Caribou

Rangifer tarandus

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Species Information

Taxonomy

Rangifer tarandus includes seven extant subspecies: Reindeer (*R. tarandus tarandus*), Wild Forest Reindeer (*R. tarandus fennicus*), and Svalbard Reindeer (*R. tarandus platyrhynchus*) in Eurasia; and Barren-ground Caribou (*R. tarandus groenlandicus*), Alaskan Caribou (*R. tarandus granti*), Peary Caribou (*R. tarandus pearyi*), and Woodland Caribou (*R. tarandus caribou*) in North America.

The Woodland Caribou includes several ecotypes, which have no formal taxonomic designation but are defined on the basis of distinct patterns of habitat use and diet/feeding behaviour. The three ecotypes described in this account are known as Mountain Caribou, Northern Caribou, and Boreal Caribou (Heard and Vagt 1998) and can be distinguished from each other by the combination of three inter-related features (Table 1).

Description

Woodland Caribou are a large, dark subspecies with short, heavy antlers (Banfield 1961) occurring in parts of boreal, cordilleran, and southeastern arctic Canada. There has been no scientific description specific to the three caribou ecotypes in British Columbia.

Distribution

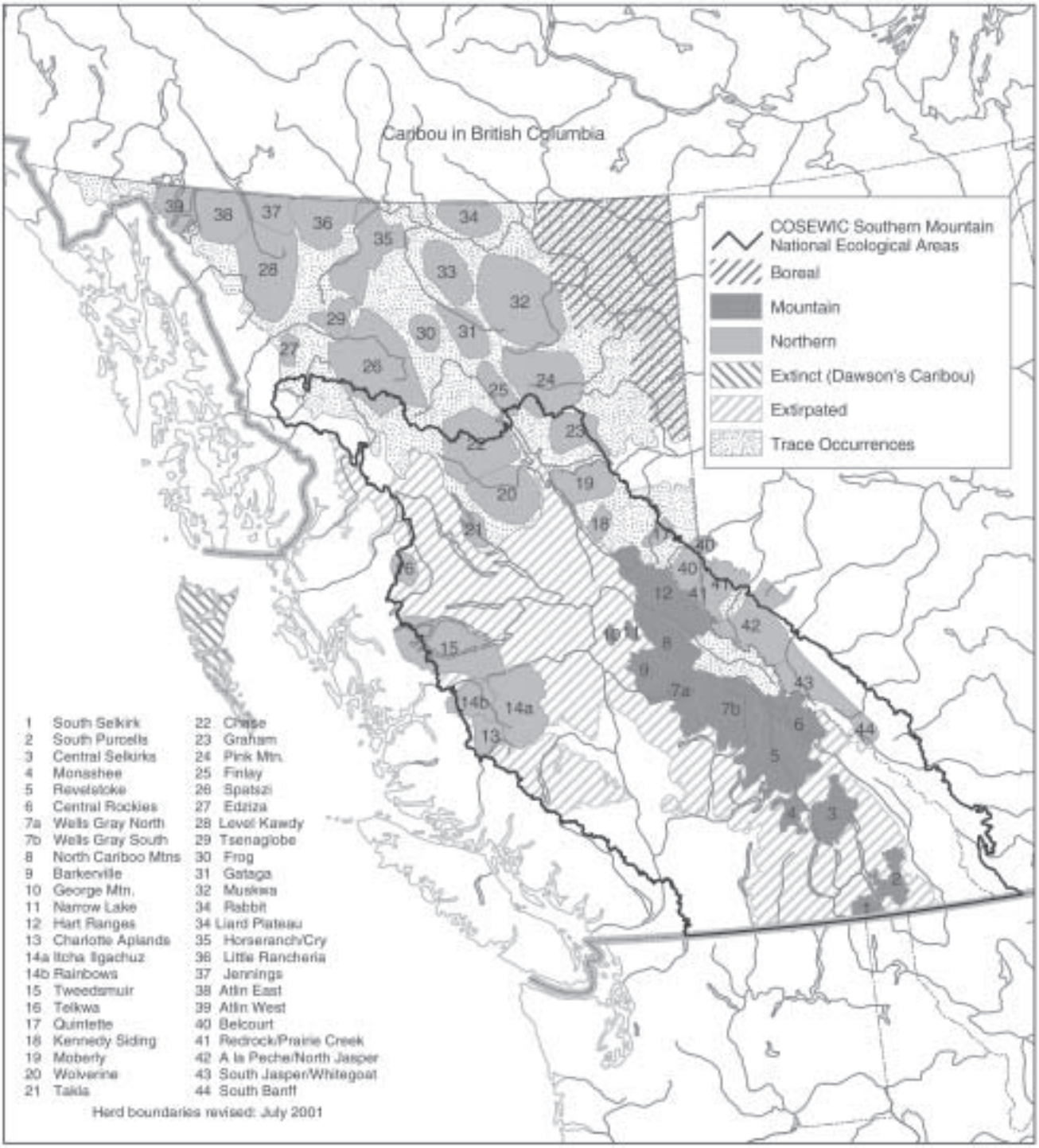
Global

Rangifer tarandus has a circumboreal distribution. In northern Europe and Asia, this species is known as Reindeer, and includes domestic, semi-domesticated, and wild populations. In North America, the species is known as Caribou and exists primarily in the wild. Extant wild subspecies in North America are:

1. Barren-ground Caribou from just south of the treeline northward in northernmost Saskatchewan and Manitoba, the Northwest

Table 1. Features of caribou ecotypes in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Occurrence	Mountainous deep-snowpack portion of southeastern British Columbia known as the Interior Wet Belt	Mountainous and adjacent plateau areas with relatively low snowpacks in west-central and northern Interior British Columbia	Peatlands (muskeg) in lowland plateau portion of northeastern British Columbia, east of the Rocky Mountains, with relatively low snowpack
Winter diet	Consists almost entirely of arboreal hair lichen, with use of terrestrial lichen and other ground-based foods only in early winter	Consists mostly of terrestrial lichens with use of arboreal lichens dependent on snow conditions	Consists mostly of terrestrial lichens with some use of arboreal lichens
Seasonal movements	Generally involve little horizontal distance but strong elevational shifts	Generally involve both horizontal distance and elevational shifts	Generally involve horizontal distance but no strong elevational shifts although for some local populations, winter and summer ranges may overlap


Caribou in British Columbia
COSEWIC Southern Mountain National Ecological Areas
Boreal
Mountain
Northern
Extinct (Dawson's Caribou)
Extirpated
Trace Occurrences
1 South Selkirk
2 South Purcells
3 Central Selkirks
4 Monashee
5 Revelstoke
6 Central Rockies
7a Wells Gray North
7b Wells Gray South
8 North Cariboo Mtns
9 Barkerville
10 George Mtn.
11 Narrow Lake
12 Hart Ranges
13 Charlotte Alpands
14a Itcha Ilgachuz
14b Rainbows
15 Tweedsmuir
16 Telkwa
17 Quintette
18 Kennedy Siding
19 Moberly
20 Wolverine
21 Takla
22 Chase
23 Graham
24 Pink Mtn.
25 Finlay
26 Spatsizi
27 Edziza
28 Level Kawdy
29 Tsenaglode
30 Frog
31 Gataga
32 Muskwa
34 Rabbit
34 Liard Plateau
35 Horseranch/Cry
36 Little Rancheria
37 Jennings
38 Atlin East
39 Atlin West
40 Belcourt
41 Redrock/Prairie Creek
42 A la Peche/North Jasper
43 South Jasper/Whitegoat
44 South Banff
Herd boundaries revised: July 2001

Territories, Nunavut, and western Greenland, totaling over 1 million;

2. Alaska Caribou in northern Yukon and much of Alaska, totalling ~1 million;
3. Peary Caribou on the Arctic islands of the Northwest Territories and western Nunavut, totalling ~2000;
4. Woodland Caribou in southern Yukon, southwestern Northwest Territories, northern, west-central and southeastern British Columbia, extreme northeastern Washington, extreme northern Idaho, west-central and northern Alberta, boreal portions of Saskatchewan and Manitoba, and the boreal and arctic portions of Ontario, Quebec, and Newfoundland and Labrador, totalling over 1 million.

Of the three Woodland Caribou ecotypes in British Columbia, Mountain Caribou occur in part of the Columbia Mountains, Idaho, and Washington, and a small portion of the west slope of the Rocky Mountains in British Columbia. Northern Caribou are found in mountainous and adjacent low elevation plateau areas in west-central British Columbia and in northern British Columbia west of and in the Rocky Mountains. Boreal Caribou are found in relatively flat boreal forests east of the Rocky Mountain in northeastern British Columbia.

British Columbia

Mountain Caribou in British Columbia occur regularly in portions of the Rocky Mountains' west slope from the Anzac River to the Morkill River, and from the Wood River drainage to the Bush Arm of Kinbasket Lake, although there are sporadic occurrences between the Morkill and Wood rivers. They also occur in the Columbia Mountains, including parts of the Cariboo Mountains, Quesnel Highlands, Shuswap Highlands, Monashee Mountains north of Whatshan Lake, Selkirk Mountains, and parts of the Purcell Mountains north of Highway 3.

Northern Caribou occur in west-central British Columbia, in and around the Itcha, Ilgachuz, Rainbow, and Trumpeter mountains as well as in and around northern Tweedsmuir Provincial Park and Entiako Provincial Park and Protected Area. They also occur in the Telkwa Mountains and around the northern part of Takla Lake. Northern Caribou are somewhat contiguous in distribution from the Williston Lake area north to the Yukon border and northwest to Atlin, and southeast along the east side of the Rocky Mountains to the Alberta border near Kakwa Park.

