West Fraser (TFL 52)
and
Weldwood Licence Areas
Wildlife Habitat Suitability Mapping
Species Accounts

Prepared for
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and
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1.0 Introduction

This report contains six Species-Habitat Models to support the *Terrestrial Ecosystem Mapping* (TEM) project completed for TFL 52 and portions of Weldwood's operating area (Cottonwood, North Big Valley). In consultation with West Fraser Mills Ltd and Weldwood of Canada Ltd (Quesnel), the Ministry of Environment, Lands and Parks (Cariboo Region) chose six wildlife species that require habitat management including grizzly bear (*Ursus arctos*), moose (*Alces alces*), mountain caribou (*Rangifer tarandus caribou*), fisher (*Martes pennanti*), Northern Goshawk (*Accipiter gentilis atricapillus*) and warbling vireo (*Vireo gilvus*). These wildlife species were identified in the Cariboo-Chilcotin Land Use Plan as priority species of concern and/or are recognized as *Identified Wildlife* under the *Forest Practices Code* (FPC). In addition to using coarse filter management approaches to meet broad biodiversity objectives (e.g., Biodiversity Guidebook), these species were chosen because they require additional habitat information and management attention (i.e., 'fine filter') in order to successfully integrate their habitat requirements into forest development planning. The information presented here will form the basis for producing wildlife suitability maps and provide the necessary information to meet wildlife habitat management objectives on TFL 52 and adjacent Weldwood license areas.

2.0 Study Area

Situated in the Quesnel Forest District, TFL 52 as well as adjoining Weldwood license areas (Cottonwood, North Big Valley) extend east of Highway 97 near the Cottonwood River towards Bowron Lake Provincial Park (Fig. 1). The study area covers approximately 320,296 ha (266,400 ha TFL 52; 53,896 ha Weldwood) and is represented by three ecosections including the Bowron Valley (BOV), Quesnel Highlands (QUH) and Quesnel Lowlands (QUL). A total of 10 biogeoclimatic subzones occur including: AT, ESSFwcp3, ESSFwc3, ESSFwk1, ICHwk4, ICHmk3, SBSwk1, SBSmw, SBSdw1 and the SBSmh.

3.0 Methods

Species Accounts were prepared using guidelines outlined in the *British Columbia Habitat Wildlife Ratings Standards* (RIC 1999). Models as well as preliminary ratings were reviewed by species experts and modified after field sampling. The mountain caribou, moose and grizzly bear models were a focus for a habitat mapping workshop where ratings were developed in cooperation with the Ministry of Environment Lands and Parks species experts (J. Young & Tony Hamilton).

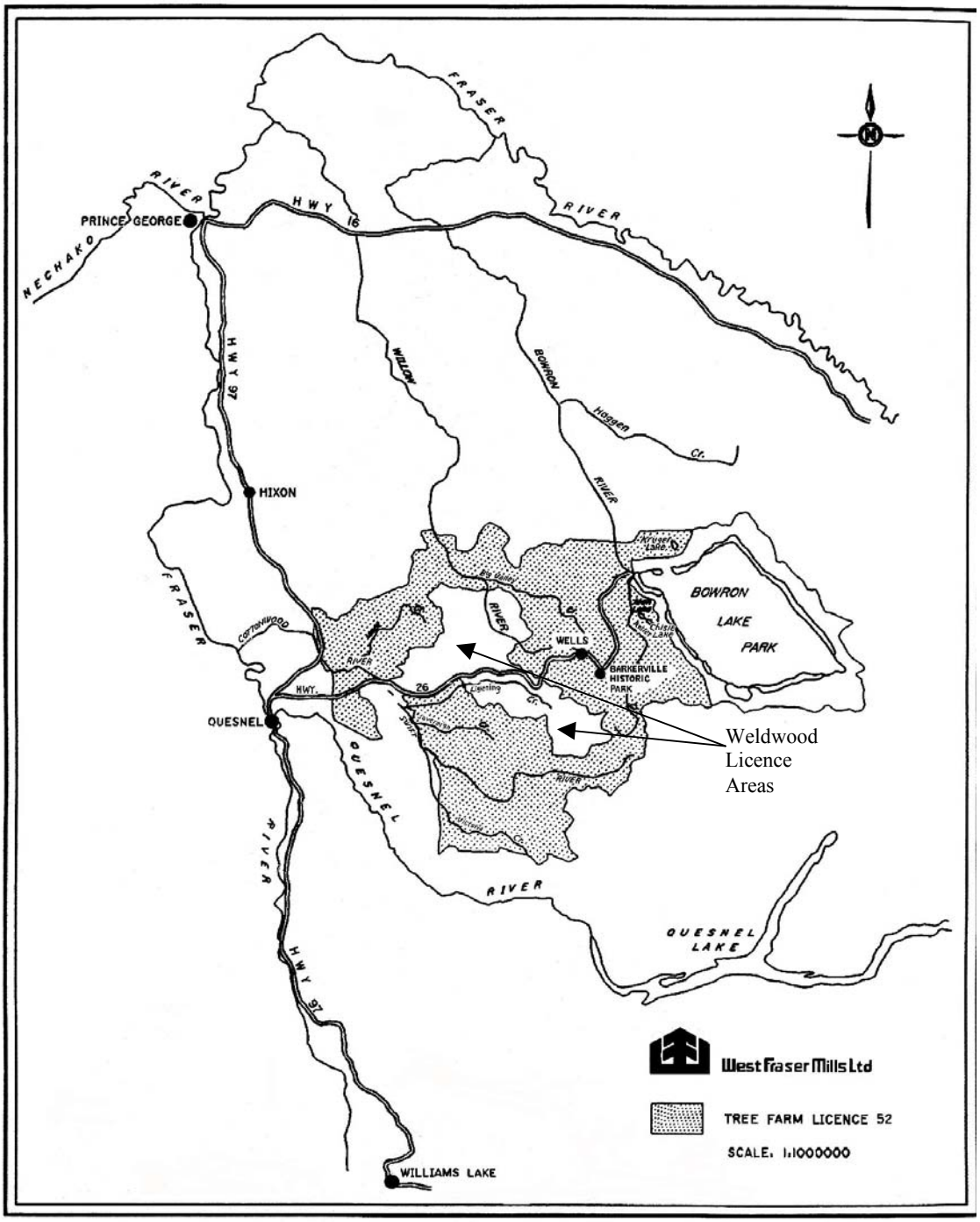

Fig.1 Location of West Fraser (TFL 52) and Weldwood study areas.

4.0 Species Accounts

4.1 MOUNTAIN CARIBOU

Scientific Name: *Rangifer tarandus caribou* (Mountain ecotype)

Species Code: **M-RATA**

Status:		
	Status in Canada (COSEWIC):	Vulnerable
	Status in British Columbia:	
	Provincial Management List:	RED
	Conservation Data Center Rank:	S4
	Identified Wildlife (Y/N):	N*

Distribution

Provincial Context

In British Columbia, mountain caribou range occurs from the Hart Ranges north-east of Prince George and extends southeast along the Columbia Mountains to the Idaho border.

Elevational Range

Valley bottom to alpine (500-2000 m)

Project Area: West Fraser TFL 52 and adjacent Weldwood operations areas, Quesnel Forest District

Ecoprovince: Southern Interior Mountains, Central Interior

Ecoregions: Columbia Highlands, Fraser Plateau

Ecosections: Bowron Valley, Quesnel Highlands

Biogeoclimatic subzones: (AT, ESSFwcp3, ESSFwc3, ESSFwk1, ICHwk4, ICHmk3), SBSwk1, SBSmh, SBSdw1, SBSmw – subzones in brackets denote winter use

Broad Habitat Units: EF, EFu, FP, IH, IS

Project Map Scale: 1:20,000.

Ecology and Key Habitat Requirements

General

There are two woodland caribou (*Rangifer tarandus caribou*) ecotypes in British Columbia: (i) the mountain caribou ecotype is found in deep snowpack ecosystems in southeastern BC and the north-western USA and feed primarily on arboreal lichens

* may be considered in Volume 2 of IWMS – currently considered a Higher Level Plan species

(*Bryoria* spp, *Alectoria sarmentosa*) during winter; and (ii) the northern caribou ecotype which occupies the lower elevation pine forests in north and central BC and feed primarily on terrestrial lichens (*Cladina* spp., *Cladonia* spp). In the Cariboo Region, the mountain caribou is confined to the eastern sections whereas the northern caribou occupies the western portion of the region. TFL 52 provides habitat for the mountain caribou ecotype (Barkerville sub-population). The most recent survey applicable to the TFL study area revealed a visibility corrected estimate of about 50 caribou in the Barkerville sub-population (Young and Roorda 1999).

Caribou migrate seasonally between subalpine and lower-elevation areas, usually twice per year. Deeper snow and a lack of accessible food sources at high elevations causes a downward migration of caribou in early-winter (Nov-Dec). Caribou that reside in the Bowron and Quesnel Highland ecosections use predominately ESSFwc3 and ESSFwk1 forests during the early winter period (Young and Roorda 2000). During this snow accumulation period, caribou primarily use stands dominated by subalpine fir/spruce on moderate slopes <45% (Young and Roorda 2000). However, depending on snow conditions, caribou in the Quesnel Highlands ecosection may also use lower elevation interior-cedar-hemlock (ICH) stands (Seip 1992, Ashcroft 1996, Young and Roorda 2000,). During late winter (Jan-Apr), when snowpacks have deepened (>2m) caribou move to higher elevation subalpine parkland habitats where they forage almost exclusively on *Bryoria* spp. lichens accessible on standing subalpine fir trees.

Habitat Use - Life Requisites

The life requisites that will be rated for mountain caribou are Early Winter Living (LI-EW) and Late Winter Living (LI-LW).

