regime for most interior grizzly bear populations appeared to be similar, and thus a number of studies have been summarised here to develop a probable grizzly bear habitat use pattern for the study area.

<u>Spring</u>

In early spring at den emergence, food is localized and generally scarce. During this time, bears may frequent ungulate wintering grounds, feeding on carrion and opportunistically preying on winter-weakened ungulates (Nagy, 1990; Nietfeld *et al.,* 1985). In many areas, *Hedysarum* roots are important in the early spring, as are over-wintered berries (crowberries and bearberries), and corms (Miller *et al.,* 1982; McCrory and Herrero, 1983). Steep south-facing river slopes with grassy areas are also important foraging areas in early spring (T. Hamilton, pers. comm.).

As green vegetation emerges, grizzlies will feed on the succulent early growth stages of grasses, horsetails, rushes, and sedges (RIC, 1998b). In late spring, bears will frequent warm aspect avalanche tracks and meadows, where the vegetation is first exposed, usually at lower elevations (Gibeau *et al.,* 1996; Hamilton, 1989).

In Alberta, Kansas and Riddell (1995) found the most important vegetation sites in April are characterised by sub-xeric moisture conditions and coarse-textured soils occurring on south and west facing steep slopes in the lower Montane and lower Subalpine ecosystems. Kansas and Riddell (1995) found that important sites used in May and June occurred on fluvial landforms and alluvial fans on the lower slopes of steep south aspects, characterised by aspen and balsam poplar forests, spruce-horsetail forests, and/or wet shrub thickets.

Summer

Green vegetation (particularly graminoids, horsetails, cow-parsnip, and forbs) form an important part of the late spring and early summer diet. These foods are probably most available in riparian areas and seeps (subhygric and hygric sites) that produce high densities of prime summer vegetation, and in run out zones on south facing avalanche chutes (Hamilton, 1989; McCrory and Herrero, 1983). On higher elevation avalanche slopes, bears feed on spring beauty, glacier lily, valerian, grasses, and sedges (Eastern Slopes Grizzly Bear Project, 1997; Hamilton, 1989). Grizzly bears will continue to forage on horsetails into late June at lower elevations, and will prey on ungulates on their calving grounds. By about mid-July, soopolallie (*Shepherdia canadensis*) berries become ripe and are thought to be an important early berry food in northern B.C. (Hamilton, 1989).

Fall

Berries form an important component of the bear's diet during late summer and fall. Use of alpine habitat is significantly reduced in late summer and early fall as bears move down into the lower elevations, where berry and root production are the highest (Miller *et al.,* 1982). Hamilton (1989) suggests that in the fall bears will be found in a wide diversity of habitats supporting berry and root production. Important fruit producing shrubs include soopolallie, huckleberry (important during August and into September), high-bush cranberry, Saskatoon, choke cherry, currants, bearberry, and crowberry (Hamilton, 1989; Nietfeld *et al.,* 1985).

Grizzly bears were found to depend heavily on soopolallie in Kananaskis Country, Alberta, to put on fat stores for the winter (Wielgus and Bunnell, 1994). Hamilton (1989) found soopolallie to occur in large burns and along active floodplains, and although these berries were observed in riparian spruce stands, berry production seemed higher under canopies that are more open. In addition to berries, grizzly bears will return to digging *Hedysarum* roots (common on floodplains), and will feed on ants and wasps (Hamilton, 1989). In years when berry crops fail, bears switch back to green vegetation sites, and use of roots intensifies (Pearson, 1975).

In some parts of interior B.C., grizzly bears will prey on small mammals such as ground squirrels (*Spermophilus* spp.), which are most easily captured in late summer after they have aestivated (RIC, 1998b).

Grizzly bears must consume high quality food in relatively large quantities to meet their daily energy requirements, as well as to develop fat reserves for denning (RIC, 1998b).

9.4.2 Security Habitat

Security habitat (cover) is used by bears for travel, during feeding and for escape (Jonkel, 1987). To date no studies have been done specifically to test grizzly reliance on cover in North-Central B.C. (Sub-Boreal Forest Ecoprovince), and overall understanding of grizzly use of habitat for security is limited. Cover requirements vary because of behavioural differences among individual bears, seasonally, and according to the condition of bears (i.e. starving bears tend to be more bold) (Jonkel, 1987).

Nietfeld *et al.,* (1985) assume that, “security cover is most likely not a limiting factor in wilderness areas” with the exception of areas of resource development (depending upon the amount and type of access - permanent, temporary, or seasonal), such as logging and oil and gas exploration with associated road construction. Security cover is probably most important for females with cubs, at den sites, and in areas of bear-bear and bear-human interaction.

Grizzlies use a variety of different cover types for escape, of varying vegetation and/or topography (Zager *et al.,* 1980). Requirements for security cover may vary between hunted versus unhunted populations, with open habitats being used more for foraging by the latter; while hunted populations may use areas with relatively high cover. Importance of security cover in hunted areas is greater than in unhunted areas, according to Mattson (1993) as cited in Gibeau *et al.* (1996). McLellan (1985) suggests that even if timber is not mapped as grizzly bear habitat, it should be noted, particularly in relation to other selected habitats. Servheen (1981) suggested that bears rely on darkness for cover and will forage and travel under cover of darkness in habitat where security is low. Hamilton (1987) found that bears on the coast (Kimsquit River) preferred to be in cover, possibly to avoid other bears.

Cover use also varies with female reproductive status (Lefranc *et al.,* 1987). Females with young often select rugged, isolated habitats and will avoid habitat more commonly used by other conspecifics, particularly males. Pearson (1975) observed sows with cubs use rock and snow zones as refuge.

9.4.3 Hibernation (Security/Thermal Habitat for Denning)

Denning by pregnant females in the northern interior region of British Columbia may begin as early as October 1, while other bears will den in November (Hamilton, 1989). Grizzlies generally den in higher elevation talus slopes, shrub-fields, krummholtz areas, or timbered subalpine areas with stable, deep, snow packs and relatively slow snow melt (Vroom *et al.,* 1980; Vroom *et al.,* 1977). Dens are often right at the edge of the tree line at the transition to alpine ecosystems. Dens are generally excavated into steep slopes (deeply bedded soils when available that are well drained and cohesive), or they may be in natural caves or hollows under the roots of trees (RIC, 1998b). Often, an initial den site may not be adequate, and bears will try excavating other den sites until a suitable site is found. Den sites are often located on slopes ranging from 25° to 40° with a predominately southeastern orientation (leeward of prevailing winds) (Miller *et al.,* 1982; Nagy, 1990; Pearson, 1975; Vroom, 1977).

Little research on denning requirements for grizzly bears in the sub-boreal forest of British Columbia has occurred. Recent research south of Mackenzie (Parsnip Grizzly Project) is investigating these requirements. Preliminary results have indicated that lodgepole pine stands provide important denning habitat (John Paczkowski pers. comm.). Elevation and adjacency of suitable spring foraging habitats likely also play a role in den site selection. According to Vroom *et al.* (1980 and 1977) as well as RIC (1998b), denning sites generally occur on high elevation areas, on slopes with stable, deep, snow packs. Suitable denning habitat may be a limiting factor affecting grizzly survival in some areas.

Den emergence times vary annually according to weather conditions. Emergence for an adult male in the Mackenzie Mountain area, Northwest Territories, occurred during the first week of May; females with cubs were not observed until mid-May (Miller *et al.,* 1982). In the Mackenzie area of B.C., Hamilton (1989) suggests that male grizzlies would probably emerge from their dens in early April, whereas lone females or females with yearlings and older offspring would probably emerge in late April, and females with cubs would remain in dens until late May. Grizzlies in Banff den some time in November and emerge around early April (Vroom *et al.,* 1977).

Dens are generally located at higher elevations in areas of deep snowfall and relatively slow snowmelt. Dens may be located in natural caves, hollows under the roots of trees, or they may be excavated under the roots of trees, or dug into steep slopes (RIC, 1998b).

9.4.4 Reproduction

Little information is available on habitat requirements for mating activities in northern B.C. Mating areas in Banff National Park included isolated mountain summits or upper-elevation ridges (Hamer and Herrero, 1990). The copulation period of grizzly bears is from approximately late May until mid-July (B.C. MELP, 1995). The estrous period may last less than one week for females of first estrous, and up to a reported 27 days for mature females (Jonkel, 1987). Implantation of the fetus is delayed until the time of denning (October to November). Weight gain during the growing season determines whether the female will then carry to pregnancy (i.e. no implantation for underweight females) (Jonkel, 1987).

Reproduction rates are low among grizzlies, because first age of reproduction ranges from age four upwards, and litter sizes range from one to four (1.4 to 2.5 average) (B.C. MELP, 1999). Bunnell and Tait (1981) found that litter size was negatively correlated with latitude, and Pearson (1975) suggests that age at first reproduction may vary with latitude and nutritional status. Some studies at more northern latitudes have found relatively larger litter sizes (e.g. Ballard *et al.,* (1993) recorded an average litter size of 2.17 cubs per female in northwestern Alaska). This higher relative litter size was attributed to an abundance of marine mammal carrion and salmon (coastal grizzly). Miller *et al.,* (1982) found a mean litter size of 1.83 cubs per female in the Mackenzie Mountains, Northwest Territories (interior grizzly). Pearson (1975) found a mean of 1.6 young per litter in the Kluane Range (interior grizzly).

Between January and March, cubs are born in the den (B.C. MELP, 1995). The den must provide favourable conditions for birthing and early survival of cubs. Cubs remain with the mother from the time of birth until they are between 26 and 28 months old (B.C. MELP, 1999). The average litter interval is every three to six years (Jonkel, 1987).

9.4.5 Seasons of Use

Grizzly bears are expected to use habitat located within the Klawli study area throughout the year. Table 54 summarizes the rated life requisites (activities) for grizzly bears for each month of the year.

Table 54: Monthly Rated Life Requisites for Grizzly Bears in the Klawli Study Area.

Month	*Season	Season	Rated Life Requisites	Estimated Time Period
January	Winter	Winter	Hibernation (HI)	
February	Winter	Winter	HI	
March	Winter	Winter	HI	
April	Winter	Winter/Early Spring	HI, Food and Security	Emerge around April to mid-May
May	Growing	Spring	Food and Security	
June	Growing	Spring	Food and Security	
July	Growing	Summer	Food and Security	
August	Growing	Summer	Food and Security	
September	Growing	Fall	Food and Security	
October	Growing	Fall	HI, Food and Security	May den as early as October 1 or as late as October 31.
November	Winter	Winter	HI	
December	Winter	Winter	HI	

*Seasons defined for the Sub-Boreal Interior Ecoprovince as per the Chart of Seasons by Ecoprovince (RIC, 1998a; Appendix B).

9.5 Ecosystem Attributes

A number of relationships between habitat use and ecosystem attributes can be determined for grizzly bears, based on current literature and research and local biologist and trapper knowledge. Often, the habitats used most frequently are associated with specific stand structure, age class, vegetation cover, etc. Table 55 lists which ecosystem attributes are considered in the habitat ratings tables.

Table 55: Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Grizzly Bears.

