Multidisciplinary Approaches to Recovering Mountain Caribou in Mountain Ecosystems

May 29–31, 2006
Revelstoke, British Columbia
Canada

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Acknowledgements

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Special thanks to our **volunteer assistants**, who took notes at the workshop and helped with the many details that kept the event running smoothly. Their records of the questions and responses after each speaker added greatly to the quality of this document. These volunteers were:

Mandy Kellner, Kingbird Biological Consulting, Revelstoke
Carmen Gustafson, Wildsight
Chris Rosenbloom, University of Guelph

Our **presenters** travelled from Idaho, Arizona, Ottawa, Edmonton, Calgary, Banff, Victoria, and various communities in the Interior of British Columbia to share their expertise with us. We are grateful for their participation and for the support of their host agencies; many of them covered the time it took to prepare and present the talks and the costs for travelling to Revelstoke.

The **Chair of the conference organizing committee** was Ian Hatter, Ungulate Specialist with the BC Ministry of Environment. Other members of the organizing committee were: Jenny Feick, BC Ministry of Environment; Cindy Pearce, Mountain Labyrinths Consulting, Rachel Holt, Veridian Ecological Consulting; and Bruce McLellan, BC Ministry of Forests and Range. We thank Jenny Feick and Cindy Pearce for performing the duties of **Master of Ceremonies.**

And, of course, we'd like to thank the **workshop participants**, who travelled from various towns in Ontario, Alberta, British Columbia, and the USA Pacific Northwest to attend the conference.

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Presentations on Wednesday, May 31, 2006

Posters and Displays

Conference Description

In 2002, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated caribou within the Southern Mountains National Ecological Area as "threatened." This conference addressed recovery planning for these woodland caribou, which occupy the plateaux and mountains of southern British Columbia, the mountains and foothills of adjacent Alberta, and the bordering states of Idaho and Washington.

Preparing and implementing recovery plans is paramount to preventing local extirpations of caribou. However, the combination of habitat loss and fragmentation, accompanied by early seral habitat creation, roads, alteration of predator/prey systems, intensive recreation, and likely climate warming, are all challenging recovery planning efforts. Integrating these biological factors with political, social, and economic factors requires us to examine a multidisciplinary approach to caribou recovery.

On May 29, 2006, Dr. Dave Mattson from the University of Northern Arizona presented an evening talk titled "Science and Politics in High Stakes Natural Resource Decisions." On May 30 and 31, presentations were held at the Revelstoke Community Centre in Revelstoke, British Columbia

The workshop was attended by about 120 people. Participants included biologists, resource managers, government staff, academics, representatives of environmental non-government organizations, and others with an interest in recovering mountain caribou populations.

Presentation on Monday, May 29, 2006

Keynote Speaker

Imagining Integration: Solving Natural Resources Problems in the Common Interest

Dr. David Mattson, Northern Arizona University, Flagstaff, Arizona
david.mattson@nau.edu

"Science integration" is often a euphemism for our collective and increasingly anxious desire to efficiently solve natural resources problems in ways that ameliorate, rather than inflame, stakeholder conflicts. The focus is on solutions that embody common, rather than particularist, interests.

Viewed this way, integration is a means, not an end, and the boundaries of integration are not only among the disciplines of science, but are also within decision making and social processes. The standards for "good" information in integration are different from those of conventional science. Relevance, comprehensiveness, timeliness, cost-effectiveness, and transparency are often paramount—perhaps more so than the conventional standard of reliability. Moreover, *belief* in the information by a critical mass of stakeholders is vital.

Without belief, information has little value other than as a strategic weapon. Belief is contingent on how, and by whom, the information is generated, assembled, and applied. For that reason, the efficacy of science and other information-producing activities cannot be divorced from the quality of processes by which stakeholders are engaged to define and solve problems. Attention to process is absolutely critical when the power, wealth, and ideological stakes are high. Under these conditions, the involved people are prone to use scientific information as a weapon to bludgeon others into submission, rather than for developing a shared vision of how the world works. The emphasis is not on solving collective problems, but rather on advancing partisan agendas.

Politicized science, the opposite of "integrated" science is common when endangered species (intrinsic values) confront traditional resource commoditization (instrumental values), as in the case of mountain caribou and timber in British Columbia. The similarly configured Glen Canyon Dam Adaptive Management Program, along the Colorado River, pits the endangered humpback chub and flannelmouth sucker against electricity generation and recreational boating and fishing. I ground my talk in this singular example from the United States, which describes the promises and pitfalls that characterize high-stakes integrated problem solving—a case with ample funding, good design, but a highly politicized context.

For a list of Dr. Mattson's projects and publications, visit his web site at the USGS Southwest Biology Centre:

http://sbsc.wr.usgs.gov/about/contact/personnel.aspx
and scroll down to David Mattson.

Books mentioned in this presentation:

The Virtue of Civility: Selected essays on liberalism, tradition, and civil society, by Edward Shils. Edited by Steven Grosby. Published by Liberty Fund, Inc. in 1997.

The Value of Life: Biological Diversity and Human Life, by Stephen Kellert. Published by Island Press, 1995.

Wealth and Democracy: A political history of the American Rich, Published by Broadway Books in 2003.

Presentations on Tuesday, May 30, 2006

About the Presentation Summaries

Conference presenters provided the following summaries. Notes on the question-and-answer periods after the talks were taken by Mandy Kellner, Carmen Gustafson, and Chris Rosenbloom. Contact information is provided for all presenters, along with an invitation to contact the presenters directly for more details about their work.

1. Mountain Caribou 2006 survey results, subpopulation trends, and extinction risks

Ian Hatter, Terrestrial Ecosystem Science Section, BC Ministry of Environment, Victoria, BC
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Introduction

Woodland caribou within the Southern Mountains National Ecological Area of Canada were designated as "threatened" by the Committee on the Status of Endangered Wildlife (COSEWIC) in Canada in 2002, and are listed under Schedule 1 of the federal *Species at Risk Act*. A subgroup of these caribou, the mountain ecotype, referred to as mountain caribou, are found in the interior wet belt of British Columbia (MCTAC 2002), and are considered "endangered" (red listed) by the provincial Conservation Data Centre (see also Hatter *et al*. 2004). The population of mountain caribou in British Columbia has declined and fragmented over the past century; they are currently distributed as 18 subpopulations, some of which are contiguous while others appear isolated (Wittmer *et al*. 2005).

In response to their endangered status, a Mountain Caribou Recovery Strategy was prepared (MCTAC 2002). The Species at Risk Coordination Office was established in 2004, with a mandate to accelerate recovery planning for mountain caribou in British Columbia. The Species at Risk Coordination Office established the Mountain Caribou Science Team to provide a science-based approach to caribou recovery. The Mountain Caribou Science Team drafted the following recovery statement for mountain caribou:

> *"To halt the current decline in mountain caribou numbers within one generation (7 years), promote a stable-increasing population trend over the next three generations (20 years), and create ecological conditions that allow Mountain Caribou herds to be self-sustaining within nine generations (60 years), where ecologically feasible."*

with the following monitoring statement (Hatter 2006):

"*To monitor the Mountain Caribou meta-population over the next 7-year period with a power of 90% to detect a change in the population of 20%.*"

This report summarizes the 2006 survey results, and re-examines subpopulation trends and extinction risk, based on survey data from 1987 to 2006.

Methods

Study Area

The study area included all 18 subpopulation ranges (Fig. 1). The subpopulation ranges were determined by analyzing radio-telemetry data of > 308 collared caribou with 95% fixed kernel utilization distributions (Wittmer *et al*. 2005).

Subpopulation Size

Specific survey details can be found from the 2006 subpopulation survey reports (Freeman and Stalberg 2006; Furk 2006; Hamilton 2006; Kinley 2006; McLellan *et al*. 2006; Seip *et al*. 2006; Wakkinnen *et al*. 2006). The following description of survey methods is adapted from Wittmer *et al* (2005:409).

Using Bell 206 helicopters, caribou subpopulations were censused in March or early April, 2006 shortly after a new snowfall when caribou were in open, high-elevation habitats. In mountainous terrain, a pilot and two or three observers flew contours along the forest-subalpine habitat boundary searching for caribou tracks, while in plateau habitats, the numerous forest openings were searched. Fresh tracks were followed until the animals were sighted, unless the tracks descended into mature timber and were lost from view. When caribou were encountered, they were counted and were classified as adult males, adult females, or calves. In forested areas where close examination was not always possible, antlered females were sometimes difficult to distinguish from young males and classification was often limited to adults and calves only. When available, the location of the sighting was recorded using a Geographic Positioning System (GPS) in the helicopter, and locations were also recorded on topographic maps.

As in previous years, sightability was measured opportunistically whenever radio-collared animals were present in the survey area. Radio-collared animals were confirmed by scanning each observed group for known collar frequencies. An average sightability correction factor (*scf*) for each subpopulation from 1987 to 2006 was calculated as the sum of all radio-collared caribou observed on all surveys divided by the sum of radio-collared caribou present on all surveys. The estimated number of caribou was the survey count (observed caribou plus tracks) divided by the *scf*.

Subpopulation Trend and Extinction Risk

The finite rate of population change (λ) was estimated using the regression method recommended by Dennis *et al*. (1991) and Morris and Doak (2002:68–69). This method regresses $\log(N_{t+1})/N_t)/(t_{i+1}-t_i)^{0.5}$ against $(t_{i+1}-t_i)^{0.5}$ with the regression intercept forced to be zero. The slope of the regression is an estimate of μ (exponential rate of increase, where $\lambda = e^{\mu}$), and the regression's error mean square is an estimate of the variance, σ^2. Estimates of μ and σ^2 were used to calculate time to quasi-extinction ($N < 20$ animals) and the probability of quasi-extinction by methods outlined in Morris and Doak (2002: 79–87). Morris and Doak (2002:97) suggest that 10 censuses should be viewed as a minimum requirement to use these methods. Only four subpopulations (South Selkirks, Purcells South, Purcells Central, and Barkerville) had 10 or more survey estimates. The average number of surveys per subpopulation was six. Thus, estimates of extinction risk are considered preliminary and should be viewed cautiously.

Results and Discussion

Subpopulation Size

Table 1 summarizes the results of the 2006 surveys, and compares these results to the mid 1990s and 2002 survey estimates when most subpopulations were also completely surveyed (Wittmer et al. 2002). A *scf* was not available for the South Selkirks or Kinbasket-South subpopulations. The estimate of 83% sightability developed by Seip (1990) was applied to North Cariboo Mountains, George Mountain, Narrow Lakes and Hart Ranges (Seip et al. 2006).