Boreal Caribou are found in approximately 15% of the province east of the Rocky Mountain foothills from the Yukon border east of the Liard River as far south as the Wapiti River Drainage downstream of its junction with the Red Deer River. The western boundary is indistinct but is approximately along the Liard River from the Yukon, North West Territories' boundary upstream as far as the junction with the Dunedin River, and then generally southeast to Fort St John. No caribou were likely to have or will live in the drier aspen forests along the lowlands near the Peace River although the occasional transient has been seen in these areas.

Forest regions and districts

Mountain Caribou		Northern Caribou		Boreal Caribou	
Region	**District**	**Region**	**District**	**Region**	**District**
Southern Interior	100 Mile House Arrow Boundary Central Cariboo Columbia Headwaters Kootenay Lake Okanagan Shuswap Quesnel Rocky Mountain	Southern Interior	Chilcotin Quesnel	Northern Interior	Peace Fort Nelson
		Norther Interior	Fort Nelson Fort St. James Mackenzie Nadina Peace Prince Geroge Skeena Stikine Vanderhoof		
Northern Interior	Prince George	Coast	North Island		

Ecoprovinces and ecosections

Mountain Caribou	Northern Caribou	Boreal Caribou
SBI: HAF	BOP: HAP, KIP	BOP: CLH, HAP, KIP
SIM: BBT, BOV, CAM, CCM, CPK, EPM, NKM, NPK, QUH, SCM, SHH, UFT	CEI: BUB, BUR, CHP, NAU, NEU, WCR, WCU	TAP: ETP, FNL, MAU, MUP, PEP, TLP
	COM: CRU, KIR, NAB, NAM	
	NBM: CAR, EMR, HYH, KEM, LIP, MUF, SBP, STP, TAH, TEB, TEP, TUR, WMR	
	SBI: BAU, ESM, HAF, MAP, MIR, PEF, SOM	
	SIM: FRR	
	TAP: MUP	

Biogeoclimatic units

ICH, ESSF, and AT occur over the majority of Mountain Caribou range and are used to varying degrees. Caribou in the northern end of the distribution (Hart Ranges, Narrow Lake, George Mountain, Barkerville, and North Cariboo Mountains local populations) use the SBS instead of or in addition to ICH. In portions of the South Purcell local population, the MS zone occurs in place of ICH, but there is very little use of the MS there.

Northern Caribou use a wide range of biogeoclimatic subzones and variants, partly because of the extent of their distribution throughout northern and west-central British Columbia. AT is used by most Northern Caribou local populations during both winter and summer. In the northern part of British Columbia, low elevation forested winter ranges occur in the BWBS zone and higher elevation ranges occur in the SWB. In north-central British Columbia, Northern Caribou low elevation winter ranges occur in SBS and BWBS, with high elevation ranges in ESSF. In west-central British Columbia, low elevation winter ranges occur in SBS, SBPS, and to some extent in the MS with high elevation ranges in the ESSF. In addition, some Northern Caribou summer range in west-central British Columbia lies within the MH at higher elevations and CWH at lower elevations.

Boreal Caribou can occur in all of the variants of the BWBS with the possible exception of the BWBSdk2.

However, the majority occur in the BWBSmw1 and BWBSmw2, which contain the wetter site series that include "peatlands" or "muskeg."

Mountain Caribou	Northern Caribou	Boreal Caribou
ESSFdk	BWBSdk1	BWBSmw1
ESSFmm	BWBSdk2	BWBSmw2
ESSFp	BWBSmw1	BWBSwk2
ESSFun[a]	BWBSwk1	BWBSwk3
ESSFvc	BWBSwk2	
ESSFvv	CWHws2	
ESSFwc	ESSFmv2	
ESSFwk	ESSFmv3	
ESSFwm	ESSFmv4	
ICHmk (limited)	ESSFwc3	
ICHmm	ESSFwk2	
ICHmw	ESSFwv	
ICHvk	ESSFwv1	
ICHwk	MHmm2	
MSdk	MSxv	
	SBPSmc	
SBSvk	SBPSmk	
SBSwk	SBPSxc	
	SBSdk	
	SBSmc2	
	SBSmc3	
	SBSmk1	
	SBSmk2	
	SBSwk2	
	SBSwk3	
	SWBmk	
	SWB (undiff)	

a A distinct subzone or variant occurs in some locations between the ESSF proper and the ESSFp, with a lower boundary where alpine larch and heathers begin (T. Braumandl, pers. comm.). This "undifferentiated" subzone has not yet been named but tentative site series for it have been identified in parts of the Kootenay region.

Broad ecosystem units

Degree of use of broad ecosystem units (BEUs) varies between local populations.

Mountain Caribou		Northern Caribou		Boreal Caribou
AH[a]	ME[c]	**AC**	**HP**	**BB**
AM	RD[c]	**AS**	**LP**	**BG**
AN[b]	RE[b,c]	**BA**	**LS**	**BL**
AT	RR	**BB**	**MI**	**BP**
AU[b]	SF[c]	**BK**	**OW**	**LP**
AV	SK	**BS**	**RD**	**LS**
EF	**SM**	**CD**	**RE**	**PR**
ER	TA[b]	**CF**	**RR**	**WL**
EW	TC[b]	**CS**	**SP**	
FP	TR[b]	**CW**	**SR**	
GL[b]	WB[c]	**FR**	**TA**	
IH	WG	**FS**	**TF**	
IS	WP[c]	**GB**	**UR**	
LL[b]		**GL**	**UV**	
LS[b]				

a Units in bold are used most consistently among local populations.

b Units used for travel or resting only.

c Units used by three or fewer local populations.

Elevation

Mountain Caribou activity is most concentrated in the upper portion of the ESSF zone, at ~1500–2100 m. However, elevation use varies by local population, year, season, and individual. Local populations occurring near the centre of current range and in areas with greater extremes of elevation tend to make more extensive use of elevations as low as 600 m for foraging, particularly in early winter and spring. Caribou in other locations are more likely to use lower elevations mainly as they cross valleys between high-elevation ranges. Sometimes elevations >2500 m are used, particularly in the summer.

Northern Caribou are found at a variety of elevations depending on season and local population. During winter, Northern Caribou are generally found either at high elevations above treeline on windswept alpine slopes or at lower elevations in

forested habitat. Due to the extent of Northern Caribou range in British Columbia, lower elevation forested habitat can range from about 500 to 1500 m depending on local population. High elevation winter habitat generally ranges from 1500 m to over 2000 m. Some high elevation winter range also includes subalpine forests. During summer, Northern Caribou may be found as low as 500 m in coastal areas in west-central British Columbia to over 2500 m in mountainous areas in most local population ranges.

Boreal Caribou are found in relatively flat boreal forests in northeastern British Columbia where they occupy all elevations in that area from about 400 to 1200 m.

Life History

Diet and foraging behaviour

The late-winter diet of Mountain Caribou consists almost entirely of *Bryoria* spp., with some *Alectoria sarmentosa* and possibly *Nodobryoria oregana*. They are able to sustain themselves on this low-protein diet (*Bryoria* has only about 4% crude protein; Rominger et al. 1996), for roughly half of the year (Rominger et al. 2000). The dependence on arboreal hair lichens is probably the result of several factors. Hair lichens are usually abundant in old forests, which have historically been extensive in the interior Wet Belt, while terrestrial lichens are not. Furthermore, deep snowpacks in this region preclude cratering for most of the winter while providing lift to allow caribou to reach lichen higher in the trees. The use of forbs and graminoids increases dramatically in the spring season. Summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs. Depending on location and year, early winter foraging may be largely restricted to the same hair lichen species as during late winter, particularly those on windthrown trees or branches, but generally also includes a variety of winter-green shrubs, forbs, graminoids, and terrestrial lichens.

During winter, Northern Caribou forage primarily by cratering through the snow for terrestrial lichens of the genera *Cladina*, *Cladonia*, *Cetraria,* and *Stereocaulon*. *Cladina* spp. are preferred but the other genera are also selected. Northern 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. Because of the relatively low snowpacks on most Northern Caribou winter ranges, caribou can forage on terrestrial lichens either in low elevation forested habitats, or on windswept alpine slopes. Similar to Mountain Caribou, the use of forbs and graminoids increases dramatically in the spring season and summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs.

Less is known about Boreal Caribou foraging behaviour in British Columbia; however, Boreal Caribou, like Northern Caribou, also appear to forage primarily on terrestrial lichens and to a lesser extent on arboreal lichens during winter. Winter foraging occurs primarily in very open forests in peatlands and to a lesser extent in nearby lichen-rich pine stands where available. Presumably, summer food also consists of a wide variety vegetation.

Reproduction

The mating system of Woodland Caribou is polygynous, with dominant bulls breeding with a number of cows in late September to mid-October. Rutting group size varies between ecotype with up to a dozen for Mountain Caribou, up to 20 (or more) for Northern Caribou, and generally <5 for Boreal Caribou. Woodland Caribou in British Columbia exhibit a number of anti-predator strategies during calving including calving alone in isolated, often rugged locations (Mountain, Northern), calving on islands in lakes in low elevation forested habitat (Northern, possibly Boreal), calving in large muskegs

where the number of predators and other prey are low (Boreal), and dispersing away from other caribou and prey in low elevation forested areas (Boreal) (Shoesmith and Storey 1977; Bergerud et al. 1984a; Bergerud and Page 1987).

