Tweedsmuir-Entiako Caribou Population

Status and Background Information Summary

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Preface

Information presented in this report specific to the Tweedsmuir-Entiako caribou population was largely extracted/summarized and updated from the following two reports:

- Cichowski, D., and N. MacLean. 2005. Tweedsmuir-Entiako Caribou Population – Technical Background Information Summary (1983-2003). Prepared for Ministry of Environment, Smithers, B.C. 199 p.

- Cichowski, D. 2010. Tweedsmuir-Entiako Caribou Project: Effects of a Mountain Pine Beetle Epidemic on Northern Caribou Habitat Use – Final Report. Prepared for the Bulkley Valley Centre for Natural Resources Research and Management, Smithers, B.C. 66p.

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1. Background

1.1 Status of Northern Caribou

All caribou and reindeer in the world belong to one genus and species, *Rangifer tarandus*. In British Columbia (BC), 3 ecotypes of caribou are recognized (mountain, northern, boreal) based on differences in habitat use, behaviour, and migration patterns (Stevenson and Hatler 1985, Heard and Vagt 1998, IWMS 2004). The Tweedsmuir-Entiako caribou population belongs to the northern ecotype.

Northern Caribou live in west-central and northern BC (Figure 1). During winter, they crater for terrestrial lichens on windswept alpine slopes and in low elevation forests. They also forage on arboreal lichens in low elevation forests, especially when foraging for terrestrial lichens is difficult, or in subalpine forests. Mountain Caribou live in the deep snowpack, interior wet belt of southeastern BC where they forage on arboreal lichens in subalpine forests during winter. Boreal Caribou live in the lowlands of northeastern BC, where they primarily use large peatlands throughout the year, and forage for terrestrial lichens during winter.

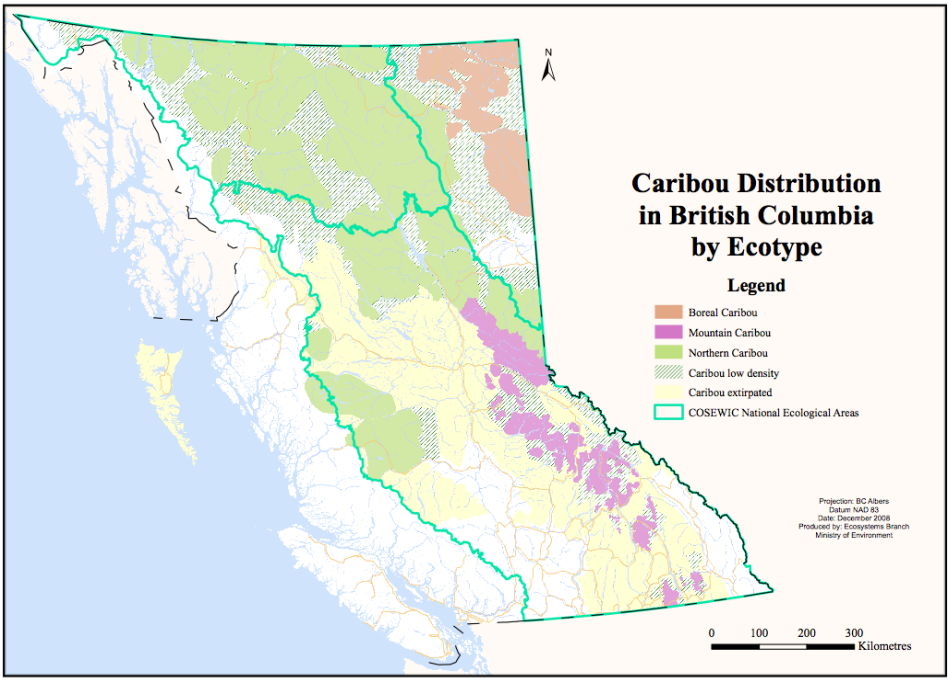

Figure 1. Three ecotypes of Woodland Caribou in British Columbia.

The Tweedsmuir-Entiako caribou population is located in the Committee on the Status of Endangered Wildlife in Canada's (COSEWIC) Southern Mountain National Ecological Area (SMNEA), which includes the southern two-thirds of BC, and the west-central portion of Alberta. All caribou in the SMNEA were listed as Threatened by COSEWIC in 2000 and reaffirmed in 2002.

Table 1. Legal designations and conservation status of Northern Caribou in the Southern Mountains National Ecological Area.

Legal Designations	
Identified Wildlife Management Strategy	Yes (2004)
Federal *Species at Risk Act*	Schedule 1 (2003)
Conservation Status	
BC Conservation Data Centre (CDC)[1]	Blue list (2000)
COSEWIC	Threatened (2002)

[1] Referred to as "Northern Mountain Population" by the CDC

Caribou in the SMNEA were designated as Threatened in Schedule 1 of the federal *Species at Risk Act*, which was fully enacted in 2003, and are listed as an Identified Wildlife Management Species under the *Forest and Range Practices Act*.

The "Northern Mountain Population" of caribou, which refers to northern ecotype caribou found in both the SMNEA and Northern Mountain National Ecological Area were blue-listed by the BC Conservation Data Centre in 2000 (Table 1).

1.2 Species Information

1.2.1 Northern Caribou Populations and Distribution

In addition to west-central and northern BC, Northern Caribou are also found in southwestern Alberta, south and central Yukon, and the southwestern portion of the Northwest Territories. In BC, Northern Caribou populations are currently found only in areas where they have access to alpine and subalpine habitat (Heard and Vagt 1998). The distribution of the 25 populations of Northern Caribou in BC is mostly contiguous except for 5 populations in west-central BC, which are isolated from the other populations by the interior plateau.

Historically, Northern Caribou were also found throughout the interior plateau region of BC (Spalding 2000). The reduction of Northern Caribou from their historic range has coincided with increases in populations of other prey species. Moose (*Alces americanus*) were largely absent from or present at low densities in central BC until the late 1800s when they started becoming more common (Spalding 1990, Santamauro *et al*. 2012). Range contraction has also been observed for caribou in other parts of Canada and the United States with the southern distribution boundary in eastern Canada shifting north (Thomas and Gray 2002, Vors *et al*. 2007), the loss of caribou from the eastern United States, and a reduction in range in the northwestern contiguous United States.

The current number of Northern Caribou in BC is estimated at about 16,000 to 18,000 (BC Ministry of Forests, Lands and Natural Resource Operations, unpublished data). Of the 25 populations of Northern Caribou currently recognized in BC, 3 populations are currently stable, 7 populations are decreasing, and the population trend is unknown for 15 populations. All 5 populations in west-central BC are currently declining (COSEWIC 2014, Environment Canada 2014).

1.2.2 Caribou Biology

Caribou are the only members of the deer family in North America in which both males and females typically have antlers. They are well adapted to winter conditions with crescent-shaped hooves and large, widely spaced dew claws set back on the foot, which reduce sinking depth and act like shovels when digging through the snow for winter forage (Thomas and Gray 2002).

Caribou have a low reproductive rate. Unlike other members of the deer family, caribou have only 1 young per year and females do not generally breed until they are 2 years old (Bergerud 1974a). The rut typically occurs in October and females calve in late May/early June. Although pregnancy rates are generally high, calf mortality is also high (especially right after birth), resulting in overall low calf recruitment rates.

The primary anti-predator strategy of Woodland Caribou is to space away from predators and other prey (Bergerud 1996). Females that calve at high elevations or at low elevations on islands in lakes have higher calving success than females that calve in low elevation forested habitat (Seip and Cichowski 1996).

1.2.3 Northern Caribou Habitat and Range Requirements

Northern Caribou are characterized by feeding primarily on terrestrial lichens during winter; however, seasonal movement and habitat use strategies vary between populations. Some populations migrate long distances between summer and winter ranges while others do not, and use of high elevation versus low elevation winter ranges differs between populations, and within populations between winters. Variation in seasonal habitat use reflects differences in topography, snow accumulation, and availability of low elevation winter ranges between areas (Cichowski 2008).

Typically, Northern Caribou calve and summer in high elevation alpine and subalpine habitat, and winter in low elevation forests or on windswept alpine slopes where they forage on terrestrial lichens (see Appendix 1 for a more detailed description of habitat and range use). They also forage on arboreal lichens during winter in subalpine forests or at low elevations in habitats where arboreal lichens are available. Because lichens are slow growing, caribou tend to select older forests (80-250 years) where terrestrial and/or arboreal lichens are more abundant. For populations that move between winter and summer ranges, spring migration routes generally follow low elevation terrain where snow accumulation is lower. Most caribou calve at higher elevations in alpine or subalpine habitat, forgoing forage quality at lower elevations in order to reduce predation risk since predators focus on other prey that remain at lower elevations. During summer, caribou prefer high elevation habitats but can be found in a variety of habitats at all elevations since snow does not limit movement and herb and shrub forage is abundant. Consequently, Northern Caribou are highly dispersed during summer, more so than during any other season.

Habitat and range requirements for Northern Caribou include:

- access to a sufficiently large area of undisturbed high elevation calving and summer habitat for predator avoidance;
- access to an adequate supply of terrestrial and arboreal lichens during winter;
- snow interception by the forest canopy to allow movement within the winter range; and,
- unfragmented large tracts of range to provide caribou the ability to shift wintering areas in response to such factors as overgrazing, fires, changing snow conditions and/or predation pressure.

1.3 Northern Caribou Recovery in British Columbia

Caribou in the SMNEA, which include both Northern and Mountain ecotype populations, were listed as Threatened in 2000 and 2002. The federal *Species at Risk Act* (SARA), which was fully enacted in 2003, directs that a recovery strategy for threatened species must be prepared within four years after listing. Because caribou in the SMNEA were already listed as Threatened at the time that the *Species at Risk Act* was enacted, a recovery strategy should have been completed by 2007.

Although the Northern Caribou Technical Advisory Committee completed a strategy for Northern Caribou in the SMNEA in BC in 2004 (Northern Caribou Technical Advisory Committee 2004), the strategy was never endorsed by the provincial government. One recovery approach from that strategy was to establish three Recovery Implementation Groups that would develop Recovery Action Plans. The West-Central Recovery Implementation Group, which was responsible for the Telkwa and Tweedsmuir-Entiako populations, met once in March 2005. That year, recovery planning for most species was suspended pending direction from the provincial Species at Risk Coordination Office.

In 2014, Environment Canada developed a recovery strategy for caribou in the SMNEA (Environment Canada 2014). The goal of the recovery strategy is:

- to achieve self-sustaining populations in all local population units within their current distribution.

Population targets include increasing the number of caribou in the SMNEA from about 5800 caribou to an overall target of 9100 caribou. The corresponding population and distribution objectives are, to the extent possible to:

- stop the decline in both size and distribution of all local population units;
- maintain the current distribution within each local population unit; and,
- increase the size of all local population units to self-sustaining levels and, where appropriate and attainable, to levels which can sustain a harvest with dedicated or priority access to aboriginal peoples.

The recovery strategy focuses on predator control in the short term to stop declines, and restoring habitat over the long term to address habitat alteration resulting from industrial activities (Environment Canada 2014).

For Northern Caribou in the SMNEA, critical habitat has been identified as:

- the habitat possessing those biophysical attributes required by southern mountain caribou to carry out life processes and which is found within:
    - the high elevation winter and/or summer (spring, calving, summer, fall/rut) range delimited by the local population unit boundaries;
    - the low elevation summer (spring, calving, summer, fall/rut) range delimited by the local population unit boundaries;
    - the local population unit boundaries, which provide for an overall ecological condition for low elevation winter range and Type 1 matrix range that will allow for an ongoing recruitment and retirement cycle of habitat, which maintains a perpetual state of a minimum of 65% of the area as undisturbed; and,
    - Type 2 matrix range that provides an overall ecological condition that will allow for low predation risk, defined as wolf population densities less than 3 wolves/1000 km^2.

Type 1 matrix range consists of areas within a local population unit's designated range that have not been mapped as summer (spring, calving, summer, fall/rut) or winter range, and may include seasonal migration areas (or portions of migration areas) and areas of relatively lower use compared to delineated seasonal ranges. Type 2 matrix range consists of areas surrounding ranges where predator/prey dynamics influence predator/prey dynamics in the population's range, and may also include areas of trace occurrences of caribou, dispersal zones between populations, and dispersal zones between local population units.

1.3.1 COSEWIC Designatable Units

In 2011, COSEWIC defined 12 Designatable Units (DUs) for caribou in Canada (COSEWIC 2011), which are discrete and evolutionarily significant units of caribou. Northern Caribou that were a part of the SMNEA for the 2002 assessment were reorganized into two DUs, and were separated from Mountain Caribou, which were given their own DU (Figure 2). All the populations in west-central and north-central BC were combined with Northern Caribou from the Northern Mountains National Ecological Area into the Northern Mountain DU (#7). In May 2002, the Northern Mountain National Ecological Area population was assessed as Special Concern and a management plan was completed in 2012 (Environment

Canada 2012). COSEWIC assessed all three western mountain caribou DUs (Northern Mountain [DU7], Central Mountain [DU8], Southern Mountain [DU9]) in May 2014. The Northern Mountain DU was assessed as Special Concern, while the Central Mountain and Southern Mountain DUs were assessed as Endangered (COSEWIC 2014). The updated listing was submitted to the Federal Minister of the Environment in fall 2014 for listing consideration under SARA. Until SARA is amended with the updated listings, the Tweedsmuir-Entiako population remains listed as Threatened under SARA.

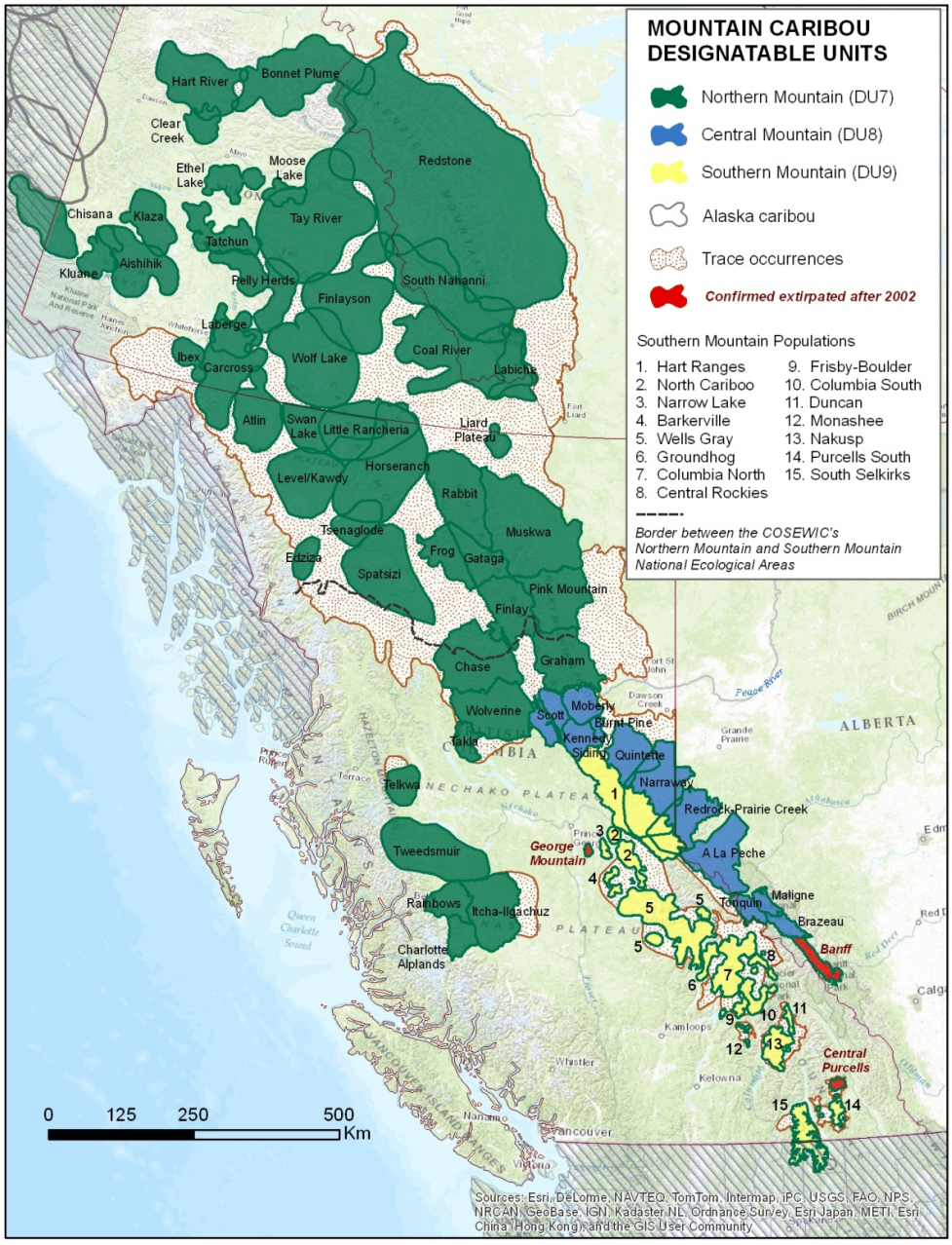

Figure 2. COSEWIC Designatable Units for caribou in western Canada (from COSEWIC 2014).

2. Tweedsmuir-Entiako Caribou Population

2.1 Description of Range

The Tweedsmuir-Entiako caribou range is located in west-central BC, approximately 200 km southwest of Smithers (Figure 3). It covers approximately 1,700,000 hectares and spans portions of 4 Ministry of Forests, Lands and Natural Resource Operations regions (MFLNRO Skeena, Omineca, Cariboo, West Coast), 6 Resource Districts (Nadina, Kalum, Vanderhoof, Quesnel, Cariboo-Chilcotin, North Island-Central Coast), 2 Fish and Wildlife Management Unit regions (Skeena, Cariboo), and 2 BC Parks regions (Skeena, Cariboo). Most of the range lies within the MFLNRO Skeena Region and the BC Parks Skeena Region.

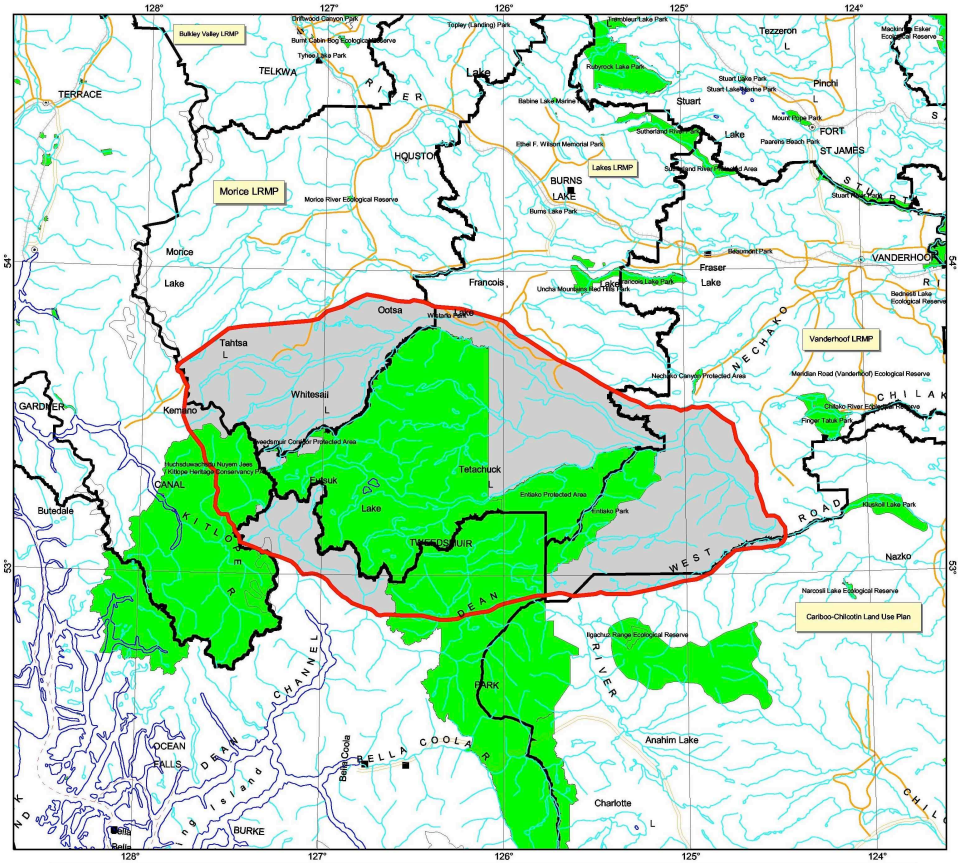

Figure 3. Tweedsmuir-Entiako caribou range (from Cichowski and MacLean 2005).

The physical landscape in the eastern portion of the range is made up of mostly flat or gently rolling terrain of the Nechako Plateau between 900 and 1500 meters in the eastern portion of the range, rising to 1900 meters in the Fawnie Mountains in the southeast and 2350 meters in the Quanchus Mountains in the northeast. The western part of the range lies on the eastern edge of the Coast Mountains and is characterized by granitic mountains rising up to 2800 meters.

The eastern portion of the study area has a dry, continental climate, with generally cool, short and dry summers, and long, cold and dry winters. Annual snowfall in the study area averages 2 meters at lower elevations and increases at higher elevations and toward the western portion of the study area. Actual snow accumulation in the eastern portion of the area is relatively low during winter, especially at lower elevations where snow accumulation generally do not exceed 1 meter in openings. The climate of the western portion of the study area is influenced by coastal weather patterns and is generally wet and very snowy with a short, cool summer and receives more precipitation than the eastern portion.

The Tweedsmuir-Entiako caribou range falls within 6 biogeoclimatic zones (Banner *et al*. 1993):

- Alpine Tundra (AT);
- Engelmann Spruce-Subalpine Fir (ESSF);
- Sub-Boreal Pine-Spruce (SBPS);
- Sub-Boreal Spruce (SBS);
- Coastal Western Hemlock (CWH); and,
- Mountain Hemlock (MH).

The majority of lower elevations in the eastern part of the study area consist of the moist cold subzone of the Sub-Boreal Pine-Spruce zone (SBPSmc), the Babine variant of the moist cold subzone of the Sub-boreal Spruce zone (SBSmc2), and the dry cool subzone of the Sub-boreal Spruce zone (SBSdk). The Kluskus variant of the moist cold subzone of the Sub-boreal Spruce zone (SBSmc3) occurs to a lesser extent and is found primarily in the Fawnie Mountain area. Higher elevations consist primarily of the moist cold subzone of the Engelmann Spruce-Subalpine Fir zone (ESSFmc) with a lesser extent of the Nechako variant of the moist very cold subzone (ESSFmv1) in the Fawnie Mountains. The moist cool subzone of the Engelmann Spruce-Subalpine Fir zone (ESSFmk) is found in the western part of the study area along with the leeward variant of the moist maritime subzone of the Mountain Hemlock zone (MHmm2) and

the montane variant of the wet submaritime subzone of the Coastal Western Hemlock zone (CWHws2).

The AT zone has a severe climate with low growing season temperatures and a very short frost-free period. Frost can occur at any time, and most of the annual precipitation falls as snow. The severe climate precludes the growth of trees; tree species are common at lower alpine elevations in stunted or krummholz form.

The ESSFmc has a continental climate with cold winters, relatively low annual precipitation and a light snowpack. Dominant tree species include subalpine fir (*Abies lasiocarpa*), hybrid white spruce (*Picea glauca* x *engelmanni*) and lodgepole pine (*Pinus contorta*). Whitebark pine (*Pinus albicaulis*) is occasionally present on the driest sites while amabilis fir (*Abies amabalis*) is absent and mountain hemlock (*Tsuga mertensiana*) is rare.

The ESSFmk has a warmer climate than the ESSFmc with less summer rainfall but a higher snowpack with minimal ground freezing. Subalpine fir is the dominant tree species, however, the climate also allows for the growth of mountain hemlock and amabilis fir. Whitebark pine is a distinctive feature of the ESSFmk and is common, especially on dry, rocky sites. Increased presence of lichens is also characteristic of the ESSFmk.

The SBSdk has relatively dry, warm summers and relatively dry, cold winters with a low snowpack. Major trees species include hybrid white spruce, lodgepole pine, trembling aspen (*Populus tremuloides*), and black cottonwood (*Populus balsamifera trichocarpa*).

The SBSmc2 has cooler and moister summers than the SBSdk and longer winters with a deeper snowpack. Hybrid white spruce, subalpine fir and lodgepole pine are dominant tree species.

The SBPSmc has a severe, cold continental climate that is drier and colder than the SBS, resulting in generally low forest productivity. Lodgepole pine is the dominant tree species in this zone with hybrid white spruce and black spruce occurring on moister sites and in depressions.

The MHmm2 has short, cool summers and long, cool, wet winters with heavy snow cover for 5-9 months. Mountain hemlock, amabilis fir, and western hemlock are the dominant trees species in this variant. Yellow-cedar (*Chamaecyparis nootkatensis*) is absent and inland species such as subalpine fir are widespread.

The CWHws2 is a high elevation variant of the CWH and occurs between 600 and 1000 meters. The climate is submaritime with a short, cool and wet growing season, and cool snowy winters. Amabilis fir, subalpine fir, mountain hemlock and Sitka alder (*Alnus viridis*) are common tree species; western redcedar (*Thuja plicata*) and red alder (*Alnus rubra*) (common in other CWH subzones) are absent or scarce.

A winter habitat map based on biogeoclimatic site series, and interpreted for terrestrial lichen abundance was developed for the winter range in 1987 (BC Ministry of Forests 1987). Concentrations of habitats with higher levels of terrestrial lichen abundance are found in the area around Entiako Lake extending south to the headwaters of the Entiako River, and in the area south of Tetachuck Lake, and smaller concentrations are found in the areas south of Laidman Lake and southwest of Moose Lake (Cichowski and Banner 1993).

Fire and forest insects are the two main large-scale disturbance factors at low elevations in the eastern portion of the Tweedsmuir-Entiako caribou range. Although large-scale, stand-replacing fires have resulted in large areas of even-aged forests, surface fires have also played a role in shaping understorey vegetation (Cichowski *et al*. 2001a). Surface fires consume terrestrial lichens but they may also be important in reducing competing vegetation. From 1950-1999, only 5 fires exceeded 100 ha in size, and only 2 of those exceeded 400 ha (Cichowski *et al*. 2001a). From 2000 to 2013, 7 large fires burned approximately 30,000 ha within the Tweedsmuir-Entiako caribou range. In 2014, the Chelaslie Fire burned over 133,000 ha of winter range and spring migration range primarily in Entiako Park and in the East Ootsa area just north of Tetachuck Lake. The main forest insects include mountain pine beetles (*Dendroctonus ponderosae*), spruce beetles (*Dendroctonus rufipennis*), and western balsam bark beetles (*Dryocoetes confusus*). A large spruce beetle outbreak was detected in northern Tweedsmuir Park in 1980 and over 26,000 ha of western balsam bark beetle was mapped in 1994 (Garbutt 1996). The recent mountain pine beetle epidemic was detected in the mid 1990s and is discussed in Section 2.7.

The main large mammals that occur in the Tweedsmuir-Entiako caribou range include caribou, moose, mountain goats (*Oreamnos americanus*), wolves (*Canis lupus*), grizzly bears (*Ursus arctos*), black bears (*Ursus americanus*), wolverine (*Gulo gulo*), coyote (*Canis latrans*) and lynx (*Lynx canadensis*). Ungulates other than caribou, moose and mountain goats are less abundant in the area and include mule deer (*Odocoileus hemionus hemionus*), black-tailed deer (*Odocoileus hemionus sitchensis*), elk (*Cervus elaphus*) and white-tailed deer (*Odocoileus virginianus*).

Northern Tweedsmuir Park and the Coast Mountains to the west are used primarily as summer range by the larger mammal species. Caribou and moose are mostly absent from North Tweedsmuir Park and the area to the west during the winter due to heavy snow accumulations. Wolves likely also leave the western area during winter and occupy areas where moose are more common.

2.2 First Nations

Portions of six First Nations' traditional territories fall within the Tweedsmuir-Entiako caribou range (Cichowski and MacLean 2005). The Cheslatta Carrier Land Claim includes most of the northern portion of the range along with the Nee Tahi Buhn Band traditional territory and the Skin Tyee Band traditional territory. The southern portion of the range falls within the Ulkatcho Traditional Use Area. The Carrier Sekani Tribal Council land claim, which includes the Saik'uz (Stoney Creek) First Nation, and the Wet'suwet'en land claim area extends to just south of the northern boundary of the Tweedsmuir-Entiako caribou range.

2.3 Historical Range and Population Trend

Prior to the 1900's, caribou were found throughout BC (Spalding 2000). In the early 1900's caribou populations began declining and now the Tweedsmuir-Entiako caribou population is only one of five caribou populations (Tweedsmuir-Entiako, Itcha-Ilgachuz, Rainbow, Charlotte Alplands, Telkwa) that still exist in west-central BC (Environment Canada 2014).

Historically, the Tweedsmuir-Entiako caribou wintered north of Whitesail and Ootsa lakes, east of Intata Lake, in the Cheslatta Lake area, and in the Quanchus Range in northern Tweedsmuir Park, as well as in their current winter range in the Entiako area (Low 1965, Hatter 1979, Stevenson and Hatler 1985, Table 2). Incidental observations indicate that scattered groups of caribou were seen in some of those areas as late as the mid 1970's and early 1980's (Hatter 1979, Stevenson and Hatler 1985) but few caribou have been reported in those areas since.

Several factors may have contributed to reduced use of those winter ranges including changes in predator/prey relationships, construction of the Kenney Dam impoundment, overhunting, forest harvesting,

agricultural clearing, and a general decline in caribou numbers. Construction of the Kenney Dam impoundment and a general decline in caribou numbers were likely the greatest factors.

Table 2. Historic observations of caribou outside the Entiako winter range during winter surveys (from Cichowski and MacLean 2005).

Year	# caribou	Area
1981 February	1	Quanchus Mountains
1979 January	1	Whitesail Reach
	4	Ootsa Lake
1978 February	23	Quanchus Mountains
1974 February	13	Quanchus Mountains
	58	Sibola Mountains[1]
1968 February	17	Quanchus Mountains
1968 January	36	Quanchus Mountains
	4	Cheslatta Lake
1966 January	16	Cheslatta Lake
1964 February	147	Quanchus Mountains
1963 January	130	Quanchus Mountains
1962 March	76	Quanchus Mountains
1956 February	12	Quanchus Mountains

[1] Possibly Telkwa caribou

Moose were either absent or rare in central BC until the late 1800s when they started to increase in number (Bergerud and Elliot 1986, Spalding 1990, Santomauro *et al*. 2012). Prior to the increase in moose, caribou probably coexisted with a relatively low density of wolves (Bergerud and Elliot 1986). It is unknown why moose were largely absent from BC prior to the 1900's since habitat was abundant and readily available. One possible explanation was that it was related to the "little ice age" (a cool moist period that climaxed about 450 years ago and that began dissipating about 200 years ago; Holland 1976), the end of which coincided with increased moose numbers in BC.

Coinciding with the increase in moose numbers in central BC, was a reduction in numbers and range of caribou. Caribou used to occupy much of the interior portion of the southern half of BC but are now restricted to isolated populations in west-central BC and the mountainous areas of southeastern BC (Spalding 2000). As more moose

occupied BC, predator populations would have had an alternate prey source to feed on. Because moose have a higher reproductive capacity than caribou (younger age of maturity, twinning) and are better able to defend themselves from wolves, moose populations were better able to respond to predation pressure. As caribou populations declined and moose populations increased, predators such as wolves are thought to have switched their primary food source from caribou to moose. Since wolves are now primarily dependent on moose in the southern part of BC, their populations appear to respond to fluctuations in moose numbers and not to fluctuations in caribou numbers as they did historically.

As moose numbers increased and their range expanded in BC, wolf numbers also appeared to increase (Bergerud and Elliot 1986). Caribou and moose generally declined until 1949. From 1949 to 1962, a large-scale wolf poisoning program was implemented in most of BC and ungulate populations increased until about 1968 and then declined again in the 1970's (Bergerud 1978, Bergerud and Elliot 1986, Hoffos 1987). In response, caribou and moose populations in the Tweedsmuir-Entiako area increased until the late 1960's but then started decreasing again in the 1970's (Hatter 1979). Alan Blackwell (pers. comm.) estimated the Tweedsmuir-Entiako caribou population at 1000 caribou in the mid 1950's. Low (1964) estimated the population in 1963 at 600 although it was likely higher.

In the early 1950's, the construction of the Kenney Dam resulted in the flooding of several large lakes and rivers in the Tweedsmuir-Entiako caribou range to create the Nechako Reservoir (see Protected Areas). Prior to the flooding, caribou crossed rivers or narrow sections of lakes to reach winter ranges north of Ootsa and Whitesail lakes and east of Intata and Natalkuz lakes. After the flooding, some of the narrow lake and river crossings turned into large lakes. For a period of years following the flooding, large amounts of debris accumulated along the shores of the reservoir. Many caribou were reported to have drowned while attempting their migrations (M. Roberson, pers. comm.). In addition, in the early 1970's, forest harvesting began in the area north of Whitesail and Ootsa lakes (Hatter 1979). Land clearing for agricultural purposes on the north side of Ootsa Lake may have also contributed to a reduction of available winter range.

Hatter (1979) and Bergerud (1978) attribute part of the decline in the 1970's to overhunting. An open season on caribou cows, hunting from the lake and at the rail portage, and hunters accessing the Quanchus

Mountains by aircraft, all likely contributed to excessive hunting pressure.

