Wildlife Species Habitat Models
and
Final Wildlife Suitability Ratings
for the
Itcha / Ilgachuz Area

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1.0 INTRODUCTION

1.1 Introduction

In the summer of 1996 Shearwater Mapping Ltd. was contracted by the Wildlife Branch of the Ministry of Environment, Lands and Parks to produce Terrestrial Ecosystem maps at a scale of 1:50 000 for the Itcha / Ilgachuz study area (Clement and Dalziel 1999). Additionally a map of ecosystem units at a scale of 1:20 000 was produced for the Punkutlaenkut Creek drainage. In the summer of 1997 the project was expanded to include Phase 2. The 1996 and 1997 study areas are depicted in Figure 1. NTS map sheets covered included 93 C/6 (north half), 7, 8, 9, 10, 11 12 (east half), 13 (east half), 14, 15 and 16.

Arctos Wildlife Services was subcontracted by Shearwater Mapping Ltd. to collect wildlife field data to produce wildlife suitability/capability models and associated ratings for the entire study area. Wildlife species rated were northern caribou (R*angifer tarandus caribou*), moose (*Alces alces*), mountain goat (*Oreamnos americanus*), California bighorn sheep (*Ovis canadensis californiana*), grizzly bear (*Ursus arctos*) and black bear (*Ursus americana*). The wildlife species sutability/capability models and associated final wildlife ratings table follow the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1998a)

Following the standards for Terrestrial Ecosystem Mapping in British Columbia (Resources Inventory Committee 1998b) 352 plots, and 225 ground visual records were located and sampled. In addition 252 quick visual records were obtained. There are nine Biogeoclimatic Units included in the study area, including IDFdk4, SBPSxc, SBPSdc, SBPSmc, SBSmc2, MSxv, ESSFxv1, ESSFxvp1 and AT. See the Biogeoclimatic Unit section (Appendix II) for a detailed names of biogeoclimatic units. For complete descriptions of the terrestrial ecosystem map units see Ecosystem Units of the Itcha / Ilgachuz Area (Clement and Dalziel 1999).

1.2 Study Area

Most of the study area lies within the Western Chilcotin Upland (WCU) Ecosection with only the southwestern corner occuring in the Chilcotin Plateau (CHP) Ecosection and a small northern portion occuring in the Nazko Upland (NAU) Ecosection. Elevations range from approximately 1120m (Anahim Lake) to 2400m (Far Mountain in the Ilgachuz Range) with the entire area primarily a gently sloping plateau with the Itcha Range, Ilgachuz Range and Rainbow Range being prominent mountainous areas. Major drainages which bissect the area include the Dean River (draining the western portion) and the Chilcotin River (draining the eastern portion). Draining into the Dean River are Holtry Creek, Nimpo Creek, Dagg Creek, Holte Creek, Lehman Creek, Corkscrew Creek, Beeftrail Creek, Festuca Creek and Obsidian Creek. Draining into the Chilcotin River are Punkutlaenkut Creek, Palmer Creek, Jorgensen Creek, Clusko Creek, and Downton Creek. The northern part of the study area is drained by the Blackwater, Kushya, Coglistiko and Baezaeko Rivers. Prominent lakes within the study area include Chilcotin, Nimpo (northern part), Anahim, Kappan, Abuntlet, Lessard, Tezla, Gatcho, Eliguk, Tsibekuz, Stuyvesant, Itcha and Narcosli.

The Itcha - Ilgachuz study area is part of the Fraser Plateau which has a flat and gently rolling topography having large areas of undissected upland lying between 1200 and 1525 meters

Figure 1. Itcha / Ilgachuz study area.

(Holland 1964). A large part of the study area is underlain by flat or gently dipping late Miocine or Pliocine olivine basalt flows. On the western edge of the study area the Rainbow Range, peaking at 2478m. at Tsitsult Peak, projects above the plateau as do the other Miocine shield volcanoes of the Ilgachuz and Itcha Ranges all composed mainly of andesite and dacite. Much of the plateau is covered with glacial drift composed of basal till modified in places by drumlins and glacial grooves interspersed by occasional areas of shallow materials overlying bedrock and exposed bedrock (Tipper 1970). The Anahim valley and Coglistiko River areas have extensive areas of ablation till, eskers and meltwater channels. Isolated areas of glaciolacustrine occur in Holtry Creek and in the Baezaeko River drainage.

The bulk of the study area occurs as SBPSxc (SubBoreal Pine-Spruce Very Dry Cold Subzone) and MSxv (Montane Spruce Very Dry Very Cold Subzone). In the SBPSxc an intensive fire history combined with a dry, cold climate results in the development of very open forests of lodgepole pine with only occasional occurrences of hybrid white spruce (Engelmann x white) and subalpine fir. Understory vegetation is dominated by soopolallie, kinnikinnick, twinflower and *Pleurozium schreberi*. Typical surficial materials are sandy gravelly and gravelly muddy morainal blankets; characteristic soil developments are Orthic Dystric Brunisol, Orthic Gray Luvisol and Brunisolic Gray Luvisol. On sites with coarse-textured soils terrestrial lichens such as *Cladonia* and *Cladina* species often proliferate. In the MSxv, which occurs above the SBPSxc up to an elevation of about 1500m, lodgepole pine still dominates forests on mesic sites. Hybrid spruce and Engelmann spruce are occasionally present both in the tree and shrub layers. Common in the understory are grouseberry, crowberry, twinflower, *Dicranum* species and *Cladonia ecmocyna.* Typical surficial materials are sandy, gravelly morainal blankets, with Eluviated and Orthic Dystric Brunisol soils.

Also occuring with limited geographic range are SBPSdc (SubBoreal Pine-Spruce Dry Cold Subzone), SBPSmc (SubBoreal Pine-Spruce Moist Cold Subzone), SBSmc2 (SubBoreal Spruce Moist Cold Subzone Babine Variant) and IDFdk4 (Interior Douglas-Fir Dry Cool Subzone Chilcotin Variant).

Occuring above the MSxv are the ESSFxv1 (Engelmann Spruce-Subalpine Fir Very Dry Very Cold Subzone West Chilcotin Variant) and the Alpine Tundra Zone (AT). Occurring sporadically and transitionally between ESSFxv1 and AT is a parkland unit of the ESSFxv1, (ESSFxvp1) which is characterized by the presence of stunted tree islands or krummholz interspersed with dry and moist meadows. Typical vegetation on mesic sites in the ESSFxv1 consists of open lodgepole pine forests, usually with a component of Engelmann spruce and subalpine fir. Common species include grouseberry, heart-leaved arnica, *Dicranum* species, *Barbilophozia* species and *Cladonia ecmocyna*. A diversity of non-forested ecosystems occur in the ESSFxv1 including dry and moist meadows, shrub carrs, riparian shrublands, talus slopes, rock outcrops, fens, and dry grasslands. In the Alpine Tundra Zone mesic sites are dominated by a cover of either scrub birch or Altai fescue. Other significant plant occurences include alpine fescue, white mountain-avens, northern goldenrod, *Cladina arbuscula* and *Cetraria* species. Other alpine ecosystems include blockfields, windswept ridges and slopes, wet meadows, talus slopes and rock outcrops.

2.0 METHODS

A total of 352 plots were located and sampled. Plots were selected in consultation with the ecosysytem mappers to characterize important habitats for the six wildlife species to be rated. An additional 225 ground visual plots were completed where brief notes were made on the most important habitat features for selected wildlife species.

At each plot location reconnaissance plot forms (FS882A) were completed according to Meidinger and Thingstead (1995) in 1996. In 1997 new forms were completed according to Resources Inventory Committee (1997). Also recorded at each plot location were information on coarse woody debris (following RIC standards), and ungulate pellet group counts (primarily caribou) and wildlife trees.

The pellet group counts were conducted as follows. Beginning at the soil pit (centre of plot) the recorder counted all ungulate pellet groups in 2m diameter quadrats at 4m intervals along a 20m transect in each of the the 4 cardinal directions (N,E,S,W). This resulted in 20 quadrats per plot. Whenever possible pellets were recorded as being from summer or winter.

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4.0 WILDLIFE SPECIES ACCOUNTS AND HABITAT RATING METHODS

4.1 Northern Caribou

4.1.1 Name: *Rangifer tarandus caribou*
Woodland Caribou (Northern ecotype)
Species Code: M-RATA

4.1.2 Status:

Northern populations:	Yellow-listed (species of management concern) Protected as big game under the British Columbia Wildlife Act (1982).
Southeastern populations:	Blue-listed.

4.1.3 Distribution

- **Provincial Range**

All caribou in British Columbia belong to one subspecies of woodland caribou, *Rangifer tarandus caribou* of which two different ecotypes are recognised, the northern and the mountain. The distinction between the two is based on biogeography and habitat use rather than on any morphological differences (Nagorsen 1990, Cowan and Guiget, 1965).

Mountain caribou are found in southeastern British Columbia and in the east-central portions of the province. They inhabit areas of high snowfall where snow depths make cratering for winter forage difficult so they rely primarily on arboreal lichens (*Bryoria, Alectoria)* for winter food. The northern caribou inhabits areas with low to moderate snow depths in the boreal forests in the north and west-central portions of BC including the Itcha, Ilgachuz and Rainbow Mountain ranges. In these areas they forage primarily on terrestrial lichens but arboreal lichen use increases as winter progresses or during winters of deep snowpack (Bergerud 1974a).

The transition between the two different ecotypes occurs between the Fraser River and Highway 97 in the Hart Ranges ecosection, and roughly corresponds to the northern limit of the Interior Cedar-Hemlock (ICH) biogeoclimatic zone in eastern British Columbia (Simpson *et al* 1997).

The Itcha / Ilgachuz / Rainbow herd which consists of approximately 1,700 caribou, summers in these mountain ranges and winters primarily in low elevation forested habitat to the west of the Itcha Mountains, and to a lesser extent, in the northern Ilgachuz and Rainbow mountains (Cichowski, D.1996, Young and Shaw, 1998a).

- **Provincial Context**

The present distribution of caribou in Canada has changed from historical times. Caribou are no longer found in Nova Scotia or New Brunswick and their distribution has been greatly reduced in

southern Quebec and Ontario. Presently caribou inhabit most of the boreal forests of Canada and Alaska. In British Columbia, caribou range has also been greatly reduced, particularly in the southern portion of the province and the Bulkley Valley-Prince George region **(**BC Ministry of Environment 1979).

The number of caribou in British Columbia is currently estimated to be about 18,000, with the greatest proportion (82%) in Administrative Regions 6 (Skeena: 6,300), and 7 (Omineca/Peace/Liard: 8,400) in the northern half of the province. The Rainbow / Itcha / Ilgachuz herd, currently (1999) estimated at 1,700-1,800 animals, comprises approximately 10% of the provincial caribou population (Hatter 1997). Post calving surveys of the Itcha / Ilgachuz herd indicate that the population has been relatively stable since the late 1980's and early 1990's. There has been an apparent increase in their numbers in the last four years, but it is unknown if this is due to an actual increase or to better sightability (Young and Shaw 1998a).

- **Range in Project Area:**

Ecoprovince:	Central Interior
Ecoregions:	Fraser Plateau
Ecosections:	Western Chilcotin Upland (WCU), Chilcotin Plateau (CHP), Nazko Upland (NAU)
Biogeoclimatic Zones:	MSxv, AT, ESSFxv1, ESSFxvp1, SBPSxc, SBPSdc, SBPSmc
Elevational Range:	In the Itcha / Ilgachuz study area, caribou range from 1,000 metres (Dean River) to 2,400 metres (Far Mountain in the Ilgachuz range).

The MS and SBPS zones have extensive dry lodgepole pine forests with substantial terrestrial ground cover providing important caribou winter habitat. The ESSF zone has the greatest arboreal lichen loads (Edwards *et al* 1960). The AT zone is important in spring for calving and predator avoidance. In summer most caribou live in this zone, and in winter, a portion of the population. Windswept areas of the AT zone are of particular importance for caribou due to reduced snow depths for winter foraging.

4.1.4 Ecology and Key Habitat Requirements

- **General**

Caribou are primarily grazers. Northern caribou forage principally on ground lichens but will also feed on arboreal lichens on both standing and windblown trees, as well as on litterfall, grasses, sedges, forbs, mosses, and fungi. In spring and summer caribou feed on variety of shrubs, forbs and graminoids which are relatively high in protein at this time of year. Lichens may still be eaten at these seasons but are not preferred (Bergerud 1972, Rominger and Oldemeyer 1990). Lichens are low in protein but high in digestible carbohydrates and become particularly important to caribou in winter, when they are the only forage that is abundantly available. However, a winter diet of only lichens can retard digestive processes in the rumen and lead to loss of condition. In early winter, access to non-lichen forage supplements such as evergreen shrubs would be advantageous, especially to pregnant cows, and might delay the potential detrimental effects of a restricted diet in late winter (Russell and Martell 1984,

Rominger and Oldemeyer 1990).

Snow depth and density can affect the availability of caribou winter forage. Deep snow may prevent cratering for terrestrial lichens, while crusted snow may provide a platform on which to reach arboreal lichens. Yearly variations in snow depth and density may be reflected by changes in patterns of caribou winter range use.

Caribou can detect lichens through 15 to18 cm of undisturbed snow cover (Bergerud and Nolan 1970), but use air vents adjacent to emergent stems of tall shrubs to detect lichens at depths of at least 72 cm (Bergerud 1974a, Helle 1981). The critical snow depth for cratering for a solitary forest caribou is 65 to 74 cm (Bergerud 1974b, Helle 1981) while a herd can crater in 80 to 90 cm of snow, provided that the sinking depth is less than 70 cm (Nasimovich 1955, Helle 1981). However, deep, soft snow can temporarily immobilize caribou and restrict them to small pockets of range (Bergrud, 1974b). Fescue-Lichen (FL) meadows, Altai fescue-Cladonia dry grassland (FC) and Timber oatgrass-Altai fescue cold dry meadow (TF) may, in some years be heavily used by the Ilgachuz caribou in the fall but are abandoned in favour of lichen-forests when snow depths approach 50cm with caribou sinking depths of 40 cm (Cichowski 1993).

Caribou display two different habitat-use strategies during winter. A minority of the population winter in the mature/old growth forests of the Engelmann Spruce-Subalpine Fir zone and on the open, windswept alpine habitats with reduced snow accumulation giving access to terrestrial lichens by cratering. The majority of caribou winter at lower elevations in the extensive lodgepole pine-dominated, mature/oldgrowth forests of the Montane Spruce and Sub-Boreal Pine-Spruce zones where terrestrial lichens are most abundant.

Arboreal lichens are also of great importance to caribou survival, especially in late winter when snow pack makes cratering for terrestrial lichens difficult. Caribou may shift to feeding on arboreal lichens when snow depths exceed 80 cm and density and hardness are sufficient for support (Nasimovich 1955). While arboreal lichens occur in all coniferous forests they are most abundant in the more moist forest types, particularly on trees in forested wetlands and on the margins of wetlands and lakes in the ESSF zone (Edwards *et al* 1960, Cichowski 1996).

Seasonal Use of Biogeoclimatic Zones and Habitat Types

Detailed information on seasonal use of biogeoclimatic zones and habitat types follows Young and Shaw (1998a). To facilitate an understanding of the relationship of caribou habitat units described in Clement (1987), and used by Young and Shaw (1998a), with the TEM units described in Clement and Dalziel (1999), a crosswalk is presented in table 1.

Table 1. Crosswalk for mapping units listed in Caribou Habitat Units of the Itcha and Ilgachuz Area (Clement 1987) and Ecosystem Units of the Itcha/Ilgachuz Area (Clement and Dalziel 1999).

Caribou Habitat Units (Clement 1987)	**TEM Habitat Units (Clement and Dalziel 1999)***
SBSa1	**SBPSxc**
R – Rock	LCv, LCkv, LCvw
DS – Dry Scarp	LCsw, LCw
DL – Dry Lichen	LC, LCs
K – Kinnikinnick	LK (plus modifiers)
P – Pine Grass	LK (plus modifiers)
ME – Meadow	WB and TS
M – Moss	SB and SF
NW – Nonforested Wetlands	BS and WT
SBSa2	**SBPSmc**
DL – Dry Lichen	LC (plus modifiers)
LM – Lichen-Moss	LF (plus modifiers)
M – Moss	BF and SB
SF – Seepage Forest	SO and SH
FW – Forested Wetlands	BB
NW – Nonforested Wetlands	BS and WT
W – Wetlands	complex of BB, BS and WT
MSd	**MSxv**
R – Rock	LKv, LKvw
DL – Dry Lichen	LF and GK
FL – Fescue-Lichen	FC and TF
LM – Lichen-Moss	LK
M – Moss	SC and SG
SF – Seepage Forest	SH
FW – Forested Wetland	none
NW – Nonforested Wetland	BS, TB, WG and WS
W – Wetlands	complex of TB, BP, BS and WS

*See Appendix II Part 6 for description of ecosystem unit names.

Summer-early Fall:

Young and Shaw (1998a) found that the majority of the Itcha / Ilgachuz caribou spent the summer and early fall in the AT zone, descending from the AT and ESSF zones to the MSxv. zone in late-fall.

Late Fall – Spring (including Winter):

From late fall to spring the MS zone was the zone most used by forest-dwelling caribou. They primarily utilised fescue meadows and mature open lodgepole pine forests with terrestrial

lichens. Their numbers here peaked in early winter. The majority of radio-collared caribou wintered north, east, and south of the Itcha Mountains. The ESSF and SBPSxc zones were used to a minor degree through different parts of the year.

The Rainbow herd wintered in the SBPS (especially the xc subzone) more than the Itcha / Ilgachuz herd, with use peaking in mid-winter. They wintered in the Dean River valley between Anahim Lake and Anahim Peak before returning to the alpine for calving in the spring.

Late Winter-Early Spring:

From late winter to early spring there was a shift from drier forested habitats to wetter sites. I.e. Moss/Seepage Forest (MSF) (Habitat units: BF, SB, SC, SF, SG/SH, SO) and Wetland/ Forested Wetland units (WFW) (Habitat units: BS, TB, WG, WS, WT/BB). The use of Moss/Seepage Forest was highest in spring (see table 1 for caribou habitat unit names and equivalency to letter codes used by Clement 1987).

Winter forest-dwelling caribou generally used mature (older than 80 years), moderately closed (more than 36% canopy closure) lodgepole pine stands on poor quality sites - generally on flat terrain in the mid to lower elevations (1,200 - 1,600 m.) of the MSxv zone. Meadows, open range, or wetlands were used predominantly in the fall, early winter, and spring. Use of clearcuts was highest in spring, possibly because snow melted faster in these open sites and allowed easier access to forage. In spring (May) some caribou moved up into the upper ESSF and AT zones. These zones (particularly the AT) are used for calving in late-May to mid-June. The Itcha / Ilgachuz herd calved at an average elevation of 1975m (i.e. the AT zone). The Rainbow herd calved in the alpine throughout the Rainbow Mountains and generally on the northerly side.

- **Summer Aspects**

In summer all aspects were used.

- **Winter Aspects**

Winter forest-dwelling caribou of the Itcha / Ilgachuz herd, were generally in flat terrain (less than 10% slope) most of the winter. All aspect categories were represented with only a slight preference shown for northerly aspects. Winter forest-dwelling caribou of the Rainbow herd showed more evidence of utilising particular aspects. In early winter northeast aspects were most used. In the seasons when use of northeast aspects was lower (early fall, late fall, late winter/early spring and spring), the use of northwest aspects increased.

Winter alpine-dwelling caribou used habitats at high elevations (1800 – 2000m) and predominantly on gentle slopes (20% or less) with shallow snow depths due to exposure to prevailing winds. They were found in habitats represented by all aspects in mid-winter. In late winter/early spring and spring, they showed a slight preference for west and northwesterly aspects (Young and Shaw 1998a).