Food Habitat – Early Winter

During early winter (Nov-Dec) caribou feed primarily on arboreal lichens. However, because arboreal lichen on stand standing trees is relatively inaccessible during these months, caribou will also browse some shrub species (e.g., huckleberries, falsebox, willow). Although caribou have been shown to prefer *Bryoria* lichen over *Alectoria* in captive feeding trials (Rominger and Oldemeyer 1990), all sources of arboreal lichen are likely important during early winter. Although arboreal lichens may be eaten from standing trees, lichen litterfall and consumption of lichen from windthrown trees are also very important sources of food, especially during early winter when arboreal lichens on standing trees is relatively inaccessible (Simpson, Hebert & Woods 1987; Terry *et al*. 1996).

Food Habitat – Late Winter

During late winter when caribou have ascended to subalpine parkland habitats, caribou consume *Bryoria* spp lichens almost exclusively. Trees with abundant arboreal lichens (Class 3,4,5) provide the best foraging trees (Rominger *et al* 1996). A well-developed matrix of open areas and clumps of subalpine fir trees on gentle slopes (<30%) provide the best parkland habitats. Areas with too few trees/ha (e.g., <300) will not provide adequate foraging areas (Rominger *et al.* 1996. Terry *et al*. 2000).

Security Habitat

Security habitat for mountain caribou is difficult to define as they do not appear to choose habitats based upon vegetation cover and screening. Because caribou use subalpine and alpine areas as part of their predator-avoidance strategy, security habitat is partly provided by spacing out during summer and ascending to higher elevations during winter (BC Ministry of Environment 1996). When not actively feeding or bedded, caribou tend be found in open areas where they have wide field of view and can spot any approaching predators.

Seasons of Use

Mountain caribou winter habitat use is usually described using two seasonal time periods, early and late winter.

Table 1. Monthly life requisites for caribou during the winter.

Life Requisites	Month	Season
Living	November	Early Winter
Living	December	Early Winter
Living	January	Late Winter
Living	February	Late Winter
Living	March	Late Winter
Living	April	Late Winter

Exact dates vary for each population, depending on local conditions, but the following seasons and dates are generally recognized: Early Winter (Nov-Dec): Late Winter (Jan-Apr).

Habitat Use and Ecosystem Attributes

Table 2 outlines how caribou life requisites relate to specific ecosystem attributes.

Table 2. TEM relationships for life requisites for mountain caribou.

Life Requisite	TEM Attributes
Early and Late Winter Living	Site/ecosystem, elevation, slope, aspect, structural stage, site modifier (gentle slope, 'j')

Ratings

There is a detailed level of knowledge of the habitat requirements of mountain caribou in BC. Therefore, a 6-class ratings scheme will be used.

Provincial Benchmark (Winter)

Ecosection: CAM (Cariboo Mountains)

Biogeoclimatic zone : ESSFwk1
Broad Ecosystem Unit: Engelmann Spruce-Subalpine Fir (EF)
(successional stage 6)

Ratings Assumptions

1) Only mature and old forests (i.e. > 140 years) provide sufficient arboreal lichen abundance to support caribou winter habitat foraging. Ecosystems that provide an abundance of *Bryoria* spp. lichens (Lichen Class ≥3) will be rated higher than those with less lichens and/or dominated by *Alectoria sarmentosa* (from field sampling).

2) The ESSFwc3 provides the highest quality early winter habitat whereas the ESSFwc3 and ESSFwcp3 provide the highest quality late winter habitats. From a landscape perspective, the highest quality caribou winter ranges occur where there are large contiguous areas of ESSFwcp3, ESSFwc3 and ESSFwk1. The highest value early winter ranges are in close elevational proximity (i.e., immediately below) to high suitability late winter habitats (ESSFwc3, ESSFwcp3). The lower portions of the ESSFwk1 may only provide moderate habitat suitability due to a larger component of spruce, which provides fewer accessible lower branches for arboreal lichens and may not produce as many windthrown trees as stands dominated by subalpine fir.

3) SBS subzones do not provide suitable mountain caribou habitat (i.e., lack deep snowpacks and access to arboreal lichens). The ICHmk3 and ICHwk4 (which makes up a small portion of the study area) may receive some caribou use depending on winter conditions (maximum Class 4).

Final Ratings

See digital file.

Table 3 summarises key caribou habitat attributes identified from the literature review. This table identifies potentially important habitat attributes and structural stages.

Table 3. Key mountain caribou habitat attributes in the Quesnel Highlands and Bowron Valley Ecosections.

Season	Habitat Attribute
Early-winter	• Elevations mostly between 1250-1750 m. (but will use 750-1250 m in some years) • low elevation forests (e.g., ICH) used in light snowfall years • moist forests dominated by subalpine fir/spruce (ESSFwc3,ESSFwk1) • low to poor productivity sites • mature and old structural stages (i.e. class 6 and 7) > • all aspects (warm and cool) • high abundance of *Bryoria/Alectoria* within 4.5 m of ground • forest edges for blowdown of arboreal lichen. • gentle topography (slopes <45%).
Late winter	• Mosaic of open subalpine fir parkland forests (ESSFwcp3, ESSFwc3) • elevations 1500-2000 m. • 400-500 stems/ha • high abundance of *Bryoria spp. w*ithin 4.5 m of ground • gentle topography (slopes <45%).

Source: Young and Roorda (2000)

Ratings Adjustments

To more accurately reflect the habitat value of the ESSFwk1, only those habitats within ~ 1.3 km of the ESSFwc3 subzone boundary were identified as potential early winter range. This captured approximately 94% of caribou radio-locations and limited the amount of lower elevation ESSFwk1 (1250-1350m), which typically provides relatively lower habitat suitability compared to upper portions.

Potential moderate to high suitability habitats including Broad Ecosystem Units are shown in Table 4.

Table 4. Potential high value mountain caribou winter habitats. West Fraser (TFL 52)/Weldwood operating areas.

Early Winter (Living)		
BEC Subzone	**TEM Ecosystem**	**Broad Ecosystem Unit (1:250,000)**
ESSFwc3	FG, FW, FR ,FQ,FD,FH	EF/6, EFu/6
ESSFwk1	FB,FO,FT	EF/6, EFu/6
Late Winter (Living)		
BEC Subzone	**TEM Ecosystem**	**Broad Ecosystem Unit**
ESSFwcp3	FV,FH	FP/6
ESSFwc3	FG, FW,FQ,FR,FD,FH,FJ	EF/6, EFu/6

TEM Legend
FG – *Subalpine Fir-Globeflower-Horsetail*
FQ – *Subalpine Fir- Rhododendron-Queens Cup*
FR – *Subalpine Fir- Rhododendron-Oakfern*
FV – *Subalpine Fir-Valerian*
FJ – *Subalpine fir-Juniper*
FH – *Subalpine Fir-Heather mesic krummholz*
FB – *Subalpine Fir-Black Huckleberry*
FT - *Subalpine Fir-Twinberry-Ladyfern*
FO- *Subalpine Fir-Oakfern-Knight's plume*

BEU Legend
EF – *ESSF Dry Forested*
FP – ESSF Dry Parkland
EFu – ESSF <15% slope

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4.2 MOOSE

Scientific Name: *(Alces alces)*

Species Code: **M-ALAL**

Status:	Status in Canada (COSEWIC):	No formal designation
	Status in British Columbia:	
	Provincial Management List:	Yellow (managed for hunting)
	Conservation Data Center Rank:	none

Distribution

Provincial Range

Three sub-species of moose are recognized in British Columbia: *Alces alces gigas* in the extreme northwest, *A. a. shirasi* in the southeast, and *A. a. andersoni* throughout the remainder of the province's interior. The species is both numerous and widespread in British Columbia, occurring from the Yukon and Alaska borders south to the 49th parallel and west to the Coast Range (Geowest 1998). Small numbers of moose have pushed through the Coast Range and live within a few kilometers of the Pacific Ocean (Spalding 1989). The latest population estimate suggests that there are as many as 170,000 moose in British Columbia. Stevens (1995) identified moose as occurring in varying levels of abundance in all 'wildlife subzone groups' in the province. Stevens and Lofts (1988) indicate that moose occur throughout the mainland with the exception of habitats occurring west of the coastal mountain range.

Elevational Range

Valley bottom to subalpine

Provincial Context

Project Area:	West Fraser TFL 52 and adjacent Weldwood operating areas, Quesnel Forest District
Ecoprovinces:	Southern Interior Mountains, Central Interior

Ecoregions: Columbia Highlands, Fraser Plateau
Ecosections: Bowron Valley, Quesnel Highland, Quesnel Lowland
Broad Habitat Units: IG,IH, WL,WR, IS,
Biogeoclimatic Zones AT, ESSFwcp3, ESSFwc3, ESSFwk1, (ICHwk4, ICHmk3, SBSwk1, SBSmh, SBSdw1, SBSmw) - subzones in brackets represent winter use

Project Map Scale: 1:20,000

Ecology and Key Habitat Requirements

General

Although predation has been shown to limit some ungulate populations, it is generally accepted that forage and cover are two key habitat attributes required for moose to survive and successfully reproduce. In order to maintain moose habitat over time, adequate quantities of quality forage and cover must be spatially and temporally distributed over the landscape.

Snow depth is an important factor influencing ungulate browse availability (accessibility) as well as the energetic cost of movement. Although moose have evolved morphological adaptations (e.g., long legs) to tolerate relatively deep snow conditions (Telfer and Kelsall 1984), variation in snowfall among biogeoclimatic subzones is an important subzone attribute affecting winter habitat capability/suitability. Snow depth of 65 cm has been cited as restricting movements of cows and calves and 90 cm has been described as the critical depth for moose (Kelsall and Prescott 1971, cited in Pierce and Peek 1984, Youds 1999).