The productivity of caribou is low compared with deer and moose because caribou only have one young per year and calves and most yearlings commonly are not pregnant. The population growth rate (l) rarely exceeds 1.26, or 26% per year. Pregnancy rate of females ranges from 90 to 97% (Seip and Cichowski 1996). Gestation is about 230 days, and calves are born in late May or early June. Calves are notably precocious, moving with their mothers shortly after birth. Calf mortality during the first few months of life is high, often 50% or greater. Causes of calf mortality may include predation, abandonment, accidents, and inclement weather. Calves generally make up 27–30% of the population at birth, but by recruitment age (1 yr old, after which mortality generally stabilizes to adult levels), their proportion is generally <20%.

Site fidelity

Fidelity patterns are complex. Some cows calve in the same location repeatedly, while others shift locations annually. Similarly, rutting sites may be occupied each year or only sporadically. Home ranges rarely remain fixed throughout an animal's life. Individual caribou typically use a predictable series of activity centres over a season or several years, but most eventually make temporary or permanent shifts to new areas. From spring through early winter, individuals may travel with several other caribou temporarily, and then shift to another band. Membership in late-winter aggregations is also inconsistent between years. At the local population level, fidelity to broad landscapes is stronger, but even at this scale there are occasional shifts of individuals and groups to areas that were not used for the past several years. Consistent use of mineral licks has been reported.

Home range

For Mountain Caribou, minimum convex polygon home ranges of 150–600 km^2 are typical, but vary from <100 to >800 km^2. For Northern Caribou, home range sizes are highly variable depending on local population size and the horizontal movement distance between summer and winter ranges. In northern and north-central British Columbia home ranges average 1100–1900 km^2 for some local populations and 150 km^2 for another (Hatler 1986; Terry and Wood 1999; Wood and Terry 1999; Poole et al. 2000). For Boreal Caribou in Alberta, home ranges averaged 710 km^2 (Stuart-Smith et al. 1997).

Movements and dispersal

Mountain Caribou

During late winter (Table 2), Mountain Caribou aggregate in open stands in or near the ESSF parkland, feeding predominantly on *Bryoria*. While there is often abundant arboreal lichen at lower elevations, the tendency to use higher elevations may result from a combination of the increased lift and support provided by a deeper snowpack, the predominance

Table 2. Approximate dates for Mountain Caribou seasons[a]

	Approximate dates	
Season	**Stevenson et al. (2001)**	**Simpson et al. (1997)**
Late winter	mid-January – April	mid-January – mid-April
Spring	mid-April – late May	mid-April – May
Summer	June – late October	June – October
Early winter	late October – mid-January	November – mid January

a Seasonal changes are often marked by distinct elevation shifts, and actual dates vary between local-populations, individuals, and years (see Apps et al. 2001).

of *Bryoria* rather than *Alectoria*, the near absence of wolves and cougars (which typically follow the more abundant ungulates to lower elevations in the winter), and the improved ability to see remaining predators (e.g., wolverines) in the open stands typical of higher elevations. During spring, the snowpack at this elevation loses its ability to support caribou, and individuals or small groups move to either exposed sites in the upper ESSF or AT or snow-free elevations in the ICH or lower ESSF to feed on newly emerged green vegetation. In June, pregnant cows ascend individually to high, exposed locations in the ESSF or AT to calve. Such sites offer safety from most predators and relief from biting insects. During summer, caribou typically occur in small groups within the upper ESSF and AT, although there is periodic summer use of the lower ESSF in many local populations, particularly in late August or early September. From mid-September through October, Mountain Caribou beginning aggregating again for the rut. As snow accumulates in early winter, rut groups break up and most local populations shift down slope into the ICH to mid-ESSF, where snow depths are reduced due to lower elevation and greater canopy closure. Foraging at this time is variable. Arboreal lichen on windthrown trees and branches is heavily used, and caribou also crater for terrestrial lichens and winter-green forbs and shrubs such as falsebox (*Pachistima myrsinites*). As snow depth exceeds 50 cm, cratering becomes less energetically efficient and caribou move into late-winter habitat. Habitat shifts between early winter and late winter may occur as a series of events, with downward movement after major snowfalls followed by upward movement as the snow consolidates, until caribou more permanently settle into late-winter habitat in about January.

Most Mountain Caribou appear to stay within the local population in which they were born. In fact, the 13 recognized local populations may under-represent the true number of areas between which there is no to very limited movement. However, temporary movements are occasionally reported between local populations, from established local populations into unused areas, and even into the range of other ecotypes.

Northern Caribou

Although Northern Caribou are characterized by feeding primarily on terrestrial lichens during winter, local populations in British Columbia exhibit variable seasonal movement and habitat use strategies. Some local populations migrate long distances between summer and winter ranges while others do not. Use of high elevation versus low elevation winter ranges differs between local populations, and within local populations between winters. Variation in seasonal behaviour reflects differences in topography, snow accumulation, and availability of low elevation winter ranges between areas. In general, Northern Caribou habitat use in British Columbia can be described using four seasonal time periods similar to Mountain Caribou. Exact dates vary for each population depending on local conditions.

Snowfall in November triggers caribou movement out of high elevation summer ranges to lower elevation early winter ranges. 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 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 habitats (Wolverine) that are abandoned as snow accumulates during mid- to late-winter.

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. In low elevation forested habitat, caribou prefer forests where terrestrial lichens are abundant; these are often on drier sites or sites with

low productivity and in older forests (80–250 yr). 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. 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, terrestrial lichen feeding.

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 migrate along relatively snow-free low elevation routes to reach summer ranges (Cichowski 1993; Johnson et al. 2002). Caribou that winter at higher elevations 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. Female caribou reach calving areas by late May and calve in early June. Most caribou calve at higher elevations in alpine or subalpine habitat where food availability and quality is relatively poor to reduce predation risk since predators focus on other prey that remain at lower elevations where more nutritious forage is available.

During summer, caribou prefer high elevation habitats but can be found in a variety of habitats at all elevations because 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.

Although studies of radio-collared Northern Caribou populations indicate that range use by adjacent local populations may overlap, especially during winter, all radio-collared caribou return to their summering areas. Northern Caribou may potentially be dispersing between local populations but no studies have yet reported any evidence of dispersal by radio-collared animals.

Boreal Caribou

Boreal Caribou do not appear to live in discrete herds but exist in small, dispersed, relatively sedentary bands throughout the year (Edmonds 1991; Heard and Vagt 1996). Although there is no specific published information on movements and habitat use by Boreal Caribou in British Columbia, studies from Alberta provide some general information that could be extrapolated to British Columbia. Boreal Caribou in northern Alberta make extensive movements or "wander" throughout the year (Hornbeck and Moyles 1995; Stuart-Smith et al. 1997) but most do not appear to make predictable seasonal migrations (Dzus 2001). Therefore, winter and summer ranges typically overlap and habitat use does not differ by season (Dzus 2001).

Habitat

Table 3 summarizes habitat characteristics of Woodland Caribou ranges in British Columbia. All habitat features are required to support Woodland Caribou populations.

Structural stage

For Mountain Caribou, structural stage 7 is consistently preferred throughout most of the year for forage, predator avoidance (typically good lines of sight and only dispersed populations of other ungulates), ease of travel, snow interception in early winter, and possibly heat avoidance in the summer (Apps and Kinley 2000a, 2000b, 2000c; Apps et al. 2001). Structural stage 6 also provides useful habitat, particularly the older and more open end of the stage. Other structural stages are used to varying degrees. Structural stage 1a and 1b are used for calving sites when occurring in rough terrain (June), predator avoidance (good line of site), insect avoidance (spring and summer), and resting areas. Structural stages 2 and 3a provide moderate to high forage value in spring and summer but also provide forage for other ungulates, especially below treeline. The least valuable stands to caribou are those in stages 3b, 4, and 5, where line of site is poor for

Table 3. General habitat requirements for Mountain Caribou, Northern Caribou, and Boreal Caribou in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Winter food supply	Access to an adequate supply of accessible arboreal lichen	Access to an adequate supply of terrestrial and arboreal lichens	Access to an adequate supply of terrestrial and arboreal lichens
Snow conditions	Snow conditions that allow caribou to travel on top of the snowpack in subalpine areas where they can access arboreal lichens and where avalanche danger is low	Snow interception by forest canopy to allow movements within the winter range	Snow conditions and frozen ground conditions to allow movements through peatlands
Winter range	Large tracts of winter range where caribou can exist at low densities as an anti-predator strategy and rotate their winter ranges		
Calving habitat	Relatively undisturbed high elevation calving habitat where caribou can disperse widely and calve in isolation away from predators	Relatively undisturbed high elevation calving habitat or low elevation forested calving habitat on islands where caribou can disperse widely and calve in isolation away from predators	Large tracts of relatively undisturbed peatland complex calving habitat where caribou can disperse widely and calve in isolation away from predators

predator avoidance and forage value is generally low for caribou but can be high for other ungulates, especially moose (3b). In some cases, these stages may form partial barriers to movement and act to isolate adjacent patches of habitat from one another. Structural stage use by Northern Caribou is similar to Mountain Caribou except that Northern Caribou may forage in structural stage 5, where, in some areas and ecosystems, forage (terrestrial lichens) may be abundant. Less is known about Boreal Caribou; however, they appear to prefer structural stages 1a to 3a, 6, and 7 within muskeg complexes and 6 and 7 in adjacent pine–lichen forests throughout the year.