- **Preferred forage species**

Caribou eat a wide variety of plant species including graminoids, forbs, mosses, fungi, shrubs, and lichens. Consumption of conifers is believed to be incidental (Rominger *et al* 1989, Cichowski pers. comm. 1998). Bergerud (1972) reported caribou food preferences were for greens in the growing season, fungi in the summer and fall, and lichens in the fall. Lichens become increasingly important in the winter due to their abundance, accessibility, and high digestibility.

Terrestrial lichens are the winter forage species of most importance to northern caribou. In descending order of preference the lichen species eaten most often are *Cladina* spp., *Cladonia* spp. and *Stereocaulon* spp. *Peltigera* species, although often abundant, are not selected for by caribou (Bergerud 1972, Holleman and Luick 1977). The most preferred terrestrial lichen species do not become established and abundant in forested areas until up to 50 years after site disturbance (Ahti 1977, Cichowski 1993).

The arboreal lichens of most importance to caribou, particularly in late winter, are *Bryoria* spp., and *Alectoria* spp. The low protein content of lichens is offset by their high digestibility in caribou (Cooperrider *et al* 1980, Thomas *et al* 1984). Arboreal lichens reach their highest abundance on trees of age classes 7 to 9 (121 to 251+ years) (Edwards *et al* 1960). Table 2 lists some of the important forage plants for northern caribou.

Table 2. Important forage species for northern caribou. The most important or preferred species are in bold type.

Terrestrial Lichens	***Cladina* spp** ***Cladonia* spp** ***Stereocaulon* spp**	
Arboreal Lichens	***Bryoria* spp** ***Alectoria* spp** ***Cetraria* spp**	
Shrubs	Willow *Salix* spp. Birch *Betula* spp. Labrador Tea *Ledum* spp. *Vaccinium* spp.	Saskatoon *Amelanchier alnifolia* Alder *Alnus* spp. Crowberry *Empetum nigrum* Bog-Laurel *Kalmia* spp.
Trees	Subalpine fir *Abies lasiocarpa*	
Graminoids	Bluegrasses *Poa* spp. **Altai Fescue** *Festuca altaica* **Fescues** *Festuca* spp. Wheatgrasses *Agropyron* spp. *Bromus* spp.	Sedges *Carex* spp. Bulrush *Scirpus* spp. Rushes *Juncus* spp.

Forbs	Lupine *Lupinus* spp. Indian Paintbrush *Castilleja* spp. Pussytoes *Antennaria* spp. *Eriogonum* spp. Cinquefoil *Potentilla* spp. **Bracted Lousewort** *Pedicullaris bracteosa* Northern Bedstraw *Galium boreale* Fireweed *Epilobium* spp. *Anemone* spp. *Aster* spp. Yarrow *Achillae* spp.	Horsetail *Equisetum* spp. Foamflower *Tiarella* spp. Mitrewort *Mitella* spp. Solomon's seal *Smilacina* spp. Bunchberry *Cornus canadensis* Sitka Burnet *Sanguisorba canadensis*
Other Forage	**Mushrooms** Mosses Voles *Microtus* spp.	

- **Reproduction**

The areas suitable for fall rutting are considered to be those that provide caribou with a relatively unobstructed line-of-site to facilitate group interactions (Fenger *et al* 1986).

To reduce predation levels on calves during parturition, Northern caribou disperse widely throughout rugged, exposed terrain above treeline. They also use this dispersal strategy in forested habitats (Bergerud *et al* 1984, Hatler 1986, Cichowski 1993) However, calf survival rates have been found to be higher in rugged, mountainous terrain where the cows and calves can distance themselves from other prey species and their predators (Seip and Cichowski1996). Habitats were not rated separately for rutting or calving.

- **Special Habitat Needs**

Caribou require habitat for calving with the absence or scarcity of predators and winter range with adequate amounts of terrestrial and arboreal lichens for forage.

- **Territory/Home Range**

Caribou are non-territorial except during the rut. The home range of an animal must provide all the specie's life requisites for all seasons throughout the life of the animal. Therefore, specie's home range size in a particular area will depend on the degree to which all it's requisites are provided for. Summer and winter ranges of caribou are often separate and distinct areas linked by migration corridors. Lance and Mills (1996) described the physical and botanical characteristics of spring migration habitats for the Tweedsmuir / Entiako caribou herd. All habitats were characterised by having raised and open aspects, sparse tree cover, free-draining soils, and a simple flora with abundant terrestrial lichens.

While most caribou range within a discrete area during each winter, they may not return to the same area the following year. An interesting exception to this occurred in the summer of 1998 when the majority of the Itcha/Ilgachuz herd used their winter range beginning in early July. This

may have been due to reduced snowpack in alpine areas making pest avoidance difficult.

The sizes of annual home ranges of collared caribou cows in the both the Itcha / Ilgachuz herd and that of the Rainbow Range have varied greatly. Over a 24 month monitoring period the Itcha / Ilgachuz caribou ranged from 597 km^2 to 4,475 km^2 with an average home range size of 2,720 km^2 (n=15). Home ranges for Rainbow caribou varied from 1,568 km^2 to 2,485 km^2 with an average range of 1,945 km^2 (n=5) (Young and Shaw 1998a).

4.1.5 Habitat Use - Life Requisites

Habitats for caribou were rated separately for two seasons: Growing and Winter. The life requisites rated were: Feeding (FD), Security (SH) and Thermal (TH) habitats for the specified season. They are described in detail below.

- **Feeding Habitat**

In winter the majority of northern caribou forage predominantly on terrestrial lichens in the lodgepole pine-dominated, mature/oldgrowth forests of the Montane Spruce and Sub-Boreal Pine-Spruce zones. As snowpack deepens in late winter, caribou increase their use of arboreal lichens. A minority of the caribou population winter on windswept subalpine and alpine slopes where they also feed mainly on terrestrial lichens supplemented by arboreal lichens on trees near treeline.

In late winter, when increased snow depths make cratering for terrestrial lichens difficult, caribou will feed increasingly on arboreal lichens. While arboreal lichens occur in all coniferous forests they are most abundant in the forests of the Engelmann Spruce-Subalpine Fir zone.

Caribou have a much more varied diet in spring, summer, and fall when, besides lichens, they will feed on a variety of graminoids, forbs, shrubs, mosses, and fungi in forests, wetlands, subalpine parkland and alpine tundra.

- **Security Habitat**

Caribou to avoid contact with predators use security habitat, where, if threatened, they can escape by fleeing. Seip (1992a) attributed major declines in caribou populations of central British Columbia to increases in numbers of moose in the 1920s. The presence of moose supports increased wolf numbers and results in higher predation levels on caribou (Seip 1992a, Seip and Cichowski 1996). Although grizzly bears, black bears, lynx, and wolverine are known to prey on caribou, wolves are believed to be their major predator through most of their range (Bergerud and Elliot 1986, Seip 1992a). Caribou are particularly susceptible to predation as they have slow reproductive rates compared to other ungulates. While moose cows can breed at 1.5 years of age, produce twins and sometimes triplets, caribou do not breed until they are at least 2.5 years and give birth to a single calf.

Rugged, exposed alpine/subalpine terrain provides caribou with the best security habitat where they can distance themselves from other prey species and best detect and avoid predators. Winter is the season in which caribou make most use of forests. When caribou use forested habitats they compromise security for foraging needs. Large frozen lakes and wetlands adjacent to forest

stands can be used as escape terrain as caribou are better adapted to travel through deep snow than are their predators.

In both forested and non-forested habitats caribou need large tracts of land through which they can disperse to reduce predation levels. This dispersal strategy is particularly important during, and immediately after, parturition as calves are the most vulnerable to predation (Bergerud *et al* 1984).

- **Thermal Habitat**

Thermal habitat is used by caribou to assist them in maintaining a constant body temperature. In summer, most caribou are in subalpine/alpine habitats where they can find relief from solar heat by using forest shade, lingering snowfields, or cool windswept alpine slopes. Thermal habitat is more critical for caribou in winter when they are nutritionally stressed and need to minimise energy expenditures. Caribou are highly adapted, both physiologically and behaviourally, to life in arctic and subarctic winters and show no thermal cover dependency (Edmonds and Bloomfield 1984). They are relatively insensitive to all but the most severe winter conditions. Russell and Martell (1984) reviewed the literature on caribou winter activity**:** Caribou will forage at temperatures as low as - 50° C (Henshaw 1968), although activity may be reduced below - 35° C (Roby 1978). Moderate wind speeds (less than 15 km/hr) have little effect on behaviour, but caribou movement increases as the animals begin to lose body heat due to increasingly greater wind speeds (Thomson 1977). In high winds (greater than 30-40 km/hr) and in blizzard conditions caribou will aggregate and eventually bed down to conserve heat (Henshaw 1968, Baskin 1970, Thomson 1977). Winter thermal habitat is provided by mature/oldgrowth forest, tree-islands in subalpine parkland, krummholz, lee-slopes, and broken terrain that give shelter from chilling winds.

4.1.6 Seasons of Use

The thermal, security and feeding habitat requirements of caribou vary with the seasons. Table 3 summarises the life requisites for northern caribou for each month of the year.

Table 3. Monthly life requisites for northern caribou.

LIFE REQUISITES	MONTH	SEASON
Feeding, Security, Thermal	January	Winter
Feeding, Security, Thermal	February	Winter
Feeding, Security, Thermal	March	Winter
Feeding, Security, Thermal	April	Winter
Parturition/Feeding, Security, Thermal	May	Growing (Early Spring)
Parturition/Feeding, Security, Thermal	June	Growing (Spring)
Feeding, Security, Thermal	July	Growing (Summer)
Feeding, Security, Thermal	August	Growing (Summer)
Feeding, Security, Thermal	September	Growing (Fall)
Rutting/Feeding, Security, Thermal	October	Growing (Fall)
Rutting/Feeding, Security, Thermal	November	Winter
Feeding, Security, Thermal	December	Winter

* Seasons defined for Central Interior Ecoprovince as per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

Two seasons were rated for caribou - Winter and Growing (an amalgamation of Spring, Summer and Fall seasons).

Winter Season (November to April) - Caribou have specific feeding requirements during the winter season. They depend on the availability of abundant terrestrial and arboreal lichens.

Growing Season (May to October) - In the growing season caribou require feeding and security habitat, taking advantage of plant phenology and food availability. At the time of spring parturition (May to June) caribou cows and calves are particularly vulnerable to predation . At this season they require isolation and concealment from predators. Pregnant cows will disperse throughout either rugged subalpine/alpine terrain or forested habitats.

4.1.7 Habitat Use and Ecosystem Attributes

Table 4 outlines how each life requisite relates to specific ecosystem attributes (e.g. site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 4. Terrestrial ecosystem mapping (TEM) relationships for each life requisite for northern caribou.

Life Requisite	TEM Attribute
Feeding Habitat	**site:** site disturbance, elevation, slope, aspect, and structural stage. **soil/terrain:** bedrock, terrain texture, flooding regime. **vegetation:** % cover by layer, species list by layer, cover for each species for each layer.
Security Habitat	**site:** elevation, slope, aspect, structural stage **soil/terrain:** terrain texture **vegetation:** % cover by layer**.** **mensuration:** tree species, dbh, height.
Thermal Habitat	**site:** elevation, slope, aspect, structural stage. **soil/vegetation:** terrain texture. **vegetation:** % cover by layer. **mensuration:** tree species, dbh, height.

4.1.8 Ratings

There is a detailed level of knowledge of the habitat requirements of northern caribou in British Columbia and therefore, a 6-class rating scheme was used.

- **Provincial Benchmark**

Ecoprovince	
Ecosection	Northern Boreal Mountains Stikine Plateau (STP)

Biogeoclimatic Zone:	**Winter**	**Growing**
Broad Ecosystem Unit:	SWBun/AT	AT
Habitats:	Lodgepole Pine/AG Mature/oldgrowth mesic forests with terrestrial and arboreal lichens; subalpine parkland and alpine tundra with terrestrial lichens.	Alpine Meadows Wetter forest types, sedge meadows, with graminoids, forbs, and deciduous shrubs; subalpine parkland and alpine tundra.

- **Ratings Assumptions**

1. Immature forests (age classes 1- 4, < 80 years; seral stages 1-5) have minimal feeding or security habitat values for all seasons (suitability $\leq$ 5).
2. Mature/oldgrowth ESSF, MS, and SBPS forests (age classes 8 and 9; structural stages 6 and 7), have high values (suitability $\leq$ 1) for feeding and moderate to low values (suitability $\leq$ 3) for security.
3. Mature/oldgrowth ESSF forests have the highest late-winter feeding values (suitability $\leq$ 1) for arboreal lichens, particularly on wetter sites. Windswept Alpine Tundra ridges and gentle to moderate slopes with access to terrestrial lichens have high feeding and security values (suitability $\leq$ 2) for winter, and moderate to low feeding value (suitability $\leq$ 3) for the growing season.
4. Mid to upper slopes of the ESSFxv1 with high terrestrial lichen cover and lichen-bearing trees (classes 3-5 *Bryoria, Alectoria*) have high feeding value (suitability $\leq$ 1) for winter. Moist forest habitats (Moss/Seepage Forest; Wetland/Wetland Forest units) have moderately high (suitability $\leq$ 2) feeding values in spring.
5. Steep, rugged, exposed terrain above treeline (e.g. subalpine rock outcrops with krummholz) has high values (suitability $\leq$ 1) for calving habitat.
6. Fescue-Lichen meadows (Habitat unit: **TF**-Timber oatgrass-Altai fescue cold dry meadow) provide moderate value (suitability 3) feeding habitat in the growing season, particularly in the fall, but are rarely used in late winter (suitability $\geq$ 5) due to deep snow.

- **Ratings Adjustments**

Final habitat capability and suitability map products should incorporate 1) landscape heterogeneity and connectivity; 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g. roads, settlements); 3) interspersion of different structural stages within the landscape. Adjustments will typically increase or decrease suitability value by a single class.

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4.2 Moose

4.2.1 Name: *Alces alces andersoni*

Species Code: M-ALAL

4.2.2 Status: Yellow-listed(species of Management concern) Protected as big game under the British Columbia Wildlife Act (1982).

4.2.3 Distribution

- **Provincial Range**

The North American moose, *Alces alces*, is a yearlong native resident of British Columbia. It has a widespread distribution throughout the provincial mainland but is absent from most coastal areas and also the arid interior of the province centred in the Okanagan Valley (Stevens and Lofts 1988). Moose are most abundant in the central and northern portion of the province.

Moose have greatly increased their range in North America over the past 100 years. In British Columbia they have spread west and southwards from the north east part of the province when fires eliminated much of the climax forests which had acted as a barrier to dispersal. Moose are believed to have first entered onto the Chilcotin plateau about 1900. Here they found abundant wetlands with rich forage and their population peaked in the 1920's and 1930's (Hatter 1950). Large fires at this period created quality foraging areas in the uplands. Although numbers have since declined, the moose is still an important big game resource for the Cariboo-Chilcotin region of British Columbia.

- **Provincial Context**

In British Columbia moose are found in habitats from sea level to alpine tundra. The 1997 moose population estimate for British Columbia was 170,000 of which 16,000 were in the Cariboo Region (Hatter 1997).

- **Range in Project Area:**

Ecoprovince:	Central Interior
Ecoregions:	Fraser Plateau
Ecosections:	Western Chilcotin Upland (WCU), Chilcotin Plateau (CHP), Nazko Upland (NAU)
Biogeoclimatic Zones:	IDFdk4, MSxv, AT, ESSFxv1, ESSFxvp1, SBPSxc, SBPSdc, SBPSmc, SBSmc2
Elevational Range:	In the Itcha / Ilgachuz study area moose range from 990 metres (Chilcotin Lake) to 2,400 metres (Far Mountain in the Ilgachuz range).

4.2.4 Ecology and Key Habitat Requirements

- **General**

While moose inhabit many different biogeoclimatic zones, the Sub-Boreal Spruce zone (SBS) represents the centre of moose abundance in BC (Meidinger and Pojar 1991). Moose will also use seral stands of lodgepole pine in the Montane Spruce (MS) zone in summer and fall, for thermal and hiding cover, within the dense thickets of regenerated forest. They will also use the forests of hybrid spruce and subalpine fir in MS zone for foraging. Forests of intermediate density may provide the optimum balance of locomotion ease and cover (Baker 1990).

Moose select wetland and riparian areas of the MS, SBS, and SBPS zones for calving because of the abundant forage and dense security cover. However, much of the SBPS zone is comprised of extensive lodgepole pine forests which, with the exception of terrestrial lichens for caribou, provide little in the way of forage for moose or other ungulates (Meidinger and Pojar 1991).

Moose may occasionally winter in the drier regions of the Engelmann Spruce-Subalpine Fir (ESSF) zone, but usually leave during winter to escape the deep snows (Meidinger and Pojar 1991). During field sampling we found extensive sign of moose winter use (winter pellets, cast antlers) in the ESSFxvp1 and At on the north facing slopes of the Ilgachuz and Itcha mountains.

Moose are mainly browsers but also forage on aquatic vegetation, grasses, sedges and forbs. While browse is always an important component of their diet, the amount varies with the seasons, depending upon the availability, palatability and nutritional values of other plant species. In summer browsing is confined to the leaves and terminal tips of shrubs and trees, while woody browse is strictly a fall and winter diet (Hatter 1950).

Important moose habitat types include mature/oldgrowth climax coniferous forests complexed with wetlands, ponds and lakes and semi-open successional stages of forested habitats with abundant browse. Moose will occasionally forage in clear-cuts depending on the size of the opening cover characteristics surrounding the cutblock (Hamilton *et al* 1980, Baker 1990).

Sedge meadows may be heavily used in spring as the sedges are among the first plants to emerge from dormancy (Baker 1990). Graminoids are highly palatable and nutritious in spring and early summer but they become less nutritious in fall and winter. Similarly, forbs quickly decline in protein and energy levels in late summer. During fall and winter seasons, the higher protein and mineral levels of woody forage encourage greater browsing (Stelfox and Stelfox 1993). When snow conditions allow, moose will dig to forage on low shrubs such as dwarf birch. When snowpack is deep and/or crusted, tall shrubs and trees are usually the only forage that is available.

Bark-stripping of deciduous trees (predominantly aspen) by moose occurs mainly in late winter and early spring and is believed to be related to a scarcity of available twigs (Gruell and Loope 1979) and possibly due to rising sap. In spring cow moose remain close to their calves (Stringham 1974), reducing their ability to search for forage resources. Intensive debarking has been observed near calving sites of radio-collared females in aspen/spruce forests (Miquelle and Van Ballenberghe 1989).

Moose are easily heat-stressed even at winter temperatures as low as -5° C, while in the summer

extreme panting and heat stress occurs at 14° to 20° C (Renecker and Hudson 1986). Areas with climates having temperatures exceeding 27° C for long periods and lacking shade, do not support moose (Kelsall and Telfer 1974).

Lakes, ponds, bogs, other wetlands, and shrub and forest cover associated with these sites are used in summer to alleviate heat stress and to provide succulent forage. The high sodium content of aquatic vegetation is believed to be important to moose nutrition (Jordan *et al* 1973, Fraser *et al* 1983).

Avalanche shrub areas and alpine/subalpine meadows with gentle to moderate terrain are important for moose in summer. These habitats provide good forage and a scarcity of predators. Cooling winds on alpine ridges can ease heat stress and provide relief from biting insects.

From late-fall to early-winter moose movements towards winter range are triggered by snow depths of as little as 20 cm (LeResche 1974, Rolley and Keith 1980). Moose are well adapted to life in temperate to cold climates with high snow pack. Their height and long legs enable them to move through snows of up to1 metre deep, giving them access to browse above the snow. However, snow depths greater than 80 cm is believed to be limiting for moose. In a study of winter habitat selection by moose along the Dean River in the west-Chilcotin region, Baker (1990) found moose favoured spruce wetlands and mature spruce forest. They concentrated primarily within 100 metres of forest/wetland edge and virtually never used areas greater than 200 metres from the edge. Spruce wetlands provide both food and cover in one cover type. Sedge meadows were not usually utilised by moose in winter due to lack of shrubs and to sedges being covered with snow. Moose on the Kenai Peninsula in Alaska dug craters to feed on sedges when snow depths were less than 30 cm but switched to feeding on birch stems when snow depths were greater than 30 cm (LeResche and Davis 1973).

