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Integrated Management of Mountain Caribou and Forestry in Southern British Columbia

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Introduction

The decline of mountain caribou (*Rangifer tarandus caribou*), particularly in the southern part of British Columbia, has been recognized for over two decades (see Bergerud, 1974). Mountain caribou are of special concern because they depend on old growth forests which are being removed by forest harvesting. Stevenson & Hatler's (1985) review documented the conflict between mountain caribou habitat requirements and forest management in British Columbia. Many recent studies in southern British Columbia, most using telemetry, were designed to determine caribou habitat requirements and limiting factors in particular areas. This paper is a summary of a larger report produced for the BC Ministry of Environment. More detailed information and data can be found in the original report.

Detailed ongoing work by the Mountain Caribou in Managed Forests (MCMF) program has contributed new information (e.g. Child *et al.*, 1989; Stevenson *et al.*, 1993). That program has completed a telemetry study and initiated habitat manipulation studies in the Prince George and Quesnel Highland areas (Terry & McLellan, 1991; Seip, 1992; Terry, 1993). Several sites have been experimentally harvested using silviculture treatments aimed at maintaining caribou habitat values while allowing commercial forestry activities. A similar program has been initiated near Mount Revelstoke and Glacier National Parks. The telemetry study is intended to identify those key habitats surrounding the parks which will be required to maintain the caribou now using the parks (McLellan & Flaa, 1993). A relevant project was initiated by the Revelstoke Forest District to assist planning for timber extraction in areas occupied by caribou. Computer modelling was used to estimate the long term effects of various caribou habitat conservation guidelines on timber supply. Using iterative processes, guidelines may be developed and tested in the model to determine if they meet the long term objectives for caribou habitat and to estimate the associated cost to the forest industry. Options are being sought which maximize the benefits to caribou while minimizing the impact on forestry (Nelson, 1993). A synthesis of the approaches used in the above projects will be helpful in developing guidelines for the province as a whole.

Wildlife inventory, radio telemetry, and forest management data for populations in the areas of north Thompson/Wells Gray Park (Antifeau, 1987; Seip, 1990), Revelstoke (Simpson & Woods, 1987; McLellan & Flaa, 1993), and the southern Selkirks/Idaho (Scott & Servheen, 1985; Warren, 1990; Wakkinen *et al.*, 1992), are useful for comparing habitat and population status. Habitat distribution and population data from isolated herds in the Monashee, Purcell and southern Selkirk Mountains is also used to provide information on the tolerance of caribou to habitat alteration (e.g. Simpson & Woods, 1987; Simpson, 1990).

The challenge is to develop workable guidelines that integrate the conflicting needs of the forest industry, which seeks to harvest older forests, and the needs of caribou which use large areas of old forests for food and shelter. The main concerns for caribou include loss of their winter food supply (arboreal lichens), fragmentation of useable habitat areas, human access and associated disturbance or mortality, and alteration of the predator/prey balance. These four concerns must be addressed in any guidelines which seek to preserve caribou populations in forests which are being harvested.

Forest values are low in the high elevation Alpine tundra (AT) and Engelmann spruce - subal-

Table 1. Caribou use and forest values in different elevation bands and biogeoclimatic zones.

Biogeoclimatic Zone	Timber Value	Caribou Use	Elevation
AT	Nil	Low - mod. (summer)	> 2000 m
ESSFp	Nil - low	High (Jan. - March)	1800 - 2000 m
ESSF	Poor - mod.	High (Jan. - March & summer)	1550 - 1800 m
ESSF	Mod. - good	High (Nov. - Dec.)	1350 - 1550 m
ICH	Good	Variable (Nov. - Dec. & May)	< 1350 m

pine fir parkland (ESSFp) biogeoclimatic zones (Table 1). However, within the Engelmann spruce - subalpine fir (ESSF) biogeoclimatic zone and particularly in the Interior Cedar Hemlock (ICH) biogeoclimatic zone, conservation of caribou habitat may conflict severely with forest management objectives.