Important habitats and habitat features

Security and foraging

Security and foraging habitat are typically the same thing for Woodland Caribou on the forested portions of their ranges, at least at broader spatial scales. For Mountain and Northern Caribou, both functions are provided by large, contiguous patches of old forest and for Boreal Caribou, both functions are provided by the older forest component of peatland (muskeg) complexes. Specific values of such areas are as follows:

1. There are generally fewer Elk (*Cervus elaphus*), Deer (*Odocoileus* spp.) or Moose (*Alces alces*) within old-growth forests on Mountain and Northern Caribou ranges and within peatland complexes on Boreal Caribou ranges than in or near non-forested areas (avalanche tracks, meadows, shrubby riparian zones, recent clearcuts), as this more abundant suite of other ungulate species tends to concentrate in early-seral sites with abundant shrubs and forbs. Thus, the predators of other species also tend to occur less commonly within old forest than at the edge or outside of old forest or in peatland complexes. For Northern and Mountain Caribou, habitat fragmentation due to the creation of early seral patches within old forest is likely to bring other prey species close to caribou, resulting in a greater incidence of predator encounters (Kinley and Apps 2001). The potential for increased prey populations on some very dry Northern Caribou ranges may be somewhat reduced where shrub

regeneration following disturbance is less pronounced (e.g., Itcha-Ilgachuz caribou winter range). Similarly, in undisturbed areas for Boreal Caribou, habitat fragmentation due to the creation of linear disturbance and the connection of early seral patches by linear disturbances within peatland complexes is likely to provide "predator trails" and bring other prey species closer to caribou, resulting in a greater incidence of predator encounters (Dyer 1999; Kinley and Apps 2001). This pattern is consistent with that found among other caribou ecotypes, in which the major habitat variable that affects numbers is space to avoid predation (Bergerud 1980; Bergerud et al. 1984a; Bergerud 1992).

2. Old forests typically have good visibility relative to younger forests, due to open stand architecture, leading to an improved ability to detect those predators that do occur there. For Boreal Caribou, peatlands also have good visibility.
3. Arboreal hair lichen such as *Bryoria* are usually abundant only in older forests. Terrestrial lichens such as *Cladina*, *Cladonia,* and *Cetraria* are often most abundant in mature and older forests but are also abundant in younger forests on some site types.
4. Old trees with large crowns provide good snow interception, which facilitates cratering and movement during early winter (Mountain Caribou, Northern Caribou, Boreal Caribou) and winter (Northern Caribou, Boreal Caribou).
5. For Mountain and Northern Caribou, the more contiguous that foraging habitat is, the less energy is expended in moving between patches.
6. For Mountain Caribou, sunlight is screened before reaching understorey plants in old forests with heavy canopies, reducing the development of unpalatable or harmful compounds in forage plants (Rominger et al. 2000) and increasing the retention of moisture to maintain plant vigour during summer dry periods.
7. Old forests and peatland complexes provide a cooler microclimate during summer.
8. The suite of forage plants in old forest is different than that available in other habitat types.

Thus, old forests provide far more than simply lichen for late-winter foraging, and old forests are selected across seasons and a range of spatial scales. On Mountain Caribou ranges, old stands of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) are widely used among caribou of all local populations, including both closed-canopy and parkland stands across a range of soil moisture conditions (see "Broad ecosystem units" above). However, tree species composition shows some variability between regions. On Northern Caribou ranges, old stands of lodgepole pine (*Pinus contorta*) or lodgepole pine and white spruce (*Picea glauca*) in low elevation forested habitat are widely used by most local populations. Boreal Caribou commonly use large patches of peatland with disconnected old forest.

Mountain Caribou also use alpine habitat during summer and Northern Caribou use alpine habitat during summer and winter. Boreal Caribou do not have access to alpine habitats and therefore do not use them. Alpine habitats also provide both forage and security features. During summer, emergent vegetation provides nutritious forage and open vistas provide good visibility for detecting predators. For Northern Caribou, during winter windswept alpine slopes also provide access to terrestrial lichens and good visibility for detecting predators.

For Woodland Caribou generally, the risk of predation is further reduced by existing at very low population densities of ~0.03–0.12 caribou/km^2 (Edmonds 1988; Seip 1991; Bergerud 1992; Stuart-Smith et al. 1997). The availability of extensive range space is thought to be an important habitat characteristic that allows Woodland Caribou to avoid predation (Bergerud 1980; Bergerud et al. 1984). All three ecotypes of Woodland Caribou use "space" to avoid predation, especially during calving. Mountain and Northern caribou move into high elevation habitat, forgoing nutritious forage at lower elevations to seek out remote locations for calving, separated from other caribou and prey, and predators.

Breeding

Calving sites and rut locations are also vulnerable habitat elements, but predicting their locations by habitat type is not feasible. Calving sites are dispersed, may vary between years, and appear to be defined primarily on the basis of isolation from

other caribou, other ungulates, and predators. Rutting sites are likely to be more consistent between years, but can be effectively located only with site-specific knowledge gained by monitoring individual caribou local populations.

The most critical aspect of Mountain Caribou and Northern Caribou ranges is access to undisturbed high elevation calving range. In fact, access to undisturbed high elevation calving ranges where caribou can distance themselves from other prey and predators, is the common feature among Mountain Caribou and Northern Caribou local populations that exist today. Historically occurring local populations of Mountain Caribou and Northern Caribou without access to high elevation calving ranges no longer exist in British Columbia.

Mineral licks

Another vulnerable habitat element is mineral licks. Licks are consistently used between years, but can be effectively located only by monitoring individual local populations of caribou.

Conservation and Management

Status

In British Columbia, Mountain Caribou are on the provincial *Red List*, Boreal Caribou are on the provincial *Blue List*, and Northern Caribou in the Southern Mountains National Ecological Area (SMNEA) and in the Northern Mountains National Ecological Area (NMNEA) are on the provincial *Blue List* (Table 4). In Canada, all Woodland Caribou within the entire SMNEA, including all Mountain Caribou and some Northern Caribou local populations in British Columbia, are considered *Threatened* (COSEWIC 2002). Boreal Caribou are also considered Threatened and Northern Caribou in the NMNEA are considered of *Special Concern*.

Trends

Population trends

Mountain caribou

About 99% of the world's 1900 Mountain Caribou live within British Columbia. The B.C. Ministry of Water, Land and Air Protection considers Mountain Caribou to occur as 13 local populations within a metapopulation of 1900 (Hatter et al. 2002). Six of those local populations have 50 or fewer individuals, and 8 are declining; no local populations are increasing (Table 5).

According to local population risk assessment criteria, seven local populations are considered Endangered, one local population is considered Threatened, and five local populations are considered Vulnerable. About 43% of the historic range of Mountain Caribou is no longer occupied, and it is believed that populations have been reduced correspondingly. One estimate of the pre-colonial population of Mountain Caribou (excluding the United States) is 5000–6000 (Demarchi 1999).

Northern caribou

In 2002, there were an estimated 5235 Northern Caribou within the SMNEA and 11 000 Northern Caribou within the NMNEA in British Columbia (Table 6). While numbers may have increased slightly since the late 1970s, it is likely that some of the "apparent" increase is from more intensive survey effort, combined with recent radio-telemetry studies, which has enabled a more reliable status assessment of this ecotype.

Currently, Northern Caribou in the SMNEA are distributed within 13 local populations, which form two metapopulations. The west-central metapopulation includes the Charlotte Alplands, Itcha-Ilgachuz, Rainbows, Tweedsmuir-Entiako, and status of three local populations was unknown. Four local populations have 100 or fewer animals. According to local population risk criteria, two local populations are considered Endangered, six local populations are considered Threatened, four local populations are considered Vulnerable, and one local population is considered Not At Risk. An overall increase in

Table 4. Summary of Woodland Caribou status in British Columbia

	Status			
Ecotype	**Global**	**Provincial**	**COSEWIC (May 2002)**	**BC status**
Dawson Caribou	G5TX	SX	Extinct	Extinct
Mountain Caribou	G5T2Q	S2	Threatened	Red
Northern Caribou (SMNEA)	G5T4	S3S4	Threatened	Blue
Northern Caribou (NMNEA)	G5T4	S3S4	Special Concern	Blue
Boreal Caribou	G5T?	S3	Threatened	Blue

Table 5. Current population estimate (2002), trend, risk status, and density of Mountain Caribou local populations in British Columbia

Local population	Local population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
South Selkirks	35	Declining	EN	A1	1 500	23
South Purcells	20	Declining	EN	A1	2 962	7
Central Selkirks	130	Declining	EN	A3	4 813	27
Monashee	10	Declining	EN	A1	2 082	5
Revelstoke	225	Declining	VU	A1	7 863	29
Central Rockies	20	Declining	EN	A1	7 265	3
Wells Gray North	220	Declining	VU	A1	6 346	35
Wells Gray South	325	Stable	VU	A1	10 381	31
North Cariboo Mountains	350	Stable	VU	A1	5 911	59
Barkerville	50	Stable	EN	A1	2 535	20
George Mountain	5	Declining	EN	A1	441	11
Narrow Lake	65	Stable	TR	A1	431	151
Hart Ranges	450	Stable	VU	A1	10 261	44
TOTAL	1 905				62 791	30

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Table 6. Current population estimate (2002), trend, risk status, and density of Northern Caribou local populations in British Columbia