Life Requisite	Ecosystem Attribute
Food	Slope, aspect, elevation, structural stage, % cover of low shrub, herb cover, herb species composition, shrub species composition, soil depth
Security	% cover trees and shrubs, height of shrubs, microtopography, riparian or water substrate
Hibernation (Security and Thermal Den Habitat)	elevation, slope, aspect, prevailing winds, bedrock, terrain texture, flooding regime, soil texture and depth, drainage

9.6 Development of the Habitat Ratings

Habitat ratings were developed through collection of habitat data within the study area over a two-week period, supported by personal communications with local biologists, local guide outfitters, and species experts, and supplemented with a current literature review.

9.6.1 Rating Scheme

A 6-Class rating scheme of high (1), moderately high (2), moderate (3), low (4), very low (5), and nil (6) is employed (as suggested for grizzly bear by RIC, 1998a) and requires a substantial knowledge of habitat use (Table 56).

Table 56: Habitat Capability and Suitability 6-Class Rating Scheme (from RIC, 1998a).

% of Provincial Best	Rating	Code
100% - 76%	High	1
75% - 51%	Moderately High	2
50% - 26%	Moderate	3
25% - 6%	Low	4
5% - 1%	Very Low	5
0%	Nil	6

This rating scheme was used when assigning habitat ratings to the ecosystem units present within the Klawli study area. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for the grizzly bear as previously outlined in Table 54.

9.6.2 Provincial Benchmark

The provincial standard (best in B.C.) for the interior grizzly bear is the Border Ranges (BRR) ecosection within the Southern Interior Mountains ecoprovince (RIC, 1998a).

Most of the Klawli study area is located within the Manson Plateau (MAP) ecosection, which has a moderate (50% to 26%) capability compared to the standard (RIC, 1998a). The northern part of the study area is located within the Southern Omineca Mountains (SOM) ecosection, which has a moderately high (75% to 51%) capability compared to the standard benchmark (RIC, 1998b).

McLellan (1989) found moderate to high quality habitat in the Ospika area, northeast of the Klawli area (the other side of the Williston Reservoir), but suspected low bear densities.

9.6.3 Ratings Assumptions

The following assumptions for habitat use by Grizzly bears in the Klawli area have been made:

Life Requisite and Season	Assumptions
Food Habitat During the Growing Season FD_G	Food habitat values were assigned based on availability (presence, percent cover) and timing of seasonally important food species as described in the food section. **Structural Stage** • In general, structural stage 1 has nil foraging value, because it is mainly unvegetated. • Stage 2, 3a, and 3b are used throughout the growing season with stage 2 receiving more use in the spring and summer (early herbaceous green-up) and stage 3a and 3b receiving more use in the summer and fall (utilization of berry crops). • Structural stages 6 and 7 are of low to high food quality throughout the growing season, depending on the ecosystem unit. **Vegetation Characteristics** • Greater percent cover of shrubs and other food plants are rated higher (productive sites). • Units with preferred species of herbs are rated higher than other units for food suitability during the growing season (especially lush herbaceous units). • Units with berry-producing shrubs are rated up to high, because they provide important foraging opportunities during the fall. **Site, Moisture Regime, Soils** • Riparian areas and other ecosystems with preferred herbs are rated high in the growing season, because these areas should provide abundant, new succulent forage, important in the spring. **Elevation** • Lower elevation units are more important in the spring, than during summer or fall. For this project, spring, summer and fall have not been separated, therefore ratings are reflective of the period in which a given ecosystem unit is of highest quality to bears.
Security Habitat During the Growing Season SH_G	Security/thermal habitat ratings are significantly less important than food ratings throughout the growing season. Cover from other animals was assumed more important than visibility of other animals. **Structural Stage** • Stage 1 and 2 have nil to low suitability due to lack of cover. • Stage 3a units provide moderate security cover if vegetation is tall enough to screen standing grizzlies. • Stage 3b and 4 forests should generally provide moderate security cover, as will most units with a dense shrub understory. • Structural stages 5, 6 and 7 range in value from low to high depending on the ecosystem unit. **Structural Elements** • Larger trees provide better security, as will more CWD and structural diversity. **Vegetation and Stand Characteristics** • Understory characteristics including shrub composition, height, and density determine the value of units as security/thermal habitat. • Units with a very sparse understory generally provide low security.

Life Requisite and Season	Assumptions
Security and Thermal Den Habitat for Hibernation ST_HI	Information on denning habitat use within and around the area of study is very limited at this time. **Structural Stage** • Although mature forested stands may be used for denning sites, suitable denning habitat may be present within any structural stage (microsite level of selection). **Vegetation Characteristics** • Mature lodgepole pine stands may be important, as per observed use in the Parsnip area study (Mamo *et al.*, 1998 – pers. comm. with author J. Paczkowski). **Site Modifiers** • Modifier k (cool aspect) and w (warm) were often associated with eskers in the area of study. As bears are known to utilize esker slopes for denning, units with these modifiers were rated up to moderate for denning potential (depending on the unit and structural stage). **Soil Moisture and Nutrient Regime** • Wet units were given a rating of nil, because they are unlikely to provide suitable denning sites. • Mesic units may have some potential for denning and are given up to moderate until more is known about denning requirements in the area. **Elevation** • Grizzlies generally den in higher elevation areas with stable, deep, snow packs and relatively slow snow melt (Vroom *et al.,* 1980) which are not present within the SBS or BWBS zones. Therefore, these zones are rated up to low for denning potential.

9.6.4 Rating Adjustment Considerations

Grizzly bears will avoid using high quality habitat near human disturbance. McLellan and Shackleton (1988) found that even low volumes of traffic on tertiary roads led to displacement of bears. Displacement, habitat loss, and fragmentation are all indirect impacts of development and industry on grizzly bear populations. Therefore, habitat ratings should be adjusted (devalued) to reflect distance and adjacency to human disturbance (i.e. urban areas and roads).

Grizzly bears are known to follow regular travel routes. Any food habitats immediately adjacent to these trails will have increased value.

Warm aspect units, especially avalanche tracks and meadows, will have increased value in early spring.

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10.0 SPECIES - HABITAT MODEL FOR WOODLAND CARIBOU

Common Name:	**Woodland Caribou** (Northern Ecotype)
Scientific Name:	*Rangifer tarandus caribou*
Species Code:	M-RATA
B.C. Status:	Northern Ecotype is Yellow-listed; Mountain Ecotype is Blue Listed (B.C. CDC, 1999)
Identified Wildlife Status:	None
COSEWIC Status:	Western populations were designated as vulnerable in Canada, following a review in 1984 (COSEWIC, 1997).

10.1 Introduction

Woodland caribou conservation has been a high profile resource management issue in British Columbia for many years, primarily because of the conflict between forest harvesting and conservation of caribou habitat (Seip, 1996). Most studies of habitat use have focused on the woodland caribou populations in the southeast part of the province due to the more immediate conflicts between forest harvesting, development, and declining populations in that area (Stevenson, 1991). However, with the increasing demands for forest products throughout the province and decreasing availability of these resources, the focus has expanded to include woodland caribou populations in the northern parts of the province (Wood, 1996). Presently, only three major studies completed in B.C. have focused on the northern caribou ecotype: Terry and Wood (1999) (Omineca Mountains), Hatler (1986) (Spatsizi Wilderness Area), and Cichowski (1989) (Tweedsmuir). The Omineca and Tweedsmuir studies were related to forest harvesting concerns.

Currently, Slocan Group, Mackenzie is conducting work on the same herds studied by the Peace/Williston Fish and Wildlife Compensation Program (Wood and Terry, 1999; Terry and Wood, 1999; Wood, 1996) in order to obtain more detailed information on caribou habitat use. The continued collection of data will aid in making responsible management decisions for both forestry and caribou in the area.

The recent (1999) Terrestrial Ecosystem Mapping (TEM) of the Klawli landscape unit for Slocan F.P. Ltd. Mackenzie included habitat interpretations for caribou. This exercise serves as an initial step towards understanding the relationships that exist between caribou and the ecosystems mapped and described through the TEM process. At this time, the model has not been verified for the area, and it is therefore predicted to have at best a moderate reliability. However, it is hoped that results from current fieldwork by Slocan F.P. Ltd. can be used to further refine the model over the next few years.

Information from past studies in northern British Columbia (Hatler, 1986; Murray, 1992; Cichowski, 1989), recent research and surveys within the Mackenzie Forest District (Wood, 1996 and 1998; Terry and Wood, 1999, Wood and Terry, 1999), and where applicable, information from outside of northern B.C., have been incorporated into the species account.

10.2 Distribution

Caribou inhabit the arctic tundra, alpine tundra, and northern boreal forests of North America, Russia, Norway, Sweden, and Finland. The caribou of northern North America and the reindeer of northern Europe and Asia are considered to belong to a single widespread species (*Rangifer tarandus*), although, there are some well-marked geographical subspecies (Banfield, 1977). There are six recognized subspecies in North America, one of which is presently found in British Columbia: *R. t. caribou* (Woodland Caribou) (Banfield, 1977). Woodland caribou range from southeastern Alaska and the boreal regions of Canada from B.C. and the Yukon Territory to Newfoundland.

10.2.1 Provincial Range

All caribou in British Columbia belong to the subspecies *Rangifer tarandus caribou* (Seip and Cichowski, 1996). They range across the northern part of the province and as far south as Tweedsmuir Provincial Park and the southern Kootenays where populations are discontinuous (Nagorsen, 1990). Based on behavioural and ecological differences they can be further classified into three different ecotypes: the mountain ecotype, the northern ecotype, and the boreal ecotype (Heard and Vagt, 1996).

Mountain caribou occur in the rugged mountains of southeastern B.C. and spend most of the year in alpine and subalpine habitats. They winter at high elevations and rely primarily on arboreal lichens for food because the deep snowpack in this region prevents them from cratering for terrestrial foods (Seip and Cichowski, 1996; Stevenson and Hatler, 1985).

Northern caribou are found in the mountains of northern and western British Columbia where there is low snowfall relative to mountain caribou habitat. They generally summer in mountainous areas and winter in mature low elevation lodgepole pine or black spruce forests or in windswept alpine areas. Low snow depths in these habitats allows northern caribou to crater for terrestrial lichens, which are their primary forage during the winter (Heard and Vagt, 1996; Seip and Cichowski, 1996).

Boreal caribou are found in the boreal forests of northeastern B.C. where they occur in small, dispersed groups that are relatively sedentary throughout the year. Sometimes authors lump the boreal ecotype and northern ecotype together (referenced to as the northern ecotype) (Heard and Vagt, 1996).

The British Columbian caribou population was estimated at a total of 18,000 animals in 1996. Of these, approximately 2,300 were mountain caribou and 16,000 were northern and boreal caribou (Heard and Vagt, 1996).

Woodland caribou occurring within the Mackenzie Forest District of North-Central B.C. are assumed to belong to the northern caribou ecotype. The Morfee Mountain herd located near the town of Mackenzie are the only known exception that behave like the mountain ecotype, using the upper ESSF in the mid-winter and foraging predominately on arboreal lichens (Wood and Hengeveld, 1998). The Wolverine Caribou Herd, which occupies the Klawli landscape unit study area during different times of the year, belongs to the northern ecotype and is therefore their habitat requirements are the focus of this species account.

10.2.2 Distribution in the Project Area

The relative abundance of caribou within the study area, based on provincial distributions, is rated as moderate (1 caribou per 3.4 km^2 to 25 km^2) to plentiful (over 1 caribou per 3.4 sq. km) (Fish, Wildlife and Habitat Protection Department, 1994).