Discussion and Recommendations

The emphasis for caribou management in B.C. has been on habitat conservation. The general premise is that if suitable habitat is properly distributed within caribou ranges then the populations will be maintained. The habitat distribution is important to maintain key winter food supplies and to enable caribou to avoid predators. Most predation occurs in summer (Seip, 1990; 1992; Compton *et al.*, 1990). Since summer habitats can also provide good late-winter range, emphasis should be on providing quality summer habitat. Compensatory management programs, such as predator control, should only be required where habitat objectives are not met due to human activities or uncontrollable events (eg. forest fires).

Knowledge of winter habitats and important foods, especially arboreal lichens, is relatively good and much research is ongoing to define methods of maintaining lichens in commercial forests. Knowledge of summer habitat needs and particularly of predator avoidance strategies of caribou, is relatively poor (Bergerud, 1983). The current habitat status for some populations has been described to provide guidance on what may be acceptable habitat distributions for caribou. Those analyses should be repeated using accurate digitally mapped habitat data. Similar analyses should also be completed for several other populations where the telemetry and habitat data are available.

Schreier *et al.* (1993) summarized a process used to define habitat management priorities for caribou and determine the consequences of various options. The recommended process corresponds to the approach used by Cichowski & Banner (1993) and is summarized in Fig. 1. That approach should be consistently applied to determine management priorities within the range of mountain caribou. It requires:

- a map based inventory of biophysical habitat units preferably accessible in digital form (GIS),
- clear definition of caribou values and forest values for habitat units which can be used to define high, moderate and low value zones,
- definition of
  1. zones valuable to both caribou and forestry (conflict areas),
  2. zones valuable to caribou which are not valuable to forestry and
  3. zones valuable to forestry which are not valuable to caribou,
- definition of habitat objectives for caribou and forest management options to provide that habitat,
- assessment of the effectiveness of each option and the relative cost.

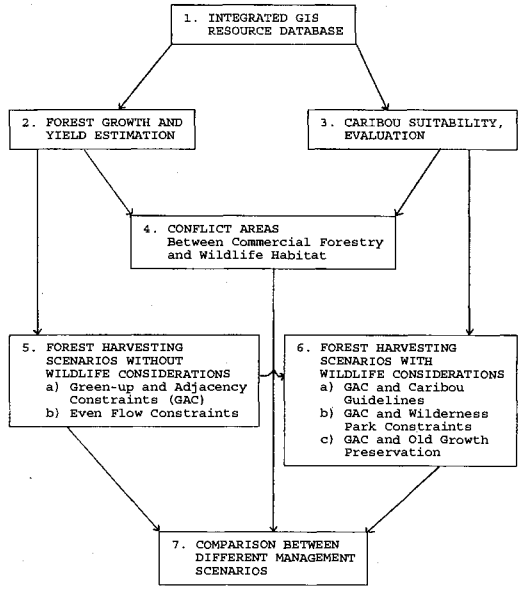

Fig. 1. Information needs and criteria used to define habitat management options for caribou habitat conservation (modified from Schreier *et al.*, 1993).

The habitat and population objectives for caribou at the landscape level are poorly defined. The lack of explicit objectives is mainly due to a lack of information on the amount of habitat needed to support caribou and the desired spacial distribution of suitable habitats. Recent censuses show that caribou are usually spread over large survey areas and occur at low densities compared to other ungulates. A large portion of each area is unused or rarely used by caribou. When unused habitats are deleted from the gross area, the density of caribou per suitable (occupied) habitat can be calculated. Gross densities (.01 - .08 caribou /km^2, Table 1) probably reflect the need for caribou to disperse over the landscape to avoid predators and allow time for slow growing lichens to regenerate in browsed areas. Net densities (0.2 - 0.5 caribou /km^2) more accurately reflect the actual carrying capacity of mountain caribou habitats (Table 1). The highest densities occurred near Prince George where areas occupied were mainly continuous unbroken old growth forest with only a minor proportion of ice, rock, avalanched or cleared areas (see Simpson *et al.*, 1994).