Radio-collared caribou studies in the Tweedsmuir-Entiako and Itcha-Ilgachuz-Rainbow areas (1983 to present) indicate that although some caribou from those populations winter in the same area during some winters, caribou always returned to their traditional summer ranges (R. Marshall, pers. comm., J. Youds, pers. comm.). Therefore, it is unlikely that any declines in the Tweedsmuir-Entiako caribou population resulted from emigration to the nearby Itcha-Ilgachuz or Rainbow populations. Reduction of use of winter ranges north of Ootsa Lake and east of Intata Reach may have also been a function of the decline in caribou numbers. As caribou populations increase, they expand their ranges so that their overall population density stays constant (Bergerud *et al*. 1984a). Conversely, as caribou populations decline, their ranges shrink. For the Tweedsmuir-Entiako caribou, the population decline in the 1970's may have contributed to caribou reducing or eliminating their use of historically used winter ranges.

2.4 Current Population Status and Trend

The size of the Tweedsmuir-Entiako caribou population has been difficult to determine. Because a large part of the population is found below treeline during all seasons, total count surveys of alpine areas often used for Northern Caribou populations are unreliable. However, during some years, a larger portion of the population may be found above treeline during the rut or during winter. Three methods for estimating population size have been attempted for the Tweedsmuir-Entiako population: total counts; mark/capture using radio-collared caribou as the marked sample; and a stratified random block survey.

The highest total count of caribou in the Tweedsmuir-Entiako caribou population was 426 during a ground survey conducted in July 1963 (Table 3). However, because the survey only included the alpine areas in the Quanchus Mountains, it was likely not representative of the total population at the time. In March 1982, 368 caribou were counted during a fixed-wing survey in the Fawnie Mountains. In October 1986, 408 caribou were estimated, and in October 1987, 471 caribou were estimated in the Tweedsmuir-Entiako population based on a mark-resight method that corrected the number of caribou counted in the Quanchus Mountains by the proportion of radio-collared caribou that were seen during each survey. The October 1987 mark-recapture estimate was a more reliable estimate since a greater proportion of the radio-collared

caribou were in the survey area, and a greater total number of caribou were counted in the survey area (Table 3). An attempt to conduct a Stratified Random Block count of caribou in the Entiako area in February 1990 was abandoned due to poor sightability conditions and a high degree of caribou mobility. The current estimate of 200-300 caribou (Environment Canada 2014) is based on a helicopter flight for radio-collared caribou in March 2003. The lower end of the estimate was extrapolated based on population growth information from radio-collared caribou from 2006 to 2009. Since 2003, the highest number of caribou counted during any survey was 166 caribou counted during a calf survival survey in October 2007 (Cichowski 2010). In October 2013, 94 caribou were counted during a survey of the Quanchus Mountains.

Table 3. Population estimates for the Tweedsmuir-Entiako caribou population (from Cichowski and MacLean 2005).

Year	Population Estimate	Number Counted – population survey area	Number counted – total survey area	Method	Population survey area	Total survey area
1963	600	426	426	Ground Survey Total Count Summer	Quanchus Mountains	Quanchus Mountains
1982		368	368	Fixed-wing Survey Total Count Winter	Fawnie Mountains	Fawnie Mountains
1986	408	104	137	Helicopter Mark/recapture Rut	Quanchus Mountains	Northern Tweedsmuir Park
1987	471	202	245	Helicopter Mark/recapture Rut	Quanchus Mountains	Northern Tweedsmuir Park
1990	N/A[1]	N/A	N/A	Helicopter Stratified Random Block Winter	Entiako winter range	Entiako winter range
2003	300		113	Helicopter Calf survival + Aerial Search Winter	Entiako winter range	Entiako winter range

[1] N/A = not available; Attempted Stratified Random Block survey – aborted due to poor survey conditions

Pregnancy rates for caribou are typically high but calf mortality during the first few months of life is also high (Bergerud 1974a, Seip and Cichowski 1996). For the Tweedsmuir-Entiako caribou population, pregnancy rate of adult female caribou radio-collared between 1983 and 2009 was 86.8% (Table 4). Most calf mortality occurred within the first few weeks of life in June and then during summer. During June post-calving surveys, an average of 49% (range: 19-73%) of the radio-collared cows were found with calves but by October, 21% (range: 8-46%) of the radio-collared caribou had surviving calves (Figure 4). Relatively little calf mortality occurred between the October and March surveys with calf survival averaging 11.5% in March.

Table 4. Pregnancy rate of radio-collared caribou in the Tweedsmuir-Entiako population, 1983-2009 (Sources: Cichowski and MacLean 2005, Cichowski 2010).

Capture session	N	# pregnant
Feb 1987	7	6
Jan 1993	11	11
Dec 1996	5	2
Jan 2000	21	19
Nov 2001	2	2
Jan 2002	3	3
Jan 2007	25	21
Dec 2007	9	8
Total	**83**	**72**

During calving, many Northern Caribou use high elevation alpine or subalpine habitat as an anti-predator strategy (Bergerud *et al*. 1984b, Bergerud and Page 1987). At that time, the mountains may still have considerable snow cover and food availability is often limited. By calving high in mountains, caribou forgo high quality forage at low elevations to distance themselves and their calves away from predators such as wolves (Bergerud and Page 1987, Seip 1989). Another anti-predator calving strategy is to calve on islands in lakes (Shoesmith and Storey 1977). Adult female radio-collared caribou in the Tweedsmuir-Entiako population used both anti-predator strategies. Adult female radio-collared caribou that calved in alpine or subalpine habitat, or below treeline on islands, had higher calving success than caribou that calved below treeline (Cichowski and MacLean 2005). In some years, the only adult female caribou below treeline that had calves were found on islands. The main islands used for calving were in Ootsa (Whitesail) and Eutsuk lakes.

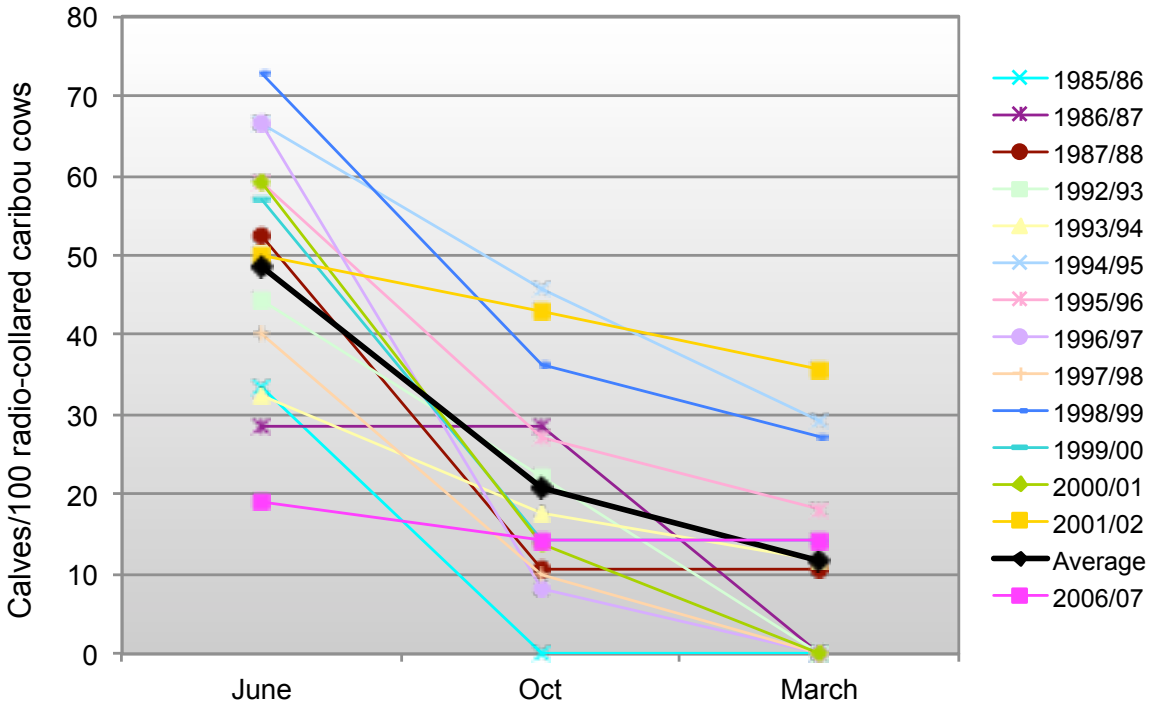

Figure 4. Calf/cow ratios for radio-collared adult female caribou in the Tweedsmuir-Entiako population during spring (June), fall (Oct/Nov), and winter (March) calf survival surveys, 1983-2009 (Sources: Cichowski and MacLean 2005, Cichowski 2010).

Although limited data is available on causes of calf mortality for the Tweedsmuir-Entiako caribou population, in general, calf mortality for Northern Caribou may include predation, abandonment, accidents and inclement weather (Northern Caribou Technical Advisory Committee 2004). The only cause of death determined for a caribou calf in the Tweedsmuir-Entiako area was a deformed (hydrocephalic) calf that died at birth that was recovered during a June calf survival survey (R. Marshall, unpublished data). Cause of death for dead calves found during ground surveys in the Itcha Mountains (just south of the study area) included wolf predation, eagle predation and birth-related defects (D. Cichowski, unpublished data).

Annual adult female mortality rate has ranged from 0 to 40% (for years when the number of radio-collared caribou was >10), based on both the proportion of adult female radio-collared caribou that were present in April each year that died within the next 12 months, and on the mortality

rate calculated using the Kaplan-Meier method, which incorporates caribou that were newly collared any time during the year (Table 5). Both adult female survival rate calculations were similar and showed similar patterns between 1983 and 2009 for years with complete data sets (Table 5). Adult male mortality rates from 1990/91 to 2002/03 ranged from 0 to 33%; however, sample sizes were <10 for most of those years (Cichowski and MacLean 2005).

A total of 70 adult female mortalities and 11 adult male mortalities were detected between 1983 and 2009 (Table 6). Cause of death was not determined for 62 adult mortalities; 4 of the unknown causes of death were not predator-related while 8 were possibly due to wolf predation and 4 were possibly due to bear predation. Bear predation and wolf predation accounted for the majority of known causes of mortality. Although wolf predation appears to be a major cause of adult caribou mortality, wolves have rarely been seen during caribou surveys on the Tweedsmuir-Entiako caribou range. Other causes of mortality included wolverine predation, accident, and hunter kill. Of the 70 adult female mortalities, timing of the mortality was not determined for 7 with unknown causes; those 7 are excluded from Figure 5.

Most radio-collared adult female mortality occurred during spring and summer while caribou were using or traveling to and from summer ranges (Figure 5). Bear predation occurred primarily during early summer (May-July) in Tweedsmuir Park, whereas there did not appear to be any seasonal pattern for wolf predation. Mortalities were infrequent during winter months with only 9 of 63 female mortalities occurring from December to March. Although fewer data were available for adult male radio-collared caribou, mortality patterns were similar to adult female radio-collared caribou with most mortalities occurring during spring and summer while caribou were using summer ranges (Cichowski and MacLean 2005).

Calf recruitment based on radio-collared caribou was variable throughout the study (Table 5). Calf recruitment based on the total number of caribou counted during March surveys was more consistent and averaged 12.7 calves/100 adults. Calf recruitment and adult female mortality rates were both reliable during 17 years from 1983 to 2009 (Table 5). Of those 17 years, adult female mortality exceeded calf recruitment for 6 years, adult female mortality was similar or less than calf recruitment for 7 years, and calf recruitment exceeded adult female mortality for 3 years.

Table 5. Calf recruitment, adult female mortality rates, and population growth rates for the Tweedsmuir-Entiako caribou population, 1983-2009 (Sources: Cichowski and MacLean 2005, Cichowski 2010).

	Adult Female Mortality				Calf Recruitment					Estimated population growth rate[6] (λ)		
	Proportion		Kaplan-Meier		Radio-collared adult females		Total caribou counted					
Year	N[1]	Mortality rate	N[2]	Mortality rate	N[3]	calves/ 100 cows	N[4]	calves/ 100 adults	Estimated Trend[5]	λ	λ_{low}	λ_{high}
1983/84	0		0									
1984/85	10	0.0	20	0.0								
1985/86	17	29.4	17	29.4	12	0.0	81	9.9	-	0.763	0.753	0.777
1986/87	12	8.3	21	8.3	7	0.0	134	11.2	0/+	0.991	0.987	1.023
1987/88	19	31.6	20	30.0	19	10.5	123	9.8	-	0.746	0.657	0.769
1988/89												
1989/90							83	14.5				
1990/91	14	14.3	25	10.7								
1991/92	16	31.3	21	26.1								
1992/93	10	10.0	42	9.1	9	0.0	58	13.8	-/0	0.996	0.998	1.071
1993/94	35	22.9	40	21.1	34	11.8			-			
1994/95	25	8.0	27	8.0	24	29.2			+			
1995/96	22	18.2	23	18.0	22	18.2			0			
1996/97	13	0.0	23	0.0	12	0.0	64	12.5	0/+	1.070	1.067	1.100
1997/98	15	6.7	22	5.9	10	0.0	67	9.0	0/+		0.996	1.024
1998/99	15	6.7	18	6.7	11	27.3	78	9.0	0/+	1.001	0.988	1.017
1999/00	9	55.6	43	40.2	7	14.3	92	7.6	-		0.623	0.636
2000/01	23	21.7	33	17.3	22	0.0	108	7.4	-	0.875	0.867	0.887
2001/02	15	6.7	38	5.6	15	33.3	147	21.1	+	1.144	1.096	1.173
2002/03	16	12.5	34	5.9			92	22.8	+	1.194	1.109	1.194
2003/04												
2004/05												
2005/06												
2006/07	8	25.0	9	16.7	8	12.5	107	15.8	-/0	0.914	0.899	0.923
2007/08	24	29.2	29	24.8	24	12.5	117	10.3	-	0.805	0.797	0.808
2008/09	21	19.1	23	17.6	21	14.3	68	7.4	-/0	0.862	0.860	0.868

[1] Mortality rate based on proportion of radio-collared caribou that died during the year; N=radio-collared caribou alive at the beginning of the year (April) minus caribou with unknown survival fates (e.g. collar failure, collared removed, etc.)

[2] Kaplan-Meier mortality rate based on monthly survival; N=radio-collared caribou alive at the beginning of the year (April) plus new collars put on that year

[3] N=number of radio-collared female caribou alive in April whose calf status was known for all 3 calf survival surveys (June, October, March); calves associated with female caribou who died, were also assumed to have died

[4] N=number of all adults counted (collared + uncollared) during March calf survival surveys

[5] Estimated population trend subjectively compares both adult female mortality rates to both calf recruitment rates

[6] Estimated population growth rate, λ = adult female survival rate/(1-R) where R = # female calves/(# female calves + # female adults); to calculate # of female calves, a calf female to male sex ratio of 1:1 was assumed and applied to the # total calves counted in March; to calculate # of female adults, the adult male to adult female ratio from the fall survey of the same year was applied to the number of adults counted in March; to provide a range for the population growth rate, λ_{low} was calculated using the lowest adult male to adult female ratio from fall surveys conducted from 1983 to 2009 (17 adult males/100 adult females) and λ_{high} was calculated using the highest adult male to adult female ratio from fall surveys over the 20 year study (45 adult males/100 adult females)

Table 6. Causes of adult female and adult male radio-collared caribou mortalities, 1983-2009 (Sources: Cichowski and MacLean 2005, Cichowski 2010).

Cause of death[1]	# adult female mortalities	# adult male mortalities	Total
Unknown	42	3	45
Unknown – not predation	4	0	4
Unknown – possible wolf predation	6	2	8
Unknown – possible bear predation	2	2	4
Unknown – possible predation	1	0	1
Suspected wolf predation	5	1	6
Suspected bear predation	7	2	9
Suspected wolverine predation	2	0	2
Accident	1	0	1
Hunter kill	0	1	1
Total	70	11	81

[1]"Suspected predation" categories include mortalities where evidence provided in the mortality investigation description indicated a high degree of certainty of the cause of death; "Unknown – possible predation" categories include mortalities where there was a low degree of certainty of the cause of death

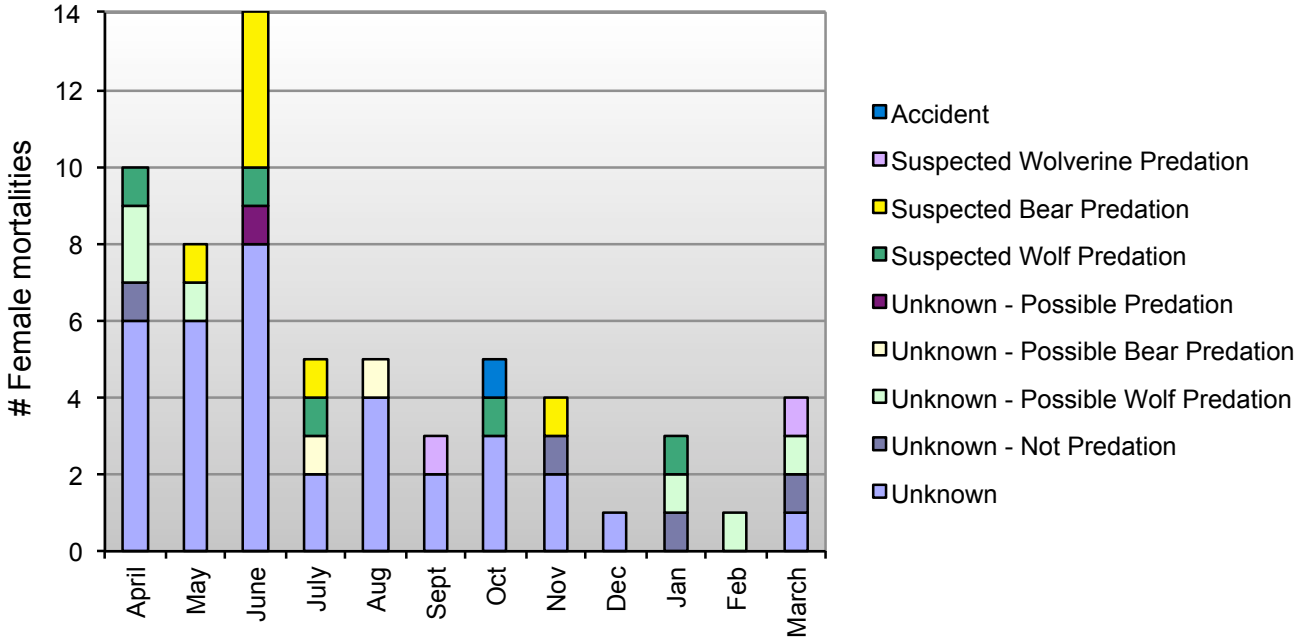

Figure 5. Cause and timing of adult female radio-collared caribou in the Tweedsmuir-Entiako population from 1983 to 2009 (Sources: Cichowski and MacLean 2005, Cichowski 2010).

The population growth rate (λ) was estimated as decreasing (λ<1.0) for 7 of 12 years for which data was available, stable (λ=1.0) for 2 years and increasing (λ>1.0) for 3 years (Table 5). The population growth rate for the 3 most recent years indicates a declining trend (Table 5). The combined population growth rate (product of all available population growth rates) suggests that the population may have declined by 54% since 1983.

Unhunted populations are considered stable when calves make up about 15% of the local population in late winter, while higher or lower proportions indicate increasing or decreasing populations, respectively (Bergerud 1980). For the Tweedsmuir-Entiako caribou population, % calves exceeded 15% only during 2001/02 and 2002/03 and 2007/08 (Table 5).

A population viability analysis completed in 2005 predicted that in 20 years, the Tweedsmuir-Entiako caribou population would decline by 50% using bull survival data from the population (based on a low sample size),

or decline by 70% assuming a more typical bull mortality rate (Cichowski and MacLean 2005).

In summary, although there are few reliable estimates of caribou numbers for the Tweedsmuir-Entiako population, other information suggests that the population was much higher in the early 1960s (perhaps 600-1000) than it is today and that currently the population is likely still declining (Hatter 1979, Cichowski and MacLean 2005, Cichowski 2010). Numerous summer and fall observations in the past indicate higher numbers of caribou seen in the Quanchus and Chikamin Mountains than are currently being observed. The radio-collared caribou studies also indicate that during most years, calf survival has been low and adult mortality has been moderate to high. All these observations suggest that the population has declined since the early 1960s.

2.5 Habitat and Range Use

(Adapted from Cichowski and MacLean 2005).

Tweedsmuir-Entiako caribou summer in Tweedsmuir Park and the area to the west, and winter mainly in the Entiako area (Cichowski 1993, Cichowski and MacLean 2005, Cichowski 2010). Figures 6-9 show summer and winter distributions prior to (Figures 6, 8) and following mountain pine beetle attack (Figures 7, 9).

Spring migration usually begins in late April as caribou start moving north across Tetachuck Lake (Figures 6-7). They spend some time on the north side of the lake before moving north to the Chelaslie River drainage and into Tweedsmuir Park through low elevation valleys. From there, some caribou continue west and cross Whitesail Lake to reach calving areas to the west. Other caribou migrate from the Entiako area along the south and north shores of Eutsuk Lake to reach summer ranges in and beyond Tweedsmuir Park.

In summer caribou use a variety of habitats. During calving in early June, some adult female caribou use high elevation alpine or subalpine habitat, while others calve below treeline. Caribou with calves are generally found at higher elevations than caribou without calves (Figure 10). For the rest of the summer, caribou are found in a variety of habitats ranging from alpine to low elevation coastal forests in the headwaters of the Gamsby River, foraging for lush seasonal vegetation as well as lichens (Cichowski 1993).

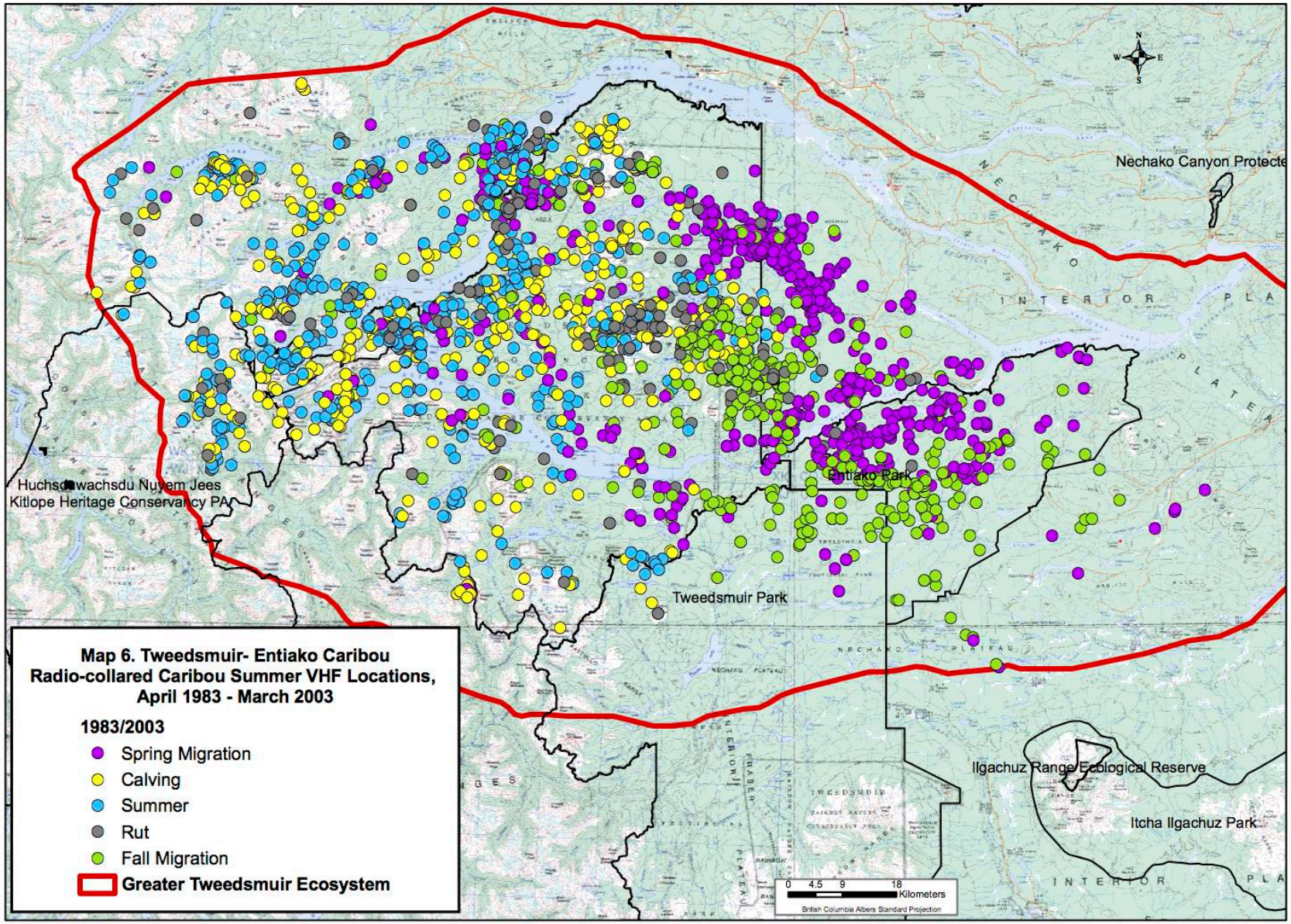

Figure 6. Tweedsmuir-Entiako radio-collared caribou summer VHF locations, April 1983 – March 2003 (from Cichowski 2010).

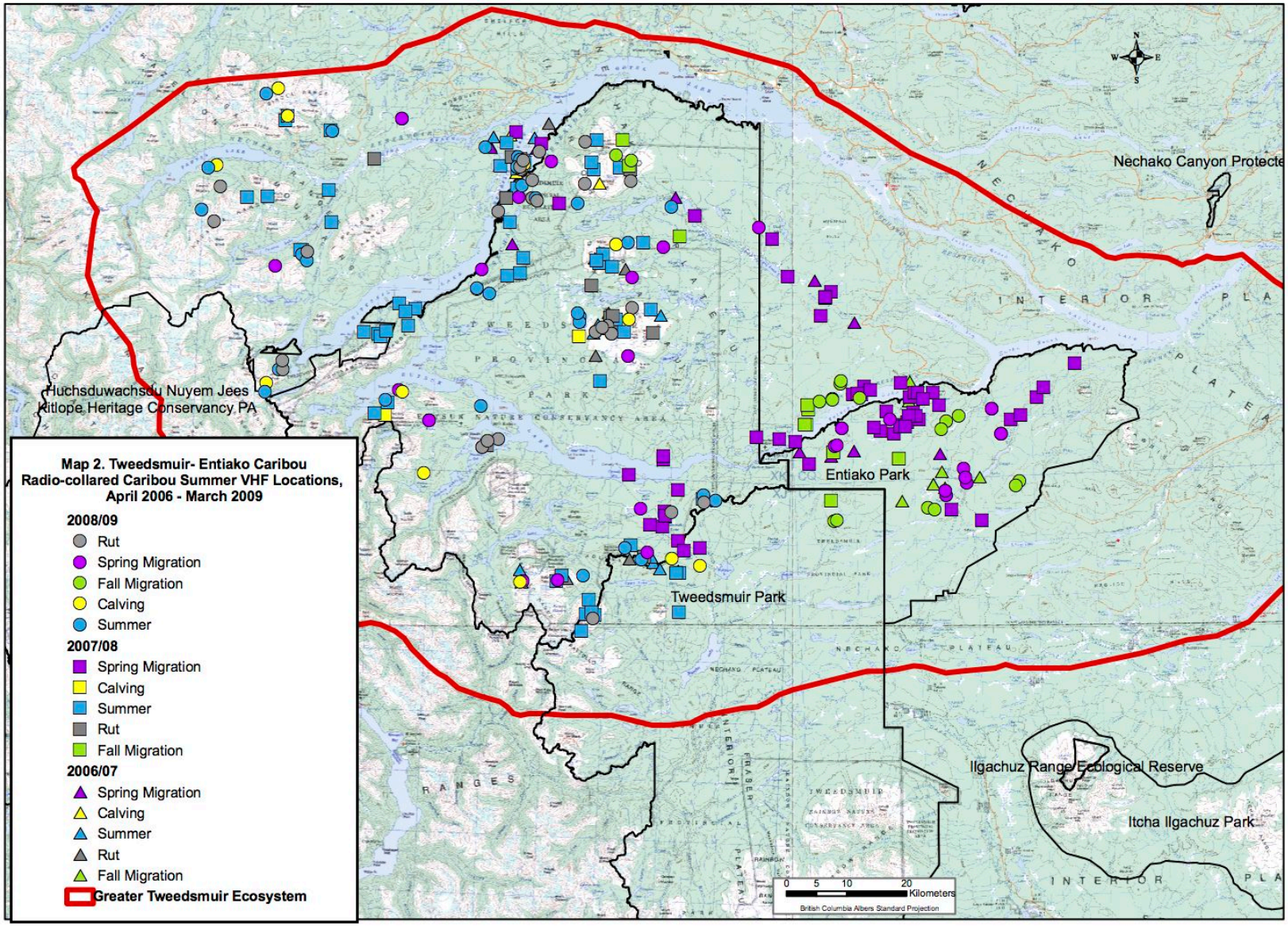

Figure 7. Tweedsmuir-Entiako radio-collared caribou summer VHF locations, April 2006 – March 2009 (from Cichowski 2010).

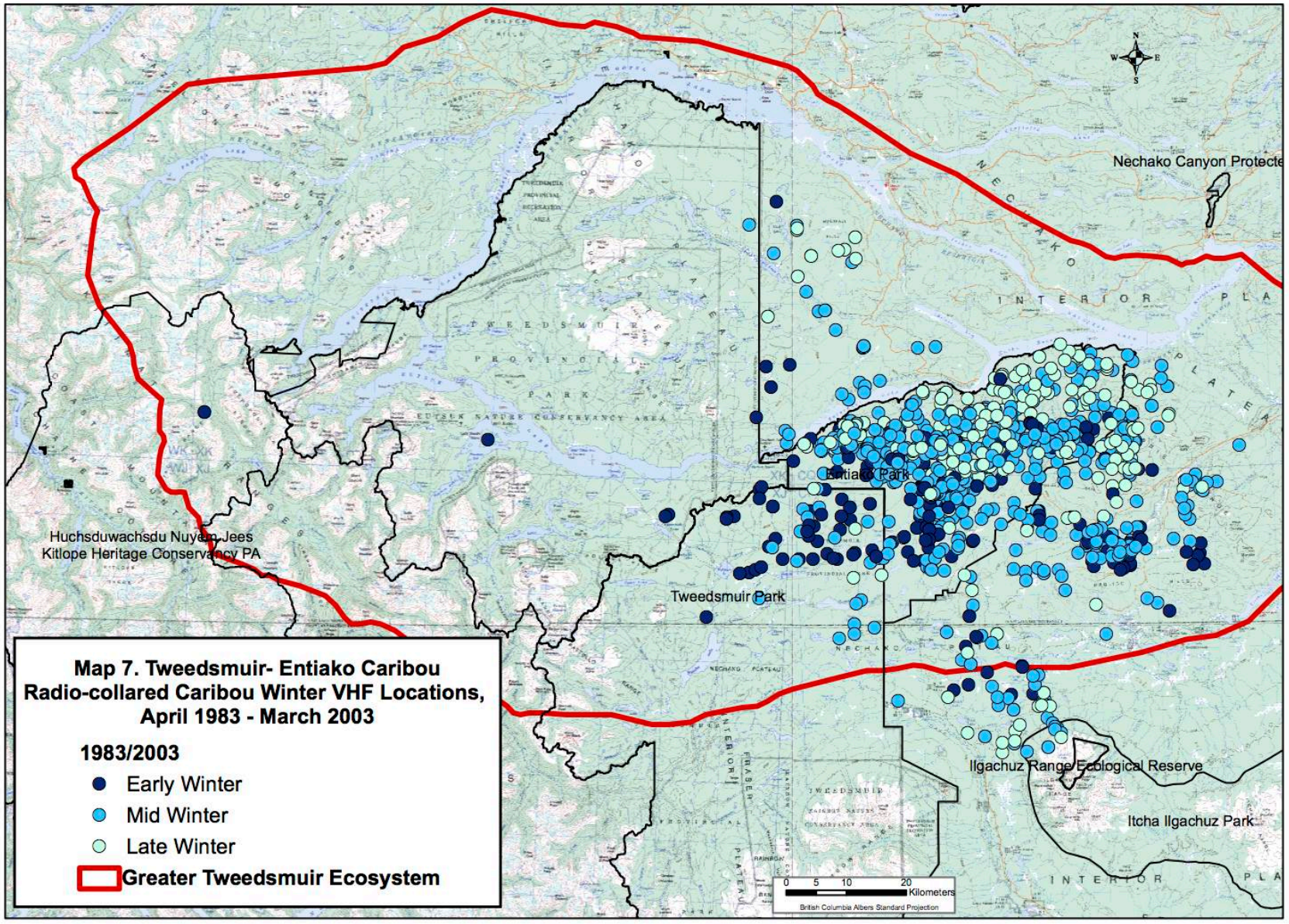

Figure 8. Tweedsmuir-Entiako radio-collared caribou winter VHF locations, April 1983 – March 2003 (from Cichowski 2010).