Thompson and Vukelich (1981) found that movements between sites were short and substantially reduced as the winter progressed. Moose usually foraged less than 60 m from cover in early winter in contrast to an average movement of 12 m after the snow reached 65 cm in depth. In late winter, cover and reduced exposure from wind may be as important as forage in the selection of sites (Polequin et al 1977).

4.2.5 Habitat Use - Life Requisites

Habitats for moose were rated separately for two seasons: growing and winter. The life requisites rated were: Feeding (FD), and Security-Thermal (ST) habitats for the specified season. They are described in detail below.

- **Feeding Habitat**

Moose prefer semi-open successional stages of forested habitats with abundant browse. They will feed in many forest types including coniferous, deciduous, and mixed forests. Foraging needs vary with the seasons. Browse is eaten at all seasons but is dominant in the winter diet. Shrub communities of willow, birch, highbush-cranberry, red osier dogwood, and aspen provide essential winter forage. In spring and summer moose seek out succulent horsetails, grasses, sedges, forbs, and aquatic vegetation. Habitats that provide the forage needs of moose include riparian forests, structural stages 3a and 3b of moist forests, shrub-carrs, avalanche shrubland,

subalpine parkland, wetlands, lakes and ponds. Depending on the age of the area, moose will also feed in clearcuts and recent burns but usually will stay within 200 metres of cover

Preferred browse species

By virtue of their great geographical range, moose have access to a wide variety of forage species. Although their diet preferences vary between regions, willows (*Salix* spp.), being palatable and abundantly available, stand out as the most important winter food for moose in British Columbia (Hatter 1950, Eastman 1977). However, a variety of forage species can more adequately provide for the nutritional needs of moose than can a single species, however abundant. Different species provide different nutrients and digestibility is often greatly enhanced by the addition of other forage to a single-species diet (LeResche and Davis 1973, Oldemeyer *et al* 1977). Diet preference depends on a number of factors such as nutritive quality, palatability, availability, and perhaps the individual animal's choice. There may also be an association between a preferred foraging site and cover aspects around that site. Forage growing in open habitats and on high elevation sites is typically more nutritious and digestible than the same species at lower elevations (Klein 1970, Eastman 1977, Dailey *et al* 1984, Stelfox *and Stelfox* 1993). Hatter (1950) reported that moose showed a strong preference for willows growing in upland versus lowland habitats.

Some browse species such as red-osier dogwood (*Cornus stolonifera)* and highbush cranberry (*Viburnum edule*) are highly sought after wherever they occur but are rarely abundant enough in central British Columbia to be important winter forage for moose. Saskatoon (*Amelanchier alnifolia)* is also a highly palatable and widely distributed forage species. However, as it never attains tree proportions it is not a dominant species in any association and thus, cannot be considered too important on most winter ranges (Hatter 1950).

Buffalo berry (*Shepherdia canadensis*) was reported to be an important food item for moose on the Kenai Peninsula, Alaska (Edwards 1940) and in Montana (Hosley 1949) but appears to be unpalatable to moose in British Columbia (Cowan *et al.* 1950, Hatter 1950). Although *Shepherdia* was commonly found in our plots, we saw few signs of browsing on the species. Other species used by moose elsewhere in their range but apparently not in British Columbia include snowberry (*Symphoricarpus racemosa*), dwarf juniper (*Juniperus communis*) flat-topped spirea (*Spirea lucida*), and black twinberry (*Lonicera involucrata*). However, we found heavy browsing by moose on *Lonicera* in one plot. Species which are only eaten in very small amounts include alder (*Alnus* spp.), kinnikinnick (*Arctostaphylus uva-ursi*), red elderberry (*Sambucus racemosa*), rose (*Rosa* spp.), and cow parsnip (*Heracleum lanatum*)(Hatter 1950).

Subalpine fir (*Abies lasiocarpa*) is the conifer most commonly eaten by moose, and can be an important forage species in late winter (Hatter 1950, Eastman 1977). Although lodgepole pine (*Pinus contorta*) has rarely been reported as moose forage, Baker (1990) found this species comprised 10-30% of their winter diet along the Dean River. Hatter (1950) believed lodgepole pine to be unpalatable for moose and constituted a starvation diet when eaten in large quantities. Baker also found high use of dwarf birch (*Betula glandulosa)* although it is considered to be only of minor importance in other studies. We seldom found heavy browsing on the species in our field survey plots. Some researchers (e.g. LeResche and Davis 1973, Eastman 1977) have reported foliose lichens (*Peltigera* spp. *Lobaria* spp.) and mosses (*Hylocomium splendens,*

Sphagnum spp.) in the diet of moose in late winter and spring. Table 5 lists some important forage plants for moose.

Table 5. Preferred forage species for moose. The most important or preferred species are in bold type.

Shrubs	**Willow** *Salix* spp. **Red-Osier Dogwood** *Cornus stolonifera* **High Bush Cranberry** *Viburnum edule* **Sitka Mountain Ash** *Sorbus sitchensis* **Saskatoon** *Amelanchier alnifolia* False Box *Pachistima myrsinites* Dwarf Birch *Betula glandulosa*	Kinnikinnick *Arctostaphylos uva-ursi* Prickly Rose *Rosa acicularis* *Vaccinium* spp. Thimbleberry *Rubus parviflorus* *Ribes* spp. Twinflower *Linnaea borealis* Red Alder *Alnus rubra* Sitka Alder *Alnus sitchensis* Devil's Club *Oplopanax horridus* Trailing Rubus *Rubus pedatus* **Saskatoon berry** *Amelanchier alnifolia*
Trees	**Black Cottonwood** *Populus balsamifera* **Trembling Aspen** *Populus tremuloides* Subalpine Fir *Abies lasiocarpa* Lodgepole Pine *Pinus contorta* Douglas-fir *Pseudotsuga menziesii*	
Aquatic and herbaceous plants	**Yellow Pond-Lily** *Nymphaea polysepala* Mare's Tail *Hippurus vulgaris* Pondweed *Potamogeton* spp.	Sedges *Carex* spp. Grasses (*Poa, Festuca, Agrostis* spp.) Rushes *Juncus* spp. **Narrow-leaved Cotton-grass** *Eriophorum angustifolium*
Forbs	**Lupine** *Lupinus* spp. **Fireweed** *Epilobium* spp. **Horsetail** *Equisetum* spp Goldenrod *Solid*ago spp. *Penstemon* spp Solomon's seal *Smilacina* spp. Broadleaf Arnica *Arnica latifolia Aster* spp. Wild Strawberry *Fragaria virginiana*	*Anemone* spp. Yarrow *Achillae* spp. Prince's Pine *Chimaphila umbellata* Sitka Valerian *Valeriana sitchensis* Bunchberry *Cornus canadensis* Clasping Twistedstalk *Streptopus amplexifolius* Cow Parsnip *Heracleum lanatum* Water Hemlock *Cicuta occidentalis*
Ferns	Lady Fern *Athyrium filix-femina* Oak Fern *Gymnocarpium dryopteris* Sword Fern *Blechnum spicant*	
Lichens	*Peltigera* spp. *Cladonia* spp. *Lobaria linita*	
Fungi	*Boletus* spp.	

- **Reproduction**

Moose tend to rut in semi-open areas often adjacent to forest openings. Calving is usually in dense shrubby areas in forested or wetland and riparian habitats (Stevens and Lofts 1988). Calving and rutting sites for moose were not rated separately because of their site-specific nature.

- **Special Habitat Needs**

Moose require areas where settled snow depths do not exceed 80cm. They will, therefore, generally winter in areas where snow depths are less than this (Franzmann 1981). Mature forest may serve as winter and summer thermal cover or provide winter foraging areas in the shallow snow under the canopy. Dense forest stands may also provide escape cover. Bedding sites are usually in forests or near forest edge, but may be in more open areas close to foraging sites. Mineral licks are often used, especially in summer (Stevens and Lofts, 1988). No mineral licks were found during our field surveys.

- **Territory/Home Range:**

Moose may live solitary lives where populations are at low densities but elsewhere small groups are common. They are non-territorial except during the rut. Moose generally have small seasonal home ranges, seldom exceeding 5-10 km^2 with bull home ranges being the largest (Van Ballenberghe and Peek 1971, Phillips *et al* 1973, LeResche 1974). However, the average winter home range of six radio-collared cow moose within the survey area near Dean River was 22 km^2 over a 2-year period (Baker 1990). Ballard *et al* (1980) reported that home ranges of cow-calf pairs in late spring and early summer in south central Alaska averaged 25 km^2. While some moose are year-round residents on a particular range others may migrate along travel corridors of up to 50 km. between summer and winter ranges depending on browse availability and snow depths (LeResche 1974). Winter ranges are smaller than those of other seasons because deep snows limit moose movements from cover.

- **Security Habitat**

Security habitat conceals moose from predators and is provided by a combination of vegetation and topography. Thomas *et al* (1979) defined hiding cover for ungulates as: vegetation capable of hiding 90% of a standing adult animal from the view of a human at a distance of 61m (200ft) or less. With this definition in mind, we considered hiding cover for moose to be provided by any forest stand of adequate density and with trees taller than 2 metres. Seral stages 3b, 4, 5, 6, and 7 generally provided these conditions. In open, non-forested habitats such as alpine slopes, undulating and broken topography, with the presence of large boulders (more than 2m tall), can provide screening cover for moose. These sites were rated as security habitat, suitability class 5. Security habitat ratings in subalpine parkland depended on the tree heights, the density and distribution of tree islands, and the nature of the topography.

- **Thermal Habitat**

Thermal habitat is used by moose to modify extremes in climate and thus assist them in maintaining a constant body temperature. The thermal needs of moose may, therefore, vary both daily and seasonally. As with security habitat, vegetation and topography combine to produce thermal habitat. Although moose may use many pole-sapling stands for this purpose in winter and summer, older, closed-canopied, multi-layered coniferous forests on broken or rolling terrain provide optimum thermal cover. The forest canopy acts as a shield against solar radiation by day and radiated heat loss to the open sky, especially at night. The combination of vegetation, large diameter tree trunks (>24 cm) and topography reduces air movement through the stand thereby minimising the effects of wind-chill (Baker 1990). In winter these older seral stage forests also provide good snow interception, reducing snowpack levels and therefore the energy expenditures

of moose (Baker 1990). Eastman (1977) found that moose selection of winter bedding sites varied with snow depth. Moose chose south aspects on upper slopes particularly when snow depths became restrictive (over 80 cm). As snow depths increased, moose bedded closer to larger than average trees in the denser canopied parts of forest stands. McNicol and Gilbert (1978) reported moose using residual islands of trees as wind breaks and benefiting from shallower snow depths on the lee sides of residual cover stands. To avoid heat stress in summer moose will use forested habitats as shelter from solar radiation, and ponds, wetlands, and subalpine/alpine ridges for cooling.

4.2.6 Seasons of Use

The thermal, security and feeding habitat requirements of moose vary with the seasons. Table 6 summarises the life requisites for moose for each month of the year.

Table 6. Monthly life requisites for moose.

Life Requisites	Month	Season
Feeding, Security, Thermal	January	Winter
Feeding, Security, Thermal	February	Winter
Feeding, Security, Thermal	March	Winter
Feeding, Security, Thermal	April	Winter
Parturition/Feeding, Security, Thermal	May	Growing (Early Spring)
Parturition/Feeding, Security, Thermal	June	Growing (Spring)
Feeding, Security, Thermal	July	Growing (Summer)
Feeding, Security, Thermal	August	Growing (Summer)
Rutting/Feeding, Security, Thermal	September	Growing (Fall)
Rutting/Feeding, Security, Thermal	October	Growing (Fall)
Feeding, Security, Thermal	November	Winter
Feeding, Security, Thermal	December	Winter

* Seasons defined for Central Interior Ecoprovince per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

Two seasons were rated for moose- Winter and Growing (an amalgamation of Spring, Summer and Fall seasons):

Winter Season (November to April) - Moose have specific thermal requirements (e.g. warm aspects, coniferous forest cover), and feeding requirements (e.g. abundant deciduous and coniferous browse, reduced snowdepths) associated with cover during the winter season.

Growing Season (May to October) - Moose require feeding and security habitat, taking advantage of plant phenology and food availability.

4.2.7 Habitat Use and Ecosystem Attributes

Table 7 outlines how each life requisite relates to specific ecosystem attributes (e.g. site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 7. Terrestrial ecosystem mapping (TEM) relationships for each life requisite for moose.

Life Requisite	TEM Attribute
Feeding Habitat	• **site:** site disturbance, elevation, slope, aspect, structural stage. • **soil/terrain:** bedrock, terrain texture, flooding regime. • **vegetation:** % cover by layer, species list by layer, cover for each species for each layer.
Security Habitat	• **site:** elevation, slope, aspect, structural stage • **soil/terrain:** terrain texture • **vegetation:** % cover by layer. • **mensuration:** tree species, dbh, height.
Thermal Habitat	**site:** elevation, slope, aspect, structural stage. • **soil/vegetation:** terrain texture. • **vegetation:** % cover by layer. • **mensuration:** tree species, dbh, height.

4.2.8 Ratings

There is a detailed level of knowledge of the habitat requirements of Moose in British Columbia and thus, a 6-class rating scheme was used.

- **Provincial Benchmark**

Ecoprovince	Boreal Plains	
Ecosection	Peace Lowlands (PEL)	
	Winter	**Growing**
Biogeoclimatic Zone:	BWBSmw	BWBSmw
Broad Ecosystem Unit:	Boreal White Spruce - Trembling Aspen	White Spruce-Balsam Poplar Riparian
Habitats: (both benchmarks)	Riparian forests; structural stages 3a, 3b of moist forests; wetlands with emergent and submerged vegetation; floodplains with shrub communities.	

- **Ratings Assumptions**

1. Sedge meadows have low to moderate (suitability $\leq$ 3) value for spring feeding.
2. Meadows (wetlands & riparian areas; what about burns) and fens of structural stage 3, when dominated by deciduous shrubs (>15%) and adjacent to forest cover, should provide abundant forage and be rated high (suitability $\leq$1) for feeding for both winter and growing seasons.
3. All habitats that have snow depths greater than 1 metre have little value (suitability5) for winter use. 4. Forage habitats lacking cover and more than 200 metres from forest cover have minimal value (suitability 5) for feeding5. Riparian forests and floodplains with well-developed shrub communities have high values (suitability $\leq$1) for feeding and security.
6. Wetlands, ponds and lakes with emergent and submerged plants (e.g. water lilies, pondweed, horsetails) provide high value (suitability $\leq$1) habitat for summer feeding.

- **Ratings Adjustments**

Final habitat capability and suitability map products should incorporate: 1) landscape heterogeneity and connectivity; 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g. roads, settlements); 3) interspersion of different structural stages within the landscape. Adjustments will typically increase or decrease suitability value by a single class.

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4.3 Mountain Goat

4.3.1 Name: *Oreamnus americana*

Species Code: M-ORAM

4.3.2 Status: Yellow-listed

4.3.3 Distribution

- **Provincial Range**

The mountain goat is a native, yearlong resident of British Columbia. The present distribution of mountain goats in the province has changed little from that of historical times. However, some populations have been exterminated and in many parts of its range numbers have decreased due to habitat loss, disease or starvation and over-hunting. Mountain goats are found throughout suitable habitats in a variety of biogeoclimatic zones on the mainland of BC. In the Itcha / Ilgachuz study area they occur mainly in the AT and ESSF zones and occasionally in the MSxv zone. Mountain goats are most abundant in the Rocky Mountains, scattered coastal mountain populations and in northern BC mountains and plateaus (Stevens and Lofts 1988).

- **Provincial Context**

Mountain goats are restricted to the northwest portion of North America, including British Columbia. British Columbia has more native goat range than any other province, territory or state and more than half of all mountain goats in the world. (Johnson, 1977). The 1997 provincial population estimate for mountain goats was 50,000 of which approximately 4,900 were in the Cariboo Region (Hatter 1997). Mountain goats in the Itcha / Ilgachuz ranges were first observed by Ministry of Environment staff in the 1980's. The most recent survey found 28 goats in the Ilgachuz and 5 goats in the Itcha ranges (P. Dielman pers. comm. March 1999).

- **Range in Project Area:**

Ecoprovince:	Central Interior
Ecoregions:	Fraser Plateau
Ecosections:	Western Chilcotin Upland (WCU), Chilcotin Plateau (CHP), Nazko Upland (NAU)
Biogeoclimatic Zones:	MSxv, AT, ESSFxv1, ESSFxvp1, SBPSxc, SBPSdc, SBPSmc, SBSmc2
Elevational Range:	In the Itcha / Ilgachuz study area, mountain goats have been observed from (Lehman Cr.) to 2,400m (Far Mountain).

4.3.4 Ecology and Key Habitat Requirements

- **General**

The mountain goat is a generalist herbivore, it's choice of habitat being determined more by topographical features than by the presence of specific forage species. Mountain goats inhabit

rugged terrain comprised of cliffs, ledges, and talus slopes in subalpine and alpine habitats. With the exception of talus slopes, such habitat features are uncommon in the study area. The Itcha / Ilgachuz ranges are the remains of shield volcanoes. They retain their conical volcanic shape with generally gentle to moderate slopes (Tipper 1970). Forage sites for mountain goats must be adjacent to suitable landforms to which they can retreat in times of danger. In spring and summer, however, mountain goats may travel several kilometres through forested habitat to feed at mineral licks Chadwick (1974). When doing so, they will generally choose the steepest and most rugged route possible. No mountain goat mineral licks have been recorded in the study area.

Mountain goats generally live in small groups of 1-5 animals. Adult males are usually segregated from nannies and young, except during the time of rut in November and December. When not breeding, the males live alone or in small bachelor groups, often in the remotest and most rugged parts of the specie's range.

Although all mountain goats in the province are regarded as a single species, ecotypes exist within the classification. Coastal mountain goat populations are regarded as a distinct ecotype, being browsers rather than grazers and at times descending to forage at sea level. Nevertheless, even within a particular geographical area, mountain goat ecology may vary between sub-populations (Chadwick 1983). Coastal mountain goat populations are usually characterised by smaller average group sizes and lower overall densities than are generally found for mountain goats farther east in the Pacific region or for those in the Rocky Mountains (Chadwick. 1983, Hebert and Turnbull 1994). Productivity and recruitment ratios are about half those of mountain goat populations elsewhere in the province (Hebert and Turnbull 1994). The mountain goats of the Itcha / Ilgachuz ranges are of the Interior ecotype.

In general, the diet of Interior mountain goat populations is primarily graminoids while Coastal mountain goats eat shrubs with lesser amounts of graminoids. Winter diet of both ecotypes is mainly shrubs, trees, litterfall and both arboreal and terrestrial lichens. Summer diets are more varied with a higher proportion of forbs, grasses and sedges and less browse (Chadwick. 1983, Fox and Smith 1988). Whereas grasses are highly palatable and nutritious in spring and early summer, they become less nutritious in fall and winter. Similarly, forbs quickly decline in protein and energy levels in late summer. During fall and winter seasons, the higher protein and mineral levels of woody forage encourage greater browsing (Stelfox and Stelfox 1993).

Sodium and other minerals such as potassium and phosphorus are important items in the mountain goat's diet and are usually obtained from mineral licks. Some forage species (*Vaccinium* spp., *Rubus* spp.) may contain high levels of these minerals, especially in or near seepage sites (Klinka 1976). As mineral licks are scarce near the coast such seepage sites may be important for the nutrition of coastal mountain goat populations. As no mountain goat mineral licks have yet been found in the Itcha / Ilgachuz ranges similar ecological factors may apply here too (see Special Habitat Needs).