Examination of the habitat use patterns of 3 isolated caribou populations in the south Selkirk Mountains, south Purcell Mountains and Monashee Mountains suggest that caribou will use areas with up to 40% of the gross area in snow, rock, alpine tundra or second growth forest. Caribou maintained use of forested habitat units where up to 40% of the area was young forest or natural openings. Most high use habitats had ≥60% old growth forest but some areas with less old growth were occasionally used. Areas with no old growth were rarely used in any area. The minimum requirement of caribou in late-winter and summer appears to be 60% of the gross area supporting forests or forests complexed with other habitats and 60% of the vegetated land units should be old growth forest. High use land units can either be continuous forest, continuous forest broken by openings and younger age classes, or may be naturally occurring mixes of forest, meadows, wetlands, rock and avalanche paths.

The requirement for old growth forest appeared to be substantially less in early-winter and spring habitats. This might be expected since caribou use primarily shrubs and herbaceous forage, rather than lichens, in those habitats. Use by isolated caribou populations suggested that 20% of the available low elevation habitat (gross area) should be suitable for use by caribou. 25% was the objective set by the United States agencies for the endangered population in Idaho. Suitable habitats again included areas where ≥60% of the forest was old growth. This implies that caribou may survive in areas where special management zones totalling 20-25% of the available cedar-hemlock forest are located in areas needed by caribou and that 60% of those zones should be old growth forest. Overall the old growth conservation required for caribou at low elevations would total 12-15% of the potential forested habitat. In order for old growth areas to be accessible to caribou they must be located adjacent to late-winter/summer habitats.

Ideally, suitable habitat should be continuous or closely linked, however, caribou appeared willing to cross up to 5 km of poor habitat to reach high use old growth forests. Mature forest (60-120 years old) and shrubland (< 20 years) was commonly used for movement while immature forest (20-60 years) was rarely crossed based on examination of radio location points and habitat distribution (see Simpson *et al.*, 1994). Large man-made or fire created openings 10-15 km wide, have isolated caribou populations near Prince George (Narrow Lake, George Mountain) and may prevent caribou from accessing suitable habitats in the south Selkirks.

It is clear that habitat management planning for caribou must be done over large areas and consider not only the forested landscape but also the other habitats in between. The areas currently occupied by caribou, mainly along the transition from highland to mountain topography, suggest that fragmentation by natural features (high mountains, lakes, glaciers, etc.) may be beneficial to caribou by reducing their overall density and making it inefficient for predators to search for them. Much emphasis has been placed on managing winter habitat for caribou, particularly lichen bearing forest, however, spring and summer appear to be the seasons when most mortality occurs (Seip, 1990, 1992; Compton *et al.*, 1990). The high mortality noted in some populations, even at very low densities, suggests that predators are capable of maintaining caribou numbers below the food carrying capacity of their environment. Since favoured summer habitats usually provide abundant lichen forage and the factor limiting caribou numbers appears to be predator avoidance space (Bergerud & Page, 1987), management should focus on providing suitably dispersed summer habitat which will also function as late-winter habitat.

Fragmentation and road access are concerns primarily due to uncontrolled or illegal activities of people within caribou ranges. Human access and activities must be managed to ensure that caribou are not unnecessarily harassed and that they are not forced into marginal terrain where movement is difficult and the risk of accidental death, particularly in avalanches, is elevated.

It has not been shown that roads influence predator/prey relationships for mountain caribou. Based on the inspection of habitat distribution within areas currently occupied by caribou, openings,

both man-caused and natural, occur in every caribou range. Predators of various kinds also occur on every caribou range and ungulates other than caribou are limited by deep winter snow, which is a characteristic of mountain caribou ranges. Provided that a suitable proportion of the range is maintained in old growth forest and provided that other prey species do not support very high predator numbers, caribou appear able to maintain stable populations. Examples in B.C. include the Revelstoke and Prince George populations which have been stable or increasing slightly in recent years.