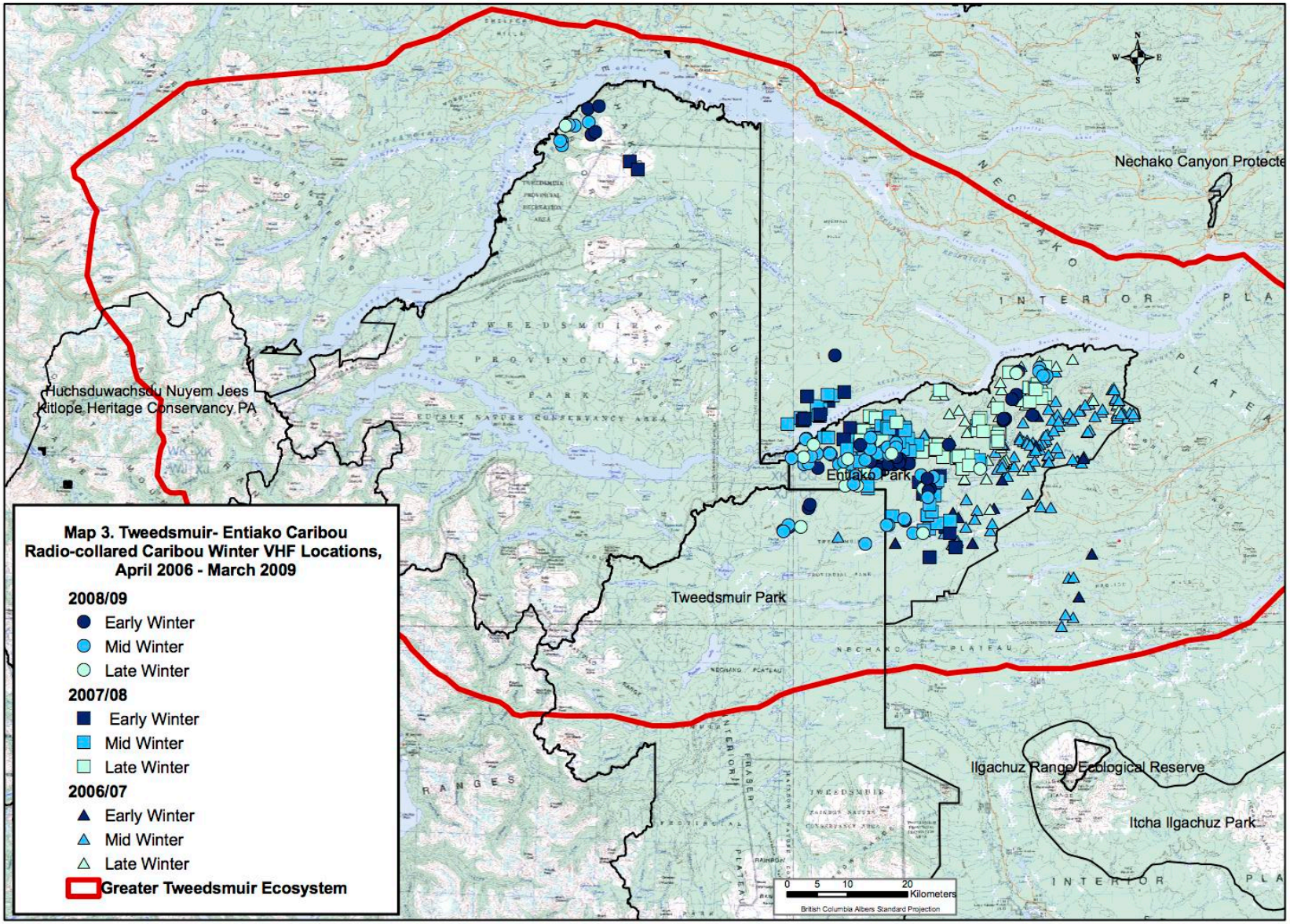

Figure 9. Tweedsmuir-Entiako radio-collared caribou winter VHF locations, April 2006 – March 2009 (from Cichowski 2010).

During the fall rut, caribou are found throughout northern Tweedsmuir Park in small rutting groups; however, some caribou congregate in larger rutting groups in the Quanchus Mountains.

In late October and early November, caribou begin moving east and south towards winter range in the Entiako area. During fall migration, caribou move east out of Tweedsmuir Park along Eutsuk Lake or east and south through the Quanchus Mountains and then across Tetachuck Lake. Fall migration is likely triggered by snowfall at higher elevations where caribou were rutting.

By early December, most caribou have returned to winter range south of Tetachuck Lake in the Entiako Lake area (Figures 8-9). During some winters, some caribou winter north of Tetachuck Lake in the East Ootsa area. The area surrounding Entiako Lake has been used consistently by caribou throughout the years and is considered the core of the winter range.

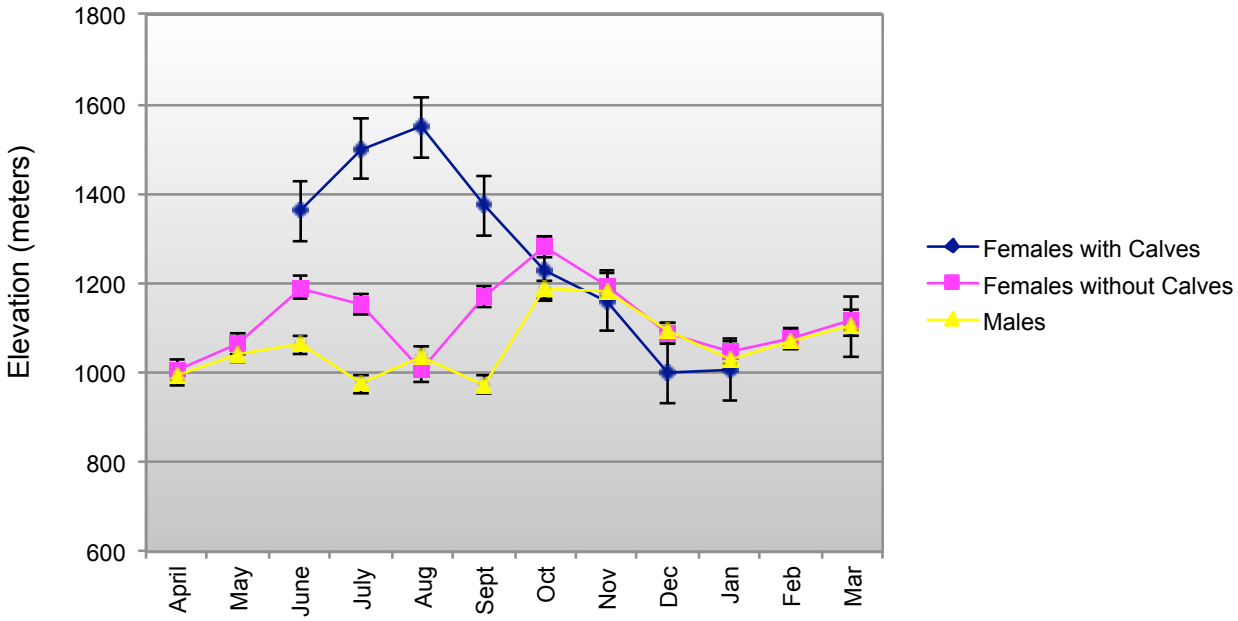

Figure 10. Average monthly elevation for VHF radio-collared caribou in the Tweedsmuir-Entiako population, 1983-2003 (from Cichowski and MacLean 2005).

During winter, caribou use mostly mature dry pine forests and feed primarily by digging through the snow (cratering) to feed on terrestrial lichens. Caribou seem to prefer terrestrial lichens but also feed on arboreal lichens when snow conditions make cratering for terrestrial lichens difficult, or in forested wetlands or wetland fringes where trees are heavily laden with arboreal lichens. The relative use of terrestrial lichens and arboreal lichens may vary between winters depending on snow conditions; arboreal lichen use also tends to increase slightly in late winter when snow conditions make cratering difficult (Cichowski 1993). During winter, caribou are also often found on lakes, cratering for slush or free water.

In the Entiako area, some caribou exhibit a shift in geographic use within the winter range. During early winter, caribou are found on the south side of Tetachuck Lake before dispersing to the rest of the winter range by January. Animals are found throughout the winter range during most of the winter, ranging from Tetachuck Lake, south to Majuba Lake and south and east to Laidman Lake and the Fawnie Mountains.

By late February, a portion of the population moves into the Fawnie Mountains to forage on terrestrial lichens on windswept alpine slopes or on arboreal lichens in subalpine forests. However, annual use of alpine and subalpine habitat is not consistent between years. In early March 1982, 368 caribou were found in the Fawnie Mountains; those caribou were assumed to represent a large portion of the population (Marshall 1985). In some years, no caribou have been found using the Fawnie Mountains. During years when caribou are found in the Fawnie Mountains in late February and early March, they represent about 25% of the population.

In mid-late March, some caribou move to the area near the mouth of the Entiako River prior to moving to the south side of Tetachuck Lake in preparation for spring migration. Although terrestrial lichens are not as abundant in the area near the mouth of the Entiako River as they are in other parts of the winter range, the area is 100-200 meters lower in elevation than most of the rest of the winter range and by mid-late March, patches of snowfree ground are evident, especially under trees. This shift in range in mid-late March corresponds to an increase in sedges, grasses and forbs in the diet (Cichowski 1993).

Although Tweedsmuir-Entiako caribou usually return to winter range south of Tetachuck Lake, their use patterns within the winter range may vary from year to year. For example, in 1983, many radio-collared caribou were found in the Laidman Lake area for most of the winter.

Only a few radio-collared caribou have used that area since and usually only for a brief period of time. Less use of the area may potentially be a result of forest harvesting or range rotation. Range rotation by caribou within their winter range has been suggested to be a response to the ecology of their main food source, lichens. Because most terrestrial caribou forage lichens do not appear until 30-50 years following disturbance, caribou use of other parts of their winter range could allow lichens on one part of their winter range time to recover.

During some years, Tweedsmuir-Entiako caribou have wintered outside of what is considered their main winter range. Individual caribou have been found as far south as the Dean River and on the north side of the Ilgachuz Mountains (Figures 8-9). In March 1991, many radio-collared caribou were found east of the Fawnie Mountains, and in 2008/09, one radio-collared caribou used low elevation forested habitat in northern Tweedsmuir Park all winter.

2.6 Caribou Winter Habitat Selection and Feeding Ecology

Winter habitat requirements for the Tweedsmuir-Entiako caribou population include:

- access to an adequate supply of terrestrial and arboreal lichens;
- snow interception by the forest canopy to allow movement within the winter range; and,
- large tracts of winter range where caribou can distance themselves away from other prey species and predators, and can continue rotating their wintering areas.

An adequate food supply and adequate snow interception are necessary for caribou to forage and travel within their winter range. Large tracts of winter range are necessary so that caribou can distance themselves away from high value habitats for other prey and from predators. Although other prey species, primarily moose, exist on the winter range, predation risk for caribou may be lower for caribou that use habitat patches that are not close to moose habitat. Because several historic winter ranges are no longer being used (north of Ootsa and Whitesail lakes, east of Intata Reach, Cheslatta Lake area), the Entiako area is now extremely important for maintaining enough winter range to ensure a supply of winter forage and for predator avoidance.

2.6.1 Winter habitat use and selection

Winter habitat use and selection by Tweedsmuir-Entiako caribou has been examined using the caribou habitat map and forest cover mapping (Cichowski 1993, 2010). During winter, at low elevations, caribou primarily use and select habitats with higher levels of terrestrial lichen abundance (Dry Lichen/Lichen Moss [DLLM], Lichen Moss [LM], Dry Lichen/Lichen Moss Mosaic [DLLM Mosaic]) and avoid habitats where abundance of terrestrial lichens is low or where terrestrial lichens are absent (Moss/Seepage Forest – Aspen Forb [MSF/AF]) (Cichowski 1993, 2010). Use of MSF/AF increases in late winter, which corresponds to caribou moving to the area near the mouth of the Entiako River and south of Euchu Reach, where habitats with abundant terrestrial lichens are less available. This area is slightly lower in elevation than the rest of the winter range and snow cover is more patchy in this area during late winter. An increase in sedges, grasses and forbs in the diet suggests that caribou may be seeking out vegetation in snowfree patches in this area during late winter (Cichowski 1993).

Mature pine stands are the dominant forest cover at low elevations (below the ESSF) on the Tweedsmuir-Entiako caribou winter range (Cichowski 1993, 2010). At low elevations, caribou primarily use and select mature pine stands throughout the winter (Cichowski 1993, 2010). They also use immature pine stands during winter, but most extensively in early and mid winter, corresponding to use of the area just south of Tetachuck Lake. Use of mature pine stands generally increases as winter progresses (Cichowski 1993, 2010). Mature pine stands selected are predominantly sites with lower productivity (Cichowski 1993), where less competition from vascular plants results in more favourable growing conditions for terrestrial lichens. Caribou also select wetlands, primarily during early winter (Cichowski 2010). Use of pine/spruce and spruce stands is generally lower than the availability of those stand types across the winter range (Cichowski 1993, 2010).

2.6.2 Winter feeding ecology

At low elevations, caribou preferentially crater for terrestrial lichens in mature pine forests, but feed on both terrestrial lichens and arboreal lichens, wherever they are available, and throughout the winter (Cichowski 1993, 2010). Caribou crater for terrestrial lichens most frequently in pine stands, followed by pine/spruce stands (Cichowski 1993, 2010). They also crater for terrestrial lichens in black spruce fringes around wetlands (Cichowski 2010). Arboreal lichen feeding is the primary

foraging activity in spruce stands and forested wetlands (Cichowski 1993, 2010).

As winter progresses, cratering for terrestrial lichens decreases while arboreal lichen feeding increases (Cichowski 1993, 2010). Snow conditions (hardness, depth) are the main factors influencing frequency of cratering (Cichowski 1993, 2010). In 2006/07, a deep snowfall early in the winter was followed by several freeze/thaw/rain cycles (Cichowski 2010). That winter, caribou cratered in up to 1 meter of snow in early winter when snow was still unconsolidated, but by late winter when the snowpack hardened (despite a generally lower snowpack), very few craters were observed (Cichowski 2010). During other years when snow pack was less consolidated in late winter (although similar in depth to 2006/07), caribou continued to crater throughout the winter (Cichowski 1993, 2010). During the early deep snow year of 2006/07, caribou cratered in "trenches"; i.e. they started a crater then expanded it, often in a linear pattern (Cichowski 2010).

Terrestrial lichen crater sites have greater terrestrial lichen cover, more open canopies, higher snow depths and higher snow penetrability than areas where caribou are travelling but not cratering (Cichowski 1993, 2010). Because terrestrial lichens are poor competitors against most other types of vegetation, they grow better on sites where growing conditions for other vegetation (including trees) is poor (Johnson 1978). Therefore, these sites tend to have lower densities of trees and more open canopies, which intercept less snow resulting in higher snow depths.

On the low elevation portion of the winter range, in addition to cratering for terrestrial lichens, caribou also occasionally crater for slush/water on lakes and for horsetails at the base of trees in mature spruce stands (Cichowski 1993, 2010). Following the mountain pine beetle epidemic, caribou also occasionally cratered at the base of mountain pine beetle killed trees (Cichowski 2010). Terrestrial lichens were mostly absent from "tree craters". Although it is unclear what caribou were cratering for, they may have been seeking mushrooms associated with secondary decay agents in dead trees (Cichowski 2010).

During some years, a portion of the population moves into high elevation habitat in the Fawnie Mountains for part of the winter. In subalpine habitat, caribou forage exclusively on arboreal lichens, and on windswept alpine slopes, they crater for terrestrial lichens and other vegetation (Cichowski 1993, 2010).

2.7 Effects of the Mountain Pine Beetle Epidemic on the Tweedsmuir-Entiako Caribou Population

(Adapted and updated from Cichowski 2010)

The scale of recent mountain pine beetle epidemic is unprecedented on caribou ranges and prior to this epidemic no information was available on the effects of mountain pine beetles on caribou or caribou habitat (Cichowski 2011). The Tweedsmuir-Entiako caribou population was the first caribou population to experience the mountain pine beetle epidemic (Cichowski 2010). The current mountain pine beetle epidemic was detected in the East Ootsa and North Tweedsmuir Park areas in the mid 1990s (Garbutt 1996). By the early 2000s, mountain pine beetle numbers reached epidemic levels on the Entiako winter range. By 2006, most mature lodgepole pine trees on the Tweedsmuir-Entiako caribou winter range had been attacked and had lost their needles, and were in the "grey attack" phase of the epidemic (Cichowski 2007). The mountain pine beetle epidemic on the Tweedsmuir-Entiako caribou range is currently in the grey attack phase.

The potential effects of the mountain pine beetle epidemic include changes to habitat (food supply, snow conditions, blowdown), changes to caribou range use/habitat use, and changes to predator-prey dynamics (Cichowski 2011). These effects interact and may vary at different scales and during different stages of the mountain pine beetle epidemic (Cichowski 2007). Two studies have addressed the effects of mountain pine beetles on the Tweedsmuir-Entiako caribou population. In 2001, permanent plots were established in the East Ootsa area and Entiako Park, and remeasured in 2003, 2005, 2007 and 2011 to assess the effects of mountain pine beetle attack on terrestrial lichens and other habitat characteristics including coarse woody debris, stand structure and regeneration (Cichowski and Haeussler 2013). And, from 2006 to 2009, a radio-collared caribou study was conducted to assess the impacts of mountain pine beetle attack on caribou and caribou habitat use during the grey phase of the attack (Cichowski 2010).

Initially following mountain pine beetle attack, dwarf shrubs, primarily kinnikinnick, increased likely due to loss of live tree function (nutrient and water uptake) while terrestrial lichen abundance decreased (Cichowski *et al*. 2008). By 10 years following attack, kinnikinnick abundance decreased on drier sites and terrestrial lichen abundance started to rebound (Cichowski and Haeussler 2013). Terrestrial lichens have also declined on other winter ranges with mountain pine beetle attack

(Cichowski *et al*. 2009, Seip and Jones 2009). Arboreal lichen abundance is expected to increase following mountain pine beetle attack due to increased ventilation in stands (T. Goward, pers. comm.). Because caribou populations are limited by predation and not food supply, caribou numbers on ranges where predators occur are generally much lower than what the food supply can sustain (Seip 1991, Bergerud 1996). Food supply would have to be dramatically reduced before caribou numbers are affected. Also, caribou forage on both terrestrial and arboreal lichens and often focus on arboreal lichens when snow conditions, particularly snow hardness, make cratering difficult such as during late winter (Bergerud 1974b, Edmonds and Bloomfield 1984, Johnson 2000, Szkorupa 2002, Jones 2007). Consequently, even if terrestrial lichen abundance is significantly reduced, caribou can still forage on arboreal lichens.

Other changes to caribou habitat include changes in snow conditions or increased blowdown, making it more difficult for caribou to travel through mountain pine beetle-killed stands. From 2001 to 2007, almost no mountain pine beetle-attacked trees had fallen on terrestrial lichen plots in the Entiako area, but falldown rate increased by 2011 (Cichowski *et al*. 2008, Cichowski and Haeussler 2013). Also, very little blowdown was observed on the winter range from the helicopter during winter site investigations conducted from 2006//07 to 2008/09 (Cichowski 2010), suggesting that blowdown was not a factor that may have potentially affected caribou travel during the 3-year caribou study. Neither the lichen study nor the caribou study were designed to address changes in snow conditions following mountain pine beetle attack so no information is available on how snow conditions have changed in mountain pine beetle-attacked stands on the Tweedsmuir-Entiako caribou winter range.

Although caribou numbers are not expected to decrease due to a reduction in terrestrial lichen abundance, caribou range use and habitat use patterns may change if caribou start focusing on arboreal lichens or other forages. Tweedsmuir-Entiako caribou range use patterns were similar during both the MPB-Grey attack and pre-MPB periods. During the MPB-Grey attack stage, caribou continued to summer in northern Tweedsmuir Park and return to the Entiako Park area for winter. Even if caribou had moved to a new area, no advantage would have been gained because the entire region has been affected by the mountain pine beetle epidemic.

Within the winter range, caribou consistently used low elevation forested habitat each year both prior to mountain pine beetle attack and during the MPB-Grey attack stage (Cichowski 2010). Some caribou used

subalpine and alpine habitat during one winter in both the pre-MPB and MPB-Grey attack studies; those caribou used low elevation forests in other years of both studies (Cichowski 2010). Snow hardness appears to be the primary factor triggering caribou to move into high elevation habitat on the Entiako winter range (Cichowski 2010). Snow hardness also triggers caribou movement to higher elevations on the Kennedy-Siding caribou winter range (Jones 2007, Seip and Jones 2009, 2010). On that range, caribou generally remain on low elevation winter range until January and then move into subalpine habitat for the rest of the winter. Caribou movements to high elevation habitat could either be in response to poor cratering conditions at low elevations or to improved snow conditions for traveling to subalpine habitat. Seip and Jones (2009) found that GPS collared caribou occasionally moved up to the subalpine for a few days at a time while they were using low elevation winter range, suggesting that travel to subalpine habitat was not restricted during early winter. Caribou movement into subalpine habitats is more likely a response to reduced cratering efficiency at lower elevations.

Although individual caribou generally return to the Entiako winter range each year, they may use different parts of the winter range, or areas outside of the main winter range during different years. One caribou that used the Entiako winter range during the first two years of the MPB study, remained in northern Tweedsmuir Park for the third winter. Forest cover mapping was not available for that area, but visual observations indicated that the area used was dominated by MPB-Grey attack and mixed MPB-Grey/live pine forests.

At the habitat scale, caribou continued to select Dry Lichen/Lichen Moss habitat (where terrestrial lichens were most abundant) and mature pine stands during the MPB-Grey attack stage. Although no spatial information is available on the degree of mountain pine beetle attack on the winter range, because most of the mature pine trees on the winter range were attacked by mountain pine beetles, caribou were presumably using and selecting MPB-Grey stands as a consequence of selecting mature pine forests. Cichowski and Haeussler (2013) reported averages of 78-96% pine killed by mountain pine beetles on terrestrial lichen plots within the Entiako winter range. Although terrestrial lichen abundance may have decreased following mountain pine beetle attack (Cichowski and Haeussler 2013), terrestrial lichens are likely still most abundant in Dry Lichen/Lichen Moss habitats where they were most abundant prior to the mountain pine beetle epidemic.

At the feeding site and forage scales, caribou continued to forage for terrestrial lichens where they were abundant, and continued to forage on

arboreal lichens in all stand types throughout the winter (Cichowski 2010). On the Entiako winter range, terrestrial lichens are most abundant in open canopy stands (BC Ministry of Forests 1987, Cichowski and Hauessler 2013). Even with the deeper snowpack in 2006/07, caribou cratered predominantly in open pine stands in as much as 93 cm of snow. Johnson *et al*. (2000) found caribou cratering in up to 97 cm of snow and craters as deep as 123 cm have been reported (Brown and Theberge 1990). In pine-dominated stands, percent MPB-Grey attack in the stand did not influence caribou crater site selection. During both pre-MPB and MPB-Grey attack studies, crater sites were most frequently found in open or very open pine stands and caribou frequently foraged in canopy gaps where terrestrial lichens are often abundant and where snow conditions are favourable for cratering. In very open canopies and canopy gaps, snow is less affected by snow dripping from trees during thaws and forming hard crusts, which could compromise the caribou's ability to detect and dig for lichens if they are present. Reindeer and caribou detect lichens by smelling them through the snow (Helle 1984). Although snow is deeper in open canopy stands, less crusting may allow better detection of lichens. Because caribou prefer foraging in stands with very open canopies during winter, the loss of needles from trees following the mountain pine beetle epidemic may not appreciably affect snow conditions at those sites. Consequently, caribou use of those sites has also not been affected. On the Kennedy-Siding caribou winter range in north-central British Columbia, snow depths were similar in forests and in a large clearcut while snow hardness was greater in clearcuts than in forests both before and after mountain pine beetle attack (Jones 2007, Seip and Jones 2009). Seip and Jones (2009) suggested that the forests on the winter range were not effective in intercepting snow, but did create conditions that led to softer snow.

Weather factors appeared to play a greater role in winter feeding site and forage selection than potential changes in snow conditions due to mountain pine beetle attack (Cichowski 2010). In 2006/07, frequent freeze/thaw events during mid winter likely influenced the reduction of terrestrial lichen foraging during late winter. Snow conditions also remained conducive to cratering in open pine stands up to mid winter due to the moderating effect of grey-attacked (dead) trees on the effects of wind. In open wetlands not protected by at least some forest cover, snow penetrability decreased as winter progressed. In 2007/08, the snowpack was relatively unconsolidated until mid February resulting in an unconsolidated snowpack and easy cratering conditions until then. After mid February, mild temperatures resulted in thawed snow conditions (at least during the winter investigations sessions) that allowed caribou to continue cratering for terrestrial lichens until at least

March. In 2008/09, snow was relatively unconsolidated throughout the winter, allowing caribou to continue to crater for terrestrial lichens until at least March, even though snow depth averaged 70 cm at crater sites.

In addition to traditional craters for terrestrial lichens, caribou were also found cratering at the base of trees (tree craters). In dense spruce stands, it appeared that caribou were cratering for horsetails at the base of mature spruce trees. Snow depths at those sites were generally less than 10 cm, even during late winter when snow depths in open pine stands averaged 50-60 cm. In pine and pine/spruce stands, tree craters were mostly found at the base of MPB-Grey attacked pine trees where caribou may have been seeking mushrooms/fungus associated with secondary decay agents on dead pine trees. In other areas, caribou and domesticated reindeer forage on mushrooms in late summer and fall (Bergerud 1974b, Inga 2007). Tree craters were not identified in the pre-MPB study; however, cratering for horsetails in spruce forests was likely occurring. Cratering by caribou at the base of MPB-Grey pine trees has likely increased as a result of the MPB epidemic. Tree craters were relatively uncommon compared to terrestrial lichen craters.

Population parameters did not appear to be affected by the grey stage of the mountain pine beetle epidemic. Timing of mortality for 2006/07 to 2008/09 was generally consistent with timing of mortality prior to the mountain pine beetle epidemic, with the majority of mortalities occurring between April and mid July, and while caribou were on their summer range (Cichowski 2010). In general, adult female mortality rate was moderate to high, and calf recruitment was low to moderate from 2006/07 to 2008/09, similar to adult female mortality rates and recruitment rates prior to the mountain pine beetle epidemic. Potential effects of the mountain pine beetle epidemic on the Tweedsmuir-Entiako caribou population will likely be due to changes in predator-prey relationships, which are not likely to change dramatically in the short term.

The next phase of the mountain pine beetle epidemic will be the fall-down phase. It is unclear how long it will take for significant levels of blowdown to occur. Reported fall down rates of beetle-killed trees vary from 10% to 90% fallen by 14 years after attack (Shore *et al*. 2006). Lewis and Hartley (2005) anticipate that beetle-killed trees will persist slightly longer on drier sites than on moister sites. Most Northern Caribou winter ranges are likely at the dry end of the moisture spectrum so dead trees could continue standing for some time. The effects of blowdown on caribou will depend on the extent and distribution of mountain pine beetle-killed trees on the landscape (Cichowski 2007). If a sufficient

matrix of live stands and trees (e.g. spruce, young pine, unattacked pine) is present, caribou could continue to move through their winter range through live stands and forage in live stands or blowdown. Presumably, caribou would also move through stands with low to moderate levels of blowdown.

2.8 Spatial Separation from moose and predators

(Adapted from Cichowski and MacLean 2005)

During winter, moose are typically found at low elevations in forested and wetland habitats in valley bottoms feeding primarily on shrubs, grasses and sedges. In the Tweedsmuir-Entiako area, most of the radio-collared moose winter in low elevation areas both north and south of Tetachuck Lake (Cichowski and MacLean 2005). One radio-collared moose also wintered in Tweedsmuir Park on the north side of Eutsuk Lake across from Connelly Point. Occasionally, individual moose have also been found in subalpine habitat in the Fawnie Mountains as well as outside the main study area near Cheslatta Lake.

In spring, female moose may move considerable distances to calving areas mostly below treeline although many cows may calve in subalpine habitats. By summer, some of the radio-collared moose move as far west as Chikamin Bay in Tweedsmuir Park, whereas others remain in the Entiako or East Ootsa areas. Calving occurs in late May/early June and females may give birth to one or two calves. During summer and fall, moose are found in all habitat types but mostly below treeline.

On average, caribou used higher elevations than moose during winter months from January to March, but were found at similar elevations during spring and fall migration (Figure 20). Adult male caribou were found at similar or lower elevations than moose during the rest of the year, whereas female caribou used higher elevations during both calving and early summer, and rutting periods. Calving at higher elevations by Tweedsmuir-Entiako female caribou provides some elevational separation from moose (Figure 11). Although both moose and caribou were found in Entiako Park during winter, moose core areas were located primarily outside of the 75% caribou winter range kernel, suggesting that some range separation was occurring during winter (Cichowski and MacLean 2005).

Caribou may also spatially separate themselves from moose, and potentially wolves, through long distance migrations. For the

Tweedsmuir-Entiako caribou population, a significant number of radio-collared caribou migrated further west to calving areas than any of the radio-collared moose (Cichowski and MacLean 2005). Although this suggests that there may be spatial separation between those caribou and the radio-collared moose in the study area, moose that winter in other areas may occupy that part of the Tweedsmuir-Entiako caribou range during summer.

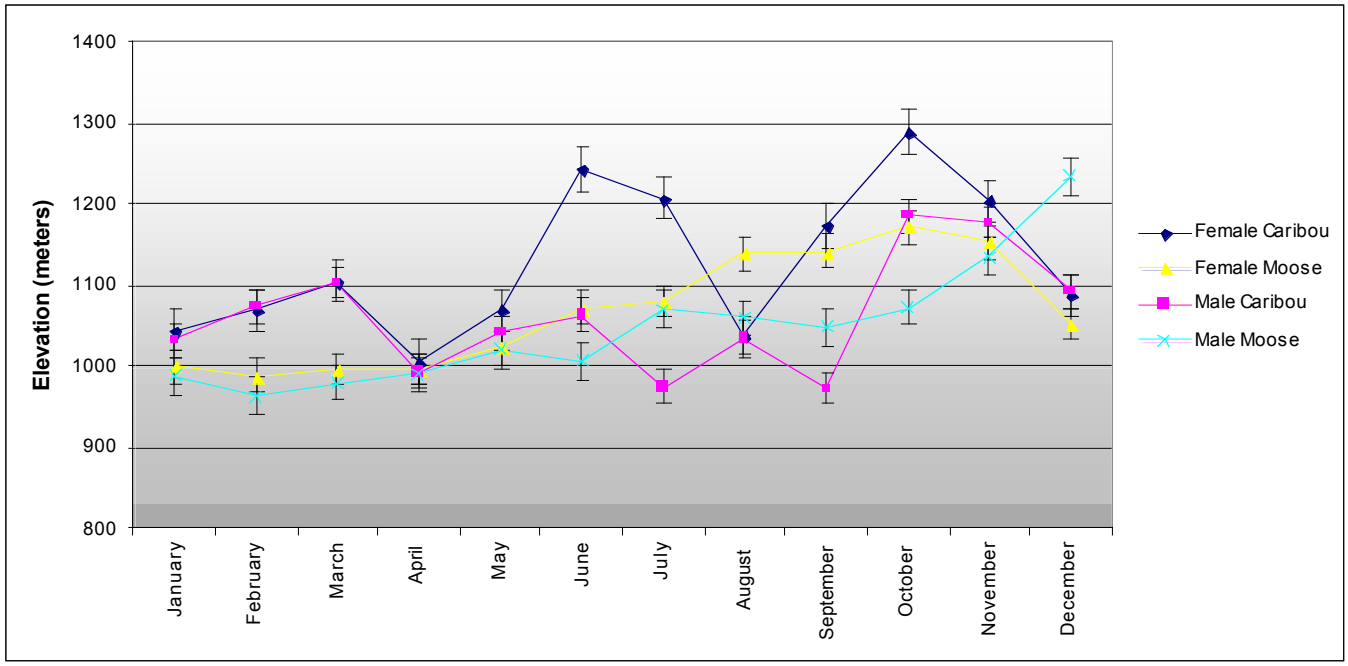

Figure 11. Average monthly elevation for VHF radio-collared Tweedsmuir-Entiako caribou (1983-2003) and moose (1996-2001) (from Cichowski and MacLean 2005).

3. Existing Land Use and Activities

Adapted and updated from Cichowski and MacLean (2005).

3.1 Forest Harvesting

Prior to the 1970's, there was little industrial activity on the Tweedsmuir-Entiako caribou range. Relatively low-value pine forests and its remote location made it unattractive for forest harvesting. Improved road access, developments in log processing that resulted in better utilization of smaller trees, suitable sites for conducting summer logging (dry pine sites) which are often in short supply, and a growing demand for pulp contributed to increased interest in the Tweedsmuir-Entiako caribou range for forest harvesting. Forest harvesting began in the area north of Whitesail and Ootsa lakes in the early 1970's and in the southeastern portion of their range in the late 1970's (Hatter 1979). Forest harvesting began in the Entiako area by the early 1980's.

Forest harvesting has occurred on most of the Tweedsmuir-Entiako caribou range outside of protected areas, except in the rugged westernmost portion of their range, west of Tweedsmuir Park (Figure 12). On the summer range, forest harvesting is concentrated in the Whitesail area south of Tahtsa Lake. In the Lakes LRMP – Migration Zone and Vanderhoof LRMP portions of the winter range, area harvested increased steadily from the 1970's to the 1990's (Cichowski and MacLean 2005). Large-scale mountain pine beetle management and salvage harvesting peaked in the late 1990's and early 2000's at the height of the recent mountain pine beetle epidemic. In response to the mountain pine beetle epidemic, the Allowable Annual Cut was increased in the Lakes and Prince George (includes Vanderhoof) Timber Supply Areas (Pedersen 2004a, 2004b). Harvesting activities then decreased on the caribou range following the peak as harvesting followed the leading edge of the beetle epidemic. Currently, forest harvesting is being conducted in the Vanderhoof portion of the winter range. Harvesting levels dropped off in the East Ootsa area in the Nadina District in the mid to late 2000s, but there has been renewed interest in harvesting in that area. Forest harvesting in the Whitesail area began in the early to mid 1990s.

