

Managing Woodland Caribou in West-Central British Columbia

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Abstract: Initial long term planning for logging on the Tweedsmuir-Entiako caribou winter range began in the early 1980's. Because little information was available on which to base winter range management, the British Columbia Fish and Wildlife Branch began studies on radio-collared caribou in 1983, and an intensive study on caribou winter habitat requirements was conducted from 1985 to 1988. Terrestrial lichens were identified as the primary winter food source for the caribou, and in 1987, caribou winter range ecosystem maps, which emphasized abundance of terrestrial lichens, were produced. The ecosystem maps and information from the caribou study, including potential direct and indirect effects of timber harvesting on the caribou population, were used to develop a management strategy for the winter range. The management strategy comprised two levels of management: a landscape level (Caribou Management Zones); and a site-specific level (caribou habitat/timber values). Timber information associated with BC Ministry of Forests forest cover maps was integrated using a Geographic Information System. Six winter range management options were proposed ranging from harvesting low value caribou habitats only throughout the winter range to total protection of the entire winter range. Impacts of those options on both the caribou population and on the timber supply were evaluated. The options were reviewed through a public planning process, the Entiako Local Resource Use Plan, and recommendations from that process were forwarded to the British Columbia Protected Areas Strategy.

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Introduction

West-central British Columbia has been identified as a high priority management area for woodland caribou (*Rangifer tarandus*) in British Columbia (Stevenson & Hatler, 1985). Two populations of caribou live in west-central British Columbia. The Itcha-Ilgachuz-Rainbow herd, which consists of about 1500 caribou, summers in the Itcha, Ilgachuz and Rainbow Mountains, and winters primarily in low elevation forested habitat to the west of the Itcha Mountains, and to a lesser extent, in the northern Ilgachuz and Rainbow Mountains (Fig. 1). The Tweedsmuir-Entiako herd, which consists of about 400 caribou, summers in northern Tweedsmuir Park and winters in low elevation forested habitat in the Entiako Lake area to the east of the park. The ranges of the two populations occupy over 1 500 000 ha of provincial forest and provincial park land and are managed through cooperation between BC Environment, BC Parks, and BC Forest Service, with involvement from public and interest groups.

Because caribou in both areas winter primarily in lower elevation forested areas outside of Tweedsmuir Park, potential conflicts with logging were anticipated. Increasing concern over current

population status, habitat disturbance by logging and increased accessibility prompted the initiation of studies on radio-collared caribou by the British Columbia Wildlife Branch. Caribou in both the Tweedsmuir-Entiako area and the Itcha-Ilgachuz-

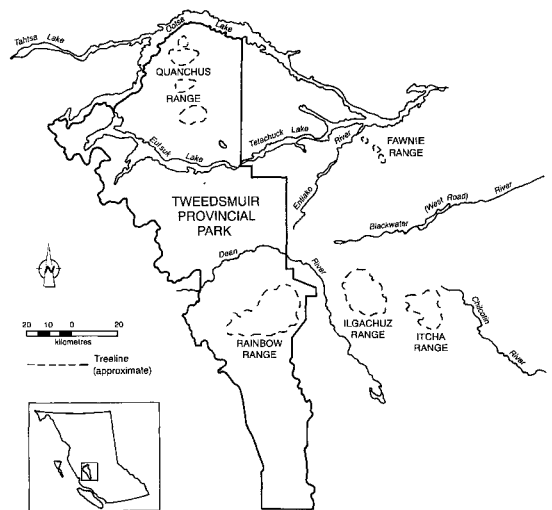


Fig. 1. Location of the study area in west-central British Columbia.

Rainbow area were radio-collared between 1983 and 1985 and basic information on habitat use, seasonal movements and population dynamics was collected (Marshall, 1983, 1984, 1985, 1986; Smith & Hebert, 1986). Because issues and study objectives were similar for both winter ranges, the two projects were combined in 1985 and expanded to include more intensive investigations of winter ecology and population parameters of the caribou. The winter field investigations were conducted for 3 years (Cichowski, 1989), and winter habitat maps were developed for both winter ranges (British Columbia Ministry of Forests, 1987a, 1987b). A winter range management strategy was then developed for the Tweedsmuir-Entiako caribou winter range based on the winter habitat map and the results from the winter ecology study (Cichowski & Banner, 1993). A similar process was also used to summarize caribou winter range characteristics and to develop 5 proposed scenarios for management of the Itcha-Ilgachuz-Rainbow caribou winter range. Winter range management planning for both areas is currently being conducted through public land management planning processes.

