Mountain Caribou Habitat Use and Habitat Ratings for TFL#23 Central Selkirks Caribou Inventory Project

draft for review

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EXECUTIVE SUMMARY

The Central Selkirk sub-population of mountain caribou (*Rangifer tarandus caribou*) is a conservation concern, and habitat management for the species could have considerable economic consequences for the region. In 1996, Forest Renewal British Columbia (FRBC), in cooperation with local forest companies and the Ministry of Environment, Lands and Parks (MELP) initiated a four-year inventory study of the Central Selkirk sub-population. The study collected population and life history data, and generated models of stand- and landscape-scale resource selection.

The inventory study also identified important knowledge gaps regarding the ability of some of the models to adequately describe habitat attributes selected by caribou. Subsequently, Pope & Talbot Limited, in cooperation with MELP, initiated a one-year study to address the knowledge gaps identified in the inventory study. Four additional mountain caribou were captured and radio-collared on TFL #23, and 6 telemetry flights, collecting 86 telemetry point locations on 18 radio-collared animals, were conducted between May and November 2000.

Stand level attributes were sampled at an additional 93 early winter use and 57 random sites. An updated early winter model was generated from the expanded sample, resulting in a model that should generalize better than the model based only on data collected in 1998-99. Significant stand-level variables were similar to those reported in the inventory study.

In addition, a species' habitat model was developed according to Resource Inventory Committee (RIC) standards for wildlife capability/suitability modelling. Field personnel generated ratings for all site series and structural stages present on the project area. The ratings can be applied to the Arrow Predictive Ecosystem Map and structural stage model (in development at the conclusion of this study) to map mountain caribou habitat capability and suitability on TFL #23.

INTRODUCTION

Mountain caribou (*Rangifer tarandus caribou*) are a species at risk in British Columbia. Of the 13 sub-populations in southeastern and central British Columbia, the Central Selkirk caribou are one of the top conservation concerns, and management for the species in this region has the potential to cause considerable socio-economic disruption (Simpson et al. 1997). In 1996, Forest Renewal British Columbia (FRBC), in cooperation with Pope & Talbot Limited, Meadow Creek Cedar, Slocan Forest Products and the Ministry of Environment, Lands and Parks established a 4-year partnership to study the mountain caribou sub-population of the Central Selkirk Mountains. The project was designed to provide the population and habitat inventory data necessary to effectively integrate the needs of mountain caribou with forest landscape planning and operational management.

The study resulting from the partnership agreement was a comprehensive examination of mountain caribou biology in the Central Selkirk Mountains, with a focus on habitat use in relation to forest cover and terrain attributes at the stand and landscape scales (Hamilton et al. 2000). The project identified a sub-population of approximately 250 animals, divided into two herds that were separated geographically and used habitat differently. The Nakusp herd occupied the southern portion of the study area, and made extensive use of ridgetops for travelling between drainages. The Duncan herd occupied the northeast portion of the study area and generally used the Duncan River valley bottom and side drainages.

A significant knowledge gap identified in the study was the inability of resource selection models to adequately resolve habitat use in low elevation interior cedar hemlock (ICH) forests, particularly in early winter. This was considered primarily a sample size problem related to the variability in caribou behaviour during this "transition" season. Resolving habitat use during early winter in low elevations forests is critical for forest management because of the high value of timber in these seasonal habitats.

The study also identified the difficultly of capturing the characteristics of high-quality caribou habitat based on a few stand level variables. This was primarily a statistical problem because some characteristics of good caribou habitat were not easily quantifiable. In addition, there was often little contrast between caribou telemetry locations and random locations, which is required to build reliable models.

As a result, we conducted a 1-year study of mountain caribou on TFL #23 to address these knowledge gaps. The broad objectives of the study were:

1. To radio-collar four additional caribou and collect point location data, with an emphasis on the early winter season, in order to expand our knowledge of mountain caribou habitat use and movements
2. To collect additional stand level data at caribou point locations identified during early winter in order to revise the stand level resource selection model and identify important attributes related to caribou habitat management

3. To generate caribou habitat suitability/capability ratings, according to RIC standards, to capture the importance of stand-level attributes that are difficult to quantify, and to bridge the gap between stand-level attributes and landscape-level mapping

The project area was located within the North Columbia Mountains Ecoregion and the Central Columbia Mountains and Northern Kootenay Mountains Ecosections. The area was characterized by steeply sloping mountainous terrain dominated by mature forest within the Interior Cedar-Hemlock (ICH), Engelmann spruce-Subalpine fir (ESSF), and Alpine Tundra (AT) biogeoclimatic zones (Figure 1).