In spring, mountain goats feed in snow-free habitats on warm aspects. As the summer progresses they will pursue receding snow lines and the emergence of young, succulent vegetation on other aspects. Feeding sites are usually rocky and closely associated with melting snow (Varley 1994). Mountain goats typically forage in a manner described by Chadwick (1974) as "trail feeding",

travelling substantial distances before stopping. This behaviour is greatest in summer and continues until winter snows restrict feeding to particular sites.

In winter, mountain goats are sedentary on traditional winter ranges of windswept cliffs or rock bluffs with low snow accumulation. These ranges are usually, but not always, on steep south to southwest aspects with access to forage. Winter habitats of mountain goats within 30-50 km of the BC coast range from sea level to about 1,700 m. Coastal snow conditions are harsh with heavy, wet snow packs making much of the ground vegetation inaccessible. Beyond 30-50 km of the ocean mountain goats can winter at higher elevations to 2,200m where snowfall is less and snow is removed from mountain tops and rock areas by wind. The scarcity of suitable winter habitat limits mountain goat populations (Hebert and Turnbull 1994).

Spring/Summer:

In spring some mountain goats use low elevation bluffs, gullies and slide paths for new green forage (McCrory *et al.* 1977). In summer a variety of habitats including alpine are used but steep and rugged escape terrain must be close by.

Table 8 lists some important forage plants for mountain goats.

Table 8. Important forage species for mountain goats. The most important or preferred species are in bold type.

Graminoids	Bluegrasses *Poa* spp. Fescues *Festuca* spp. Wheatgrasses *Agropyron* spp. *Calamagrostis* spp. *Trisetum* spp.	*Bromus* spp. Sedges *Carex* spp. Rushes *Juncus* spp. Woodrush *Luzula* spp. *Agrostis* spp.
Forbs	Moss Campion *Silene acaulis* *Penstemon* spp. *Aster* spp. Cinquefoil *Potentilla* spp. Yarrow *Achillea millefolium* Stonecrop *Sedum* spp. *Arnica* spp.	Pussytoes *Antennaria* spp. Mountain Sagewort *Artemisia norvegica* Field Chickweed *Cerastium arvense* Edible Thistle *Cirsium edule* Jacob's Ladder *Polimonium* spp. Smooth Alumroot *Heuchera glabra*
Shrubs	Yellow Mountain-Heather *Phyllodoce glanduliflora* White Moss Heather *Cassiope mertensiana* Trailing Bramble *Rubus pedatus* *Salix* spp. *Vaccinium* spp. Black Twinberry *Lonicera involucrata* Kinnikinnick *Arctostaphylos uva-ursi* Saskatoon *Amelanchier alnifolia* Crowberry *Empetrum nigrum*	

Trees	Subalpine Fir *Abies lasiocarpa* Douglas-fir *Pseudotsuga menziesii* Common Juniper *Juniperus communis*
Ferns	Lady Fern *Athyrium filix-femina* Deer Fern *Blechnum spicant* Spiny Wood Fern *Dryopteris* spp. Bracken *Pteridium aquilinum*
Mosses	*Hylocomium splendens* *Rhytidiadelphus spp.* *Sphagnum cuspidatum*
Lichens	*Bryoria* spp. *Alectoria* spp. *Usnea* spp. *Lobaria* spp.

Reproduction

Natal areas are in the steepest and most rugged parts of mountain goat range and usually within winter ranges (Smith 1976, Adams 1981).

Special Habitat Needs

Mountain goats require steep rocky cliffs or bluffs as escape terrain with a variety of microclimates for thermoregulation, including snow or ice, steep forested areas, and north-and south-facing rocky bedding sites.

Throughout much of mountain goat range the presence of mineral licks is believed to be important for their nutritional balance (Chadwick 1983, Stelfox and Stelfox 1993). However, in some mountain ranges of alkaline rock types with relatively high sodium and/or potassium content, mineral sources may be abundantly dispersed throughout the range, rather than concentrated in particular sites. Forage growing in the volcanic soils may also provide minerals (Varley 1994). The Itcha-Ilgachuz ranges are the remains of shield volcanoes composed of very alkaline rock types with high sodium content compared to those of the surrounding Fraser Plateau (Kathy Hickson Geological Survey of Canada pers. comm.).

- **Territory/Home Range**

Mountain goats are local migrators between winter and summer ranges. Winter ranges are, by necessity, smaller than at other seasons due to snow conditions burying much of the ground vegetation and limiting mountain goat movements. No data is currently available on size of mountain goat home ranges in our study area. Both Rideout (1977) in Montana, and McFetridge (1977) in Alberta, reported annual home range sizes of adult mountain goats as approximately 25 km^2. Except during the season of the rut, mature males have separate home ranges from those of the nannies, kids, and sub-adults (Chadwick 1983).

4.3.5 Habitat Use - Life Requisites

- **Feeding Habitat**

Mountain goats select habitat more for its topographical features than for the availability of specific forage species. Mountain goats will feed on moderate to steep slopes in a variety of habitats such as alpine tundra, alpine/subalpine wet meadows, avalanche shrubland, and subalpine parkland, provided they are adjacent to precipitous escape terrain. In winter, some mountain goats in wet snow areas may feed in coniferous forest at lower elevations, while mountain goats in drier locations may use windswept ridges. A scarcity of suitable security habitat in the Itcha / Ilgachuz ranges is more likely a limiting factor for mountain goat populations than is the amount of forage available.

Mountain goats are adapted to eating a wide range of plant foods. Grasses, sedges, rushes, ferns, forbs, lichens, shrubs and conifers are important at different seasons and may vary in importance between ranges. The winter diet is mainly shrubs, coniferous trees, litterfall and both arboreal and terrestrial lichens. Summer diets are more varied with a higher proportion of forbs, grasses and sedges and less browse.

Security Habitat

Security habitat is used by mountain goats to escape predators. For security habitat mountain goats need steep, preferably greater than 80% slope, rugged terrain with cliffs, rock ledges, and talus slopes. Escape terrain should optimally be within 400-500 metres of forage sites (Schoen and Kirchoff 1981, Fox and Taber 1981**).** Suitable security habitat is uncommon in the Itcha / Ilgachuz ranges due to the geological nature of the area.

Although cougars will sometimes kill an adult or golden eagles (*Aquila chrysaetos*) the occasional kid, predation is not a major cause of mortality for mountain goats. More significant causes of death are environmental factors such as avalanches, rockslides, and starvation through unavailability of forage in severe weather conditions.

- **Thermal Habitat**

Thermal habitat is used by mountain goats to assist them in maintaining a constant body temperature. The most critical season is winter when, to minimise heat loss, mountain goats will forage and rest on steep slopes with warm aspects or bed down under an insulating blanket of snow. They will also use lee-slopes, krummholz, caves and rock over-hangs for shelter to avoid the effects of wind-chill. These habitat features will also be used in summer to avoid solar

radiation during hot periods. Glaciers, snowfields, and windswept ridges are also used for cooling in summer.

4.3.6 Seasons of Use

The thermal, security and feeding habitat requirements of mountain goat vary with the seasons. Table 9 summarises the life requisites for mountain goats for each month of the year.

Table 9. Monthly life requisites for the mountain goat.

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

* Seasons defined for Central Interior Ecoprovince as per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

Two seasons were rated for mountain goat - Winter and Growing (an amalgamation of Spring, Summer and Fall seasons).

Winter Season (November to April) - Mountain goats have specific thermal requirements (e.g. warm aspects, lee slopes, rock overhangs), and feeding requirements (e.g. grasses, sedges, shrubs, conifers) during the winter season.

Growing Season (May to October) - Mountain goats require feeding and security habitat, taking advantage of plant phenology and food availability.

4.3.7 Habitat Use and Ecosystem Attributes

Table 10 outlines how each life requisite relates to specific ecosystem attributes (e.g. site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 10. Terrestrial ecosystem mapping (TEM) relationships for each life requisite for mountain goats.

Life Requisite	TEM Attribute
Feeding Habitat	• **site:** site disturbance, elevation, slope, aspect, structural stage. • **soil/terrain:** bedrock, terrain texture, flooding regime. • **vegetation:** % cover by layer, species list by layer, cover for each species for each layer.
Security Habitat	• **site:** elevation, slope, aspect, structural stage • **soil/terrain:** terrain texture • **vegetation:** % cover by layer. • **mensuration**: tree species, dbh, height.
Thermal Habitat	• **site:** site disturbance, elevation, slope, aspect, structural stage. • **soil/terrain:** bedrock, terrain texture, flooding regime. • **mensuration:** tree species, dbh, height.

4.3.8 Ratings

There is a detailed level of knowledge of the habitat requirements of Mountain Goats in British Columbia and thus, a 6-class rating scheme was used.

- **Provincial Benchmark**

There are benchmarks for mountain goats in two ecoprovinces of British Columbia:
1) Coast and Mountains Ecoprovince.
2) Southern Interior Mountains Ecoprovince.

1) Ecoprovince	Southern Interior Mountains	
Ecosection	Southern Park Ranges (SPK)	
	Winter	**Growing**
Biogeoclimatic Zone:	ESSFdk	AT
Broad Ecosystem Unit:	White Spruce - AM – Alpine Meadow	Subalpine Fir- RO - Rock

2) Ecoprovince	Coast and Mountains	
Ecosection	Nass Ranges (NAR)	
Biogeoclimatic Zone:	**Winter**	**Growing**
Broad Ecosystem Unit:	MHmm Mountain Hemlock - Amabilis Fir-RO - Rock	AT AM - Alpine Meadows

Habitats: (both benchmarks)

Mature - oldgrowth forests, subalpine parkland, and seepage areas complexed with cliffs, rock bluffs, talus slopes, and avalanche tracks , on steep, optimally greater than 80% slope, south to southwest aspects. Mountain goats may at times use habitats on gentle to

moderate slopes but usually within close proximity to steep escape terrain. Northerly aspects may be used in winter if windswept of snow accumulations.

- **Ratings Assumptions**

1. Late seral stage dry forest types complexed with cliffs, rock bluffs, avalanche tracks, and seepage areas, on south to southwest aspects provide high value (suitability ≤1) feeding and security habitat for all seasons.
2. Forage habitats greater than 400 – 500 metres from security habitat have minimal (suitability ≤5) value for feeding)

- **Ratings Adjustments**

Final habitat capability and suitability map products may incorporate: 1) landscape heterogeneity and connectivity; 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g. roads, settlements); 3) interspersion of different structural stages within the landscape. Adjustments will typically increase or decrease suitability value by a single class.

4.3.9 Literature Cited

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4.4 California Bighorn Sheep

4.4.1 Name: *Ovis canadensis californiana*
Species Code: M-OVCA

4.4.2 Status: Blue-listed

4.4.3 Distribution

- **Provincial Range**

There are two subspecies of Bighorn sheep that are native, yearlong residents of British Columbia: the Rocky Mountain subspecies, *Ovis canadensis canadensis,* and the California subspecies, *Ovis canadensis californiana.* The Rocky Mountain Bighorn sheep are distributed along the Rocky Mountains and the Rocky Mountain Trench from the United States border to Golden and in scattered bands from Mount Robson to the Sunkunka River. Two bands have been introduced into unoccupied California Bighorn sheep ranges at Squilax and Spences Bridge.

There are indigenous populations of California Bighorn sheep in the Okanagan, Similkameen, and mid-Fraser River basin areas of south-central interior British Columbia. Re-introduced herds are established near Kamloops Lake and near Grand Forks (Stevens and Lofts 1988). The provincial total of both subspecies of bighorn sheep was estimated at 7,100 in 1997 (Hatter 1997)

There is a small non-migratory band of California bighorn sheep ($\pm$12 animals) in the alpine/subalpine habitats of the Ilgachuz Mountains. Two rams and a ewe with one lamb were seen by one of the authors in 1998.

- **Provincial Context**

There were an estimated 7,100 Bighorn sheep, of both subspecies, in British Columbia in 1997. The province has approximately 65% of the North American population of bighorn sheep (59% *O.c.californiana*, 6% *O.c.canadensis*). The Cariboo region has an estimated 1250 California bighorn and they appear to be declining (Hatter 1997).

- **Range in Project Area:**

Ecoprovince:	Central Interior
Ecoregions:	Fraser Plateau
Ecosections:	Western Chilcotin Upland (WCU)
Biogeoclimatic Zones:	AT, ESSFxv1, ESSFxvp1
Elevational Range:	In the Itcha / Ilgachuz study area, bighorn sheep range from 1,000 metres (Chilcotin Lake) to 2,400 metres (Far Mountain in the Ilgachuz range).

4.4.4 Ecology and Key Habitat Requirements

- **General**

Bighorn sheep are predominantly grazers, and therefore require early seral stage habitats, mainly grassland communities, in open, moderate to steep sloping, alpine or subalpine meadows with low snow accumulation (less than 30 cm). Escape cover in the form of steep (optimally more than 80% slope), broken, or rocky terrain, usually including cliffs, should be within 250 metres of forage sites (Wakelyn 1984, Cooperrider *et al* 1986). Good visibility for detection of predators is an important attribute of habitat and sheep will use forage sites greater than 400m from escape terrain provided this attribute is present. Rams, and sheep in large groups will use areas further from escape terrain than will ewes with lambs or sheep in small groups (Risenhoover and Bailey 1985). Although sheep will usually avoid heavily timbered areas, they will, when necessary, cross them, favouring streambeds when possible. Sheep have been observed travelling over 10 km through forested habitats (Geist 1971a).

Bighorn sheep use south-to west-facing grassland slopes for winter forage. Other habitat requisites include bedding sites, lambing grounds, rutting areas, water, mineral licks, and migration routes between winter and summer ranges. Favourable combinations of these resources exist in a patchy distribution. Therefore, bighorn sheep range usually consists of a series of seasonal ranges connected by migration corridors (Geist 1971a, Ough and DeVos 1984).

- **Preferred browse species**

Bighorn sheep are adaptable foragers. Their food habits vary greatly among regions and seasons (Cooperrider *et al* 1980). In northern parts of their range grasses dominate in bighorn sheep diet, especially during spring, summer and fall, and modest amounts of browse (including conifers) are eaten in winter when snow covers herbs. Besides grasses and sedges, dense stands of forbs and shrubs can provide excellent forage (Pitt and Wikeem 1979, Eccles 1983).
The diet composition of bighorn sheep is not always similar to the botanical composition of the area as bighorn sheep are highly selective, not only for particular plant species, but for plant parts as well (Pitt and Wikeem 1979). No data is currently available on the foraging strategy and/or forage preferences of California bighorn sheep with an ecology similar to those of our study area. Seip (1983) found Stone sheep, *Ovis dalli stonei* on subalpine and alpine ranges in northern British Columbia heavily favoured *Poa* spp. even though it was sparsely distributed. At particular times of the spring and summer, various forb species such as *Achillea* spp. were taken far in excess of their availability. Willows (*Salix* spp) were heavily browsed in summer whereas the almost equally abundant scrub birch (*Betula glandulosa*) was not eaten. Kinnikinnick (*Arctostaphylos uva-ursi*) was the dominant ground cover on the subalpine ranges but comprised less than 5% of the diet. Terrestrial lichens covered up to 30% of the alpine ranges but was only found in trace amounts in the Stone sheep's diet.

Table 11 shows some of the preferred forage species of bighorn sheep in British Columbia.

Table 11. Preferred forage species for California bighorn sheep in British Columbia. The most important or preferred species are in bold type.

Graminoids	Bluegrasses *Poa* spp. Fescues *Festuca* spp. Wheatgrasses *Agropyron* spp.	*Bromus* spp. Sedges *Carex* spp. Rushes *Juncus* spp.
Forbs	Lupine *Lupinus* spp. Yarrow *Achillae* spp. Pussytoes *Antennaria* spp. *Eriogonum* spp. Cinquefoil *Potentilla* spp.	Northern Bedstraw *Galium boreale* Fireweed *Epilobium* spp. *Anemone* spp. Indian Paintbrush *Castilleja* spp. *Aster* spp.
Shrubs	Willows *Salix* spp. Kinnikinnick *Arctostaphylus uva-ursi* Saskatoon *Amelanchier alnifolia*	
Trees	Subalpine Fir *Abies lasiocarpa*	

- **Habitat requirements – Reproduction**

Lambing usually occurs in rugged, steep terrain, with good visibility, and adjacent to adequate forage and water. Thermal and hiding cover for ewes and newborn lambs is provided by cliffs and rock outcrops with a sparse cover of shrubs and trees.

- **Special Habitat Needs:**

For escape terrain and for bedding and lambing sites, bighorn sheep require steep broken cliffs with traversable terraces, steep slopes, talus, and ridge tops (Stevens and Lofts 1988).

Throughout much of bighorn sheep range the presence of mineral licks is believed to be important for their nutritional balance (Stelfox and Stelfox 1993). Seip (1983) observed frequent use of mineral licks by Stone sheep between April and July. Soil analysis indicated that sodium was the mineral attracting stone sheep to the sites. However, in some mountain ranges of alkaline rock types with relatively high sodium and/or potassium content, mineral sources may be abundantly dispersed throughout the range, rather than concentrated in particular sites. Forage growing in the volcanic soils may also provide minerals (Varley 1994). The Itcha-Ilgachuz ranges are the remains of shield volcanoes composed of very alkaline rock types with high sodium content compared to those of the surrounding Fraser Plateau (Kathy Hickson Geological Survey of Canada pers. comm.).

- **Territory/Home Range:**

Bighorn sheep are non-territorial. They tend to live in relatively large groups. Outside of the rutting season mature rams are usually segregated in separate bands from ewes and young. While most herds migrate from 2-60 km between summer and winter ranges, some herds are yearlong residents on a particular range (Stevens and Lofts, 1988). The small band of bighorn sheep in the Ilgachuz Mountains is a yearlong resident of alpine/ subalpine habitat. Their range is limited by the scarcity of suitable escape terrain and winter foraging areas (J. Young 1998 pers. comm.). We

are not aware of any data currently available on the size of home ranges of California bighorn sheep with an ecology similar to those of the Ilgachuz range. Bighorn sheep densities on optimal ranges may reach 1.0/ km^2 (Stelfox and Stelfox 1993). Much higher densities than this may occur temporarily on low elevation winter ranges when bighorn sheep concentrate into small areas of good habitat as along the Fraser River (P. Dielman pers. comm. 1999).

Although Van Dyke *et al* (1983) suggested foraging areas for bighorn sheep should be located within 800 m of escape terrain, out of 13 studies of bighorn sheep surveyed, only one showed more than 10% of the observed groups of bighorn sheep over 250 m from escape terrain (Wakelyn 1984).

4.4.5 Habitat Use - Life Requisites

Habitats for bighorn sheep were rated separately for two seasons: growing and winter. The life requisites rated were: Feeding (FD), Security (SH) and Thermal (TH) habitats for the specified season. They are described in detail below.

- **Feeding Habitat**

For feeding habitat bighorn sheep require large areas of open grasslands with a mixture of grasses, sedges, and forbs. In winter bighorn sheep will browse on shrubs and conifers when other forage is unavailable due to deep snow. Although bighorn sheep will dig craters in snow to uncover forage, snow depths greater than 30 cm severely hamper their mobility, increase energy expenditures, and the animals vulnerability to predators. Feeding habitat should, optimally, be within 250 - 400 metres of escape terrain.

- **Security Habitat**

Security habitat is used by bighorn sheep to detect and escape from predators and is provided by steep rugged subalpine/alpine terrain with talus slopes, cliffs, and terraces and good all-round visibility. Subalpine forest and krummholz may be used as security and thermal cover in summer. In winter, bighorn sheep are hampered in their movements by snow depths that exceed 30 cm. Therefore, to escape predators they require steep slopes with little or no snow. In British Columbia most bighorn sheep migrate to winter ranges on low elevation grasslands where mild temperatures keep winter snow accumulations light. However, other bighorn sheep herds, like those of the Ilgachuz range, must use subalpine/alpine habitats where strong winds sweep snow from the grasslands (Stelfox and Stelfox 1993).