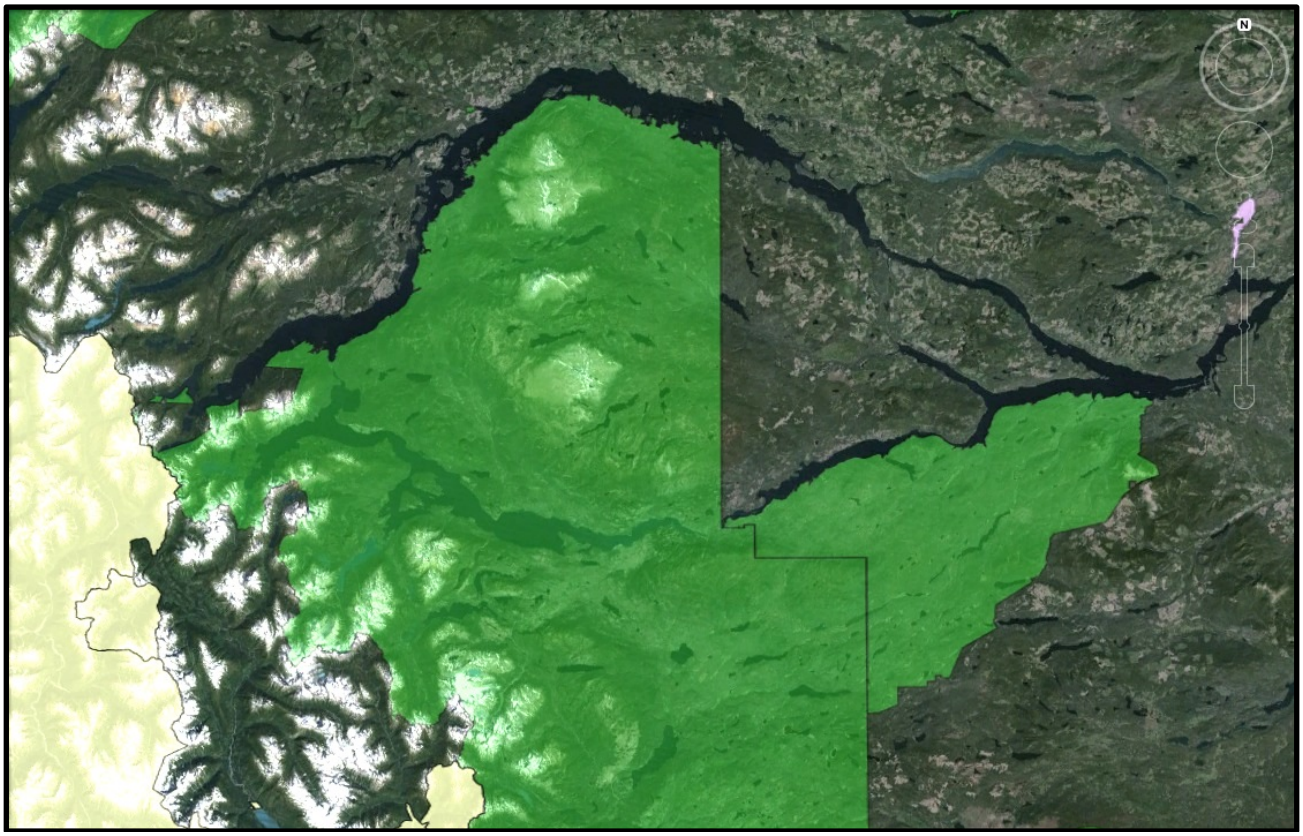

Figure 12. Distribution of forest harvesting in the Tweedsmuir-Entiako caribou range and surrounding area (accessed from Google Earth, September 2014).

3.2 Mining and mineral exploration

Mineral claims cover most of the winter range in the Vanderhoof Resource District, and most of the summer range in the Whitesail area and in the Sibola Mountains in the Morice LRMP portion of the Nadina Resource District (Figure 13). There are a few mineral claims in the East Ootsa portion of the spring migration and winter range in the Lakes LRMP portion of the Nadina District.

One active large-scale mine, Huckleberry Mine, is located near the northern boundary of the range on the north side of Ootsa Lake near Sweeny Lake. Currently, the Blackwater Gold Project in the Mount Davidson area in the Vanderhoof portion of the winter range is the only potential project in the rest of the range that has entered the environmental assessment process. Mineral exploration has occurred throughout the range outside of Tweedsmuir and Entiako Parks. Recently, there has also been increased interest in the Whitesail area.

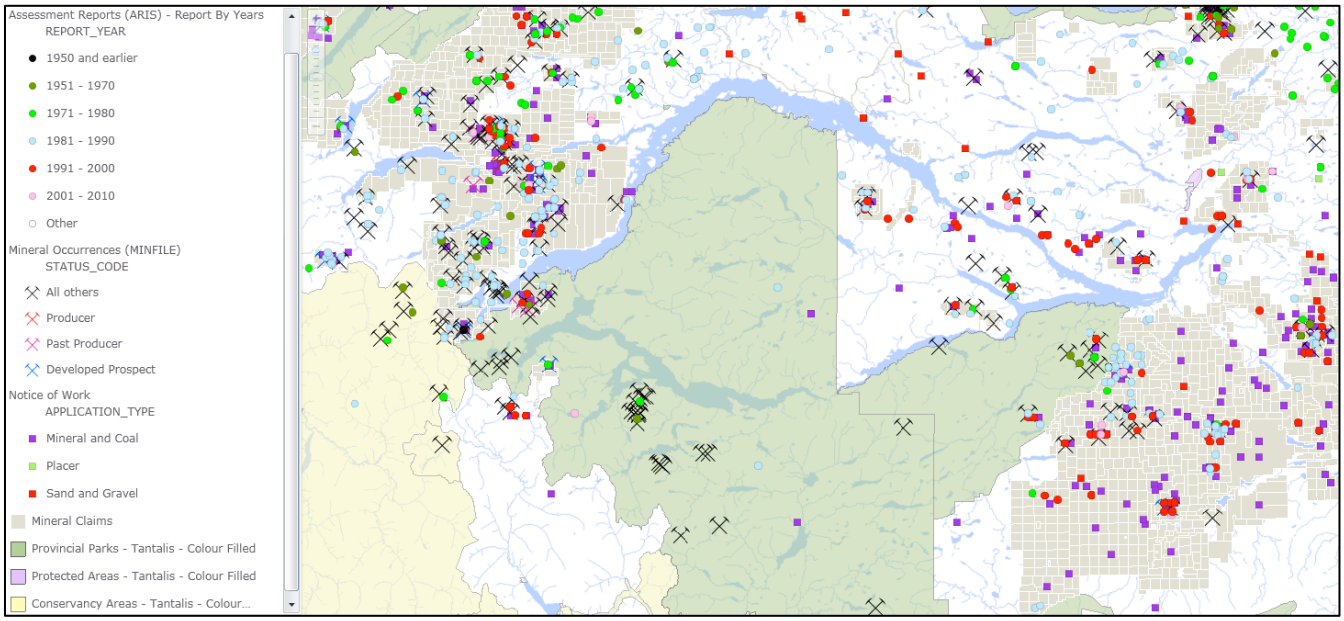

Figure 13. Distribution of mineral exploration activity and mineral claims in the Tweedsmuir-Entiako caribou range and surrounding area (accessed from IMAP, September 2014).

3.3 Hydroelectric Generation

In the early 1950's, the construction of the Kenney Dam resulted in the flooding of Tahtsa, Whitesail, Sinclair, Ootsa, Intata, Natalkuz, Euchu, Chelaslie, and Tetachuck lakes (see Section 4.1). Flooding of the reservoir contributed to caribou mortality in the first few years as caribou crossed the lake and had difficulty reaching shore because of debris (M. Robertson, pers. comm.), and may have contributed to abandonment of ranges north of Ootsa Lake (Cichowski *et al*. 2001a). A potential future impact of the reservoir could include drawdown of the lake level exposing muddy shorelines that may make it difficult for caribou to reach the water to cross the lake, or to reach shore once they have crossed. Drawdown of the reservoir could also potentially result in land links between calving islands in Ootsa Lake and the mainland.

3.4 Agriculture, Settlements, and Transportation and Utility Corridors

Agricultural and private lands are located primarily on the north side of Ootsa Lake in association with the rural communities of Wisteria and

Ootsa Lake (Figure 14). Ootsa Lake is accessed by a paved road from the south side of Francois Lake. Other roads along the north and east sides of Ootsa Lake are primarily gravel roads.

Some private and agricultural lands are also located on Tatelkuz Lake in the southeastern portion of the range and in the Moose and Laidman Lake areas. Tatelkuz Lake and Laidman Lake are accessed by the Kluskus Forest Service Road from Vanderhoof. There is also an old homestead located within Entiako Park, southwest of Bryan Arm.

The road network within the Tweedsmuir-Entiako caribou range outside of protected areas is made up primarily of gravel industrial resource roads. Two barge crossings are located on Ootsa Lake: one on the east side of the lake that accesses the East Ootsa area (the area east of northern Tweedsmuir Park, south of Ootsa Lake, and north of Tetachuck and Natalkuz Lakes), and one at Tahtsa Reach that accesses the Whitesail area (south of Tahtsa Lake and Tahtsa Reach).

There are currently no utility corridors within the Tweedsmuir-Entiako caribou range.

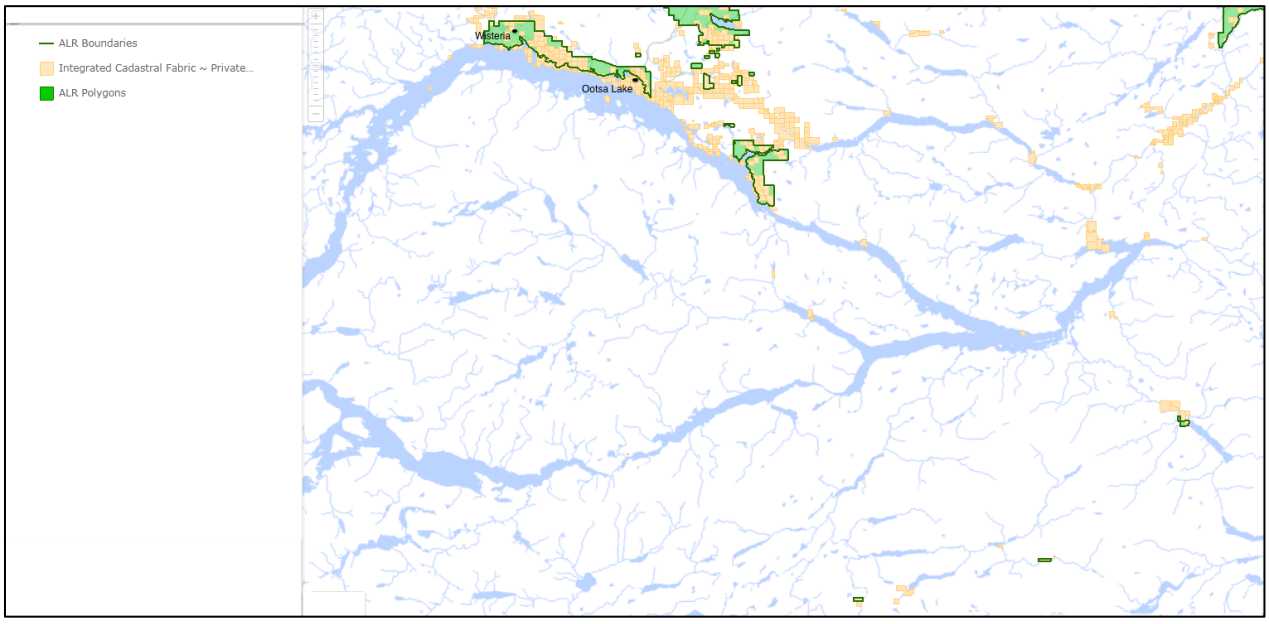

Figure 14. Agricultural Land Reserve (ALR) and private lands in the Tweedsmuir-Entiako caribou range and surrounding area (accessed from IMAP, September 2014).

3.5 Recreational Activities

Most tourism/commercial recreation activities within the Tweedsmuir-Entiako caribou range are wilderness-based and are conducted mostly in the summer months. Lodges are located at Pondosy Bay and Eutsuk Lake in northern Tweedsmuir Park, at Redfern Rapids on the north side of Tetachuck Lake, and on Moose Lake in the Vanderhoof LRMP Laidman Resource Management Zone. Most of the lodge buildings at Aslin Creek in Entiako Park were consumed by the Chelaslie Arm Fire in 2014. Additional commercial recreation and private lease cabins are scattered throughout the area and include cabins at Chief Louis Lake, Tesla Lake, Coles Lake, Tetachuck Lake (including Bryan Arm), Entiako Lake, and Cow Lake. During summer, commercial operators provide guided angling, boating, hiking and hunting services. Activities are primarily water-based from the system of large lakes, but also include fly-in opportunities for guided angling to smaller lakes. Guided hunting activities are mostly land-based.

Currently, backcountry recreation levels on the Tweedsmuir-Entiako range are likely low during winter and low to moderate during summer. During winter, some snowmobile use occurs in the Fawnie Mountains and potentially some fly-in ice fishing occurs on some lakes. Observations of radio-collared caribou suggest that caribou moved away from a portion of the Fawnie Mountains that was used by snowmobiles (D. Cichowski, unpublished data). Seip *et al*. (2007) concluded that intensive snowmobiling displaced caribou from an area of suitable habitat. Other winter recreation activities such as backcountry skiing are likely uncommon due to the remoteness of most of the area. Some backcountry skiing activity has occurred in northern Tweedsmuir Park in the Fenton Lake area. However, improved access resulting from increased industrial activity in some parts of the range may lead to increased backcountry recreation activity. During summer, recreational activities include primarily fishing (fly-in to remote lakes; boat-in on accessible lakes), boating, canoeing, hiking and hunting. In the Whitesail area, ATV use is becoming an increasing concern (M. Todd, pers. comm.) and ATV's have now accessed Chief Louis Lake in the Lakes LRMP – Migration Zone (Chelaslie area).

Although the Tweedsmuir-Entiako caribou range currently supports low levels of backcountry recreation, use levels could potentially increase as increased demand and advances in technology may result in currently unheard of backcountry recreation activities.

4. Management to Date

Table 3 provides a chronological list of management and planning activities that have been conducted in the Tweedsmuir-Entiako caribou range area. These are described in the following sections by type of activity or in other sections as noted. Some activities listed were not conducted specifically for the Tweedsmuir-Entiako caribou population but are included because of how they influence or could potentially influence caribou management. Appendix 2 (from Cichowski 2015) contains a detailed chronology of management, planning and policy affecting the Tweedsmuir-Entiako caribou range.

Table 7. Management activities and planning conducted in the Tweedsmuir-Entiako caribou range area.

Year	Activity Type	Activity	Sections
1938	Protected areas	Tweedsmuir Park established	4.1
1950s-early 1960s	Population management	Predator control	4.4.2
1955	Industrial activities	Nechako Reservoir flooding completed	3.3, 4.1
1956	Protected areas	Tweedsmuir Park boundary amended to exclude floodwaters	4.1
1963	Research and monitoring	First population estimate	2.4, 4.5
1970s	Industrial activities	Forest harvesting starting within range	3.1
1977	Hunting	Eutsuk Nature Conservancy closed to hunting	4.4.1
1978	Hunting	Caribou hunting closed	4.4.1
1982	Hunting	Limited entry hunting established for Tweedsmuir-Entiako caribou	4.4.1
1983	Research and monitoring	Radio-collared caribou study initiated	4.5
1985-89	Research and monitoring	Intensive radio-collared caribou study on seasonal movements, habitat use, winter feeding ecology	4.5
1987	Research and monitoring	1:50,000 scale terrestrial lichen abundance map based on biogeoclimatic site series	2.1, 4.3.1
1988	Planning	Tweedsmuir Park Master Plan	4.6.1
1992	Habitat management	Management Guidelines for the Tweedsmuir-Entiako caribou herd migration corridor	4.6.1
1993	Habitat management	Management Strategy and Options for the Tweedsmuir-Entiako Caribou Winter Range	4.6.2
1992-93	Planning	Entiako LRUP (not completed)	4.2.1

Year	Activity Type	Activity	Sections
1992-95	Research and monitoring	Calf survival and adult mortality study	4.5
1993-95	Research and monitoring	Migration corridor/winter range study	4.5, 4.6.3
1994	Natural disturbances	Mountain pine beetle epidemic started	2.7
1996-2003	Research and monitoring	Seasonal movements, habitat use, calf survival and adult mortality study	4.5
1996	Habitat management	Caribou Habitat Use in the Chelaslie River Migration Corridor and Recommendations for Management	4.6.3
1997	Planning	Vanderhoof LRMP approved	4.1, 4.2.2
1998	Protected areas	Risks to caribou of management options for the Entiako Proposed Protected Area	4.1
1999	Protected areas	Vanderhoof portion of Entiako Park established	4.1
2000	Planning	Lakes LRMP approved	4.1, 4.2.3
2000	Protected areas	Lakes portion of Entiako Protected Area established	4.1
2000	Status and recovery	COSEWIC assessment - Threatened	1.1
2000	Habitat management	Lakes Higher Level Plan	4.2.3
2001	Research and monitoring	Study on the effects of MPB on caribou terrestrial forage lichens initiated	2.7, 4.5
2001	Planning	Entiako Park and Protected Area Ecosystem Management Study	4.3.4
2001	Planning	Tweedsmuir Park North Vegetation Management Study	4.3.4
2002	Status and recovery	COSEWIC assessment – Threatened reaffirmed	1.1
2003	Status and recovery	Federal *Species at Risk Act* fully enacted	1.1
2003	Hunting	Caribou hunting closed	4.4.1
2003	Habitat management	Lakes South Strategic Resource Management Plan Order	4.2.3
2004	Habitat management	Morice – Section 7 Order for species at risk – caribou calving habitat in Whitesail Reservoir	4.2.4, 4.6.4
2004	Habitat management	Vanderhoof – Order – Landscape Biodiversity Objectives for PG TSA (old forest targets)	4.2.2, 4.6.4
2004	Habitat management	Vanderhoof – Section 7 Order for species at risk – caribou calving/rutting/matrix/mineral licks	4.2.2, 4.6.4
2004	Status and recovery	A Recovery Strategy for Northern Caribou in BC completed (not endorsed by government)	1.3
2005	Status and recovery	Provincial recovery planning efforts suspended	1.3
2005	Habitat management	Vanderhoof District Ungulate Winter Range (7-012) for caribou established	4.2.2, 4.6.4
2005	Research and monitoring	Tweedsmuir-Entiako Caribou Technical Background Information Summary (1983-2003)	4.5

Year	Activity Type	Activity	Sections
2005-10	Research and monitoring	Study on the effects of MPB on Tweedsmuir-Entiako caribou	4.5
2006	Planning	Entiako Park and Protected Area Management Direction Statement and Ecosystem Management Plan	4.3.2
2007	Planning	Morice LRMP approved	4.2.4
2007	Habitat management	Lakes South Old Growth Management Areas established	4.2.3, 4.6.4
2007	Protected areas	Entiako Protected Area and lapsed mineral claims incorporated into Entiako Park	4.1
2007	Planning	Tweedsmuir Park North and Entiako Park and Protected Area – Managing natural and cultural values in a post-MPB landscape	4.3.4
2007	Research and monitoring	Study on the effects of fire on caribou terrestrial forage lichens in the Entiako fire initiated	4.5
2008	Access management	Vanderhoof LRMP Access Management Plan for Forest Recreation	4.2.2, 4.7
2009	Industrial activities	Blackwater Gold project – increased exploration activities	3.2
2012	Planning	Huchsduwachsdu Nuyem Jees/Kitlope Heritage Conservancy Management Plan	4.3.3
2013	Research and monitoring	Radio-collared moose study initiated	4.5
2014	Planning	Vanderhoof Resource District Best Management Practices for caribou	4.6.5
2014	Natural disturbances	Chelaslie Fire burn 133,100 ha of winter and spring migration range in Entiako Park and East Ootsa area	2.1
2014	Research and monitoring	Radio-collared caribou study initiated	4.5
2014	Status and recovery	COSEWIC status assessment for Southern, Central and Northern Mountain DUs completed	1.3.1
2014	Status and recovery	Recovery Strategy for the Southern Mountain Caribou Population completed (Environment Canada)	1.3

4.1 Protected Areas

Tweedsmuir Park was established in 1938 to protect a wilderness chain of lakes including Tahtsa, Whitesail, Troitsa, Sinclair, Ootsa, Intata, Natalkuz, Euchu, Chelaslie, Tetachuck and Eutsuk lakes. At that time, most of the Tweedsmuir-Entiako caribou range was included in the park (Cichowski *et*

al. 2001a, 2001b). In the early 1950's the construction of the Kenney Dam resulted in the flooding of all the previously mentioned lakes except for Eutsuk and Troitsa lakes. The flooding created one large body of water that connected and encompassed Tahtsa, Whitesail, Sinclair, Ootsa, Intata, Natalkuz, Euchu, Chelaslie and Tetachuck lakes.

In 1956 the Tweedsmuir Park boundaries were amended to exclude all flooded waters from the park and to include more area in the southern mountainous region (Figure 15). At that time, the Entiako area, the area north of Tetachuck Lake and the area northwest of Whitesail Lake were removed and the resulting Tweedsmuir Park looked much the same as it does today.

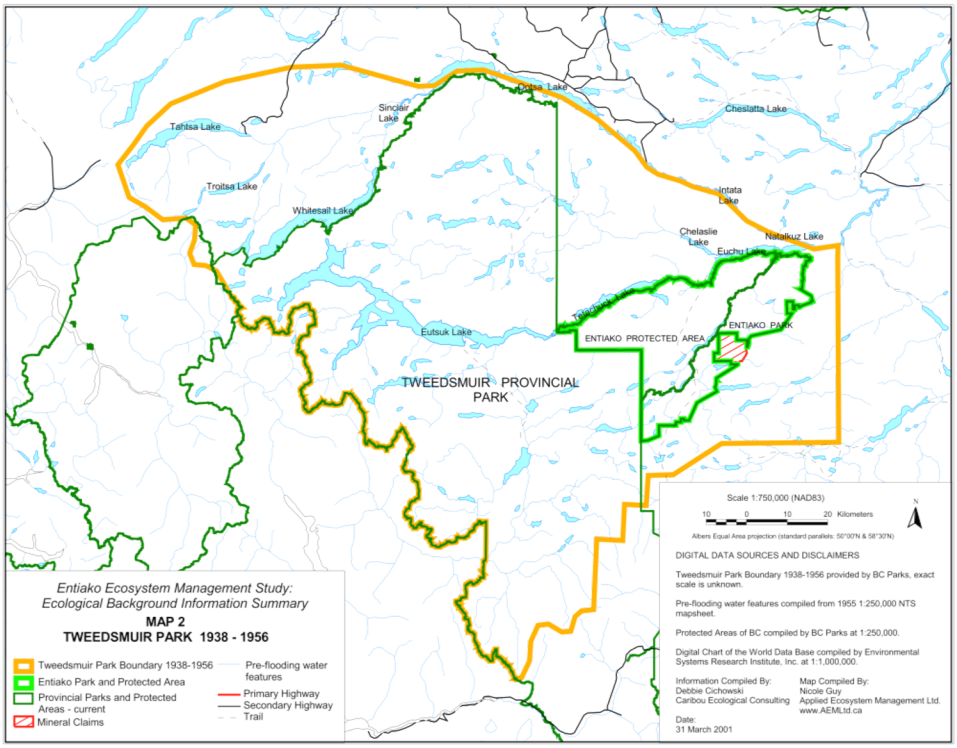

Figure 15. Tweedsmuir Park boundary 1938-1956 and pre-floodwaters lake system (from Cichowski *et al*. 2001a).

As a result of the 1988 Tweedsmuir Master Plan, Tweedsmuir Park was converted to Class A Park except for a portion at the west end that included the northern portion of the Chikamin Mountains and Lindquist Lake. That area was classified as a Recreation Area, which, unlike Class A Parks, permitted mineral exploration (BC Parks 1988). In 2000, the Lakes

Land and Resource Management Plan (LRMP) reclassified a portion of the Tweedsmuir Recreation Area into Class A Park status, and two portions of the Recreation Area (Chikamin area: 4300 hectares; Lindquist area: 5200 hectares) were excluded from the park for mineral exploration (Lakes District LRMP Resource Council 2000). Forest harvesting is not permitted in those two areas.

In the 1990s, the Prince Rupert Regional Protected Areas Team identified the Entiako area as a Goal 1 Area of Interest/Official Study Area during the Protected Areas Strategy to increase representation of the SBSdk in the Bulkley Basin Ecosection and to protect important caribou migration and winter range. The Protected Areas Strategy was then integrated into the land and resource management planning (LRMP) process and the Vanderhoof Forest District portion of the official study area was designated in 1999 as Entiako Park under the *Park Act*, and Lakes Forest District portion was designated in 2000 as Entiako Protected under the *Environment and Land Use Act*. When the Vanderhoof portion of Entiako Park was designated, the Wolf mineral claims were excluded from the park. Within a few years, those claims lapsed and were eventually incorporated into the park in 2007. During the Lakes LRMP, concerns were raised about establishing a protected area for caribou as the mountain pine beetle epidemic was reaching its peak in the region. A risk assessment of 10 options with varying degrees of protection and forest harvesting concluded that full protection of the proposed Entiako protected area posed the lowest risk to caribou (Steventon *et al.* 1998). The Lakes portion of Entiako Park was initially designated as a protected area with the intent to designate it as a Class A Park once an ecosystem based management plan was completed that met the dual objectives of preserving the long-term ecological viability for the area for caribou, and maintaining an acceptable level of mountain pine beetle infestation risk to adjacent timber resource values (Lakes District LRMP Resource Council 2000). Entiako Protected Area was converted to Class A Park in 2007 following completion of the Management Direction Statement and Ecosystem Management Plan (BC Parks 2006).

A large part of the Tweedsmuir-Entiako caribou winter range remains within the Provincial Forest landbase in the Vanderhoof Resource District, and the Chelaslie Migration Corridor and Winter Range remains in the Nadina Resource District (formerly the Lakes Forest District).

In 1996, the Kitlope watershed was designated as a protected area under the *Environment and Land Use Act*, which provided protection to a portion of the summer range. In 2008, the area was established as the Huchsduwachsdu Nuyem Jees/Kitlope Heritage Conservancy as a

conservancy under the *Protected Areas of British Columbia Act*. A large portion of the summer range remains within the Provincial Forest within the Nadina (formerly Morice), Kalum, and North Island-Central Coast Resource Districts.

4.2 Land Use Planning

4.2.1 Entiako Local Resource Use Plan

The Entiako Local Resource Use Plan (LRUP) was initiated in 1992 to address caribou habitat and forest harvesting issues in the Entiako area (Entiako Local Resource Use Plan Working Group 1993). The Management Strategy and Options for the Tweedsmuir-Entiako Caribou Winter Range (Cichowski and Banner 1993; see Section 4.6.2) was used to inform the process. Participants included government personnel from the Ministry of Environment, Lands and Parks and Ministry of Forests (both Lakes and Vanderhoof Forest Districts), logging companies, other stakeholders and interested parties. LRUPs were established as part of the Ministry of Forests' planning framework to develop area-specific resource management objectives and prescriptions to address complex resource use issues (Ness 1992), and were not always the best tool for addressing land use. After 2 years of meetings and negotiations, the Entiako LRUP process was suspended and land use decisions for the area were deferred to the newly initiated Vanderhoof Land and Resource Management Plan (LRMP) and Lakes LRMP for resolution.

4.2.2 Vanderhoof Land and Resource Management Plan and Objectives Set by Government

The Vanderhoof Land and Resource Management Plan (LRMP) provides strategic level guidance for land use and management within the Vanderhoof Resource District (Vanderhoof LRMP Working Group 1997). The Tweedsmuir-Entiako caribou range includes the Laidman Lake (multi-value emphasis) Resource Management Zone (RMZ) and portions of the Upper Blackwater (multi-value emphasis), Davidson Creek (resource development emphasis) and Chedakuz (special resource) RMZs (see Appendix 3).

Management direction for caribou included establishing Entiako Park and providing strategies for managing for caribou in the Laidman Lake RMZ. The management objective for the Laidman Lake RMZ was to manage for

general biodiversity with an emphasis on caribou. Specific strategies for that RMZ included:

- conduct more detailed wildlife assessments prior to resource development:
- manage for caribou habitat throughout the zone;
- general management direction – consider caribou habitat management the overriding concern;
- stand level and site specific direction – emphasize caribou habitat management, general biodiversity or management of other species;
- use caribou as the indicator species for ecosystem management in this zone; and,
- request that a monitoring and access management plan for caribou management will be developed through the government agencies and be brought to the First Annual Implementation Meeting.

Caribou were not the management priority in the other RMZs (Upper Blackwater, Davidson Creek, Chedakuz) and there was no caribou-specific management direction in those RMZs.

The Vanderhoof LRMP included access management strategies and also called for a monitoring and access plan for caribou management. A consensus based access management plan addressed year round motorized use (BC Integrated Land Management Bureau 2008). In 2008, the access management plan was replaced with the Access Management Plan for Forest Recreation, which revised access zones to reflect current use and addressed only summer recreation (BC Integrated Land Management Bureau 2008).

Since completion of the LRMP, three legal orders have been established that affect caribou range management. In 2004, legal orders were established for Northern Caribou calving/rutting range, mineral licks and matrix range, and for old forest targets (BC Ministry of Sustainable Resource Management 2004, Province of British Columbia 2004a). In 2005, Ungulate Winter Ranges (UWRs) were established under the *Forest and Range Practices Act* (FRPA) in high elevation and low elevation range within the Vanderhoof portion of the Tweedsmuir-Entiako caribou range (BC Ministry of Environment 2005a; see also Section 4.6.4). Because the UWRs are considered an implementation product of the LRMP, currently, other management direction for caribou from the LRMP is considered but not necessarily directly utilized on an operational basis (C. Middleton, pers. comm. 2015).

4.2.3 Lakes LRMP and Lakes Sustainable Resource Management Plan

The Lakes Land and Resource Management Plan (LRMP) provides strategic level guidance for land use and management within the Lakes Timber Supply Area (TSA) portion of the Nadina Resource District (Lakes District LRMP Council 2000; see Appendix 4).

Management direction for caribou included establishing Entiako Protected Area and providing a strategy for managing caribou and caribou range in the Chelaslie migration corridor (see Appendix 3 of that plan: Chelaslie Caribou Migration Corridor Management Strategy). The general objective of the management strategy was to maintain quality caribou habitat and movement opportunities, which enable caribou migration during spring and autumn, and provide for winter range. The area was zoned based on caribou use zones developed by Steventon (1996) and included low, moderate, high and very high use zones. Seral stage targets were defined for each zone, and forest harvesting was not permitted in the very high use zone. Access management included no new road building in the very high use zones, minimizing road building in other zones, and defining access control points. The management strategy also directed to address herd management issues other than habitat management (e.g. low recruitment, predation, poaching).

A Higher Level Plan Order was completed in 2000, which included seral stage objectives for the Chelaslie Migration Corridor that were recommended by the LRMP, and established a no harvest zone in the portion of the former Tweedsmuir Recreation Area that was converted to Crown Land (Province of British Columbia 2000). The Lakes South Sustainable Resource Management Plan (SRMP) was completed in 2003 (BC Ministry of Sustainable Resource Management 2003) and incorporated the seral stage targets for the Chelaslie Migration Corridor established in the LRMP. It also set targets for the amount of old seral to be incorporated into Old Growth Management Areas (OGMAs) but did not incorporate any access management direction. In the Chelaslie Migration Corridor, the two Very High use zones (Tetachuck Lake, Chief Louis Lake/Chelaslie River) were designated as OGMAs in 2007 as part of the order to amend old growth forest retention objectives (BC Ministry of Agriculture and Lands 2007a). In 2009, all objectives in the 2000 Higher Level Plan order were cancelled except the no harvest zone in the portion of the former Tweedsmuir Recreation Area (BC Ministry of Agriculture and Lands 2009). The cancelled objectives were mostly addressed by the Lakes South SRMP order. No objectives have yet been set to address the access management direction in the LRMP.

4.2.4 Morice LRMP and Objectives Set by Government

The Morice LRMP was completed by the Morice LRMP planning table in 2004 and then was finalized in 2007 following government to government negotiations with First Nations (BC Ministry of Agriculture and Lands 2007b). It provides specific direction on maintaining high value seasonal forage habitats and calving/post-calving habitats for caribou, and limiting disturbance from development activities adjacent to calving/post-calving habitats (see Appendix 5).

Management direction from the Morice LRMP includes a no harvest zone over a portion of the Whitesail area and over a portion of the area north of Tahsta Lake (BC Ministry of Agriculture and Lands 2007b). The remainder of the Tweedsmuir-Entiako caribou range within the Morice LRMP area is in the General Forested Area, which extends throughout the plan area. Seral stage targets for the General Forested Area were established by biogeoclimatic subzone and are not area-specific, but the Morice LRMP also indicates that seral stage targets set by Landscape Unit may be developed if needed. Old growth targets for the General Forested Area are 30% lower than those recommended for the lowest biodiversity emphasis option in the Biodiversity Guidebook (BC Environment 1995).