Caribou that are present within the Klawli TEM study area belong to the Wolverine Caribou Herd (WCH), estimated at between 262 and 580 animals (Wood, 1998). The WCH has been studied closely since 1991 and is known to inhabit the Klawli landscape unit during the early winter and summer months (Figures 29 and 30) (Terry and Wood, 1999; Wood and Terry, 1999). However, most of the herd spends the majority of the year in the Wolverine and Germansen landscape units to the north and northeast of the Klawli area (Mari Wood pers. comm.).

Summer use by the WCH is considered to be limited within the Klawli, with individuals and small groups spread throughout the Klawli and adjacent landscape units (Figure 29). In comparison to the summer, habitat use during the early winter can be quite high, with large numbers of caribou moving into the area to feed on terrestrial lichens and other available forage (Mari Wood pers. comm., 1999; Terry and Wood, 1999; Wood and Terry, 1999).

Spring use of the Klawli area is considered minor. To date calving records for the area are limited with one record from the Adade Yus Mountains at the southwestern periphery of the study area, and another from the South Germansen River area at the northwestern periphery of the study area (Mari Wood, pers. Comm., 1999). Late winter use of the Klawli area is also considered to be limited to absent, due to deep snow depths occurring in the area at that time of year (Figure 30) (Wood and Terry, 1999).

The Klawli study area contains a wide range of habitat, from the low plateaus and valley country of the SBS and BWBS (a small component of the area), the higher elevation plateaus of the ESSF (predominant throughout the area), to ESSF parkland and alpine tundra (AT) at the highest elevations. Table 2 lists the area and percentage of cover by each zone and subzone within the Klawli study area. Caribou are expected to utilize all biogeoclimatic zone, subzone and variant combinations that occur within the Klawli study area for food (see Table 57). For information on caribou observations and evidence of use during fieldwork for this project, refer to section 3.5.8.

Table 57: Expected Northern Caribou (Wolverine Caribou Herd) Occurrence within the BEC Zone, Subzone, Variant Combinations Found within the Klawli Study Area.

Ecoprovince	Ecoregions	Ecosections	BEC Variants	Expected Occurrence
Sub-Boreal Interior	Omineca Mountains	Manson Plateau (MAP)	AT	•
			ESSFmv3	•
			ESSFmvp3	•
			SBSmk1	•
		Southern Omineca Mountains (SOM)	BWBSdk1	•

Legend: • = occurs in the variant

10.2.3 Elevational Range

Topographic relief over the entire study averages 1000 m, and ranges from the heights of Mount Germansen at 1926 m down to Klawli Lake at 997 m. Most of the land that lies below 1200 m occurs within the southern half of the study area. At some time during the year, caribou are expected to utilize habitat present at all elevations within the study area.

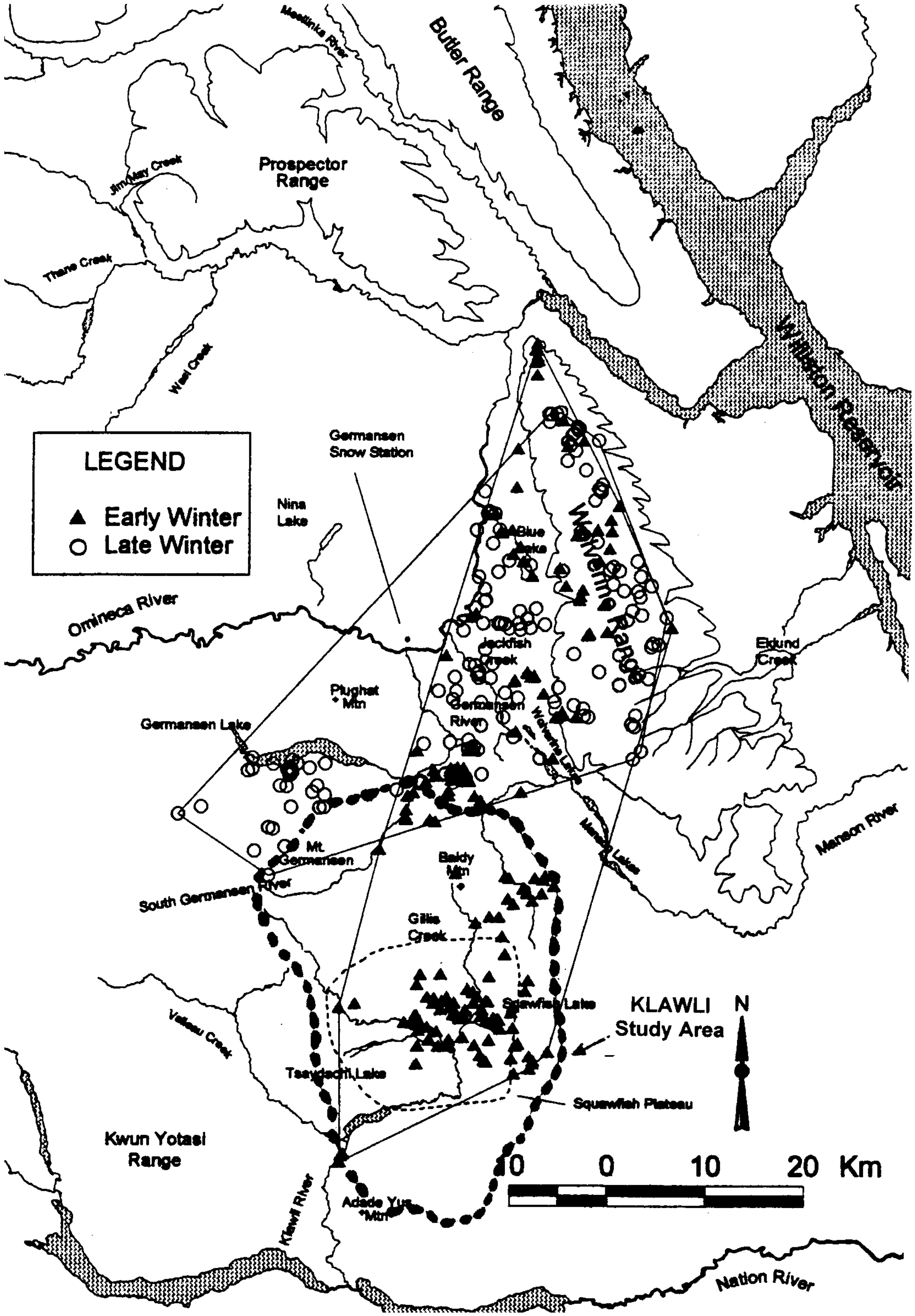

Figure 29: Early and Late Winter Locations of Radio-Collared Caribou in the Wolverine Caribou Herd (1994-1997) (Terry and Wood, 1999), in Relation to the Klawli Study Area

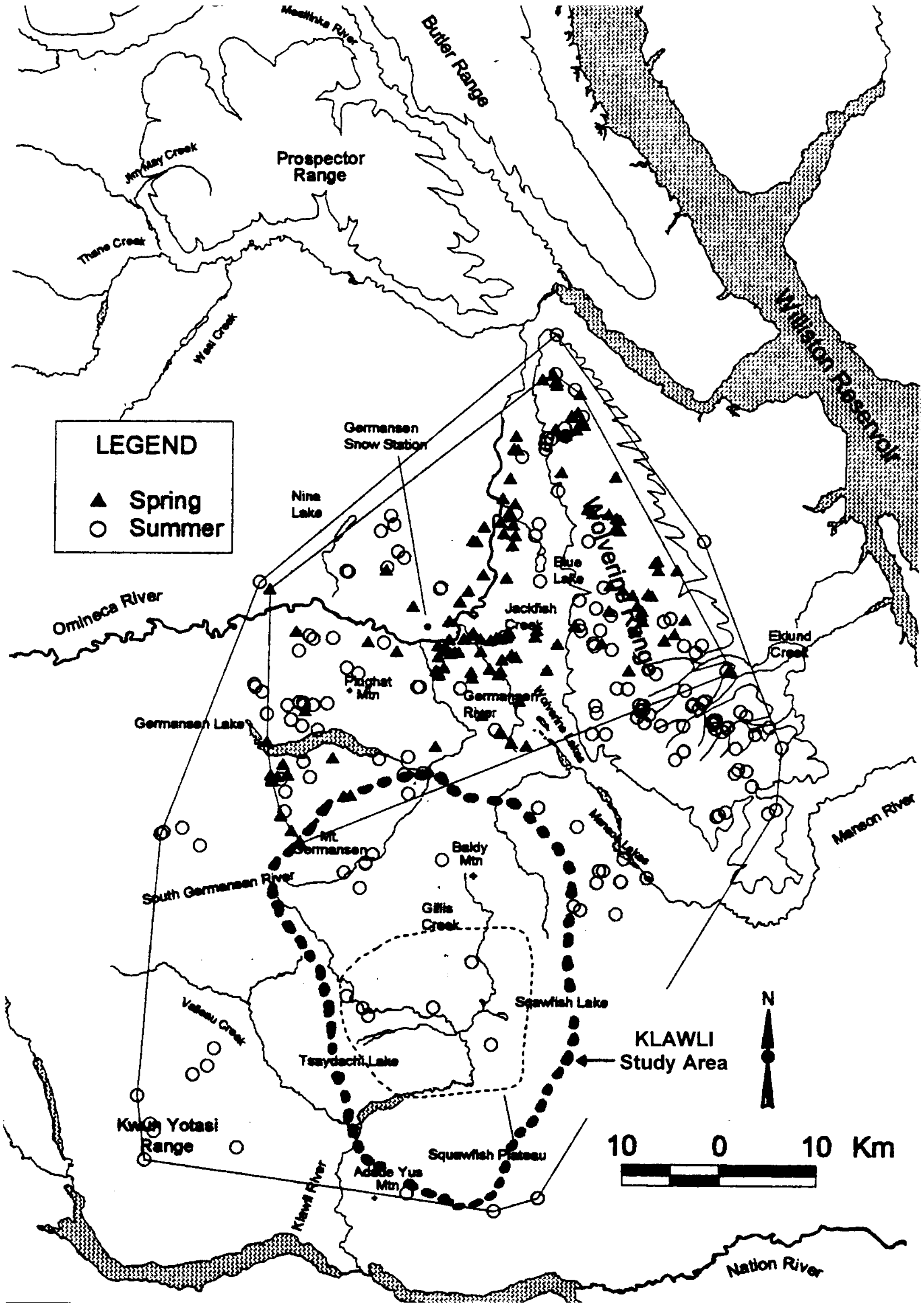

Figure 30: Spring and Summer Locations of Radio-Collared Caribou in the Wolverine Caribou Herd (1994-1997) (Terry and Wood, 1999), in Relation to the Klawli Study Area.

10.3 Ecology and Habitat Requirements

Unlike their barren ground counterparts, woodland caribou do not form large herds but instead move in relatively smaller groups (B.C. MELP, 1992). Northern caribou occupy large home ranges and migrate in response to seasonal habitat requirements. Generally they use high elevation forests and alpine habitat for calving, post-calving, summer, and rutting grounds and move to lowland forested areas in the winter (Fenger *et al.,* 1986). When snow conditions become prohibitive in the winter, caribou may move to windswept slopes in the alpine where terrestrial lichens are accessible (Heard and Vagt, 1996; Wood, 1996).