ACKNOWLEDGEMENTS

METHODS

CARIBOU CAPTURE AND AERIAL MONITORING

Bighorn Helicopters of Cranbrook, BC was contracted to capture four additional caribou on the project area. Aerial monitoring of newly radio-collared animals as well as caribou radio-collared during the previous study followed the methods of Hamilton et al. (2000). Caribou point locations were collected from the air using a twin engine Cessna 337 fixed wing aircraft equipped with directional receiving antennae and radio receiver. A trained technician operated a Lotek STR 1000 scanning receiver and directed the pilot to locate radio-collared caribou. Locations and habitat types were plotted on aerial photographs, along with UTM's recorded from the aircraft's GPS. Location data were entered into a Microsoft Access database and then imported to ArcInfo GIS. Caribou travel routes identified by track observations during telemetry flights were also recorded by the technician.

STAND LEVEL DATA COLLECTION AND RESOURCE SELECTION MODELLING

Stand level attributes (Table 1) were collected at a random sample of early winter caribou telemetry point locations and at random locations within the 95% composite home range of radio-collared caribou. Methods followed those for the 1999 field season outlined in Hamilton et al. (2000).

Data were pooled among caribou and years for analyses. We used a multiple logistic regression analysis to examine resource selection (Manly et al., 1993; Menard, 1995; Mace et al., 1999). Logistic regression regresses independent variables (in this case, habitat attributes) against a dichotomous dependent variable ("used" or caribou point locations versus "unused" or random locations). An important caution regarding this analysis method is that the dependent variable in wildlife resource selection studies is rarely dichotomous because there is an unknown probability that random locations classified as “unused” were actually used by animals. Therefore, the resulting selection models are conservative (Mace et al., 1999).

Categorical variables with *n* categories were coded to *n* – 1 indicator variables. We started by including all variables in an initial model, and then generated a final model based on the most parsimonious subsets of variables according to the Akaike information criterion (AIC; Burnham and Anderson 1998). Variable inclusion based on AIC is more accurate than inclusion based on the significance of Wald statistics (Menard, 1995); therefore, there were instances where variables that were not significant at $P = 0.1$ were included in final model. The model with the highest AIC was not necessarily the one chosen because models that differ in AIC values from the most parsimonious model by <2 have considerable support. Therefore, we chose the model with the most degrees of freedom with an AIC value that differed by <2 from the model with the highest AIC. Model fit was considered significant if the χ^2 value of the reduced model was significantly different from the intercept-only model (Statistica 1995).

Significant ($P < 0.1$) positive coefficients indicated selection and significant negative coefficients indicated avoidance. We used 2 X 2 contingency tables to measure the classification accuracy of the models. We also reported the “odds ratio,” which is an overall measure of goodness of fit based on the classification tables. Values >1 suggested a model was better at predicting the classification of a location than expected by chance (Statistica 1995).

HABITAT CAPABILITY/SUITABILITY MODELLING AND MAPPING

Development of the mountain caribou habitat capability/suitability model followed the procedures outlined in British Columbia Wildlife Habitat Rating Standards (Resource Inventory Committee 1999). First, we drafted a species account that outlined the life history and habitat requirements of mountain caribou in the project area. Second, we developed the wildlife habitat ratings table (a preliminary ratings table was not developed due to time and budget constraints). This step involved developing a matrix of ratings (nil-high) for each site series and structural stage that occurs in the project area. Ratings were based on seasonal life requisites and habitat requirements outlined in the species account. Habitats were rated against a provincial benchmark that represented the highest capability habitat for caribou in the Province. The species account and ratings table constituted the species’ habitat model.

The ratings table can be applied to predictive ecosystems mapping coverages of the project area, when they become available. This will provide a spatial representation of caribou habitat, by season, on TFL #23.

RESULTS

CARIBOU CAPTURE AND AERIAL MONITORING

Four caribou were net-gunned from a helicopter by Bighorn Helicopters staff on 12 April 2000. Two adult males and two adult females were fitted with VHF radio-collars in the following areas of TFL #23: Silvercup (2), Mohawk (1), and Wilke-Asher-Halfway (1).

Eighty-six additional caribou telemetry locations were collected on 18 radio-collared animals during six telemetry flights conducted between 8 May and 28 November 2000. Flights occurred at approximately six-week intervals, with two flights in November. All but one caribou (#21, which was located twice) were located four to six times.

STAND LEVEL DATA COLLECTION AND RESOURCE SELECTION MODELLING

Stand level attributes were sampled at 93 early winter caribou point locations, for a total of 121 sites sampled during 1998-2000. Fifty-seven random sites were also sampled, for a total of 210 sites. Sites with missing data were excluded from analyses (Table 2). No pairs of variables were highly correlated with each other (*i.e.,* $r > 0.75$); therefore, all attributes were included in the initial model.

The final stand level model suggested that caribou used sites in early winter that were on gentler slopes (suggested by the negative coefficients for warm and cool aspects, indicating selection for aspects classified as "flat"), with more windthrow, higher crown closure, and fewer but larger pieces of coarse woody debris than random sites. Stands were also older, with more stems/ha, higher lichen loads, and more branch litterfall (Table 3). The model generated a significantly better fit than the intercept-only model (-2LL = 280, $\chi^2 = 79$, df = 11, $P < 0.000$), and correctly classified 70.2% of random and 78.6% of telemetry locations, for an odds ratio of 8.6.