Habitat management planning should be completed over large areas (3000 to 5000 km^2). Along the boundaries of administrative regions, management plans must be coordinated to ensure that habitat contiguity is maintained. Areas valuable to caribou which are not valuable to forestry have been identified in some regions. Current 1:250,000 scale mapping of management zones (I. Stewart - pers. comm.) identifies broad areas occupied by caribou but does not identify key high value habitats within those zones or the habitats unimportant to caribou.

Management zones should be prioritized based on the expected level of conflict between caribou habitat management objectives and other resource users, particularly forestry and winter recreation. Some caribou herds are dependant mainly on low conflict areas (eg. parks, non-productive forests). Contentious habitats important to those herds must receive a high priority for conservation or special management. Two good examples of top priority management zones are the upper Raft River area, and the Mackay River to Deception Creek area, used by the largely protected Wells Gray Park caribou herd. Linkage areas between secured caribou populations must also receive careful attention.

Analyses of forest landscape patterns within the range of various caribou populations have been completed using small scale mapping and visually quantified area estimates. They should be considered first approximations to estimate the actual habitat needs of caribou. More detailed planning using GIS analysis and larger scale mapping should be completed within the range of core caribou populations. Computer analytical tools have been developed by the Wildlife Branch, the Ministry of Forests and by various researchers to enable efficient processing of information. Using GIS modelling in the Kamloops region they were able to highlight high use caribou habitats in drier ESSF zones based on aspect criteria (D. Low - personal communication). The newly developed tools and information have the potential to improve the definition of caribou habitat management zones and greatly reduce the potential cost to forest harvest operations.

The desired landscape distribution of habitat types provides direction for planning caribou habitat conservation within large areas. The second level of planning requires definition of stand level management objectives. Caribou select particular site associations within cedar-hemlock and spruce-subalpine fir forests (Summerfield, 1985; Scott & Servheen, 1985; Idaho Panhandle National Forest, 1987; Terry & McLellan, 1991). After contiguous forested units (polygons) are mapped to provide linked seasonal habitats, the high use associations within those polygons should be the target for the 60% conservation of old growth forests. Some of the habitat characteristics important in summer and late-winter include:

- wet gentle to moderately sloping sites (sedge, sitka valerian associations)
- subalpine fir leading with heavy lichen loads especially Bryoria sp.
- open herbacious understory ie. not *Rhododendron* or *Azalea* associations.

Some habitat characteristics important in early-winter and spring include:

- dry moderate sloping sites *(Pachystima, Aralia* and *Vaccinium* associations),
- western hemlock leading with an open low shrub understory ie. not Devil's club or skunk cabbage associations.

Scott & Servheen (1985) probably provides the best assessment currently available of micro-site characteristics of mountain caribou seasonal habitats in the ESSF and ICH biogeoclimatic zones. That information was used to develop a cumulative effects model to predict the suitability of any land unit for use by caribou (Summerfield, 1985). An updated version of that model is being prepared by the US Forest Service (L. Allen-Johnson - pers. comm.). Recent work by the MCMF committee has identified stand level prescriptions and operational guidelines needed to maintain stand attributes important to caribou (Stevenson *et al.*, 1993). Trials are currently underway to test various prescriptions (H. Armleder - pers. comm.).

Recommendations

Population objectives for mountain caribou should be defined using all available information with consideration of minimum viable populations and contiguity.

Preliminary landscape objectives for the habitat distribution could be set using the approximate gross density estimates provided here (Table 2) or by completing recommended habitat distribution analyses for each population.

Table 2. Caribou density based on gross area within range and suitable habitat within range.