10.3.1 Seasonal Migration

Caribou are characterised by seasonal migrations, often over long distances, to frequent traditional calving, rutting, wintering, and post-calving ranges (Child and King, 1991). Caribou within the study area and elsewhere have shown fidelity to core areas for calving, for rutting, and to seasonal ranges (Terry and Wood, 1999; Wood and Terry, 1999; Farnell and McDonald, 1989; Hatler, 1986). Results from the WCH study 1994-1997 in North-Central B.C. (Terry and Wood, 1999) indicated that caribou made three separate, seasonal long distance movements throughout the year which included:

- early to mid May - moving from spring habitats to calving areas (20-45 km)
- early November - moving from summer and rut habitats to early winter ranges (20-50 km)
- early December to early January - moving from early winter range to late winter range.

Movements within the seasons were generally shorter and varied between 0.5-10 km (Terry and Wood, 1999).

In addition, seasonal vertical movement patterns were observed within the WCH. In general, caribou descended to lower elevations twice each year, once during spring (Apr-May) and again in early winter (Nov-Dec) (Terry and Wood, 1999; Wood and Terry, 1999).

10.3.2 Rutting

The rut generally occurs between late-September and mid-October (Fenger *et al.,* 1986). Alpine habitats appear to be preferred during the rutting period. The Klaza caribou herd in the Yukon moved to form large aggregations on rutting ranges on north aspect alpine areas (Farnell *et al.,* 1991). Rutting ranges were also found in the alpine by numerous authors including Farnell and McDonald (1990), Fenger *et al.,* (1986), and Terry and Wood (1999). Rutting generally occurs on, "gently sloping or rolling terrain with low vegetation where herd members are easily visible to each other" (Fenger *et al.,* 1986).

10.3.3 Predation

Predation is thought to be the major limiting factor for caribou, particularly in areas where the amount of usable habitat has been reduced by logging, fires, or fragmentation. In Saskatchewan, Rock (1992) suggests habitat selection is probably related more to predation considerations year-round and to thermal cover from insect harassment factors during the summer than it is to any of the food requisites. If food does become a limiting factor, it is generally during late winter when unfavourable snow conditions force caribou out of lowland habitats onto windswept alpine slopes where more terrestrial lichen species may be available. Historically, it would appear that late winter habitat, although important, was over-emphasised at the expense of other considerations such as predation (Rock, 1992). It is now clear that predators (wolf, bear and wolverine) interact in an additive or compensatory way with other regulatory factors (such as hunting mortality, climatic extremes, and food limitations) in their degree of influence on caribou populations (Rock, 1992).

10.3.4 Calving

Most calving occurs during late May through mid-June with the peak of calving around the first week of June (Hatler, 1986; Wood, 1996). Recruitment (the number of individuals entering the population at 1 year of age) is low and caribou do not twin; therefore potential population growth is slow (Rock, 1992).

During the calving season, northern caribou move to areas that "minimize risks from predation either by using escape terrain with good visibility such as steep, isolated rock outcrops, higher than the usual areas travelled by terrestrial predators, or by dispersing widely over shrubby vegetation that affords concealment and lowered probability of detection" (Fenger *et al.,* 1986). Undisturbed mountainous habitat is important for calving success and early calf survival of woodland caribou (Bergerud *et al.,* 1984). Calving sites are usually on secluded alpine ridges, tree line, or in high elevation coniferous stands. By calving at high elevations, female caribou space themselves away from predators such as wolves (*Canis lupus*).

In late May to early June, female caribou in west-central B.C. forgo forage quality at lower elevations to calve high in the Itcha and Ilgachuz Mountains (Cichowski, 1989). The Omineca Mountain caribou were also found to calve in upper elevation balsam-spruce forests, in rocky outcrops at tree line, or in alpine and subalpine areas (Wood, 1996). In the central Yukon, northern caribou also calved in alpine habitats in a widely dispersed pattern (Farnell *et al.,* 1991).

Woodland caribou often show fidelity to specific areas for calving (Terry and Wood, 1999; Wood and Terry, 1999; Hatler, 1986; Farnell and McDonald, 1989; Farnell *et al.,* 1991). The use of traditional calving sites and the highly dispersed pattern employed by female woodland caribou is thought to be an anti-predator tactic to reduce the vulnerability of calves to predators and to make use of previously successful sites (Bergerud *et al.,* 1984, Seip, 1992).

10.3.5 Security Habitat

Security cover is most often mentioned in conjunction with calving sites, with individual dispersion across high elevation landscapes being as important as cover for security from predators. Security habitat during the calving season consists of either escape terrain combined with good visibility or shrubby vegetation providing concealment (Fenger *et al.,* 1986). High elevations also afford some protection from wolves, which generally use valleys as travel routes (Bergerud and Elliot, 1986).

In winter, large contiguous patches of unfragmented habitat may provide security cover. Habitats that offer good visibility for avoiding predators, such as the alpine, also afford some security during the winter. The use of large home ranges allows caribou to select habitats offering acceptable combinations of snow conditions and food availability, select habitats that have given them an advantage over predators, and reduce their vulnerability to predators by dispersing themselves widely (Stevenson, 1991).

10.3.6 Thermal Habitat

Traditionally thermal cover has been an important consideration for the over-winter survival of large ungulates. For woodland caribou, however, the summer period would appear to be the most critical in terms of thermal cover requirements and tends to be overlooked (Mari Wood, pers. comm.). Alpine habitat as well as dark timbered forests in the ESSF provide cooler temperatures during periods of hot weather.

Insect harassment has also been suggested as one of the reasons that caribou move to alpine habitats during part of the summer (Mari Wood, pers. comm.). Cooler weather and constant breezes provide relief from insects. Farnell and McDonald (1990) found that caribou will often move to patches of snow, glaciers, and windy ridges that act as 'relief habitat' to escape harassment by insects and/or heat stress.

10.4 Habitat Use (Life Requisites and Seasons)

Northern caribou food habitat use is divided into five seasons – early winter, late winter, spring, summer, and fall, as summarized in Table 58. For this habitat suitability model, ecosystem units were not rated for security, because security habitat is not well defined for caribou at this time. In addition, security habitat is often described according to calving, which does not occur within the Klawli landscape unit (Wood and Terry, 1999). Although not rated, additional information on reproducing, rutting, security and thermal habitat have been summarized in order to provide a more comprehensive overview of caribou habitat use throughout the year.

Table 58: Summary of Rated Life Requisites and Seasons for Northern Caribou (Wolverine Caribou Herd) in the Klawli Study Area.

Rated Life Requisites and Seasons	Code	Month(s)*	Comments
Early winter - Food Habitat	**FD_WE**	**November 1 to December 30**	**- regions of low snow cover and abundant terrestrial lichens** **- low-elevation forests**
Late winter – Food Habitat	FD_WL	January 1 to March 31	- either windswept alpine ridges or lower elevation pine-lichen forests (dependent on snow accumulations)
Spring – Food Habitat	FD_P	April 1 to May 15 May 15 to June 16	- habitats with early forage production usually at low elevation snow free sites
Summer - Food Habitat	**FD_S**	**June 16 to September 15**	**- feed in areas of late snow-melt which can be in the alpine and ESSF**
Fall - Food Habitat	FD_F	September 16 to October 30	- move to higher elevation habitat near rutting grounds, rutting generally occurs in the alpine

*As outlined in Terry and Wood (1999); Wood and Terry (1999).

Note: Bold indicates the seasons when the WCH are known to utilize the Klawli TEM study area (Figures 29 and 30).

10.4.1 Food Habitat

<u>Spring</u>

During the spring, northern caribou mainly occupy lower elevation habitat (Terry and Wood, 1999; Wood and Terry, 1999; Hatler, 1986), but will also continue to forage in alpine and subalpine. WCH surveys showed that although caribou continued to use alpine areas during the earliest part of the spring, they also used mixed deciduous stands (aspen slopes) more frequently compared to other seasons (Terry and Wood, 1999). Wood (1996) found northern caribou primarily in low elevation lodgepole pine and pine-spruce forests in the spring (April and May). At this time of year, northern caribou also forage in meadows and younger seral stands of pine and pine-aspen stands (Terry and Wood, 1999; Wood and Terry, 1999; Wood, 1996).

Summer

During the summer northern caribou tend to space out widely throughout the herd's annual home range (4,933 km^2 for the WCH calculated from 6 years of radio-telemetry locations) (Wood, 1998). During this time, an increase in the use of balsam (24% of locations) as well as spruce dominated stands and AT was observed, while pine stands were used less frequently compared to use during other seasons (Terry and Wood, 1999). According to Stevenson (1991), summer ranges for northern caribou are typically alpine or subalpine, although some animals in some populations use low elevations.

Little information has been collected on growing season diets because these are not generally considered limiting. Northern caribou will forage on a diversity of grasses, sedges, forbs, browse, and lichens. Throughout the summer in the Kluane Range, Yukon Territory, northern caribou fed disproportionately in birch-sedge meadows, sedge meadow communities, and other communities with high sedge components in the subalpine and alpine (Oosenburg and Theberge, 1980). Sedge was considered to be the most important forage in determining summer habitat selection (Oosenburg and Theberge, 1980). Willows and other shrubs were also important components of the summer diet (Oosenburg and Theberge, 1980). Commonly used landforms during the summer season included ridges, plateaus, and stream bottoms (Oosenburg and Theberge, 1980).

Fall

Throughout the summer and early fall, northern caribou were found to prefer flat to rolling terrain with slopes less than 20° and northern aspects in the Kluane Range, Northwest Territories (Oosenburg and Theberge, 1980). Use of these sites may have reflected their hygric nature and consequent predominance of sedges (Oosenburg and Theberge, 1980). In North-Central B.C., during the fall rut, animals were generally found to aggregate at high elevation alpine and subalpine areas for mating with some use of pine flats (Mari Wood, pers. comm.).

Winter - General

Northern caribou depend on ground lichens for winter foraging rather than on arboreal lichens, which constitute only a very minor component of the winter diet (Bergerud, 1978). Ground lichens make up over 70% of the winter diet of northern caribou in the Yukon and northern B.C. with *Cladina* spp. and *Cladonia* spp. predominating the diet (Wood, 1996; Farnell and McDonald, 1990; Farnell and McDonald, 1989; Farnell *et al.,* 1991; Stevenson and Hatler, 1985). Horsetails, grasses, and sedges (primarily *Carex* spp.) are also important components of the winter diet when accessible (Farnell and McDonald, 1990).

For northern caribou, some of the primary early winter habitats are mature lodgepole pine or pine-spruce forests with abundant terrestrial lichens (Heard and Vagt, 1996; Wood, 1996). Wood and Terry (1999) found that northern caribou in the Omineca Mountains (the WCH) foraged on terrestrial lichens in both lowland lodgepole pine flats and windswept alpine slopes, while the Chase herd foraged on arboreal lichens in upper elevation Engelmann Spruce Subalpine Fir (ESSF) forests. Cichowski (1989) also found that in pine forests, northern caribou fed predominantly by cratering for terrestrial lichens, and cratering sites were selected based on terrestrial lichen abundance. Arboreal lichens were also used but appear to be less important than terrestrial lichens in the diet. Arboreal lichen use is greater during late winter when snow conditions are less favorable for cratering (Cichowski, 1989).