The availability of both a caribou winter habitat map and a study on caribou winter habitat requirements was a key factor in developing a management strategy for caribou winter range in west-central British Columbia. Because the ecology and issues of both herds were similar and the winter range management strategy was initially developed for the Tweedsmuir-Entiako herd, this paper summarizes the evolution of the current state of management for the Tweedsmuir-Entiako winter range, and includes:

1. the initial caribou winter range study
2. the caribou winter ecology study and winter habitat mapping
3. the winter range management strategy and options; and
4. land use planning processes and winter range management.

Study area

The Tweedsmuir-Entiako caribou winter range is located in west-central British Columbia, 200 km south of Smithers (Fig. 1). Most of the winter range lies between 850 and 1300 m on the Nechako Plateau and is characterized by flat or gently rolling terrain (Holland, 1976). The round-topped Fawnie Mountains in the eastern portion of the study area rise up from the Nechako Plateau to 1920 m. Most of the study area is included within the moist cold subzone of the Sub-Boreal Pine-Spruce (SBPSmc) Biogeoclimatic Zone (Pojar *et al.*, 1988). A dry, cool subzone of the Sub-Boreal Spruce Zone

(SBSdk) occurs in the northern portion of the study area and the Engelmann Spruce-Subalpine Fir Zone (ESSF) occurs above 1200 m in the Fawnie Mountains, below the Alpine Tundra Zone (AT). Only the SBPS and SBS zones were mapped because they encompass most of the forested terrestrial lichen caribou winter habitat.

Low elevation forests consist mostly of lodgepole pine (*Pinus contorta*) or mixed lodgepole pine/white spruce (*Picea glauca*) stands. Spruce stands occur primarily on wetter seepage sites and as bands along lake shorelines and wetlands. Black spruce (*Picea mariana*) is generally restricted to forested wetlands, as well as to cooler north and east facing upland sites. Subalpine fir (*Abies lasiocarpa*) occurs only at higher elevations in the eastern and (though rarely) northern-most part of the study area. Deciduous stands of trembling aspen (*Populus tremuloides*) are not extensive except in the northern portion of the study area. Lakes and sedge fens are common and often occur in mosaics of lakes, fens, and fringe forests of spruce.

Most of the pine and pine/spruce stands that dominate the study area have poorly developed shrub and herb layers. Common understory vascular plant species are *Shepherdia canadensis*, *Spiraea betulifolia*, *Rosa acicularis*, *Arctostaphylos uva-ursi*, *Linnaea borealis*, *Cornus canadensis*, and *Vaccinium caespitosum*. Drier stands on coarser textured tills and glaciofluvial sands and gravels typically have from 30 to 50% cover of ground lichens (mainly *Cladonia* and *Cladonia* spp. and *Stereocaulon* spp.). Arboreal lichens (primarily *Bryoria* spp.) occur throughout the forested habitats, but are especially abundant in forested wetlands and spruce fringes surrounding lakes and fens.

The study area lies within the rainshadow of the Coast Mountains and is characterized by a dry continental climate. Summers are typically cool, short, and dry, and winters are very cold, long and dry. Soils throughout the winter range are predominantly Brunisolic Gray Luvisols and Dystric Brunisols on morainal and glaciofluvial deposits (Lewis *et al.*, 1986; B.C. Ministry of Forests, 1987b).

Fire is an integral part of the vegetation landscape in west-central British Columbia. Fire interval for the SBS and SBPS averages 100 to 175 years and fire size averages 50 to 500 ha (Parminter, 1992).

During winter, moose (*Alces alces*) and wolves (*Canis lupus*) also occupy the caribou winter range, however, no data are available on population densities of those species.