Local population	Population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km²)	Density (no./1000 km²)
Southern Mountains National Ecological Area						
Charlotte Alplands	50	Declining	EN	A1	2 650	19
Itcha-Ilgachuz	2 500	Increasing	NAR	A1	9 457	264
Rainbows	125	Stable	TR	A2	3 804	33
Tweedsmuir-Entiako	300	Declining	TR	A3, C3	12 811	23
Telkwa	55	Increasing	EN	A1	1 828	30
Quintette	200	Unknown	VU	A1	1 421	141
Kennedy Siding	170	Increasing	VU	A1	1 470	116
Moberly	170	Declining	TR	A2	5 115	33
Wolverine	590	Increasing	VU	A1	8 315	71
Takla	100	Unknown	TR	A1	1 850	54
Chase	575	Stable	VU	A1, A2	11 390	50
Graham	300	Declining	TR	A3	4 734	63
Belcourt	100	Unknown	TR	A1	2 045	49
TOTAL	5 235				66 890	78
Northern Mountains National Ecological Area						
Pink Mountain	850	Declining	VU	A1	11 602	73
Finlay	200	Unknown	VU	A1	3 084	65
Spatsizi	2 200	Stable	NAR	A1	16 929	130
Mount Edziza	100	Unknown	TR	A1	1 281	78
Level-Kawdy	1650	Stable	NAR	A1	12 568	131
Tsenaglode	200	Unknown	VU	A1	3 015	66
Frog	150	Unknown	VU	A1	2 421	62
Gataga	250	Unknown	VU	A1	4 437	56
Muskwa	1 250	Unknown	NAR	A1	16 786	74
Rabbit	800	Unknown	VU	A1	5 936	135
Liard Plateau	150	Stable	VU	A1	5 069	30
Horse Ranch/Cry Lake	850	Stable	VU	A1	9 499	89
Little Rancheria	1 000	Stable	NAR	A1	7 431	135
Jennings	200	Unknown	VU	A1	4 080	49
Atlin East	800	Stable	VU	A1	7 053	113
Atlin West	350	Stable	VU	A1	4 398	80
TOTAL	11 000				115 590	95

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Northern Caribou numbers in the SMNEA has been strongly influenced by the increase of the Itcha-Ilgachuz caribou population over the last 8 years (from 1400 to 2500; $\lambda = 1.075$), which is the largest local population in the SMNEA.

Telkwa local populations. The north-central metapopulation includes the other eight local populations in the SMNEA. In 2002, four local populations were declining, two were stable, four were increasing, and the Currently, Northern Caribou in the NMNEA are distributed within 16 local populations. Metapopulation structure has not yet been assessed for these local populations. In 2002, one local population was declining, seven were stable and the status of eight local populations was unknown. Six local populations have 200 or fewer animals. According to local population risk criteria, 12 local populations are considered Vulnerable and 5 local populations are considered Not At Risk. Little population information is available for many of the Northern Caribou local populations in the NMNEA.

Boreal caribou

The only estimate of Boreal Caribou numbers in British Columbia is 725 (Heard and Vagt 1996). The current estimate is based on that number (Table 7); however, the reliability of this estimate is unknown. Currently, there is no information on metapopulation structure or on population trend. According to COSEWIC criteria, Boreal Caribou in northeastern British Columbia are considered Vulnerable.

Habitat trends

There is little quantitative information on Woodland Caribou habitat trends in British Columbia; however, Woodland Caribou rely on large tracts of older forests where terrestrial and/or arboreal lichens are abundant and where they can use "space" to avoid predators. Industrial activities such as forest harvesting and oil and gas development affect Woodland Caribou habitat through fragmentation and conversion of older forests to early seral stands. The current rate of loss and fragmentation of caribou habitat through forest harvesting, oil and gas development, and natural disturbances (fire and forest insects) appears to be greater than the rate of habitat recruitment.

Threats

Population threats

Threats to Woodland Caribou populations may affect caribou numbers directly through mortality or indirectly through disturbance or displacement resulting in increased energetic costs or mortality risks. Direct threats include predation, hunting, poaching, vehicle collisions, and diseases and parasites. Indirect threats include road development and associated traffic, persistent recreational activities on caribou ranges, and habitat alteration that results in increased mortality risks.

Table 7. Current population estimate (2002), trend, risk status, and density of Boreal Caribou in British Columbia

Local population	Population estimate	Recent trend[a]	Population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
Boreal Caribou	725	Unknown	VU	A1	51 541	14

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Predation

Woodland Caribou populations in British Columbia exist within dynamic and complex predator–prey systems. Wolves appear to be the most significant predator, but bear predation during early summer contributes significant mortality in some areas. Recent studies (see Seip and Cichowski 1996) have found that predation during the summer can be a major cause of caribou mortality. The increase in moose populations in central British Columbia during the 1900s has been associated with long-term declines in the number of some caribou populations and extirpation of caribou from previously occupied areas (Seip and Cichowski 1996). Increased moose populations may have led to caribou declines because moose can sustain wolf numbers even when caribou number decline. In contrast, in a caribou/wolf system, wolf numbers would decline along with any decline in caribou numbers and allow for a subsequent recovery in caribou numbers (Seip 1992a). The susceptibility of caribou to predation may also be influenced by habitat change as favourable moose browsing conditions in cutblocks result in widespread distribution of moose and wolves. Disturbance to the forest (forest harvesting, fire, etc.), whether human-caused or natural, alters the distribution of early seral habitats. Such disturbance could be detrimental to caribou if it increases their contact with predators associated with other ungulates that use early seral stands, such as deer, elk, and moose. Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species because there is no negative feedback on the number of wolves as caribou numbers decline. If true, this would mean that wolves could persist on moose as they extirpate local caribou populations.

Within a multiple predator–prey system, it is possible for predator numbers to remain relatively high even if predation (or human harvest) has drastically reduced one of the prey species. Caribou are extremely vulnerable to wolf predation compared with most other ungulates (Seip 1991). Caribou usually occur at much lower densities, have larger home ranges, and do not normally use habitats frequented by moose or deer. They also do not use escape terrain as efficiently as mountain sheep or mountain goats, and they have a low reproductive rate relative to moose or mule deer. Therefore, caribou are usually the most vulnerable species in a multiple predator–prey system, the first to decline and the last to recover (Seip 1991). Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species, because there is no negative feedback on the number of wolves as caribou decline in numbers. Thus, wolves could persist on moose or deer as they extirpate local caribou populations.

Human-caused mortalities

Aboriginal people who are hunting within their traditional territories may legally hunt caribou. There are no legal hunting seasons on Mountain Caribou or Boreal Caribou in British Columbia for resident or non-resident hunters, but poaching and "mistaken identity" shootings probably remove some animals, as do motor vehicle collisions. The extent of this mortality is unknown, although Johnson (1985) found human-caused deaths in the South Selkirks Mountain Caribou local population to equal recruitment in some years. Legal hunting seasons for resident and non-resident hunters exist for most Northern Caribou local populations in the NMNEA. Hunting regulations are generally conservative with either a five-point bull, Limited Entry Hunt regulation, or a combination of both. Hunting mortality is low for most Northern Caribou local populations in the SMNEA with most of the hunter harvest concentrated in the Itcha-Ilgachuz and Chase local populations. There are no legal hunting seasons for seven of the 13 local populations in the SMNEA (Charlotte Alplands, Rainbows, Telkwa, Takla, Kennedy-Siding, Wolverine, Belcourt) and for one of the 16 local populations in the NMNEA (Mount Edziza). Parts of three Northern Caribou ranges fall within No Hunting areas or Caribou Closed areas (Atlin West, Spatsizi, Tweedsmuir-Entiako).

Diseases and parasites

There do not appear to be any diseases or parasites occurring with enough frequency among Mountain Caribou to pose a significant population-level health risk. Parasites reported by McTaggart-Cowan (1951) from caribou elsewhere in British Columbia or adjacent areas of Alberta include caribou nostril-fly or caribou bot fly (*Cephenemyia trompe* = *C. nasalis* = *Oestrus trompe*), caribou warble (*Hypoderma tarandi* = *Oestrus tarandi* = *Hypoderma tarandi*), thin-necked bladderworm (*Cysticercus tenuicollis*), the tapeworm *Cysticercus krabbei*, and pinworm (*Skrjabinema oreamni*). Other caribou parasites in British Columbia include hydatid cysts (*Echinococcus granulosus*) and the nematode *Parelaphostrongylus odocoilei* (H. Schwantje, pers. comm.). Winter ticks (*Demacentor albipictus*) have been recorded on caribou in Alberta (Samuel 1993) so likely also occur on B.C. caribou. Besnoitia (*Besnoitia tarandi*) is a protozoan that forms cysts in the connective tissue of caribou and other intermediate hosts. It can be fatal (Glover et al. 1990) but rarely is, generally resulting only in dermal damage (H. Schwantje, pers. comm.). This parasite was found in 23% of 320 caribou leg pairs examined from British Columbia, but most of the infections were from the far northern part of the province and few had skin lesions (R. Lewis, pers. comm.). Liver flukes (*Fascioloides magna*) have not been recorded from caribou in British Columbia, but occur in caribou of northern Quebec and other ungulates in British Columbia. The risk of liver flukes occurring in caribou is greater when there is overlap with elk or white-tailed deer (F. Leighton, pers. comm.), so their eventual occurrence in Mountain Caribou can be expected due to increasing range overlap with other ungulates. One of the greatest potential risks to Woodland Caribou from parasites may be the meningeal worm (*Parelaphostrongylus tenuis*) in areas where it occurs. It is a parasite of white-tailed deer throughout eastern North America. The adult worms live in the spaces around the brain in white-tailed deer and rarely cause disease. However, when other cervids, such as caribou, are infected the worms migrate to the central nervous system causing severe, usually fatal, neurological disease. Fortunately the parasite has not been found to date west of the Manitoba-Saskatchewan border.