Some northern caribou populations regularly winter in alpine habitats. More commonly, the alpine is used by a small proportion of caribou or by many caribou for a short time when snow conditions below tree line restrict their ability to move around or to forage (Terry and Wood, 1999; Hatler, 1986). The WCH resides in areas with low to moderate snow depths, and is therefore able to forage on terrestrial lichens primarily in low elevation forests during the early winter and sometimes late winter (depending on the snow depth). Deep snowpacks force the caribou into the alpine areas where windswept slopes allow access to lichens (Terry and Wood, 1999, Wood and Terry, 1999).

Cichowski (1989) found caribou selected mature stands with a combination of abundant terrestrial lichens (Dry Lichen-Lichen Moss, Lichen Moss understories) and low productivity (low and poor forest cover types). Because terrestrial lichens are poor competitors against vascular plants, they are most abundant on open, nutrient poor sites (Hale, 1983 and Rowe, 1984 in Cichowski, 1996). These xeric (poor) growing sites can support abundant terrestrial lichens for hundreds of years. On more productive sites, terrestrial lichens may be abundant in mid-aged stands but are replaced by mosses in older stands and thus require periodic disturbance to be perpetuated. Very productive (nutrient rich) sites are usually dominated by vascular plants and never produce substantial amounts of terrestrial lichens (Seip, 1996).

Use of frozen lakes in the winter has also been documented. In North-Central B.C., Terry and Wood (1999) observed caribou using lakes during early and late winter possibly for drinking overflow water containing dissolved minerals (Mari Wood pers. comm., 1999). In Manitoba, caribou used frozen lakes for travel, escape habitat, and to crater to drinking overflow water throughout the winter (Darby and Pruitt, 1984).

Early Winter

Northern caribou generally winter in low-elevation, mature pine or pine-spruce-lichen stands (Hatler, 1986). Open areas below timberline including muskegs and shrub or herb meadows are also used in early winter (Terry and Wood, 1999; Hatler, 1986). During the early winter in North-Central B.C., the WCH was observed to primarily utilize pine-lichen forests (56% of locations - of 756 radio locations obtained over 3 years from 17 animals) as well as fen and wetland habitat (21% of locations), while spruce and mixed deciduous stands were the least preferred (Terry and Wood, 1999). Analysis of data indicated that the pine and fen and wetland habitat were used significantly more than their availability, demonstrating habitat selection (Terry and Wood, 1999).

Snow depths exceeding 50 cm to 60 cm are limiting to single caribou cratering for lichens, and snow depths of 80 cm to 90 cm are considered limiting to cratering by groups of caribou (Russell and Martell, 1984). Beyond these snow depths or when hard-packed crusts develop, caribou are unable to locate and dig down to lichens (Russell and Martell, 1984). When snow depths become limiting, northern caribou will move from early winter ranges to late winter ranges. In winters of low snowfall, northern caribou will often remain in their early winter ranges (primarily lowland, coniferous forests) for the entire winter (Hatler, 1986).

Late Winter

During the late winter season, unfavourable snow conditions may force northern caribou to concentrate in alpine and subalpine habitat, or move to other low elevation areas (Mari Wood pers. comm., 1999; Terry and Wood, 1999; Hatler, 1986). When snow-depths preclude feeding in forests caribou will move to high windswept ridges where there is access to terrestrial lichens (Stevenson and Hatler, 1985). In studies that have covered multiple years, northern caribou have been found to use alpine habitat in winter when snow depths preclude the use of lower elevation mature and old pine-lichen forests (Terry and Wood, 1999; Wood and Terry, 1999; Cichowski, 1996; Wood, 1996). Terry and Wood (1999) and Hatler (1986) suggested the use of alpine habitats was the result of heavy snow accumulations forcing the animals to move to higher elevation windswept slopes. According to Hatler (1986) such use of alpine by northern caribou indicates a stressed situation occurring in severe winters and should not be interpreted as a preferred winter habitat.

10.4.2 Seasons of Use

Caribou are expected to occur within the Klawli TEM study area during the early winter and summer seasons. Table 59 summarizes the life requisites for northern caribou for each month of the year, including those months in which the WCH occupy locations outside of the Klawli study area. As some individuals may occur at some time during the spring and/or fall food habitat for these seasons has also been rated.

Table 59: Monthly Life Requisites for Northern Caribou (Wolverine Caribou Herd).

Month	Season*	Dates	Life Requisites
January	Late Winter	Jan 1-Mar 31	Food
February			
March			
April	Spring	Apr 1-May 15	Food
May	Spring	May 16-Jun 15 - Calving	Birth, Security, Food
June	Spring and Summer	May 16-Jun 15 - Calving Jun 16-Sep 15 - Summer range	Birth, Security, Food Food
July	**Summer**	**Jun 16-Sep 15 - Summer range**	**Food**
August			
September	Summer and Fall	Jun 16-Sep 15 - Summer range Sep 16-Oct 30 - Fall Rut	Food Food, Reproduction
October	Fall	Sep 16-Oct 30 - Fall Rut	Food, Reproduction
November	**Early Winter**	**Nov 1-Dec 30**	**Food**
December			

*Seasons defined by Terry and Wood (1999) for Wolverine Caribou Herd in North-Central B.C.

***Bold months indicate the time of year that the WCH occupy the Klawli Study Are (Figures 29 & 30).**

10.5 Ecosystem Attributes

A number of relationships between habitat use and ecosystem attributes can be determined for caribou based on current literature, research, and local biologist knowledge. Often the habitats used most frequently are associated with specific stand structure age class, vegetation cover, etc. Table 60 lists the ecosystem attributes that are considered in the habitat ratings tables.

Table 60: Terrestrial Ecosystem Mapping (TEM) Relationships for Food Habitat Requisites for Northern Caribou (Wolverine Caribou Herd) in the Klawli Study Area.

Life Requisite	Ecosystem Attribute
Food	site: slope, aspect, elevation, structural stage, site disturbance soil and terrain: bedrock, terrain texture, flooding regime vegetation: % cover by layer, species list by layer, cover for each species for each layer, terrestrial lichen biomass

10.5.1 Slope and Aspect

Research on Northern Caribou in North-Central B.C. by Terry and Wood (1999) indicates that slope and aspect play an important role in habitat selection. Use of aspects as well as slope classes were found to vary significantly among seasons. Caribou used cool aspects more frequently than warm aspects during all seasons, however, caribou used warm aspects more often during spring compared to other seasons (45% of locations) (Terry and Wood, 1999). In respect to slope class use, caribou used flat and gentle slopes (<15%) extensively during all seasons. However, caribou confined their use to predominately flat areas during early winter and increased their use of moderate slopes (16-30%) during other seasons, particularly during late winter (Terry and Wood, 1999).

10.6 Development of the Habitat Ratings

10.6.1 Rating Scheme

A 6-Class rating scheme of high (1), moderately high (2), moderate (3), low (4), very low (5), and nil (6) is employed due to the substantial level of knowledge on habitat use of northern caribou (RIC, 1998). This rating scheme is suggested by RIC (1998) for use with woodland caribou at the 1:20,000 map scale and is defined in Table 61.

Table 61: Habitat Capability and Suitability 6-Class Rating Scheme (from RIC, 1998).

% of Provincial Best	Rating	Code
100% - 76%	High	1
75% - 51%	Moderately High	2
50% - 26%	Moderate	3
25% - 6%	Low	4
5% - 1%	Very Low	5
0%	Nil	6

This rating scheme is used when assigning habitat ratings to the ecosystem units present within the Klawli study area. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for northern caribou as previously outlined in Table 59.

10.6.2 Provincial Benchmark

The provincial standard (best in B.C.) for the winter season for the northern caribou is the Stikine Plateau (STP) ecosection, SWBun and AT subzones (within the Central Interior ecoprovince) and the provincial standard for the growing season is the STP ecosection, AT subzone (Table 62) (RIC, 1998).

Most of the Klawli study area is located within the Manson Plateau (MAP) ecosection, which has a moderate (50% to 26%) capability compared to the standard (RIC, 1998). The northern part of the study area is located within the Southern Omineca Mountains (SOM) ecosection, which has a moderately high (75% to 51%) capability compared to the standard (RIC, 1998). The study area is therefore expected to have a moderate to fairly high capability for northern caribou.

Table 62: Provincial Benchmark (shaded rows) for Woodland Caribou (RIC, 1998).

Ecoprovince	Ecosection		BGC	Broad Ecosystem Unit/Seral Stage	Rating
	Unit	Rating	Subzone		
Winter					
Sub-Boreal Interior	SOM	2	AT/ BWBSmv	AT – Alpine Tundra/ WL - Wetland	3
Northern Boreal Mountains	STP	B	AT	AT – Alpine Tundra	1
Northern Boreal Mountains	STP	B	SWBun	LP/6 – Lodgepole pine AG – Alpine grassland	1
Growing Season					
Sub-Boreal Interior	SOM	2	AT	AT – Alpine Meadow	1
Northern Boreal Mountains	STP	B	AT	AT – Alpine Tundra	1
Northern Boreal Mountains	STP	B	SWBun	LP/6 – Lodgepole pine AG – Alpine grassland	1

10.6.3 Ratings Assumptions

The following habitat model assumptions have been made:

Life Requisite and Season	Assumptions
Food Habitat During the Early Winter **FD_WE**	During the early and late winter seasons, food habitat is largely rated on the presence and abundance of terrestrial lichens, because this is the predominant winter forage. This model assumes all habitats are accessible to northern caribou in the early winter season because they can tolerate fairly deep snow depths. **Structural Stage** • In general, structural stage 1 has poor foraging quality, because it is mainly unvegetated. • Stage 2 or 3 units at high elevations may also provide good lichen growth. • Stunted units in stages 3b or 4 may support lichen growth, and these units receive high ratings if lichens are abundant (associated with the unit and stage). • Younger forests (stage 4) generally do not support lichen growth and are therefore given low foraging ratings in this season. • Lichen production is greatest in late successional structural stages of lodgepole pine forests, therefore stages 5, 6 and 7 generally receive the highest food values during the early winter. **Vegetation Characteristics** • Lodgepole pine stands with high terrestrial lichen coverage is assumed to be of highest quality for food habitat during the early winter. • Wetland-sedge fens also important early winter food habitat – rated up to high. • Spruce dominated forests are rated up to moderate for food ratings. **Site, Moisture Regime, Soils** • Dry pine stands (poor nutrient regimes – generally xeric sites) are likely to have higher lichen productivity and are therefore of higher food quality (modifier x - drier than usual). • Wet units with a predominance of sedges, horsetails or grasses receive up to moderate food ratings in the early winter, because caribou forage in these units under low snow conditions. • Wet forested sites that provide poor lichen abundance receive nil to low ratings throughout the winter. **Snow Conditions** • Units are also rated on the perceived accessibility of these sites due to snow depth. This becomes a limiting factor mainly in the late winter season. In a winter with non-restrictive snow conditions, food ratings over the entire winter will be the same as those of the early winter season. **Elevation** • Primarily found in lower elevation forested units. • Windswept ridges in AT and parkland for access to terrestrial lichens, especially when deeper snow conditions prevail at lower elevations.