Specific habitat attributes that influence snow depths are aspect, canopy closure and slope. In general, warmer aspects (south-facing slopes) provide shallower snow depths because they receive more direct sunlight. In addition, snow depths are shallower on steeper slopes than on flat areas because the same amount of snow is distributed over a greater surface area. Finally, tree crowns can intercept considerable amounts of snow, therefore, the greater the canopy closure the easier it is for ungulates to travel and search for food.

Although moose have less restrictive winter cover requirements compared to other ungulates (e.g. mule deer), moose still tend to move to lower elevations and seek out forested areas that provide greater canopy closure and snow interception. This generally occurs as winter progresses (Jan-Mar) and snow packs deepen in more open areas. These stands are typically composed of mature and old spruce and subalpine fir that are found along river corridors. Pine leading stands tend to be avoided during the winter largely due to the lack of adequate browse plants and poor snow interception. Some researchers have suggested moose require at least 30% canopy closure in boreal mixed-wood forests (Romito *et al*. 1995) while others have suggested a considerably higher canopy closure (70%) (Costain 1989). Clearly, the amount of canopy closure required by moose will

vary according to local snow conditions and weather patterns. Overall, mature (SS6) and old growth (SS7) stands with canopy closures >30% likely provide adequate snow interception for moose during early winter with slightly higher (>50%) canopy closure requirements during late winter.

Food Habitat (winter)

Snow condition is a major determinant of moose winter habitat selection in most moose ranges as snow depth, hardness, and crusting conditions all influence the availability of browse. In this portion of the Cariboo Region, moose winter habitats consist of low elevation riparian floodplains, shrub carrs, wetlands, burns, cutblocks and other open areas (Young 1991, Sopuck *et al*. 1997). These areas provide many preferred winter browse species such as willow, red-osier dogwood, birch, aspen, cottonwood, saskatoon, mountain ash, and red elderberry. Moose will also browse heavily on subalpine fir when forced into conifer dominated forests. Each of these browse species may be used preferentially due to their height and growth form (i.e. accessibility).

Security / Thermal Cover Habitat:

Immature forest stands may provide some security cover and food (depending on tree height) in snow-free months, but is scarcely used in winter. Although semi-mature stands have lower value than mature forest for snow interception or forage, such sites are frequently used during periods of deep snow. Forests dominated by mature closed canopy spruce, balsam or Douglas fir are used by moose during perennial periods of deep, soft snow exceeding critical depths of approximately 70 cm.

Seasons Of Use

For moose, all three major life requisites are required during winter including feeding, security and thermal habitat.

Habitat Use and Ecosystem Attributes

Table 5 outlines how each life requisite for moose relates to specific ecosystem attributes (e.g., such as site series, structural stage, canopy closure etc).

Table 5 . Terrestrial Ecosystem Mapping (TEM) relationships for each life requisite for moose during winter (Nov-April).

Life Requisite	TEM Attribute
Feeding (FD)	Site/ecosystem unit, elevation, aspect, slope, structural stage, stand appearance modifier % cover by layer, species list by layer Soil/terrain; flooding regime
Thermal/Security Cover (SH)	Site/ecosystem unit, elevation, aspect, slope, structural stage, stand appearance modifier % cover by layer, species list by layer, %canopy closure Soil/terrain; flooding regime

Ratings

There is a detailed level of knowledge of the habitat requirements of moose in British Columbia to warrant a 6-class ratings scheme.

Provincial Benchmarks (winter)

Ecoprovince:	Southern Interior Mountains
Ecosection:	Upper Fraser Trench (UFT)
Biogeoclimatic Zone:	SBSdh
Broad Ecosystem Unit:	SA (Sub-boreal White Spruce-Trembling Aspen)

Ecoprovince:	Boreal Plains
Ecosection:	Peace Lowlands (PEL)
Biogeoclimatic Zones	BWBSmw
Broad Ecosystem Unit:	BA (Boreal White Spruce-Trembling Aspen)

Habitats (winter): wetlands, riparian willow and floodplain habitats, spruce forests, cut blocks, burns, mixed deciduous forests on warm/dry aspects.

Ratings Assumptions

1. Consistent with the Broad Ecosystem Units derived for moose in the Cariboo Region, all TEM ecosystems that occur in the AT, ESSFwcp3, ESSFwc3 and ESSFwk1 are considered to provide nil to low moose winter habitat suitability due to excessive snow depths (>90 cm).

2. Abundant forage interspersed with adequate thermal/security cover is the primary factor determining quality of moose winter habitat. In particular, riparian habitats including floodplains and spruce-dominated forests adjacent to willow-dominated wetlands provide the best winter habitat for moose in this portion of the Cariboo Region (Young 1991, Youds 1999, Sopuck *et al* 1997).

3. As forest succession advances, the quality of moose feeding habitat decreases. As such non-forested ecosystems and early seral habitats (structural stage 3) provide the highest value feeding areas whereas mature and old seral stages (structural stages 6 and 7) may provide either adequate thermal/security cover or both feeding and cover values.

Final Ratings Table

See digital file.

Table 6. Summary of habitat requirements for moose in the study area during winter (Nov-Apr).

Habitat Use	Specific Habitat Attributes	Structural stage
Feeding	Shrub Species Composition Dominated (>15%) by *Salix* spp.or other browse species (e.g. saskatoon, elderberry, high bush cranberry)	3, 6-7
	Shrub Cover 15-30%	3, 3a, 3b
	Shrub Height < 2.5 m	3, 6 -7
Thermal Cover	Tree Species Composition Dominated by spruce	6 - 7
	Canopy Closure >50%	6 - 7

Table 8. Potential high value moose winter habitats. West Fraser (TFL 52)/Weldwood operating areas.

Winter Feeding		
BEC Subzone	**TEM Ecosystem**	**Broad Ecosystem Unit**
SBSmh	Structural stage 3	WL, SC, WR
SBSdw	WW, cutblocks	WL, SC, WR
SBSmw	WD, AD,AT,BW,WW	WL, SC, WR
SBSwk1	WT, AD, cutblocks	WL,WR, SC
ICHmk3/ICHwk4	Structural stage 3	DL, RR, RB, IH, IS
Winter Thermal		
BEC Subzone	**TEM Ecosystem**	**Broad Ecosystem Unit**
SBSmh	Structural stages 6 and 7*	SF, WR
SBSdw	Structural stages 6 and 7	SF, WR
SBSmw	Structural stages 6 and 7	SF, DL, WR
SBSwk1	Structural stages 6 and 7	SF, WR
ICHmk3/ICHwk4	Structural stages 6 and 7	DL, IH, RB

TEM Legend

AD – *Mountain Alder Red Osier dogwood floodplain*
WW - *Willow Tall Sedge Fen*
WT – *Willow-Black Twinberry-Sedge Swamp*
WD – *Drummond's Willow Swamp*
AT – *Mountain Alder-Black Twinberry Swamp*

BEU Legend

WL - *wetland*
WR – *White Spruce-Black Cottonwood Riparian*
RR – Western Red Cedar-Cottonwood Riparian
SC – Shrub Carr
SF – White Spruce-Subalpine Fir

* most mature and old forested ecosystem units received similar preliminary thermal cover ratings – field sampling and proximity to feeding areas will determine final spatial distribution of moose winter range on the TFL.

Ratings Adjustments:

Adjustments to habitat ratings are suggested to reflect the proximity to cover from feeding areas and the potential adverse impact of roads on habitat quality. Because roads can increase hunter success, roads are assumed to limit the effectiveness of moose habitat quality. That is, an inverse relationship between habitat quality and road density (i.e. habitat quality declines as road density increases) is assumed and ratings should be adjusted downward. Romito *et al*. (1995) used threshold distances of < 400 m to cover from feeding areas and assumed perfect food habitat <100m from cover. High quality food habitat was assumed to be >100 m from a road. In general, their model assumed food habitat to be degraded the farther away it is from cover and the closer to road access.

As such, ratings adjustments were made to the final ratings table (see Table 9) including:

1. Proximity to roads, which reduces habitat effectiveness (suitability).
2. Proximity of feeding habitats (typically shrub dominated wetlands) to mature conifer dominated forests.

Table 9. Suggested adjustments to habitat ratings for moose.

Attribute	Winter (Nov-Apr)
Proximity of mature forest cover to open feeding areas	100 m - no change > 100m -400m downgrade by 1 >400m down grade to nil
Distance to road (m)	< 100 m cross hatch to denote potential displacement/avoidance

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4.3 GRIZZLY BEAR

Scientific Name: *Ursus arctos*

Species Code: **M-URAR**

Status:		
	Status in Canada (COSEWIC):	Vulnerable
	Status in British Columbia:	Blue
	Conservation Data Center Rank:	S3
	Identified Wildlife (FPC):	Yes

Distribution

Provincial Range:

Grizzly bears occur throughout British Columbia except for Vancouver Island and the Queen Charlotte Islands. On the British Columbia mainland, grizzly bears have been extirpated from the Lower Mainland (Vancouver area), portions of the south-central interior (Okanagan, Thompson River valley, and Williams Lake), and portions of the northeast parkland (Peace River valley at the Alberta border).

Elevational Range
Sea level to alpine.

Project Area:	West Fraser TFL 52 and adjacent Weldwood operating areas, Quesnel Forest District
Ecoprovinces:	Southern Interior Mountains, Central Interior
Ecoregions:	Columbia Highlands, Fraser Plateau
Ecosections:	Bowron Valley (BOV), Quesnel Highland (QUH), Quesnel Lowland (QUL)
Biogeoclimatic Subzones:	AT, ESSFwcp3, ESSFwc3, ESSFwk1, ICHwk4, ICHmk3, SBSwk1, SBSmh, SBSdw1, SBSmw.
Broad Ecosystem Units:	AV,SM,AM,EF,FP,IS,IH,WL.