Currently, there is only one legal order from the Morice LRMP that affects the Tweedsmuir-Entiako caribou range. A Section 7 order for species at risk for calving range for the Tweedsmuir-Entiako caribou in the Whitesail Reservoir that cannot exceed an impact of more than 570 ha to the mature timber harvesting landbase was established in 2004 (Province of British Columbia 2004b). A Wildlife Habitat Area with accompanying General Wildlife Measures is currently being proposed for the Whitesail Landscape Unit, which includes most of the General Forested Area in the Whitesail area, and which incorporates the Section 7 impact (D. Bate, pers. comm. 2015). Also, a draft order has been prepared that includes seral stage targets and confirms the no harvest zones (BC Ministry of Forests, Lands and Natural Resource Operations, in prep.).

4.2.5 Other Land Use Plans

Smaller portions of the Tweedsmuir-Entiako caribou range overlap the Kalum, North Island-Central Coast, Quesnel and Chilcotin Resource Districts.

Although there are no specific references to caribou in the Kalum LRMP, one of the objectives is to "identify and manage critical habitats and plant communities for vulnerable, rare, threatened and endangered wildlife species and plant communities where resource development is planned". It also provides seral stage targets, which were incorporated into orders for OGMAs and land use. One small mountain goat UWR and one small OGMA are located within the plan area that overlaps the Tweedsmuir-Entiako caribou range. The order establishing land use objectives for the Central and North Coast include old forest targets.

The Chilcotin and Quesnel Resource Districts are covered by the Cariboo-Chilcotin Land Use Plan (CCLUP). As part of the CCLUP, Itcha-Ilgachuz Park was established and a Northern Caribou Strategy was developed for the Itcha-Ilgachuz, Rainbow and Charlotte Alplands ranges, including the area of overlap with the Tweedsmuir-Entiako caribou (Youds *et al*. 2002). The strategy was updated in 2011 (Youds *et al*. 2011). The strategy zones the range area into no harvest, modified harvest and conventional harvest. Tweedsmuir-Entiako caribou primarily use a portion of the conventional harvest zone, and to a lesser extent, portions of the no harvest and modified harvest zone on the north side of the Ilgachuz Mountains.

4.3 Protected Area Management Planning

4.3.1 Tweedsmuir Park Master Plan

Management in Tweedsmuir Park is guided by the Tweedsmuir Park Master Plan (BC Parks 1988). The Master Plan provides direction on management of natural and cultural values, and recreation. Park zoning defines the types of activities that may occur. Most of the northern portion of Tweedsmuir Park, which lies in the Tweedsmuir-Entiako caribou range, is zoned as "Wilderness", which provides for a wide range of backcountry activities in a natural, undisturbed (roadless) setting. In the Quanchus Mountains area (Quanchus Unit), protection of the Tweedsmuir-Entiako caribou population is the primary objective. Although predator control is not considered appropriate, it may be undertaken where valued wildlife populations, such as caribou, are at risk. The overall objective for vegetation management is to allow natural processes to occur while considering other values within and outside of the park.

4.3.2 Entiako Provincial Park and Protected Area Management Direction Statement and Ecosystem Management Plan

Management of Entiako Park is guided by the Entiako Provincial Park and Protected Area Management Direction Statement and Ecosystem Management Plan (BC Parks 2006). At the time that the management direction statement was completed, the northern portion of Entiako Park was still a protected area. The protected area was converted to park status following completion of the management direction statement and ecosystem management plan. The park was zoned into 5 ecosystem management areas based on ecosystem management zones developed for the Entiako Park and Protected Area Ecosystem Management Study (Cichowski 2001b). Overall the management priority for the park is to protect and maintain the Tweedsmuir-Entiako caribou population and winter range. Specific management for caribou includes protecting terrestrial lichen and arboreal lichen habitats from human disturbance, minimizing the amount of forest edge habitat favoured by moose, and considering managing predator and alternate prey number if required to maintain the long-term viability of the caribou population. Overall vegetation management is to manage natural processes in as natural a state as possible, including re-establishing the natural fire pattern, while considering adjacent land values. Management of recreational activities emphasizes summer backcountry recreation when caribou are not using the park. Winter recreational activities and access that results in disturbance and displacement of caribou are not permitted.

4.3.3 Huchsduwachsdu Nuyem Jees/Kitlope Heritage Conservancy Management Plan

Although caribou and caribou calving habitat are listed as significant values in the Huchsduwachsdu Nuyem Jees/Kitlope Heritage Conservancy Management Plan (BC Parks and Haisla Nation 2012), there is no specific direction for caribou in the plan. Management direction for wildlife includes: assessing high value habitats for key wildlife species and identifying critical habitats at a local scale; and, avoiding inappropriate disturbance or damage to wildlife by completing comprehensive impact assessments when developing facilities, trail and camping areas.

4.3.4 Other protected area management strategies

In addition to protected area management plans, three management strategies have been developed in Tweedsmuir Park (North) and Entiako Park to address the mountain pine beetle epidemic including:

- Entiako Park and Protected Area – Ecosystem Management Study (Cichowski *et al*. 2001b);
- North Tweedsmuir Provincial Park – Strategic Vegetation Management Study (Cichowski *et al*. 2001c); and,
- Tweedsmuir (North) Provincial Park and Entiako Park and Protected Area: Managing Natural and Cultural Values in a Post-Mountain Pine Beetle Landscape (Cichowski 2007).

All three management strategies provide direction for caribou.

The Entiako Park and Protected Area Ecosystem Management Study included a comprehensive summary of all natural and cultural information available for the park at the time (Cichowski *et al*. 2001a) and a proposed interim ecosystem management strategy for the park in light of the expanding mountain pine beetle epidemic. The park was zoned into 5 Ecosystem Management Zones based on caribou winter range, vegetation and fish values, biogeoclimatic subzones, rare and sensitive species and ecosystems, fire patterns and potential, and mountain pine beetle hazard and distribution. Interim short-term goals included minimizing disturbance and maximizing intervention (fire suppression, beetle management) on the caribou winter range following the conclusion of the mountain pine beetle outbreak, and maintaining remaining older forests for caribou habitat. The interim long-term goal was to re-establish ecosystem processes to support a more natural mosaic of forest stands.

Similar to the Entiako Park and Protected Area Ecosystem Management Study, the North Tweedsmuir Provincial Park Strategic Vegetation Management Study included a comprehensive summary of all natural and cultural information available for the park at the time (Cichowski *et al*. 2001c). The interim strategic vegetation management goal was "to permit a natural disturbance regime to occur to maintain forest ecosystem process, structure and function." Natural disturbances and the current vegetation mosaic were considered to be already in a natural state, so the focus of management was on maintaining natural disturbance functioning rather than on achieving an ideal forest mosaic structure.

"Tweedsmuir (North) Provincial Park and Entiako Park and Protected Area: Managing Natural and Cultural Values in a Post-Mountain Pine Beetle Landscape" provides specific direction for managing identified values following the mountain pine beetle epidemic (Cichowski 2007). For vegetation, management direction included conducting prescribed burns in northeastern Tweedsmuir Park to create areas with disturbance history different from mountain pine beetles, and to conduct prescribed burns to assess fire behaviour in heavy blowdown by falling trees to simulate blowdown conditions. Management direction for caribou included continuing research on the effects of mountain pine beetles on caribou, conducting research on the effects of mountain pine beetles on moose and predator-prey relationships, and considering population management (e.g. predator management, alternate prey management).

4.4 Population Management

4.4.1 Hunting

Information on historical levels of hunting on the Tweedsmuir-Entiako caribou population is limited. Prior to 1956, the Tweedsmuir-Entiako caribou range was part of the Eastern District, which included most of British Columbia east of the Coast Mountains. From 1956 to 1966, it was part of Management Area (20), which included a large part of central BC, and which encompassed a number of Northern Caribou as well as Mountain Caribou ranges. From 1967 to 1975, the Tweedsmuir-Entiako caribou range was part of Management Area 22, which extended from the area around northern Tweedsmuir Park and Entiako Park, to Tatla Lake in the north and Prince George in the east, and which contained portions of several Northern Caribou ranges making it difficult to attribute which caribou range caribou were harvested from.

Spalding (2000) suggests that hunting was additive to predation in contributing to caribou declines in BC in the first 40 years of this century. Bergerud (1978) and Hatter (1979) attributed part of the decline of the Tweedsmuir-Entiako caribou population in the 1970's to overhunting. An open season on caribou cows, hunting from the lake and at the rail portage, and hunters accessing the Quanchus Mountains by aircraft, all likely contributed to excessive hunting pressure at that time. More conservative harvest management of all caribou in BC began in the late 1970's (Northern Caribou Technical Advisory Committee 2004), including hunting closures for some populations. In 1977, the Eutsuk Nature

Conservancy in northern Tweedsmuir Park was closed to all hunting. The Tweedsmuir-Entiako caribou population was closed to hunting from 1978 to 1981. Caribou hunting re-opened in 1982 for adult males under Limited Entry Hunting regulations. In 1988, the portion of the Eutsuk Nature Conservancy closed area that was in Wildlife Management Unit 6-02 (Quanchus area) was removed from the no hunting area. Caribou hunting was again closed in 2003 after all caribou in the Southern Mountains National Ecological Area, including the Tweedsmuir-Entiako population, were designated as Threatened by COSEWIC.

Resident and non-resident harvests of adult male Tweedsmuir-Entiako caribou were modest between 1984 and 2002 and averaged less than 2/year (Cichowski and MacLean 2005). Adult male harvest rates may become a concern if they lead to low bull/cow ratios, which could potentially result in low pregnancy rates for adult female caribou. The bulls/100 cows ratio for the Tweedsmuir-Entiako caribou population ranged from 16.9 (1992) to 44.6 (2002) from 1985 to 2009 (Cichowski and MacLean 2005, Cichowski 2010). Pregnancy rate for adult female caribou was high throughout the study (see Section 2.4), so the number of bulls in the population were sufficient to ensure that a high proportion of the adult females were becoming pregnant.

First Nations have hunted caribou for thousands of years, primarily for food and clothing, but also for other uses (BC Ministry of Environment, Lands and Parks 1997). There is no information on recent First Nations harvest of Tweedsmuir-Entiako caribou; however, harvest is likely low because most First Nations in the area prefer to harvest moose (Mark Williams, pers. comm.).

4.4.2 Predator and alternate prey management

There have not been any predator management or alternate prey management programs conducted to specifically benefit the Tweedsmuir-Entiako caribou population.

From 1949 to 1962, a large-scale wolf poisoning program was implemented in most of BC and ungulate populations increased until about 1968 and then declined again in the 1970's (Bergerud 1978, Bergerud and Elliot 1986, Hoffos 1987).

4.5 Research and Monitoring

Monitoring of the Tweedsmuir-Entiako caribou population started in the late 1950s with sporadic reconnaissance flights, which were often incomplete and unsuitable for estimating population size (Hatter 1979). In 1963, a general ecology study of caribou in northern Tweedsmuir Park was undertaken over a period of 4 months including July to August, and October (Low 1964). In July 1963, 426 caribou were counted during a ground survey and the population was estimated at 600 (Low 1964). Another 5 weeks of fieldwork were conducted in January/February 1964, but difficulties in travelling within the study area and locating animals resulted in termination of that study (Low 1965). During a fixed-wing flight conducted during that study, 147 caribou were seen on windswept alpine slopes in the Mt. Wells/Tweedsmuir Peak area (Low 1965). Caribou were also found wintering in lower elevation forests. Snowfall was reported to be less than normal that year (Low 1965).

Sporadic reconnaissance flights continued until the early 1980s (Hatter 1979). A ground-based wildlife and fisheries inventory during summer in 1975 detected 90 caribou in the Chikamin Mountains, but few caribou were found in the Quanchus Mountains and forested areas to the east (Hazelwood 1975). Two ground surveys for caribou in northern Tweedsmuir Park were conducted in August (8 days) and September (5 days) in 1977 but few caribou were seen (Miller 1977). In 1978, a series of ground surveys and flights detected 114 caribou in the Chikamin Mountains on July 9, and 89 caribou in the Quanchus Mountains on October 12 (Hatter 1979). Hatter (1979) compiled all information on caribou in the northern Tweedsmuir Park area available at that time.

In 1982, 368 caribou were counted in the Fawnie Mountains during a fixed-wing flight on March 20 (Marshall 1982). Lack of information on caribou seasonal distribution and habitat use and increased forest harvesting activity in the area around the Fawnie Mountains led to initiation of a radio-collared caribou study in 1983 (Marshall 1984). Caribou were radio-collared with VHF collars from boats when they crossed Tetachuck Lake in November 1983 and November 1984 (Marshall 1984, 1985, 1986) and by net-gun from a helicopter in February 1987. From November 1983 to April 1985, fixed-wing radio-telemetry flights were conducted approximately monthly to assess seasonal movements and habitat use. From April 1985 to March 1988, a more intensive study was conducted on seasonal movements, habitat use, winter feeding ecology and population dynamics (Cichowski 1989, 1993, Cichowski and MacLean 2005). The study included approximately biweekly radio-

telemetry flights during summer months (April to November), weekly radio-telemetry flights during winter months (December to March), biweekly winter ground investigations sessions (December to March), mark-recapture population surveys conducted during the rut in October using radio-collared caribou as the marked sample, adult mortality investigations, and calf production and survival surveys conducted in June, October and March. In addition, a 1:50,000 scale biogeoclimatic site series map interpreted for terrestrial lichen abundance was developed to support the winter habitat use portion of that study (BC Ministry of Forests 1987, Cichowski and Banner 1993).

Research/monitoring activity was sporadic for the first few years following the 1985-1988 study. Calf survival flights were conducted in June 1988, June 1990, November 1990, June 1991 and November 1991. Additional caribou were collared with VHF collars as they were crossing Tetatchuck Lake in November 1989 and 1990. A stratified random block survey was attempted on the winter range in March 1990 but survey conditions were poor (poor sightability, high degree of caribou mobility) so population size was not estimated (Marshall 1990). A 1-day winter site investigations ground survey was conducted in the Fawnie Mountains and in the Windfall Hills in March 1991 (Cichowski 1991).

In 1992, a 4-year study was initiated that focused on calf survival and on causes of adult mortality. Additional caribou were captured and collared with VHF collars in November 1992 as they were crossing Tetachuck Lake, and then in January and March 1993 by net-gun fired from a helicopter. From 1993 to 1995, weekly fixed-wing reconnaissance flights were conducted to listen for mortality signals from May to approximately mid July, and mortality investigations were conducted as soon as possible following detection. Calving (June), fall (Oct/Nov) and late winter (March) calf survival surveys were conducted each year starting in 1992/93 and carried through to 2001/02. Fall and late winter calf survival surveys were also conducted in 2002/03. In addition to the adult mortality/calf survival study, from spring 1993 to spring 1995, approximately weekly radio-telemetry flights were conducted in the Chelaslie Migration Corridor area (East Ootsa) to better understand caribou use in this area (Steventon 1996). Flights were conducted mostly during spring and fall, and also during winters when caribou occupied the area. Flights focused mostly on caribou in the migration corridor area. Caribou that were outside of the migration corridor area were not located during most flights.

From 1996 to 2003, monitoring of radio-collared caribou focused again on seasonal movements and habitat use, as well as calf survival and adult

mortality. Caribou were netgunned from a helicopter and collared with VHF collars in November 1996, December 1997 and January 2000. In January 2000, caribou were also collared with GPS collars. Additional caribou were collared with GPS collars in November 2001 and January 2002. Radio-telemetry flights were conducted generally monthly from October 1996 to November 2002, with approximately biweekly flights during winter/spring months in 1996/97, 1997/98 and 1999/2000. This phase of monitoring of the Tweedsmuir-Entiako caribou population also included monitoring of radio-collared moose (Cichowski and MacLean 2005). From spring 2001 to fall 2002, additional radio-telemetry flights were conducted for a habitat use study in the Whitesail area. Radio-telemetry flights were conducted approximately weekly during summer months when caribou were using the Whitesail area. Those flights focused mostly on caribou that were using the Whitesail area.

No research or monitoring activities were conducted on the Tweedsmuir-Entiako caribou population between March 2003 and February 2006. During this time, a synthesis of all information collected on caribou between 1983 and 2003 was completed (Cichowski and MacLean 2005).

In March 2006, a study was initiated to investigate the impacts of the mountain pine beetle epidemic in the grey phase of the attack on caribou seasonal movements, habitat use, winter feeding ecology and population status (Cichowski 2010). Caribou were radio-collared with VHF and GPS collars in March 2006, January 2007 and December 2007. Fieldwork was conducted from March 2006 to March 2009 and included approximately monthly radio-telemetry flights during summer months (April to November), bi-weekly radio-telemetry flights during winter months (December to March), monthly winter ground investigations sessions (December to March), adult mortality investigations, a calf production survey in July 2007, and calf survival surveys conducted in October/November and March each year.

Between April 2009 and September 2014, only two monitoring activities were conducted for the Tweedsmuir-Entiako caribou population. A late winter calf survival flight was conducted in March 2012, and a fall calf survival flight was conducted in October 2013. In 2013, as part of wider scale assessment of moose populations in central BC, moose in the Entiako area were radio-collared with GPS collars. In October 2014, a study was initiated to assess the effects of the 133,100 ha Chelaslie Fire using GPS collared caribou. The caribou study also included collaring and tracking wolves.

In 2001, a study assessing the impacts of mountain pine beetles on terrestrial caribou forage lichens was initiated (Williston and Cichowski 2002). The study was based on permanent plots that were established in 2001 in a range of bioclimatic subzones/site series and that were re-measured in 2003, 2005, 2007 and 2011 (Williston and Cichowski 2002, Cichowski and Williston 2003, Williston and Cichowski 2004, Williston *et al*. 2006, Cichowski *et al*. 2008, Cichowski and Haeussler 2013).

In 2007, a study was initiated to assess response of caribou terrestrial forage lichens and competing vegetation to fire in Entiako Park (Cichowski and Williston 2008). In 2007, permanent plots were established in the Entiako Fire (2006 wildfire) using the same methods that were used for the mountain pine beetle/lichen study. Plots were re-measured in 2009 (Cichowski and de Groot 2010).

4.6 Habitat Management

4.6.1 Management Guidelines for the Tweedsmuir-Entiako Caribou Herd Migration Corridor

Management guidelines for the Tweedsmuir-Entiako caribou herd migration corridor were developed in 1992 (BC Ministry of Forests 1992). The guidelines zoned the migration corridor into 5 zones and 7 subzones and included objectives for the whole corridor, and objectives and guidelines for each zone/subzone. The guidelines also defined "caribou passable stands" as stands that are less than 2000 stems/ha and a minimum of 10-12 meter in height.

4.6.2 Management Strategy and Options for the Tweedsmuir-Entiako Caribou Winter Range

In 1993, a management strategy and options were developed for the Tweedsmuir-Entiako caribou winter range (Cichowski and Banner 1993). The Entiako portion of the winter range was zoned into 12 Caribou Management Zones based on terrestrial lichen abundance and known caribou use patterns. Six management options were developed ranging from no forest harvesting in all zones, to various combinations of zones allowing or not allowing forest harvesting, to some level of forest harvesting in all zones. The effects of the each option on timber supply in the Lakes and Prince George Timber Supply Areas were evaluated. At a minimum, it was recommended that at least the core of the winter range

be protected from forest harvesting, but that protecting the northern portion of the winter would result in the least potential negative impacts on the Tweedsmuir-Entiako caribou population and winter range, without restricting harvesting from the winter range completely.

4.6.3 Caribou Habitat Use in the Chelaslie River Migration Corridor and Recommendations for Management

In 1996, management recommendations were completed for the Chelaslie River Migration Corridor following a 3 year intensive study of radio-collared caribou in the Chelaslie migration corridor area (Steventon 1996). As part of the study, the migration corridor area was zoned into 5 zones based on intensity of use by caribou. The study also indicated that a significant number of caribou also used the area during winter in some years. Objectives for the Chelaslie migration corridor area included maintaining travel and forage opportunities throughout the area, reducing potential for human displacement of caribou, and minimizing potential overlap of caribou and moose to reduce potential predation risk. Management recommendations included: maintaining a substantial proportion of the area in mature and old forest, especially in terrestrial lichen areas; avoiding development in the high use zone around Chief Louis Lake and minimizing disturbance along the high use zone on the north side of Tetachuck Lake; maintaining a variety of travel options throughout the area; considering access controls and scheduling harvest to minimize potential for displacement of caribou; applying adaptive management; and, addressing other herd management issues.

4.6.4 Land and Resource Management Plans/Legal Orders

In the mid to late 1990s, habitat management for the Tweedsmuir-Entiako caribou population outside of protected areas was largely directed by LRMPs. Old growth targets, seral stage targets, and some objectives for wildlife from the LRMPs were eventually included in legal orders.

An order setting seral stage targets is currently in place for the Lakes LRMP area that includes the Chelaslie Migration Corridor, and old growth orders are in place for the Lakes and Vanderhoof LRMP areas. Seral stage targets for the Chelaslie Migration Corridor were incorporated from direction provided in the Lakes LRMP. The old growth order for the Lakes LRMP includes spatially explicit OGMAs, which includes the two very high caribou use zones in the Chief Louis Lake area and the area along the

north side of Tetachuck Lake. Additional OGMAs within the migration corridor include some high elevation habitat adjacent to Tweedsmuir Park, and smaller areas scattered throughout the corridor. The Prince George Timber Supply Area Biodiversity Order provides old forest targets by biogeoclimatic zone for the Vanderhoof LRMP area, but does not provide for spatially explicit OGMAs. The biodiversity order for the Morice LRMP area, which includes old growth objectives recommended by the Morice LRMP, is still in the draft stage.

A Section 7 order was established in 2004 in the Vanderhoof LRMP area for Northern Caribou calving/rutting range, mineral licks and matrix range (Province of British Columbia 2004a). The order limits the impact to the mature timber harvesting landbase to 6100 ha.

A Section 7 order for species at risk for calving range for the Tweedsmuir-Entiako caribou in the Whitesail Reservoir in the Morice LRMP area was established in 2004 (Province of British Columbia 2004b). The order limits the impact to the mature timber harvesting landbase to no more than 570 ha, which is being incorporated into the proposed Whitesail Wildlife Habitat Area (see Section 4.2.4).

In 2005, Ungulate Winter Ranges U-7-012 and associated general wildlife measures were established for caribou in the Vanderhoof Resource District under the Government Actions Regulation of the Forest and Range Practices Act, which include 26,067 ha of low elevation and 22,629 ha of high elevation UWRs (BC Ministry of Environment 2005a). These UWRs were also grandparented under the Oil and Gas Activities Act (OGAA) in 2011. Although the GWMs do not apply under OGAA, they may be used when determining whether activities will lead to material adverse effects as required by the Act. Forest harvesting and road building is not permitted in high elevation UWRs. In low elevation UWRs, 50% (+/- 10%) of the economically viable timber can be harvested within a 70 year pass, but as close as possible to 50% of the terrestrial lichen habitat must be in a successional stage that will provide moderate or high class lichen value (as defined in the Ministry of Environment's "Classification Guide for Terrestrial Lichen habitat in the Omineca Region"; BC Ministry of Environment 2005b).

4.6.5 Best Management Practices for Industrial Activities Affecting Caribou in the Vanderhoof Resource District

Best management practices were developed for industrial activities affecting caribou in the Vanderhoof Resource District in response to

concerns about the level of industrial activities in the Vanderhoof Resource District portion of the Tweedsmuir-Entiako caribou range (Cichowski and McNay 2014). Best management practices included both landscape level and site level practices and were based on the following principles: avoiding increasing mortality risk for caribou (landscape and site levels); maintaining connectivity with the Itcha-Ilgachuz and Rainbow caribou ranges (landscape level); avoiding destroying forage and forage habitat (site level); avoiding increasing alternate prey forage (site level); and, prioritizing landscape level best management practices over site level practices.

4.7 Access Management

Access management in northern Tweedsmuir Park and Entiako Park is guided by park zoning. Both parks are mostly zoned as wilderness recreation, which focuses on unroaded non-motorized recreational experiences. In Tweedsmuir Park, the Natural Environment zone allows for motor-boat access on Eutsuk and Pondosy lakes. Airplane access is permitted in both parks.

Access management in the Tweedsmuir-Entiako caribou range outside of protected areas has largely been developed as part of LRMPs. The original access management plan for the Vanderhoof LRMP was a consensus-based plan that addressed year round motorized use. The current Access Management Plan for Forest Recreation in the Vanderhoof portion of the Tweedsmuir-Entiako caribou range only addresses summer recreational activities and access zones in the plan reflect current use (BC Integrated Land Management Bureau 2008). A plan for winter recreation has not yet been developed, so there is no guidance for access management during winter when caribou are using their winter range. UWR #U-7-012 in the Vanderhoof Resource District contains the only legal objectives for access on the Tweedsmuir-Entiako caribou range. No new main roads are permitted within the high elevation UWR units.

The Chelaslie Migration Corridor Strategy in the Lakes LRMP provided specific access management direction including no new road building in the very high use zones, minimizing road building in other zones, and defining access control points. None of the current legal orders incorporate access management direction from the LRMP.

Access management direction from the Morice LRMP for the Tweedsmuir-Entiako caribou range focuses on zoning for motorized and

non-motorized recreational activities. The Sibola Mountains are zoned as motorized. The area south of Tahtsa Lake is mostly zoned as summer non-motorized (the portion south of Troitsa Lake is summer non-motorized only above 1000 m) except for the area along Tahtsa, Troitsa and Blanket Lakes, which is zoned as motorized, and the area south of Coles Lake, which is zoned as winter non-motorized. The remaining area outside of those zones is undesignated.

5. Threats

While predation is considered the main proximate limiting factor for caribou populations, large-scale habitat alterations that affect abundance, habitat use and movements of predators and alternate prey ultimately affect caribou populations (Festa-Bianchet *et al*. 2011).

The following sections are adapted from the discussions of threats in the Recovery Strategy for Woodland Caribou, Southern Mountain population in Canada (Environment Canada 2014) and the COSEWIC Status Report on Caribou in the Northern Mountain, Central Mountain and Southern Mountain Designatable Units (COSEWIC 2014). Each section describes an individual threat; however, because threats interact, some discussion crosses over between sections.

5.1 Predation

The most significant threat to Northern Caribou is increased predation resulting from habitat alteration due to industrial activities (Environment Canada 2014). Industrial activities such as forest harvesting, mining and mineral exploration, and oil and gas exploration and development remove or destroy caribou habitat (mature and old forests) and create early seral habitats favoured by other prey species such as moose and deer. In ranges with habitat alterations that provide favourable conditions for other prey species, predators such as wolves can increase in number, which can significantly reduce or even eliminate caribou populations (Seip 1991; Seip 1992a; Wittmer *et al*. 2005).

Wolves are the primary predator of caribou in western Canada (Edmonds 1988, Farnell and McDonald 1988, Seip 1992a, Hayes *et al*. 2003, McNay 2009, Whittington *et al*. 2011), but bears, cougars, and wolverine can be important predators locally and/or seasonally (Kinley and Apps 2001, Cichowski and MacLean 2005, Wittmer *et al*. 2005, Gustine *et al*. 2006a, McNay 2009, Milakovic and Parker 2013). For the Tweedsmuir-Entiako caribou population, wolf predation and bear predation were the primary known causes of adult mortality, and other known causes of mortality included wolverine predation, and injury/accident (Cichowski and MacLean 2005, Cichowski 2010).

Historically, predator-prey dynamics on caribou ranges have fluctuated with environmental conditions and management practices. Moose were largely absent or present at extremely low densities in southern and

central BC until the late 1800s when they started to increase (Spalding 1990, Santomauro *et al*. 2012). In the Tweedsmuir-Entiako area, moose began increasing in abundance in the early 1900s (Spalding 1990). In the 1950s and 1960s, wolves and coyotes were poisoned through widescale predator control programs (Bergerud 1978, Hoffos 1987, Bergerud and Elliott 1998). Legal harvests of caribou in the late 1960s and early 1970s combined with recovering wolf populations may have contributed to caribou population decreases in BC, including the Tweedsmuir-Entiako area, in the 1970s (Bergerud 1978, Hatter 1979).

Although predation is the primary cause of caribou mortality (Edmonds and Smith 1991, Seip 1992a, Wittmer *et al*. 2005), caribou are usually a secondary prey species in the diet of predators, especially wolves, whose populations are sustained by other prey species such as moose and deer (Seip 1992a, Stotyn 2008, Williamson-Ehlers 2012). While caribou and other prey do not compete directly for resources, other prey affect caribou populations through ”apparent competition”, which is the indirect interaction between species when they share a common predator (Holt 1977, Wittmer *et al*. 2007, DeCesare *et al*. 2009). For caribou, this interaction is usually negative with caribou declining when other prey species increase in numbers (Wittmer *et al*. 2007, DeCesare *et al*. 2009).

Caribou that coexist with predators and other prey on their ranges are generally spatially separated from predators and other prey through much of their annual cycle (Seip 1992a, Stotyn 2008, Hebblewhite *et al*. 2010a, Steenweg 2011, Robinson *et al*. 2012). For Mountain Caribou in southeastern BC, spatial separation is greatest during late winter when caribou are found in subalpine forests, and wolves, cougars, moose and deer are found in valley bottoms; the lowest degree of spatial separation occurs during spring (Seip 1992b, Stotyn 2008, Steenweg 2011). Wolf predation on Mountain Caribou occurs primarily at low elevations (Apps *et al*. 2013). Northern Caribou in west-central Alberta and BC select higher elevations and forested habitats and avoid burns, while wolves select burns, areas close to burns, and open habitats and avoid high elevation/alpine areas (Gustine and Parker 2008, Hebblewhite *et al*. 2010a, Robinson *et al*. 2010). Wolves also frequent early seral habitats while caribou do not (Williamson-Ehlers 2012). In west-central Alberta, wolves use high elevations most in summer and fall (Whittington *et al*. 2011).

During calving, caribou spatially separate themselves from other prey and predators by dispersing into high elevation alpine and subalpine habitat (where forage is limited) or onto islands in lakes where predators are less

abundant (Bergerud *et al*. 1984b, Bergerud 1985). In the Tweedsmuir-Entiako area, caribou that calve in mountains or on islands in lakes have higher early calf survival than caribou that calve in low elevation forests (Seip and Cichowski 1996, Cichowski and MacLean 2005).

Because spatial separation of caribou from predators and other prey is important for maintaining caribou populations, any human activities that result in reduced spatial separation, or increased access to caribou ranges, can result in increased predation risk and reduced calf and adult survival rates.

Predator reduction and sterilization are tools used for reversing caribou population declines (Bergerud and Elliot 1998, Hayes *et al*. 2003). Wolf removals of 60-90% have resulted in increased numbers of caribou, reduced caribou adult mortality, and increased calf recruitment (Farnell and McDonald 1988, Bergerud and Elliot 1998). In most cases, the effects of wolf removal are short lived and caribou populations decline once wolf removal has ended (Adamczewski *et al*. 2007). However, for the Aishihik caribou population in the Yukon, caribou continued to increase even after the wolf removal and sterilization program ended (Hegel and Russell 2010). On the Barkerville and Wells Gray (north) Mountain Caribou ranges where wolves were removed and sterilized, and wolf densities were reduced to 3.2-3.4 wolves/1000 km^2 on about 60% of the study area, the Barkerville population increased and the Wells Gray (north) population remained stable, but calf recruitment was variable (Roorda and Wright 2012).

Reduction of alternate prey is another potential tool for reversing caribou population declines. Reduction of moose through liberalized hunting resulted in a 71% reduction in moose numbers and about a 50% reduction in wolf numbers on three Mountain Caribou ranges in southern BC; the Columbia North population (the largest subpopulation in the study) experienced a modest increase while the two small populations (Columbia South, Frisby-Boulder) decreased (Serrouya 2013). In the Parsnip portion of the Hart Ranges Mountain Caribou range in central BC, moose numbers declined, possibly due to a severe winter affecting moose mortality, but over 6 years, neither wolf nor caribou numbers appeared to respond (Steenweg 2011, D. Heard, pers. comm. 2013).

5.2 Industrial Activities

Forest harvesting, mineral exploration and development, and hydro-electric generation (Nechako Reservoir) are the primary industrial

activities affecting the Tweedsmuir-Entiako caribou population. Salvage harvesting of mountain pine beetle-killed stands and mid-term timber supply issues are also contributing to increased pressure to harvest within or directly adjacent to important caribou habitat. In the short term, coal exploration and development, oil and gas exploration and development, and wind-farms do not appear to be threats to the Tweedsmuir-Entiako caribou population.

Although the impacts of industrial activities do not generally result in direct mortality of Northern Caribou, indirect impacts include facilitated movement of predators through caribou ranges and altered predator/prey dynamics due to habitat alteration, which lead to increased predation rates on caribou. Where infrastructure is involved (e.g., open pit mines, roads) or habitat is converted to other uses (e.g., agriculture, pipelines, transmission lines), habitat alteration is essentially permanent. Fire-adapted forest habitat can take 60-80 years to recover following forest harvesting and more than 100 years may be required for high elevation subalpine habitat to once again become suitable caribou habitat.