Life Requisite and Season	**Assumptions**
Food Habitat During the Late Winter **FD_WL**	**Structural Stage** • Structural stages 2 or 3 generally have the highest value for foraging at upper elevations of the ESSF and AT. **Vegetation Characteristics** • In late winter, presence and availability of lichens determines feeding areas. **Snow Conditions** • Late winter snow depths in an average winter are assumed to force caribou onto windswept ridges where forage is accessible. **Elevation** • As windswept ridges are probably very site specific, this makes it difficult to assign ratings. Therefore, units in the ESSFmvp3 and AT were assumed accessible in the late winter, and food values were assigned based on the vegetation present. These ratings will be too high if these areas do not blow free of snow. Late winter ratings for these units are generally higher than the early winter ratings, because these units are probably the only ones accessible in late winter. • Food habitat in lower elevation forests is assumed to be mainly inaccessible in late winter due to deep snow depths. Therefore, most BWBS and SBS units are given ratings of nil or low for food value in the late winter. Units in these subzones with abundant lichens are rated slightly higher because some lichen may be available.
Food Habitat During the Spring **FD_P**	**Structural Stage** • In general, structural stage 1 is of poor foraging quality, because it is mainly unvegetated. • Caribou will forage more extensively in younger structural stages during the growing season. • Units in younger structural stages (stage 4 to 5) will often have moderate food values. **Vegetation Characteristics** • ecosystem units with preferred vegetation and high percent cover are given high food ratings. **Site, Moisture Regime, Soils** • Warm aspect slopes with early "green-up" are of high value in the early spring because they provide forage access earlier than other sites. **Elevation** • Caribou forage at lower elevations in the spring. • During spring calving, females are located in the high elevation, mainly barren habitat of the parkland and alpine tundra - to avoid predators.

Life Requisite and Season	Assumptions
Food Habitat During the Summer **FD_S**	<u>**Structural Stage**</u> • See spring assumptions above. <u>**Vegetation Characteristics**</u> • See spring assumptions above. <u>**Site, Moisture Regime, Soils**</u> • Wet units with a predominance of sedge and horsetails receive high food ratings. <u>**Elevation**</u> • Caribou move to alpine and subalpine ranges in the summer. • Higher elevation units in the AT, ESSFmv3, and ESSFmvp3 have greater value for foraging in the summer and fall due to the delayed phenology of these sites.
Food Habitat During the Fall **FD_F**	<u>**Structural Stage**</u> • See spring assumptions for structural stages. <u>**Vegetation Characteristics**</u> • ecosystem units with preferred vegetation and high percent cover are given high food ratings. <u>**Elevation**</u> • Higher elevation units in the AT, ESSFmv3, and ESSFmvp3 have greater value for foraging in the summer and fall due to the delayed phenology of these sites. • Higher elevation (AT and ESSFmv3p), open areas are also utilized during the fall rut, where caribou groups concentrate.

10.6.4 Limitations

Although units within the Klawli TEM study area contain forage habitat for caribou during the late winter, spring, and fall (rut), the area is not known to be used by the WCH during these periods (Terry and Wood, 1999). Therefore, ratings during these periods are not reflective of actual use and should not be interpreted as such. Rather, the values should be interpreted as habitat availability, for potential caribou use.

Variation in snow depth and conditions can directly influence habitat use selection by caribou from year to year, yet there is insufficient understanding of this factor within the study area and surroundings to build it into the species-habitat model at this time. Therefore, ratings at present account for use under all foreseeable winter conditions (i.e. both AT as well as low elevation forests are rated as having important winter food values). Future information on snow conditions within the Klawli, Germansen and Wolverine Range areas will help to refine the model.

10.6.5 Rating Adjustment Considerations

Recent work on the WCH indicates that the distance to nearest non-forested wetlands (meadows, swamps, small lakes) influences habitat selection during the early winter (Terry and Wood, 1999). Pairwise comparisons of seasons revealed caribou were significantly closer to wetland areas (<500 m) compared to all other seasons. Therefore, forested areas located out of this range from wetland areas during the early winter may be of lesser value. A spatial analysis of this relationship could result in ratings adjustments for various polygons, which would more accurately reflect areas most likely to be utilized during the early winter.

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APPENDIX 1: ADDITIONAL SPECIES – HABITAT MODELS

The Yellow-bellied Flycatcher and the Peregrine Falcon were originally included as project species in the contract for the Wolverine Range study area, and preliminary draft species accounts and partial ratings tables were completed. Subsequently, through discussions with the contract monitor, it was agreed the information level regarding distribution and habitat requirements was insufficient to produce complete models for these species at this time. These species were therefore removed from the project species list, but the compiled preliminary information has been included here, as it may prove useful in subsequent research.

PRELIMINARY PEREGRINE FALCON SPECIES ACCOUNT

Common Name:	**Peregrine Falcon**
Scientific Name:	*Falco peregrinus*
Species Code:	B-PEFA
Status:	*Falco peregrinus anatum* is Red listed in British Columbia, designated as endangered in Canada.

Distribution

Peregrine Falcons are found on every continent except Antarctica. They can be found breeding in the arctic tundra, through Europe, and North America, and south into Africa, South America, the Pacific Islands, and Australia.

General declines in peregrine populations worldwide were noticed in the 1960s. These declines were attributed to the effects of pesticide poisoning from DDT among other factors. Populations have been recovering over the past two decades particularly in Alaska, the Yukon, the Northwest Territories, and some European countries. Populations of *F. p. anatum* in the rest of Canada have shown little recovery (Fyfe, 1988).

Provincial Range

Peregrine falcons are found throughout British Columbia. Although *F. pereginus* are non-migratory in southern areas, individuals in the northern part of the distribution migrate south during the winter months spending their winters along coastal and southern areas of British Columbia. Winter migrations continue as far south Mexico but reports of migrant peregrines have been documented from every major region of the world excepting Antarctica (Hickey and Anderson, 1965). A study in Alaska using banding suggests that the majority of the peregrines from that area winter in South America (Ambrose and Riddle, 1988).

In the study area Beebe (1965) commented on the northern interior areas offering good falcon habitat with wide, open valleys-vegetation predominately on the valley bottoms (Beebe, 1965). With large numbers of ptarmigan and a combination of good hunting and good nesting sites, it is likely that peregrine are using ecosystems in the subalpine and alpine environments in the summer.

Breeding densities are not available for the study area, but estimates observed in the southern portion of the Northwest Territories suggest a density of one pair of breeding peregrine falcons per 17 km^2 (Court *et al.*, 1988). The highest density being that calculated for the Queen Charlotte Islands of a mean distance between nests of 1.6 km (Beebe, 1960). Another estimate of density for the Northwest Territories was one pair per 50 km^2 in “optimal” habitat (Court *et al.*, 1988).

Elevational Range

Quite varied ranges of altitudinal distributions are reported in the literature. One study in Alaska found the highest eyrie in Alaska to occur at 2,200 feet (671 m) with prey species occurring up to 3,000 ft (914 m) (Hickey and Anderson, 1965).

Key Life Requisites and Habitat Requirements

General

Following the population declines observed in the 1960s, pesticide control and reintroduction boosted populations in some countries. The subspecies *F.p. tundrius* was taken off of the endangered list in 1994, but the *F. p. anatum* is still not showing recovery in most parts of Canada due to poor reproductive success and residual pesticide effects (Henny *et al.*, 1996). In some parts of the United States studies show that peregrines continue to be exposed to environmental contaminants which result in thin eggshells (Steidl *et al.*, 1991). Due to lack of historical data, it is difficult to determine if densities are increasing (Holroyd *et al.*, 1995).

Peregrines arrive in the northern parts of their ranges in late April (White, 1965) and stay until after young have fledged in August (most adults depart before the end of September).

The peregrine is well adapted for speed and power, with short wings and a long tail, it hunts in the open using height for its advantage to build speed as it descends upon its prey (Hickey and Anderson, 1965). Peregrines use large hunting territories extending for approximately a 30 km radius from the nest site preferring open areas such as shore lines, marshes, river valleys, open moors and tundra (U. S. Fish and Wildlife, 1997; Towry, R.K., 1984).

Food Habitat

As peregrines are so widely distributed across a vast range of habitats, prey species vary upon the local habitat and prey availability (Hickey and Anderson, 1965). The peregrine feeds on a large range of avian species including domestic pigeons, finches, starlings and jays of which the pigeon was the most significant prey (Hickey and Anderson, 1965). Mammals including lemmings and hares are occasionally found in the diet of the peregrine (Hickey and Anderson, 1965). Court *et al.* (1988) found that in peregrine populations in the Northwest Territories mammalian prey were commonly taken including ground squirrels and lemmings and thus it is likely that peregrine population fluctuations in this area are influenced by cycles in microtine rodents populations (Court *et al.*, 1988).

It is suggested that peregrine select hunting habitat that reduces the risk of loss of prey to other larger predators including bald or golden eagles and buteo hawks (Dekker, 1987).

Reproduction

Selection of breeding and brood rearing sites is likely a limiting factor for peregrine falcons as they do not build nests, rather they seek ledges, cliffs, ravines, hollows in trees, nests abandoned by other birds where eggs are laid on scrapes of debris, dirt or sticks. These sites are likely a measure taken to avoid disturbance during the sensitive incubation and brood-rearing period (Hickey and Anderson, 1965). If cliffs and higher sites are not available, as on low plains, nest sites have been found in cut banks which are ground nests (Hickey and Anderson, 1965). Nests are always located near water (either salt or fresh) (Fyfe, 1965).

Clutches are laid in April and May with an average clutch size of between 2 and 4 eggs. Eggs hatch in approximately 30-35 days and the young fledge in July/August.

It is suggested that prey abundance could limit reproductive success of peregrines (Court *et al.*, 1988; Thiollay, 1988).

Security/Thermal Habitat

Cliffs and other terrain features function as security or escape cover for peregrines while nesting and for resting while hunting (Hickey and Anderson, 1965).

Hierarchy of Life Requisites

1. Reproducing - Security Habitat for Nesting, and Food availability

2. Food - availability of food may limit peregrine populations

Seasons of Use

Reproducing by eggs (RE) from April through to fledging at the end of the growing season. Migration occurs in the fall (August and September).

Life requisites and habitat attributes

Activity	Habitat Attribute
RE, ST	riparian, cliffs, cutbanks, marshes
RE, FD	availability of prey habitat

Development of the Habitat Ratings

Rating Scheme and Seasons

There is an intermediate knowledge of the habitat use by peregrine falcons which would merit a 4-class rating scheme high (H), moderate (M), low (L) and nil (N). The only season when peregrines occur in the study area is during the growing season as they migrate south for the winter. There is little difference in habitat use during the growing season. Habitat will be rated for nesting security and food availability (an index of prey species occurring).

Ratings Adjustments

Adjustments do not have to be made for human settlement and development as peregrines have adapted to nesting in cities (skyscrapers and high buildings).

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PRELIMINARY YELLOW-BELLIED FLYCATCHER SPECIES ACCOUNT

Common Name:	**Yellow-bellied Flycatcher**
Scientific Name:	*Empidonax flaviventris*
Species Code:	B-YBFL
Status:	Blue listed, considered to be a rare migrant and rare to uncommon summer visitor to Northeastern B.C.

Distribution

Wintering in Mexico and Panama, the yellow-bellied flycatcher summers in Canada and migrates through the United States (Peterson and Peterson, 1990).