HABITAT CAPABILITY/SUITABILITY MODELLING AND MAPPING

The species account for mountain caribou that was drafted as part of the capability/suitability modelling exercise is presented in Appendix A.

A workshop was held in Nelson on 5 and 6 February 2001 to define suitability ratings for mountain caribou in BEC zones, subzones, site series, and structural stages found on the project area (Appendix B). Although our focus was on the early winter season, we took the opportunity to define ratings for all seasons, as defined by Hamilton et al. (2000). A list of workshop participants and a narrative of workshop activities is presented in Appendix C. Ratings were assigned according to the ability of a specific site series and structural stage to provide all of the "living" (RIC 1999) requirements of mountain caribou. Ratings were based on a consensus of opinion of experienced field personnel.

DISCUSSION

The principal objective of this project was to collect additional data on mountain caribou habitat use, particularly during early winter, in order to refine and extend modelling products that could be applied in habitat management on TFL #23. Adding four caribou to the radio-collared portion of the herd and conducting additional telemetry flights expanded our general knowledge of caribou ecology in the central Selkirk Mountains, particularly during critical "transition" seasons.

Collecting stand level attributes at additional early winter caribou telemetry locations, as well as at additional random locations, improved the resolution of the early winter stand level model. Variables retained in the final model were similar to those retained in the model based on 1998-99 data (Hamilton et al., 2000). The model had a slightly poorer fit than had the 1998-99 model, suggesting that the 1998-99 model might have been overfit to the smaller sample of early winter and random sites. The model arising from this project should generalize better because of the considerably larger sample available for the analysis.

The addition of seasonal capability/suitability models to the tools available to guide habitat management for mountain caribou on TFL #23 is significant. The models distil the broad experience acquired by technicians during >600 person-days in the field, and attempt to capture habitat associations that are difficult to quantify. Although the models were derived by expert opinion, their goodness of fit can be assessed quantitatively like any other model by examining the fit to caribou telemetry data to model predictions.

The ratings tables can be applied to the Arrow Predictive Ecosystem Map (PEM), currently in development, to map habitat capability for mountain caribou. A structural stage model is also in development, which will allow the mapping of mountain caribou habitat suitability. Because the ratings tables cover all structural stages, the models can also form the basis of habitat supply projections for mountain caribou.

CRITIQUE OF INVENTORY PROTOCOLS

This project followed the inventory protocols outlined in Hamilton et al. (2000). Comments on the inventory methodologies can be found in that document. A critique of the capability/suitability methodology is premature; strengths and weaknesses should become apparent when the ratings are mapped and goodness of fit assessed.

MANAGEMENT RECOMMENDATIONS

The stand level model presented in this report should be considered an updated version of the early winter model reported in Hamilton et al. (2000). Relationships explained by the model should generalize better than those explained by the model based only on 1998-99 data.

Ratings tables of the capability/suitability model should be applied to the final PEM and related stand structure model when they become available. We expect that there will be similarities between maps generated by the seasonal capability/suitability models and those presented in Hamilton et al. (2000). Caribou data should be used to assess the goodness of fit of the models. Ultimately, the models could be used to project caribou habitat supply on TFL #23 under a number of forest management scenarios.

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Figure 1: Central Selkirk Caribou Inventory project area 2000/2001