While several sub-populations showed evidence of >20% decline since 2002 (e.g. Purcell Central, Duncan, Kinbasket-South, George Mountain, Narrow Lakes) there were also some subpopulations that showed evidence of >20% increase (e.g. Monashee-South, Groundhog, and Hart Ranges). Overall, the metapopulation size was slightly higher in 2006 than in 2002 (1907 versus 1838). If the Hart Ranges is excluded from the analysis, the remaining sub-population declined from an estimate of 1948 in the mid 1990s to 1388 in 2002, to 1190 animals in 2006, for an average rate of decline of about 4.5% per year.

Subpopulation Trends and Extinction Risk

Table 2 shows changes in annual growth rates of subpopulations, as well as preliminary estimates of quasi-extinction risks, using the methods of Morris and Doak (2002). Based on an analysis of all survey results since 1987, 2 subpopulations have become extirpated (Purcells-Central and George Mountain), 12 have declined, 2 are stable (Barkerville and North Caribou Mountains) and 1 (Hart Ranges) has increased (Fig. 2 to 19). The large increase in the Hart Ranges, while likely reflecting some population growth, is also partially attributed to more complete survey coverage in the Parsnip drainage in 2006. For example, 191 caribou were counted in Parsnip in 2006, compared to 81 in 2005 (Seip *et al*. 2006). Tables 3 and 4 provide the raw survey counts and estimated numbers for each subpopulation from 1987 to 2006.

The subpopulations at highest risk of quasi-extinction (> 75% probability of 20 or fewer caribou in 20 years) include: Purcell South, Nakusp, Duncan, Monashee-South, Columbia South, Frisby-Boulder, Kinbasket-South, Groundhog, Allan Creek, and Narrow Lakes.

However, confidence limits indicate a low level of confidence with these predictions for Nakusp, Columbia South, Groundhog, Allan Creek, and Narrow Lakes (Table 2). The extinction risks were similar to those reported by Wittmer (2004) based on vital rates.

It is recommended that another survey of all subpopulations be undertaken in 2009. However, some subpopulations that are at, or close to, quasi-extinction thresholds should be monitored more frequently (preferably annually), if possible. A *scf* should be developed for the South Selkirk subpopulation. A Bayesian analysis of sightability should be investigated to enable calculation of credibility intervals on all population estimates.

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Wittmer, H.U., B.N. McLellan, D.R. Seip, J. A. Young, T. A. Kinley, G. S. Watts, and D. Hamilton. 2005. Population dynamics of the endangered mountain ecotype of woodland caribou (*Rangifer tarandus caribou*) in British Columbia, Canada. Can. J. Zoo. 83:407–418.

Discussion after Ian's presentation

Q: Do you have any estimates of pre-contact population sizes?

A: The first attempt was by Dr. Bergerud in the 1970s and his work might provide answers. There is severe contraction and fragmentation of known former ranges.

Table 1. Summary of subpopulation counts (observed number of caribou and tracks) and estimates based on application of a sightability correction factor (*scf*). Count years include the mid 1990s, 2002 and 2006 when all subpopulations were surveyed.[1]

Herd[1]	**Mid-to-late 1990s Survey**			**2002 Survey**		**2006 Survey**		***scf***
	Year	**Count**	**Estimate**	**Count**	**Estimate**	**Count**	**Estimate**	
SS	1995	52	52	34	34	37	37	1.00
PS	1995	63	77	14	17	16	20	0.81
PC	1995	15	18	5	6	0	0	0.86
NA	1996	186	211	76	103	74	85	0.87
DU	1996	25	29	20	23	0	9	0.87
MS	1994	10	12	4	5	7	8	0.83
CS	1994	105	114	29	34	16	29	0.89
FB	1996	20	24	20	24	16	19	0.83
CN	1997	203	280	145	145	125	138	0.96
KS	1995	19	25	5	5	0	2	1.00
GH	1995	37	48	15	19	23	30	0.78
WG	1995	511	620	310	516	398	422	0.81
AC				22	38	11	33	0.58
BV	1994	39	55	41	58	44	51	0.71
NC	1993	232	279	236	284	209	267	0.83
GM	1992	20	24	3	4	0	0	0.83
NL	1999	67	81	61	73	33	40	0.83
HR[2]		n/a	n/a	374	450	578	717	0.83
Total[3]				1414	**1838**	1587	**1907**	

[1]SS, South Selkirks; PS, Purcells-South; PC, Purcells-Central; NA, Nakusp; DU, Duncan; MS, Monashee South; CS, Columbia-South; FB, Frisby-Boulder; CN, Columbia-North; KS, Kinbasket-South; GH, Groundhog; WG, Wells Gray; AC, Allan Creek; BV, Barkerville; NC, North Cariboo Mountain; GM, George Mountain; NL, Narrow Lake; and HR, Hart Ranges

[2]There is no mid-1990s survey data for the Hart Ranges that includes the Parsnip portion. Excluding the Parsnip portion the estimates are: 1992: 376; 2002: 331; 2006: 487

[3]Including the non-Parsnip portion of the Hart Ranges, the totals are 1992: 1917, **2325**; 2002: 1315, **1719**; and 2006: 1396, **1677**

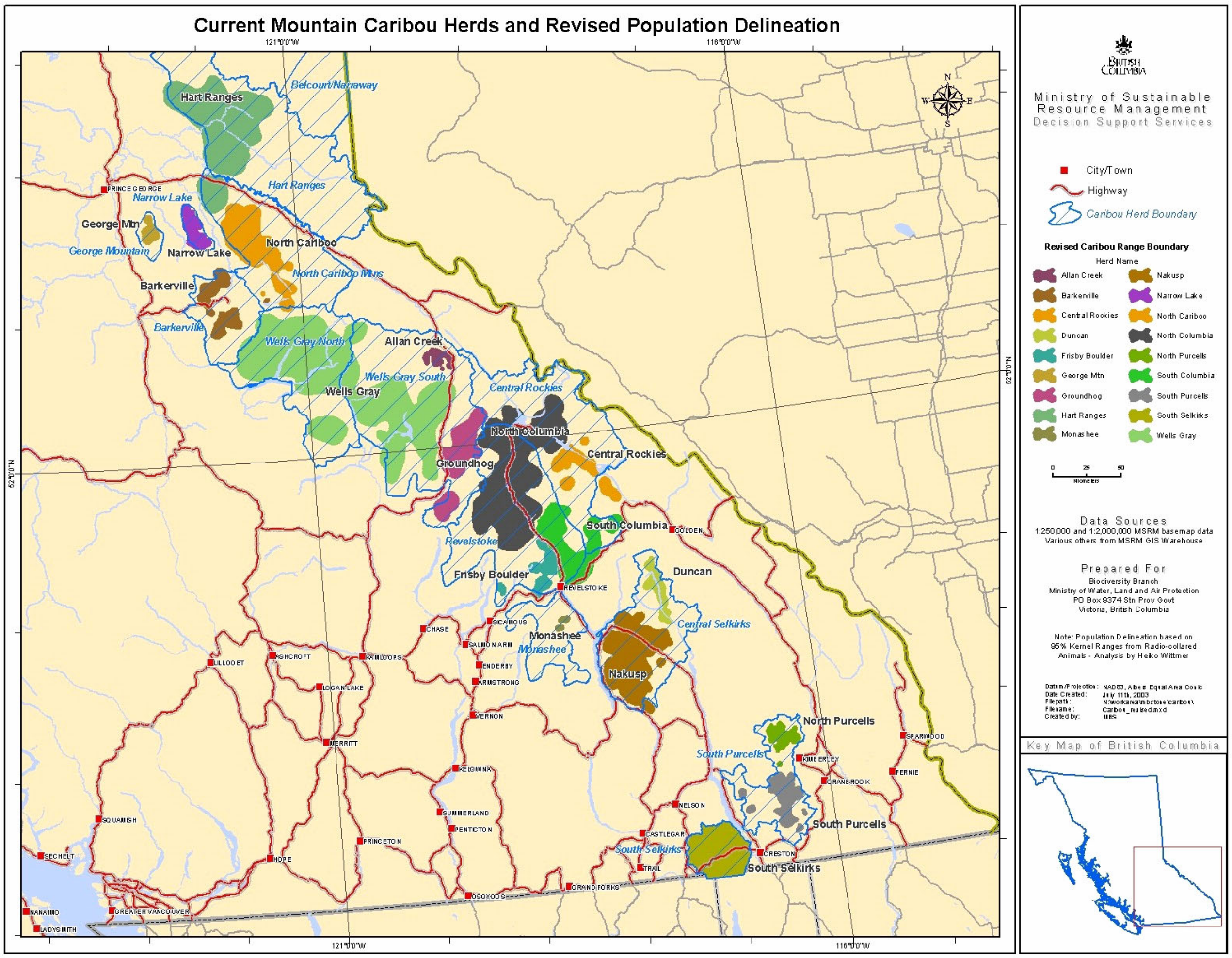
[1] Allan Creek was not surveyed in 1995. Recent radio-telemetry surveys suggest that Allan Creek is actually part of the Wells Gray subpopulation (Furk 2006).

Table 2. Annual population growth rate, time to quasi-extinction (N < 20 animals), and probability of quasi-extinction in 20 years. LCL and UCL are the 95% lower and upper confidence limits respectively.

Survey Area[1]	Annual Growth Rate (λ)			Time (yrs) to Quasi-Extinction			Probability of Quasi-Extinction in 20 yrs		
	mean	LCL	UCL	mean	LCL	UCL	mean	LCL	UCL
SS	0.98	0.90	1.08	39	0	233	54%	0%	97%
PS	0.91	0.77	1.08	0	0	0	100%	100%	100%
PC	extirpated			extirpated			extirpated		
NA	0.91	0.83	1.00	16	5	27	83%	0%	99%
DU	0.89	0.76	1.05	0	0	0	100%	100%	100%
MS	0.97	0.63	1.42	0	0	0	100%	100%	100%
CS	0.89	0.76	1.04	3	0	6	100%	5%	100%
FB	0.93	0.70	1.25	0	0	0	100%	100%	100%
CN	0.97	0.76	1.23	58	0	325	24%	0%	94%
KS	0.79	0.41	1.52	0	0	5	100%	100%	100%
GH	0.95	0.76	1.18	8	0	33	91%	10%	99%
WG	0.97	0.81	1.15	87	0	356	0%	0%	78%
AC	0.97	0.03	33.89	14	0	170	86%	0%	100%
BV	1.00	0.76	1.32	200	0	10720	69%	4%	98%
NC	1.00	0.95	1.05	799	0	4837	0%	0%	7%
GM	extirpated			extirpated			extirpated		
NL	0.90	0.54	1.50	7	0	26	92%	0%	100%
HR	1.02	0.87	1.19	173	0	708	0%	0%	60%

[1]SS, South Selkirks; PS, Purcells-South; PC, Purcells-Central; NA, Nakusp; DU, Duncan; MS, Monashee South; CS, Columbia-South; FB, Frisby-Boulder; CN, Columbia-North; KS, Kinbasket-South; GH, Groundhog; WG, Wells Gray; AC, Allan Creek; BV, Barkerville; NC, North Cariboo Mountain; GM, George Mountain; NL, Narrow Lake; and HR, Hart Ranges (excludes counts in Parsnip drainage)

Figure 1. Map of mountain caribou distribution showing identified subpopulations. The previous 13 local populations identified by MCTAC (2002) are also shown.