Initial caribou winter range study (1982-1985)

Concern over the Tweedsmuir-Entiako caribou winter range began in the late 1970's when logging

was first proposed for the area. Although specific winter ranges had not yet been identified, incidental observations of caribou suggested that caribou wintering areas occurred outside of Tweedsmuir Park, with the Entiako area identified as a major wintering area (Hatter, 1979). Historically, caribou wintered north of the Ootsa Lake area, but the flooding of the Ootsa Lake complex by the Kenny Dam in the early 1950's, likely contributed to the abandonment of those winter ranges (Hatter, 1979), thus increasing the significance of the winter ranges east of Tweedsmuir Park.

In November 1983, the BC Wildlife Branch, with cooperation from the Tweedsmuir Rod and Gun Club, captured and radio-collared 13 caribou as they moved south across Tetachuck Lake during fall migration (Marshall, 1983). An additional 6 caribou were collared in November 1984 (Marshall, 1984). The BC Wildlife Branch began locating radio-collared caribou on a monthly basis to determine general seasonal movements and habitat use (Marshall, 1984, 1985, 1986).

During summer, caribou were found in northern Tweedsmuir Park in a variety of habitats. In November, caribou migrated out of Tweedsmuir Park and south across Tetachuck Lake to low elevation forests on the Nechako Plateau. During winter, caribou used primarily mature pine forests at low elevations in the Entiako and Laidman lakes area.

Caribou winter ecology study and winter habitat mapping (1985-1988)

In April 1985, the West-central B.C. Caribou Research Project was initiated to investigate the potential effects of logging on caribou (Cichowski, 1989). The focus of the study was to determine habitat use and foraging strategies.

Radio-collared caribou were located on a weekly basis from December to March to monitor winter habitat use and movements and to identify areas for ground investigations of feeding sites. Results indicated that caribou were selecting mature pine forests on low productivity sites, and were feeding primarily on terrestrial lichens. Selection of feeding sites within forested areas depended primarily on lichen presence and abundance; snow characteristics were less important. Arboreal lichens were used to a lesser extent than terrestrial lichens, and were most heavily used where arboreal lichens were abundant (trees in forested wetlands and on the margins of wetlands and lakes).

From this initial information, a winter range habitat map was developed for the study area (1: 50 000 scale) based on terrestrial lichen abundance (BC Ministry of Forests, 1987a). Seven site units were described: Dry Lichen, Lichen Moss, Moss, Seepage

Forest, Aspen Forb, and Forested and Nonforested Wetlands. Dry Lichen sites contain the greatest abundance of terrestrial lichens followed by Lichen Moss sites. Moss, Seepage Forest, Aspen Forb and Wetland sites generally contain few or no terrestrial lichens. Because terrestrial lichens are poor competitors against vascular plants (Kershaw, 1977; Hale, 1983; Rowe, 1984), terrestrial lichen abundance was closely associated with site productivity. Dry Lichen and Lichen Moss sites are less productive than Moss, Seepage Forest and Aspen Forest sites (Cichowski & Banner, 1993). Lichens are also very slow growing (Ahti, 1977; Johnson, 1981) and are most abundant late in succession. In the Tweedsmuir-Entiako winter range, *Cladina* spp. only start becoming abundant in stands of 50 years and greater.

Because of the scale of mapping, each map polygon contained several site units resulting in a large number of polygons with unique combinations of site units. To facilitate use of the map, polygons were aggregated into Caribou Habitat Types based on site unit combinations. The resulting Caribou Habitat Types, in descending order of terrestrial lichen abundance, were:

- Dry Lichen / Lichen Moss (DLLM)
- Lichen Moss (LM)
- Dry Lichen / Lichen Moss Ecomosaic (DLLM MOSAIC)
- Moss - Dry Lichen / Lichen Moss (MDLLM)
- Moss / Seepage Forest - Aspen Forb (MSF/AF)
- Wetlands / Moss - Seepage Forest Wetlands (W/FW)

The Dry Lichen / Lichen Moss Ecomosaic consisted of polygons which contained a Dry Lichen or Lichen Moss unit associated with a Wetland, Forested Wetland or Seepage Forest unit. These polygons contained a combination of both abundant terrestrial lichens (Dry Lichen and Lichen Moss units) and abundant arboreal lichens (Wetlands, Forested Wetlands, and Seepage Forest units).