Project Map Scale: 1:20,000

Ecology and Key Habitat Requirements

General

Grizzly bears in British Columbia occupy a variety of habitats, occurring in all major Biogeoclimatic Zones and utilizing habitats ranging from coastal estuaries to alpine meadows. Habitat use by grizzly bears is primarily influenced by food availability, the presence of suitable denning sites, and the presence of other bears (Geowest 1998).

Grizzly bears inhabit mainly subalpine and alpine environments where grasslands and shrublands integrated with forests, subalpine meadows, and alpine communities are the species' typical habitat. A high diversity of habitat is required within the limits of a grizzly bear's home range such that areas for travel, seclusion, feeding, and denning are all available in close proximity. However, grizzly bears are selective in their seasonal use of various kinds of forage and, therefore, have concise movement patterns across the landscape as they track the phenological development of their preferred forage items. Therefore, the productivity of grizzly bear populations is more strongly influenced by the availability of high quality food resources than by density-dependent regulating factors.
Early spring and summer/fall habitats are generally considered most important to grizzly bear survival because spring is a period when food resources are relatively scarce and berry-producing habitats because fat reserves are required for overwinter survival (Geowest 1998).

The seasonal availability and distribution of forage items is an important determinant of home range size for grizzly bears. Patchy food distribution and the variable nature of production of certain forage sources makes the occurrence of such resources unpredictable in space and time. The probability of any one given area having sufficient numbers of productive food patches at any one time is a function of the size of the area. Thus, it can be said that grizzly bears have compensated for resource unpredictability through large home range sizes and a correlation can often be drawn between home range size and overall habitat quality (Canfield and Harting 1987, Nagy and Gunson 1990). In British Columbia, Lofroth (n.d.) reported coastal grizzly bears as having smaller home ranges than most bears in the interior, probably because spawning salmon is a predictable and relatively concentrated food source.

Habitat Use - Life Requisites

The life requisites that will be rated for grizzly bear are (i) spring feeding and (ii) summer feeding.

Food Habitat

The annual feeding cycle of grizzly bears follows plant phenological patterns that are, in turn, directly related to elevation and associated growing conditions. As such, grizzly bear foraging strategies vary seasonally with vegetation emergence. Although diets vary among individual populations of grizzly bears (especially between coastal and interior populations), research has shown that a few items comprise a significant portion of their diet in all areas. These food items and food groups are described below, as summarized from Mace (1987a) and McLellan and Hovey (1995). These staple forage sources may be supplemented throughout the year by high protein prey such as ungulates, ground squirrels, microtines, and fish. While salmon constitute a vital food source for coastal grizzly bear populations, grizzlies in the interior are much less dependent on such foods.

Spring Feeding (May-June)

Spring foods consist mainly of new green vegetation and winter-killed or weakened ungulates. These food sources are typically found in herb-dominated avalanche chutes, lower elevation meadows, wetlands as well as seepage areas and south and westerly aspects. Riparian areas and floodplain forests are also heavily used during spring, especially those with back channels and meandering streams which provides the most favourable conditions for succulent forb and grass production (Ash 1985). Ungulate winter ranges are the most likely habitats to encounter winter-killed ungulates. Habitats dominated by grasses, sedges, horsetails, cow parsnip, peavine, and clover are heavily used by interior grizzly bears (McLellan and Hovey 1995, Simpson 1990). As such, avalanche chutes, floodplains, riparian forests and wetland complexes likely provide the best early spring range for bears in the study area.

Summer Feeding (July-August)

Although grizzly bears continue to feed on herbaceous vegetation such as cow parsnip, sweet vetch and nettles during the summer, berries become the dominant summer food for all interior grizzly bear populations. In particular, huckleberries (*Vaccinium spp*.), soopolallie (*Shepherdia canadensis*), and saskatoon (*Amelanchier alnifolia)* are used heavily by grizzly bears during the summer months (Hamer and Herreo 1987, McLellan and Hovey 1995). However, other berry-producing shrubs can also be locally important including kinnikinnick (*Arctostaphylos urva-ursi),* crowberry (*Empetrum nigrum*), cranberry (*Viburnum edule*), and rose hips (*Rosa spp.*) (Mace & Bissell 1986, McLellan & Hovey 1995, MacHutcheon 1996, McCann 1997).

Berries tend to be most abundant in natural openings as well as those areas that have been recently disturbed through fire or clear-cut logging. As a result, structural stage can be an important variable when correlated with the availability of berries (Gyug 1999).

Regenerating burns and 10-20 year old clear-cuts (depending on type of logging and site preparation) typically provide abundant berries and receive relatively high summer use (Gyug 1999). In forested habitats, canopy closures of 20-50% are optimal for berry production (Ash 1985).The roots of *Hedysarum* spp. are dug in mountainous habitats. *Hedysarum* spp. have been reported as major food items in the central Rocky Mountains (Hamer and Herrero 1983) and in southeastern British Columbia (McLellan and Hovey 1995, Edge *et al.* 1990). The roots of other robust legumes such as yellow glacier lily (*Erythronium grandiflorum*) and springbeauty (*Claytonia* spp.) are also often dug (Gyug 1999).

Table 10. summarizes potential key grizzly bear forage plants that may occur on TFL 52.

Table 10. Key Forage Plants for Grizzly Bears potentially found on TFL 52

Fruits	Stems and Leaves		Catkins and Buds	Roots
***Vaccinium* spp.**	***Graminae***	*Penstemon spp.*	***Populus balsamifera***	*Hedysarum spp.*
Shepherdia canadensis	***Equisetum* spp.**	*Polygonium spp.*	*Alnus spp.*	*Clintonia uniflora*
***Lonicera* spp.**	***Carex* spp.**	*Potentilla spp.*	*Salix spp.*	*Claytonia spp.*
Viburnum edule	***Heracleum lanatum***	*Ranunculus spp.*		*Erythronium spp.*
Arctostaphylos uva-ursi	***Trifolium* spp.**	*Smilacina spp.*		*Lomatium spp.*
Streptopus roseii	***Valeriana sitchensis***	*Urtica dioica*		*Lonicera spp.*
Fragaria spp.	***Veratrum veride***	*Viola spp.*		*Sambucus racimosa*
Ribes spp.	***Taraxacum* spp.**			
Rosa spp.	***Lathyrus* spp.**			
Rubus spp.	***Angelica* spp**.			
Oplopanax horridum	*Aralia nudicaulis*			
Cornus stolonifera	*Epilobium angustifolium*			
Disporum spp.	*Arnica spp.*			
Sorbus spp.	*Athyrium felix-femina*			
	Astragalus spp.			
	Cirsium spp.			
	Erigeron spp.			
	Fritillaria spp.			
	Gymnocarpium dryopteris			

Note: bolded plant species represent major seasonal food items

Security / Thermal Habitat

With the exception of horsetail and devil's club dominated sites, the majority of food items preferred by grizzly bears characteristically occur in early seral communities where forest cover is absent or under-stocked (Hammer and Herrero 1983). While biologists agree that preferred habitats of grizzlies are early seral, fire-successional types, the proximity of security cover is also an important variable that has been shown to influence the use of early seral foraging habitat. Given equal foraging opportunities in cover and in the open, McLellan (1992) suggested bears will preferentially feed in cover. Despite a documented increase in bear food production after forest disturbances such as timber harvesting (Zager *et al.* 1983, Bratkovich 1986), research conducted in British Columbia

has shown that the use of such clear-cut logged areas remains low and infrequent in many cases (McLellan and Shackleton 1989, McLellan 1989, 1990a, 1990b, 1992). Other researchers have also reported grizzly bears to be extremely sensitive to security cover, citing the fact that food sources may be unavailable if adequate cover is not present, especially in areas where threatening encounters with people are possible (Zager et al. 1980).

Security cover requirements for grizzly bears can be divided into two types:

1. Bear / bear avoidance: Shrub and tree cover, as well as topographic landscape features, are used as security from other bears during the growing season in general. Specifically, females with cubs require spatial separation from aggressive boars. This is particularly true in spring when young-of-the-year cubs are most prone to attack.

2. Bear / human avoidance: Human access and development have been shown to negatively impact grizzly bears in otherwise pristine and wilderness areas (McLellan 1990). Adequate security cover to reduce visual contact by humans is vegetation or topography that hides 90% of a grizzly from view of a person 122 m away (Zager et al. 1980).

Grizzly bears have been documented to use alder thickets, lodgepole pine downfall and other dense vegetation as bedding sites (Craighead *et al*. 1982). Overall, bedding and resting habitats are provided in the same environments that provide security and thermal cover requisites.

Table 11 summarizes the feeding habitats for spring and summer seasons

Table 11. Important grizzly bear habitat types and their season of use.

Habitat Types	Season of Use	
	Spring	Summer
South facing, low elevation (below 1200m) early seral habitats, wetlands, floodplain habitats	✔	
Herb/shrub dominated avalanche tracks	✔	✔
Meadow - wetland complexes and seepage sites	✔	✔
Riparian areas	✔	✔
Subalpine parkland meadows		✔
Berry producing sites including wildfires		✔

Habitat Use and Ecosystem Attributes

Table 12 outlines how each life requisite for grizzly bears relates to specific ecosystem attributes (e.g., site series/ecosystem unit, structural stage, canopy closure etc).

Table 12. Relationship between Terrestrial Ecosystem Mapping (TEM) attributes and each life requisite for grizzly bear.