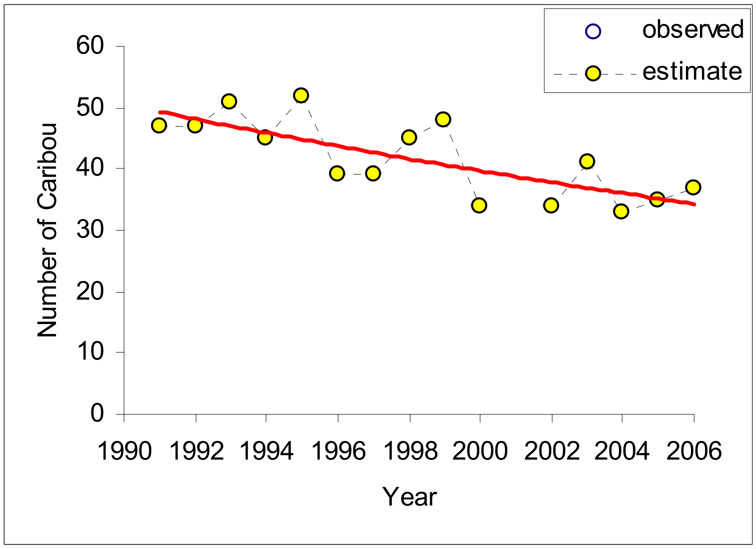


Figure 2. South Selkirk subpopulation trend from 1991 to 2006.

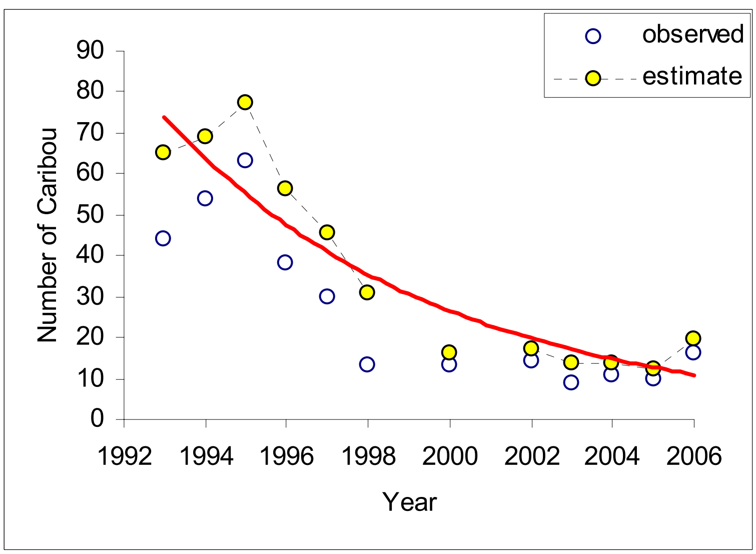


Figure 3. Purcell-South subpopulation trend from 1993 to 2006.

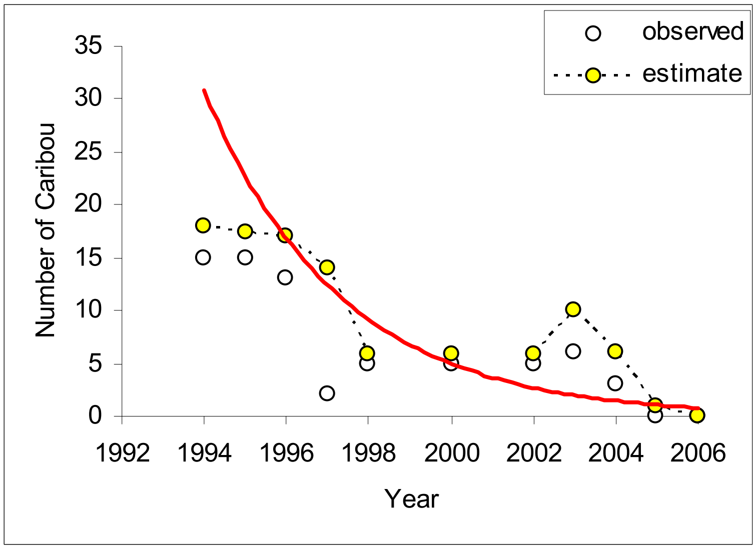


Figure 4. Purcell-Central subpopulation trend from 1994 to 2006.

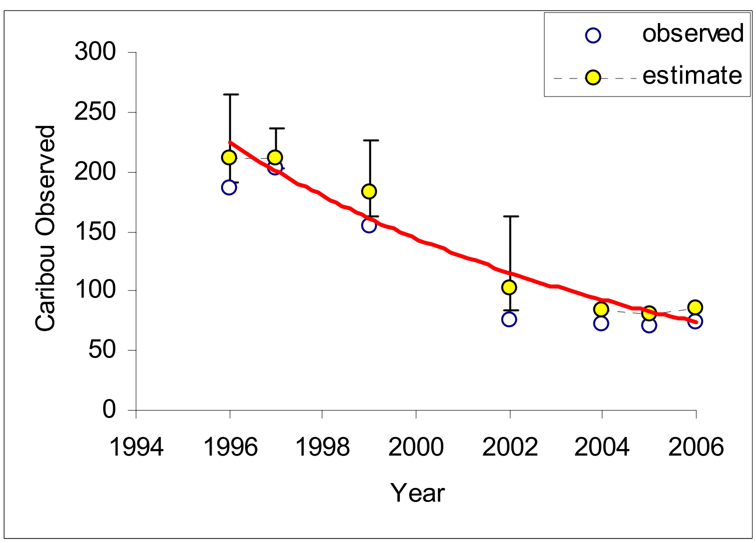


Figure 5. Nakusp subpopulation trend from 1996 to 2006.

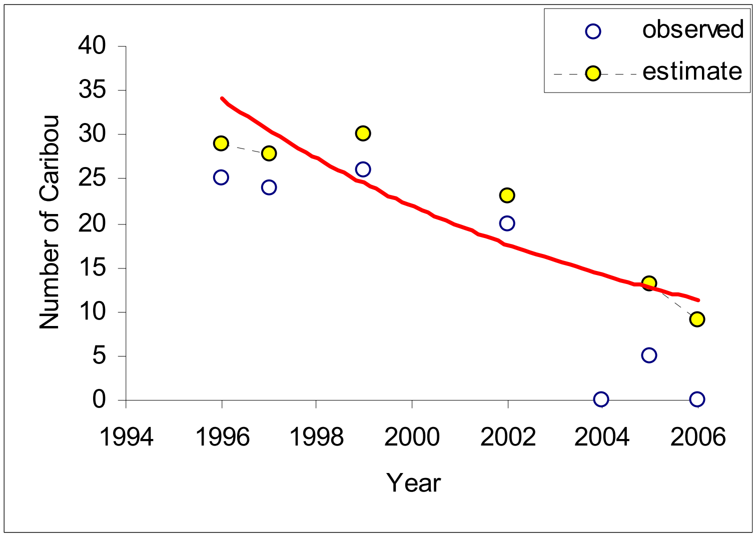


Figure 6. Duncan subpopulation trend from 1996 to 2006.

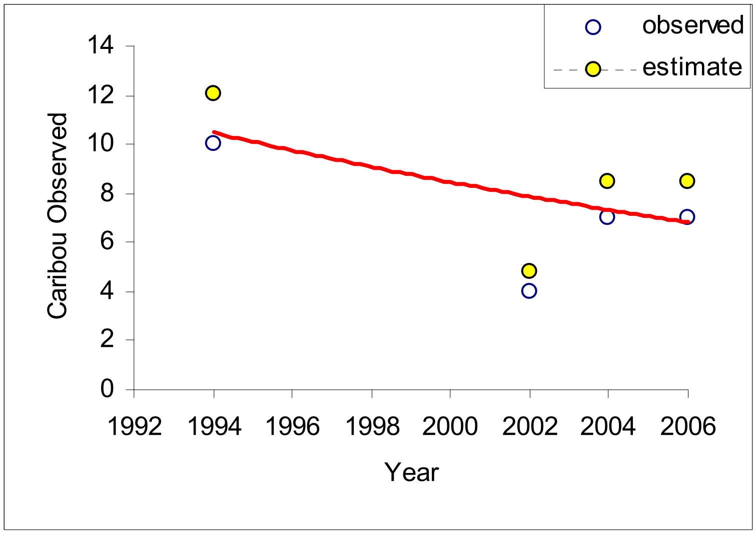


Figure 7. Monashee-South subpopulation trend from 1994 to 2006.

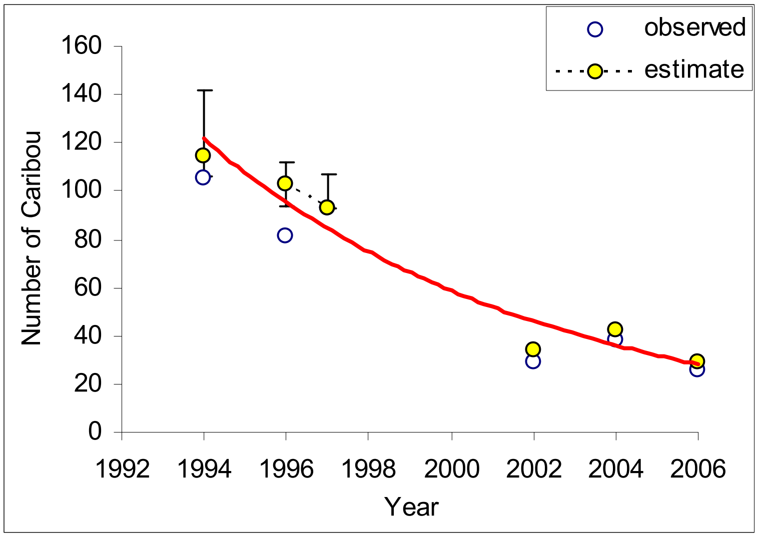


Figure 8. Columbia-South subpopulation trend from 1994 to 2006.