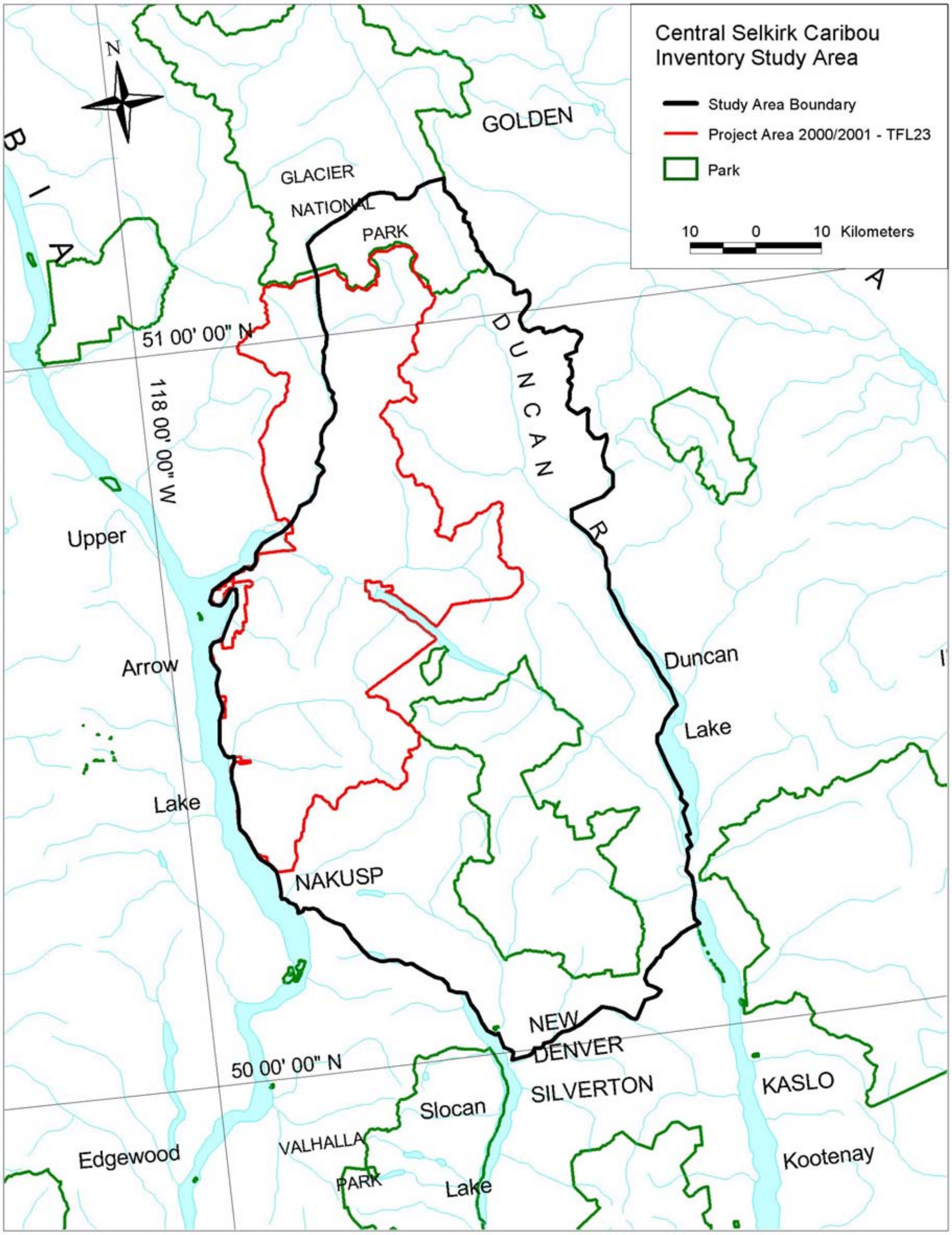

Table 1: Variables, variable codes, and details of data collection methods for stand level attributes

Variable	Code	Details
Aspect	FLAT, WA, C	Categorized as flat (<25 degrees), warm, or cool
Moisture	MOIST	From site series classification
Nutrient	NUTR	From site series classification
Windthrow	WINDTHRO	See form FS 39DHSP 96/7 for criteria
Mean slope	SLOPE_AV	Average of up and downslope percent slope measured by clinometer
Crown closure	CROWN_AV	Mean of % crown closure estimates in 4 cardinal directions
Sightability	SIGHT_AV	Average of 4 sight board intersection counts from 4 cardinal directions. Intersections are counted from 15m on boards 0.5m above the ground.
Coarse woody debris (# pieces)	CWD	Number of pieces of downed wood >7.5cm in diameter and >0.5m above the ground intersecting hip chain string line
Average CWD diameter	CWD_AVG	Average of all pieces noted above
Age	AGE	Mean age of all trees in prism sweep
Leading species	Bl, Hw, Sx, Cw	From timber type, categorical variable relative to other/none
Stems/ha	STEMS_HA	Count of all stems of all species in all strata
Average lichen load	LICH_AV	Mean of lichen class estimates for sample trees, from Armleder *et al.* (1992)
Branch litterfall	BRANCH_L	1 (low) - 3 (high) visual estimate for entire plot

Table 2: Descriptive statistics of stand level attributes collected at early winter telemetry locations and random sites

	Telemetry sites (n=112)				Random sites (n=149)			
	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
FLAT_ASP	0.24	0	1	0.43	0.19	0	1	0.40
WA_ASP	0.41	0	1	0.49	0.50	0	1	0.50
C_ASP	0.35	0	1	0.48	0.31	0	1	0.46
MOIST	3.54	1	7	1.14	3.44	1	6	1.06
NUTR	3.00	1	4	0.68	2.96	1	5	0.73
LEAD_BL	0.14	0	1	0.35	0.34	0	1	0.48
LEAD_HW	0.51	0	1	0.50	0.34	0	1	0.48
LEAD_SX	0.08	0	1	0.27	0.09	0	1	0.28
LEAD_CW	0.12	0	1	0.32	0.10	0	1	0.30
LEAD_FD	0.10	0	1	0.30	0.06	0	1	0.24
OTH_NONE	0.05	0	1	0.23	0.07	0	1	0.25
WINDTHRO	1.88	1	3	0.69	1.55	1	3	0.65
SLOPE_AV	45.28	0	95	23.63	44.86	0	99.5	21.19
CROWN_CL	58.70	10	96	29.35	57.80	2	96	27.72
SIGHT_AV	10.88	0	25	6.48	9.84	0	25	6.45
CWD	7.08	0	26	4.92	8.15	0	28	5.47
CWD_AVG	22.42	0	65.2	12.55	19.51	0	59	9.81
AGE	176.58	0	300	66.62	149.15	0	335	62.65
STEMS_HA	383.04	0	1050	242.57	218.29	0	1300	276.53
LICH_AVG	1.76	0	4.3	0.83	1.65	0	8.6	1.23
BRANCH_L	1.98	1	3	0.72	1.66	1	3	0.78