- **Thermal Habitat**

Bighorn sheep use thermal habitat to assist them in maintaining a constant body temperature. The most critical season is winter when, to minimise heat loss, bighorn sheep will forage and rest on steep slopes with warm aspects or bed down under an insulating blanket of snow. They will also use lee-slopes, subalpine forest, krummholz, caves, and rock over-hangs for shelter from chilling winter winds. These habitat features will also be used in summer to avoid solar radiation during hot periods. Bighorn sheep may also use stands of mature forest as thermal habitat when escape terrain is nearby.

4.4.6 Seasons of Use

The thermal, security and feeding habitat requirements of Bighorn sheep vary with the seasons.

Table 12 summarises the life requisites for bighorn sheep for each month of the year.

Table 12. Monthly life requisites for California bighorn sheep.

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

* Seasons defined for Central Interior Ecoprovince as per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

Two seasons were rated for bighorn sheep, Winter and Growing (an amalgamation of Spring, Summer and Fall seasons).

Winter Season (November to April) - California Bighorn sheep have specific thermal requirements (e.g. warm aspects, shelter from chilling winds), security requirements (e.g. rugged terrain, reduced snow depths), and feeding requirements (e.g. grasses, sedges, shrubs, conifers, reduced snow depths) during the winter season.

Growing Season (May to October) - California Bighorn Sheep require feeding and security habitat, taking advantage of plant phenology and food availability.

4.4.7 Habitat Use and Ecosystem Attributes

Table 13 outlines how each life requisite relates to specific ecosystem attributes (e.g. site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 13. Terrestrial ecosystem mapping (TEM) relationships for each life requisite for California bighorn sheep.

Life Requisite	TEM Attribute
Feeding Habitat	• **site:** site disturbance, elevation, slope, aspect, structural stage. • **soil/terrain:** bedrock, terrain texture, flooding regime. • **vegetation:** % cover by layer, species list by layer, cover for each species for each layer.
Security Habitat	• **site:** elevation, slope, aspect, structural stage • **soil/terrain:** terrain texture • **vegetation:** % cover by layer. • **mensuration**: tree species, dbh, height.
Thermal Habitat	• **site:** site disturbance, elevation, slope, aspect, structural stage. • **soil/terrain:** bedrock, terrain texture, flooding regime. • **mensuration:** tree species, dbh, height.

4.4.8 Ratings

There is a detailed level of knowledge of the habitat requirements of California Bighorn Sheep in British Columbia and thus, a 6-class rating scheme was used.

- **Provincial Benchmark**

Ecoprovince Central Interior
Ecosection Fraser Basin (FRB)

	Winter	**Growing**
Biogeoclimatic Zone:	BGxh	BGxw
Broad Ecosystem Unit:	Big Sagebrush Shrub/Grassland/Steep	Bunchgrass Grassland

Habitats: (both benchmarks) Areas of steep, optimally greater than 80% slope , rugged terrain on southerly aspects with low snow accumulation, good visibility, and an abundance of grasses, forbs and shrubs..

- **Ratings Assumptions**

1. Large tracts of continuous forest in structural stages 4-7 have little or no value for food or security. However, small stands of trees on bighorn sheep range may be used for thermal cover.
2. Forage areas more than 400 metres from escape terrain have minimal value (suitability 5) for feeding.
3. Structural stages 1-3 may provide good feeding habitat, depending on the availability and abundance of forage species, ability to detect predators and the adjacency of escape terrain.

- **Ratings Adjustments**

Final habitat capability and suitability map products **may** incorporate: 1) landscape heterogeneity and connectivity; 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g.

roads, settlements); 3) interspersion of different structural stages within the landscape. Adjustments will typically increase or decrease suitability value by a single class.

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4.5 Grizzly Bear

4.5.1 Name: *Ursus arctos*

Species Code: M-URAR

4.5.2 Status: Blue-listed

4.5.3 Distribution

- **Provincial Range**

Grizzly bears inhabit all forested and non-forested regions of British Columbia, with the exception of Vancouver Island, the Queen Charlotte Islands and outer coastal islands. They can be found within all biogeoclimatic zones, except the Coastal Douglas Fir zone (CDF) and occupy a wide variety of habitats ranging from coastal estuaries to alpine meadows.

- **Provincial Context**

Grizzly bears in British Columbia are rare to abundant throughout their range. The COSEWIC status of grizzly bears in the Southern Interior Ecoprovince is designated as threatened. The status of grizzly bears in all other ecoprovinces in which they still occur is vulnerable, except for the Northern Boreal Mountains Ecoprovince, the northern portion of the Sub-boreal Interior Ecoprovince and the extreme south-east portion of the Southern Interior Mountains Ecoprovince, in which their status appeared relatively secure (Ministry of Environment, Lands and Parks, 1995)**.** The current population estimate for grizzly bears in British Columbia is between 10,000 and 13,000.(Ministry of Environment, Lands and Parks, 1995)**.** Grizzly bears occur from sea level in coastal estuaries up to high elevation alpine areas and are found in every biogeoclimatic zone in the province, with the exception of the CDF. The highest coastal concentrations of grizzly bears occur in the Kitimat Range (KIR), and Nass Ranges (NAR) ecosections, whereas, the Chilcotin and Okanagan areas have low densities. Grizzly bears are not found on Vancouver Island or on the Queen Charlotte Islands.

- **Range in Project Area:**

Ecoprovince:	Central Interior
Ecoregions:	Fraser Plateau
Ecosections:	Western Chilcotin Upland (WCU), Chilcotin Plateau (CHP), Nazko Upland (NAU)
Biogeoclimatic Zones:	MSxv, AT, ESSFxv1, ESSFxvp1, SBPSxc, SBPSdc, SBPSmc, SBSmc2, IDFdk4
Elevational Range:	In the Itcha / Ilgachuz study area, grizzly bears range from 1,000 metres (Chilcotin Lake) to 2,400 metres (Far Mountain in the Ilgachuz range).

4.5.4 Ecology and Key Habitat Requirements

- **General**

Habitat use by grizzly bears is influenced primarily by food availability, the presence of suitable resting, denning and mating sites, the presence of other bears and by human development. Grizzly bears are very adaptable and inhabit a wide variety of plant communities. Grizzly bears are omnivorous and opportunistic in their feeding habits. Green leafy material forms the bulk of their diet, especially in late spring and early summer. They also feed on insects, fruits, berries, fish, carrion, and small and large mammals. During periods of inactivity, Grizzly bears periodically utilise bed sites in forest habitats with thick understory vegetation. These sites are often a simple shallow depression in the forest leaf litter, but may become deeper with use. Bedding requirements are generally site-specific, cannot be mapped based on TEM attributes, and so were not rated. If located, these features were identified in the "Evidence of Use" section in the Wildlife habitat assessment form.

Grizzly bears are not considered to be truly territorial; while they have individual home ranges, these may overlap and in general, are not aggressively defended. Home ranges may change seasonally or annually to account for differences in weather and food availability. Seasonal movements of grizzly bears within a geographic area are influenced by the juxtaposition and availability of seasonally important food resources or habitat components, breeding activity, reproductive status of individuals and availability of denning habitat. In some regions grizzly bears may make extensive seasonal movements to areas of food abundance such as spring green-up sites, salmon spawning areas, berry patches, and garbage dumps. In particular, these extensive movements occur to and from winter den sites and during the late summer and fall when foraging activities increase. Migrating grizzly bears will use movement corridors such as game trails, human trails, open edges, shorelines, ridges, creek beds, snow filled avalanche chutes, logging roads, sandbars or rivers. Generally, adult males have the largest home ranges, that may be several times as large as those of females and may also overlap more than those of females (MacHutchon *et al* 1993). Females have well-defined ranges of between 25 and 600 km^2. Male grizzly bears have much larger home ranges up to 2000 km^2, sometimes travelling 140 km or more to a preferred food source or winter denning site (Himmer and Gallagher 1995).

With the exception of females with cubs, grizzly bears are solitary for most of the year but pair up briefly during the mating season. Breeding occurs in late May until mid-July (LeFranc et al. 1987). Gestation is 229 to 266 days with one to three cubs being born from January through March. Birth and early maternal care occurs in the winter den. The cubs remain with their mother for 2 to 3 years. Natural caves, or excavated dens are used for hibernating habitat.

4.5.5 Habitat Use - Life Requisites

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

- **Feeding Habitat**

Grizzly bears are opportunistic omnivores and alter their food habits according to the availability of food items throughout the seasons. They depend heavily on plant food but will feed on fish, wildlife and domestic animals when available. Grizzly bears will also feed on carrion and insects such as carpenter ants (*Camponotus* spp.), yellow jackets (*Vespula* spp.), and bees (*Apidae*). Grizzly bear diets change seasonally. Predation on ungulate calves is mainly in spring and summer. High quality foods (e.g. caribou and moose calves) in spring and early summer may regulate cub survival and growth. There is an increase in the amount of fruit and berries through summer and fall. (LeFranc *et al*. 1987). Fall diets largely control cub production the following spring. Table 14 shows some of the preferred forage species of grizzly bears.

Table 14. Known and potential forage species for grizzly bears in the Itcha / Ilgachuz study area (items indicated in bold are known to be important or preferred)

Common Name	Scientific Name	Parts Consumed
Saskatoon	*Amelanchier alnifolia*	Berries
Kneeling angelica	*Angelica genuflexa*	Leaves, stems, roots
Kinnikinnick	*Arctostaphylos uva-ursi*	Berries
Lady fern	*Athyrium filix-femina*	Fronds
bluejoint reedgrass	*Calamagrostis canadensis*	Leaves
Sitka sedge	*Carex sitchensis*	Leaves
Sedge	*Carex spp.*	Leaves
Edible thistle	*Cirsium edule*	Flowers
Red-osier dogwood	*Cornus stolonifera*	Berries
tufted hairgrass	*Deschampsia cespitosa*	Leaves
Crowberry	*Empetrum nigrum*	Berries
Fireweed	*Epilobium angustifolium*	Leaves, flowers
purple-leaved willowherb	*Epilobium ciliatum*	Leaves, flowers
common horsetail	*Equisetum arvense*	Foliage
wood horsetail	*Equisetum sylvaticum*	Foliage
wild strawberry	*Fragaria virginiana*	Berries
cow parsnip	*Heracleum lanatum*	Leaves, stems, flowers, roots
Arctic lupine	*Lupinus arcticus*	Roots
black twinberry	*Lonicera involucrata*	Berries
bog cranberry	*Oxycoccus oxycoccos*	Berries
Whitebark pine	*Pinus albicaulis*	Cone seeds
stink currant	*Ribes bracteosum*	Berries
northern blackcurrant	*Ribes hudsonianum*	Berries
black gooseberry	*Ribes lacustre*	Berries
northern gooseberry	*Ribes oxyacanthoides*	Berries
prickly rose	*Rosa acicularis*	Hips
Nootka rose	*Rosa nutkana*	Hips
Nagoonberry	*Rubus arcticus*	Berries
dwarf nagoonberry	*Rubus arcticus spp. acaulis*	Berries
five-leaved bramble	*Rubus pedatus*	Berries

trailing raspberry	*Rubus pubescens*	Berries
Willow	*Salix* spp.	Catkins
Mountain ash	*Sorbus* spp.	Berries
Soopolallie	*Shepherdia canadensis*	Berries
common dandelion	*Taraxacum officinale*	Foliage, flowers
Clover	*Trifolium spp.*	Foliage, flowers
stinging nettle	*Urtica dioica ssp. gracilis*	Foliage
dwarf blueberry	*Vaccinium caespitosum*	Berries
black huckleberry	*Vaccinium membranaceum*	Berries
Grouseberry	*Vaccinium scoparium*	Berries
Sitka valerian	*Valeriana sitchensis ssp. sitchensis*	Foliage
highbush-cranberry	*Viburnum edule*	Berries
tree cambium	*Picea* spp, *Pinus* spp	Cambium under bark
Animal Foods		
Ants	Formicidae	Larva, adults
wasps	Vespidae	Larva, adults
beetles	Coleoptera	Larva, adults
moose	*Alces alces*	Carcasses, fresh kills
mule deer	*Odocoileus hemionus*	Carcasses, fresh kills
mountain goat	*Oreamnos americanus*	Carcasses
California bighorn sheep	*Ovis canadensis californiana*	Carcasses
Northern caribou	*Rangifer tarandus caribou*	Carcasses, fresh kills
grizzly bear	*Ursus arctos*	Carcasses, fresh kills
black bear	*Ursus americanus*	Carcasses, fresh kills
largescale sucker	*Catostomus macrocheilus*	Carcasses, fresh kills
trout & charr	*Salmo* spp, *Salvelinus* spp	Carcasses, fresh kills
voles	*Microtus* spp.	Fresh kills
marmot	*Marmota caligata*	Fresh kills

Spring Feeding

In early spring, grizzly bears feed on the early green vegetation found in meadows, avalanche chutes and seepage sites that become snow-free first. Grasses, sedges, horsetails and overwintering berries are the most commonly selected spring food items of bears, mainly because these plants develop early. In early spring bears require high-protein, digestible forage and so feed on succulent vegetation in wet meadows, riparian areas, skunk cabbage swamps, avalanche chutes, and burns. Warm aspect avalanche tracks, slides and non-herbicided-clearcuts are important feeding habitat because of early exposed vegetation. In the study area ungulate calves, marmots and late spawning suckers may also be available to grizzly bears in spring.

Summer feeding

Green leafy material and wild berries in old-growth and mid-seral, deciduous forests provide summer food for grizzly bears. Recent clearcuts (5-15 years old) in nutrient rich, moist habitats may also be important feeding areas. Berries are utilised as they become available (e.g. black twinberry, elderberry, raspberry, blueberry, currants, red-osier dogwood and highbush cranberry). Bears will roll rocks and rip apart rotten logs looking for insects, especially ants and wasps that are important summer foods.

Late Summer/Fall Feeding

In the late summer and fall, grizzly bears continue to feed on late-producing berry species and other available vegetation. Grizzly bears will raid squirrel cone caches to feed on whitebark pine nuts. As marmots begin to hibernate bears will dig out their burrows to feed on them. There are no spawning salmon in the study area therefore some grizzly bears travel to adjacent coastal rivers to feed on salmon (Himmer and Gallagher 1995).

- **Security Habitat**

Security habitat for grizzly bears can be divided into two types:

1/ Bear/bear avoidance - During the growing season shrub and tree cover are used as security from other bears. To avoid aggressive males, females with cubs may rely on wildlife tree patches (with a structural stage beyond pole-sapling). In alpine areas females with cubs will descend below the treeline for secure bedding habitat or they may use cliff ledges and talus slopes which provide good visual and olfactory vantages points.

2/ Bear/human avoidance - Grizzly bears typically will avoid high-traffic roads (e.g. highways or active logging roads) and human settlements, unless attracted there by human food sources (e.g. garbage dumps, fruit trees, etc.). Suitable habitat adjacent to such non-habitat features are less suitable.

- **Thermal Habitat**

Grizzly bears will temporarily seek shelter from precipitation and heat under oldgrowth trees forest/patches with low canopy or rock overhangs. Bears will also seek relief from heat by using open water (e.g. ponds, lakes, rivers, streams and springs), and using beds in cool, moist sandy areas. Generally, these habitat features are too small to map as TEM polygons, and are difficult to rate. When located, these features were identified in the "Evidence of Use" section in the Wildlife Habitat assessment form. In alpine and subalpine areas grizzly bears will bed in small tree or shrub islands for security and thermal protection.

- **Reproduction**

The only habitat requirements identified for grizzly bear reproduction are those for winter den/parturition sites.

- **Hibernation**

With the exception of some individual coastal grizzly bears, all grizzly bears in British Columbia hibernate for the winter. Suitable dens for grizzly bears are warm, dry, and secure. Grizzly bears in the interior of British Columbia hibernate between October and May. Typically, grizzly bears dig dens on moderately steep to steep slopes in locations that catch early snow and maximize the snow's insulative qualities (e.g. alpine and subalpine areas). A review of the literature on grizzly

bear dens sites suggests that the angle of slope in which dens were excavated ranged from about 41% to 90 % (Lentfer *et al*. 1972, Pearson 1975, Russell *et al*. 1979, Vroom et al. 1980, Nagy *et al*. 1983). Sloped sites are often selected because they facilitate easier digging and the slope surface is generally stabilised by root systems of herbaceous plants and trees or boulders. Natural rock caves and cavities under old-growth structures, including large old trees and root bolls also make suitable den sites. Tree root den sites are likely based on den structure, rather than on a particular tree species.

4.5.6 Seasons of Use

Food and security are required throughout the growing season while hibernating habitats are the only requirements for the winter months. In the Western Chilcotin Uplands, Chilcotin Plateau, and Nazko Uplands ecosections grizzly bears begin hibernating between mid-October and the end of November and they emerge from hibernation between the middle of April and the end of May. Table 15 summarises the life requisites required for each month of the year.

Table 15. Monthly life requisites for grizzly bears.

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

* Seasons defined for Central Interior Ecoprovince as per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

Four seasons were rated for grizzly bears: Spring, Summer, Fall, Winter (Hibernation)

Spring Season (late April – early June) – Grizzly bears concentrate their activity to spring feeding, near adequate security habitat. Feeding occurs primarily on early emergent, succulent vegetation.

Summer Season (late June - August)- Grizzly bears take advantage of plant phenology and food availability and require feeding, security and thermal habitat.

Fall Season (September – October) Grizzly bears continue to feed on late-producing berry species and other available vegetation. Feeding on the cone seeds of whitebark pine may occur pre-denning.

Winter Season (November to early April) - Grizzly bears are typically hibernating during this season.

4.5.7 Habitat Use and Ecosystem Attributes

Table 16 outlines how each life requisite relates to specific ecosystem attributes (e.g. site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 16. Terrestrial ecosystem mapping (TEM) relationships for each life requisite for grizzly bears.

Life Requisite	TEM Attribute
Feeding Habitat	• site: site disturbance, elevation, slope, aspect, structural stage. • soil/terrain: bedrock, terrain texture, flooding regime. • vegetation: % cover by layer, species list by layer, cover for each species for each layer, coarse woody debris (CWD).
Security Habitat	• site: elevation, slope, aspect, structural stage • soil/terrain: terrain texture • vegetation: % cover by layer. • mensuration: tree species, dbh, height.
Hibernating Habitat	• site: site disturbance, elevation, slope, aspect, structural stage. • soil/terrain: bedrock, terrain texture, flooding regime. • mensuration: tree species, dbh, height.

4.5.8 Ratings

There is a detailed level of knowledge of the habitat requirements of grizzly bears in British Columbia and thus, a 6-class rating scheme was used.

Provincial Benchmark

Ecosection: Kitimat Ranges
Biogeoclimatic Zones: CWHvm1, CWHvm2
Habitats: Skunk cabbage forests; floodplains; wetlands; estuaries/beaches; salmon streams

Highest densities of grizzly bears are associated with extensive areas of valley bottom old growth forests interspersed with early seral stage habitats (avalanche chutes, wetlands, sedge meadows), when combined with salmon streams and marine estuarine habitats.

- **Ratings Assumptions and Adjustments Polygon Ratings**

1. Riparian areas and other ecosystems with preferred sedges, grasses and herbs are rated high in spring, as these areas should provide abundant, new, succulent forage.
2. Units with preferred species of herbs and berry-producing shrubs are rated high in summer. Structural stages 2 and 3 may provide abundant forage and have good spring and summer values. Clearcuts on rich, moist sites should provide moderate to high summer forage. Structural stage 4 stands generally have poor, year-round feeding value.
3. All habitats greater than 200 m from forest cover were rated nil (suitability 6) for grizzly bear

use.
4. Hibernation is dependent on digging substrate, slope and the presence of old-growth structures, but structural stages 1-5 may contain residual old-growth features (e.g. snags and large stumps) and so may be similarly, rated up to high.
5. Water and minerals are not limiting for grizzly bears.
6. All active roads have the same effect on grizzly bear behaviour or survival regardless of use.
7. All human activities have the same effect on grizzly bear behaviour and survival.