Radio-collared caribou locations were then used to verify the predictive capability of the caribou winter habitat map. Locations were plotted onto the map and frequency of use of each Caribou Habitat Type, and the availability of each Caribou Habitat Type were determined and compared. The analysis indicated that caribou primarily used mature DLLM and LM Caribou Habitat Types and use of those habitats exceeded their availability (Cichowski, 1989). Consequently, the winter range habitat map was determined to be a good predictor of caribou habitat value.

Information was also collected on population status of the Tweedsmuir-Entiako caribou. Low calf

recruitment and high adult mortality suggested that the population was declining (Cichowski, unpubl. data). Wolf and bear predation was documented, mostly during summer months, however, the population limiting factor has not yet been determined (Cichowski, unpubl. data). Because of the declining population trend, it was necessary for the winter range management strategy to address the potential impacts of forest harvesting on the caribou population as well as on caribou habitat.

Winter range management strategy and options

Potential Impacts

With the completion of the caribou winter ecology study and the caribou winter range habitat map, enough information was available to identify important habitats for winter range management purposes. Because terrestrial lichens are highly susceptible to mechanical damage, and regeneration could take 50-100 years (Hale, 1983; Rowe, 1984), a conservative approach is necessary to ensure an adequate winter food supply for the caribou. However, because terrestrial lichens are most abundant where competition from vascular plants is low (i.e. where site productivity is low), the best caribou habitat (DLLM) occurs on poor growing sites for timber. Potential conflicts with forest harvesting will occur mostly on LM habitat types where caribou winter habitat value is high and growing potential for timber is adequate.

Identifying and managing for important caribou habitat only considers the potential direct effects of logging on caribou (i.e. reduction of the winter food source). However, potential indirect impacts of logging on caribou may also significantly affect the caribou herd. Potential indirect impacts of logging include increased human disturbance, hunting and poaching as a result of improved access, and altered predator-prey relationships.

Altering the mosaic of forested stand areas and ages may favour habitat for other ungulate species such as moose. Currently, the landscape is dominated by large scale disturbance patterns. Extensive stands of even-aged lodgepole pine have been shaped in the past by stand destroying fires. A logging scenario consisting of small clearcuts with lots of edge habitat, may be more favourable to moose than to caribou. An increase in the number of moose may result in an increased number of wolves which in turn could result in increased predation pressure on the caribou population (Bergerud *et al.*, 1984; Racey *et al.*, 1991). Wolf predation has been implicated as the major limiting factor of woodland caribou populations in Alaska, the Yukon, western Alberta and southeastern British Columbia

(Gasaway *et al.*, 1983; Farnell & MacDonald, 1987; Edmonds, 1988; Seip, 1992). In southeastern British Columbia, predation pressure on caribou was lower in Wells Gray Park where caribou were spatially separated from moose, than in the Quesnel Highlands, where less spatial separation existed (Seip, 1992).

One anti-predator strategy of caribou is to space out over large areas and to exist at low densities so that it is harder for predators to find them (Bergerud *et al.*, 1984; Bergerud & Page, 1987). If the available mature forested habitat for caribou is reduced, their density within that habitat will increase which could result in increased predator efficiency. Predator efficiency may also be improved if ploughed roads or snowmobile tracks provide easier travel routes for wolves (Edmonds & Bloomfield, 1984).

Therefore, both potential direct and indirect effects of logging on caribou were considered while developing a management strategy for the Tweedsmuir-Entiako caribou winter range.

Management Strategy

To consider both potential direct and indirect impacts in the Tweedsmuir-Entiako Caribou Winter Range Management Strategy, a two level management approach was developed (Cichowski & Banner, 1983). At the landscape level, the winter range was divided into Caribou Management Zones based on caribou habitat value and use. At the site specific level, both caribou habitat and timber values were considered. The advantage of the dual level approach was that site specific management strategies could vary between zones, depending on the zone's significance to the caribou population and winter range.