Population size

Within the 12 smallest local populations (local populations ≤100 caribou: seven Mountain Caribou local populations, five Northern Caribou local populations), the most immediate threat is simply low population size. Low numbers increase the probability that a random event (i.e., one predator, one emigration movement, one avalanche, one extreme weather event, a few key animals poached) will remove a large proportion of the breeding population and also increase the chance of creating an unfavourable sex composition. There are no reliable estimates of the minimum viable population size for Woodland Caribou.

Access/Disturbance

One of the major indirect threats to Woodland Caribou populations is increasing road development and access into their habitat (Bergerud 1978; Johnson 1985; Seip 1991). The resulting threat may take several forms. 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. Historically, overhunting was primarily a result of road access associated with human industrial and recreational development (Bergerud 1978; Stevenson and Hatler 1985). While the more accessible Woodland Caribou populations are currently not hunted, poaching losses, which are most common along roads during hunting season for other game species, remain a concern. Road kills can also be a concern, such as those that have occurred with the opening of Highway 3 across the range of the South Selkirk Mountain Caribou local population (Johnson 1976; Simpson et al. 1994).

The effects of disturbance of human activities on caribou are more difficult to document and remain controversial. Hauling by logging trucks in Ontario apparently caused Woodland Caribou to move out of the haul road areas that were preferentially used by caribou in the years before and after hauling

(Cumming and Hyer 1998). In Alberta, simulated petroleum exploration noise was also found to increase energy expenditure by Woodland Caribou (Bradshaw et al. 1997). Physical disturbance from such exploration, such as roads, drilling sites, and seismic lines resulted in avoidance of habitats well beyond actual development "footprints" (Dyer et al. 2001).

After noting the absence of studies showing that disturbance limits caribou populations, Bergerud et al. (1984b) concluded that disturbance should not pose a major threat provided sufficient space is available for caribou to escape unwelcome stimuli. They qualified this conclusion by adding that there is likely an upper limit to the tenacity of caribou to withstand disturbance. Eight years later, Harrington and Veitch (1992) demonstrated this upper limit for Woodland Caribou in Labrador where calf survival during both calving and post-calving periods was negatively correlated to the exposure of females to low-altitude jet flyovers. This led the authors to suggest that the greatest effects of disturbance on calf survival occur during critical periods when other stressors are also acting. Research on stress effects of recreation specific to caribou requires further development; however, a recent study in Yellowstone National Park (Creel et al. 2002) documented a significant increase in stress-related hormone levels in elk and wolves during the snowmobile season. For elk, these levels increased in concert with the daily number of snowmobiles. The authors also noted that despite these stress responses, there was no evidence that current levels of snowmobile activity were affecting the population dynamics of either species.

Recreation

Studies such as Harrington and Veitch (1992) add support to a growing concern that excessive levels of recreational activity within caribou winter range may place animals under stress and displace caribou from suitable winter habitats (Stuart-Smith et al. 1996). Mountain Caribou local populations and some or portions of Northern Caribou local populations use subalpine or alpine terrain during winter. In some areas, Mountain Caribou habitat overlap snowmobile use areas; areas of heavy use by snowmobiles may displace caribou into less desirable foraging habitat and where mortality risks (i.e., predation, avalanches) are higher. The creation of trails in an area may also render caribou vulnerable to predators (James and Stuart-Smith 2000). Compacted trails such as those created by snowmobiling and snowshoeing may provide easier travel corridors for wolves into late winter caribou habitats (Bergerud 1996). Dumont (1993) found that hikers in the Gaspésie disrupted normal caribou behaviours, and shifted caribou from preferred areas on the summit to wooded areas with higher predation risk.

The increasing interest in recreational snowmobiling, combined with better access from roads to high-elevation cutblocks and more powerful machines that are able to access Woodland Caribou ranges, is believed to represent a significant threat to many Mountain Caribou local populations and some Northern Caribou local populations currently, and a significant threat to other populations in the future as access increases into their ranges. A recent review of the potential impacts of four winter backcountry recreation activities on Mountain Caribou, including snowmobiling, heli-skiing, snowcat skiing, and backcountry skiing, indicated that snowmobiling has the greatest perceived threat to Mountain Caribou (Simpson and Terry 2000). Although there is no documentation in British Columbia that snowmobiling has permanently displaced caribou off winter ranges, a single occurrence of snowmobile use in alpine habitat in the Tweedsmuir-Entiako caribou winter range displaced radio-collared caribou from that area for the duration of the winter (D. Cichowski, pers. obs.).

Industrial activities

Industrial activities may alter predator–prey relationships and potentially could increase the total predation rate of caribou by:

- producing early seral stages with enhanced understorey shrub and forb production which may increase the abundance of other ungulates

or change ungulate distribution within Woodland Caribou habitat; specifically:

- increased shrub production at low elevations may increase ungulate populations (e.g., elk, deer, and moose) which in turn may increase predator populations, leading to more predator–prey encounters with caribou during winter;
- increased forb production at higher elevations may attract elk, moose, and deer into caribou habitat during summer; predators following their prey into these higher elevation areas may come into contact with caribou more frequently, leading to increased predation rates on caribou during summer;
- restricting caribou into mature forest habitat patches which may increase the search efficiency of predators; and/or
- providing easier access, through construction of roads, for predators to travel into caribou habitats and prey on caribou (James and Stuart-Smith 2000).

In addition, all threats identified below under "Habitat threats" are threats to population size and viability. There is little or no evidence that Woodland Caribou can be maintained over the long term in areas having relatively high levels of forestry, predation, and recreation activity.

Habitat threats

One of the main long-term threats to Woodland Caribou habitat is the reduction and fragmentation of contiguous old-growth forest, mainly due to industrial activities such as forest harvesting. Fragmentation of old forest and peatland complexes in Boreal Caribou habitat in northeastern British Columbia by oil and gas development is also a concern. Past fires have also contributed to the loss of habitat over large areas, and there are risks of future large fires. Forest insects are also currently playing a larger role in forest renewal on some Northern Caribou ranges. Habitat loss has several effects:

- It reduces the amount of space available for caribou, thereby limiting ecological carrying capacity.
- Terrestrial and arboreal lichen supply (although currently not limiting) may be reduced. Because lichen regeneration is often slow, impacts on lichen supply are often long term.
- It may impact caribou movement patterns.
- By fragmenting habitat, it may decrease the chance of caribou using some portions of the remaining habitat, because parcels tend to be smaller and discontinuous. Alternatively, if the remaining parcels are used, caribou may expend more energy travelling between patches.
- Caribou can become more susceptible to predation as available habitat is compressed and fragmented (see "Population threats").

Forest harvesting

Forest harvesting has been recognized as the greatest concern to Mountain Caribou habitat management over the past 20 years. Early winter habitat in the ICH has always been attractive for forest harvesting due to good forest productivity on those sites. Late winter ESSF habitat has only recently (last 10 yr) become attractive for forest harvesting. Prior to the 1970s there was little industrial activity on low productivity Northern Caribou low elevation winter ranges in British Columbia. Relatively low-value pine forests and the remote location of most of those winter ranges made them 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 caribou winter ranges for forest harvesting.

Forest harvesting affects Woodland Caribou winter habitat at both the stand and landscape levels. At the stand level, some harvesting and silvicultural techniques disturb lichens. Because lichen regeneration is slow, forest harvesting has long-term implications for caribou winter habitat. Harvesting techniques that minimize disturbance to lichens may help reduce stand level impacts. Although food supply (lichens) is currently not a limiting factor, cumulative impacts of forest harvesting over time could potentially have long-term impacts on food

supply. Caribou require an adequate supply of lichens over the landscape to allow for rotation of winter ranges. Forest fragmentation could potentially result in caribou concentrating on portions of their range, thereby depleting lichen reserves over time.

At the landscape level, forest harvesting results in a patchwork of different forest age classes, which leads to avoidance and possibly abandonment of that portion of the winter range (Smith et al. 2000). Caribou populations persist at low densities due to a number of interacting factors, including predation (Bergerud et al. 1984b; Bergerud and Page 1987). Abandoning a portion of a winter range forces caribou to concentrate in a smaller area, which may lead to increased predator efficiency by making them easier for predators to locate (Seip 1991). A patchwork of early seral and mature forests may also enhance habitat for other prey species such as moose that prefer early seral forests, which could lead to increased predator numbers and increased predation on caribou (Seip 1992a). Potential indirect effects of forest harvesting and habitat fragmentation on caribou populations through increased energetic costs and predation risk are discussed in the "Population threats" section.

Although caribou winter habitat must provide adequate amounts of terrestrial lichen, it is now recognized that food is not the primary limiting factor, and that the distribution of both the summer and winter habitats on the landscape, and the ability of caribou to become spatially separated from predators, particularly during the summer months, are the most important factors to the long-term persistence of Northern Caribou (Seip and Cichowski 1996). Forest harvesting practices that produce a patchwork of different forest age classes linked with a network of roads may contain enough lichens to support a caribou population, but probably will not provide an environment where caribou can effectively avoid predators and poachers. The threat from increasing predation may also be exerted at broader scales, independent of issues of fine-scale habitat changes. Predation risk has probably increased over roughly the past century due both to larger numbers of predators at the regional level and less spatial separation due to habitat fragmentation at the stand or landscape level. Ongoing forest harvesting by conventional means may make this situation more severe.