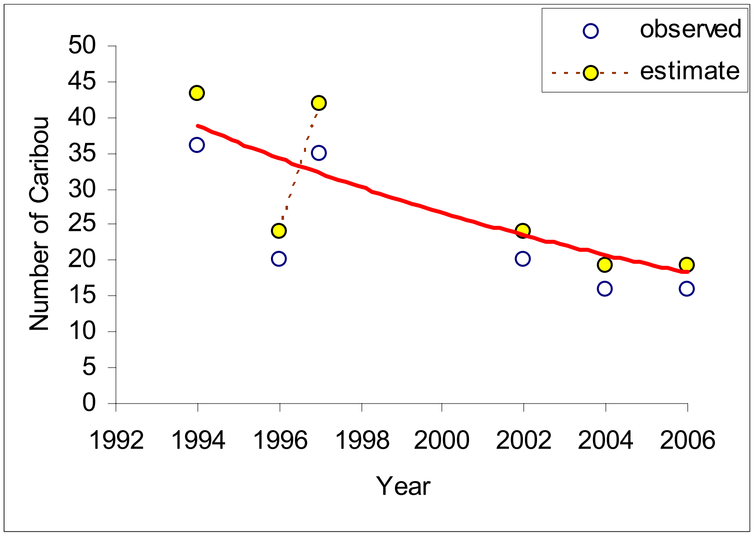


Figure 9. Frisby-Boulder subpopulation trend from 1994 to 2006.

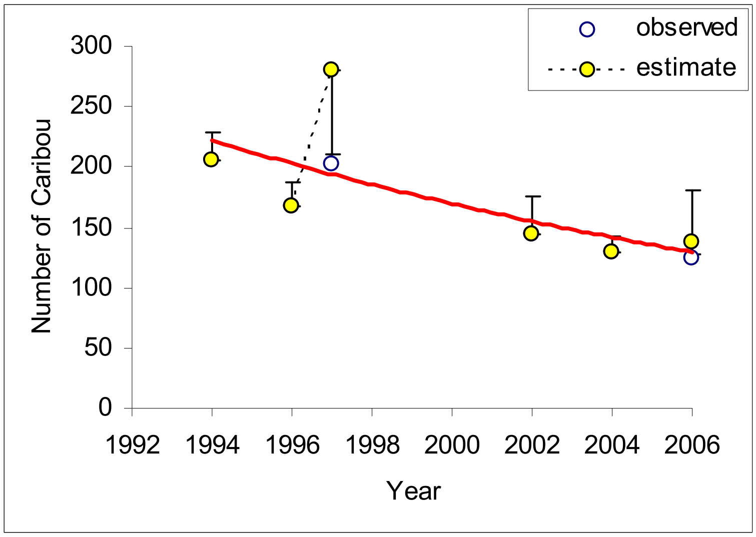


Figure 10. Columbia-North subpopulation trend from 1994 to 2006.

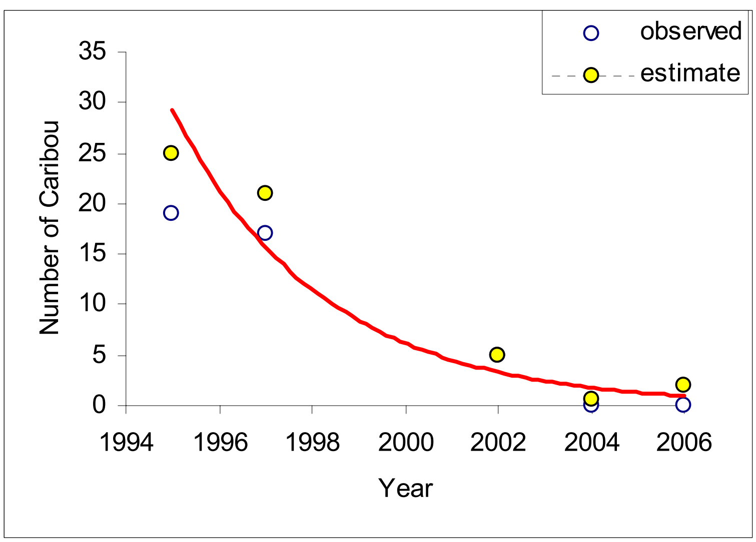


Figure 11. Kinbasket-South subpopulation trend from 1995 to 2006.

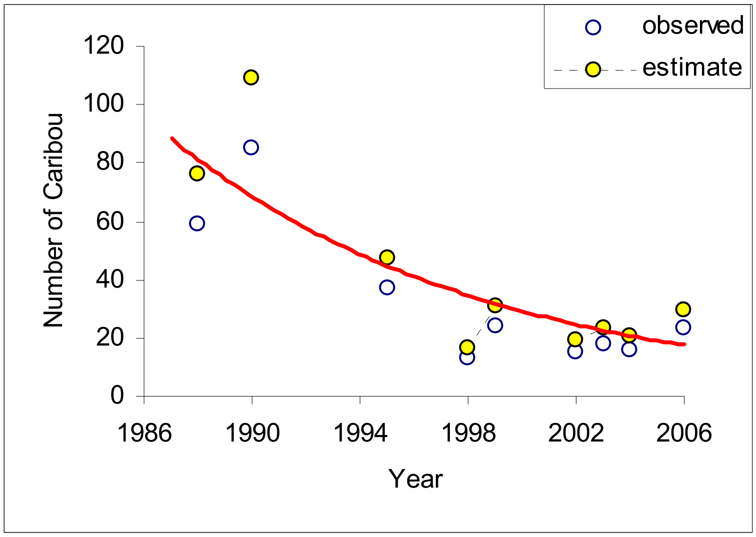


Figure 12. Groundhog subpopulation trend from 1988 to 2006.

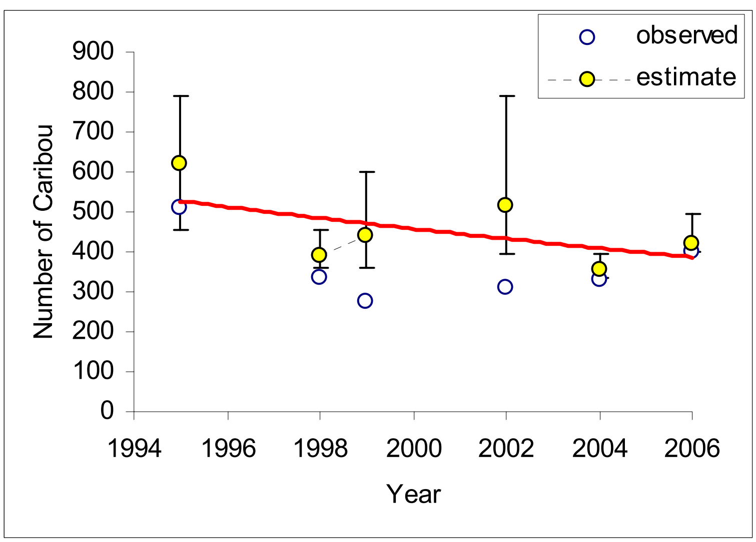


Figure 13. Wells Gray subpopulation trend from 1995 to 2006.

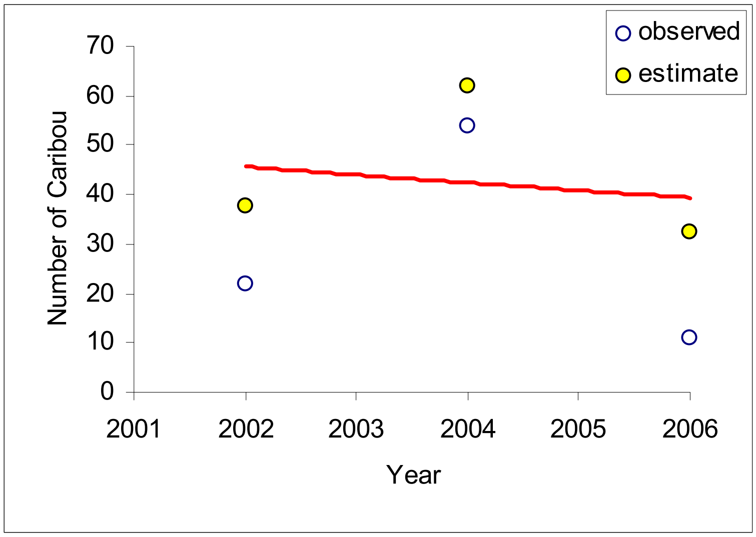


Figure 14. Allan Creek subpopulation trend from 2002 to 2006.

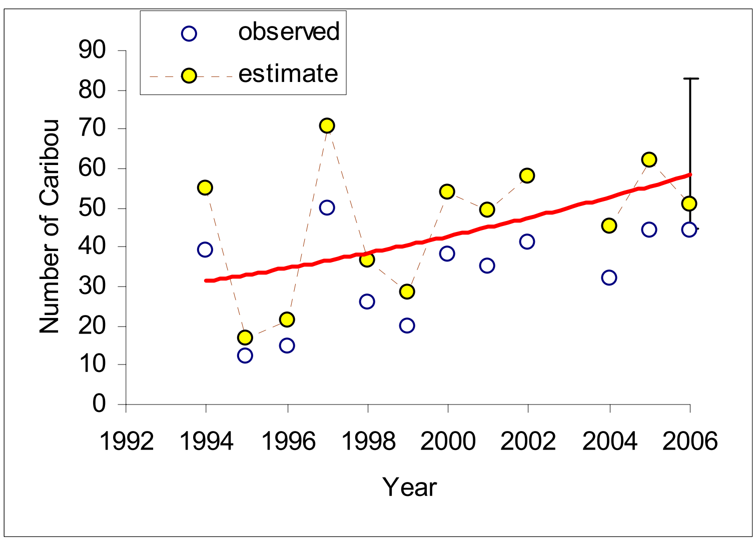


Figure 15. Barkerville subpopulation trend from 1987 to 2006.

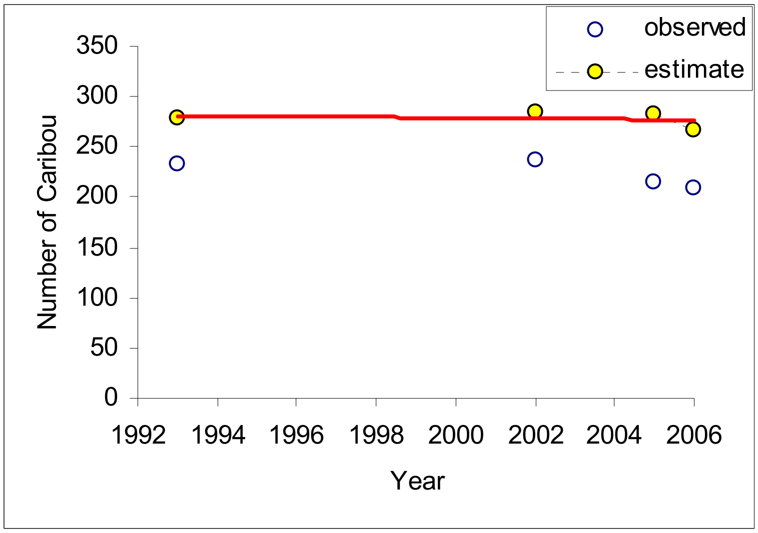


Figure 16. North Caribou Mountains subpopulation trend from 1993 to 2006.