Thirteen Caribou Management Zones were delineated based on areas of similar caribou habitat value, consistent use by radio-collared caribou, and special considerations such as travel corridors and late winter ranges (Fig. 2, Table 1). Caribou habitat value was visually determined from the winter habitat map, which was colour-themed by Caribou Habitat Type. Each zone was rated as low, medium or high value caribou winter range. Zone 4 was delineated as the core of the winter range and was considered the most important zone in terms of winter range value.

For the site specific level, the PAMAP Geographic Information System (PAMAP Graphics Ltd., 1989) was used to overlay the Caribou Habitat Type map with the Ministry of Forests forest cover map. The resulting map was colour-themed based on a combination of caribou habitat and timber value. The colour-themed map could then be used to determine which stands had the lowest potential

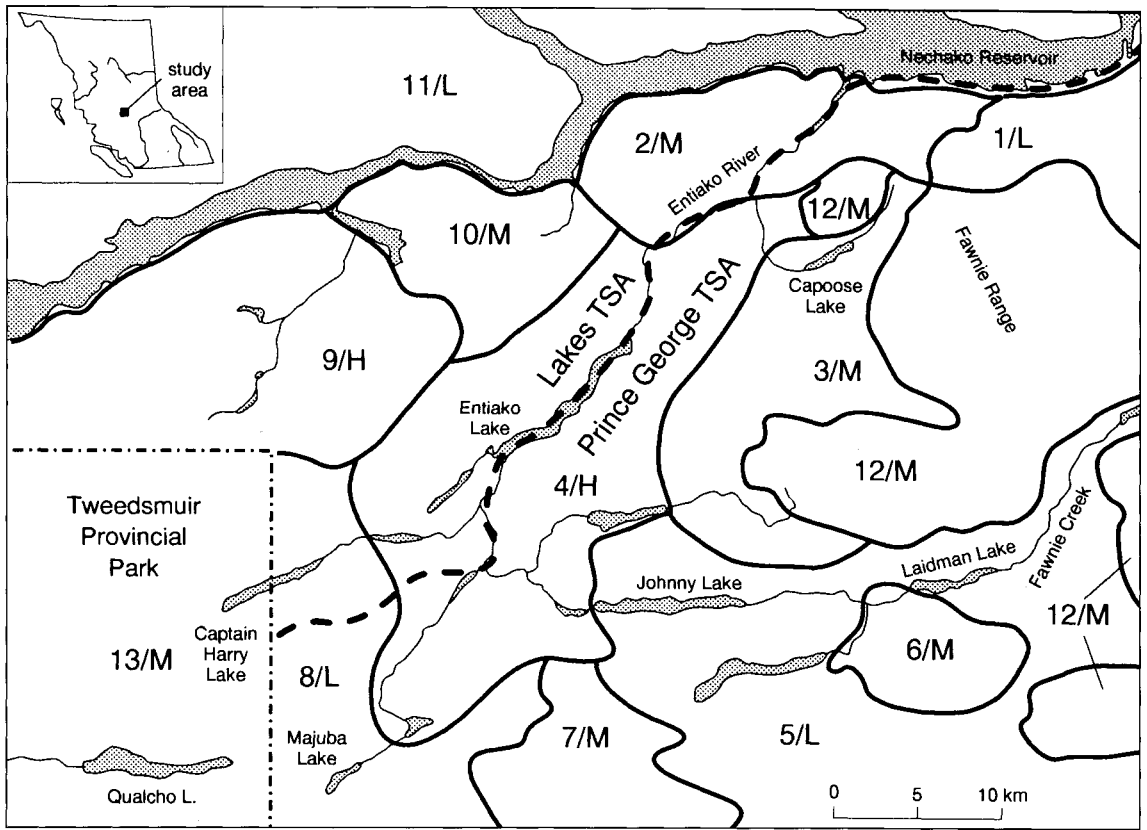


Fig. 2. Location of 13 Caribou Management Zones (solid lines) in the Tweedsmuir-Entiako caribou winter range. Caribou winter habitat value is indicated by H - high, M - medium, and L - low. Timber Supply Area boundary is indicated by a dashed line.

Table 1. Summary of Caribou Management Zones (CMZs) of the Tweedsmuir-Entiako caribou winter range.