Table 17 summarises the habitat requirements for grizzly bears in the study area for the seasons and life requisites being modelled.

Table 17. Summary of habitat requirements for grizzly bears in the Itcha\Ilgachuz study area.

Season	Life Requisite	Structural Stage	Requirements
Spring Season	Feeding (FD) Security/ Thermal (ST)	2-3, 6-7	• Abundance of early green-up vegetation. Sedges, grasses and horsetails are important. Flood plains, valley bottoms, and lower snow-free side slopes with moist to wet soil moisture regimes and a rich soil nutrient regime support the best spring habitat. • Ungulate calving areas may be important to grizzly bears. • Habitats with marmot colonies may be utilised in the spring but are more heavily used in late summer and fall when marmots are still hibernating and digging is easier. • Bedding and security cover in mixed conifer/deciduous mature to old growth forests, shrub thickets and tree and shrub islands in alpine and subalpine areas
Summer Season	Feeding (FD) Security/ Thermal (ST)	2-3, 6-7	• Mature and old-growth mixed coniferous/deciduous and deciduous forests on floodplains, valley bottoms, and lower side slopes with moist to wet soil moisture regimes and a rich soil nutrient regime support the best summer habitats. • Habitats with marmot colonies may be utilised in late summer as marmots begin to hibernate. • Bedding and security as for spring

Fall Season	Feeding (FD) Security/ Thermal (ST)	2-3, 6-7	• Moist forests and meadows with cow parsnip and late berry producing shrubs are important feeding areas during this period. • Whitebark pine stands may be very important depending on annual cone production. • Habitats with marmot colonies may be utilised • Bedding and security as for spring
Winter Season	Hibernating (HI)	2-3, 6-7	• Moderately steep to steep slopes in the alpine and subalpine with good digging substrate; mature and old-growth coniferous forests adjacent to avalanche chute areas with natural rock caves.

- **Ratings Adjustments**

Final habitat capability and suitability map products should incorporate: 1) landscape heterogeneity and connectivity; 2) habitats adjacent to significant anthropogenic disturbance regimes (e.g. roads, settlements); 3) interspersion of different structural stages within the landscape. Adjustments will typically increase or decrease suitability value by a single class.

4.5.9 Literature Cited

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4.6 Black Bear

4.6.1 Name: *Ursus americanus*

Species Code: M-URAM

4.6.2 Status: Yellow-listed

4.6.3 Distribution

- **Provincial Range**

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

- **Provincial Context**

Black bears occur commonly throughout their range. Populations in British Columbia are stable and the current provincial population is estimated to be between 140,000 and 160,000 black bears. Black bears occur from sea level in coastal estuaries up to high elevation alpine areas and are found in every biogeoclimatic zone in the province. The highest coastal concentrations of black bears occur in the Kitimat Range (KIR) and Nass Ranges (NAR) ecosections, whereas, the Chilcotin and Okanagan areas have low densities.

- **Range in Project Area:**

Ecoprovince:	Central Interior
Ecoregions:	Fraser Plateau
Ecosections:	Western Chilcotin Upland (WCU), Chilcotin Plateau (CHP), Nazko Upland (NAU)
Biogeoclimatic Zones:	MSxv, ESSFxv1, ESSFxvp1, SBPSxc, SBPSdc, SBPSmc, SBSmc2, IDFdk4
Elevational Range:	In the Itcha / Ilgachuz study area, black bears range from 1,000 metres (Chilcotin Lake) to 1800 metres (approximate treeline).

4.6.4 Ecology and Key Habitat Requirements

- **General**

Black bears prefer forested and shrubby areas, but use wet meadows, estuaries, marine shorelines, ridge tops, burned areas, riparian areas and avalanche chutes (Pelton 1979). They prefer mesic over xeric sites and timbered over open areas (particularly in areas inhabited by grizzly bears)(Unsworth *et al* 1989).

Black bears are very adaptable and inhabit a wide variety of plant communities. In the U.S. Northwest black bears are found in spruce-western red cedar-hemlock forests as well as pine and fir forests (Pelton 1987).

Black bears are omnivorous and opportunistic in their feeding habits. Green leafy material forms the bulk of their diet, especially in late spring and early summer. They also feed on insects, fruits, berries, fish, carrion, and small mammals. Occasionally, black bears will prey on young or small ungulates.
During periods of inactivity, black bears periodically utilise bed sites in forest habitats with thick understory vegetation. These sites are often a simple shallow depression in the forest leaf litter, but may become deeper with use. Bedding requirements are generally site-specific, cannot be mapped based on TEM attributes, and so were not rated. If located, these features were identified in the "Evidence of Use" section in the Wildlife habitat assessment form.

Seasonal movement of black bears within a geographic area are influenced by the juxtaposition or availability of seasonally important food resources or habitat components, breeding activity, reproductive status of individuals and availability of denning habitat (Rogers 1977). Black bears make extensive seasonal movements to areas of food abundance such as spring green-up sites, spawning areas, berry patches, and garbage dumps (Amstrup and Beecham 1976, Rogers 1977, Modafferi 1978). In particular, these extensive movements occur to and from winter den sites and during the late summer and fall when foraging activities increase (Pelton 1982, Rogers 1987). Migrating black bears will use movement corridors such as game trails, human trails, open edges, shorelines, ridges, creek beds, snow filled avalanche chutes, logging roads, sandbars or rivers (Stevens and lofts 1988).

Black bears are solitary for most of the year but pair up briefly during the mating season. Breeding occurs in May or June (Stevens and Lofts 1988). Gestation is 6 to 7 months long with one to three cubs being born from late November through February. Birth and early maternal care occurs in the winter den. The cubs remain with their mother for 1 to 2 years. Hollow trees, fallen logs, or excavated dens are used for hibernating habitat.

Generally, adult males have the largest home ranges, which may be several times as large as those of females and overlap more than those of females (Amstrup and Beecham 1976, Rogers 1977, Young and Ruff 1982). Adult females establish exclusive home ranges during the summer. Adult males use overlapping mating ranges, which are generally larger than those of females. Females have well-defined home ranges of between 12 and 50 km^2. Male black bears, especially sub adults, have much larger home ranges, sometimes travelling 50 km or more to a preferred food source or winter denning site (Rogers 1977). Home ranges may change seasonally to account for weather and food availability (Stevens and Lofts 1988). In a boreal forest in Alberta, Young and Ruff (1982) reported average size of an adult male home range as 119 km^2 and 19.6 $km^2$for females. In north-eastern Minnesota male black bear home ranges averaged 75 km^2 and those of females, 9.6 km^2. (Rogers 1987) In the Nimpkish Valley, Vancouver Island, Davis (1996) found the mean annual home range of adult and subadult female black bears to be 10.28 km^2 and 10.50 km^2 respectively. The mean home ranges of adult males was 80.79 km^2 while the ranges of subadult males averaged 72.29 km^2

4.6.5 Habitat Use - Life Requisites

The life requisites that were rated for black bears were hibernation, feeding, and security/thermal, which are described in detail below.

- **Feeding Habitat**

Black bears are opportunistic omnivores and alter their food habits according to the availability of food items throughout the seasons. They depend heavily on plant food but will feed on fish, wildlife and domestic animals when available. Black bears will also fed on carrion and insects such as carpenter ants (*Camponotus* spp.), yellow jackets (*Vespula* spp.), bees (*Apidae*), and termites (*Isoptera*). Black bears will also climb trees to eat young shoots (Stevens and Lofts 1988). Black bear diet changes seasonally. Predation on ungulate calves is mainly in spring and early summer. High quality foods (e.g. moose calves) in spring and early summer may regulate cub survival and growth(Schwartz and Franzmann 1991). However, predation on ungulate calves has not been documented in the study area. There is an increase in the amount of fruit and berries through summer and fall (Schwartz and Franzmann 1991).

Fall diets largely control cub production the following spring (Rogers 1987, Elowe 1987, Schwartz and Franzmann 1991). Table 18 shows some of the preferred forage species of black bears.

Table 18. Known and potential forage species for black bears in the Itcha / Ilgachuz study area (items indicated in bold are know to be important or preferred)

Common Name	Scientific Name	Parts Consumed
Saskatoon	*Amelanchier alnifolia*	Berries
Kneeling angelica	*Angelica genuflexa*	Leaves, stems, roots
Kinnikinnick	*Arctostaphylos uva-ursi*	Berries
Lady fern	*Athyrium filix-femina*	Fronds
bluejoint reedgrass	*Calamagrostis canadensis*	Leaves
Sitka sedge	*Carex sitchensis*	Leaves
Sedge	*Carex spp.*	Leaves
Edible thistle	*Cirsium edule*	Flowers
Red-osier dogwood	*Cornus stolonifera*	Berries
tufted hairgrass	*Deschampsia cespitosa*	Leaves
Crowberry	*Empetrum nigrum*	Berries
Fireweed	*Epilobium angustifolium*	Leaves, flowers
purple-leaved willowherb	*Epilobium ciliatum*	Leaves, flowers
common horsetail	*Equisetum arvense*	Foliage
wood horsetail	*Equisetum sylvaticum*	Foliage
wild strawberry	*Fragaria virginiana*	Berries
cow parsnip	*Heracleum lanatum*	Leaves, stems, flowers, roots
Arctic lupine	*Lupinus arcticus*	Roots
black twinberry	*Lonicera involucrata*	Berries
bog cranberry	*Oxycoccus oxycoccos*	Berries

Whitebark pine	*Pinus albicaulis*	Cone seeds
stink currant	*Ribes bracteosum*	Berries
northern blackcurrant	*Ribes hudsonianum*	Berries
black gooseberry	*Ribes lacustre*	Berries
northern gooseberry	*Ribes oxyacanthoides*	Berries
prickly rose	*Rosa acicularis*	Hips
Nootka rose	*Rosa nutkana*	Hips
Nagoonberry	*Rubus arcticus*	Berries
dwarf nagoonberry	*Rubus arcticus ssp. acaulis*	Berries
five-leaved bramble	*Rubus pedatus*	Berries
trailing raspberry	*Rubus pubescens*	Berries
Willow	*Salix* spp.	Catkins
Mountain ash	*Sorbus* spp.	Berries
Soopolallie	*Shepherdia canadensis*	Berries
common dandelion	*Taraxacum officinale*	Foliage, flowers
Clover	*Trifolium spp.*	Foliage, flowers
stinging nettle	*Urtica dioica ssp. gracilis*	Foliage
dwarf blueberry	*Vaccinium caespitosum*	Berries
black huckleberry	*Vaccinium membranaceum*	Berries
Grouseberry	*Vaccinium scoparium*	Berries
Sitka valerian	*Valeriana sitchensis ssp. sitchensis*	Foliage
highbush-cranberry	*Viburnum edule*	Berries
tree cambium	*Picea* spp, *Pinus* spp	Cambium under bark
Animal Foods		
Ants	Formicidae	Larva, adults
wasps	Vespidae	Larva, adults
beetles	Coleoptera	Larva, adults
moose	*Alces alces*	Carcasses, fresh kills (calves)
mule deer	*Odocoileus hemionus*	Carcasses, fresh kills (fawns)
mountain goat	*Oreamnos americanus*	Carcasses
California bighorn sheep	*Ovis canadensis californiana*	Carcasses
Northern caribou	*Rangifer tarandus*	Carcasses
grizzly bear	*Ursus arctos*	Carcasses
black bear	*Ursus americanus*	Carcasses, fresh kills
largescale sucker	*Catostomus macrocheilus*	Carcasses, fresh kills
trout & charr	*Salmo* spp, *Salvelinus* spp	Carcasses, fresh kills
voles	*Microtus* spp.	Fresh kills
marmot	*Marmota caligata*	Fresh kills

Spring Feeding

In early spring, black bears feed on the early green vegetation found in meadows and seepage sites that become snow-free first. Grasses, sedges and horsetails are the most commonly selected spring food items of bears, mainly because these plants develop early (Hatler 1967, Lloyd and Fleck 1977, Ruff 1982). In early spring bears require high-protein, digestible forage and so feed on succulent vegetation in wet meadows, riparian areas, avalanche chutes, and burns (Stevens and Lofts 1988). Warm aspect avalanche tracks, slides and clearcuts are important feeding habitat because of early exposed vegetation. Late spawning suckers may also be available to grizzly bears in spring.

Summer feeding

Green leafy material and wild berries in old-growth and mid-seral, deciduous forests provide summer food for black bears. Recent clearcuts (5-15 years old) in nutrient rich, moist habitats may be important feeding areas. Berries are utilised, as they become available (e.g. black twinberry, red huckleberry, raspberry, blueberry, currants, elderberry, highbush cranberry, soopolallie, red-osier dogwood and crowberry Insects, especially ant and wasps are also important summer food.

Late Summer/Fall Feeding

In the late summer and fall, black bears continue to feed on the late-producing berry species and other available vegetation. There are no spawning salmon in the study area and it is possible that some black bears may travel to adjacent coastal areas to feed on salmon. An important pre-denning food are the cone seeds of whitebark pine which black bears dig out of red squirrel (*Tamiascurius hudsonicus)* caches.

- **Security Habitat**

Security habitat for black bear can be divided into two types:

1/ Bear/bear avoidance - During the growing season shrub and tree cover are used as security from other bears. To avoid aggressive males, females with cubs rely on wildlife tree patches (with a structural stage beyond pole-sapling), and will generally not forage greater than 100 metres from a stand that provides this kind of security habitat (Jonkel 1978). Black bears also prefer immature forest stands (14-23 yr. preferred over 5-12 yr. old stands and stands older than 38 yr.)(Lindsey and Meslow 1977), likely because of the cover value associated with these stands. Moreover, habitat use rarely occurred beyond 183 m. of forest cover (Rogers and Allen 1987).

2/ Bear/human avoidance - Black bears typically will avoid high-traffic roads (e.g. highways or active logging roads) and human settlements, unless attracted by anthropogenic food sources (e.g. garbage dumps, fruit trees). Suitable habitat adjacent to such non-habitat features are less suitable.

- **Thermal Habitat**

Black bears will temporarily seek shelter from precipitation under forest/patches with low canopy or rock overhangs. Bears will also seek relief from heat by using open water (e.g. ponds, lakes, rivers, streams, springs), and using beds in cool, sandy areas. Generally, these habitat features are too small to map as TEM polygons, and are difficult to rate. When located, these features were identified in the “Evidence of Use” section in the Wildlife Habitat assessment form.

- **Reproduction**

The only habitat requirements identified for black bear reproduction are those for winter den/parturition sites.

- **Hibernation**

With the exception of some coastal black bears, all bears in British Columbia hibernate for the winter. Suitable dens for black bears are warm, dry, and secure. Black bears in the interior of British Columbia hibernate between October and May. Typically, Interior dens are underground and in locations that catch early snow and maximize the snow's insulative qualities. Cavities in old-growth structures, including large old trees, stumps, root bolls and logs having a diameter greater than 85 cm are suitable
dens. Davis (1996) recorded coastal black bear dens in or under large trees (mainly red, and yellow cedar with mean diameter breast height of 143cm). Tree den entrances were sometimes as high as 16m above ground.

Hibernation sites are likely based on den structure, rather than particular tree species. Hibernating in second growth forest stands is limited by suitable denning locations unless residual old-growth features such as large logs and stumps are present. Davis (1996) reported an avoidance of early seral stages for denning and a selection for late successional stages.

4.6.6 Seasons of Use

Food and security are required throughout the growing season while hibernating habitats are the only requirements for the winter months. In the Western Chilcotin Uplands, Chilcotin Plateau, and Nazko Uplands ecosections black bears begin hibernating between mid-October and the end of November and emerge from hibernation between the middle of April and the end of May. Table 19 summarises the life requisites required for each month of the year.

Table 19. Monthly life requisites for black bears.

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

* Seasons defined for Central Interior Ecoprovince as per the Chart of Seasons by Ecoprovince (RIC 1998, Appendix B).

Four seasons were rated for black bears: Spring, Summer, Fall, Winter (Hibernation)

Spring Season (late April – early June) – Black bears concentrate their activity to spring feeding, near adequate security habitat. Feeding occurs primarily on early emergent, succulent vegetation.
Summer Season (late June - August)- Black bears take advantage of plant phenology and food availability and require feeding, security and thermal habitat.
Fall Season (September – October) Black bears continue to feed on late-producing berry species and other available vegetation. Feeding on the cone seeds of whitebark pine may occur pre-denning.
Winter Season (November to early April) - Black bears are typically hibernating during this season.

4.6.7 Habitat Use and Ecosystem Attributes

Table 20 outlines how each life requisite relates to specific ecosystem attributes (e.g. site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 20. Terrestrial ecosystem mapping (TEM) relationships for each life requisite for black bears.

Life Requisite	TEM Attribute
Feeding Habitat	• site: site disturbance, elevation, slope, aspect, structural stage. • soil/terrain: bedrock, terrain texture, flooding regime. • vegetation: % cover by layer, species list by layer, cover for each species for each layer, coarse woody debris (CWD).
Security Habitat	• site: elevation, slope, aspect, structural stage • soil/terrain: terrain texture • vegetation: % cover by layer. • mensuration: tree species, dbh, height.
Hibernating Habitat	• site: site disturbance, elevation, slope, aspect, structural stage. • soil/terrain: bedrock, terrain texture, flooding regime. • mensuration: tree species, dbh, height.

4.6.8 Ratings

There is a detailed level of knowledge of the habitat requirements of black bears in British Columbia and thus, a 6-class rating scheme was used.

- **Provincial Benchmark**

Ecosection: Kitimat Ranges
Biogeoclimatic Zones: CWHvm1
Habitats: Skunk cabbage forests; floodplains; wetlands; estuaries/beaches; salmon streams

Highest densities of black bears are associated with extensive areas of early seral stages

associated with logged areas (less than 15 years old), when combined with salmon streams and marine beach habitats.

- **Ratings Assumptions and Adjustments Polygon Ratings**

1. Riparian areas and other ecosystems with preferred grasses and herbs are rated high in spring, as these areas should provide abundant, new, succulent forage.
2. Units with preferred species of herbs and berry-producing shrubs are rated high in summer. Structural stages 2 and 3 may provide abundant forage and have good spring and summer values. Clearcuts on rich, moist sites should provide moderate to high summer forage. Structural stage 4 stands generally have poor, year-round feeding value.
3. All habitats greater than 200 m from forest cover were rated nil (suitability 6) for black bear use (especially alpine areas because of the presence of grizzly bears).
4. Hibernation is dependent on old-growth structures, but structural stages 1-5 may contain residual old-growth features (e.g. stumps) and so may be similarly, rated up to high.
5. Water and minerals are not limiting for black bears.
6. All roads have the same effect on black bear behaviour or survival regardless of use.
7. All human activities have the same effect on black bear behaviour and survival.

Table 21 summarises the habitat requirements for Black Bears in the study area for the seasons and life requisites being modelled.

Table 21. Summary of habitat requirements for black bears in the Itcha/Ilgachuz study area.

Season	Life Requisite	Structural Stage	Requirements
Spring Season	Feeding (FD) Security/ Thermal (ST)	2-3, 6-7	Abundance of early green-up vegetation. Sedges, grasses and horsetails are important. Flood plains, valley bottoms, and lower snow-free side slopes with moist to wet soil moisture regimes and a rich soil nutrient regime support the best spring habitat.
Summer Season	Feeding (FD) Security/ Thermal (ST)	6-7 3b, 5-7	Mature and old-growth coniferous forests. Riparian forests. Mixed conifer/deciduous mature forest. Shrub cover >50% and canopy closure >66%. Larger trees (>40cm DBH), within <200 m of feeding areas are required for security cover, particularly for sows with cubs.
Fall Season	Feeding (FD) Security/ Thermal (ST)	2-3, 6-7	Moist forests and meadows with cow parsnip and late berry producing shrubs are important feeding areas during this period. Whitebark pine stands may be very important depending on cone production.
Winter Season	Hibernating (HI)	6-7, 5-7	Mature and old-growth coniferous forests. Canopy closure >50% and tree compositions dominated by spruce and pine-spruce. Younger forests with residual old-growth features (e.g. stumps) Natural rock caves.