Table 3: Resource selection coefficients

Resource selection coefficients and 95% confidence limits based on multiple logistic regression analysis of stand level attributes of early winter telemetry sites and random sites. Model fit was significantly better than the intercept-only model (-2LL = 280, χ^2 = 79, df = 11, P < 0.000).

	Estimate	Lower CI	Upper CI	p
Intercept	-4.547	-6.219	-2.875	0.000
WA_ASP	-0.935	-1.727	-0.142	0.021
C_ASP	-0.768	-1.602	0.067	0.071
WINDTHRO	0.747	0.267	1.227	0.002
CROWN_CL	0.011	-0.001	0.023	0.069
CWD	-0.116	-0.182	-0.051	0.001
CWD_AVG	0.032	0.004	0.060	0.025
AGE	0.007	0.002	0.012	0.005
STEMS_HA	0.004	0.002	0.005	0.000
LICH_AVG	0.207	-0.085	0.498	0.165
BRANCH_L	0.325	-0.099	0.749	0.133

APPENDIX A

Species-Habitat Model
Mountain Caribou Species Account

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

Species Code: M-RATA

Status: Designated as threatened in Canada (COSEWIC,2000)

Red-listed (BC Conservation Data Centre, 2000)

Not considered Identified Wildlife (BC Ministry of Forests and Ministry of Environment, Lands and Parks,1997)

DISTRIBUTION

Provincial Range

Two subspecies, or ecotypes, of caribou, Dawson's (*R.t. dawsoni*) and mountain caribou (*R.t. caribou*), are currently recognized in British Columbia. Inhabitating only Graham Island on the Queen Charlotte Islands, Dawson's caribou is thought to have become extinct shortly after 1910. The mountain caribou is found throughout the northern boreal zones of British Columbia and as far south as Tweedsmuir Provincial Park and in the southern Kootenays where small populations are isolated from each other (McTaggart-Cowan and Guiguet 1965, Nagorsen 1990). Southern interior areas important to mountain caribou include the Purcell, Selkirk and Monashee Ranges, Nelson Mountains, Wells Gray Park, Quesnel Highlands and the eastern slope of the Coast Mountains

Provincial Context

It is estimated that about 2,500 mountain caribou are currently distributed amoung 13 sub-populations in central and southeastern British Columbia (Simpson *et al* 1997). Of this provincial total, the Kootenay region supports an estimated 800 caribou (Simpson *et al* 1997, Hamilton *et al* 2000). The Central Selkirk caribou sub-population is estimated at 250 caribou (Hamilton *et al* 2000) and is ranked sixth out of the 13 sub-populations in terms of conservation priority for management (Simpson *et al* 1997).

Caribou in British Columbia occupy seasonal habitats from valley bottom to timberline/alpine. Elevational migrations are undertaken from season to season. These are described in more detail in the sections below.

Project Area:

Area:	Central Selkirk Mountains
Ecoprovince:	Southern Interior Mountains
Ecoregions:	Northern Columbia Mountains
Ecosections:	Central Columbia Mountains and Northern Kootenay

	Mountains
Biogeoclimatic zones and variants:	ICHmw2, ICHmw3, ICHvk1, ICHwk1, ICHwm, ICHdw, IDF, ESSFwc2, ESSFwc1, ESSFwc4, ESSFwcp, AT
Elevational Range:	valley bottom to alpine
Mapping Scale:	1:20,000

ECOLOGY AND KEY HABITAT REQUIREMENTS

Woodland caribou (*Rangifer tarandus caribou*) of North America are broken into two "ecotypes": mountain and northern. Ecotypic differentiation is based on habitat use and behavior patterns. Northern ecotype caribou inhabit areas in which snow conditions commonly permit the use of terrestrial vegetation as winter forage. Mountain caribou inhabit areas where snowfall is heavier, and arboreal lichens are used as their primary winter forage (Stevenson and Hatler 1985). These areas include the moist coniferous forests of the Columbia and Rocky Mountains of southeastern British Columbia and northern Idaho. Because their dependence on arboreal lichen and other aspects of their ecology, mountain caribou are assumed to depend on old forests, and may be susceptible to the loss of effective habitat through forest harvesting and displacement by human disturbance (Stevenson *et al*. 1994, Simpson *et al*. 1997).