CMZ	Area (ha)	Percent of study area	Caribou winter habitat value	Special values
1	8 412	2.5	low	
2	14 329	4.2	moderate	-late winter range
3	12 475	3.7	moderate	-migration corridor
4	43 982	13.0	high	-core winter range, migration corridor
5	45 452	13.5	low	
6	5 467	1.6	moderate	
7	9 969	3.0	moderate	
8	18 697	5.5	low	-adjacent to Tweedsmuir Park
9	28 310	8.4	high	-early winter/late winter range
10	11 300	3.4	moderate	-late winter/early spring range
11	59 786	17.7	low	-spring migration route
12	43 801	13.0	moderate	-not mapped; alpine and high elevation forests; mid-winter range; may be important during deep or extreme crusty snow years
13	35 554	10.5	moderate	-Tweedsmuir Park; early winter range
Total area = 337 534 ha				

for conflicts between caribou habitat and timber values (i.e. high caribou habitat value on low value timber stands, high value timber stands on low value caribou habitat).

Options

With the two level management approach, a timber harvesting strategy could be developed for the winter range which considers both direct and indirect impacts on caribou. At the landscape level, a harvesting strategy could be prescribed for each Caribou Management Zone based on its unique characteristics. Site specific management is achieved by restricting timber harvesting to specific Caribou Habitat Types or site units.

Table 2. Management options for the Tweedsmuir-Entiako caribou winter range.

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1. No harvesting.
 2. No harvesting in CMZ¹ 2, 4, 9, 10.
 - Other moderate value zones: harvest in MSF/AF², MDLLM³, ESSF⁴
 - Low value zones: harvest in MSF/AF, MDLLM, ESSF
 3. No harvesting in CMZ 4, 9.
 - Moderate value zones: harvest in MSF/AF, MDLLM, ESSF
 - Low value zones: harvest in MSF/AF, MDLLM, ESSF
 4. No harvesting in CMZ 4.
 - Other high value zones (CMZ 9): harvest in MSF/AF, ESSF
 - Moderate value zones: harvest in MSF/AF, MDLLM, ESSF
 - Low value zones: harvest in MSF/AF, MDLLM, ESSF
 5. Restricted harvesting.
 - High value zones: harvest in MSF/AF, ESSF
 - Moderate value zones: harvest in MSF/AF, MDLLM, ESSF
 - Low value zones: harvest in all habitat types
 6. Restricted harvesting.
 - All zones: harvest in MSF/AF, MDLLM, ESSF
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¹ Caribou Management Zone.

² Moss/Seepage Forest - Aspen Forest Caribou Habitat Type.

³ Moss - Dry Lichen/Lichen Moss Caribou Habitat Type.

⁴ Engelmann Spruce-Subalpine Fir Biogeoclimatic Zone.

For the Tweedsmuir-Entiako area, to best mimic historic fire disturbance patterns that caribou evolved with, partial retention timber harvesting was recommended. Opening sizes of 200 to 300 ha were suggested with islands of trees within the openings and stringers of trees along wetlands and creeks.

Six management options were proposed which varied from total protection of the winter range in Option 1 to a moderate level of harvesting throughout the winter range (Table 2). Options 1 to 4 varied by the number of Caribou Management Zones from which harvesting was restricted. All had the common element of protection of Zone 4, the core of the winter range. Protection of the core of the winter range was considered a minimum requirement for caribou management. Options 5 and 6 allowed harvesting in all zones and varied in the intensity of harvesting within several Caribou Management Zones. In option 6, the Caribou Management Zone classification system was ignored; the same harvesting strategy was applied to all zones, although high quality caribou habitat was protected in all zones.

The impacts of each option on the caribou population and on the timber supply were evaluated and compared. Although absolute impacts on caribou could not be determined, each successive option allows harvesting in an increasing number of zones and will likely result in progressively increasing impacts on the caribou. The impact of each option on the timber supply was evaluated using the forest inventory database associated with the forest cover map, which was overlaid onto the caribou habitat map. The Tweedsmuir-Entiako caribou winter range encompasses portions of two Timber Supply Areas (TSAs), the Lakes TSA and the Prince George TSA (Fig. 2). Because timber supply calculations differed between the two TSAs, the impacts on the timber supply had to be evaluated separately. To simplify the analysis, it was assumed that clearcut harvesting would occur within the Caribou Habitat Types where harvesting was permitted.