Life Requisite	TEM attribute
Feeding (FD)	site, structural stage, site modifier soil/terrain: flooding regime vegetation - % cover by layer, species list by layer, structural stage modifier, stand composition modifier, CWD
Security & Thermal (ST)	site - site series, slope, structural stage, structural stage, modifier vegetation - total % cover, % cover by layer, stand composition modifier

Ratings

There is a detailed level of knowledge on the habitat requirements of interior grizzly bears in British Columbia, thus a six-class ratings system will be used.

Provincial Benchmark

Ecosection: Border Ranges (BRR)
Biogeoclimatic Zone: ESSFdk (Engelmann Spruce Subalpine Fir dry cool) and MSdk
(Montane Spruce dry cool)

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

Ratings Assumptions

1) Alpine Tundra (AT), ESSFwcp3 (parkland) ecosystems not considered spring feeding areas due to excessive snowpack during May and June. Within the ESSFwc3, only avalanche chutes on warm aspects considered available as spring feeding areas (June).

2) The majority of dry SBS subzones situated in Quesnel Lowlands ecosection assumed to provide relatively low grizzly bear habitat capability/suitability (i.e., generally class 4/5). However, to facilitate regional grizzly bear Recovery Plan efforts, some critical habitat types rated moderate (Class 3).

3) Ecosystem units with a high abundance and/or diversity of preferred forage plants provide the best foraging habitats. In particular, ecosystems that provide an abundance of grasses, sedges (*Carex spp*.), horsetails (*Equisetum spp*.), cow parsnip, stinging nettle, and/or hellebore represent the highest rated grizzly bear spring feeding habitat. This will generally include wetlands, forested horsetail ecosystems, seepage sites [e.g., *Alder-Lady Fern (AF)]*, meadows and avalanche chutes.

4) Ecosystems on warmer aspects provide slightly better spring foraging habitat than cooler aspects due to earlier green up (warm aspects generally rated 1 higher than cooler aspects).

5) Ecosystem units (structural stages 3,6 or 7) that have the potential to provide the most abundant supply of preferred berry-producing shrubs such as huckleberry, blueberry, black twinberry, soopollalie, saskatoon, thimbleberry, devil's club, red elderberry and/or other berry producing shrubs assumed to provide the highest rated summer grizzly bear habitat. Because we do not know whether grizzly bears use the SBS zones during summer, this model has assumed that the ESSFwk1 provides relatively better berry-producing habitats in the study area and likely receive the greatest use by grizzly bears compared to the SBS.

6) Habitats within 100m of 2-wheel drive road may result in reduced effectiveness due to human activity and traffic levels (see adjustments).

Table 13. Summary of grizzly bear habitat attributes. West Fraser (TFL 52) / Weldwood operating areas.

Habitat Use	Suitable Grizzly Bear Habitat Attributes	Structural Stage
Spring Feeding	• high diversity and or abundance of preferred forage plants including grasses, sedges (*Carex spp*.) horsetails (*Equisetum spp*.); cow parsnip, stinging nettle, hellebore. • moist forests with abundant forage plants • ungulate winter range (winter killed moose/deer)	2,3,6,7
Summer Feeding	• low-elevation berry producing habitats as defined by: • Structural Stage 3, 6,7 • 15-30% total shrub cover • shrub species composition dominated (>15%) by *Vaccinium and/or* • other berry producing shrubs (e.g. soopollalie, thimbleberry, twinberry, saskatoon, devil's club, elderberry, high bush cranberry) • shrub Height < 2.5 m • high coarse woody debris (ants)	3, 6,7

Ecosystem units estimated to provide high value spring and summer foraging habitats for grizzly bears are listed in Table 14.

Table 14. Potential high value spring and summer feeding grizzly bear habitats. West Fraser (TFL 52)/Weldwood operating areas.

Spring Feeding		
BEC Subzone	**TEM Ecosystem**	**Broad Ecosystem Unit (1:250,000)**
ESSFwc3	VM,BV,AF (warm aspects only)	AV
ESSFwk1	PF, AF, AL,FH,FL	AV, WL, SM, ER
ICHmk3/ICHwk4	RD,RH	IS, IH, WL
SBSwk1	AF,AD,AL; SH,ST,SD (floodplains)	ME,WR
Summer Feeding		
BEC Subzone	**TEM Ecosystem**	**Broad Ecosystem Unit**
AT	AD,MC,MM, SL	AM
ESSFwcp3	FB,FA,SG,SD,HV,MC	AV, FP,SM
ESSFwc3	AF,BV, FA, HB, SM,VM	AV, WL, SM, EFu
ESSFwk1	PF, FF, FT (FB,FO)	AV, WL, SM, EFu
ICHmk3/ICHwk4	HO, RD, RH	IS, IH, RB, WL
SBSwk1	AF,AD,AL,ST	SF,SL,ME

TEM Legend
AF - *Alder - Fern avalanche track*
SL - *Sedge - Leafy liverwort wet meadow*
AD - *Mountain arnica - subalpine daisy meadow*
AL - *Alder -Lady fern seepage site*
BV- *Barratt's willow - Valerian avalanche track*
FA - *Subalpine fir - Mountain arnica mesic meadow*
HB - *Mountain hairgrass - Sitka burnet meadow*
SM- *Sedge - Marsh Marigold wet meadow*
VM - *Sitka valerian - Western meadowrue avalanche track*
PF - *Cow-parsnip - fireweed avalanche track*
Berry-producing habitats
FO, FT, FB

BEU Legend
AV – *Avalanche track*
FP – *ESSF parkland*
SM –*Subalpine meadow*
AM – *Alpine meadow*

Ratings Adjustments

1. Grizzly bears use areas near open roads significantly less than expected (McLellan and Shackleton 1988), resulting in a significant amount of habitat loss in some circumstances. Habitats within 100m of 2-wheel drive road may result in reduced effectiveness due to human activity and traffic levels. (cross hatched on map to denote reduced habitat suitability).

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4.4 Fisher

Name: *Martes pennanti*

Code: M-MAPE

Status: Blue-listed
Identified Wildlife (FPC)

Distribution

Provincial Range
Fisher are found throughout most of British Columbia but are believed to remain absent from the southern interior and occur only sporadically on the coast (Stevens and Lofts 1988). In terms of area, Banci (1989) reports British Columbia as having more fisher range than any other Canadian province.

Elevational Range
Fishers generally occur in valley bottoms below 1000m.

Project Area: West Fraser (TFL 52) and adjacent Weldwood operating areas, Quesnel Forest District

Ecoprovinces:	Southern Interior Mountains, Central Interior
Ecoregions:	Columbia Highlands, Fraser Plateau
Ecosections:	Bowron Valley, Quesnel Highland, Quesnel Lowland
Biogeoclimatic Zones:	AT, ESSFwcp3, ESSFwc3, ESSFwk1, ICHmk3, ICHwk4 (SBSmh, SBSdw1, SBSmw, SBS wk1).

Project Map Scale: 1:20 000.

Ecology and Key Habitat Requirements

General
Fisher distribution and habitat selection occurs on broad geographic scales and is determined by numerous factors, of which prey availability seems to be predominant. Among the habitats that are used by fisher, the presence of overhead cover between 20% to 60% is an important attribute (Arthur *et al.* 1989b, Buskirk and Powell 1994, Coulter 1966, Douglas and Strickland 1987, Jones and Garton 1994, Kelly 1977, Powell 1977, Powell 1993, Powell and Zielinski 1994, Raphael 1984, Rosenburg and Raphael 1986, Thomasma *et al.* 1991) and fisher exhibit a distinct avoidance of habitats with sparse overhead cover. This distinct habitat characteristic is highly preferred as a provision for addressing forage and security issues. Fisher select a wide variety of habitats including coniferous and mixed wood forests. However, forests that provide large diameter cottonwood trees, coarse woody debris and well developed shrub layers are preferred. Kelly (1977) proposed that the greatest combination of these features is found within

low-lying habitats where high tree density is available in association with overhead cover. Fisher has been reported from numerous forest structural types including riparian, cutblocks, and general habitat edges (Powell 1993). These habitat types appear to be used more extensively during summer months when foliage can provide the required overhead cover.

Habitat Use – Life Requisites

The life requisite that will be rated for fisher is reproductive or birthing habitat (**RB**), to reflect the limited availability of maternal den sites. Other life requisites, however, are also discussed (food, security/thermal).

Birthing Habitat

Fishers appear to be extremely specific when selecting structures for natal (birthing) and maternal (subsequent rearing) dens. Of the 17 natal and maternal dens for fishers that have been identified in British Columbia (Weir 1995), all have been in branch-hole cavities in large-diameter ($\bar{x}$ =103 cm dbh), declining black cottonwood trees. These den trees have all had very specific attributes that make them appropriate for rearing kits.

Black cottonwood trees have several unique features that may account for the extremely strong selectivity that fishers have for rearing offspring in them. Black cottonwoods are prone to decay of the heartwood at maturity (Maini 1968). It is in cavities caused by heart-rot that fishers rear their kits. Entrances to dens are through branch holes or wounds to the bark located between 5 and 28m above ground. The diameter at the den appears to need to be between 50cm and 70cm diameter for a suitable cavity to develop in the heartwood. Female fishers also seem to prefer to den in black cottonwoods that are not surrounded by extensive coniferous canopy (Weir 1995).

The availability of whelping and rearing structures across the landscape may limit the distribution of fishers across the landscape. Female fishers appear to require a certain number of denning opportunities to establish a home range. Male fishers will establish home ranges wherever there are females. Black cottonwoods appear to develop to the size and decay classes that allow them to be used by fishers in very few site series, generally moist-rich sites. Habitat units that support large declining black cottonwoods are likely the most important type found in the landscape.