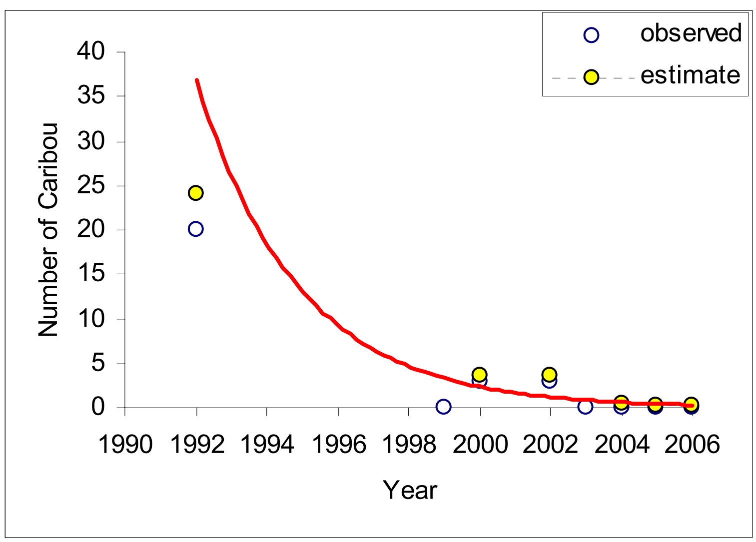


Figure 17. George Mountain subpopulation trend from 1992 to 2006.

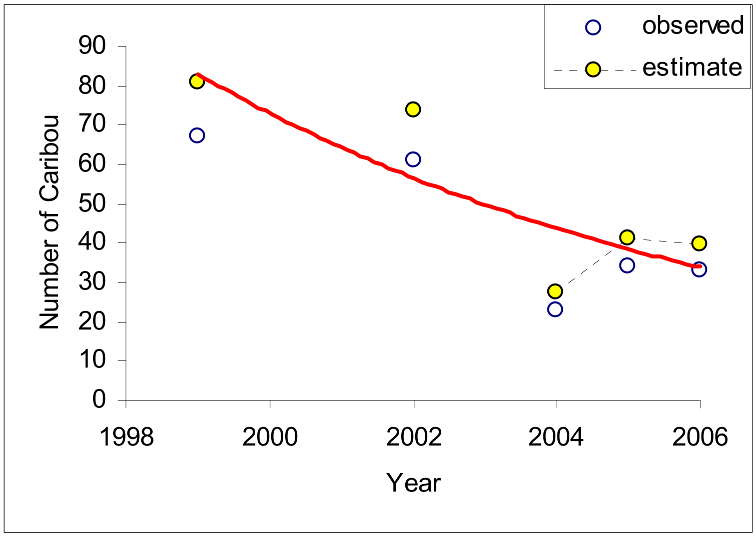


Figure 18. Narrow Lakes subpopulation trend from 1999 to 2006.

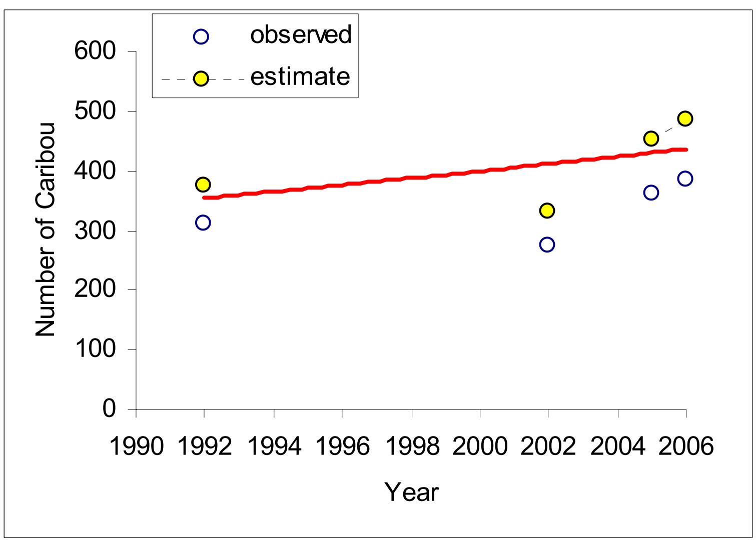


Figure 19. Hart Ranges subpopulation trend from 1992 to 2006 (excludes Parsnip portion or range).

Table 3. Number of caribou counted (plus tracks) in each subpopulation by year.

Year	SS[1]	PS	PC	NA	DU	MS	CS	FB	CN	KS	GH	WG	AC	BV	NC	GM	NL	HR
1987														33				
1988											59			38				
1989														37				
1990											85							
1991	47													31				
1992	47													27		20		
1993	51	44												16	232			
1994	45	54	15			10	105	36	206					39				
1995	52	63	15							19	37	511		12				
1996	39	38	13	186	25		81	20	167					15				
1997	39	30	2	203	24		93	35	280	17				50				
1998	45	13	5								13	337		26				
1999	48			155	26						24	276		20		0	67	
2000	34	13	5											38		3		
2001														35				
2002	34	14	5	76	20	4	29	20	145	5	15	310	22	41	236	3	61	374
2003	41	9	6								18					0		
2004	33	11	3	72	0	7	38	16	129	0	16	331	54	32		0	23	
2005	35	10	0	70	5									44	215	0	34	458
2006	37	16	0	74	0	7	26	16	138	0	23	398	11	44	209	0	33	596

[1]SS, South Selkirks; PS, Purcells-South; PC, Purcells-Central; NA, Nakusp; DU, Duncan; MS, Monashee South; CS, Columbia-South; FB, Frisby-Boulder; CN, Columbia-North; KS, Kinbasket-South; GH, Groundhog; WG, Wells Gray; AC, Allan Creek; BV, Barkerville; NC, North Cariboo Mountain; GM, George Mountain; NL, Narrow Lake; and HR, Hart Ranges (excludes counts in Parsnip drainage)

Table 4. Estimated number of caribou in each subpopulation by year.

Year	SS[1]	PS	PC	NA	DU	MS	CS	FB	CN	KS	GH	WG	AC	BV	NC	GM	NL	HR
1987														47				
1988											76			54				
1989														52				
1990											109							
1991	47													44				
1992	47													38		24		
1993	51	65												23	279			
1994	45	69	18			12	114	43	206					55				
1995	52	77	18							25	48	620		17				
1996	39	56	17	211	29		103	24	167					21				
1997	39	45	14	211	28		93	42	280	21				71				
1998	45	31	6								17	390		37				
1999	48			182	30						31	441		28			81	
2000	34	16	6											54		4		
2001														49				
2002	34	17	6	103	23	5	34	24	145	5	19	516	38	58	284	4	73	451
2003	41	14	10								23							
2004	33	14	6	83		8	42	19	129	1	21	355	62	45		0	28	
2005	35	12	1	81	13									62	283	0	41	552
2006	37	20	0	85	9	8	29	19	138	2	30	422	33	51	267	0	40	718

[1]SS, South Selkirks; PS, Purcells-South; PC, Purcells-Central; NA, Nakusp; DU, Duncan; MS, Monashee South; CS, Columbia-South; FB, Frisby-Boulder; CN, Columbia-North; KS, Kinbasket-South; GH, Groundhog; WG, Wells Gray; AC, Allan Creek; BV, Barkerville; NC, North Cariboo Mountain; GM, George Mountain; NL, Narrow Lake; and HR, Hart Ranges (excludes counts in Parsnip drainage)

2. *Factors influencing the dispersion and fragmentation of endangered mountain caribou populations*

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Biological Conservation Volume 130, Issue 1, June 2006, Pages 84–97

Abstract

Mountain caribou, an ecotype of woodland caribou, are endangered due to the loss and fragmentation of old forests on which they depend. However, a wider array of natural and human factors may limit caribou persistence and isolate populations and understanding these may help to stop, or reverse, population declines by forecasting risk and targeting core habitat areas and key linkages for protection, enhancement, or restoration.

Across most of the historic range of mountain caribou, we conducted a bi-level analysis to evaluate factors related to the persistence of, and landscape occupancy within, remaining subpopulations. We used caribou location data from 235 radio-collared animals across 13 subpopulations to derive a landscape occupancy index, while accounting for inherent sampling biases. We analyzed this index against 33 landscape variables of forest overstorey, land cover, terrain, climate, and human influence.

At the metapopulation level, the persistence of subpopulations relative to historic range was explained by the extent of wet and very wet climatic conditions, the distribution of both old (>140 years) forests, particularly of cedar and hemlock composition, and alpine areas. Other important factors were remoteness from human presence, low road density, and little motorized access. At the subpopulation level, the relative intensity of caribou landscape occupancy within subpopulation bounds was explained by the distribution of old cedar–hemlock and spruce–subalpine fir forests and the lack of deciduous forests. Other factors impeding population contiguity were icefields, non-forested alpine, hydro reservoirs, extensive road networks, and primary highway routes. Model outputs at both levels were combined to predict the potential for mountain caribou population persistence, isolation, and restoration. We combined this output with the original occupancy index to gauge the potential vulnerability of caribou to extirpation within landscapes known to have recently supported animals. We discuss implications as they pertain to range-wide caribou population connectivity and conservation.

3. *Can mountain caribou foraging habitat be maintained in a managed forest? The Quesnel Highland Project, ten years post-harvest*

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Summary

Group selection silvicultural systems are being tested as an option for managing mountain caribou habitat in high-elevation Engelmann spruce–subalpine fir zoned forests. The response of arboreal forage lichen to harvesting 30% of the forested area using three partial cutting treatments (small [0.03 ha], medium [0.13 ha], and large [1.0 ha] openings) and a no-harvest treatment were measured over a 10-year, post-harvest period. There was an increase in lichen abundance on trees in the three partial cutting treatments relative to trees in the uncut forest in the caribou feeding zone (up to 4.5 m). Partially cut treatments showed a greater likelihood of shifting towards more *Bryoria spp*. than the no-harvest treatment. Tree fall rates were low and similar among treatments. The 10-year, post-harvest results indicate that caribou foraging habitat is maintained in the residual forest when group selection systems that removed only 30% of the area are applied.

Other related research on the same study areas shows that trees can be re-established in the harvested openings and that initial tree growth is adequate. All of this research has led to operational application of partial cutting in caribou habitat. The planned silvicultural system involves returning every 80 years to harvest one-third of the stand and allows 240 years before any openings are cut again. An adaptive management trial is underway to assess caribou use of a landscape-level application of this partial cutting. A combination of this type of modified timber harvesting, plus large contiguous no-harvest areas characterizes current management for about 70% of the mountain caribou in British Columbia (covering the northern part of their range). However, providing lichen-bearing habitat meets just one of the needs of caribou. In addition to habitat management, a comprehensive approach that considers all factors (e.g., predators, primary prey, motorized recreational access) and their interactions is essential to maintain and recover the threatened mountain caribou.