Location	#Caribou counted	Gross area (km^2)	# Caribou/ Gross area (#/km^2)	Suitable habitat area (km^2)	Caribou/ suitable area(#/km^2)
Prince George					
Captain-Otter	98	1100	.087		
Bear Paw-Dezaiko	300	2800	.11		
Sugarbowl	146	600	.24	320	.46
George	20	300	.067		
Narrow Lake	40	500	.08	300	.133
Haggen	214	1300	.16	820	.26
Quesnel Highland					
Bowron	4	1900	.0022		
Wells	19	1600	.012		
Stevenson	114	1500	.078		
Junction	23	1400	.017		
Horsefly	51	1100	.046		
Total	211	7500	.028		
Wells Gray	238	4800	.050		
North Thompson	187	4000	.047		
Revelstoke	350	7400	.047		
South Purcells	100	1400	.071	630	.158
South Selkirks	30	370	.081	220	.209

Note: based on BC Environment population estimates and 1:250,000 scale habitat mapping.

Suitable habitat which is not contentious should be mapped and assessed to determine its effectiveness in meeting the preliminary gross area landscape objectives (60% suitable and 60% old growth). These areas are key habitats but because they are not contentious, they do not require special management. Such areas may include non-commercial forest, parks and other protected areas.

Additional habitats, which are contentious and are required to meet seasonal habitat, movement or population linkage needs (core habitats and corridors), should be mapped and identified as special management zones.

Harvesting should only be permitted where the desired habitat distribution described above can be maintained in special management zones. Selected harvesting may be preferable at high elevations (see Stevenson *et al.*, 1993).

However, large openings in low elevation habitats may be beneficial to discourage use by moose and associated predators. Harvest prescriptions should be adjusted to meet local landscape objectives within larger landscape planning units.

Within special management zones, any permissible development should target the site associations used least by caribou. Important habitats should be located in close proximity to each other and never more than 5 km apart.

Harvest scheduling should ensure that mature forests that are useable by caribou, link special management zones at all times.

Human and vehicular disturbance on late-winter caribou ranges should be discouraged, especially where such activities will force caribou onto avalanche prone terrain. An integrated management program for snowmobiling near Revelstoke should be investigated to determine its success and applicability in other areas.

In some instances, where specific habitat objectives cannot be met due to other resource interests, it may be possible to maintain caribou through compensatory management. Potential special management programs, which are less desireable than proper habitat management, include:

- access control signs, physical barriers on roads or removal of roads,
- predator control through liberal public hunting or active professionally executed control programs,
- reduction in the numbers of other ungulates and associated predators through liberalized hunting regulations.

Such compensatory programs should only be considered where habitats are already below target levels, where catastrophic events (eg. fires, disease) alter the habitat values or where economically viable alternatives are limited. Careful site specific planning must be completed to ensure that key caribou habitats are identified and protected.

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References

Antifeau, T.D. 1987. *The significance of snow and arboreal lichens in the winter ecology of mountain caribou* (Rangifer tarandus caribou) *in the North Thompson watershed of British Columbia.* M.Sc. Thesis, Univ. of B.C., Vancouver. 142pp.

Bergerud, A.T. 1974. Decline of caribou in North America following settlement. – *J. Wildl. Manage.* 38(2): 357-370.

Bergerud, A.T. 1983. The natural population control of caribou. *In* Bunnell, F.L., D.S. Eastman, and J.M. Peek (eds.). *Symp. on the Nat. Regul. Wildl. Populations.* Forest, Wildl. and Range Experiment Sta., Univ. Idaho, Moscow. Proc. 14: 14-61.

Bergerud, A.T. & R.E. Page. 1987. Displacement and dispersion of parturient caribou at calving as antipredator tactics. – *Can. J. Zool.* 65: 1597-1606.

Child, K.N., S.K. Stevenson & G.S. Watts. 1989. *Mountain caribou in managed forests: cooperative ventures for new solutions.* Prog. Rep. B.C. Min. of Env., Prince George.

Cichowski, D.B. & A. Banner. 1993. *Management strategy and options for the Tweedsmuir-Entiako caribou winter range.* Minist. For., Land Manage. Rep. No. 83., Victoria, 48pp.