Foraging Habitat

Fishers have been classified as opportunistic terrestrial predators with the ability to pursue many prey types. Martin (1994) summarized the diet analyses of 13 separate studies in eastern North America and found that five distinct food items were repeated within the fisher diets in all studies, including: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer (*Odocoileus* spp.), passerine birds, and vegetation. Weir (1995), examined the stomach contents of 331 fishers in BC and found snowshoe hares to be the most common species of prey (31%) followed by red squirrels *(Tamias*

hudsonicus) (27%), southern red-backed voles (*Cleithronomys gapperi*) (18.5%) and porcupine (16%). Shrews, northern flying squirrels, beaver, bushy tailed woodrats, muskrats, martens, short-tailed weasels, deer, moose, cattle, galliform birds and *vaccinium* berries were also present. All of these items are present and available to fishers in northeastern British Columbia.

In general, habitats that provide coniferous canopy cover as well as deciduous tree cover, elevated coarse woody debris and a well developed shrub layer (i.e., which provides food and cover for prey species) provide good foraging areas for fisher. These forage-producing areas have the most value if located adjacent to stands providing shelter or den sites (e.g., riparian areas).

Table 15. Summary of the resource requirements of fishers described by structural attributes at the stand and patch scales (Weir 1995)

Structural attribute	Resource requirement
Above-ground CWD High Shrub Low Shrub	Foraging habitat
CWD>20cm diameter Stocking of rust broom trees Stocking of trees >40cm dbh	Resting habitat
Stocking density of trees	Overhead cover
Coniferous canopy strata	Snow interception

Fishers may use "unsuitable" habitat as long as patches of good habitat structure occur in the stand. They exhibit a fair amount of patch-level selection while foraging. For example, fishers may forage in regenerating clearcuts that generally have little structure in them. While travelling through a clearcut, fishers often make direct movements from slash pile to slash pile searching for mice within these piles of structure.

Resting Habitat

Fishers in British Columbia tend to select a very narrow range of forest attributes for resting. The habitats in which fishers rest are less variable than habitats they use for other activities. The types of structures that are used most frequently by fishers for resting include; rust brooms in hybrid spruce trees, cavities in the boles of large black cottonwood, trembling aspen, Douglas fir trees and in/under single large pieces of CWD (Weir 1995). Rust brooms suitable for resting upon appear to form predominantly in older (and larger) hybrid spruce trees. The mean age of 17 hybrid spruce trees used for resting by radio-collared fishers in the SBSdw was over 100years (Weir 1998). Large black cottonwood trees suitable for resting develop only after they reach maturity (60-90 years) and develop the rot of the heartwood. Large pieces of CWD occur only where large trees once grew. All of these types of structures used by fishers for resting are generally associated with late-successional forests and develop primarily in areas with wetter ecological moisture regimes. They may occur as remnant, isolated elements or patches in earlier structural stage forests. Jones (1991) found that, of 172 resting sites in

Idaho, most were within habitats that exceeded 61% canopy closure. Reynolds and Self (1994) further noted that 34 rest sites in north-central California averaged 82% canopy closure (from Powell and Zielinski 1994). Resting sites have been reported to include: live trees with hollows, snags, logs, stumps, rock piles, squirrel nests, holes in the ground, brush piles, and raptor nests. Resting requirements, however, are site-specific and are not likely to be related to a particular ecosystem type. Therefore, resting habitat itself will not be rated as a life requisite but is assumed to be incorporated into living, security, and / or denning habitats.

Seasons of Use

Fishers are active year round and, consequently, security cover and forage requirements are constant issues with which they must contend. The use of seasonal nomenclature (spring, summer, fall, and winter) is based on that defined by RIC (1997) for the Southern Interior Mountains and the Central Interior Ecoprovinces. Table 16 summarizes the primary life requisites for fisher for each month of the year:

Table 16. Life Requisites For Fisher during the growing season months.

Life Requisite	Month	Season
Reproduction / Security / Forage	April	Spring
Reproduction / Security / Forage	May	Spring
Security / Forage / Thermal	June	Spring
Security / Forage / Thermal	July	Summer
Security / Forage / Thermal	August	Summer
Security / Forage / Thermal	September	Fall
Security / Forage / Thermal	October	Fall

Habitat Use and Ecosystem Attributes

The following section describes how each life requisite for fisher relates to specific ecosystem attributes (e.g., site series, percentage cover of vegetation etc)

Table 17. Terrestrial Ecosystem Mapping Attributes Required For Each Life Requisite for Fisher

Life Requisite	TEM Attribute
Reproduction Habitat (birthing, maternal den sites)* * life requisite that will be rated for this project	Site; structural stage CWD (decay class, size) Mensuration: tree species, DBH, wildlife tree class

Ratings Scheme

There is a reasonably sound level of knowledge of the habitat requirements of fisher in British Columbia, so a six class suitability rating scheme will be used.

Provincial Benchmarks

There is no provincial benchmark for fisher; however, Weir suggests that the provincial benchmarks (i.e., highest densities of fishers) could occur in the warmer SBS variants that occur in the study area (e.g., SBSmh, SBSdw).

Ratings Assumptions

The fisher habitat model included the following assumptions:

1) Although female fishers have been found to whelp exclusively in large diameter, declining black cottonwoods larger than 90cm dbh (Weir 1995), large Douglas Fir were also included as potential den sites. Overall, mature to climax successional stages provide the best combination of required overhead security cover and potential den sites for fisher.
2) Forested riparian habitats (or those forested sites with sub-hygric moisture regimes) are the most important habitat units for fishers.
3) Fishers require foraging habitat to be in close proximity to later successional forest stages.
4) Fishers frequent ecotones and edges, the transition areas between different types of habitats, and riparian areas associated with rivers and streams
5) Fishers avoid areas of deep soft snow during winter (Banci 1989, Raine 1983). Thus, biogeoclimatic subzones with heavy snowfalls are unlikely to support fishers (e.g., ESSFwk1, wc3). The overall capability of each subzone that occurs in the study area can be ranked according to the amount of annual snowfall received as follows:

BEC subzone variant	Broad suitability
1) SBSmh	High
2) SBSdw	High
2) SBSmw	High
3) SBSwk1	Medium
4) ICHmk3	Medium
5) ICH wk4	Medium
6) ESSFwk1	Low
7) ESSFwc3	Low
8) ESSF wcp3	Nil
9) AT	Nil

Table 18. Summary of habitat requirements for fisher in the study area (maternal den sites)

Life Requisite	Requirements
Reproduction Habitat (birthing, maternal den sites)* * life requisite that will be rated for this project	• Presence of large diameter cottonwood or Douglas fir; existing or potential tree attributes (e.g., large cavity, broken top) • tree diameters >80 cm dbh • Stocking of trees with rust brooms (1-20 stems/ha) • Large amounts of CWD (>200 m^3/ha) • moist-rich sites • Structural stages 6 and 7

Ratings Adjustments

1) Because female fishers require large diameter cottonwoods as maternal den sites, forest cover data was used to identify TEM polygons that had either a cottonwood or Douglas fir component (i.e., no stand appearance modifiers are available in the current TEM database). In general, polygons leading in cottonwood or Douglas fir were rated higher than mixed stands (see GIS query).

Because fishers have relatively large seasonal home ranges (25-122 km^2 ; Weir 1995), additional habitat area (foraging, dispersal) could be identified in the future as a refinement to the maternal denning suitability.

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Northern Goshawk

Scientific Name: *Accipiter gentilis*
Species Code: B-NOGO
Status: *Accipiter gentilis atricapillus*: Yellow-listed
Accipiter gentilis laingi: Red-listed

Distribution

Provincial Range

The Northern Goshawk is found in all Ecosections of the province and has been recorded in all BGC Units in the province except the Alpine Tundra (AT).

Elevational Range: In British Columbia, goshawks breed up to 1400m (Campbell *et al*. 1990).

Provincial Context

Two subspecies of Northern Goshawk are found in British Columbia. *Accipiter gentilis atricapillus* is distributed throughout the interior and mainland of the province and is generally non-migratory (Campbell et al. 1990). The red listed Queen Charlotte subspecies (*Accipiter gentilis laingi*) is found on the Queen Charlotte Islands and Vancouver Island and is suspected to be resident (Taverner 1940 in Campbell *et al.* 1990). Both are *Identified Wildlife* species under the Forest Practices Code of BC. Population trends are unknown in the province, but given the extent of conversion of old-growth forest to early seral stages, which goshawks tend to avoid, it is reasonable to suggest that populations are probably declining (Cooper and Stevens 1998).

Project Area: West Fraser (TFL 52) and adjacent Weldwood operating areas, Quesnel Forest District

Ecoprovince: Central Interior, Southern Interior Mountains
Ecoregions: Fraser Plateau, Columbia Highlands
Ecosections: Quesnel Highlands (QUH), Quesnel Lowlands (QUL) Bowron Valley (BOV)
Biogeoclimatic Zones: SBSmh, SBSdw1, SBSmw, SBSwk1, ICHmk3, ICHwk4, ESSFwk1.

Project Map Scale: 1:20,000.

Ecology and Key Habitat Requirements

General

The Northern Goshawk is a rare to uncommon forest-dwelling raptor that is widely distributed in BC and throughout the world. Although the distribution and ranges of the

two subspecies in BC are still unclear at present, *A. g. atricapillus* is predominant in the interior of BC and is the subspecies expected to occur in the study area. Northern Goshawks appear to be dependent on mature and old forests, which makes them a good indicator species for other old-growth dependent wildlife. Goshawks are known to be resident in British Columbia (McClaren 1999; Beebe 1974) although the species is partly migratory in the northern portion of the range in winters of food shortages (Mueller and Berger 1967).