This presentation was partially based on:

Waterhouse, M.J., H.M. Armleder and A.F.L. Nemec. xxxx. Arboreal forage lichen response to partial cutting of high elevation mountain caribou range in the Quesnel Highland of east-central British Columbia. Submitted to *Rangifer xx:xxx-xxx*.(not yet accepted for publishing when this conference summary was compiled)

<u>Discussion after Harold's presentation</u>

Q: Are you planting openings or relying on natural regeneration?

A: We tested both. There are advantages to each. With natural regeneration, you can leave standing dead trees. With planting, you need to fall all of the trees for worker safety. However, although you leave snags with natural regeneration, the regeneration is slower. But if it takes 240 years for trees to grow again, 10 years is not a big concern.

Q: Does your study address the issue of foraging efficiency of mountain caribou in this managed landscape?

A: We didn't look at that. The openings average .5 ha. Given the meandering way that mountain caribou forage, I don't think we are impacting foraging efficiencies. The caribou can stay out of openings or cross at narrow parts.

Q: What kind of wolf management do you plan to have?

A: The Ministry of Environment can answer that, but I believe it will involve sterilization of alpha male and females, and reduction in pack sizes, where packs overlap with caribou range.

4. *Mountain caribou foraging ecology and small-scale habitat use: Is it really all about lichen?*

Rob Serrouya, Columbia Mountains Caribou Project, Revelstoke, BC
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No summary provided.

<u>Discussion after Rob's talk</u>

Q: What about the creation of early seral stages and altering predator/prey dynamics? Does the creation of edges increase alternate prey habitat?

A: With partial cuts, you need to keep the openings small, to prevent a shrub response to the light, and thus not encourage food growth for alternate prey species. It is hard to measure alternate prey numbers, and easier to measure shrubs. Openings need to be less than 0.5 ha to prevent shrubs from growing in response to increased light. We also have 15 GPS collars on moose in the Columbias, and would like to look at intensity of use under different harvesting systems. However, the partial cuts in this area are new, and not mature enough to be used by moose. Moose do use large openings – I have seen them in 20 year old openings, right in the middle. Higher edge density does not create more moose habitat.

5. *Mountain pine beetle: New hope for mountain caribou?*

Dr. Trevor Goward, Enlichened Consulting, Clearwater, BC
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Lodgepole pine in southern British Columbia is currently being decimated by an unprecedented outbreak of mountain pine beetle. In many areas this will result, at least temporarily, in an anomalously open canopy structure highly conducive to the production of arboreal hair lichens. Within the next 10–15 years, both beetle-killed pine stands and adjacent living stands of other tree species can be expected to support hair lichen loadings many times heavier than at present. Though hair lichen production will be most copious in the middle and upper canopy, well-ventilated sites are likely to yield heavy loadings within foraging reach of mountain caribou. Putting aside the increased possibility of wildfire, the existence of more open canopy structure within the wintering range of mountain caribou is likely to considerably enhance winter foraging opportunities in the years to come. To the extent these animals are currently under pressure from predators, it seems clear they would greatly benefit from greater foraging options. If only for this reason, future salvage logging operations of beetle-killed pine within the winter range of the mountain caribou should be kept to a minimum. Stands with a high potential for heavy hair lichen loadings are most critical in this regard, and should be allowed to remain standing.

Following from these recommendations, I am currently seeking funding for two projects. In the first project I will devise a simple predictive model for the recognition of lodgepole pine stands conducive to heavy hair lichen loadings. In the second, longer-term project, I will test this model against observed trends in hair lichen composition and biomass in beetle-killed stands. In the meantime, biologists and resource managers are urged to act decisively to ensure that protocols for the salvaging of beetle-killed lodgepole pine are sensitive to the pressing need of mountain caribou for increased foraging options. Interested parties are invited to contact the author for further details.

6. *Predation: Its role in recent declines and future recovery*

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Introduction

Understanding and potentially limiting predation of mountain caribou is of key importance in maintaining and recovering caribou populations because of the following:

Predation accounts for most deaths. Data assembled by Simpson and Woods (1987), Compton *et al*. (1995), Almack (2000), and Wittmer (2004), along with recent unpublished data for several herds, show that over 40% of collared caribou deaths have been of unknown cause, but of the known-cause deaths about 60% have been due to predation. Because human-caused mortalities and accidents (and often malnutrition) are easier to diagnose, the proportion of predation deaths among the "unknowns" is probably higher. There is strong circumstantial evidence to indicate that predation levels are now higher than historical levels, and in many recent cases, predation alone (excluding all other forms of mortality) has exceeded recruitment. If controversy over dealing with predation results in inaction, current demographic trends indicate that there is a high chance of most remaining herds being extirpated.

Woodland caribou of all ecotypes, including mountain caribou, are vulnerable to predation because they provide a large amount of food, present little risk to carnivores attempting to kill them, and are physically and behaviourally adapted to avoiding predation in open areas rather than forest. Despite this, they have persisted for thousands of years for two related reasons. First, they have occurred at low densities relative to other prey species, which themselves have typically been at low to moderate densities (Thomas 1992) in caribou range, so they have not supported particularly large predator populations. Second, at a finer scale, this persistence has been related to woodland caribou using habitats (peatlands, lichen forest, alpine, old forest, and deep-snow zones) that separate them from the preferred habitats of other ungulates such as moose, elk, and deer (which predominantly use early seral habitats such as young forest, shrubby areas, meadows, burns, and slide paths [Cumming *et al*. 1996; McLoughlin *et al*. 2005]). In summary, mountain caribou and other woodland caribou have occurred where predators aren't abundant and those predators that are present have not found it worthwhile to specifically target caribou. However, when encountered, caribou are more vulnerable than most other ungulates. Caribou are thus predated upon in an incidental, rather than targeted, fashion. Conditions that once permitted the historic persistence of caribou in landscapes containing other ungulate species are now changing in at least two ways, as described below.

Predator Numbers

Throughout much of woodland caribou range, including most of mountain caribou range, there are more total ungulates than there were a century or two ago, and they are of species that are available year round. This reflects potentially natural expansion of the ranges of some species (Messier *et al*. 2004) combined with human-caused habitat alteration (see below). These ungulate increases lead to greater predator numbers and therefore greater incidental kills of caribou. Estimated populations of moose, elk, mule deer, and white-tailed deer are all moderately to dramatically higher within the range of mountain caribou than they are believed to have been in the 1800s. A threshold of 0.2 moose/km^2 has been suggested as the limit beyond which the number of wolves supported (0.008/km^2) will lead to declining caribou populations in west-central Alberta (Lessard 2005). The corresponding values within mountain caribou range likely differ, given the difference in prey and predator composition and the greater diversity of ecosystems here.

Predation – Distribution in time and space

British Columbia mountain caribou habitat is concentrated on gentle high-elevation terrain within a complex of high mountains and deep narrow valleys. Little in the way of extensive ungulate winter range is available in much of the area traditionally associated with mountain caribou. However deer, elk, moose, cougars, and wolves are often seasonally migratory and will move from distant winter ranges to caribou habitat in summer. Winter ranges are highly concentrated and are considered by most British Columbia ungulate biologists to be the primary limit on the populations. The distribution and abundance of these primary prey species are highly variable as a result and present mountain caribou management opportunities.

Deer, elk, and moose populations also undergo wide variations in population size over time as predation, hunting, and winter range conditions vary from year to year. These population variations need to be understood and acted upon if mountain caribou populations are to be sustained.

Research on predation

A good deal of research has taken place on caribou and the causes of mortality. Wittmer (2004) summarized this research in his thesis, observing:

- Grizzly bears, black bears, and wolverine are important predators across the ranges of caribou.
- Wolves are particularly important in north.
- Cougars are particularly important in south.
- There appears to be a relatively constant level of bear predation since bear populations change slowly.
- There appears to be wide variation in wolf and cougar populations.
- Wolves and cougar may be the proximal cause of caribou population declines.
- Predator populations have numerical response to alternate prey.
- Mountain caribou have become secondary prey.
- Habitat alteration may be influencing alternate (primary) prey population growth.

Consumption rates by cougars and wolves have been integrated into Bayesian models developed by the Provincial Mountain Caribou Science Team (McNay *et al.* 2006). These consumption rates show how little caribou contribute to the survival of cougar and wolf populations and how important other primary prey species are to the survival of these predator populations. A cougar forced to live only on mountain caribou is likely to consume about one caribou per 1.5 weeks or 35 caribou annually, approximately the entire mountain caribou population in the South Selkirks. An average wolf pack is likely to consume about two caribou per week and, therefore, one wolf pack would be capable of consuming the entire Revelstoke caribou population in less than two years. Clearly, cougar and wolves are not relying entirely on caribou for food and the caribou are secondary prey.

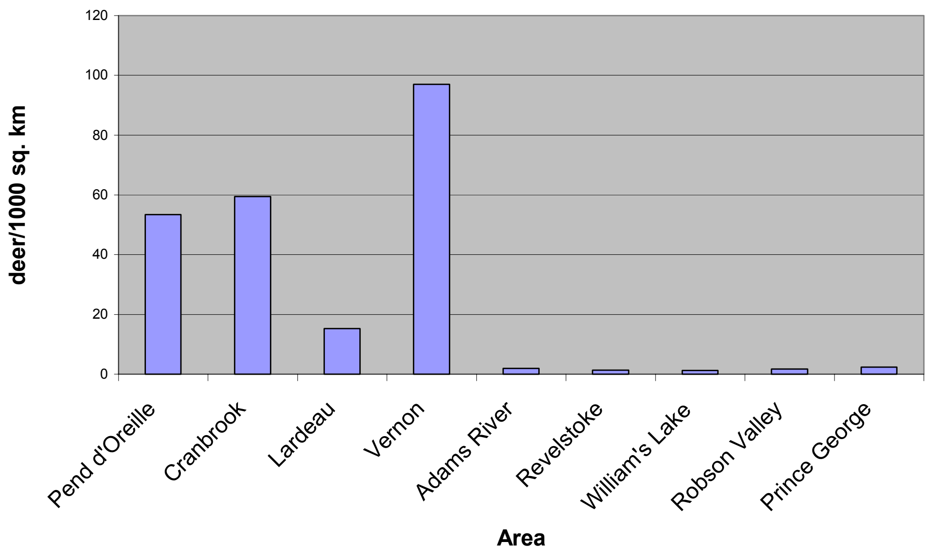
Deer, elk, and moose populations across mountain caribou range

Estimating the number of deer, elk, and moose present in, and adjacent to, mountain caribou habitat is difficult since resources have not been allocated to determining these populations with any precision or consistency. In addition, tracking these populations over time has not been possible. Hunter harvest statistics gathered annually by the BC Ministry of Environment through questionnaires provide one source of data that is both consistently collected and has a long time series. Clearly these data have problems of interpretation relative to population estimations since the rate of harvest is not known. In addition harvest rates change annually. Nonetheless they are useful in portraying broad patterns of density and long-term changes in populations as hunters seek to maximize their harvest. One hundred-fold differences in population size between areas are large enough to make annual variations in harvest success, and even differences in hunting seasons, largely irrelevant. Time series data is more difficult to compare from area to area but can be used to compare trends within areas.