The ability of caribou to move through fragmented habitats or barriers is not well known. However, Smith et al. (2000) documented that Northern Caribou avoid portions of their winter range that have been fragmented by logging. Large human-caused fire-created openings 10–15 km wide have isolated the Narrow Lake and George Mountain local populations of Mountain Caribou (Simpson et al. 1997; Heard and Vagt 1998). Highways and roads may also limit caribou movements, particularly to female and young caribou moving between seasonal ranges (Simpson et al. 1994). Caribou north of Revelstoke appear unwilling to venture south of the Canadian Pacific Railway tracks and the Trans-Canada Highway, possibly due to the rail and highway corridors or to the dense, second-growth stands (Simpson et al. 1997). However, caribou appear to regularly cross Highway 16, east of Prince George, between the North Cariboo Mountains and the Hart Ranges (D. Heard, pers. comm.), and caribou elsewhere in the world make regular migrations through greatly varied habitat conditions. Even if caribou do cross fragmented habitats, there may be costs associated with increased energy expenditure required to locate isolated foraging patches, as well as increased exposure to human-caused harassment and mortality.

Although little information is available on Boreal Caribou in British Columbia, resource extraction in the form of forestry, petroleum and natural gas exploration and production, mining (coal, peat, and potentially diamonds), and agricultural expansion are all recognized as potentially having negative impacts on Boreal Caribou in Alberta (Dzus 2001).

Natural disturbances

Fire and forest insects are important disturbance factors on many Northern Caribou ranges. Fire suppression has resulted in reduced fire impacts on most woodland caribou ranges in central

British Columbia over the last 40 years, although fire disturbance has likely had greater impacts on caribou ranges in the northern part of the province. Recently, mountain pine beetles have affected a significant portion of the Tweedsmuir-Entiako Northern Caribou range. Although the effects of mountain pine beetles on caribou habitat and winter range use are not known, mountain pine beetles could potentially result in increased or decreased lichen productivity depending on site conditions. A reduction in the forest canopy and consequently snow interception could have implications to caribou movement and foraging during winter. Eventual blowdown of beetle-killed trees could also have implications for caribou movement. Larger mountain pine beetle outbreaks are often managed through increased forest harvesting efforts; extensive salvage logging also occurs soon after beetle attack. Winter ranges not located in protected areas will likely be subjected to increased forest harvesting and salvage if mountain pine beetle outbreaks occur, leading to concerns over the additive effects of mountain pine beetles, forest harvesting for mountain pine beetle management, and salvage logging of mountain pine beetle killed forests on caribou winter ranges.

Climate change

Climage change has the potential to affect Caribou habitat through changes to natural disturbance regimes and vegetation structure which may ultimately lead to changes in lichen abundance.

Legal Protection and Habitat Conservation

All Woodland Caribou in British Columbia are protected from willful killing, wounding, and taking, and legal harvesting is regulated under the provincial *Wildlife Act*. Hunting of Mountain Caribou and Boreal Caribou is prohibited while hunting for 22 of the 29 Northern Caribou local populations is currently permitted.

Protected areas, both provincial and federal, provide habitat protection from industrial activities and unroaded wilderness. Some of the larger protected areas occurring in Woodland Caribou ranges are Wells Gray Provincial Park, Glacier National Park, Tweedsmuir Provincial Park, Itcha-Ilgachuz Provincial Park, Entiako Provincial Park and Protected Area, Spatsizi Plateau Wilderness Provincial Park, Stikine River Provincial Park, and Mount Edziza Provincial Park.

Under the results based code, specific regulations address winter range and mineral licks.

Land use plans (LUP) or land and resource management plans (LRMP) have been developed for all areas where Mountain Caribou and Boreal Caribou regularly occur and for most areas where Northern Caribou occur (see Cichowski 2003). Resource management zone (RMZ) objectives from these have been or are being considered for designation as higher level plans or establishment of legal objectives under the *Land Act*.

Mountain caribou

For Mountain Caribou, each LUP or LRMP requires or allows for:

- zones where there will be no or very limited timber harvest;
- zones where modified timber harvest to maintain habitat values will occur; and
- areas with no special provisions for caribou.

However, guidelines have not been developed according to provincial standards, and the level of habitat protection varies regionally (Table 8). The great majority of recently occupied Mountain Caribou range within the Cariboo-Chilcotin Land Use Plan area is now within (in descending order) provincial parks, no-harvest zones, or modified-harvest zones and the Mountain Caribou Strategy provides specific and detailed guidance on silvicultural systems (Youds et al. 2000). The Prince George and Robson Valley LRMPs have included most of the caribou habitat within interim deferral areas and to a lesser degree, in parks. The Kamloops LRMP area is immediately adjacent to Wells Gray Provincial Park so caribou there have habitat security within Wells Gray and a few new parks, and 20–33% of the caribou zone outside of parks is to be maintained

Table 8. Current approaches to Mountain Caribou habitat management within LRMPs and LUPs

LRMP/LUP	Approach
Cariboo-Chilcotin	No-harvest and modified-harvest zones, each of which is mapped.
Kootenay-Boundary	No-harvest and modified-harvest zones conceptual only. Overall management areas are mapped, but precise locations of zones are not (in progress).
Prince George	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Robson Valley	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Kamloops	Similar to Kootenay/Boundary but based on the retention of old-growth attributes, not old-growth forests per se, and partial cutting is preferred but not required in non-reserve areas.
Okanagan-Shuswap	Identifies OGMAs to be maintained as reserves and also identifies research areas, which may later become reserves, conventional harvest areas, or modified-harvest areas, pending research results.

with old-growth attributes. The Okanagan-Shuswap LRMP allots approximately 20% of the caribou resource management zone to Old-Growth Management Areas (OGMAs) and about 3% to new or existing parks, with a further 20% deferred as research areas. The Kootenay-Boundary Land Use Plan allocates 40–50% of the operable portion of caribou management areas for reserves or modified harvest, and perhaps 10% of the total occupied caribou range is in new or existing provincial and federal parks.

Mountain Caribou have been a major consideration in the designation of OGMAs, but these often overlap with lands that were already, or would otherwise have been, reserved for caribou, so generally do not add additional protection. In the Okanagan-Shuswap LRMP, all permanent caribou reserves are OGMAs. Areas that are currently considered inoperable provide additional habitat for each local population of caribou, but the extent of these is likely to be reduced as technological or economic conditions change.

Access management approaches and (for most plans) guidelines for alternative silvicultural systems are less specific than habitat protection guidelines and are typically not included in higher level plans. Local decisions on alternative silviculture will presumably be guided mainly by the recommendations for managers guidebook (Stevenson et al. 2001). Interim guidelines for access and disturbance management relative to new commercial recreation tenures have been developed (MELP 2000).

A recovery strategy for the entire Mountain Caribou metapopulation has recently been completed (Hatter et al. 2002) and a recovery action plan specific to the South Purcell local population is currently being developed (Kinley 2000). Plans for other local populations may be developed in the future as determined by Regional Action Groups (Hatter et al. 2002). The recovery strategy and proposed recovery action plan for the South Purcell local population do not create any additional legal obligations. However, they do indicate an intent to maintain Mountain Caribou, consistent with the federal-provincial National Accord for the Protection of Species at Risk, and will provide a benchmark from which to measure regional and sub-regional management plans. Several factors influencing caribou population viability that do not fall within the results based code or do so only partially are addressed in recovery plans, including population goals for predators and alternate prey species, and motorized recreation management.

Northern caribou

Current strategies to protect local populations of Northern Caribou and habitat have been mostly developed independently for each population and are reflected in regional land and resource management plans (Chicowski 2003). Although there is no province-wide strategy that guides management direction for all local populations of Northern Caribou, planning efforts have often been co-ordinated between land use planning processes that share a common caribou winter range. However, core caribou ranges for some local populations, and corridor/linkage areas between local populations still must be mapped and considered in various plans.

Some form of caribou habitat management guideline(s) or planning/operational direction is in place in most MWLAP regions that support Northern Caribou. Currently, an LRMP process is underway for the Morice Forest District which includes portions of three Northern Caribou local populations in the SMNEA (Tweedsmuir-Entiako, Telkwa, Takla) and a Strategic Resource Management Plan is being developed for the Dease/Liard portion of the Bulkley-Cassiar Forest District. Only two areas remain without regional level management plans: the Nass portion of the Kalum Forest District, which includes a small portion of the Spatsizi caribou local population's range; and the Atlin-Taku region of the Bulkley-Cassiar Forest District, which includes four local populations (Atlin West, Atlin East, Jennings, Level-Kawdy).

Prescriptions vary by planning area and local populations of caribou although communication between planning processes has resulted in mostly consistent prescriptions for local populations of caribou whose ranges straddle planning areas. Most plans consist of a combination of protected area or no-harvest zone in portions of each caribou range, with varying degrees of industrial activity within the rest of the range. Although unprotected portions of most caribou ranges have some special management status, large portions of some ranges are located in general resource management zones or even enhanced resource management zones.

In most of the land use plans, caribou and caribou habitat management are a high priority. District-wide Caribou Management Strategies were developed in the Mackenzie, Cassiar-Iskut-Stikine, and Fort St. James LRMPs. In the Lakes, Vanderhoof, and Bulkley LRMPs, caribou management strategies are concentrated within resource management zones that encompass most of the caribou range found in those districts. The Cariboo-Chilcotin Land Use Plan also defines a regional level Northern Caribou Strategy, that provides specific direction on all aspects of caribou management including mountain pine beetle infestations (Youds et al. 2002). The Dawson Creek, Fort St. John, Fort Nelson, and Prince George LRMPs do not contain specific district wide strategies for managing caribou and caribou habitat; instead, caribou management guidelines have been developed for individual resource management zones. However, portions of the Fort St. John, Fort Nelson, and Mackenzie LRMP areas are included within the Muskwa-Kechika Management Area, which includes special provisions for access management and resource extraction. Many of the protected areas established under the *Environmental Land Use Act* within the Muskwa-Kechika Management Area contain provisions for road corridors and most of the area outside of protected areas is under special management.