The impacts generally decreased for both Timber Supply Areas from option 1 to option 6 (Table 3). The most significant change in impact occurred between options 1 and 2 for the Prince George Timber Supply Area and between options 2 and 3 for the Lakes Timber Supply Area, since the Lakes Timber Supply Area contained most of the high and moderate value Caribou Management Zones (Fig. 2). The impacts of Option 6 on the timber supply were similar to those of options 3, 4 and 5 in the Prince George TSA and options 4 and 5 in the Lakes TSA. Although the impacts to the timber supply were similar for those options, the implications to the caribou population differ significantly. Because Options 3 and 4 offer some degree

Table 3. Relative effects of management options (as a percentage of Option 1 [no harvesting]) for the Tweedsmuir-Entiako caribou winter range on the harvestable forest land base of the Prince George and Lakes Timber Supply Areas.

Options	PRINCE GEORGE TSA		LAKES TSA	
	Reduction to harvestable land base %	ha	Reduction to harvestable land base %	ha
1	100.0	81 856	100.0	39 412
2	38.5	31 477	97.9	38 587
3	36.7	30 064	69.1	27 246
4	36.7	30 064	60.6	23 890
5	28.4	23 254	60.3	23 763
6	33.2	27 180	54.1	21 311

of protection to the winter range, they will have fewer impacts on the caribou population than Option 6 which ignores the zonation scheme. Option 2 was recommended as the best option for caribou given some level of harvesting in the caribou winter range (Cichowski & Banner, 1993).

Because some harvesting was proposed, additional recommendations included prohibiting access to the winter range on forest access roads, monitoring caribou movements and habitat use in relation to first pass forest harvesting, developing a fire management plan for that portion of the winter range that will be protected, and conducting research on harvesting techniques that would mimic disturbance to terrestrial lichens and that would accelerate regeneration of terrestrial lichens after forest harvesting.

Although six options were assessed in the Tweedsmuir-Entiako winter range management strategy and options report, an infinite number of options were possible. The purpose of the Tweedsmuir-Entiako winter range management strategy was to develop a framework from which a management plan could be developed. Through the management planning process, existing options could be modified or new ones developed.

Land use planning processes and caribou winter range management

In British Columbia, although BC Environment sets objectives for wildlife population and habitat management, the BC Forest Service is responsible for forest land planning with cooperation from other agencies such as BC Environment and BC Parks, as well as involvement by the public. Currently, Land and Resource Management Plans (LRMPs) are being developed to guide harvesting strategies in each Forest District. In areas within a

Forest District where specific issues need to be addressed, a Local Resource Use Plan (LRUP) is developed. A provincial land use strategy is also being developed for the province, spearheaded by the Commission on Resources and the Environment (CORE). A major part of that land use strategy is the Protected Areas Strategy which is currently considering areas of interest for future protection.

The Entiako LRUP was initiated in August 1992 to address caribou winter range requirements and other issues in the Entiako area (Entiako Local Resource Use Plan Working Group, 1993). Participants ranged from interested individuals to forest industry representatives. Some timber harvesting had already occurred in the southeastern part of the winter range and new logging had been approved but redirected to lower value CMZs. As part of the LRUP planning process, results from the caribou study and the winter range management strategy and options were presented to the group. That information was considered and several new management options were developed. Most of those options proposed protection of some portion of the caribou winter range and were subsequently forwarded to the Protected Areas Strategy for consideration for protected area status.

The Protected Areas Strategy is currently evaluating the Entiako area as a candidate for an area of interest for protection. Pending that outcome, the Entiako LRUP planning group will reconvene to develop a plan for that part of the winter range not proposed for protection or recommend that the issue be addressed by the new Land and Resource Management Planning groups in both Forest Districts. The planning group will address issues such as access management and forest harvesting techniques. For that part of the winter range that will be protected, a fire management plan will be developed to accommodate protection and regeneration of caribou winter habitat.

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