Ten wildlife management units are identified across the range of mountain caribou and harvest densities are averaged over the 1987 to 2004 period for white-tailed deer, mule deer, elk, and moose. These have been added to give an estimate of the total primary prey base that may be available to predators within each area. This data is presented in Figures 1 to 5 (BC Ministry of Environment, Warkentin tables 2005).

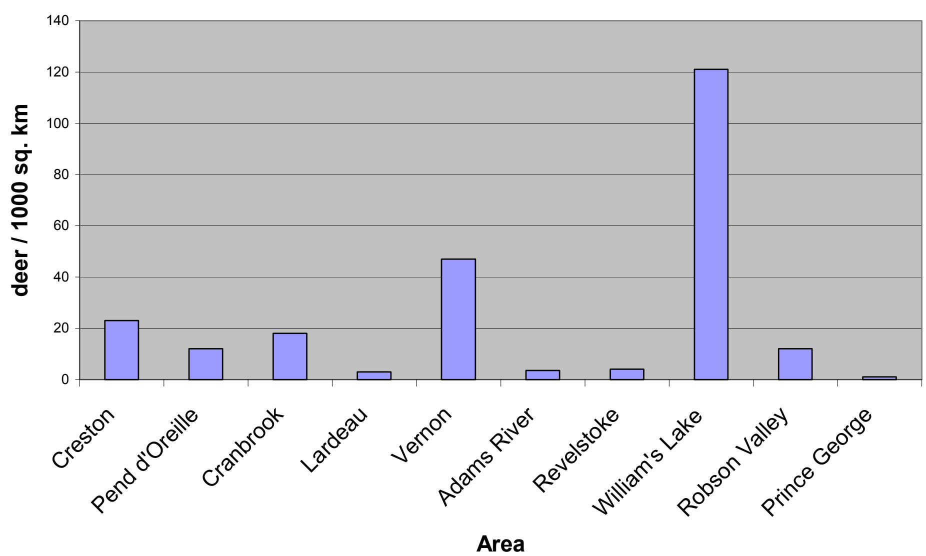
White-tailed deer are highly concentrated in the southern third of the study area (Figure 1). Harvest densities of 53 to 97 white-tailed deer harvested per 1000 sq. km occur in the best areas. Conversely, the low areas support harvests of 1 to 2 white-tailed deer per 1000 sq. km.

Figure 1. White-tailed deer Harvest Density Deer/ 1000 sq. km



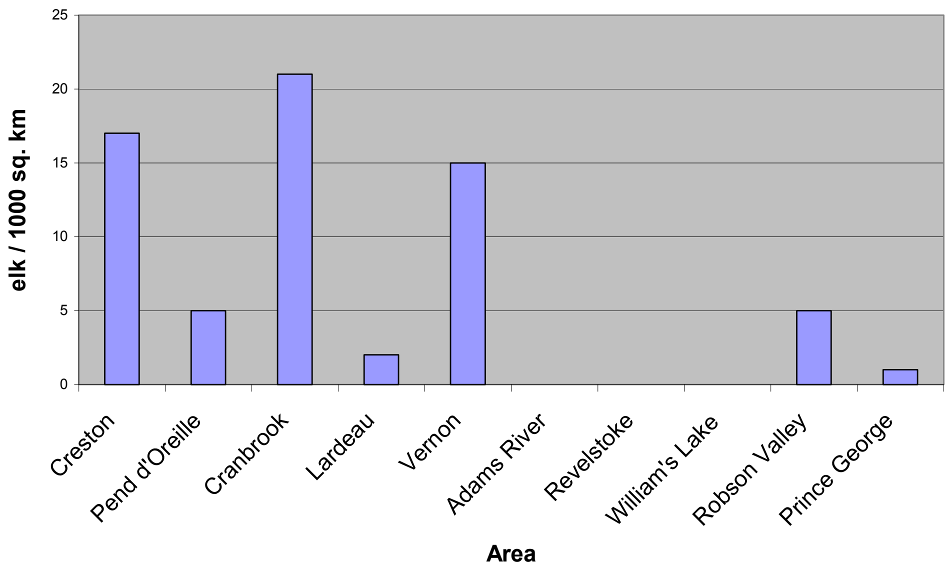
High mule deer harvests occur in the Vernon and Williams Lake area with 47 to 121 mule deer harvested per 1000 sq. km while northern and some southern areas support harvests of only 1 to 3 mule deer per 1000 sq. km (Figure 2).

Figure 2. Mule deer harvest density (deer / 1000 sq.km



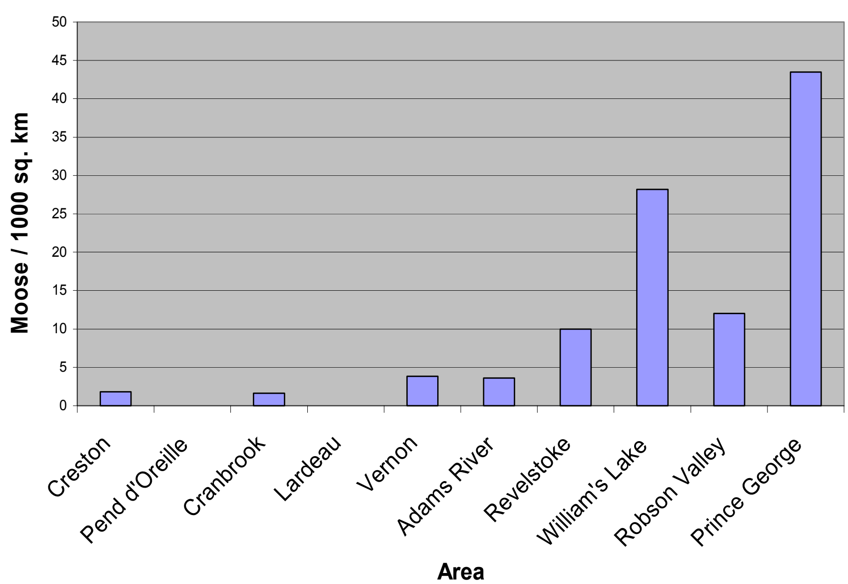
Elk harvest concentrations are in the Creston, Cranbrook, and Vernon areas with harvests of 15 to 21 bulls per 1000 sq. km while areas in the central and northern portion of caribou range have no elk (Figure 3)

Figure 3. Elk harvest density (elk/ 1000 sq. km)



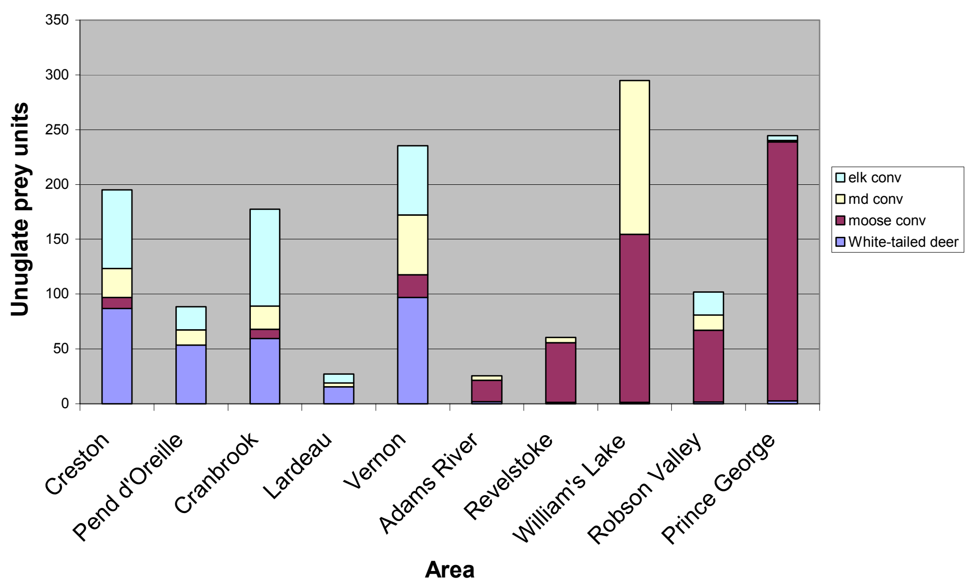
Moose concentrations are the geographical opposite of deer and elk concentrations with high numbers in the northern zones and low numbers in the southern zones, with the exception of Revelstoke, which has had a dramatic change in density over the past 25 years (Figure 4). Harvest densities in the high areas are 50 to 140 per 1000 sq. km range while low areas have low or no moose populations.

Figure 4. Moose Harvest Density Moose/1000 sq. km



The total ungulate prey base available to predators is presented in Figure 5. This total ungulate prey base is expressed in terms of "white-tailed deer units" with a moose equal to 5.4 white-tailed deer, an elk equal to 4.2 white-tailed deer, and a mule deer equal to 1.2 white-tailed deer. (Shackleton 1999; McNay 2006). It is noteworthy to observe that three areas (the Lardeau, the Adams River, and the Revelstoke areas) have very low total ungulate prey units available. These areas support lower predator bases and therefore have an advantage for mountain caribou survival. Other sub-units within caribou habitat support lower and higher densities of primary prey. A detailed analysis of this distribution is built into the Bayesian Belief Network model of predator/prey relationships and will paint a picture of the relative difficulties that may be encountered in managing primary prey species in various areas (McNay 2006).

Figure 5. Total ungulate prey



Wolf and cougar harvest data are also available for comparison with the primary prey densities but has not been included in this analysis. On a general basis, the data follow the expected pattern of low wolf and cougar harvests where primary prey densities are low.

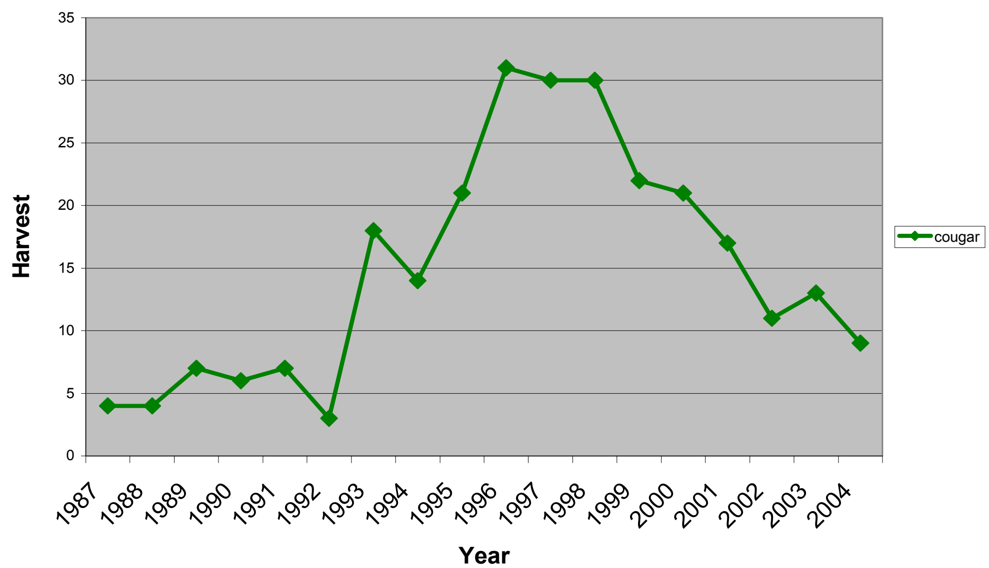
The difference in primary prey base from high to low density areas is more than 100-fold and presents clear opportunities for caribou management in the future through precise hunting management efforts and recognition of areas that inherently do not support high primary prey densities, but are of high value to mountain caribou.