Caribou select habitat in a hierarchical manner; at the landscape scale the priority of selection is to reduce predation risk (Johnson *et al*. 2002, Gustine *et al*. 2006b). Habitat alteration resulting from industrial activities on caribou ranges has been linked to: reduced spatial separation between caribou and other prey or predators (Peters 2010); reduced occupancy by caribou (Smith *et al*. 2000, Apps and McLellan 2006, Wittmer *et al*. 2007); reduced calf recruitment (McCarthy *et al*. 2011); displacement of caribou (Chubbs *et al*. 1993, Schaefer and Mahoney 2007, Weir *et al*. 2007); reduced adult caribou survival (Smith 2004, Wittmer *et al*. 2007); and caribou population declines (Wittmer *et al*. 2007). Industrial activities can also affect caribou directly through impacts on forage lichens (Kranrod 1996, Sulyma 2001, Miège *et al*. 2001, Stevenson and Coxson 2007).

The effects of habitat alteration due to industrial activities may reduce the viability of a caribou population through increased predation rates within caribou ranges or displacement of caribou to areas of higher predation risk. This could lead to a reduction in the size of the annual range and potentially result in the extirpation of a population. Habitat alteration due to industrial activities also reduces the suitability of adjacent habitat (Smith *et al*. 2000; Williamson-Ehlers 2012). In some cases caribou may use areas of inadequate or degraded habitat (e.g. habitat surrounding certain types of development), particularly in highly disturbed ranges where opportunities for movement to suitable

undisturbed habitat are limited or unavailable (Williamson-Ehlers *et al*. 2013). In these situations caribou are at a higher mortality risk. In addition, large-scale industrial disturbances to the landscape (e.g., widespread forest harvesting) can cause caribou to discontinue their use of portions of the range (Smith *et al*. 2000).

Caribou distance themselves away from habitat alteration if there is an opportunity to; however, where the density of habitat alteration is high, caribou may not have opportunities to use areas that are distant from the habitat alteration (Polfus *et al*. 2011, Williamson-Ehlers *et al*. 2013). For example, on very disturbed landscapes, during calving when fidelity to ranges is higher, caribou may need to choose between reducing range fidelity (potentially resulting in lower female and calf survival due to reduced familiarity with escape cover, predation risk and food distribution) or maintaining site fidelity in a landscape where predation risk has increased due to increased habitat alteration (Faille *et al*. 2011, Tracz *et al*. 2010).

Habitat alteration affects the distribution and configuration of high quality habitat on the landscape. In west-central Alberta, caribou selected winter habitat patches with high area to perimeter ratios (Saher 2005). Also in west-central Alberta, at the landscape level, caribou avoided and were less abundant in areas disturbed by forest harvesting (Smith *et al*. 2000, DeCesare *et al*. 2012). For Mountain Caribou, Apps *et al*. (2013) were unable to link localized habitat fragmentation due to forest harvesting within caribou ranges with predation on caribou, and suggest that habitat alteration functions at a broader scale and includes winter ranges of primary prey beyond caribou ranges. Schneider *et al*. (2010) suggest that large undisturbed patches may need to be protected to prevent infiltration by predators from surrounding areas.

Forest succession after forest harvesting differs from that after natural disturbance. In particular, succession of terrestrial lichens after forest harvesting depends on initial ecological conditions, degree of disturbance, surface treatment, and restocking methods. On extremely dry sites dominated by terrestrial lichens, lichen cover may decrease after clearcut harvesting (Miège *et al*. 2001), while on more moist sites, harvesting may promote an increase in terrestrial lichen cover where other vegetation has outcompeted the lichens (Sulyma 2001). Partial cutting can result in increased arboreal lichen abundance in the lower canopy of the residual forest until new regeneration begins to shelter the lower canopy of remaining trees, while heavier cuts can result in reduced arboreal lichen abundance (Stevenson and Coxson 2007).

Disturbance due to noise, traffic and/or other factors caused by human activities and associated access could result in displacement of caribou from preferred or low predation risk habitats, increased stress, changes in movement patterns, increased energy expenditures and/or physical injury or death. Female caribou with calves during the calving season are the most prone to disturbance, while bulls throughout the year and all caribou during the insect harassment season are less likely to avoid disturbances (Wolfe *et al*. 2000). Physical disturbance from roads, drilling sites and seismic lines have resulted in avoidance of habitats well beyond actual development footprints (Polfus *et al*. 2011, Williamson-Ehlers *et al*. 2013).

Studies from other areas provide further insight into effects of industrial activities on caribou. In Alaska, oil and gas facilities appeared to displace calving caribou to other areas, which could potentially lead to increased predation on calves (Nellemann and Cameron 1998). Logging activities, including hauling logs through winter habitat, have resulted in displacement of caribou (Darby and Duquette 1986, Darby *et al*. 1989, Cumming and Hyer 1998). In Newfoundland, female caribou showed reduced use of areas within 9.2 km of timber harvest cutblocks (Schaefer and Mahoney 2007), and construction of a hydroelectric development in Newfoundland displaced some caribou and disrupted the timing of migration (Mahoney and Schaefer 2002). Cameron *et al*. (1995) found significantly lower abundance and reduced movements of female caribou within a developed oil field compared with more remote areas. In Alberta, simulated petroleum exploration noise resulted in higher mean movement rates and displacement of Boreal Caribou, but feeding patterns were not affected (Bradshaw *et al*. 1997, 1998). Avoidance of well sites by Boreal Caribou in Alberta was greatest during late winter and calving (Dyer *et al*. 2001).

5.3 Roads and other anthropogenic linear features

Roads impact caribou directly through vehicle collisions and increased access for regulated and unregulated hunting (Brown and Ross 1994, ASRD & ACA 2010). Roads and linear features such as pipelines, seismic lines, and hydro transmission lines also affect caribou indirectly through habitat fragmentation and improving the efficiency of movement for some predators. Linear features can also support permanent early seral habitat favoured by other prey species. For example, grass seeding on road and transmission line right-of-ways provides forage for other prey species.

In general, caribou avoid disturbance associated with roads and other anthropogenic linear features (Oberg 2001, Hebblewhite *et al*. 2010a, Polfus *et al*. 2011, DeCesare *et al*. 2012, Williamson-Ehlers 2012), often despite the availability of preferred habitat (e.g. lichen producing winter habitat) near those features (Florkiewicz *et al*. 2007). Caribou avoid areas in close proximity to roads (Hebblewhite *et al*. 2010a, Williamson-Ehlers 2012), while response of wolves to roads is variable (Hebblewhite *et al*. 2010a).

Roads and anthropogenic linear features associated with industrial and recreational activities affect predation risk. For Northern Caribou in west-central Alberta, encounter rates between wolves and caribou increased with proximity to anthropogenic linear features (Whittington *et al*. 2011). For Mountain Caribou, wolf predation on caribou occurred in association with roads at the fine scale (Apps *et al*. 2013). Roads and other anthropogenic linear features were associated with increased predation risk for Boreal Caribou in Alberta and with facilitating wolf movements (James 1999, James and Stuart-Smith 2000, Latham *et al*. 2011).

Improved access to the summer calving range may increase risk of disturbance by humans during calving; calving areas are the most sensitive of all habitats for caribou (Seip and Cichowski 1996) and require protection. In Alaska, Nellemann and Cameron (1998) found that the greatest incremental impacts of roads were attributed to initial construction and related facilities and that females and calves were far more sensitive to surface development than adult males and yearlings. Displacement could lead to increased predation risk if caribou are forced into habitats where predation risk is higher. During winter, displacement could also lead to poorer body condition if caribou have to increase energy expenditure to avoid disturbances, or use lower quality habitats where food quantity and/or quality are lower.

5.4 Recreational Activities

Snowmobiling, boating/fishing and hiking are the primary recreational activities that affect the Tweedsmuir-Entiako caribou population.

Snowmobiling has been found to result in displacement of Northern Caribou in the Yukon (Powell 2004) and Mountain Caribou in BC (Seip *et al*. 2007), increased stress for Mountain Caribou (Freeman 2008), reduced feeding due to increased vigilance and movement after disturbance for Northern Caribou (Powell 2004), and increased access for wolves along packed trails in winter for Northern Caribou (Powell 2004).

Mountain Caribou in southeastern BC were absent from an area that had extensive snowmobile use, even though it contained high quality habitat (Seip *et al*. 2007). Displacement could force caribou into areas where mortality risk is higher. Increased concentrations of the fecal stress hormones (glucocorticoids) were detected in Mountain Caribou located up to 10 km away from winter recreational activities (Freeman 2008). Chronic disturbance and stress could potentially lead to reduced body condition and consequent population level effects if reproductive rates, survival or recruitment are affected (Simpson and Terry 2000).

Non-motorized recreational activities such as backcountry skiing/snowshoeing has resulted in displacement of reindeer in mountainous terrain in Norway (Reimers *et al*. 2003, 2006), increased vigilance following encounters for caribou in the Laurentian Highlands in Quebec (Duchesne *et al*. 2000), and increased access for wolves on packed trails (Bergerud 1996). During summer, reindeer in mountainous areas in Norway avoided areas with tourist trails, resorts, and cabins (Vistnes and Nellemann 2001, Vistnes *et al*. 2008).

Caribou reactions to recreational disturbance may also be influenced by environmental conditions. In Newfoundland, Mahoney *et al*. (2001) found that caribou in Newfoundland fled from shorter distances and responded more slowly to snowmobiles during a high snowfall winter, presumably as an attempt to decrease energy expenditure when cost of locomotion was higher and forage was less available. In Scandinavia, reindeer selected insect relief areas distant from human activity during the insect harassment season if available, but did use insect relief areas where hiking activity was high if they did not have access to insect relief areas that were distant from human activity (Skarin *et al*. 2004, Vistnes *et al*. 2008).

5.5 Natural disturbances

Fire and forest insects are the primary natural disturbances on the Tweedsmuir-Entiako caribou range. Habitat alteration by natural disturbances can affect caribou through direct impacts on forage (Cichowski *et al*. 2009, Seip and Jones 2010, Waterhouse *et al*. 2011, Cichowski and Haeussler 2013) or through indirect impacts associated with habitat change favouring other prey species (Festa-Bianchet *et al*. 2011). Successional changes after disturbance on caribou ranges can vary depending on ecological conditions (e.g. cover type, soil conditions, disturbance characteristics, slope, aspect, elevation, climate change). Following fire, terrestrial lichens preferred by caribou are most abundant in forests 50-150 years in age (Coxson and Marsh 2001).

Use of burned areas by caribou is typically low (Schaefer and Pruitt 1991, Thomas *et al*. 1998, Joly *et al*. 2003, Dalerum *et al*. 2007, Hebblewhite *et al*. 2010a, Robinson *et al*. 2010); however, caribou may make greater use of burned areas on ranges where the amount of fire disturbance is high (Dunford 2003). Barren-ground caribou were reported to travel up to 25 km through very large burns but they did not spend much time in them (Thomas *et al*. 1998). Thomas *et al*. (1998) suggest that blow-down, thick re-growth, or poor snow conditions in burns rarely create movement barriers to caribou, and that lack of use of burned areas is likely more due to a lack of available food.

The recent mountain pine beetle epidemic initially resulted in increased abundance of dwarf shrubs and a corresponding decrease in terrestrial lichens (Cichowski *et al*. 2009, Seip and Jones 2010, Waterhouse 2011, Cichowski and Haeussler 2013). However, by 10 years following mountain pine beetle attack, dwarf shrub abundance decreased and terrestrial lichen abundance increased on drier, less productive sites (Cichowski and Haeussler 2013). Despite habitat alteration due to mountain pine beetles in west-central and east-central BC, caribou continued to crater for terrestrial lichens in beetle-killed mature pine forests even after needle loss (Cichowski 2010, Seip and Jones 2010). Continued research is needed to follow the changes in ecosystem components as trees fall.

Pine rusts are also a concern on some low elevation winter ranges. The treatment for pine rusts is drag scarification, which impacts terrestrial lichens.

Historically, when natural disturbance occurred, caribou could shift their use of habitat from affected areas to areas that were more suitable. However, with the increase of industrial activities, resulting in habitat loss and fragmentation, caribou will have fewer suitable areas into which they can move either within or between ranges.

5.6 Other Threats

5.6.1 Hunting

The Tweedsmuir-Entiako caribou population was closed to hunting from 1978 to 1981, and then again in 2003. Resident and non-resident harvests of adult male between 1982 and 2002 averaged less than 2/year

and likely had little impact on the caribou population. The extent of unlicensed hunting is not known but suspected to be low. Historically, overhunting of caribou in BC was primarily a result of road access associated with human industrial and recreational development (Bergerud 1978, Stevenson and Hatler 1985).

5.6.2 Severe Weather/Climate Change

Large-scale climate patterns can affect calf recruitment. In the Yukon, the Pacific Decadal Oscillation (PDO) during the winter prior to birth and weather conditions during the May calving period was positively related to calf recruitment (Hegel *et al*. 2010a). Higher PDO values during winter represent decreased precipitation during May and increased temperature, both leading to a reduced snowpack at calving and an earlier onset of the first snowfree day of the year. This affords pregnant females easier movement to higher elevation areas. In Alaska, birth weight of calves born in mountainous terrain is related to reproductive history the previous year and availability of food in winter (e.g., Adams and Dale 1998) and particularly in the last trimester of pregnancy.

Deep snow conditions could also affect predation by delaying spring migration (Edmonds and Smith 1991) and could potentially affect winter energy requirements. Caribou can forage through up to a metre of snow or more (Johnson *et al*. 2000) but at a cost to energy reserves.

Detrimental effects of climate change could include altered frequency and severity of natural disturbances (fire and forest insects), changes in vegetation composition, shifts in distribution of other ungulates, and increased incidence of diseases and parasites (Vors and Boyce 2009). Increased summer temperatures and extended fire seasons could result in increased area disturbed by fire. Increased winter temperatures and fewer cold weather extremes could lead to increased forest insect activity, such as mountain pine beetles. Increased temperatures could also potentially result in increased severity of biting insects.

Climate change can result in changes to vegetation composition even without changes to natural disturbance patterns. Predicted warmer temperatures could lead to ecological conditions that favour vegetation species that can outcompete terrestrial lichens and/or that are preferred by other prey species (Hamann and Wang 2006), leading to northward expansion of ranges of other ungulate species, further altering predator/prey relationships. For example, Hoefs (2001) reports both

mule and white-tailed deer have colonized the southern Yukon, with white-tailed deer first observed north of the BC border in 1975.

Climate change could also result in more favourable conditions for diseases and parasites that affect caribou. Disease has played a major role in caribou declines in eastern North America where altered landscapes and mild winters allowed white-tailed deer carrying the meningeal worm to expand north and infect caribou (Bergerud and Mercer 1989). Longer summer seasons could also speed up life cycles for some parasites.

Although climate change is not expected to result in major habitat shifts in the short term, climate-related changes in habitat in the long term are expected to favour deer and other prey species, thereby increasing predator populations and predation on caribou, and facilitating the spread of diseases and parasites. However, impacts of climate change on caribou in the short term are expected to be low compared to other immediate threats that they face.

5.6.3 Parasites and Diseases

Although parasites and infectious diseases have not been found to be a significant direct cause of mortality in caribou in BC, they may be under-diagnosed (H. Schwantje, pers. comm. 2013). Some have the potential to affect reproductive output, and/or as chronic diseases, can lead to reduced vigour, potentially resulting in greater susceptibility to predation. Climate change can lead to: increased prevalence, intensity and geographic distribution of some parasites; reduced parasite survival of others; facilitated invasion of new parasites; and, the invasion of new hosts, resulting in introduction of new parasites and changes in abundance and distribution of endemic parasite species (Kutz *et al*. 2009).

5.6.4 Avalanches

No avalanche related mortalities have been documented for the Tweedsmuir-Entiako caribou population (Cichowski and MacLean 2005, Cichowski 2010). Avalanches are a known cause of caribou mortality in other areas, especially for Mountain Caribou. In west-central Alberta, the last five caribou in the Banff population were killed in an avalanche in 2009 (Hebblewhite *et al*. 2010b).

5.6.5 Settlements and Agriculture

Human settlements and agriculture result in permanent alteration of caribou habitat. Agriculture also converts forested habitat into early seral habitat favoured by other prey species. Currently there is very little area within the Tweedmuir-Entiako caribou range that is occupied by settlements or agriculture.

5.7 Cumulative Effects

Although individual natural disturbances or human activities may impact the Tweedsmuir-Entiako caribou population, the impacts of all the activities combined need to be considered when assessing the overall effects on the population. Also, because predator/prey dynamics function at a scale that extends beyond the caribou range boundaries, habitat and predator/prey dynamics adjacent to the Tweedsmuir-Entiako caribou range must also be considered.

For the Tweedsmuir-Entiako caribou population, habitat alteration/conversion within and adjacent to the range includes industrial developments (Nechako Reservoir, forest harvesting, mineral exploration and development), and agriculture.

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Appendix 1. Summary of Northern Caribou seasonal habitat and range use (from Cichowski 2008)

In general, Northern Caribou habitat use in B.C. can be described using 4 seasonal time periods. Exact dates for the seasonal time periods vary for each population and depend on local conditions. The following seasons, their approximate dates, and factors that influence caribou movements in each season are summarized below.

Fall Migration and Early-winter *(November to mid-January*)

Snow accumulation in November or the approach of weather systems may trigger caribou movement out of high elevation summer and rutting ranges to lower elevation early winter ranges although some local populations may remain in alpine/subalpine habitat on windswept slopes. Low elevation early winter ranges may be adjacent to the summer range or some distance away. At this time, caribou continue to seek out terrestrial forage and avoid deeper snow accumulations where terrestrial forages are difficult to access. Fall migration between summer and winter ranges tends to be diffuse as caribou migrate in response to changing weather patterns and/or snow accumulation.

During early winter, snow depth at low elevations may be highly variable between years. In general, snow depth on low elevation winter ranges is lowest during early winter and gradually increases as the winter progresses. Shallower snow depths in early winter allow caribou to use the higher and more open portions of their forested plateau winter ranges (Itcha-Ilgachuz), or low elevation forested habitat (Wolverine) that are abandoned if sufficient amounts of snow accumulates during mid- to late-winter.

Late-winter (mid-January to mid-April)

By mid- and late-winter, caribou have moved to low elevation forested winter ranges, or high elevation alpine/subalpine winter ranges to feed primarily on terrestrial lichens. Preferred terrestrial lichens include *Cladina* sp., *Cladonia* sp., *Cetraria* sp. and *Stereocaulon* sp.

In low elevation forested habitat, caribou prefer older pine forests on drier sites where terrestrial lichens are abundant. Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. Arboreal lichen use increases as snow hardness increases later in winter with melt/freeze conditions. During milder winters, frequent melt/freeze episodes could make cratering for terrestrial lichens difficult earlier in the winter, especially when ice crusts form close to the ground, forcing caribou to increase their reliance on arboreal lichens. *Bryoria* spp. are the most abundant arboreal lichens on most Northern Caribou winter ranges.

At higher elevations, caribou prefer windswept alpine slopes for cratering for terrestrial lichens. Subalpine forests are also used for arboreal lichen feeding, and to a lesser extent, for terrestrial lichen feeding.

Caribou that winter in low elevation forested areas and share winter ranges with moose would be expected to be more susceptible to wolf predation than caribou wintering at higher elevations. However, adult mortality during winter is relatively low for caribou that have extensive, large, low elevation winter ranges (Itcha-Ilgachuz, Tweedsmuir-Entiako, Spatsizi). Northern Caribou that winter at higher elevations distance themselves from moose, and presumably wolves. Other high elevation ungulates present on or near caribou winter ranges (mountain sheep, mountain goats) may also influence the distribution of wolves on the winter range, but to a lesser extent than moose.

Spring (mid-April to May)

By late April, caribou that migrate between winter and summer ranges begin moving back to calving and summering areas. Spring migration is more concentrated than fall migration both geographically and temporally. During spring, caribou may migrate along relatively snow-free low elevation routes to reach summer ranges.

Caribou that winter at higher elevations may move to lower elevations in spring to take advantage of an earlier green-up. Spring ranges may be adjacent to late-winter ranges or may be a function of migration patterns.

As caribou move to and through low elevations during spring, they are highly susceptible to predation by wolves and bears. Significant adult and calf mortality occurs during spring. Where bear predation is a major mortality factor for caribou, most of it occurs during spring and early summer (May-June).

Summer (June-October)

Female caribou reach calving areas by late May and calve in early June. Many caribou calve at higher elevations in alpine or subalpine habitat where food availability and quality is poor, to avoid other prey and predators that remain at lower elevations where more nutritious and abundant forage is available. Caribou that calve at higher elevations have higher calf survival rates than caribou that calve at lower elevations (Seip and Cichowski 1996). Caribou that calve below treeline may use islands in lakes, where they are available, as an anti-predator strategy (Bergerud and Page 1987, Shoesmith and Storey 1977).

During summer, caribou prefer high elevation habitats but can be found in a variety of habitats at all elevations since snow does not limit movement and herb and shrub forage are abundant. Consequently, Northern Caribou are highly dispersed during summer, more so than during any other season.

During the rut in October, some caribou move to rutting areas at higher elevations while others rut within their summer ranges. Portions of some local populations concentrate on rutting ranges, usually in open alpine or subalpine habitat.

Regional Differences in Habitat Use

Although foraging for terrestrial lichens during winter is a common feature of Northern Caribou, seasonal habitat use, especially use of higher elevation winter ranges, is variable. Variation in seasonal behaviour between local populations in the Southern Mountains National Ecological Area reflects differences in topography, snow accumulation, availability of low elevation winter ranges, and distribution of predators and human activities.

In general, caribou in the Southern Mountains National Ecological Area with access to low elevation winter ranges appear to prefer those winter ranges unless snow conditions preclude their use. In the Tweedsmuir-Entiako and Itcha-Ilgachuz areas, most caribou winter at

low elevations throughout the winter with a smaller component of the population using alpine and subalpine habitat during all or part of the winter. In the Wolverine area, caribou use lower elevation habitat throughout the winter during low snow years but move up to windswept alpine slopes in late winter during heavy or normal snow years.

Geographic differences in calving habitat use also occur. In west-central BC, caribou are found in alpine habitat during calving. In north-central BC, caribou often calve at or near treeline, presumably because of excessive snow loads in the alpine, and then move higher up as the summer progresses.

Less information is available on habitat use patterns of Northern Caribou in the Northern Mountains National Ecological Area. Habitat use patterns appear similar to those in the Southern Mountains National Ecological Area; however, more information will be available from studies currently being conducted.

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Appendix 2. History of Legislation, Policy and Land Use affecting Tweedsmuir-Entiako caribou and their range

Table A2-1 summarizes legislation, policy and events that shaped current management and current conditions on the Tweedsmuir-Entiako caribou range. Management actions affect caribou either through direct effects on their numbers (e.g. hunting, predator management), or effects on their ranges (e.g habitat alteration, fire suppression), which indirectly affect caribou numbers.

1800s to 1950

Early policies affecting Tweedsmuir-Entiako caribou and their range were focused on other values or were broad in scope and were not necessarily intended specifically for managing caribou. Threats to people and to the forest harvesting industry from forest fires led to the establishment of the *Bush Fire Act* in 1874 (Parminter 1978). The Act originally focused on preventing forest fires resulting from intentionally set fires for land clearing or other activities, but eventually evolved to include fire suppression (Parminter 1978). The first four fire wardens were appointed in 1905, but that number increased to 123 by the time the *Forest Act* and the BC Forest Branch were established in 1911 (Parminter 1978). Initial fire detection and suppression activities were ground-based, but effectiveness of fire suppression began to increase in the mid-1940s with the introduction of dedicated fire suppression crews and increased use of aircraft (including water bombers) some of which were re-purposed following World War II (Parminter 1978, Bell 2011a)

In the early years, wolves were considered 'vermin' and a bounty on wolves began sometime before 1907 and continued until 1955 (BC Ministry of Environment 1979). Provincially, the number of bounties paid each year peaked at between 915 and 1659 in the late 1930s and in the 1940s, and then started to decline in the early 1950s. With the establishment of the Predator Control Branch in 1947, hired predatory animal hunters killed between about 100 to 200 wolves each year from 1949 to 1954 (BC Ministry of Environment 1979).

Table A2-1. Timeline of legislation, policies and land use affecting the Tweedsmuir-Entiako caribou range.

Year	Land Use/Forest Management	Protected Areas/ Wildlife/Caribou Management
1874	• New *Bush Fire Act* to protect forests from fire	
1896	• *Bush Fire Act* revised (established and defined Fire Districts)	
Early 1900s		• Moose numbers began increasing in central BC
1905	• First Fire Wardens appointed	• Bounty on wolves (started before 1907 and continued until 1955)
1911	• *Bush Fire Act* replaced by *Forest Fires Act*	• *Forest Reserves and Park Act* established
1912	• New *Forest Act* (established Provincial Forests) • BC Forest Branch established	
1920s		• Mineral exploration started in the Chikamin Range, Lindquist Lake and the Sibolas
1938		• Tweedsmuir Park established
1940		• Parks class system established – Tweedsmuir Park established as Class B Park
1942-1943	• Alternative Service Workers (conscientious objectors) used as first fire suppression crews	
1945	• Sloan Commission (recommended sustained yield management and planning, and increased fire protection) • Forest Branch changed to Forest Service • Start of era of extensive use of aircraft for fire protection in BC	
1947	• *Forest Act* Amended (established Tree Farm Licenses and Public Sustained Yield Units)	• Predator Control Branch established
1948		• Caribou hunting closed in Tweedsmuir-Entiako caribou range area
1955	• Kemano Project – Nechako Reservoir completed	• Caribou hunting opened in Tweedsmuir-Entiako caribou range area • Predator control (poisoning) program in Tweedsmuir Park (1955-56)
1956	• 2nd Sloan Commission (found that little planning had been done for PSYUs)	• Tweedsmuir Park boundary revised to exclude floodwaters • Game Management Units changed from 2 Districts (Eastern & Western) to 21 Management Areas (TE range in MA20)
1957		• Parks Branch established (independent from BC Forest Service) (BC Parks website)
1961		• Provincial wide-scale wolf poisoning program ended
1963		• Predator Control Branch disbanded
1965		• *Park Act* established (website)
1967	• Establishment of Timber Sale Harvesting Licences (TSHL) and Timber Sale Licences (TSL) requiring 5 year development Plans	• Game Management Areas revised (TE range now in new Management Area 22) • Eutsuk Nature Conservancy established in northern Tweedsmuir Park, which excluded mining
1969		• First Master Plan for Tweedsmuir Park
1972		• Use of helicopters for transporting hunters or wildlife prohibited
1973	• Resource Folio Planning system initiated based on watersheds and requiring integrated resource use	
1975	• Pearse Commission recommended consolidating PSYUs into larger Timber Supply Areas (TSAs)	• Game Management Areas revised into current Wildlife Management Units • Tweedsmuir Park Management Plan 1975-76
1977		• Eutsuk Nature Conservancy closed to hunting
1978	• New *Forest Act* passed incorporating most of the recommendations of the Pearse Commission	• Additional areas within Wildlife Management Unit (WMU) 6-01 south of Eutsuk and Whitesail Lake closed to hunting • Caribou hunting closed in Tweedsmuir-Entiako caribou range
1982		• Limited Entry Hunting (LEH) for caribou established in Tweedsmuir-Entiako caribou range

Year	Land Use/Forest Management	Protected Areas/ Wildlife/Caribou Management
1983	• Local Resource Use Plans (LRUPs) established to provide a process for local area-specific resource planning	• First radio-collared caribou project initiated for Tweedsmuir-Entiako caribou
1987	• Forest Wilderness Legislation established	• Terrestrial lichen map developed for the winter range
1988		• "Striking the Balance" – first comprehensive statement of provincial park policy (balancing conservation and recreation) • Tweedsmuir Park Master Plan completed (park converted to Class A park status, Eutsuk Nature Conservancy deleted) • No hunting area in northern Tweedsmuir Park reduced to the area south of Eutsuk Lake west of the Chezko River, the Chikamin Mountains, and a 1 km strip along Eutsuk Lake
1989-1990	• Wilderness Policy released and wilderness system planning initiated (Wilderness for the 90s) • Old Growth Management Strategy initiated	• System planning initiated for BC Parks (Parks Plan 90s) • Parks and Wilderness for the 90s initiated (amalgamated Parks Plan 90s and Wilderness for the 90s) • Study on seasonal movements, habitat use and winter feeding ecology completed
1991		• Summary of public response to Parks and Wilderness for the 90s
1992	• Old Growth Management Strategy released • Management Guidelines for the Tweedsmuir-Entiako caribou herd migration corridor • Entiako LRUP initiated	• Parks and Wilderness for the 90s morphed into the Protected Areas Strategy
1993	• Land and Resource Management Plans (LRMPs) established to provide a sub-regional process for land use decisions • Entiako LRUP disbanded and responsibility for decisions on land use forwarded to the Lakes LRMP and Vanderhoof LRMP • Vanderhoof LRMP initiated	• A Protected Areas Strategy for British Columbia released (overall goal to increase provincially protected lands to 12% by 2000) • Regional Protected Area Teams established to identify proposed protected areas • Responsibility of deciding on new protected areas included in LRMP process • Management Strategy and Options for the Tweedsmuir-Entiako caribou winter range
1994	• Lakes LRMP initiated	• Mountain pine beetle (MPB) infestations starting on the Tweedsmuir-Entiako caribou range
1995	• Forest Practices Code enacted	
1996		• Caribou Habitat Use in the Chelaslie River Migration Corridor and Recommendations for Management • Kitlope Protected Area established under the *Environment and Land Use Act*
1997	• Vanderhoof LRMP approved	
1998		• Kitlope Protected Area converted to Huchsduwachsdu Nuyem Jees/Kitlope Heritage Conservancy under the *Protected Areas of British Columbia Act* • Risks to caribou of management options for the proposed Entiako Protected Area (Options for MPB management)
1999		• Entiako Park established (Vanderhoof LRMP portion) under the *Park Act* to protect a portion of the Tweedsmuir-Entiako caribou winter range • Height of MPB epidemic on Tweedsmuir-Entiako caribou range (1999-2002)
2000	• Lakes LRMP approved • Lakes LRMP Higher Level Plan Order	• Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses caribou in the Southern Mountain National Ecological Area (SMNEA) as nationally Threatened • Northern ecotype caribou blue-listed by the BC Conservation Data Centre • Entiako Protected Area established (Lakes LRMP portion) under the *Environment and Land Use Act* to protect a portion of the Tweedsmuir-Entiako caribou winter range • Tweedsmuir Recreation Area partly incorporated into Tweedsmuir Park (remainder reverted to Crown Land – no forest harvesting)

Year	Land Use/Forest Management	Protected Areas/ Wildlife/Caribou Management
2001	• Caribou Management Strategy for the Vanderhoof Forest District	• Entiako Ecosystem Management Study • Tweedsmuir North Vegetation Management Study • Study on the effects of the MPB epidemic on terrestrial lichens on the Tweedsmuir-Entiako caribou winter and spring migration range
2002	• Morice LRMP initiated • Lakes LRMP Monitoring Report	• COSEWIC reaffirms Threatened status of SMNEA caribou
2003	• Lakes South Strategic Resource Management Plan Order • Vanderhoof LRMP Implementation Progress Report	• Federal *Species at Risk Act* fully enacted; SMNEA caribou listed as Threatened in Schedule 1 • Caribou hunting closed for SMNEA caribou (except Itcha-Ilgachuz and Chase herds)
2004	• New *Forest and Range Practices Act* replaces Forest Practices Code • Forestry Revitalization Plan • Prince George TSA Biodiversity Order (old forest targets) • Vanderhoof – Section 7 Order for species at risk – caribou calving/rutting/matrix/mineral licks • Morice – Section 7 Order for species at risk – caribou calving habitat in Whitesail Reservoir	• A Strategy for Northern Caribou in the SMNEA in British Columbia completed but not endorsed by government • Northern Caribou added to Identified Wildlife Management Strategy list • Lapsed mineral claims incorporated into Entiako Park under the *Protected Areas of British Columbia Act*
2005	• Vanderhoof District Ungulate Winter Range (7-012) for caribou established • Vanderhoof LRMP MPB Risk assessment and Review	• Tweedsmuir-Entiako Caribou Technical Background Information Summary completed • Study on the effects of the MPB epidemic on Tweedsmuir-Entiako caribou seasonal movements, habitat use and winter feeding ecology initiated
2006	• Lakes LRMP Implementation Plan and Progress Report • New direction for strategic land use planning in BC – land use plans now streamlined Strategic Land and Resource Plans; updates to existing plans restricted to specific priority components	• Entiako Park and Protected Area Management Direction Statement and Ecosystem Management Plan
2007	• Morice LRMP approved • Lakes South Old Growth Management Areas established	• Entiako Protected Area and remaining lapsed Wolf mineral claims incorporated into Entiako Park under the *Parks and Protected Areas Statutes Amendment Act* • Tweedsmuir Park North and Entiako Park and Protected Area – Managing natural and cultural values in a post-mountain pine beetle landscape
2008	• Vanderhoof LRMP Access Management Plan for Forest Recreation	
2009	• Lakes LRMP Higher Level Plan Order Objectives 1-5 and 7 cancelled • Blackwater Gold Project – increased exploration activities	
2010		• MPB/caribou study completed
2011		• COSEWIC Designatable Units for caribou in Canada
2013		• MPB/lichen study 10 years following attack – report completed • Radio-collared moose study initiated in Entiako area
2014	• Vanderhoof Resource District Best Management Practices for caribou	• Chelaslie Arm Fire burns 133,100 ha of winter and spring migration range in Entiako Park and the East Ootsa area • Radio-collared caribou study initiated • COSEWIC reassessed Tweedsmuir-Entiako caribou as part of the Northern Mountain Designatable Unit as Special Concern • Recovery Strategy for SMNEA caribou completed by Environment Canada • COSEWIC status reassessment submitted to Federal Minister of Environment for decision

The value of protected areas was recognized with the passing of the *Forests Reserves and Park Act* in 1911 (Taylor 1999). Administration of protected areas was included as part of the responsibilities of the newly created Forest Service. Tweedsmuir Park was established in 1938 to protect the "Great Circle" lakes, which included Tahtsa, Whitesail, Troitsa, Sinclair, Ootsa, Intata, Natalkuz, Euchu, Chelaslie, Tetachuck and Entiako lakes (BC Ministry of Lands 1938, BC Ministry of Environment and Parks 1986). The original park boundary extended from the Sibola Mountains in the north, to the Fawnie Mountains in the southeast, and to the western portion of the Rainbow Mountains in the south. The original boundary included almost all of the current known range of the Tweedsmuir-Entiako caribou population. In 1940, the Class A, B & C park classification system was introduced and Tweedsmuir Park was established as a Class "B" park. Class B parks are protected under the *Park Act* but a broader range of activities can be allowed if they are not detrimental to the recreational values of the park (BC Parks 2015). At the time, mineral exploration and development were permitted. By 1944, extensive exploration activities had been conducted in the Lindquist Lake area and on the north side of the Chikamin Range, including a 95 foot tunnel (Lyons and Trew 1944). Prior to park establishment, the Department of Mines funded the building of a trail from Kimsquit over the Sakumtha Pass to the Tesla Mountain area in 1927; however, no claims had been staked in the Tesla Mountain area by 1944 (Lyons and Trew 1944).