The mountain caribou of southeastern BC spend most of the year in high elevation sub-alpine forest and alpine habitats, descending to low elevation forests during early winter and spring periods (i.e., snow conditions, avalanche danger) (Simpson and Woods 1987, Stevenson and Hatler 1985). Caribou inhabiting rugged mountainous terrain, similar to that of the project area, use seasonal habitats within the full range of elevations from low-elevation cedar/hemlock to mid and high elevation spruce/fir forests, including fir/spruce parkland habitats. Although the times of seasonal migrations and habitat use by caribou may vary between populations, four seasonal habitat use patterns are generally recognized (Stevenson and Hatler 1985, Simpson and Woods 1987, McLellan, Flaa and Woods 1994). These four periods are late winter, spring, summer/fall and early winter. USA research biologists have identified calving as fifth seasonal habitat for the South Selkirk caribou population (Scott and Serhveen 1985).

The breeding season is in late autumn with gestation averaging seven to eight months. Calves are born in late May to early June and a cow will average only six calves over her lifetime. Single births are most common. Calves are not camouflaged and must be able to travel with the cows almost immediately after birth (Hunter 1972). The migration of caribou to seasonal habitats and calving areas is largely attributed to predator avoidance (Seip and Cichowski 1994).

Winter snow depth and snow consolidation is an important factor that influences caribou habitat use and seasonal migrations within the Central Selkirks. In early winter, until the snow consolidates or hardens, the caribou use mid to low elevation forest habitats where dense forest canopies reduce ground snow depths thereby affording the animals greater mobility and forage availability. The caribou further appear to migrate to lower elevations as dictated by both snow depth/consolidation and forage availability (vegetation, lichen on litterfall and blowdown) – making most use of the ICH/ESSF transition zones during the early winter period (Hamilton *et al* 2000). By late winter, when the snow has hardened to the extent that it facilitates 'on top of the snow migration', the animals migrate to higher elevation ESSF/ESSF parkland habitats where the animals rely totally on arboreal lichens for food.

HABITAT USE – LIFE REQUISITES

The Central Selkirks caribou inventory project assessed Mountain caribou habitat use and population characteristics in the study area (Hamilton *et al*. 2000).

Feeding Habitat

Feeding requirements for Mountain caribou are tied closely to food availability – particularly arboreal lichen feeding during the winter period.

Early Winter

Caribou populations in high snowpack ecosystems make early-winter movements to lower elevations before the first snowfall and remain there until snow depths and hardness enable sufficient mobility (Simpson et al. 1985, Antifeau 1987). Early winter forage habitats are dominated by *paxistima myrisinites* and *Pyrola* species (Servheen and Lyon 1989, Simpson et al. 1997). As the snowpack increases, caribou shift their diet to arboreal lichen (*Alectoria spp. and Bryoria spp.*) attained from litterfall and on windthrow trees or branches (Simpson *et al*. 1985, Antifeau 1987, Rominger and Oldemeyer 1989, Hamilton *et al* 2000).

Late Winter

The movement of mountain caribou to late-winter ESSF/parkland habitat occurs when the snow pack deepens and consolidates, allowing easier movement and lifting the caribou to the lichen-bearing portion of the forest canopy (Scott and Servheen 1985, Simpson et al. 1985, Rominger and Oldemeyer 1989, Servheen and Lyon, 1989). Lichens on windthrown trees and litterfall are used when available, but the major source of during late winter are arboreal lichens found on both dead and living standing trees (Simpson *et al*. 1985, Antifeau 1987, Hamilton *et al* 2000).

Spring

Areas used in spring have newly emergent green forage, which is important in order for the animals to recover weight loss from a winter long lichen diet and to prepare cows for the heavy demands of lactation when they move to food-deficient areas for calving (Scott and Servheen 1985). Snow-covered calving areas typically support high lichen densities because vascular forage is not available (Scott and Servheen 1985, Servheen and Lyon 1989).

Summer/Fall

Summer/fall habitat use appears driven primarily by the availability of abundant forage. Forage includes a wide range of herbaceous green vegetation and shrubs including grasses, sedges, buds, lichens and flowering plants (Hamilton *et al* 2000).

Security Habitat

Caribou seem to prefer areas where they can see around them (e.g., they tend to avoid areas where tall shrubs, conifer regeneration, or other obstructions restrict horizontal visibility (Stevenson *et al*. 1994, Hamilton *et al* 2000)). Older forest habitats characterized by low shrub cover, low levels of conifer regeneration and gentle to moderate slopes characterize good security cover habitat areas for caribou. Caribou also migrate from lower elevation to higher elevation habitats for calving – presumably for predator avoidance purposes.