Although large-scale mountain pine beetle outbreaks have occurred or may potentially occur in most caribou winter ranges in the central part of the province, most of the land use plans provide little guidance for mountain pine beetle management on caribou winter ranges. Potential additive effects of mountain pine beetles, mountain pine beetle management, and salvage logging are of concern.

In general, most Northern Caribou management prescriptions in these plans focus on:

- avoiding critical habitats through no harvesting or special management;
- providing large contiguous areas of mature and old forest;
- conducting harvesting strategies that emulate natural disturbances;

- maintaining forest structure and age classes close to natural disturbance patterns;
- creating large forest harvesting openings and concentrating them in time and space to minimize industrial activity on caribou ranges;
- using forest harvesting and silvicultural systems that enhance retention and recovery of terrestrial lichens; and,
- developing recreation and access management strategies that limit or prohibit recreational activities and access in specific areas during critical seasons.

Boreal caribou

Boreal Caribou range in British Columbia falls within two forest districts with completed LRMPs: the Fort Nelson LRMP and the Fort St. John LRMP. There are no district-wide caribou management strategies and strategies for Boreal Caribou are primarily contained in individual resource management zones. In the Fort Nelson LRMP, most of the Boreal Caribou range is in enhanced resource development zones with the southwestern portion in general resource development zones; provisions for caribou are included under general provisions for wildlife. In the Fort St. John LRMP, most of the Boreal Caribou range is in general management zones with a small portion in enhanced resource development, and the southern portion in the agriculture/settlement zone. Provisions for caribou vary between resource management zones with some zones with caribou-specific provisions and others with general wildlife provisions. Lack of management strategies specifically for Boreal Caribou is likely partially due to the lack of knowledge about this ecotype in British Columbia.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

A conservation assessment should be conducted for Woodland Caribou metapopulations to determine the relative risk to long-term persistence of each metapopulation and ecotype based on current management guidelines, and also on a range of potentially more or less stringent guidelines.

LRMPs and LUPs provide a suitable scale of management for Woodland Caribou because individual caribou are wide-ranging and use a variety of sites within and between years, yet each local population occurs within a reasonably well-defined geographic and habitat range. Furthermore, regional differences in Woodland Caribou ecology and in forest harvesting history indicate that detailed management direction is best provided through a series of regional plans than through a single provincial plan. However, broad approaches are best standardized at a provincial scale to ensure better understanding of the purpose of areas given special designation for caribou, and to ensure that all regional plans meet the basic requirements of Woodland Caribou. The following recommendations should be considered when existing higher level plans are periodically reviewed and revised.

- ❖ Conduct local conservation assessments (including risk assessments) for the local population or area under consideration. The assessment should consider risks to the individual local population and the metapopulation based on current guidelines, and therefore determine the relative need for no-harvest relative to modified-harvest and conventional-harvest zones, and effects of resource exploration activities.
- ❖ Identify areas that should be designated as no-harvest zones, where there will be no or very limited harvest, and/or modified-harvest zones, where partial cutting that maintains habitat values may occur. Within the no-harvest zones, include inoperable areas that are suitable for caribou, in addition to appropriate operable areas.
- ❖ Map the final boundaries of no-harvest zones or modified-harvest zones at 1:20 000.
- ❖ For Mountain Caribou, where plans currently advocate or permit the use of extended-rotation clearcuts (typically 240 yr), either via conventional blocks or strip harvesting, consider a shift to a mix of permanent no-harvest zones and conventional harvest (no caribou constraint) zones, and formalize this as an option in the

plans. The percentage of the plan area potentially shifted from long-rotation to no-harvest should be calculated on the basis of modelling long-term timber production reductions that would otherwise result from the extended rotation. The advantages of smaller permanent no-harvest zones versus larger areas on extended rotations would be:

- no new economic impact relative to existing extended rotation assumptions, yet retention of a large portion of the planning area as caribou habitat;
- a greater assurance that designated habitat would in fact provide suitable habitat because it would be of natural origin and older age, rather than originating as a plantation with a maximum age of 160–240 years;
- fewer roads and off-road access points;
- long-term spatial certainty regarding the areas that would provide caribou habitat, which would simplify planning and allow caribou to develop traditions of use; and
- overlapping of benefits to other obligates of very old forests.

The disadvantage is that less gross area would be managed for caribou. This option should also be considered in cases where long-rotation group- or single-tree selection is currently planned, although there are likely to be fewer benefits in changing to the mixed no-harvest/conventional harvest scenario in such instances. For plans that currently recommend the use of clearcut harvesting with moderate block sizes (~1–40 ha), consider a shift to guidelines requiring partial cutting through single-tree selection or group selection or, as a secondary option, a mix of very large cutblocks and very large reserves as outlined in Stevenson et al. (2001). This will reduce the degree of landscape fragmentation relative to an equivalent area of moderate-sized clearcut blocks, and should therefore reduce the enhancement of habitat for other ungulates and allow caribou to separate themselves from predators.

❖ For plans in which habitat-influenced predation risk is not explicitly identified as an issue relative to forest harvesting, it should be added to revised versions of the plans.

❖ Revise existing guidelines for movement routes based on new research. Add guidelines to plans currently lacking them. As research indicates differences in habitat requirements for providing long-term genetic connectivity between local populations versus regular local intra- or interseasonal movement, modify plans to ensure that the terminology and guidelines are appropriate for the type of movement intended to be facilitated.

❖ Revise access management guidelines based on new research. Add access guidelines to plans currently lacking them. Do not create new roads or upgrade existing roads in areas where forests have been reserved as caribou habitat. To the extent possible, deactivate or close existing roads in areas reserved or managed for caribou when the roads are no longer required for industrial activities. Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000).

❖ Ensure a mechanism is included to allow the boundaries or locations of no-harvest and modified-harvest zones to be modified as additional information becomes available about caribou distribution, habitat use, risks associated with various management options, and requirements for long-term viability. This mechanism should also allow boundary changes necessary for the recovery of currently depressed local populations, including augmentation with additional animals or the establishment of new bands of caribou.

Wildlife habitat area

Goal

To temporarily secure critical Woodland Caribou habitat features that have not been yet been addressed through strategic or landscape level planning. As existing plans are amended or developed, WHAs established for Woodland Caribou should be considered for inclusion within legal objectives of the revised plans or new plans.

Feature

Establish WHAs at mineral licks, rutting or calving sites (if used repeatedly), and small areas of "matrix" habitat necessary for connectivity between winter foraging areas (if used repeatedly). Preferably, WHAs

should be established in areas of suitable caribou habitat where:

- no-harvest zones and modified-harvest zones are not sufficiently large to maintain or restore viable caribou local populations as indicated by a conservation assessment; or
- there is a high level of uncertainty that this is the case; or
- critical habitat features not addressed within an existing regional or sub-regional plans are determined to be of high value or high use.

WHAs designated under the provincial timber supply impact limit (1% by district) for the Identified Wildlife Management Strategy will only be established within threatened or endangered local populations, except for sites where there is no timber supply impact or the site is considered provincially significant and approved by the Director of the Biodiversity Branch, B.C. Ministry of Water, Land and Air Protection. Normally, WHAs will only be established to protect critical habitat features deemed important to the long-term persistence of the local population.

For matrix habitat connectivity, WHAs should be located immediately adjacent to protected areas or areas designated under strategic land use plans for caribou management.

Size

Larger WHAs will almost always be of greater benefit to caribou than smaller WHAs, primarily because increased size improves the ability of caribou to avoid predation. When WHAs are established in matrix habitat for connectivity, they should be roughly 100–1000 ha. In most cases, calving sites, rutting areas, and mineral licks may be adequately managed in areas of 50–300 ha. For calving sites on islands, the entire island should be considered for inclusion within a WHA. The appropriate size for a WHA will be determined in part by whether it is possible to link to existing habitat and the degree of disturbance that is expected adjacent to the WHA.

Design

Design WHA to minimize the amount of edge, and consider habitat use and the needs of the local population. The size of the area included within the WHA to reduce disturbance will depend on topographic barriers and vegetative cover.

General wildlife measures

Goals

1. Minimize predation risk.
2. Maintain critical habitat features (e.g., mineral lick, undisturbed travel corridor or calving or rutting areas).
3. Minimize disturbance.

Measures

Access

- Do not construct roads or trails.

Harvesting and silviculture

- Do not harvest WHAs established for mineral licks, rutting, and calving sites. For matrix habitat, develop a management plan that is consistent with the general wildlife measures goals.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites or trails.

Additional Management Considerations

Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000). (See MWLAP Web site at http://wlapwww.gov.bc.ca.)

In addition to reducing the effect of predation through forest management that minimizes fragmentation and habitat creation for other ungulates, large mammal species should be managed with the goal of locally reducing the number of other ungulates and associated predators, where such species were historically rare or absent.

If motor vehicle collisions (Highways 3, 5, and 16, Alaska Highway) are identified as a significant source of mortality in some local populations, and kill locations and timing are consistent, seasonal speed zones should be instituted.

Information Needs

1. Metapopulation conservation assessment/risk analysis relative to a range of management options.
2. Long-term suitability of areas cut through modified harvest to support caribou, with reference to both forage and predation risk.
3. Relative contribution to predation of regional increases in alternate prey numbers versus stand level or landscape level habitat fragmentation.

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