Provincial Range

The Yellow-bellied Flycatcher is a neotropical migrant restricted in British Columbia to the Taiga Plains, the Boreal Plains and the southeastern portions of the Sub-Boreal Interior Ecoprovinces of the northwest (Campbell *et al.*, 1997). They have been detected on the Liard river in the southeast Yukon (Sinclair, 1996) and a recent study by Bennett and Enns (1996) noted presence and probable breeding of Yellow-bellied Flycatchers along the Liard river in the northwest.

Elevation

The yellow-bellied flycatcher uses elevations between 13 and 975 m (Campbell *et al.*, 1997).

Key Life Requisites and Habitat Requirements

General

As specific studies of yellow-bellied flycatcher habitat requirements have not been undertaken in the northern interior, information from other studies have been summarized. Extrapolations from studies done in different ecosystem types must be interpreted with caution. Literature indicates that habitat used includes: shady woodlands, wooded streams, bogs and alder and willow thickets often mixed with conifers (Godfrey, 1986). Yellow-bellied Flycatchers are likely to use wet, thick shrubby areas and the ecotones between heavily forested and open areas, where diversity is greatest (Campbell *et al.*, 1997). Edges where deciduous and coniferous forests are interspersed are also likely to be used, especially along wet areas, young pine/aspen forest, and spruce bogs. On the Liard river, Bennett and Enns (1996) found Yellow-bellied Flycatchers to be using immature deciduous stands at a variety of elevations. Many of their sites were characterized by small slope failures with associated slumping. Stands were generally densely spaced with closed canopies, in a stage prior to self-thinning. Birch, alder, and willow with some spruce were the main associated tree species.

Yellow-bellied flycatchers are noted to have been observed using spruce muskeg in the northwest, and young pine stands in the northeast (Mark Pfinney, *pers. comm.*). Due to the limited information available on habitat associations and corresponding site series, preliminary ratings have not been developed for ecosystem units in the study area. Within the study area, yellow-bellied flycatchers are likely to use younger structural stages of open pine forests (stage 4), although stages 5-7 will have some value. Spruce bogs may be used for breeding as they appear to be utilised in other areas (Godfrey, 1986).

Reproducing

Yellow-bellied flycatchers likely nest on the ground in mossy hummocks. Eggs may be laid as early as June 18, and incubation takes approximately 12-15 days (Campbell *et al.,* 1997).

Season of Use

This flycatcher is likely to occur in the study area from early June to late July or early August.

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APPENDIX 2: WILDLIFE SPECIES OBSERVATION LIST

	Common Name	*Scientific Name*
	AMPHIBIANS	
A-BUBO	Northwestern Toad	*Bufo boreas*
A-RAPR	Spotted Frog	*Rana pretiosa*
	BIRDS	
B-AMKE	American Kestrel	*Falco sparverius*
B-AMRO	American Robin	*Turdus migratorius*
B-BCCH	Black-capped Chickadee	*Parus atricapillus*
B-BLTE	Black Tern	*Chlidonias niger*
B-BOCH	Boreal Chickadee	*Parus hudsonicus*
B-CAGO	Canada Goose	*Branta canadensis*
B-CHSP	Chipping Sparrow	*Spizella passerina*
B-CLNU	Clark’s Nutcracker	*Nucifraga columbiana*
B-COHA	Cooper’s Hawk	*Accipiter cooperii*
B-COLO	Common Loon	*Gavia immer*
B-CONI	Common Nighthawk	*Chordeiles minor*
B-CORA	Common Raven	*Corvus corax*
B-COYE	Common Yellowthroat	*Geothlypis trichas*
B-DEJU	Dark-eyed Junco	*Junco hyemalis*
B-GCKI	Golden-crowned Kinglet	*Regulus satrapa*
B-GOEA	Golden Eagle	*Aquila chrysaetos*
B-GRJA	Gray Jay	*Perisoreus canadensis*
B-MALL	Mallard	*Anas platyrhynchos*
B-MOCH	Mountain Chickadee	*Parus gambeli*
B-NHOW	Northern Hawk Owl	*Surnia ulula*
B-NOFL	Northern Flicker	*Colaptes auratus*
B-NOGO	Northern Goshawk	*Accipiter gentilis*
B-NOHA	Northern Harrier	*Circus cyaneus*
B-OSPR	Osprey	*Pandion haliaetus*
B-PEFA	Peregrine Falcon	*Falco peregrinus*
B-RBNU	Red-breasted Nuthatch	*Sitta canadensis*
B-RCKI	Ruby-crowned Kinglet	*Regulus calendula*

B-RTHA	Red-tailed Hawk	*Buteo jamaicensis*
B-RUGR	Ruffed Grouse	*Bonasa umbellus*
B-SOSP	Song Sparrow	*Melospiza melodia*
B-SPGR	Spruce Grouse	*Dendgragapus candensis*
B-SWHA	Swainson's Hawk	*Buteo swainsoni*
B-TOWA	Townsend's Warbler	*Dendroica townsendi*
B-TTWO	Three-toed Woodpecker	*Picoides tridactylus*
B-WIPT	Willow Ptarmigan	*Lagopus lagopus*
B-WIWR	Winter Wren	*Troglodytes troglodytes*
B-YRWA	Yellow-rumped Warbler	*Dendroica coronata*
	MAMMALS	
M-MIPE	Meadow Vole	*Microtus pennsylvanicus*
M-CLGA	Southern Red-backed Vole	*Clethrionomys gapperi*
M-SO??	Unidentified Shrew	*Sorex* sp.
M-LESI	Northern Lemming	*Lemmus sibiricus*
M-MACA	Hoary Marmot	*Marmota caligata*
M-LEAM	Snowshoe Hare	*Lepus americanus*
M-ONZI	Muskrat	*Ondatra zibithecus*
M-CACA	Beaver	*Castor canadensis*
M-ERDO	Porcupine	*Erethizon dorsatum*
M-TAMI	Least Chipmunk	*Tamias minimus*
M-TAHU	Red Squirrel	*Tamiasciurus hudsonicus*
M-CALA	Coyote	*Canis latrans*
M-CALU	Gray Wolf	*Canis lupus*
M-LYCA	Lynx	*Lynx canadensis*
M-LOCA	River Otter	*Lontra canadensis*
M-MAPE	Fisher	*Martes pennanti*
M-URAR	Grizzly Bear	*Ursus arctos horribilus*
M-ALAL	Moose	*Alces alces*
M-ODHE	Mule Deer	*Odocoileus hemionus*
M-RATA	Caribou	*Rangifer tarandus*

APPENDIX 3: FINAL RATINGS TABLE

This appendix provides suitability and capability ratings values for each mapped ecosystem (attached disc). Suitability ratings are provided for each of the rated life requisites and seasons for each species. The structural stage with the highest rating will be the capability for the ecosystem. Definitions for the codes used in the final ratings table are provided in Table A1.

Legend for Wildlife Capability and Suitability Ratings

<u>Species Codes</u>

BNOGO	Northern Goshawk
MFECA	Lynx
MGUGU	Wolverine
MMAAM	Marten
MMAPE	Fisher
MURAR	Grizzly Bear
MRATA	Woodland Caribou

<u>Life Requisites</u>

FD	food
SH	security
ST	security/thermal
HI	hibernation
RB	reproduction (live birthing)
RE	reproduction (eggs)

<u>Seasons</u>

A	all seasons
PE	early spring
S	summer
F	fall
WE	early winter
W	winter
G	growing

<u>Habitat Capability and Suitability Rating Schemes</u>

4 class rating scheme:

H	high (100 - 76% of provincial standard)
M	moderate (75 - 26% of provincial standard)
L	low (25 - 1% of provincial standard)
N	nil (0% of provincial standard)

6 class ratings scheme:

1	high (100 - 76% of provincial standard)
2	moderately high (75 - 51% of provincial standard)
3	moderate (50 - 26% of provincial standard)
4	low (25 - 6% of provincial standard)
5	very low (5 - 1% of provincial standard)
6	nil (0% of provincial standard)

APPENDIX 4: KLAWLI HABITAT AVAILABILITY SUMMARY TABLES

Total hectares in study area: **113, 150 ha**

LABEL	Map Label Count	Total hectares/ ecosystem	Percentage in study area	Percentage in Subzone
AT CF3a	22	32	0.03%	10.5%
AT CL1	2	3	0.00%	1.0%
AT FK3a	20	26	0.02%	8.5%
AT FW2b	36	104	0.09%	34.0%
AT MH2d	9	7	0.01%	2.3%
AT PD	1	0	0.00%	0.0%
AT RO1	15	34	0.03%	11.1%
AT RU1	9	10	0.01%	3.3%
AT TA1	33	90	0.08%	29.4%
total per zone	**147**	**306**	**0.27%**	
BWBSdk1 BC5	1	33	0.03%	3.6%
BWBSdk1 BH3b	4	6	0.01%	0.7%
BWBSdk1 CS2b	4	5	0.00%	0.5%
BWBSdk1 LL3	1	5	0.00%	0.5%
BWBSdk1 LL4	24	302	0.27%	33.2%
BWBSdk1 LL5	8	74	0.07%	8.1%
BWBSdk1 RI	6	12	0.01%	1.3%
BWBSdk1 SC5	1	3	0.00%	0.3%
BWBSdk1 SC6	10	46	0.04%	5.1%
BWBSdk1 SC7	5	22	0.02%	2.4%
BWBSdk1 SF2b	1	1	0.00%	0.1%
BWBSdk1 SM4	1	12	0.01%	1.3%
BWBSdk1 SM5	9	61	0.05%	6.7%
BWBSdk1 SM6	13	54	0.05%	5.9%
BWBSdk1 SM7	8	73	0.06%	8.0%
BWBSdk1 SR3	2	6	0.01%	0.7%
BWBSdk1 SR5	1	0	0.00%	0.0%
BWBSdk1 SR6	2	6	0.01%	0.7%
BWBSdk1 SS4	8	47	0.04%	5.2%
BWBSdk1 SS5	17	101	0.09%	11.1%
BWBSdk1 SS6	2	6	0.01%	0.7%
BWBSdk1 SS7	1	9	0.01%	1.0%
BWBSdk1 TC2b	2	3	0.00%	0.3%
BWBSdk1 WF3b	9	23	0.02%	2.5%
total per zone	**140**	**910**	**0.80%**	
ESSFmv3 BS3a	11	36	0.03%	0.04%
ESSFmv3 BS3b	48	112	0.10%	0.11%