Goshawks are highly aggressive predators who consume forest-dwelling birds and squirrels and will take prey as large as a snowshoe hare. Food appears to be the major factor limiting goshawk populations, especially during the nestling/fledgling stages (Iverson *et al.* 1996; Jones 1981).

Goshawk home ranges consist of hierarchically organised nest sites, nest areas (~12 ha), a post-fledging areas (~170 ha) and a much larger foraging area (up to ~2400 ha for *A. g. laingi*) (Kennedy *et al.* 1994). Breeding home range size can vary widely across regions and between individuals in a population depending on sex and habitat characteristics. In southeast Alaska, home ranges varied from 270 ha to 111,400 ha (Titus *et al.* 1994) and 1083-6908 ha in Oregon (Austin 1993). Goshawks are found at low densities in general due to intraspecific aggression. Few North American studies have produced reliable estimates of goshawk abundance, as most are based on searches for active nests and assume all nesting pairs are located. For A. g. *laingi*, the average inter-nest distance is 8.7$\pm$ 4.5 km (McClaren 1999). Pair densities of 7.4/259 km^2 were recorded in Colorado (Shuster 1976), 17-18/259 km^2 in Oregon (DeStefano *et al.* 1994) and 0.3 to 2.4/259 km^2 in Alaska (McGowan 1975).

Habitat Use-Life Requisites

The life requisite that will be rated for Northern Goshawks is Reproducing (RE) or nesting habitat The life requisite of Reproducing is satisfied by the presence of suitable nesting habitat which also provides Food (FD) and Security/Thermal (ST) values.

Living Habitat

Nonbreeding habitat use is poorly understood but when studied has been similar to breeding habitat (Widen 1989; Iverson *et al.* 1996). Individuals likely shift to areas of highest prey availability which may mean lower elevations and narrower habitat use than in the summer. In southeast Alaska, goshawks strongly selected productive old-growth forests during the winter.

Considered opportunists, goshawks kill a wide range of small to medium-sized mammals and birds depending on region, season, vulnerability and availability. Primary prey species in the growing seasons are jays, grouse, thrushes, red squirrels, hares and woodpeckers (Iverson *et al.* 1996). In northern British Columbia and some other parts of the interior, Beebe (1974) infers that main prey include grouse, snowshoe hare, red squirrel and Northern Flicker. On Vancouver Island, prey species most abundant in the diets of goshawks include Steller's and Gray Jays, Varied Thrush, American Robin,

Swainson's Thrush, Northern Flicker, Red-Breasted Sapsucker, Hairy Woodpecker, Pileated Woodpecker, Blue and Ruffed Grouse and red squirrel (McClaren 1999; Beebe 1974). In the Kispiox, red squirrels were the dominant mammals eaten and Northern Flicker, Red-Breasted Sapsucker and thrush species the most dominant avian prey. Key prey species in the study area are unknown. Areas where many prey species are most abundant (younger forests) may be different from areas where prey is accessible to goshawks (older forests) (Schaffer *et al.* 1995). Structural stages 3-4 may act as a prey "source" although hunting rarely occurs in them (Schaffer *et al*. 1995). If prey is particularly abundant, natural openings, forest edges and clearcuts may be used for hunting (Cooper and Stevens 1998) but goshawks may be excluded from these niches by other raptor species, such as the Red-tailed Hawk, which are better adapted to treeless environments.

Goshawks are food-limited (Iverson *et al.* 1996) and the most critical periods are the nestling and fledgling-dependency stages (Jones 1981). Therefore, limiting (critical) habitat is reproductive habitat, consisting of old forest with high prey populations and suitable structural attributes for nesting and for effective hunting. Hunting typically occurs in structural stage 6-7 forest with high canopy closure and open understorey (Bright-Smith and Mannan 1994; Duncan and Kirk 1994; Crocker-Bedford 1990). The foraging area comprises the entire breeding home range. Goshawks forage in areas that have the following attributes: 1) adequate prey, 2) sufficient cover for goshawk approach to prey and 3) suitable perches available for the goshawk's spot and attack hunting method (Beebe 1974; Squires and Reynolds 1997).

Reproductive Habitat

On a large spatial scale, goshawks have been found to breed in a wide range of forest types (Squires and Reynolds 1997) and are known to imprint on their natal habitat (Schaffer *et al* 1995). Regardless of region or forest type, there is a common trend for goshawks to nest in stands that have some larger trees (>35 cm DBH) with a high canopy closure (> 50%) (Beak Consultants 1997, Daw *et al.* 1998, Cooper and Stevens 2000, Mahon and Doyle 2000) and near the bottom to middle portion of moderate hill slopes (0-30%) (Reynolds *et al.* 1982; Doyle and Mahon 1998; McClaren 1999). In the Cariboo Region, nest trees have included Douglas-fir, lodgepole pine and trembling aspen (Cooper and Stevens 2000). Mahon and Doyle (2000) recently reported that in the SBS biogeoclimatic zone (Lakes District), most nest areas are in mature (age class 7 or greater), pine leading stands, on zonal sites, with moderate to high canopy closure (>50%) and a sparse understory.

On Vancouver Island, goshawks have been found nesting in Douglas-fir, western hemlock, Sitka spruce, red alder and western redcedar (McClaren 1999) and in the Kispiox, the most dominant nest tree species were Western Hemlock and Amabilis fir (Doyle and Mahon 1998). It appears that goshawks select for structure rather than tree species and as long as a tree has a sufficient support structure for a nest and is surrounded by a forest that will provide foraging opportunities, protection from predators and suitable habitat to raise young, goshawks will nest in that location. Nests are built in almost any kind of tree as long as the tree is forked or divided (large limbs or crotch) to

provide good anchorage for the nest. Other tree attributes such as witches broom or candelabra branching also provide good nest platforms Free water such as a forest pond or an ephemeral stream is often present near nests (Squires and Reynolds 1997). The nest is about 1 m across and 1 m deep, made of sticks, fresh greenery and bark, placed 10-20 m above ground and well below the forest crown, close to the trunk on side limbs (Beebe 1974). Pairs will maintain 1-8 alternate nest areas within their home range (Reynolds *et al.* 1992).

Stands of dense saplings are strongly avoided (Beak 1997). Areas of blowdown provide a discontinuous canopy that may act as a landmark or flyway for the adults returning to the nest, reduce flight barriers to fledglings or support open country prey (Reynolds *et al.* 1992).

The post-fledging family area ranges from 120-240ha (Reynolds *et al.* 1992; Kennedy *et al*. 1994) with abundant prey, canopy closure >50%, well developed understories and structural attributes such as snags, coarse woody debris and forest openings. These qualities provide fledglings with cover from predators, and ample prey to develop hunting skills prior to dispersal (Kennedy 1988; Reynolds *et al*. 1992; Kennedy *et al*. 1994). Approximately 90% of fledglings disperse from nest area between 65 and 90d of age, and 98% by 95d; females disperse significantly later than males (Squires and Reynolds 1997)

Seasons of Use

Goshawk life requisites by season are summarised in Table 14.

Table 14. Monthly life requisites for Northern Goshawks in BC (interior).

Life Requisites	Month	Season (Southern Interior Mountains, Central Interior)
Food, Security, Thermal	January	Winter
Food, Security, Thermal	February	Winter
Food, Security, Thermal	March	Winter
Food, Security, Thermal	April	Winter
Food, Security, Thermal, Reproductive	May	Growing (Spring)
Food, Security, Thermal, Reproductive	June	Growing (Spring)
Food, Security, Thermal, Reproductive	July	Growing (Summer)
Food, Security, Thermal, Reproductive	August	Growing (Summer)
Food, Security, Thermal	September	Growing (Fall)
Food, Security, Thermal	October	Growing (Fall)
Food, Security, Thermal	November	Winter
Food, Security, Thermal	December	Winter

Habitat Use and Ecosystem Attributes

Table 15 summarises the relationships between goshawk life requisites and ecosystem attributes.

Table 15. Ecosystem attributes and life requisites for goshawks.

Life Requisite	ECOSYSTEM ATTRIBUTE
Living	site: structural stage, moisture regime, elevation, slope, mesoslope position vegetation: % cover by layer, canopy closure, canopy height
Reproducing	site: structural stage, moisture regime, slope, slope position vegetation: % cover by layer, canopy closure, species list by layer, CWD volume, tree density, mensuration: tree height, tree species, DBH

Ratings

There is a moderate level of knowledge of goshawk habitat requirements in the province. Therefore, a 4-class rating scheme was used. Reproductive habitat is defined as the critical life requisite for goshawks, so habitats were rated for **RE** (reproduction - nesting habitat) in the growing season.

Provincial Benchmark

Ecosection: unknown
Biogeoclimatic zone: unknown
Broad Ecosystem Unit: unknown
Habitats: mature to old forest with dense canopy closure and sparse understory.

Ratings Assumptions

1) Because a variety of information sources were used (e.g., BC, Alaska), it is assumed that there are broad similarities in habitat selection patterns across the BC interior and larger pacific northwest that can be applied to goshawk nesting habitat in the study area.

2) SBS subzones provide the best breeding habitat (moderate to moderate-high) due to the occurrence of coniferous (spruce, pine) or mixed conifer/deciduous stands with high canopy closure (>50%). Mesic and submesic sites (with some exceptions) typically provide potentially higher crown closures than drier or wetter sites. ICH and ESSF subzones considered to have relatively open canopies (<50%) so provide relatively lower nesting habitat suitability (Class 4 or 5).