Thermal Habitat

Thermal habitat allows caribou to expend less energy to maintain body temperature thus allowing allocation of conserved energy to growth and reproduction. Thermal cover is considered an important component of ungulate habitat. It has been defined as overstory vegetation that, for a given combination of solar radiation flux density, ambient air temperature and wind speed, allows an animal to remain in its thermoneutral zone (air temperatures in which animals exist most comfortably) or minimize thermoregulatory costs (Demarchi and Bunnell 1993). Thermal cover also provides snow interception that can lower an animal's energy expenditures for locomotion (Parker *et al*.1984). Energy is a limiting factor under adverse environmental conditions for many ungulates. In summer, increased metabolic costs associated with heat dissipation can translate into decreased summer weight gain while in winter animals lacking sufficient energy reserves are more vulnerable to winter-spring mortality (Mautz 1978).

Mature to old forests appear to provide caribou thermal cover habitat on all seasonal habitats. Such forests also provide snow interception, reduced ground snow depths and greater animal mobility on early winter habitats.

SEASONS OF USE

Four seasons of use have been identified for mountain caribou in the Central Selkirks.

Table 1: Seasonal Habitat Use Patterns for Mountain Caribou in the Central Selkirks

Season	Code	Dates
early winter	WE	October 25 – January 15
late winter	WL	January 16 – May 12
spring	P	May 13 – June 30
summer fall	S/F	July 1 – October 24

Mountain caribou require primarily feeding habitat in winter and feeding and security/thermal habitat for the spring, summer and fall growing season. The monthly life requisites the Central Selkirks caribou sub-population is summarized in the following table and further described below.

Table 2: Monthly Life Requisites for Mountain Caribou

Life Requisite	Month	Season
feeding	January	early winter/late winter
feeding	February	late winter
feeding	March	late winter
feeding	April	late winter
feeding/security/calving	May	late winter/spring
feeding/security/calving	June	spring
living	July	summer
living	August	summer
living	September	summer/fall
living	October	fall/early winter
feeding	November	early winter
feeding	December	early winter

Early Winter (October 25 – January 15)

- important period when animals are forced into mid to lower elevation forest habitats by unconsolidated snow accumulations at mid to higher elevations
- valley bottoms and gentle to moderate slope forest habitats in lower ICH zone and ESSF/ICH ecotone (wet, cool sites)
- selected habitats usually consisting of closed crown, older age class forests (snow interception and thermal cover, reduce ground snow accumulations, old growth structural attributes) and low shrubs (not tall shrubs or conifers), particularly *paxistima myrisinites* and *Pyrola* species
- feed on *paxistima*, sedges and other vegetation when not snow covered, otherwise rely on arboreal lichens from standing trees and/or fallen or windthrown lichen-bearing trees and branches

Late Winter (January 16 – May 12)

- migrate from lower elevation forest habitats to high elevation forested ESSF/ESSF parkland habitats when snow conditions allows animals easy travel on top of consolidated snow
- high elevation mature to old growth ESSF and ESSF parkland habitats characterized by moderate slope, open canopies (20-50 percent crown closure) and low basal area
- feed entirely on arboreal lichens (primarily *Bryoria* spp and *Alectoria sarmentosa*) found on live and dead standing trees, blowdown and litterfall

Spring (May 13 – June 30)

- migrate from higher elevation habitats to lower elevation snow-free habitats when snow conditions at higher elevations become restrictive to movement and access to arboreal lichens is reduced
- in snow-free habitats in the ICH and ICH/ESSF ecotone, caribou select sites where obstructions to visibility and movement are low (e.g., closed canopy forest habitats, gentle to moderate slopes, cool, moist sites)
- pregnant cows may again move from lower elevation habitats with easy mobility and food quality to food-limiting but predator-free higher elevation habitats for calving. Calving usually occurs in the ESSF or AT, at or near the snowline, in secluded areas in proximity with adequate security forest cover attributes
- forage includes arboreal lichens in snow covered habitats and new green vegetation in snow free habitats. Use of snow covered areas that support abundant lichen production is important because vascular forage availability may be low due to ground snow cover but pregnant cow energy demand is high

Summer/Fall (July 1 – October 24)
- use of upper ESSF and AT zones, particularly relatively open, older age class forest stands in association with seeps, bogs and riparian type habitats where vegetation is succulent and abundant
- Forage includes a wide range of herbaceous green vegetation and shrubs including grasses, sedges, buds, lichens and flowering plants

HABITAT USE AND ECOSYSTEM ATTRIBUTES

Table 3: Predictive Ecosystem Mapping (PEM) Relationships and Life Requisites for Mountain Caribou in the Central Selkirks

Life Requisite	PEM Attributes
living habitat (feeding)	• *site*: structural stage, elevation, slope, aspect • *soil/terrain*: moisture regime, bedrock, terrain texture • *vegetation*: species composition • *mensuration*: tree species composition, density, blowdown, lichen abundance
living habitat (security/thermal)	• *site*: structural stage, slope, elevation • *soil/terrain*: moisture regime • *vegetation*: % cover by layer • *mensuration*: tree species, density, crown closure

RATINGS

Provincial Benchmark

The Cariboo Mountains (CAM) ecosection is the provincial benchmark for mountain caribou. Both the CAM and NKM ecosections accommodate Class 1 ratings for caribou in ESSF for the winter and growing seasons.