- **Ratings Adjustments**

Final habitat capability and suitability map products **may** incorporate: 1) landscape heterogeneity and connectivity; 2) patch analysis of habitats taking into consideration size, distribution, frequency and habitat type ratings, 3) habitats adjacent to significant anthropogenic disturbance regimes (e.g. roads, settlements); 4) interspersion of different structural stages within the landscape. Adjustments will typically increase or decrease suitability value by a single class.

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APPENDIX I

FINAL WILDLIFE RATINGS TABLE

APPENDIX II

ECOSYSTEM UNITS OF THE ITCHA / ILGACHUZ AREA

Part 1 Field Plots

A total of 352 plots were located and sampled, as well as 225 ground visual records and 252 quick visual records. Plots were selected to characterise the range of ecosystems and structural stages occurring on the various surficial materials. The existing Site Series classification (Steen and Coupe 1997) was utilised, except for non-forested units which were named according to RIC standards.

Table 22. Itcha / Ilgachuz field sample matrix

BIOGEO UNIT	PLOTS	GROUND VISUALS	QUICK VISUALS	TOTAL
IDFdk4	4	5	2	11
SBPSxc	96	79	77	252
SBPSdc	4	4	7	15
SBPSmc	25	8	29	62
SBSmc2	2	2	3	7
MSxv	125	88	64	277
ESSFxv1	31	22	45	98
ESSFxvp1	28	8	7	40
AT	37	12	18	67
TOTAL	352	225	252	829

Part 2 Structural Stages

Structural stages sampled, and also mapped, are:

- **1a** Non-vegetated (<5% total cover)
- **1b** Sparsely vegetated (<10% vascular plants, up to 100% bryophytes / lichens)
- **2** Herb (wetlands, grasslands, tundra or recently logged)
- **3** Shrub / Herb (early successional stage or disclimax / communities dominated by shrubby vegetation <10m tall <20 years for normal forest succession, up to 100+ years for disclimax / climax communities)
- **3a** Low Shrub (early successional stage or disclimax / climax communities dominated by shrubby vegetation <2m tall).
- **3b** Tall Shrub (early successional stage or disclimax / climax communities dominated by >2m tall and <10m).
- **4** Pole Sapling (trees greater than 10m tall, <40 years for normal succession or up to 100 years for stagnant stands
- **5** Young Forest (40 to 80 years)
- **6** Mature Forest (80 to 140 years)
- **7** Old Forest (>140 years)

Part 3 Site Modifiers

These site modifiers which are attached to the site series symbols on the maps, are as follows:

a - active floodplain the site series occurs on an active fluvial floodplain (level or very gently sloping surface bordering a river that has been formed by river erosion and deposition), where evidence of active sedimentation and deposition is present.

c - coarse-textured soil

the site series occurs on soils with a coarse texture, including sand and loamy sand; and also sandy loam, loam, and sandy clay loam with greater than 70% coarse fragment volume.

d - deep soil

the site series occurs on soils greater than 100 cm to bedrock.

f - fine-textured soil

the site series occurs on soils with a fine texture including silt and silt loam with less than 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay and heavy clay with less than 35% coarse fragment volume.

k - cool, northerly aspect

the site series occurs on gently sloping topography (less then 25% in the interior, less than 35% in the CWH, CDF, and MH zones).

n - fluvial fan

the site series occurs on a fluvial fan (most common), or on a colluvial fan or cone.

p - peaty soil

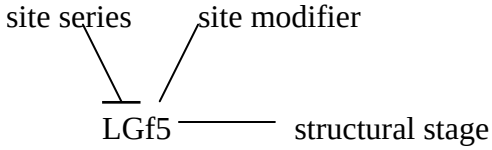
the site series occurs on deep organics or a peaty surface (15-60 $cm)^3$ over mineral materials (e.g., on organic materials of sedge, sphagnum, or decomposed wood).

r - ridged
the site series occurs throughout an area of ridged terrain, or it occurs on a ridge crest.
s - shallow soil
the site series occurs where soils are considered to be shallow to bedrock (20-100 cm).
t - fluvial terrace
the site series occurs on a fluvial or glaciofluvial terrace, lacustrine terrace, or rock cut terrace.
v - very shallow soil
the site series occurs where soils are considered to be very shallow to bedrock (less than 20 cm).
w- warm, southerly aspect
the site series occurs on warm, southerly or westerly aspects (135^0 - 285^0), on moderately steep slopes (25%-100% slope in the interior and 35%-100% slope in the CWH, CDF and MH zones).

Definitions are from standard for Terrestrial Ecosystem Mapping in British Columbia (Resources Inventory Committee 1998).

Part 4 Map Symbols

Map symbols consist of a site series, site modifier (if applicable) and structural stage. For example:



Pl - Crowberry - Feathermoss (site series), fine-textured (site modifier), young forest (structural stage). Up to two site modifiers can be attached to a site series. Complex (2 or 3 part) map symbols are utilized where landscape, site or vegetation conditions are diverse. For example:

8 LGf5 - 2 SGp5

Eighty percent Pl - Crowberry - Feathermoss site series, fine-textured, young forest with twenty percent Sxw - Horsetail - Crowberry site series, peaty, young forest. Note that for complex map symbols deciles are placed before the site series symbols, and deciles must always total 10 (10 = 100%).

Part 5 Ecosections and Biogeoclimatic Units

The Western Chilcotin Upland (**WCU**) Ecosection occupies approximately 90% of the study area, whie the Chilcotin Plateau (**CHP**) Ecosection occurs around Chilcotin Lake, and lower Chilcotin River and Palmer Creek. The Nazko Upland (**NAU**) Ecosection occupies a small area in the northwest corner. Information contained in the biogeoclimatic unit descriptions is taken from Steen and Coupe (1997).

IDFdk4 - Interior Douglas-Fir Dry Cool Subzone Chilcotin Variant

The IDFdk4 occurs within the Chilcotin Plateau below approximately 1250m in the southeast corner of the study area. The typical zonal climax sites in this zone are dominated by multiaged Douglas-fir while the seral stands are dominated by lodgepole pine. Due to and extensive fire history, most stands are dominated by lodgepole pine; small stands of trembling aspen occur throughout this zone as well. The dominant understory includes, soopolallie, kinnikinnick, prickly rose, pinegrass, red-stemmed feathermoss and *Peltigera malacea*.

SBPSxc - Sub-Boreal Pine-Spruce Very Dry Cold Subzone

The SBPSxc occurs below 1300m in the southeast and southwest portions of the study area. Fire history has resulted in extensive lodgepole pine stands with white spruce occuring in regeneration layers on gentle slopes and on moist sites with medium to fine-textured soils. Trembling aspen occurs throughout this zone in small stands or scattered amongst the lodgepole pine. A low-growing understory is dominated by soopolallie, kinnikinnick, twinflower, pinegrass and *Cladonia* species with lesser amounts of prickly rose and common juniper and a sparse moss cover.

SBPSdc - Sub-Boreal Pine-Spruce Dry Cold Subzone

The SBPSdc occurs as two small lobes east of Mount Sheringham and around Narcosli Lake in the northeast, below 1250m. Fire history maintains lodgepole pine as the dominant overstory species with hybrid spruce rarely surpassing the understory except on moist sites. Level to gently sloping sites, sometimes have small locally occuring aspen stands while the majority have moderately open to closed canopies of lodgepole pine. Kinnikinnick, pinegrass and red-stemmed feathermoss dominate the understory with various herbs and scattered shrub species also occuring.

SBPSmc - Sub-Boreal Pine-Spruce Moist Cold Subzone

The SBPSmc occurs in the lower Dean River and Blackwater River valleys below 1250m. Zonal sites in this subzone occur on level to mid-slope positions and soil types dominated by even-aged lodgepole pine in the tree canopy. Hybrid white spruce is a commonly abundant in the regeneration layer with soopolallie, prickly rose, birch-leaved spirea and common juniper present in the shrub layer. The sparse to moderate herb layer includes bunchberry, twinflower, dwarf blueberry and kinnikinnick with *Peltigera* species, *Cladonia* species and red-stemmed feathermoss common.

SBSmc2 - Sub-Boreal Spruce Moist Cold Subzone Babine Variant

The SBSmc2 occurs as a small lobe east of Narcosli Lake between 1200 and 1350m. Loamy soils occuring on gentle to moderately steep slopes dominated by lodgepole pine are characteristic of the zonal site in this subzone. (On upper slopes a shallow soil phase (25-50cm) sometimes occurs over bedrock while all other zonal sites are in the deep soil phase). Fire

history prevents the majority of the stands from reaching their climax where they would be dominated by hybrid white spruce and subalpine fir. Stands are characterized by a nearly continuous moss layer with an understory dominated by black huckleberry, green alder, bunchberry, queen's cup and twinflower.

MSxv - Montane Spruce Very Dry Very Cold Subzone

The MSxv occurs as an extensive belt below the ESSFxv1 and above the SBPS units with an elevational range of 1250 to 1700m. The climax forest of hybrid white spruce and subalpine fir is rarely present due to slow succession and frequent fire history. Lodgepole pine usually dominates these stands with hybrid white spruce, lodgepole pine and occasional subalpine fir regenerating beneath. The understory is commonly made up of crowberry, grouseberry and twinflower with lesser amounts of heart-leaved arnica and bunchberry and a continuous layer of *Dicranum* species, red-stemmed feathermoss, knight's plume and *Cladonia* species on the forest floor.

ESSFxv1 Engelmann Spruce-Subalpine Fir Very Dry Very Cold Subzone West Chilcotin Variant

The ESSFxv1 occurs as a horizontal band around all mountains above the MSxv; approximate elevational range is 1650 to 2100m. The ESSFxv1 zonal site series most commonly occurs on mid slopes and on upper or lower slopes to a lesser extent. Lodgepole pine dominates the majority of stands where forest fires have occurred, with subalpine fir and Engelmann spruce dominating climax stands. A sparse shrub layer and low covers of heart-leaved arnica, heathers, grouseberry and Arctic lupine and scattered *Dicranum* and *Cladonia* species comprise the understory.

ESSFxvp1 Engelmann Spruce - Subalpine Fir Parkland Very Dry Very Cold Subzone West Chilcotin Variant

The ESSFxvp1 occurs as discontinuous patches above the upper limits of the ESSFxv1 proper, typically becoming part of the alpine / subalpine mosaic. Elevations range from 1750 to 2100m. Parkland landscapes are typically composed of tree islands interspersed with dry grasslands and rich herbaceous meadows. Tree islands are composed of stunted, wind-blown subalpine fir, and meadows are commonly dominated by Altai fescue, dwarf blueberry, globeflower, subalpine daisy, arrow-leaved groundsel and mountain sagewort.

AT Alpine Tundra Zone

The Alpine Tundra Zone occurs on all mountain tops at elevations above approximately 1820m. Elevation varies depending on aspect, wind exposure and landform. Mesic alpine ecosystems are dominated by either scrub birch or Altai fescue, typically on subdued slopes of morainal or colluvial material. Other consistently present herbs include alpine fescue, white mountain-avens, kinnikinnick, mountain sagewort and northern goldenrod. The patchy moss layer is dominated by *Flavocetraria nivalis, Stereocaulon* spp., and *Cetraria* species.

Part 6 Ecosystem Units

An ecosystem unit incorporates site series, site modifiers and structural stage. Site series are named according to the plant association they belong to; for forested site series usually one or two tree species and one or two of a shrub, herb, moss, lichen or liverwort; non-forested site units two or three of any of shrub, herb, moss, lichen and liverwort species. Two letter site series symbols are now standardized for all biogeoclimatic units in the province (Resource Inventory Committee 1998). A summary of all ecosystem units is provided in Table 23.

Table 23. Ecosystem Units of the Itcha / Ilgachuz Area.

IDFdk4	01	LP	FdPl - Pinegrass - Feathermoss, typic (gentle mesic slopes, deep, medium-textured moraine)
		LPf	FdPl - Pinegrass - Feathermoss, fine-textured soil
		LPfs	FdPl - Pinegrass - Feathermoss, fine-textured soil, shallow soil
	04	DS	Fd - Juniper - Pasture sage,typic (deep soil,medium-textured moraine,warm aspect)
		DScs	Fd - Juniper - Pasture sage, coarse-textured and shallow soil
		DSv	Fd - Juniper - Pasture sage, very shallow soil
	05	DW	Fd - Bluebunch wheatgrass - Pinegrass,typic (warm aspect, deep,medium-textured moraine)
		DWf	Fd - Bluebunch wheatgrass - Pinegrass, fine-textured soil
		DWs	Fd - Bluebunch wheatgrass - Pinegrass, shallow soil
	07	DM	Fd - Feathermoss - Stepmoss,typic (deep soil, cool aspect, medium-textured moraine)
		DMs	Fd - Feathermoss - Stepmoss, shallow soil
		DMf	Fd - Feathermoss - Stepmoss, fine-textured soil
	08	SS	Sxw - Scrub birch - Feathermoss, typic (lower moist slopes, deep, coarse-textured soil)
		SSf	Sxw - Scrub birch - Feathermoss, fine-textured soil
	00	ND	Needlegrass meadow, typic (deep soil, gentle slope, medium-textured)
	00	WM	Wet meadow, typic (deep soil, gentle slope, medium-textured)
SBPSxc	01	LK	Pl - Kinnikinnick - Feathermoss, typic (gentle mesic slopes, deep, medium-textured soil)
		LKf	Pl - Kinnikinnick - Feathermoss, fine-textured soil
		LKfk	Pl - Kinnikinnick - Feathermoss, fine-textured soil, cool aspect
		LKfs	Pl - Kinnikinnick - Feathermoss, fine-textured and shallow soil
		LKfw	Pl - Kinnikinnick - Feathermoss, fine-textured soil, warm aspect
		LKk	Pl - Kinnikinnick - Feathermoss, cool aspect
		LKks	Pl - Kinnikinnick - Feathermoss, cool aspect,shallow soil
		LKkv	Pl - Kinnikinnick - Feathermoss, cool aspect, very shallow soil
		LKs	Pl - Kinnikinnick - Feathermoss, shallow soil
		LKsw	Pl - Kinnikinnick - Feathermoss, shallow soil, warm aspect
		LKw	Pl - Kinnikinnick - Feathermoss, warm aspect
	02	LC	Pl - Kinnikinnick - Cladonia, typic (coarse-textured glaciofluvial, deep soil, gentle slope)
		LCf	Pl - Kinnikinnick - Cladonia, fine-textured soil
		LCfk	Pl - Kinnikinnick - Cladonia, fine-textured soil, cool aspect
		LCfw	Pl - Kinnikinnick - Cladonia, fine-textured soil, warm aspect
		LCk	Pl - Kinnikinnick - Cladonia, cool aspect
		LCks	Pl - Kinnikinnick - Cladonia, cool aspect, shallow soil
		LCkv	Pl - Kinnikinnick - Cladonia, cool aspect, very shallow soil
		LCr	Pl - Kinnikinnick - Cladonia, ridged
		LCs	Pl - Kinnikinnick - Cladonia, shallow soil
		LCsw	Pl - Kinnikinnick - Cladonia, shallow soil, warm aspect
		LCv	Pl - Kinnikinnick - Cladonia, very shallow soil
		LCvw	Pl - Kinnikinnick - Cladonia, very shallow soil, warm aspect
		LCw	Pl - Kinnikinnick - Cladonia, warm aspect

Note: Only those site series and site units described and mapped, are presented here.

SBPSxc continued...

03	SB	Sxw - Scrub birch - Fenmoss, typic (cold air depressions, deep soil,gentle slope,medium-textured)
	SBc	Sxw - Scrub birch - Fenmoss, coarse-textured soil
	SBf	Sxw - Scrub birch - Fenmoss, fine-textured soil
	SBp	Sxw - Scrub birch - Fenmoss, peaty soil
04	SF	Sxw - Scrub birch - Feathermoss,typic (cold air depressions, deep soil, gentle slope, medium-textured)
	SFc	Sxw - Scrub birch - Feathermoss, coarse-textured soil
	SFf	Sxw - Scrub birch - Feathermoss, fine-textured soil
	SFp	Sxw - Scrub birch - Feathermoss, peaty soil
	SFs	Sxw - Scrub birch - Feathermoss, shallow soil
05	SH	Sxw - Horsetail - Glow moss, typic (gentle slope, medium-textured)
	SHf	Sxw - Horsetail - Glow moss, fine-textured soil
	SHp	Sxw - Horsetail - Glow moss, peaty soil
06	SMc	Sxw - Horsetail - Meadowrue, typic (coarse-textured fluvial terrace)
	SMa	Sxw - Horsetail - Meadowrue, active floodplain
	SMf	Sxw - Horsetail - Meadowrue, fine-textured soil
	SMn	Sxw - Horsetail - Meadowrue, fan
	SMp	Sxw - Horsetail - Meadowrue, peaty soil
00	BS	Sedge - Bluejoint fen, typic (peaty)
	BSf	Sedge - Bluejoint fen, fine-textured soil
00	TSf	Timber oatgrass - Sedge dry meadow, fine-textured soil
	TSp	Timber oatgrass - Sedge dry meadow, peaty soil
00	WBf	Willow - Scrub birch shrub carr, fine-textured soil
	WBc	Willow - Scrub birch shrub carr, coarse-textured soil
	WBp	Willow - Scrub birch shrub carr, peaty soil
00	WT	Willow - Sedge fen, typic (organic over floodplain)
	WTa	Willow - Sedge fen, active floodplain
SBPSdc 01	LJ	Pl - Juniper - Feathermoss, typic (deep soil, gentle slope, medium-textured moraine)
	LJf	Pl - Juniper - Feathermoss, fine-textured soil
	LJk	Pl - Juniper - Feathermoss, cool aspect
	LJks	Pl - Juniper - Feathermoss, cool aspect,shallow soil
	LJs	Pl - Juniper - Feathermoss, shallow soil
	LJw	Pl - Juniper - Feathermoss, warm aspect
02	LC	Pl - Kinnikinnick - Cladonia, typic (coarse-textured, deep soils on upper slopes)
	LCr	Pl - Kinnikinnick - Cladonia, ridged
	LCs	Pl - Kinnikinnick - Cladonia, shallow soil
	LCsw	Pl - Kinnikinnick - Cladonia, shallow soil, warm aspect
	LCvw	Pl - Kinnikinnick - Cladonia, very shallow soil, warm aspect
	LCw	Pl - Kinnikinnick - Cladonia, warm aspect
03	LFc	Pl - Kinnikinnick - Feathermoss, typic (coarse-textured)
04	BF	PlSb - Feathermoss, typic (deep soil, gentle slope, medium-textured moraine)
	BFf	PlSb - Feathermoss, fine-textured soil

SBPSdc continued ...