Increased interest in planning and responsible use of forest resources led to the 1945 Royal Commission on the Forest Resources of British Columbia under Chief Justice Gordon Sloan (Ness 1992). The Sloan Commission recommended a system of sustained yield management and planning, as well as increased fire protection (Ness 1992, Parminter 1978). Most of the recommendations were incorporated into the 1947 amendment to the *Forest Act,* which set up Tree Farm Licenses (TFLs) and Public Sustained Yield Units (PSYUs) (Ness 1992).

1950s – 1960s

The 1950s ushered in a significant change to the landscape and to land administration on the Tweedsmuir-Entiako caribou range. Alcan's Kemano project resulted in the flooding of the Nechako Reservoir and by 1955, the lands around the Great Circle lakes were flooded except for in the Eutsuk Lake and Troitsa Lake areas (BC Ministry of Environment and Parks 1986). The Cheslatta people reported that many caribou drown during migration from the 1950s to the 1970s due to debris in the lakes caused by the flooding (Cichowski *et al*. 2001a). In 1956, the park

boundaries were amended to exclude the floodwaters (BC Ministry of Environment and Parks 1986). The exclusion resulted in deletion of: summer range in the area northwest of Whitesail Lake and in the Sibola Range north of Tahtsa Lake; spring migration and winter range east of the Quanchus Mountains; and, winter range in the Entiako area. The amended boundaries included the addition of high elevation areas in the Rainbow Mountains and south of Highway 20, and the resulting Tweedsmuir Park looked much the same as it does today.

Mineral exploration had increased in northern Tweedsmuir Park since the mid-1940s. Although it was difficult for the Parks Branch to track active mineral claims because mineral claims were continuously being staked and cancelled, concentrations of claims were located in the following areas: Chikamin Range, Lindquist-Kenney Lakes, Surel Lake, Mt. Preston, Rivers Peak, Tesla Mountain, Oppy Lake and Ramsey Creek (Wood 1969). Developments by the 1960s included an airstrip at Pondosy Bay with a 9-mile road leading to a property on Haven Lake just outside the park, a road and camp at Zinc Bay on the north side of the Chikamin Range, and extensive developments between Kenney and Lindquist Lakes (Wood 1969). If mines were to be developed, access roads would result in the destruction of the wilderness character of the park (Wood 1969). In 1967, the Eutsuk Nature Conservancy was established over a large portion of northern Tweedsmuir Park to preclude mineral exploration (BC Ministry of Environment and Parks 1986). The first Management Plan for Tweedsmuir Park in 1969 addressed the mining issue and recommended focusing attention on the conservancy (Wood 1969).

In the midst of these changes to northern Tweedsmuir Park, the Parks Branch was established in 1957 under the Department of Conservation and Recreation, divesting it from the BC Forest Service, and the stand-alone *Park Act* was established in 1965.

Provincially, predator control activities continued into the 1950s. While the bounty on wolves was discontinued in 1956, the Predator Control Branch shifted to the use of poison baits as a means of predator control (BC Ministry of Environment 1979). Wolf poisoning was conducted in the northern Tweedsmuir Park area in 1956 and 1957 (Hatter 1979, Stevenson and Hatler 1985). Provincially, predator control using poison was discontinued in 1961 and the Predator Control Branch was disbanded in 1963 (BC Ministry of Environment 1979).

The 1950s and 1960s also saw a shift to more area-specific regulation of hunting. In 1956, the 2 districts in the province (Eastern, Western) were

divided into 21 Management Areas and in 1967, additional revisions resulted in 28 Game Management Areas.

Forest management planning was still in a fledgling state. The second Sloan Commission in 1956 found that little planning had been conducted for PSYUs since they were established in 1947 (Ness 1992). In 1967, Timber Sale Harvesting Licenses and Timber Sale Licenses were established and required forest companies to prepare 5-year Development Plans (Ness 1992). In the meantime, effectiveness of fire suppression continued to improve with increased use of aircraft for patrols and transport, and with the introduction of air tankers and helicopters in fire suppression activities (Bell 2011a, 2011b, 2012).

1970s – 1980s

Forest management planning continued to evolve in the 1970s and 1980s. In 1973, the BC Forest Service initiated the Resource Folio Planning system, with the intent of planning for integrated resource use (Ness 1992). In 1978, the new *Forests Act* was established, which incorporated recommendations by the Pearse Commission to consolidate PSYUs into Timber Supply Areas adjacent to major manufacturing communities and to increase consideration of environmental and other resources in determining harvest rates (Ness 1992). In 1983, the Local Resource Use Plan (LRUP) was established as one of a number of tools for resolving local area-specific issues. However, strategic level land use planning was still lacking, making it difficult to resolve area-specific issues at the local level. In the 1980s, there was greater public demand for input into land use decisions with the rise of the "war in the woods" movement, which included high profile campaigns for protecting specific areas from logging (Forest Practices Board 2008). By the end of the 1980s, momentum was building for increased public involvement in strategic land use decisions and the BC Forest Service initiated processes for wilderness systems planning and old growth management (Erlandson 1991, BC Ministry of Forests 1992).

Wildlife and park management also continued to evolve. Another management plan was developed for Tweedsmuir Park in 1975, which focused primarily on recreation and staffing (BC Parks Branch 1975). By 1975, the airstrip and mining road at Pondosy Bay had been abandoned, the north shore of Lindquist Lake had been impacted by avalanches due to mining activities, and mineral claims around Tesla Lake and Surel Lake continued (BC Parks Branch 1975). In 1988, BC Parks completed the Tweedsmuir Park Master Plan with public input (BC Parks 1988). In the 1988 Master Plan, most of northern Tweedsmuir Park was upgraded to

Class A park status (which does not permit any industrial activities), which resulted in the deletion of the Eutsuk Nature Conservancy. Recreation Areas were designated along Ootsa Lake, and in areas associated with mining claims in the Mt. Preston, Tesla Mountain, Haven Lake, Lindquist/Kenney Lake area and on the north side of the Chikamin Range. The Tweedsmuir Park Master Plan has not been updated since it was completed in 1988 and is the primary guidance document for current management. Also in 1988, BC Parks provided its first comprehensive statement of provincial park policy about balancing conservation and recreation (BC Parks 1991). That policy was revised following public input and became the basis for park system planning in the 1990s (Erlandson 1991, see 1990s).

Limited Entry Hunting was first introduced as a tool for managing hunting in 1973. In 1975, the 28 Game Management Areas were refined into 217 Wildlife Management Units (WMUs) administered within 7 regions. No changes have been made to the Wildlife Management Units in the Tweedsmuir-Entiako caribou range area since then. In 1977, the Eutsuk Nature Conservancy was closed to all hunting, and in 1978 the portions of northern Tweedsmuir Park south of Eutsuk Lake not located in the conservancy, and in the Chikamin Mountains were also closed to hunting. The open season for caribou hunting in the Tweedsmuir-Entiako caribou range was closed in 1978 and caribou hunting was reopened as Limited Entry Hunting in 1982. With the elimination of the Eutsuk Nature Conservancy in 1988, the no hunting area was reduced to the portion of northern Tweedsmuir Park south and west of Eutsuk Lake west of the Chezko River, a 1 km strip along the north and south shores of the rest of Eutsuk Lake, and the Chikamin Mountains.

Prior to the 1970s, the remote location of and relatively low-value pine forests in the Tweedsmuir-Entiako caribou range made it unattractive for forest harvesting. However, interest increased as road access improved, demand for pulp increased, developments in log processing resulted in better utilization of smaller trees, and demand for dry sites for conducting summer harvesting increased. Forest harvesting began in the area north of Whitesail and Ootsa lakes in the early 1970s, and in the southeastern part of their range in the late 1970s (Hatter 1979). In response to proposed forest harvesting activities in the Tweedsmuir-Entiako caribou range, the Fish and Wildlife Branch of BC Environment initiated a radio-collared caribou study in 1983 to address the lack of information on range use and population dynamics of the population (Marshall 1984). The study was expanded in 1985 to include a more detailed examination of winter habitat use and foraging ecology, which was completed in 1989 (Cichowski 1989). To support this study, an

ecosystem-based map interpreted for terrestrial lichen abundance was developed for the winter range in 1987 (BC Ministry of Forests 1987, Cichowski and Banner 1993).

1990s

The 1990s was the decade of land use planning in British Columbia. In the early 1990s, interest in sustainability, land use certainty, and protection of the environment continued to grow. In 1992, three federal-provincial councils (Canadian Council of Ministers of the Environment, the Canadian Parks Ministers' Council, the Wildlife Minister's Council of Canada) signed a Statement of Commitment to "make every effort to complete Canada's networks of protected areas representative of Canada's land-based natural regions by the year 2000" (Commission of the Environment and Sustainable Development 2000). Also in 1992, the provincial government established the Commission on Resources and the Environment (CORE) to develop regional integrated land use plans (Forest Practices Board 2008). Four regional land use planning processes were initiated, including the Cariboo-Chilcotin Land Use Plan, but CORE was eventually disbanded in 1996 (Forest Practices Board 2008). In 1993, A Protected Areas Strategy for British Columbia was released with the overall goal of increasing the amount of area protected in British Columbia to 12% by 2000 through comprehensive land use planning. In the mid-1990s, land-use planning shifted to sub-regional land and resource management plans (LRMPs). A systems approach to identification of protected areas was implemented by Regional Protected Areas Teams, which included representation from a number of government agencies. The Regional Protected Areas Teams identified representative areas of natural, cultural and backcountry recreation features (Goal 1), as well as special features (Goal 2) and provided the proposed protected areas as input into protected area discussions by the LRMP tables. For most LRMPs, a cap was placed on the amount of protected area landbase that could be added. LRMPs also included recommendations on zoning outside of protected areas that directed the intensity of resource development and on types of resource values to be considered within each zone (Forest Practices Board 2008).

Growing concern about the effects of potential industrial activities on the Tweedmuir-Entiako caribou range led to development of "Management Guidelines for the Tweedsmuir-Entiako caribou herd migration corridor" for the East Ootsa area north of Tetachuck Lake (BC Ministry of Forests 1992), and the initiation of the Entiako LRUP in 1992 for the winter range area south of Tetachuck Lake (Entiako Local Resource Use Plan Working Group 1993). Management guidelines for the migration corridor were

developed based on information from the habitat use study completed in 1989. The Entiako LRUP process was informed by "Management Strategy and Options for the Tweedsmuir-Entiako Winter Range" (Cichowski and Banner 1993). The Entiako LRUP ended in an impasse in 1993 due to lack of a strategic land use plan providing direction on how to address protected areas. The process was designed more to address "how to log" and not "where to (or not to) log" or "if logging should occur". Planning for the Entiako area was then forwarded to the newly formed LRMP processes in the Vanderhoof and Lakes districts. In 1996, management recommendations were completed for the Chelaslie River Migration Corridor following a 3 year intensive study of radio-collared caribou in the migration corridor (Steventon 1996). As part of the study, the migration corridor area was zoned based on intensity of use by caribou.

LRMPs for the Vanderhoof and Lakes portions of the Tweedsmuir-Entiako caribou winter range were completed in 1997 and 2000 respectively. Both LRMPs recommended protection for the core of the caribou winter range. The Vanderhoof portion of the winter range was established as Entiako Park in 1999 and the Lakes portion of the winter range was established as Entiako Protected Area in 2000. Entiako Park (Vanderhoof) initially excluded several mineral claims, but eventually all but one of those claims lapsed and were incorporated into the park. Entiako Protected Area (Lakes) was established as a protected area until a mountain pine beetle management strategy could be completed. The Entiako Park and Protected Area Management Direction Statement and Ecosystem Management Plan completed in 2006 fulfilled this requirement and the protected area was subsequently converted to park status. The Lakes LRMP also converted part of the remaining portion of the Tweedsmuir Recreation Area in the Chikamin Range area to Class A Park, and the remainder was converted to Crown Land to allow mineral exploration and development. The portion of the area converted to Crown Land was zoned as no harvesting.

The Huchsduwachsdu Nuyem Jees/Kitlope Heritage Conservancy was established in 1996 as Kitlope Protected Area under the *Environment and Land Use Act* and protects an important portion of the Tweedsmuir-Entiako caribou summer range. In 1998, the protected area was converted to the Huchsduwachsdu Nuyem Jees/Kitlope Heritage Conservancy under the *Protected Areas of BC Act*.

Both the Lakes and Vanderhoof LRMPs also provided direction for areas within the Tweedsmuir-Entiako caribou range but outside of the protected areas. The Lakes LRMP included a management strategy for the Chelaslie Caribou Migration Corridor specifically addressing the

Tweedsmuir-Entiako caribou population and range. It was based on zones developed by Steventon (1996), with recommendations for no harvesting and no new access in the very high use zones, and provided seral stage objectives and access management guidance for the whole area. The Vanderhoof LRMP developed Resource Management Zones (RMZ) for the Tweedsmuir-Entiako caribou range outside of Entiako Park. Most of the range was included in the Laidman RMZ, which was zoned as Multi-Value Emphasis, with caribou as the overriding concern. A recreational access management plan was also developed, which included both winter and summer recreation and access management points.

The 1990s also witnessed a significant change to forest practices regulation with the enactment of the Forest Practices Code in 1995. The Forest Practices Code was linked to strategic direction from LRMPs through legally binding higher level plans, which were used to develop operational forest development plans (Forest Practices Board 2008). Legal orders in higher level plans often included objectives for old growth and landscape level biodiversity (e.g. seral stage targets). Objectives for some wildlife habitat were implemented through specific designations under the Code such as Ungulate Winter Ranges (Forest Practices Board 2008).

By the 1990s, much of the forested area within the Tweedsmuir-Entiako caribou range was in a mature state, partly due to fire suppression activities. In the early to mid 1990s, patches of mountain pine beetle attack were detected in the East Ootsa and northern Tweedsmuir Park areas (Garbutt and Stewart 1991, Garbutt and Vallentgoed 1992, Garbutt 1994, 1996, Wood and Unger 1996). By 2006, about 525,000 ha of forests in northern Tweedsmuir Park and Entiako Park sustained moderate or greater levels of mountain pine beetle attack (Cichowski 2007).

2000-2015

At the turn of the century, attention to the precarious status of caribou in British Columbia increased. In the first five years of the 2000s, the Tweedsmuir-Entiako population was one of a number of populations that were blue-listed by the BC Conservation Data Centre (2000), assessed as Threatened by COSEWIC (2000, 2002), included as Threatened in Schedule 1 of the federal *Species at Risk Act* (2003), and added to the Identified Wildlife Management Strategy list (2004). The Threatened listing under the *Species at Risk Act* resulted in closure of the hunting season in 2003. In response to the Threatened listing under the *Species*

at Risk Act, the Northern Caribou Technical Advisory Committee completed a strategy for Northern Caribou in the SMNEA in BC in 2004 (Northern Caribou Technical Advisory Committee 2004), but the strategy was never endorsed by the provincial government. One recovery approach from that strategy was to establish three Recovery Implementation Groups that would develop Recovery Action Plans. The West-Central Recovery Implementation Group, which was responsible for the Tweedsmuir-Entiako population, met once in March 2005. That year, recovery planning for most species at risk in British Columbia was suspended pending direction from the provincial Species at Risk Coordination Office on how to address socio-economic values. Provincial caribou recovery planning for Northern Caribou never resumed. In 2014, Environment Canada completed a recovery strategy for caribou in the SMNEA, the population listed in Schedule 1 of the *Species at Risk Act* (SARA; Environment Canada 2014). The recovery strategy process ran concurrently with COSEWIC's update to the status report (COSEWIC 2014), which assessed status of caribou based on the new Designatable Unit (DU) structure. In the new DU structure, the Tweedsmuir-Entiako caribou population was included in the Northern Mountain DU, which was recommended for Special Concern status. COSEWIC's recommended status has been submitted to the federal Minister of Environment for decision, but until SARA is amended with the updated listings, the Tweedsmuir-Entiako population remains listed as Threatened under SARA.

The 2000s saw further changes to forest harvest management and strategic land use planning. In 2004, the Forestry Revitalization Plan was initiated as part of the Heartland Economic Strategy (BC Ministry of Forests 2004). The plan included reforms to forest tenures, and removed the requirement for forest companies to process logs in their own or specified mills and in communities close to where the trees were harvested. Also in 2004, the Forest Practices Code was replaced by the results-based *Forest and Range Practices Act* (FRPA). The *Government Actions Regulation* of FRPA deals with ungulate winter ranges, wildlife habitat areas, species at risk and other non-timber values, while the *Land Act* can grandparent higher level plans from the Forest Practices Code into legal land use objectives (Forest Practices Board 2008).

For the Lakes LRMP portion of the winter range, the 2000 Higher Level Plan Order included seral stage objectives for the Chelaslie Caribou Migration Corridor that were recommended by the LRMP, and established a no harvest zone in the portion of the former Tweedsmuir Recreation Area that was converted to Crown Land (Province of British Columbia 2000). Seral stage targets for the Chelaslie Caribou Migration

Corridor also carried through to the Lakes South Sustainable Resource Management Plan (SRMP) which was completed in 2003 (BC Ministry of Sustainable Resource Management 2003). The Lakes South SRMP also set targets for the amount of old seral to be incorporated into Old Growth Management Areas (OGMAs). In the Chelaslie Caribou Migration Corridor, the two Very High use zones (Tetachuck Lake, Chief Louis Lake/Chelaslie River) were designated as OGMAs in 2007 as part of the order to amend old growth forest retention objectives (BC Ministry of Agriculture and Lands 2007a). In 2009, all objectives in the 2000 Higher Level Plan order were cancelled except the no harvest zone in the portion of the former Tweedsmuir Recreation Area (BC Ministry of Agriculture and Lands 2009). The cancelled objectives were mostly addressed by the Lakes South SRMP order.

For the Vanderhoof LRMP portion of the winter range, legal orders for old forest targets and a for Northern Caribou calving/rutting range, mineral licks and matrix range were established in 2004 (BC Ministry of Sustainable Resource Management 2004, Province of British Columbia 2004a) and an Ungulate Winter Range for caribou was established in 2005 (BC Ministry of Environment 2005). The recreation and access management portions of the Vanderhoof LRMP were updated in the Access Management Plan for Forest Recreation (BC Integrated Land Management Bureau 2008). The updated access management plan includes revised access zones to reflect current use and only considers summer recreation.

The Morice LRMP, which covers a portion of the Tweedsmuir-Entiako caribou summer range, was finalized in 2007 (BC Ministry of Agriculture and Lands 2007b). A Section 7 order for species at risk, which includes calving range for the Tweedsmuir-Entiako caribou in the Whitesail Reservoir was established in 2004 (Province of British Columbia 2004b)

The mountain pine beetle epidemic reached its peak in the Tweedsmuir-Entiako caribou range in the late 1990s and early 2000s. In 2001, two assessments were completed that addressed the potential impacts of the epidemic on natural and cultural values in Entiako Park and northern Tweedsmuir Park (Cichowski 2001b, 2001c). A study based on permanent sample plots was initiated in 2001 to assess the impacts of mountain pine beetles on terrestrial caribou forage lichens (Williston and Cichowski 2002). The study is ongoing and plots have been revisited in 2002, 2003, 2005, 2007 and 2011 (Cichowski and Haeussler 2013). A study assessing the impacts of mountain pine beetles on caribou habitat use and seasonal movements was conducted from 2006 to 2010 (Cichowski 2010). Information from those studies was used to develop

guidance for managing natural and cultural values in northern Tweedsmuir Park and Entiako Park following the mountain pine beetle epidemic (Cichowski 2007).

Mineral exploration activity began increasing in the southeast portion of the winter range in the late 2000s. In response to forest harvesting and mineral exploration activity in this area, best management practices for industrial activities affecting caribou in the Vanderhoof Resource District were developed in 2014 (Cichowski and McNay 2014).

In July 2014, a wildfire was detected on the north side of Tetachuck Lake, just east of Chelaslie Arm. By late September, 133,100 ha of the Tweedsmuir-Entiako caribou winter and spring migration range in the East Ootsa and Entiako Park areas had burned (R. Krause, pers. comm. 2015). In response, the BC Ministry of Forests, Lands and Natural Resource Operations initiated a radio-collared caribou and wolf study in the Tweedsmuir-Entiako area (C. Thiessen, pers. comm. 2014).

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Appendix 3. Management Direction for caribou in the Vanderhoof LRMP (adapted from Cichowski 2008).

Vanderhoof Land and Resource Management Plan

Reference: Vanderhoof LRMP Working Group. 1997. Vanderhoof Land and Resource Management Plan. Prepared by the Vanderhoof LRMP Working Group for the Omineca Peace Inter-agency Management Committee, Prince George, B.C.

Landscape level guidelines/strategies/recommendations:

- Entiako Park in the Tweedsmuir-Entiako caribou winter range
- seral stages (different ages and species mixes) should occur in a variety of patch sizes within a landscape unit and follow a distribution appropriate for the Natural Disturbance Type
- manage timber harvesting to reflect the seral stage distribution in accordance with the biogeoclimatic zone and disturbance type
- even-aged management (harvesting and silviculture) systems with wildlife tree patches most closely simulate natural disturbance types (frequent stand initiating events) in much of this area
- maintain a significant component of the landscape unit in communities with plant species composition similar to that found in communities which have developed through natural dynamics and succession
- mimic the natural pattern of connectivity by establishing Forest Ecosystem Networks (FEN) to provide for movement corridors and special areas (e.g., wetland complexes, old growth attributes, etc.); the full spectrum of biogeoclimatic subzones and variants within a landscape unit should be represented; FENs should incorporate variable widths of linkages
- the size range of leave areas should be the same as that for harvested areas
- patch sizes greater than 60 hectares can be created by harvesting the entire larger patch at one time and/or by aggregating small cut-blocks over time; in either case, structural attributes (i.e., live and dead trees) consistent with Natural Disturbance Type are to be retained within the patch
- old growth management strategies are met primarily by maintaining mature and seral stage requirements as outlined in the Biodiversity Guidebook for NDT3 and NDT2, with a particular emphasis on maintaining the distribution and abundance of Douglas-fir, the most fire-resistant tree species in this area; old growth management strategies will also incorporate snag/wildlife tree retention and recruitment within harvesting areas
- maintain or enhance rare and uncommon habitats, or plant species and plant associations by identifying them and developing appropriate management plans
- the emphasis on non-arable lands in Resource Development Emphasis zones will be on the timber resource
- management within Multi-Value Emphasis zones will place an equitable emphasis on other appropriate values, integrating the timber resource with other values
- proactive pest management is recommended for all RMZs, including Protected Areas; although commercial harvesting (including salvage) in Protected Areas will not be a management tool, pest management is an appropriate method to maintain levels of timber production within Resource Development Emphasis zones and to keep endemic pest populations from becoming epidemic

Stand level guidelines/strategies/recommendations:

- timber harvesting and silvicultural practices in Special RMZs or subzones, Sensitive Areas and Forest Ecosystem Networks will be highly modified to meet management objectives for other resources in these areas

Other guidelines/strategies/recommendations (if available):

- endorse identifying the location of at-risk species within the plan area
- endorse developing management plans to maintain at-risk species which are consistent with this LRMP
- consider fire as a tool for range and wildlife enhancement where appropriate
- maintain opportunities and access for mineral and energy exploration and development across all resource management zones except Protected Areas and sites excluded under the Mineral Tenures Act (i.e., no-staking reserves)
- integrate mineral exploration and development activities with other resource users' activities in all RMZs except in Protected Areas, where mineral development will not take place
- permit road building only when sufficient exploration demonstrates that road access is required for further development
- allow for the maintenance of existing access and infrastructure corridors
- endorse integrating all resource values into management plans which will upgrade access or provide new access
- in key areas (as noted in Section 2.2 -RMZ Direction), access management and the concentrated scheduling of harvesting and silvicultural activities is a critical component in the integration of timber - harvesting with the maintenance of other values, particularly with regard to maintaining a diversity of recreational experience and protecting important wildlife habitat and populations.
- prior to restricting access, this LRMP endorses undertaking public consultation
  - strategic level (LRMP, mine development review or equivalent) and operational level plans (Forest Development, Access Management, and Range Use Plans) are considered to be appropriate public processes through which to make access management recommendations
- loop roads are acceptable within the plan area with site-specific limitations
  - within each RMZ, wildlife, recreation, and economic values will be considered in making recommendations on whether loop roads should be permitted
  - construction will be managed with consideration for sensitive wildlife values/needs
  - more detailed access guidelines need to be developed for wildlife, (i.e., protection of marten corridors, caves, etc.) similar in detail to those already in place for fisheries habitat and water quality protection
- where access is restricted, it will incorporate both a physical closure, if possible, and a posted sign announcing the closure (gates are not a preferred form of physical access closure)
- access management should be used when it is generally agreed that other strategies (e.g. angling restrictions, habitat enhancement, hunting regulations) will not meet resource management objectives
- full rehabilitation (site recontouring, preparation, and vegetation) of block spur roads is generally encouraged in all zones
- where extraction activities are to occur:
  - existing roads will be used wherever possible and the amount of new road construction will be minimized
  - roads will be built and deactivated according to existing and future standards (i.e. Forest Practices Code and Mines Act and Mining Right-of-Way Act legislation) to protect other resource values
- consider the potential option for the Vanderhoof-Anahim connector in the future, with Forest Service Road status; consider all possible routes through a public planning process
- the Vanderhoof LRMP recommendations will be used to develop a comprehensive and coordinated Access Management Plan to clearly identify the access status of all roads for both industrial and recreational users; although it is recognized that access is managed throughout the landbase, the LRMP working group has identified areas where additional access management is endorsed; the following map identifies the location and extent of these areas

Resource Management Zone specific recommendations:

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Vanderhoof LRMP Resource Management Zone Recommendations which affect caribou				
Tweedsmuir-Entiako				Northern Caribou Local Population
Laidman Lake	**Upper Blackwater**	**Davidson Creek**	**Chedakuz**	Resource Management Zones
MV	SRM	RD	MV	Management category: MV=Multi-Value; RD=Resource Development; SRM=Special Resource Management
Wildlife/Biodiversity				
High			High	• recommended biodiversity emphasis
X				• consider caribou habitat management the overriding concern
X				• manage for caribou habitat throughout the zone
X				• use caribou as the indicator species for ecosystem management in this zone; emphasize caribou habitat management, general biodiversity or management of other species
	X			• manage habitat for red & blue listed species appropriately in Total Resource Planning (TRP)
	X			• maintain the integrity of primary feeding & travel corridors for wildlife (i.e. wetland, stream lake corridors)
		X		• manage access with priority on wildlife value protection
		X		• identify and map Natural Disturbance Types and incorporate into management plans
Timber				
X		X	X	• forest openings larger than 60 ha, designed as aggregate harvesting areas, will be considered if managed with characteristics parallel to natural disturbances; principles for this type of harvesting that are consistent with the Forest Practice Code will be provided as guidance by the Ministry of Forests District Manager during the implementation phase
		X		• Landscape Unit planning will identify the target levels for seral stage distribution (forest cover and various age classes) over time ; Landscape Unit Plans will form a part of the LRMP implementation phase
X		X		• establish this RMZ as a priority for Landscape Unit Planning
X				• develop and assess silvicultural strategies that are appropriate to the timber harvesting strategies in this RMZ, including the ones that are not typically associated with timber types and processes in this area
X				• maintain stand and landscape structures, and the age-class distributions similar to natural disturbance patterns
X		X		• manage logging and silviculture activities to maintain a natural range of species and age classes
X				• manage or prevent endemic beetle population expansion within this and adjacent zones, while maintaining natural forest attributes • actively monitor beetle activity • inventory timber stands and develop plan to proactively address spruce and mountain pine bark beetle • for areas remote to current development plans, consider: ○ using low impact techniques such as fall and burn or trap trees to control beetle populations ○ using low impact techniques such as helicopter logging or low ground pressure skidding for removal of green attack trees • in Subzone C : Avoid large-scale clearcuts to salvage trees unless there is a definite risk to forest health • give priority to health of forests critical to fish and wildlife

Laidman Lake	Upper Blackwater	Davidson Creek	Chedakuz	Resource Management Zones
Timber continued				
X				• Subzone A: 90-95% clearcut, 5-10% small clearcut (5 to 10 ha); 0-5% selective harvesting • Subzone B: 50-75% clearcut; 15-30% small clearcuts; 10-20% selective harvesting • Subzone C: 90-95% selective harvesting, 5-10% small clearcuts • for clearcut harvesting in zones A & B ○ give preference to amalgamating cutting areas (i.e. greater than 6Oha) while maintaining ecosystem connectivity through ecosystem networks ○ pattern the volume removed, distribution of cutblock sizes, and the amount and characteristics of retention areas based on a determination of the Sub-boreal Spruce Mean Fire Disturbance regime for the Laidman zone ○ refine percentage ranges for these factors in Landscape Unit Planning ○ specify the retention of vets, retention patches, riparian areas, species, volumes within amalgamated blocks ○ set levels of retention at "moderate to high" in these larger openings ○ ensure retention areas contain the full range of all the forest structures/attributes of the Laidman zone ○ ensure retention areas contain mature, old growth components; mixed wood, old growth with companion dry lichen sites ○ ensure retention areas contain older and medium aged stands associated with terrestrial and arboreal lichen habitat ○ large cutblocks means anything over the 60 hectares maximum cutblock size as defined by the Forest Practices Code
	X		X	• strive to maintain the current species composition when possible; encourage changes that will enhance wildlife habitat
	X			• minimize site disturbance
	X			• develop guidelines for juvenile spacing. (BC Environment & Ministry, of Forests agreement) Consider variation in densities; clumping, areas of dense stands, and managing for sites below the maximum density for lodgepole pine
	X			• design silvicultural prescriptions that will use advance regeneration and promote diversity; preserve advanced regeneration on many of the site units within this zone
	X			• consider hydrological, habitat, viewscape, access, and fisheries values in a long term total resource plan
	X			• ensure land is reforested and managed to maintain timber growth
	X			• a Total Resource Plan should be completed by May 1998, showing operating plans for all resource users ○ modified harvesting only, should occur west of Naglico Access closure point, within the Upper Blackwater RMZ ○ modified harvesting must consider other values noted in this strategic plan and the Upper Blackwater LRUP ○ modified harvesting should be demonstrated in an adjacent RMZ and may include: • 2-10 ha cutting areas • selectively logged strip cutting areas perpendicular 'to prevailing winds (an example is adjacent to Johnson Lake in Crystal Lake RMZ) • horse logging/selective logging • other types of sensitive harvesting to be developed

Laidman Lake	Upper Blackwater	Davidson Creek	Chedakuz	Resource Management Zones
Timber continued				
		X		• when developing timber and silvicultural management strategies, integrate environmental and wildlife values, and any future assessments
		X		• use mechanical site prep where appropriate
		X		• use cost-effective intensive silvicultural treatments, including spacing, commercial thinning, fertilization and pruning where appropriate
		X		• consider reducing rotation age to maximum M.A.I. (mean annual increment)
		X		• consider permitting harvesting areas to exceed 60 ha if managed with retention patches, some deciduous attributes (where naturally occurring) and coarse woody debris and other habitat attributes
		X		• in specific areas north of Kluskus, manage harvesting to minimize the duration of activities (i.e. 2 years to completion of planting) and then manage access with physical
			X	• develop a Total Resource Plan which considers spatial distribution of the following age classes: ○ 50% of age class 8, 40% of age class 7, and 30% of age classes 1-6 should be maintained in Subzone A ○ 60% of all age classes of timber should be maintained in Subzone B ○ 90% of age class 8, 80% of age class 7, and 70% of age classes 1-6, should be maintained as a minimum in Subzone C
			X	• maximum cut block sizes: ○ subzone A: 40 to 60 ha (average 50 ha) ○ subzone B: 20 to 40 ha (average 30 ha) ○ subzone C 10 ha • reserve widths: ○ subzone A: 500m for 50 ha blocks, 600m for 60 ha blocks ○ subzone B: 200m for 20 ha blocks, 400m for 40 ha blocks ○ subzone C: 150m minimum • harvest timber in Subzone C to enhance wildlife habitat only
Access				
X				• request that a monitoring and access management plan for caribou management will be developed through the government agencies and be brought to the First Annual Implementation Meeting
X				• avoid parallel road networks to riparian areas
X				• deactivate roads in areas of identified sensitive wildlife habitats
X				• allow snowmobile/ATV use by licensed tenure holders
X				• coordinate timing and location of harvesting with areas in zones B & C, followed by temporary to full deactivation of secondary roads to ensure longer time periods of inactivity • implement and maintain effective and existing access control in Subzones B & C • primary roads for the purposes of this RMZ are the approximately three main access corridors needed to access zones B & C