ESSFmv3 BT3	18	54	0.05%	0.05%
ESSFmv3 BT4	137	640	0.57%	0.64%
ESSFmv3 BT5	209	817	0.72%	0.82%
ESSFmv3 BT6	92	391	0.35%	0.39%
ESSFmv3 BT7	13	55	0.05%	0.05%
ESSFmv3 CF3a	21	29	0.03%	0.03%
ESSFmv3 CS2b	771	2531	2.24%	2.53%
ESSFmv3 ES1	5	11	0.01%	0.01%
ESSFmv3 FC2d	4	7	0.01%	0.01%
ESSFmv3 FC3	128	818	0.72%	0.82%
ESSFmv3 FC3b	172	668	0.59%	0.67%
ESSFmv3 FC4	28	75	0.07%	0.07%
ESSFmv3 FC5	49	346	0.31%	0.35%
ESSFmv3 FC6	64	435	0.38%	0.43%
ESSFmv3 FD3	9	42	0.04%	0.04%
ESSFmv3 FD4	6	65	0.06%	0.06%
ESSFmv3 FD5	4	43	0.04%	0.04%
ESSFmv3 FD6	17	77	0.07%	0.08%
ESSFmv3 FD7	1	17	0.02%	0.02%
ESSFmv3 FH3	111	480	0.42%	0.48%
ESSFmv3 FH3b	15	56	0.05%	0.06%
ESSFmv3 FH4	190	758	0.67%	0.76%
ESSFmv3 FH5	393	1691	1.49%	1.69%
ESSFmv3 FH6	556	2202	1.95%	2.20%
ESSFmv3 FH7	92	546	0.48%	0.54%
ESSFmv3 FK3a	63	207	0.18%	0.21%
ESSFmv3 FM3	99	765	0.68%	0.76%
ESSFmv3 FM3b	221	968	0.86%	0.97%
ESSFmv3 FM4	30	151	0.13%	0.15%
ESSFmv3 FM5	35	164	0.14%	0.16%
ESSFmv3 FM6	187	1455	1.29%	1.45%
ESSFmv3 FM7	20	203	0.18%	0.20%
ESSFmv3 FO3	33	212	0.19%	0.21%
ESSFmv3 FO4	68	300	0.27%	0.30%
ESSFmv3 FO5	102	350	0.31%	0.35%
ESSFmv3 FO6	362	1780	1.57%	1.78%
ESSFmv3 FO7	58	425	0.38%	0.42%
ESSFmv3 FR3	449	4450	3.93%	4.44%
ESSFmv3 FR4	872	8915	7.88%	8.90%
ESSFmv3 FR5	1120	10865	9.60%	10.84%
ESSFmv3 FR6	1567	18138	16.03%	18.10%
ESSFmv3 FR7	206	3940	3.48%	3.93%
ESSFmv3 FV3	182	1345	1.19%	1.34%
ESSFmv3 FV3b	30	120	0.11%	0.12%
ESSFmv3 FV4	24	154	0.14%	0.15%

ESSFmv3 FV5	165	955	0.84%	0.95%
ESSFmv3 FV6	515	3423	3.03%	3.42%
ESSFmv3 FV7	111	958	0.85%	0.96%
ESSFmv3 FW2b	32	78	0.07%	0.08%
ESSFmv3 FW2d	41	141	0.12%	0.14%
ESSFmv3 GB1	1	1	0.00%	0.00%
ESSFmv3 LA	7	189	0.17%	0.19%
ESSFmv3 LC3	167	1013	0.90%	1.01%
ESSFmv3 LC3b	9	26	0.02%	0.03%
ESSFmv3 LC4	1097	11866	10.49%	11.84%
ESSFmv3 LC5	589	5140	4.54%	5.13%
ESSFmv3 LC6	85	745	0.66%	0.74%
ESSFmv3 LC7	8	75	0.07%	0.07%
ESSFmv3 MH2d	53	168	0.15%	0.17%
ESSFmv3 OW	165	254	0.22%	0.25%
ESSFmv3 PD	40	102	0.09%	0.10%
ESSFmv3 RI	30	27	0.02%	0.03%
ESSFmv3 RO1	102	147	0.13%	0.15%
ESSFmv3 RP	7	19	0.02%	0.02%
ESSFmv3 RU1	5	9	0.01%	0.01%
ESSFmv3 SB2c	63	85	0.08%	0.08%
ESSFmv3 SF2b	434	1038	0.92%	1.04%
ESSFmv3 ST3	8	25	0.02%	0.02%
ESSFmv3 ST4	12	33	0.03%	0.03%
ESSFmv3 ST5	10	43	0.04%	0.04%
ESSFmv3 TA1	98	198	0.17%	0.20%
ESSFmv3 TC2b	129	365	0.32%	0.36%
ESSFmv3 VG2a	266	846	0.75%	0.84%
ESSFmv3 VG3a	136	434	0.38%	0.43%
ESSFmv3 WB3a	927	3103	2.74%	3.10%
ESSFmv3 WF3b	302	803	0.71%	0.80%
total per zone	**14506**	**100218**	**88.57%**	

ESSFmvp3 CF3a	79	180	0.16%	5.88%
ESSFmvp3 CL1	1	1	0.00%	0.03%
ESSFmvp3 CS2b	3	7	0.01%	0.23%
ESSFmvp3 FC2d	4	13	0.01%	0.42%
ESSFmvp3 FC3b	21	72	0.06%	2.35%
ESSFmvp3 FK3a	211	942	0.83%	30.79%
ESSFmvp3 FM3	2	6	0.01%	0.20%
ESSFmvp3 FM3b	61	176	0.16%	5.75%
ESSFmvp3 FM5	1	2	0.00%	0.07%
ESSFmvp3 FM6	1	1	0.00%	0.03%
ESSFmvp3 FV3b	7	14	0.01%	0.46%
ESSFmvp3 FV6	1	0	0.00%	0.00%

ESSFmvp3 FW2b	129	520	0.46%	17.00%
ESSFmvp3 FW2d	21	61	0.05%	1.99%
ESSFmvp3 MH2d	100	256	0.23%	8.37%
ESSFmvp3 OW	1	1	0.00%	0.03%
ESSFmvp3 RO1	52	132	0.12%	4.32%
ESSFmvp3 RU1	7	18	0.02%	0.59%
ESSFmvp3 TA1	166	496	0.44%	16.21%
ESSFmvp3 VG2a	48	161	0.14%	5.26%
ESSFmvp3 VG3a	15	47	0.04%	1.54%
total per zone	**931**	**3059**	**2.70%**	
SBSmk1 BB3a	24	79	0.07%	0.92%
SBSmk1 BB3b	14	109	0.10%	1.27%
SBSmk1 BE1	4	17	0.02%	0.20%
SBSmk1 BH4	90	875	0.77%	10.16%
SBSmk1 BH5	123	952	0.84%	11.06%
SBSmk1 BH6	15	61	0.05%	0.71%
SBSmk1 BH7	2	5	0.00%	0.06%
SBSmk1 BS3a	66	315	0.28%	3.66%
SBSmk1 ES1	1	1	0.00%	0.01%
SBSmk1 GB1	13	27	0.02%	0.31%
SBSmk1 LA	1	440	0.39%	5.11%
SBSmk1 LC3	4	7	0.01%	0.08%
SBSmk1 LC4	91	774	0.68%	8.99%
SBSmk1 LC5	100	951	0.84%	11.05%
SBSmk1 LC6	3	19	0.02%	0.22%
SBSmk1 OW	21	34	0.03%	0.39%
SBSmk1 PD	6	24	0.02%	0.28%
SBSmk1 RI	10	44	0.04%	0.51%
SBSmk1 RO1	3	6	0.01%	0.07%
SBSmk1 RP	3	3	0.00%	0.03%
SBSmk1 RR	2	0	0.00%	0.00%
SBSmk1 SB3	6	57	0.05%	0.66%
SBSmk1 SB4	28	205	0.18%	2.38%
SBSmk1 SB5	154	725	0.64%	8.42%
SBSmk1 SB6	107	865	0.76%	10.05%
SBSmk1 SB7	6	69	0.06%	0.80%
SBSmk1 SF2b	34	83	0.07%	0.96%
SBSmk1 SH3	4	12	0.01%	0.14%
SBSmk1 SH3b	30	108	0.10%	1.25%
SBSmk1 SH4	8	24	0.02%	0.28%
SBSmk1 SH5	41	130	0.11%	1.51%
SBSmk1 SH6	84	250	0.22%	2.90%
SBSmk1 SH7	1	5	0.00%	0.06%
SBSmk1 SM1b	3	7	0.01%	0.08%

SBSmk1 SO3	3	10	0.01%	0.12%
SBSmk1 SO4	5	19	0.02%	0.22%
SBSmk1 SO5	19	64	0.06%	0.74%
SBSmk1 SO6	62	226	0.20%	2.62%
SBSmk1 SO7	4	21	0.02%	0.24%
SBSmk1 ST3	3	2	0.00%	0.02%
SBSmk1 ST4	13	83	0.07%	0.96%
SBSmk1 ST5	33	161	0.14%	1.87%
SBSmk1 ST6	1	9	0.01%	0.10%
SBSmk1 TA1	2	4	0.00%	0.05%
SBSmk1 TC2b	32	68	0.06%	0.79%
SBSmk1 WB	1	13	0.01%	0.15%
SBSmk1 WB3a	133	605	0.53%	7.03%
SBSmk1 WB3b	11	42	0.04%	0.49%
Total per zone	**1424**	**8610**	**7.61%**	

Total hectares in Klawli study area: 113, 150

Total hectares of Klawli covered by LC (including all modifiers): 20, 628.60

BEC/Ecosystem	Hectares	Percentage of Study area
ESSFmv3 LC3	537.27	0.47%
ESSFmv3 LC3b	23.01	0.02%
ESSFmv3 LC4	5759.56	5.09%
ESSFmv3 LC5	3635.44	3.21%
ESSFmv3 LC6	523.68	0.46%
ESSFmv3 LC7	75.01	0.07%
Total Covered by LC with no modifiers	**10553.97**	**9.33%**
ESSFmv3 LChx4	16.44	0.01%
ESSFmv3 LChx5	4.29	0.00%
ESSFmv3 LCnx4	18.77	0.02%
ESSFmv3 LCsx3	6.09	0.01%
ESSFmv3 LCtx4	23.98	0.02%
ESSFmv3 LCtx5	4.65	0.00%
ESSFmv3 LCvx3	3.24	0.00%
ESSFmv3 LCvx4	2.13	0.00%
ESSFmv3 LCx3	375.85	0.33%
ESSFmv3 LCx4	5439.67	4.81%
ESSFmv3 LCx5	1157.09	1.02%
ESSFmv3 LCx6	189.48	0.17%
Total covered by LCx:	**7241.68**	**6.40%**
ESSFmv3 LCsw3	4.26	0.004%
ESSFmv3 LCsw4	74.37	0.066%
ESSFmv3 LCsw5	93.02	0.082%

ESSFmv3 LCsw6	4.32	0.004%
ESSFmv3 LCvw3	54.31	0.048%
ESSFmv3 LCvw3b	1.58	0.001%
ESSFmv3 LCvw4	10.39	0.009%
ESSFmv3 LCvw5	27.40	0.024%
ESSFmv3 LCvw6	1.26	0.001%
ESSFmv3 LCw3	35.27	0.031%
ESSFmv3 LCw3b	1.36	0.001%
ESSFmv3 LCw4	518.84	0.459%
ESSFmv3 LCw5	223.92	0.198%
ESSFmv3 LCw6	29.15	0.026%
Total Covered by LCw:	**1079.45**	**0.954%**
SBSmk1 LC3	6.87	0.006%
SBSmk1 LC4	763.88	0.675%
SBSmk1 LC5	933.02	0.825%
SBSmk1 LC6	19.49	0.017%
Total	**1723.26**	**1.523%**
SBSmk1 LCvw4	3.29	0.003%
SBSmk1 LCw4	8.47	0.007%
SBSmk1 LCw5	18.48	0.016%
Total	**30.24**	**0.027%**