	05	SB	Sxw - Scrub birch - Feathermoss, typic (deep soil, gentle slope, medium-textured moraine)
		SBf	Sxw - Scrub birch - Feathermoss, fine-textured soil
	06	SMc	Sxw - Horsetail - Meadowrue, typic (deep, gentle slope, medium-textured fluvial)
		SMa	Sxw - Horsetail - Meadowrue, active floodplain
	07	BB	Sb - Scrub birch - Sedge, typic (forested bog, peaty)
	00	BS	Sedge - Bluejoint fen, typic (peaty)
	00	WB	Willow - Scrub birch shrub carr, typic (deep soil, level, medium-textured moraine)
	00	WT	Willow - Sedge fen, typic (organic over floodplain)
		WTa	Willow - Sedge fen, active floodplain
SBPSmc	01	LF	Pl - Feathermoss - Cladonia, typic (gentle mesic slopes, deep, medium-textured moraine)
		LFf	Pl - Feathermoss - Cladonia, fine-textured soil
		LFfk	Pl - Feathermoss - Cladonia, fine-textured soil, cool aspect
		LFfw	Pl - Feathermoss - Cladonia, fine-textured soil, warm aspect
		LFk	Pl - Feathermoss - Cladonia, cool aspect
		LFks	Pl - Feathermoss - Cladonia, cool aspect, shallow soil
		LFs	Pl - Feathermoss - Cladonia, shallow soil
		LFw	Pl - Feathermoss - Cladonia, warm aspect
	02	LC	Pl - Kinnikinnick - Cladonia, typic (deep glaciofluvial, gentle slope)
		LCk	Pl - Kinnikinnick - Cladonia, cool aspect
		LCks	Pl - Kinnikinnick - Cladonia, cool aspect, shallow soil
		LCkv	Pl - Kinnikinnick - Cladonia, cool aspect, very shallow soil
		LCr	Pl - Kinnikinnick - Cladonia, ridged
		LCrv	Pl - Kinnikinnick - Cladonia, ridged, very shallow soil
		LCs	Pl - Kinnikinnick - Cladonia, shallow soil
		LCsw	Pl - Kinnikinnick - Cladonia, shallow soil, warm aspect
		LCv	Pl - Kinnikinnick - Cladonia, very shallow soil
		LCvw	Pl - Kinnikinnick - Cladonia, very shallow soil, warm aspect
		LCw	Pl - Kinnikinnick - Cladonia, warm aspect
	03	BF	SbPl - Feathermoss, typic (gentle slope, deep soil, medium-textured moraine)
		BFk	SbPl - Feathermoss, cool aspect
	04	SB	Sxw - Scrub birch - feathermoss, typic (flat, deep soil, medium-textured moraine)
		SBf	Sxw - Scrub birch - feathermoss, fine-textured soil
		SBk	Sxw - Scrub birch - feathermoss, cool aspect
		SBks	Sxw - Scrub birch - feathermoss, cool aspect, shallow soil
		SBsw	Sxw - Scrub birch - feathermoss, shallow soil, warm aspect
		SBw	Sxw - Scrub birch - feathermoss, warm aspect
	05	SO	Sxw - Horsetail, typic (riparian forests, deep soils, medium-textured moraine)
		SOa	Sxw - Horsetail, active floodplain
		SOn	Sxw - Horsetail, fan

SBPSmc continued ...

	06	SH	Sxw - Horsetail - Glow moss, typic (flat, deep soil, medium-textured moraine)
		SHa	Sxw - Horsetail - Glow moss, active floodplain
		SHc	Sxw - Horsetail - Glow moss, coarse-textured soil
		SHf	Sxw - Horsetail - Glow moss, fine-textured soil
		SHp	Sxw - Horsetail - Glow moss, peaty soil
	07	BB	Sb - Scrub birch - Sedge, typic (peaty)
	00	BS	Sedge - Bluejoint fen, typic (peaty)
	00	TSf	Timber oatgrass - Sedge dry meadow, fine-textured soil
		TSp	Timber oatgrass - Sedge dry meadow, peaty
	00	WBf	Willow - Scrub birch shrub carr, fine-textured soil
		WBc	Willow - Scrub birch shrub carr, coarse-textured soil
		WBn	Willow - Scrub birch shrub carr, fan
		WBp	Willow - Scrub birch shrub carr, peaty soil
	00	WT	Willow - Sedge fen, typic (organic over floodplain)
		WTa	Willow - Sedge fen, active floodplain
SBSmc2	01	SB	Sxw - Huckleberry, typic (mesic medium-textured moraine, deep soil,gentle slope)
		SBs	Sxw - Huckleberry, shallow soil
		SBk	Sxw - Huckleberry, cool aspect
		SBks	Sxw - Huckleberry, cool aspect, shallow soil
		SBsw	Sxw - Huckleberry, shallow soil, warm aspect
		SBw	Sxw - Huckleberry, warm aspect
	02	PH	Pl - Huckleberry - Cladonia, typic (glaciofluvial terrace, deep soil)
		PHs	Pl - Huckleberry - Cladonia, shallow soil
		PHsw	Pl - Huckleberry - Cladonia, shallow soil, warm aspect
		PHw	Pl - Huckleberry - Cladonia, warm aspect
	04	HB	Sxw - Huckleberry - Dwarf blueberry,typic (moist medium-textured morainal,deep soil,gentle slope)
		HBk	Sxw - Huckleberry - Dwarf blueberry, cool aspect
		HBks	Sxw - Huckleberry - Dwarf blueberry, cool aspect, shallow soil
	08	ST	Sxw - Twinberry - Oak fern, typic (deep soil, gentle slope, medium-textured)
		STa	Sxw - Twinberry - Oak fern, active floodplain
		STn	Sxw - Twinberry - Oak fern, fan
	11	HGf	Sxw - Horsetail - Glow moss, (fine-textured soil, gentle slope, medium-textured moraine)
		HGp	Sxw - Horsetail - Glow moss, peaty soil
	00	BS	Sedge - Bluejoint fen, typic (peaty)
	00	TS	Timber oatgrass - Sedge dry meadow, typic (deep soil, gentle slope, medium-textured)
		TSp	Timber oatgrass - Sedge dry meadow, peaty
	00	WB	Willow - Scrub birch shrub carr, typic (deep soil, gentle slope, medium-textured)
		WBc	Willow - Scrub birch shrub carr, coarse-textured soil
		WBa	Willow - Scrub birch shrub carr, fan
		WBp	Willow - Scrub birch shrub carr, peaty soil

	00	WF	Willow - Sedge fen, typic (organic over floodplain)
		WFa	Willow - Sedge fen, active floodplain
MSxv	01	LG	Pl - Crowberry - Feathermoss, typic (deep soil, gentle slope, medium-textured moraine)
		LGc	Pl - Crowberry - Feathermoss, coarse-textured
		LGf	Pl - Crowberry - Feathermoss, fine-textured soil
		LGk	Pl - Crowberry - Feathermoss, cool aspect
		LGfk	Pl - Crowberry - Feathermoss, fine-textured soil, cool aspect
		LGfs	Pl - Crowberry - Feathermoss, fine-textured and shallow soil
		LGfw	Pl - Crowberry - Feathermoss, fine-textured soil, warm aspect
		LGks	Pl - Crowberry - Feathermoss, cool aspect, shallow soil
		LGkv	Pl - Crowberry - Feathermoss, cool aspect, very shallow soil
		LGs	Pl - Crowberry - Feathermoss, shallow soil
		LGsw	Pl - Crowberry - Feathermoss, shallow soil, warm aspect
		LGv	Pl - Crowberry - Feathermoss, very shallow soil
		LGw	Pl - Crowberry - Feathermoss, warm aspect
	02	LF	Pl - Fescue - Stereocaulon, typic (deep, coarse-textured soil, gentle slope)
		LFs	Pl - Fescrue - Stereocaulon, shallow soil
	03	LK	Pl - Kinnikinnick - Cladonia, typic (shallow soil, ridgetop, gentle slope, medium-textured)
		LKkv	Pl - Kinnikinnick - Cladonia, cool aspect, very shallow soil
		LKv	Pl - Kinnikinnick - Cladonia, very shallow soil
		LKvw	Pl - Kinnikinnick - Cladonia, very shallow soil, warm aspect
		LKw	Pl - Kinnikinnick - Cladonia, warm aspect
	04	GKc	Pl - Grouseberry - Kinnikinnick, coarse-textured glaciofluvial
		GKk	Pl - Grouseberry - Kinnikinnick, cool aspect
		GKks	Pl - Grouseberry - Kinnikinnick, cool aspect, shallow soil
		GKkv	Pl - Grouseberry - Kinnikinnick, cool aspect, very shallow soil
		GKr	Pl - Grouseberry - Kinnikinnick, ridged
		GKs	Pl - Grouseberry - Kinnikinnick, shallow soil
		GKsw	Pl - Grouseberry - Kinnikinnick, shallow soil, warm aspect
		GKv	Pl - Grouseberry - Kinnikinnick, very shallow soil
		GKvw	Pl - Grouseberry - Kinnikinnick, very shallow soil, warm aspect
		GKw	Pl - Grouseberry - Kinnikinnick, warm aspect
	06	SC	Sxw - Crowberry - Knight's plume, typic (gentle slope)
		SCc	Sxw - Crowberry - Knight's plume, coarse-textured soil
		SCf	Sxw - Crowberry - Knight's plume, fine-textured soil
		SCfs	Sxw - Crowberry - Knight's plume, fine-textured soil, shallow soil
		SCfk	Sxw - Crowberry - Knight's plume, fine-textured soil, cool aspect
		SCp	Sxw - Crowberry - Knight's plume, peaty soil
		SCs	Sxw - Crowberry - Knight's plume, shallow soil
	07	SG	Sxw - Crowberry - Glow moss, typic (deep soil, gentle slope, medium textured moraine)
		SGc	Sxw - Crowberry - Glow moss, coarse-textured soil
		SGf	Sxw - Crowberry - Glow moss, fine-textured soil
		SGp	Sxw - Crowberry - Glow moss, peaty soil
	08	SHp	Sxw - Horsetail - Crowberry, typic (organic over floodplain)
		SHa	Sxw - Horsetail - Crowberry, active floodplain
		SHc	Sxw - Horsetail - Crowberry, coarse-textured soil
		SHf	Sxw - Horsetail - Crowberry, fine-textured soil
		SHn	Sxw - Horsetail - Crowberry, fan

MSxv continued…

	00	FC	Altai fescue - Cladonia dry grassland,typic (coarse-textured, deep soil, gentle slope)
	00	BS	Sedge - Bluejoint fen, typic (peaty soil)
		BSc	Sedge - Bluejoint fen, coarse-textured soil
		BSf	Sedge - Bluejoint fen, fine-textured soil
	00	BP	Scrub birch - Small-flowered penstemon shrub carr,typic (coarse-textured and medium textured, gentle slope)
	00	LB	Pl - Scrub birch - Altai fescue, typic (deep soil, gentle slope, medium-textured moraine)
		LBc	Pl - Scrub birch - Altai fescue, coarse-textured soil
	00	TB	Timber oatgrass - Sedge - Herb wet meadow, typic (glaciofluvial, deep soil, medium-textured)
		TBf	Timber oatgrass - Sedge - Herb wet meadow, fine-textured soil
		TBp	Timber oatgrass - Sedge - Herb wet meadow, peaty soil
	00	TFc	Timber oatgrass - Altai fescue cold dry meadow, coarse-textured soil
	00	WG	Willow - Glow moss shrublands,typic (active fluvial, level)
	00	WS	Willow - Scrub birch - Sedge fen, typic (active floodplain)
		WSp	Willow - Scrub birch - Sedge fen, peaty soil
ESSFxv1	01	AC	Bl - Arnica - Cladonia, typic (deep soil, gentle slope, medium-textured moraine)
		ACks	Bl - Arnica - Cladonia, cool aspect, shallow soil
		ACc	Bl - Arnica - Cladonia, coarse-textured soil
		ACs	Bl - Arnica - Cladonia, shallow soil
	02	WJ	BlPa - Juniper - Cladonia, typic (shallow soil, ridgetops)
		WJd	BlPa - Juniper - Cladonia, deep soil
		WJk	BlPa - Juniper - Cladonia, cool aspect
		WJkv	BlPa - Juniper - Cladonia, cool aspect, very shallow soil
		WJv	BlPa - Juniper - Cladonia, very shallow soil
		WJvw	BlPa - Juniper - Cladonia, very shallow soil, warm aspect
		WJw	BlPa - Juniper - Cladonia, warm aspect
	03	LC	Pl - Cladonia - Stereocaulon, typic (glaciofluvial, deep soil, gentle slope)
		LCk	Pl - Cladonia - Stereocaulon, cool aspect
		LCks	Pl - Cladonia - Stereocaulon, cool aspect, shallow soil
		LCkv	Pl - Cladonia - Stereocaulon, cool aspect, very shallow soil
		LCr	Pl - Cladonia - Stereocaulon, ridged
		LCs	Pl - Cladonia - Stereocaulon, shallow soil
		LCsw	Pl - Cladonia - Stereocaulon, shallow soil, warm aspect
		LCv	Pl - Cladonia - Stereocaulon, very shallow soil
		LCvw	Pl - Cladonia - Stereocaulon, very shallow soil, warm aspect
		LCw	Pl - Cladonia - Stereocaulon, warm aspect
	04	JG	BlPa - Juniper - Grouseberry, typic (coarse-textured, deep soil, warm aspect)
		JGs	BlPa - Juniper - Grouseberry, shallow soil
		JGv	BlPa - Juniper - Grouseberry, very shallow soil
	05	AT	BlPa - Arnica - Twinflower, typic (coarse-textured, deep soil,cool aspect)
		ATs	BlPa - Arnica - Twinflower, shallow soil

ATv BlPa - Arnica - Twinflower, very shallow soil

ESSFxv1 continued…

	06	FRk	Bl - Rhododendron - Crowberry, cool aspect
		FRs	Bl - Rhododendron - Crowberry, shallow soil
	07	FV	Bl - Valerian - Arnica, typic (lower gentle slopes, medium-textured, deep moraine)
		FVc	Bl - Valerian - Arnica, coarse-textured soil
	08	FH	Bl - Horsetail - Glow moss, typic (valley floor, medium-textured, deep moraine)
		FHa	Bl - Horsetail - Glow moss, active floodplain
		FHn	Bl - Horsetail - Glow moss, fan
		FHp	Bl - Horsetail - Glow moss,peaty soil
	00	BP	Scrub birch - Small-flowered penstemon shrub carr, typic (deep soil, gentle slope, medium-textured moraine)
	00	BS	Sedge - Bluejoint fen, typic (peaty)
	00	DG	Subalpine daisy - Arrow-leaved groundsel wet meadow,typic (deep soil, gentle slope, medium-textured)
	00	FC	Altai fescue - Cladonia dry grassland, typic (deep, coarse-textured soil, gentle slope)
		FCsw	Altai fescue - Cladonia dry grassland, shallow soil, warm aspect
	00	LB	Pl - Scrub birch - Altai fescue, typic (deep soil, gentle slope, medium-textured moraine)
		LBc	Pl - Scrub birch - Altai fescue, coarse-textured soil
	00	TB	Timber oatgrass - Sedge - Herb wet meadow, typic (deep, coarse-textured soil, gentle slope)
		TBp	Timber oatgrass - Sedge - Herb wet meadow, peaty soil
	00	TF	Timber oatgrass - Altai fescue cold dry meadow, typic (deep soil, gentle slope, medium-textured moraine)
	00	WG	Willow - Glow moss shrublands, typic (active floodplain)
		WGn	Willow - Glow moss shrublands, fan
	00	WS	Willow - Scrub birch - Sedge fen, typic (peaty)
ESSFxvp1	00	AF	White mountain-avens - Altai fescue grassland, typic (deep soil, gentle slope, medium-textured)
		AFk	White mountain-avens - Altai fescue grassland, cool aspect
		AFks	White mountain-avens - Altai fescue grassland, cool aspect, shallow soil
		AFkv	White mountain-avens - Altai fescue grassland, cool aspect, very shallow soil
		AFs	White mountain-avens - Altai fescue grassland, shallow soil
		AFsw	White mountain-avens - Altai fescue grassland, shallow soil, warm aspect
		AFv	White mountain-avens - Altai fescue grassland, very shallow soil
		AFvw	White mountain-avens - Altai fescue grassland, very shallow soil, warm aspect
		AFw	White mountain-avens - Altai fesuce grassland, warm aspect
	00	DG	Subalpine daisy - Arrow-leaved groundsel wet meadow(deep soil, gentle slope, medium-textured)
	00	FB	Bl - Dwarf blueberry - Dicranum parkland, typic (deep soil, gentle slope, medium-textured)
		FBs	Bl - Dwarf blueberry - Dicranum parkland, shallow soil
		FBk	Bl - Dwarf blueberry - Dicranum parkland, cool aspect
		FBks	Bl - Dwarf blueberry - Dicranum parkland, cool aspect, shallow soil
		FBsw	Bl - Dwarf blueberry - Dicranum parkland, shallow soil, warm aspect
		FBw	Bl - Dwarf blueberry - Dicranum parkland, warm aspect

ESSFxvp1 continued…

	00	FC	Altai fescue - Cladonia grassland, typic (deep soil, gentle slope, medium-textured)
		FCc	Altai fescue - Cladonia grassland, coarse-textured soil
		FCks	Altai fescue - Cladonia grassland, cool aspect, shallow soil
		FCs	Altai fescue - Cladonia grassland, shallow soil
		FCsw	Altai fescue - Cladonia grassland, shallow soil, warm aspect
		FCw	Altai fescue - Cladonia grassland, warm aspect
	00	FM	Bl - Heather parkland, typic (deep soil, gentle slope, medium-textured)
		FMk	Bl - Heather parkland, cool aspect
		FMks	Bl - Heather parkland, cool aspect, shallow soil
		FMs	Bl - Heather parkland, shallow soil
	00	SF	Altai fescue - Scrub birch grassland/shrub steppe, typic (deep soil, gentle slope, medium-textured)
		SFk	Altai fescue - Scrub birch grassland/shrub steppe, cool aspect
		SFks	Altai fescue - Scrub birch grassland/shrub steppe, cool aspect, shallow soil
		SFs	Altai fescue - Scrub birch grassland/shrub steppe, shallow soil
		SFsw	Altai fescue - Scrub birch grassland/shrub steppe, shallow soil, warm aspect
		SFw	Altai fescue - Scrub birch grassland/shrub steppe, warm aspect
AT	00	AF	White mountain-avens - Altai fescue grassland, typic (shallow soil, gentle slope)
		AFd	White mountain-avens - Altai fescue grassland, deep soil
		AFdk	White mountain-avens - Altai fescue grassland, deep soil, cool aspect
		AFdw	White mountain-avens - Altai fescue grassland, deep soil, warm aspect
		AFk	White mountain-avens - Altai fescue grassland, cool aspect
		AFw	White mountain-avens - Altai fescue grassland, warm aspect
		AFv	White mountain-avens - Altai fescue grassland, very shallow soil
	00	FC	Altai fescue-Cladonia grassland, typic (deep soil, gentle slope, medium-textured)
		FCk	Altai fescue-Cladonia grassland, cool aspect
		FCks	Altai fescue-Cladonia grassland, cool aspect, shallow soil
		FCs	Altai fescue-Cladonia grassland, shallow soil
		FCsw	Altai fescue-Cladonia grassland, shallow soil, warm aspect
		FCw	Altai fescue-Cladonia grassland, warm aspect
	00	MW	Moss campion-Spiked wood-rush tundra, typic (shallow, medium-textured, gentle slope)
	00	SF	Scrub birch - Altai fescue shrub steppe, typic (deep soil, medium-textured, gentle slope)
		SFk	Scrub birch - Altai fescue shrub steppe, cool aspect
		SFks	Scrub birch - Altai fescue shrub steppe, cool aspect, shallow soil
		SFs	Scrub birch - Altai fescue shrub steppe, shallow soil
		SFsw	Scrub birch - Altai fescue shrub steppe, shallow soil, warm aspect
		SFw	Scrub birch - Altai fescue shurb steppe, warm aspect
	00	SM	Sedge - Mountain sagewort wet meadow, (deep soil, gentle slope, medium-textured)

A number of map units which are not true site series are recognized, including:

BF	Blockfield
CF	Cultivated field
GB	Gravel bar
LA	Lake
OW	Open water
RI	River
RO	Rock outcrop
TA	Talus slope
UR	Urban

No descriptions are provided for these units (except for CF in SBPSxc, TA in ESSFxv1, RO in MSxv, and BF in AT).

Part 7 Literature Cited

Resources Inventory Committee. 1998. Standards for terrestrial ecosystem mapping in British Columbia. Ministry of Environment, Lands and Parks. Victoria, B.C.

Steen, O.A. and R.A. Coupe. 1997. A field guide to forest site identification and interpretation for the Cariboo Forest Region. B.C. Ministry of Forest, Victoria, B.C. Land Mangement Handbook 39 p. (Ports 1 and 2).