Ratings Assumptions

Food (feeding) and cover (security/thermal) are considered primary life requisites for caribou survival. In terms of relative importance, caribou survival relies heavily on forage convenience with less emphasis on the availability of associated cover. The seasonal ratings for feeding thus reflect weighting of 80% forage with 20% security or thermal cover availability assumed due to the tree presence required for arboreal lichen production.

CLASS 1:

Season	Life Requisite	Structural Stage	Requirements
early winter	feeding (FD)	6-7	• abundant lichen available on live and dead trees, litterfall and windthrow • *paxistima myrisinites* or *pyrola* presence • <80% slope • mesic to subhydric • medium to high blowdown potential
late winter	feeding (FD)	all	• abundant lichen • presence of white bark pine (preferred) • gentle, rolling terrain • mesic to subhygric
spring	feeding (FD)	2-3, 6-7	• abundant lichen and litterfall • mesic to subhygric • <80% slope • early green-up sites
summer/fall	feeding (FD) security (SH)	2-3, 6-7	• <80% slope • mesic to subhygric • abundant vegetation • abundant lichen and litterfall • cooler aspects

CLASS 2:

Season	Life Requisite	Structural Stage	Requirements
early winter	feeding (FD)	6-7	• abundant lichen available on live and dead trees, litterfall and windthrow • *paxistima myrisinites* or *pyrola* presence • >subhygric + <subxeric than Class 1 • <100% slope • medium probability of blowdown
late winter	feeding (FD)	6-7	• abundant lichen • <80% slope • presence of whitebark pine (preferred)
spring	feeding (FD)	all	• medium to high lichen abundance and litterfall

			• submesic to hygric • <100% slope • early green-up sites
summer/fall	feeding (FD) security (SH)	all	• mesic to hygric • <100% slope • abundant vegetation • abundant lichen and litterfall

CLASS 3:

Season	Life Requisite	Structural Stage	Requirements
early winter	feeding (FD)	2-3, 6-7	• >100% slope • structural stages 6-7 that are either wetter or drier than Class 2
late winter	feeding (FD)	all	• less lichen abundance • <100% slope
spring	feeding (FD)	all	• structural stages 6-7 that are subxeric to subhygric • >100% slope
summer/fall	feeding (FD) security (SH)	all	• >100% slope • structural stages 6-7 that are submesic

CLASS 4:

Season	Life Requisite	Structural Stage	Requirements
early winter	feeding (FD)	5-7	• less abundance in litterfall/blowdown due to decrease in trees • >100% slope • less lichen
late winter	feeding (FD)	5-7	• limited lichen production • >100% slope
spring	feeding (FD)	all	• less lichen and vegetation • >100% slope • northerly aspects
summer/fall	feeding (FD) security (SH)	all	• less lichen and vegetation • >100% slope

CLASS 5:

Season	Life Requisite	Structural Stage	Requirements
early winter	feeding (FD)	2-5	• limited food, cover • lichen almost lacking from stand
late winter	feeding (FD) migrate (MS)	all	• limited food, cover • potential travel

spring	feeding (FD) migrate (MS)	all	• limited food, cover • potential travel
summer/fall	feeding (FD) migrate (MS)	all	• limited food, cover • potential travel • cold aspect

CLASS 6:			
Season	**Life Requisite**	**Structural Stage**	**Requirements**
all			non habitat (e.g., no food or shelter available, impassable terrain such as lakes, cliffs, etc.)

Preliminary Ratings Tables
See Appendix B.

Ratings Adjustments

Table 4: Habitat Ratings Adjustment Table

Issue	Description	Season(s)	Rating Adjustment
highways	habitat within 250m of road	WE	<1 class
road construction	industrial road construction (e.g., blasting) – temporary impact	P S/F	<1 class
urban	urban and rural developments	all	<2 classes
forest harvesting and fragmentation	> 60% harvest/burn (<age class 3) within 500ha area	all	<3 classses
snowmachine use	• high intensity snowmachine use (>6/day) • medium intensity snowmachine use (6 or less/week) • low intensity snowmachine use (6 or less/month)	WL WL WL	<3 classes <2 classes <1 class
snow cat operation for skiing	• daily use • 1-2 times/week (within 1km of snowcat route)	W W	<2 classes < 1 class
cattle grazing	structural stages 2-3	P/S/F	class 5
arboreal lichen	absence of arboreal lichens	WL	class 6
blowdown	• where blowdown is low (as evidenced by CWD) • where blowdown is absent	WE WE	<1 class <2 classes
predation			
inter-species competition			

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