Laidman Lake	Upper Blackwater	Davidson Creek	Chedakuz	Resource Management Zones
Access continued				
X				• ensure road widths are as narrow as possible while maintaining safety
X				• subject secondary roads to higher levels of permanent deactivation
X				• recommend legislated closure of recreational snowmobile use in sensitive grizzly and caribou habitats (Subzones B & C) • maintain current access restrictions in Subzones B & C • the intent is not necessarily to limit ATV access on main roads in Subzones B & C; however, while timber harvesting is being integrated into those sensitive zones, ATV access will be deterred; once more information is available on the integration of enforcement, caribou habitat requirements and timber harvesting, the issue of recreational access will be revisited during the LRMP review; this staged approach will allow the gradual introduction of activities in these areas in a manner which will satisfy all interests • no road crossing of the Forest Ecosystem Network along Fawnie Creek • for the Fawnie Range: ○ develop a plan to close recreational access in those years, and during those seasons, when caribou are present on the Fawnie Range ○ educate the public with regard to the conflict between caribou and recreational snowmobile use, and consider closing the range to snowmobiles in some years when caribou are present • establish a sensitive area in the Fawnie Dome to be delineated by BC Environment/Ministry of Forests staff • require access management planning for future developments in the currently unaccessed portion of Subzone A
	X			• permit new mine development road access where mineral exploration demonstrates need
	X			• where possible, use coordinated access management between industry and resource agencies
	X			• restrict access equally for all users, where access closures are located in the zone. (the exception that is local resident use of the Messue Wagon Road)
	X			• allow snowmobile access
	X			• post signage on the trail providing local access from the junction with the Kluskus-Ootsa Forest Service Road (167km), indicating hazards and recommending foot or horse access to the Alexander Mackenzie Heritage Trail area; the access trail will not be closed as it provides critical access for local residents; BC Environment and BC Wildlife Federation do not support a permit-type closure on this trail; any industrial use of portions of this trail will be left in condition to provide year round access for the local residents.
	X			• private land owners residing along the Upper Blackwater River have the right to access their property, with proposals for new roads or upgrading existing trails to consider other resource values and management strategies identified in this LRMP; the trail to Diana Phillip's ranch is being upgraded with minimal road construction
	X			• legislated restrictions and physical access closures, and signage are preferred where access restrictions are identified in this plan
	X			• winter ice road across wetlands can be acceptable
	X			• bladed road with narrow right-of-way is preferred method of road development for winter logging
		X		• no major haul loop road development (refer to the "Access Management Strategies") unless there is a demonstrated requirement for such

Laidman Lake	Upper Blackwater	Davidson Creek	Chedakuz	Resource Management Zones
Access continued				
		X		• consider access management in undeveloped areas that are slotted for development; restrict access in consideration of time constraints and seasonal constraints
		X		• implement access management in Davidson zone high elevation above existing development plan proposals
		X		• control access at bridge removal on main creek at end of Chedakuz Road
		X		• impose access barriers where appropriate
		X		• allow access into areas supporting moose populations which can withstand hunting pressure
			X	• no permanently accessible roads into Subzone C, except for private lands
			X	• no permanent roads within 1 km of Chedakuz Creek in the long term
			X	• permit no permanent access south from 124.5 km on the Kluskus-Ootsa Forest Service Road into the Davidson Zone
			X	• assess road closures on the forest roads north and south of the Valley to detail appropriate points of closure
Minerals and Oil and Gas				
X				• allow mineral exploration and development within the newly recognized high mineral potential areas while ensuring sensitivity to the high wildlife and recreation values of the zone
X				• ensure zone objectives are not unduly compromised by the localized impacts of mineral exploration and development
X				• ensure compliance with permitting and reclamation process which enable activities to be conducted with sensitivity to primary conservation goals
X				• recommend continued no-staking reserves in Subzones B & C • create a development strategy and access management plan for the Wolf and Capoose claims which are sensitive to the other values in the zone
	X	X	X	• maintain mineral exploration and development while ensuring that these activities are undertaken with sensitivity to natural, cultural, and recreational values
	X			• maintain mineral lands in designations open to mineral exploration and development and ensure access to those lands
	X			• ensure multi-resource objectives are flexible enough and adaptable to allow for localized impacts of advanced exploration and mining activities
	X			• ensure mining development follows the same principles as outlined for timber harvesting & silviculture and access management
	X	X	X	• minimize exploration site disturbance in areas of sensitive wildlife habitat
	X			• use existing access wherever possible
Recreation/Range/Agriculture				
	X			• maintain and enhance grazing opportunities where appropriate
	X			• develop targets for resource enhancement through the Range Use Planning process
	X			• permit existing ranches to expand onto wetland meadows with agricultural leases upon consideration of wildlife values
	X			• no vehicular accessed recreation sites will be constructed by the Ministry of Forests on lakes or rivers within this RMZ
		X	X	• consider fire as a tool for range and wildlife enhancement where appropriate

Appendix 4. Management Direction for caribou in the Lakes LRMP (adapted from Cichowski 2008).

Lakes Land and Resource Management Plan

Reference: Lakes District LRMP Resource Council. 2000. Lakes District Land and Resource Management Plan. Prepared by the Lakes District LRMP Resource Council for the Skeena Inter-agency Management Committee, Smithers, B.C.

Landscape level guidelines/strategies/recommendations:

- Entiako Protected Area in Tweedsmuir-Entiako caribou winter range
- an ecological approach to land and resource planning and management will be applied; in addition to other resource legislation, regulations and policies, the *Forest Practices Code of British Columbia Act (FPC)*, and its guidebooks will be used as a primary means of implementing an ecological approach to land and resource planning and management
- Landscape Unit planning will determine the mix and distribution of biodiversity management attributes (e.g., landscape connectivity, seral stage distribution, patch size and distribution) appropriate to each Landscape Unit
- design resource development plans to minimize the fragmentation of forest habitat and maximize the maintenance of interior forest conditions
- harvesting activities will be planned to distribute a variety of seral stages across the landscape; **s**ite-specific forest development activities will, where possible, be designed to resemble the shape and pattern of natural disturbances, except where otherwise intended by this Plan; patch size distribution will also emulate natural disturbance patterns
- develop and implement an old growth management strategy which establishes, throughout the district, Old Growth Management Areas (OGMAs) dominated by old tree cover and containing most of the structure, function, microclimatic conditions and biota associated with old forest, including interior forest conditions; within OGMAs, maintain old growth and interior forest conditions, and provide a representative cross-section of ecosystem types occurring in the District
- generally, the old growth management strategy will take advantage of existing old forest within special resource management areas, habitat linkages, riparian and lakeshore reserves, and forest harvesting landbase exclusions; where sufficient old forest is not available, OGMAs may be recruited from other age-class and/or resource management categories
- establish appropriate linkages among critical wildlife habitat areas, both within and between Landscape Units, through development and maintenance of a network of landscape connectivity corridors which provide opportunities for the distribution of species, populations and genetic material
- landscape connectivity corridors will incorporate, wherever possible, areas which are identified for conservation management, are constrained for purposes of forest management, or have limited commercial timber value; these may include protected and special resource management areas, habitat linkages, old growth management areas, lakeshore and riparian reserves, rare ecosystem types, habitat of red/blue listed species, and forested/non-forested areas which have been excluded from the harvesting landbase
- resource development activities within landscape connectivity corridors will be conducted in a manner which maintains the integrity and function of the corridor

- consistent with landscape unit objectives, timber management activities in landscape connectivity corridors will maintain 70% of forest structure and function; management prescriptions may require a mixture of small scale even and uneven aged silvicultural systems, including openings which vary in shape and size
- red, blue and regionally significant or regionally extirpated species whose habitat is being affected by resource development practices will be evaluated as candidates for designation as identified wildlife species under the FPC; essential habitats for these species will be designated as either wildlife habitat areas or sensitive areas under the FPC, and addressed in landscape unit objectives
- wildlife habitat areas or sensitive areas will be recommended for establishment adjacent to alpine and subalpine environments, specifically the headwaters of Tildesly Creek, to provide security/escape cover for goat, caribou and other animals using alpine habitats

Stand level guidelines/strategies/recommendations:

- productivity enhancements are generally acceptable where proposed activities are not in conflict with the resource management emphasis, objectives and strategies of resource management zones
- where economically feasible and ecologically appropriate, sensitive and innovative approaches to timber harvesting and silviculture will be promoted

Other guidelines/strategies/recommendations (if available):

- opportunities for mineral, energy and quarry materials tenure acquisition, exploration, access, development and mining, will be maintained on all lands outside of protected areas consistent with LRMP objectives
- agriculture lease development plans and range use plans will outline habitat protection or conservation measures including, where necessary, the location of restricted activities to minimize agriculture and habitat conflicts; a lease with no purchase option may be considered where it is deemed necessary for government to retain management flexibility to reduce potential land use conflicts, protect ecologically sensitive areas, or to manage land subject to periodic flooding; every attempt will be made to exclude critical habitat areas from agricultural lease boundaries
- wildlife viewing will be encouraged at times and places that do not put undue stress on wildlife species and populations
- proposals for allocating Crown land for settlement purposes will be reviewed on an integrated coordinated basis with other interested agencies; where possible, allocations will be directed away from significant environmental or resource values, such as biodiversity connectivity corridors, key wildlife habitats and high capability agricultural lands or forest lands
- an access management strategy will be produced for the Lakes Forest District, in consultation with the Monitoring Committee (as per the provisions of Chapter 6), to identify access opportunities and restrictions for public, industrial and commercial uses of the provincial land base
- recreational opportunities will be provided, at both area-based and site-based scales, within all resource management zones; recreation activities and access will be managed according to LRMP direction and provincial policy, programs and guidelines
- caribou habitat will be maintained principally by management of key areas as defined in the Special Resource Management Zone (Chapter 4, Section 4.4); landscape unit objectives and Forest Development Plans will reflect the intent of the subzone designation
- in areas where caribou habitat overlaps with other ungulate winter ranges, management for caribou will take precedence
- more detailed strategic plans will identify migration and wintering habitats and will incorporate information on caribou densities, habitat, and movement with a view to avoiding roads (if possible) or minimizing road densities within key areas
- sensitive resource management practices will be applied to key ungulate winter habitat areas (Chapter 4, Section 4.4)
- ungulate forage and habitat enhancement measures will be undertaken in key winter range and habitat areas, or as determined through more detailed strategic planning and ongoing Ministry of Environment, Lands and Parks program initiatives; where undertaken, these initiatives will consider other resource

values (e.g. Crown range)

- more detailed strategic planning will incorporate information on ungulate habitats and movement, with a view to reducing stress and displacement of wintering ungulates
- access plans will be developed to control the level of access development; this will involve providing guidance for new construction and the deactivation of existing access structures, where appropriate
- access plans will address access to sensitive terrain such as alpine and sub-alpine areas, sensitive wetlands, sensitive rare and endangered plant communities (such as those occurring on steep south facing slopes); typically, access into these areas will be avoided
- circular routes within the Lakes District and connecting to adjacent districts can be potentially detrimental and should be discouraged wherever possible; this applies particularly when other values are paramount

Resource Management Zone specific recommendations:

Caribou Migration Corridor Subzone - Special Resource Management Zone

- where resource management guidelines overlap on the ground, the most constraining guideline should be implemented for that area in order to better sustain all resource values; an exception to this strategy is the Caribou Migration Corridor, where requirements for Caribou management will apply
- resource management emphasis will be placed on maintaining/enhancing habitat values for which the resource management zone was established
- review existing silviculture prescriptions to determine consistency with the objectives and strategies of this zone; strive to implement measures for rehabilitation or enhancement of previously harvested sites or affected habitats, through modifications to silvicultural plans, in order to meet wildlife habitat and recreation objectives
- forest development plans will address caribou habitat requirements in terms of seral stage distribution, caribou passability, and the timing, nature, location and degree of timber harvesting activity such that the quality of caribou habitat is optimized
- management emphasis in the caribou migration corridor will be placed on the conservation of caribou migratory and winter range habitat values
- future timber harvesting will be restricted to caribou-impassable timber areas, as outlined in the *Chelaslie IRM Management Report*, with exact harvesting locations to be determined through the forest development planning process
- apply an adaptive management approach to development based on research into recovery of lichen from disturbance, and caribou movement and habitat use over time with respect to resource development
- address herd management issues other than habitat management (e.g. low recruitment, predation, poaching) to enable the population to thrive and potentially increase
- within the caribou migration corridor ensure that management of resource development is consistent with the maintenance/enhancement of identified caribou habitat values
- the duration and extent of resource exploration and development disturbances within high and very high use areas will be managed to minimize impacts to identified caribou habitat values
- timber harvesting within very high use areas will focus, as a first priority, on forest health management particularly, reactive removal of Mountain Pine Beetle infested trees; forest management beyond forest health activities will be directed toward the maintenance and enhancement of caribou habitat values
- maintain forest cover associated with good lichen sites and when harvesting in very-high-use areas through use of alternative harvesting systems (e.g. selection and partial cutting systems)
- through harvest pattern and scheduling, avoid fragmentation of old forest and maintain a variety of travel options throughout the area
- in development planning and silvicultural prescriptions, retain good terrestrial or arboreal lichen habitat
- schedule harvesting activities to minimize human activity when greatest use of the area by caribou occurs
- surface access within very high use areas should be minimized; where alternatives do not exist, temporary surface access structures may be permitted provided they are located, constructed, and managed so as to minimize impacts on caribou habitat values; generally:
  - use of existing access is to be maximized;
  - less permanent/intrusive forms of access (i.e. skid trails) are preferred to more permanent/intrusive

forms (i.e. roads);
  - access controls (i.e. gates) will be required on all access structures during periods of caribou migration and occupancy
  - full reclamation/rehabilitation of new access will be required following completion of activities
- fire and forest health management activities within very-high-use areas of the caribou migration corridor will be carried out according to light-hand-on-the-land management approach; where the severity of the disturbance makes it necessary to exceed such standards, full rehabilitation of management access and structures, including re-contouring of disturbed areas, will be undertaken

Chelaslie Caribou Migration Corridor Management Strategy

- subzones:
  - moderate use (Zone A)
  - very high use - Chief Louis and Uduk Lakes and Chelaslie River (Zone B)
  - high use - migration corridor between Zones B &D (Zone C)
  - very high use - along Tetachuck Lake (Zone D)
  - low use - along Ootsa Lake (Zone E)
- all subzones
  - fragmentation of forest should be avoided in all subzones; development should be clustered in such a way as to promote the retention of large contiguous areas of older forests; this involves the development of larger blocks, placed more closely together, containing windfirm and representative habitat retention areas
  - seral stage distribution management guidelines for each of the subzones; note that the High Use seral stage management subzone lumps the areas of subzones B, C, and D; the High Use subzone guidelines are based on maintaining 100 % of the "natural" old and mature seral area, where "natural" area is determined through principles outlined in Appendix 4 in the Biodiversity Guidebook; the Moderate Use and Low Use subzone values are based on 75 % and 50 % respectively of the High Use zone values; a fire rotation interval of 150 years was used in the calculations for the SBS seral proportions instead of 125 years (as in the Biodiversity Guidebook) as this more accurately reflects the fire rotation interval in this area

Seral Stage Management Zones	Seral Stages		
	> 140 Years	> 80 Years	< 40 Years
High Use (B, C, and D)	40 %	60 %	25 %
Moderate Use (A)	30 %	45 %	32 %
Low Use (E)	20 %	30 %	54 %

  - *NOTE: In agreeing to these objectives and strategies, members of the forest sector have requested it be noted that, although the seral stage objectives recommended by the LRMP are based on informed professional judgment, they feel this judgment may be overly conservative in relation to their understanding of the biodiversity guidebook*
  - retain good lichen sites as patches within cutblocks
- high use subzones (B, C, D)
  - focus logging in areas of low priority to caribou; caribou/human interactions less likely to occur in subzone C than in subzones B and D
  - role of IFS IRM Report:
    - the principles for managing forest development within the migration corridor area contained within the Integrated Resource Management Plan for the Chelaslie Caribou Migration Corridor by IFS will be followed; the above plan area is divided into the "IRM plan area" and a "deferred plan area"; the planning in the report only refers to the IRM plan area; the IRM plan area falls entirely within the area designated by this report as "High" and "Very High"
    - within the area covered by the IRM plan produced by IFS, harvesting will be restricted to the caribou-impassable timber areas as mapped out in the above plan; it is understood that the harvesting may not take place in the exact locations indicated in the IRM plan as long as it occurs within the mapped caribou-impassable timber areas
    - the "Deferred Plan Area," as mapped in the IRM plan produced by IFS, bordering Tweedsmuir Park and Tetachuck Lake falls largely within the "Very High" subzone; it is understood that development may occur within this "Deferred Plan Area" falling outside the "Very High" subzone as long as it conforms to the "caribou-impassable" area principle discussed in the point above and to the objectives for the caribou management subzones

- operational harvesting will not occur in subzones B and D ("Very High Use"); management in these subzones will be for forest health reasons only and these activities will be guided by the principle of protecting the integrity of caribou habitat
- high priority forest health management is necessary to prevent catastrophic events requiring large scale management activities that would threaten the integrity of habitat in subzones B, C, and D
- no access to non-tenured motorized users to protect lichens, which are fragile and are easily damaged by motorized vehicles

- access
  - no access into subzones B and D is the desired objective; however, where access is the only alternative, a rigorous joint agency (MOELP and MOF) approval process is required; this approval process should consider caribou objectives as the top management priority *(Mining interest input required)*
  - a high level of access control is required in the areas immediately adjacent to subzones B and D to meet the above objective; road construction within 1 km of these subzones should be minimized and avoided as much as possible; access control will involve the full deactivation of all on-block roads within 500 m of the boundary of subzones B and D and a high level of deactivation of all other access structures within 1 km of these subzones
  - access control points to be located at the Chelaslie River bridge on the Chelaslie Main and at the beginning of the Blanchet Road; signage to be posted at access points with reasons for closure
  - avoid activity when caribou are migrating; access closures at the above control points will occur from April 1 to May 31 for the spring migration and October 1 to December 1(Note: Ministry of Environment, Lands and Parks would prefer to see closure extended to December 7) for the fall migration; planting activities are permitted during the spring migration although such activity should be concentrated in space and time
  - access closure dates for the Chelaslie River bridge and Blanchet Main may be adjusted in the fall based on results of radio-relocation overflights; in the absence of overflights the gates at these two locations will be closed from October 1 to December 1 (see above bullet)
    - if overflights prior to October 1 indicate caribou moving into the Uduk Lake - Chief Louis Lakes area, the gates will be closed early; if an overflight just prior to October 1 indicates that caribou are still well within the park and have not started migrating, Ministry of Environment, Lands and Parks staff may, at their discretion, authorize the gates to remain open beyond October 1 until migration begins; this depends on an overflight schedule frequent enough to detect the beginning of migration
    - if overflights prior to December 1 indicate that all the caribou have moved south of Tetachuck Lake, Ministry of Environment, Lands and Parks staff may authorize the early opening of the gates
  - minimize road building; no loop routes on haul roads should be created; special treatment of this area in the LRMP strategic access plan (i.e. higher level of deactivation of roads than required in the Forest Practices Code)
  - development in the "High" zone will be concentrated in time; for example development in a pass would take between 2 and 5 years followed by a 15 to 18 year period of inactivity
  - road material sites to be chosen that avoid disturbance of lichen areas (e.g. eskers)
  - recommend reintroduction of hunting regulations for East Ootsa South zone that existed prior to 1989 which prevented motorized hunting beyond 0.25 miles of a lakeshore

General Resource Management Zone

- management in this zone will accommodate a mix of resource development (e.g. recreation, tourism, trapping, guiding, agriculture and grazing, and timber and mineral extraction), and conservation (e.g. biodiversity, wildlife habitat, rare or endangered species, scenic views and community watersheds) uses and values; site specific uses associated with settlement, industry, and commerce may also be accommodated; detailed objectives and strategies as per general direction
- in areas that are least constrained by non-timber resource values, implement intensive timber management as per direction under GRMZ1, Intensive Timber Management Areas Sub-zone

Intensive Timber Management Areas Sub-zone

- emphasize the enhanced development of timber resources through application of intensive harvesting and silvicultural practices in identified ITMAs

- pursue intensive silvicultural practices, within the regulatory framework of the FPC, including: harvesting, site preparation, artificial regeneration (i.e. planting, seeding), spacing, pruning, fertilization and commercial thinning
- apply accelerated backlog (incremental) reforestation, including site preparation, planting and brushing, to harvested areas
- maximize efforts to reduce regeneration delay
- where applicable, plant improved stock to reduce the green-up period, achieve full site occupancy, and increase long-term yields
- apply rigorous density control at the free-to-grow stage
- pre-commercial and commercial thinnings will be undertaken where economically feasible and biologically appropriate, to recoup mortality losses, improve timber quality and increase short-term timber supply
- effective vegetation management practices will be applied, possibly including herbicides to control competing vegetation and enhance growth of crop species
- higher utilization standards may apply (within the bounds of long-term sustainable timber productivity and basic biodiversity requirements)
- harvest on the basis of merchantibility in the absence of other harvesting priorities
- intensive forest health surveys and effective pest management techniques will be applied to protect timber values and silvicultural investments, in accordance with FPC requirements, while minimizing impacts on significant non-timber resource values
- within these areas, emphasis will be placed on increasing the timber harvesting land base through:
  - development and application of new and innovative harvesting technologies,
  - increased utilization of stands that have been excluded (problem forest types), and
  - minimization of site degradation
- harvest openings may exceed 60 ha where designed to simulate Natural Disturbance Type 3 (NDT3) fire maintained forest ecosystems

Mineral/Wildlife Management Zone

- timber harvesting will only be allowed for purposes associated with approved mineral exploration and development
- all applicable exploration proposals within the areas shall be subject to an enhanced referral to BC Parks by the Ministry of Energy and Mines; these referrals shall provide the opportunity for BC Parks to consult with and provide recommendations to the Ministry of Energy and Mines regarding:
  - timing of exploration and/or development work to avoid impact on grizzly bear and Caribou;
  - reclamation provisions;
  - minimization of impacts from exploration and/or development activities on grizzly bear, caribou and recreation values in the area adjacent to the height of land between Chikamin Valley and Eutsuk Lake drainage;
  - the location of access trails and roads, and
  - any other aspect of a development proposal for which BC Parks may have concerns
- existing mineral claims within the areas shall remain in good standing unless withdrawn or allowed to lapse by the claim holder
- new mineral claims may be staked by existing or new claimants
- all prospecting and initial stage development work shall be completed in compliance with the Mineral Exploration Code (Mx Code)
- minimize impacts on wildlife, particularly Caribou and grizzly, through the appropriate timing of exploration and development activities including the timing and location of roads and trails
- minimize the visual impacts of exploration and development activities between the Chikamin Valley and Eutsuk Lake drainage
- BC Parks, Ministry of Environment Lands and Parks – Skeena District to provide recommendations on levels of reclamation and bonding appropriate to the conservation values being affected

Appendix 5. Management Direction for caribou in the Morice LRMP (adapted from Cichowski 2008 and updated).

Morice Land and Resource Management Plan

Reference: BC Ministry of Agriculture and Lands. 2007. Morice Land and Resource Management Plan. Ministry of Agriculture and Lands, Integrated Land Management Bureau, Victoria, B.C.

Landscape level guidelines/strategies/recommendations:

- maintain a distribution of representative seral stages across the plan area that is reflective of the range of natural variation
  - manage 10-20% of the plan area in HBEA
  - distribute High Biodiversity Emphasis Areas (HBEA) throughout plan area, independent of Landscape Unit (LU) boundaries; BEC variant and LU will be considered as units of measure for assessing distribution of HBEA

BEC	% representation across each HBEA		
	Early Seral Maximum (<40 years)	Mature + Old Seral Minimum (>100 years)	Old Seral Minimum (>140 years)
ATp	NA	NA	NA
CWHws2, MHmm2	16	71	70
ESSFmc, ESSFmv3	28	48	42
ESSFmk	7	86	84
SBSdk	50	21	16
SBSmc2, SBSwk2	37	33	26

BEC	% representation across the general forested area		
	Early Seral Maximum (<40 years)	Mature + Old Seral Minimum (>100 years)	Old Seral Minimum (>140 years)
ATp	NA	NA	NA
CWHws2, MHmm2	27	64	62
ESSFmc	38	37	34
ESSFmk	9	83	82
ESSFmv3	34	48	47
SBSdk	64	10	8
SBSmc2, SBSwk2	48	20	17

- Old Growth Areas (OGAs) will be delineated by 2008 to achieve old seral targets, in combination with existing reserves and management
  - OGAs will meet the following criteria: representative of ecosystem diversity at the scale of measure; maintain structural and functional forested connections between OGAs; in an unmanaged or natural condition; represent a range of sizes; spatial distribution is representative across the HBEA

Stand level guidelines/strategies/recommendations:

- maintain effective high value seasonal forage habitats for woodland caribou
  - 70% of area of known high value seasonal foraging habitats not impacted
  - use predictive modeling and existing field knowledge to outline potential high value seasonal foraging habitats

- high value seasonal habitats are productive ecosystems as suggested by predictive modeling or local or First Nations knowledge and/or evidence of caribou tracks and/or feeding
- high value habitats during spring, summer and fall are: those that produce large amounts of green forage used during spring, summer and fall seasons, and may include open habitats in riparian areas, or other forests with rich soils and open canopies; terrestrial lichen habitats (e.g. dry forest types)
- high value winter habitats include: alpine or subalpine ridges with terrestrial lichen; dry forests with terrestrial lichen; forests, mostly but not entirely high elevation, with arboreal lichen
- comply with the existing and any future Telkwa Caribou Recovery Plan and use Best Management Practices (see below) regarding woodland caribou until these practices are replaced by enactment of a species recovery strategy under the Species At Risk Act of Canada
- current Best Management Practices for the Telkwa Caribou herd are found in Appendix 9 - Interim Harvesting Guidelines for the Telkwa Recovery Plan Area (see Map 12: Caribou Management Areas for locations of Key Forested Habitats)
- current Best Management Practices for the Takla herd are based on the Ungulate Winter Range guidelines for the Takla herd and are found in Appendix 10

- maintain effective calving/postcalving habitats for woodland caribou
  - 100% of known calving/postcalving sites not impacted
  - use predictive modeling and existing field knowledge to outline potential calving/post-calving habitats
  - calving and post-calving habitats include: high elevation (>1200m) alpine and sub-alpine habitats, wetland complexes, and known calving islands (Map 12, *Caribou Management Areas*)
  - presence of multiple (>3) caribou cows with calves indicates calving/post-calving habitats
  - comply with the existing and any future Telkwa Caribou Recovery Plan and use Best Management Practices regarding woodland caribou until these practices are replaced by enactment of species recovery strategies under the Species At Risk Act of Canada
- maintain effective security cover adjacent to high value seasonal forage or calving/postcalving habitats
  - maintain no less than 70% of the area of functional screening coverage associated with each known high value seasonal foraging or calving/post calving habitat
  - screening cover is located adjacent to high value seasonal forage or calving/post-calving habitats
  - screening cover – provides visual screening especially from roads; and exists when vegetation obscures a person 20m away from the observer
- achieve structurally complex forested ecosystems, through all successional stages, distributed across the plan area
  - large patches can be created through the aggregation of several smaller cutblocks over time; manage aggregation of cutblocks to achieve a range of age complexities within early seral patches
  - guidance for implementation of ecologically sound wildlife tree retention will be as per Provincial Wildlife Tree Policy and Management Recommendations (MOF 2000); these recommendations will be replaced by the Best Management Practices once they are developed
  -

BEC	% land in patches <40 ha		% land in patches >250 ha	
All SBS	20	30	50	60
All CWH, ESSF, MH	15	25	50	60
AT, ATp	NA	NA	NA	NA

Percentage of harvested area required in wildlife tree retention					
% of area available for harvest that has already been harvested without recommend wildlife tree retention	% of biogeoclimatic subzone within the Landscape Unit available for harvest				
	90	70	50	30	10
10	10	8	6	4	3
30	12	10	8	6	4
50	14	12	10	8	6
70	16	14	12	10	8
90	18	16	14	12	10

Other guidelines/strategies/recommendations:

- limit disturbance from development activities adjacent to calving/postcalving habitats
  - no human, industrial or commercial activity on known calving islands (Map 12, *Caribou Management Areas*)
  - no industrial activities within 500 meters of known calving/post-calving habitats from May 15 to June 30
- limit disturbance from motorized activities in identified caribou management subareas
  - no motorized access within identified caribou management sub-areas
  - identified caribou management sub-areas are from the Telkwa Caribou Recovery Plan and the proposed Ungulate Winter Range map for the Takla Caribou herd (Map 12, *Caribou Management Areas*)
  - the sub-areas map identifies areas where winter motorized access is restricted and where summer motorized access is restricted
  - where practicable, avoid repeated flights in or near no-fly zones identified through the Telkwa Caribou Recovery Plan on Map 12, *Caribou Management Areas* (no fly zone map) during the period May 15 to June 30; in other Caribou Management areas, use best management practices when operating aircraft in the vicinity of caribou habitat; inform local pilots of known high value areas and season of use; provide information on flying and landing practices that minimize caribou disturbance
- limit risk of disease transfer between caribou and cattle
  - no new grazing tenures issued above 1000m within the Telkwa and Takla Caribou Management Areas or south of Tahtsa Reach and Tahtsa Lake in the Tweedsmuir Caribou Management Area
  - where possible, investigate all known caribou deaths to determine if a disease communicable between livestock and caribou was the cause
  - encourage development of best management practices for management of herd health of livestock in the vicinity of caribou
  - existing grazing tenures will be renewed subject to compliance with best management practices
- minimize and where necessary mitigate both immediate and cumulative access-related impacts, to environmental values as described in Table 9
- encourage access development to support social and economic values and address associated issues as described in Table 10
- develop a strategic access management plan for the plan area
- complete spatial access management plans, with public involvement, for areas of significant concern to determine: designated access routes; specific spatial and temporal access restrictions; access to present and future Crown land lot development (lakeshore, residential, recreation etc.); and, deactivation schedule and/or plan
- designated motorized and non-motorized recreational access (Map 7):
  - summer non-motorized - Tstsutl Mountain (3)
  - non-motorized (all seasons) – Telkwa Mountains Area (9B)
    - some winter motorized recreation access opportunities are available through the Smithers and Houston snowmobile clubs. Refer to the "Letter of Understanding, March 2003" as agreed to by the Voluntary Access Management Group which details the conditions of recreational use
  - non-motorized – Telkwa Mountains Area (9D)
    - non-motorized access is acceptable between July 15 and September 15.
  - summer non-motorized – Telkwa Mountains Area (9)
    - this area is generally designated summer non-motorized . Sub unit areas within have higher levels of access restrictions (Refer to 9B, 9C and 9D)
  - summer non-motorized – Telkwa Mountains Area (9C)
    - no summer motorized access is allowed pas the "Gas Stop" (May 1-September 15)
  - non-motorized – Burnie North (11)
  - summer non-motorized – Burnie South/Morice Range (12)
  - summer non-motorized – Whitesail South (17), Kasalka (20)
    - Kasalka (20) – summer non-motorized above 1000 m elevation.
  - winter non-motorized – Little Whitesail (18)

- where practicable, retain all existing access routes to guide territories and methods of transportation on these routes whether in protected areas, special management areas or general management areas
- changes to access routes (e.g. deactivation, motorized access restrictions, new development) should be carried out in consultation with tenure holders or through a TSA Access Management Plan
- promote mineral, aggregate and energy projects that provide a variety of economic opportunities for their full life cycles
- maintain the legal right to access for mineral exploration
- allow for access for aggregate and energy exploration and development outside of protected areas
- minimize environmental impacts, over the full lifecycle of mineral, aggregate and energy projects
- encourage opportunities to develop mineral and energy resources
- maintain or increase timber production and harvesting across the available landbase
  - apply adaptive management principles to meet timber objectives
- maintain the health of the timber resource
  - maintain forest health through integrated pest management
  - use best management practices for beetle management within the context of other resource values
- maintain or enhance moose summer and winter forage habitats
- maintain or enhance deer winter range

Resource Management Zone specific recommendations:

Herd Dome – Telkwa

- conserve the function and integrity of large contiguous forested ecosystems by managing as a non-timber harvesting area
  - no timber harvesting or salvage
  - no impacts to alpine ecosystems
- maintain the quality of the wilderness recreation experience
  - no motorized summer recreation use

Starr Creek - Telkwa

- conserve the function and integrity of large contiguous forested ecosystems by managing as a non-timber harvesting area
  - no timber harvesting or salvage
- maintain the quality of the wilderness recreation experience
  - develop a recreation plan with caribou recovery to take precedence, and to reduce conflicts between users and between users and wildlife

Tahtsa-Troitsa – Tweedsmuir-Entiako

- conserve the function and integrity of large contiguous forested ecosystems by managing as a non-timber harvesting area
  - no timber harvesting or salvage
  - single tree management for forest health is acceptable; biomass must be retained on site
- maintain or improve opportunities for a range of wilderness recreation experiences across the landscape
  - provide a range of recreational opportunities at Coles Lake
  - designated summer non-motorized areas
  - designated winter non-motorized areas

Other findings/discussion:

-