Table 16. Habitat attributes required during nesting season for Northern Goshawk (BC interior)

Season	Habitat Attribute
Growing (reproductive)	• mature and old structural stages (6 and 7) • relatively high canopy closure (>50%) • open understory • some trees >35 cm DBH; large limbs, broken tops • moderate slope (0-30%) • Lodgepole pine or mixed coniferous/deciduous stands • high coarse woody debris and snags • cone-producing trees (squirrels) • high numbers of terrestrial fungi • moderate productivity (mesic sites)

Ratings Adjustments

1) Because canopy closure is considered the most critical variable influencing goshawk nesting habitat selection (and is not available in the TEM data base), crown closure classes from the forest cover data base were used to help identify which TEM ecosystems had high (>56-90%) and moderately high (45%-55%) canopy closure.

2) Because nesting areas have been reported to be between 8-20 ha (Reynolds *et al*. 1992 cited in Cooper and Stevens 2000), habitat areas had to be at least 8 ha in size (i.e., either single polygons or aggregations of polygons).

Final Ratings

See digital file.

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Warbling Vireo

Scientific Name: *Vireo gilvus*
Species Code: B-WAVI
Status: Yellow-listed

Distribution

Provincial Range

Warbling Vireos are found throughout British Columbia during the spring, summer and fall seasons with most breeding records from the central and southern portions of the province. Warbling Vireos are widespread breeders with the highest numbers of summer records in the Sub-Boreal Interior Ecoprovince (Campbell *et al*. 1990).

Elevational Range: Sea-Level to 1450m (Campbell *et al*. 1990)

Provincial Context

Although found throughout the province, Warbling Vireos become thinly distributed north of the Peace Lowlands. They are considered uncommon to fairly common along the coast and interior regions of the province. They are considered rare along Western Vancouver Island and absent from the Queen Charlotte Islands. No winter sightings of this species have been recorded (Campbell *et al*. 1997).

Project Area: West Fraser (TFL 52) and adjacent Weldwood operating areas, Quesnel Forest District

Ecoprovince: Central Interior, Southern Interior Mountains
Ecoregions: Fraser Plateau, Columbia Highlands
Ecosections: Quesnel Highlands (QUH), Quesnel Lowlands (QUL) Bowron Valley (BOV)
Biogeoclimatic Zones: AT, ESSFwcp3, ESSFwc3 (ESSFwk1, ICHmk3, ICHwk4, SBSmh, SBSdw1, SBSmw, SBSwk1).

Ecology And Key Habitat Requirements

General

Warbling Vireos are found in the upper canopy of open mature deciduous and mixed forests and usually avoid continuous coniferous forests (Godfrey 1974; Campbell *et al*. 1997; Banks *et al*. 1995). The Warbling Vireo is not usually found within the conifer dominated mountain areas and plateaus (Campbell *et al*. 1997). Deciduous and mixed stands are usually found along valley bottoms, wetlands, riparian forests and forest edges. These birds can also be found in dense deciduous trees along roadsides, agricultural land and in willow and alder thickets (Farrand Jr. (ed), 1988). In the mountainous interior areas of the province they have been found mainly in valleys, lower elevation passes and edges of slides and avalanche chutes where deciduous patches occur (Campbell *et al*. 1997). Breeding habitats are usually open deciduous stands, but also in mixed woodlands with some conifers (Campbell *et al*. 1997). Tall large trees of riparian areas and valley bottoms are usually preferred for nesting (Campbell *et al*. 1997). On the coast, breeding

occurs from late May to late July and in the interior, early June to early August (Campbell *et al*. 1997; Cannings *et al*. 1987).

Habitat Use and Life Requisites

Living Habitat

The life requisite that will be rated for Warbling Vireos is Reproduction (nesting), which is satisfied by the presence of suitable feeding and security (nesting) habitats.

Feeding Habitat

Insects are the primary diet of Warbling Vireos during the breeding season (Godfrey 1986, Paridis 1993, Salt 1973 in Banks et al. 1995). They show a preference for hairy caterpillars, which are usually avoided by many other birds (Paridis 1993). During the post breeding period, Warbling Vireos will also consume berries (Chapin 1925 in Paridis, 1993).

Warbling Vireos feed in shrubby habitats (MacCallum and Ebel 1985 in Banks *et al*. 1995). The more dense the shrubs in the feeding area, the more food is available. Due to this feeding habitat preference, Banks *et al.* (1995) assumed that at 50% shrub and tree canopy closure, an area will become optimal habitat for Warbling Vireos. They also assumed then that vegetated habitats up to 25m from the shrub/sapling edge is optimal feeding habitat but that the area will decline in feeding value any distance greater than 25m down to 75m where the area becomes unusable (Banks *et al*. 1995).

Reproductive Habitat

Warbling Vireo nests consist of a basket-like woven cup usually suspended by its rim from a twig fork at the end of a branch (Paridis 1993; Elrich 1988). The female constructs the nest alone using materials such as hair, bark, twigs, plant down and lichen bound with spider webs and lined with grass (Paridis 1993; Elrich 1988). On the coast, nest records indicate eggs are laid between May 25 and July 19 (Campbell *et al*. 1997; Cannings *et al*. 1987). Elrich (1988) reported an incubation period of 12 days. Brood sizes ranged from 1 to 5 with an average of three or four young (Campbell *et al*. 1997). Both parents participate in incubation and tending to the nestlings. Fledging occurs two weeks after hatching where the parents continue feeding for a few more days. In BC, 76% of nests have been found in deciduous trees. Trembling aspen made up 27% of nest trees. Other nest trees included: poplar (10%), birch (10%), red alder (8%), black cottonwood (7%), vine maple or other deciduous shrubs (14%) such as willow, red-osier dogwood and elderberry (Campbell *et al*. 1997). Nest heights in BC (114 nests) range between 1 to 16 m with 61% between 2 and 6m (Campbell *et al*. 1997).

In the Alberta foothills Warbling Vireos are associated with old deciduous forests (>60 years) with open canopy and a well developed shrub understorey (Westworth *et al*. 1984 in Banks et al. 1995). They also occurred along edge areas where shrub/sapling and deciduous forest types meet (Salt and Salt 1976, Thormin 1989 in Banks et al. 1995). In the Bulkley Valley of BC, Warbling Vireos have been found in variable aged stands of saplings, mixed conifer aspen and the highest densities of singing males found in mature

and old-growth trembling aspen (Pojar 1995 in Campbell et al 1997). In the Cariboo Region (Quesnel Forest District), Davis *et al*. (1999) studied bird abundance in the ESSFwk1 and found Warbling Vireos to be more abundant in early seral (<40 yrs) forests compared to either mid (40-120 yrs) or late seral forests (>120 yrs). This apparently reflected the presence of a deciduous component in these upper elevation forests.

In the Alberta Foothills, Banks *et al*. (1995) assumed that a tree height of 15m would provided optimal habitat. They concluded that if at least 30% of the canopy were deciduous, it would provide optimal habitat for Warbling Vireos. Since Warbling Vireos most often nest in stands with dense canopy closure they also concluded that a canopy closure of 50% makes the habitat area optimal for Warbling Vireos to nest. However, other researchers have found warbling vireos to prefer deciduous forests with low to intermediate canopy cover (Pack 2000).

Seasons of Use

Warbling Vireos have been recorded arriving in the province as early as April 4th and remaining as late as October 10 (Campbell *et al*. 1997). In the project area Warbling Vireos arrive during the first week of May and have remained up to mid-September (Prince George Naturalist Club, 1996). The peak spring migration in the central interior is mid-May while peak fall migration occurs between mid-August and early September (Campbell *et al*. 1997). No distinction has been made between breeding and nonbreeding habitats in BC.

Since Warbling Vireos only occur in the study area during the growing (reproducing) season, habitats will be rated for growing season living and reproducing. Table 17 summarizes the life requisites required for each month of the year.

Table 17. Monthly Life Requisites for Warbling Vireo

Life Requisite	Month	Season*	Life Requisite	Month	Season*
NA	January	Winter	Living	July	Growing
NA	February	Winter	Living	August	Growing
NA	March	Winter	Living	September	Growing
NA	April	Winter	Living	October	Growing
Living	May	Growing	NA	November	Winter
Living	June	Growing	NA	December	Winter

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

Habitat Use and Ecosystem Attributes
Table 18 outlines how each life requisite relates to specific ecosystem attributes.

Table 18. Ecosystem attributes and life requisites for Warbling Vireo

Life Requisite	TEM Attribute
Reproductive (nesting, feeding)	Site: structural stage, moisture regime, elevation vegetation: % cover by layer, canopy closure mensuration: tree species, age class, height, DBH

Ratings
There is an intermediate level of knowledge on the habitat requirements of Warbling Vireos in British Columbia and thus, a 4-class rating scheme will be used (H = high, M = moderate, L = low, N = nil).

Provincial Benchmark
No provincial benchmark is available.

Ratings Assumptions
1) This species is territorial and will feed and reproduce within the same stand.
2) Ecosystems that contain mature (60+ years) aspen/cottonwood forests provide the highest quality reproducing habitat. Deciduous component must be at least 20% (forest cover data base).
3) Although vireos may use shrub-dominated as well as early seral forests including those at higher elevations (e.g., ESSFwk1). Lower elevation forests (i.e., SBS subzones) provide higher quality habitats due to the greater occurrence of mature deciduous trees.

Final Ratings Table
See digital file.

Table 19. Summary of habitat requirements for Warbling Vireos in the study area.

Season	Life Requisite	Structural Stage	Requirements
Growing Seasons	Living (feeding and reproducing)	5-7	Stands > 60 years with >20% deciduous component Early seral forests

Ratings Adjustments

Because the TEM database did not have a stand appearance modifier available, habitat ratings were adjusted using the forest cover database (tree species composition). This

provided a much more accurate map by identifying which polygons were leading in aspen or cottonwood as well as those polygons considered mixed deciduous-coniferous (>=20%).

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