Compton, B.B., P. Zager & L. Allen-Johnson. 1990. *Selkirk mountains caribou transplant: October 1989 - September 1990.* Idaho Dept. Fish and Game, Annu. Rep., Threatened and Endangered Species Rep., Boise. 31pp.

Idaho Panhandle National Forest. 1987. *Caribou habitat management guidelines.* Appendix N of the Forest Plan for IPNF. Pages N-1 to N-7.

McLellan, B. N. & J. Flaa. 1993. *Integrating mountain caribou and forestry: the Revelstoke project.* Annu. Rep. 1 1992-93. B.C. Minist For. and Canadian Parks Serv., Revelstoke. 34pp.

Nelson, J.D. 1993. *Area based timber supply analysis of the southern portion of the Revelstoke TSA.* Report to the Revelstoke Forest District, Revelstoke, B.C. 25pp.

Schreier, H., S.J. Brown, W.A. Thompson & C. Heaver. 1993. *Resolving wildlife/ forestry conflicts in the Tangier watershed using simulation models linked with CIS techniques.* Rep. to B.C. Hydro, Vancouver. 57pp.

Scott, M.D. & G. Servheen. 1985. *Caribou ecology.* Unpubl. Rep., Job Prog. Rep., Proj. No. W-160-R-11, Dept. Fish and Game, Idaho. 137pp.

Seip, D.R. 1990. *Ecology of woodland caribou in Wells Gray Provincial Park.* Wildl. Bull. No. B-68, B.C. Minist. Environ. and Parks, Wildl. Br., Victoria. 43pp.

Seip, D.R. 1992. *Habitat use and population status of Woodland Caribou in the Quesnel Highland, British Columbia.* Wildl. Bull. No. B-71, B.C. Minist. Environ., Lands and Parks, Williams Lake. 50pp.

Simpson, K. 1990. *Monashee caribou management plan.* Prepared by Keystone Bio-Research, Surrey, for Min. Environ., Lands and Parks. Penticton. 34pp.

Simpson, K. & G.P. Woods. 1987. *Movements and habitats of caribou in the mountains of southern British Columbia.* Wildl. Bull. No. B-57, Wildl. Br., B.C. Min. Environ. and Parks, Nelson. 36pp.

Stevenson, S.K., H. Armleder, K.N. Child, G. Watts, D. King, M. Jull, B.N. McLellan & E. Terry. 1993. *Mountain caribou in managed forests: preliminary recommendations for managers.* Draft Rep. 25pp. + Tables.

Stevenson, S.K., H. Armleder, K.N. Child, G. Watts, D. King, M. Jull, B.N. McLellan, E. Terry & D.F. Hatler. 1985. *Woodland caribou and their habitat in southern and central British Columbia.* Vols. I and II. Land Manage. Rep. No. 23, B.C. Min. For., Res. Branch, For. Div.. 355 and 112 pp.

Summerfield, B. 1985. *Woodland Caribou Cumulative Effects Analysis Model.* Idaho Panhandle National Forest. Working Draft. 44pp.

Terry. E. 1993. *Habitat use and seasonal movements by woodland caribou in east-central B.C.* Prog. Rep., Univ. B.C., Dept. Anim. Sci. 25pp.

Terry, E. & B.N. McLellan. 1991. *Micro habitat characteristics of mountain caribou winter range and selective timber harvesting in east-central B.C.* MCMF Prog. Rep. 1990-91. 42pp.

Wakkinen, W.L., B.B. Compton, P. Zager & L. Allen-Johnson. 1992. *Selkirk Mountains caribou transplant, December 1991 - December 1992.* Annu. Rep. Threatened and Endangered Species Proj. E-7-4. Idaho Dept. Fish and Game, Boise. 65pp.

Warren, C.D. 1990. *Ecotypic response and habitat use of woodland caribou translocated to the southern Selkirk Mountains, northern Idaho.* M.Sc. Thesis, Univ. Idaho. 194pp.

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