Time Series Harvest Data

Cougar, mule deer, white-tailed deer, and elk harvest data are combined with caribou population estimates for the period 1987 to 2004 as an example of the changes in primary prey availability and predator population changes that have occurred. The rapid changes in these populations and the time differences that occured between them suggest predator and primary prey management options that may limit the impacts of cougars on caribou in the future.

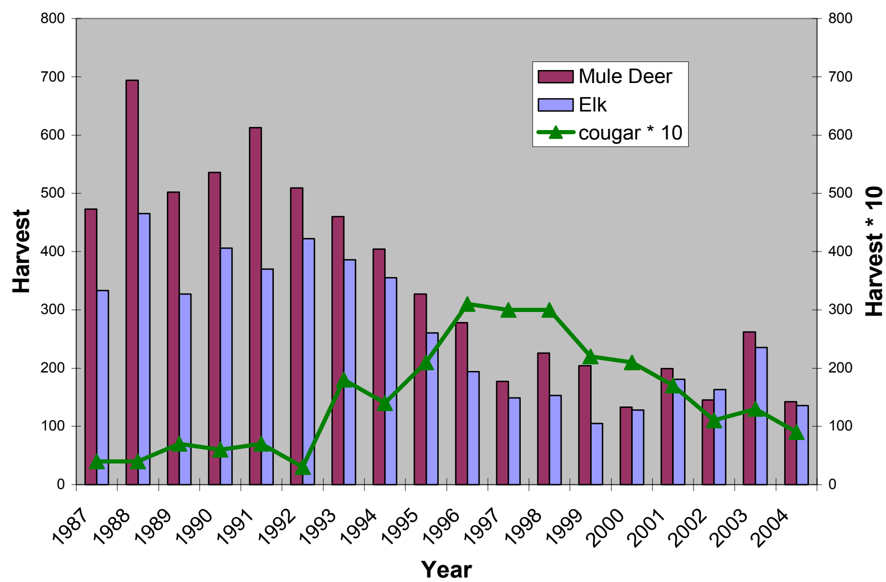
Cougar harvest data for the Southern Purcells (MU 4-05, 4-06, 4-19, 4-20, 4-26) demonstrate a rapidly increasing harvest from 1987 to 1996, and a rapidly decreasing harvest from 1998 to 2004 (Figure 6). About 30 cougars were harvested annually at the peak and about 10 annually during the low periods.

Figure 6. Cougar harvest - S. Purcell - 1987 - 2004



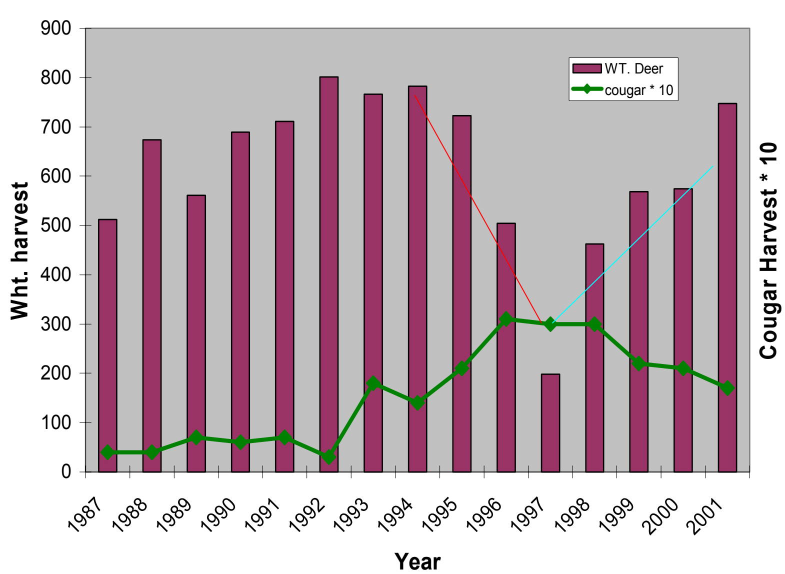
Mule deer buck and bull elk harvests (MU 4-05, 4-06, 4-19, 4-20, 4-26) both began high in the late 1980s and declined rapidly between 1991 and 1997 (Figure 7). Subsequent to the low point in the late 1990s, both have increased slowly, although not to the level they were in the late 1980s. Bull elk antler-point regulation changes in 1996 reduced the bull elk harvest and the data are therefore not entirely comparable. Nonetheless, the pattern of change is representative of the timing of the changes observed in other work.

Figure 7 - Mule Deer, Elk and Cougar Harvest - 1987 - 2004



South Purcell mountain caribou population changes were monitored by Kinley (2006) and population changes are presented in Figure 8. The pattern and timing of the population changes are very similar to the pattern and timing of the elk and mule deer population changes, as well as being the converse of the cougar harvest change during the 1992 to 1997 period. The caribou population continued to decline until 2000. Subsequently, the caribou population has been about the same through 2006 (Kinley 2006).

Figure 8. White-tailed deer and cougar harvest - 1987 - 2004



White-tailed deer harvest data (MU 4-05, 4-06, 4-19, 4-20, 4-26) exhibit a somewhat different pattern with a peak in the 1992 to 1995 period and a very rapid decline occurring from 1995 through 1997, followed by a very rapid rebound. It is instructive to note the difference in timing of the change in the white-tailed deer harvest relative to the earlier decline observed in mule deer and elk and the timing of the increase in the cougar population. Robinson (2002) presents information from the South Selkirks that suggests the white-tailed deer population supported the increasing cougar population well past the point that it might normally have declined. The mountain caribou population decline in the South Purcells may have been a similar secondary prey effect of initial high cougar numbers based on the deer and elk populations, particularly the high white-tailed deer population; caribou may have suffered ongoing impacts into 2000, as all primary prey species declined due to a severe 1996/97 winter for deer and elk and the concurrent high cougar population.

A similar pattern in the Revelstoke area was examined in detail by an expert panel (Messier *et al*. 2004). The moose population increased from about 250 moose in the early 1980s (Bonar 1983) to an estimated 1650 in 2003 (Poole and Serrouya 2003). Subsequently, wolves increased in total population. Recommendations by Messier *et al*. (2004) include habitat management to reduce moose winter forage and winter forage creation, moose harvest to reduce the population base, and wolf harvest to keep the wolf population in balance with the moose primary prey base.

South Purcell primary prey populations increased and decreased during the past 20 years and are very dynamic. Predator populations seem to increase and decrease in response to the available primary prey base. Secondary prey species such as mountain caribou are periodically subject to unsustainable predation pressure as a result. Managers need to adapt to the changes in primary prey population and anticipate the predator population changes that may occur. Proactive harvest management of both the primary prey and the predators may avert declines in mountain caribou populations. Winter and summer range habitat quality may also influence primary prey populations and must also be considered in the management mix. However, during the 20-year span of data that are presented, the fundamental primary prey habitat quality in the South Purcells was relatively constant or declining slowly while the primary prey populations fluctuated.

Management Tools

The BC Ministry of Environment’s Fish and Wildlife Branch has legislative authority and regulatory tools to manage primary prey and predator populations in mountain caribou habitat. General open seasons are a coarse tool for harvesting all species, although they can be refined with precise season dates and bag limits. These regulations are normally applied to males of the species since male harvest of most large mammals has little impact on population dynamics. Limited Entry Hunt (LEH) regulations are often applied to female large mammal harvest situations. LEH regulations can be used very precisely to manage populations and are being used successfully to reduce the Revelstoke moose population.

Management Recommendations

Future primary prey management to benefit mountain caribou should:

- focus on areas that have low total prey base and are easier to manage;
- understand and work with the problems presented by areas with high prey densities;
- use precise management tools to manage primary prey;
- use precise management tools to manage predators;
- track changes in primary prey carefully over time to understand and react early to potential threats; and
- proactively manage long term growth of invading species, particularly moose and white-tailed deer.

Habitat Alteration

Conversion of old growth to early seral can directly enhance numbers of prey (e.g., Eastman and Ritcey 1987) and therefore the number of predators on the overall landscape (Seip 1992), leading to the situation described above. However, in addition to that purely numerical response, there is evidence that the greater amount and interspersion of early seral habitats simply brings caribou in closer contact with the ungulates dependent on those early seral habitats, and therefore with their predators. In other words, there is also a spatial effect. Thus, caribou not only have to contend with more predators, they are also in closer contact with them.

Some papers indicating the effects of forest disturbance on the distribution of caribou, on other prey or predators, or on caribou mortality are listed below.

Wallmo (1969) found that mule deer density in Colorado was three times greater in cutblocks within spruce–subalpine fir forests than in the forest itself.

Rettie and Messier (2000, 2001) interpreted habitat modelling from Saskatchewan to indicate that broad-scale caribou habitat selection was aimed at avoiding disturbed areas with high predation risk.

Kinley and Apps (2001) noted a higher caribou mortality rate in the portion of their southern Purcell Mountains study area having greater forest fragmentation.

Kuzyk (2002) observed wolves to select cutblocks over forest in Alberta.

Kinley (2005) reported that, in relation to live radio-telemetry locations, caribou mortality sites in the southern Purcells were disproportionate in landscapes with more roads, logged land, and young forest.

Weclaw and Hudson (2004) modelled caribou persistence in Alberta and predicted that industrial activity will cause declines both because of, and independent of, predation.

Vors (2006) found the best predictor of caribou extirpation in Ontario to be the extent of logging up to 20 years previous.

Apps *et al*. (in prep.) found mountain caribou mortality due to predation and unknown causes to be generally correlated with measures indicating forest disturbance.

Cumming and Beange (1993) in Ontario, Smith *et al*. (2000) in Alberta, and Chubbs *et al*. (1993) and Rettie and Mahoney (in prep.) in Newfoundland found caribou to avoid areas near cutblocks.

James and Stuart-Smith (2000), Dyer *et al*. (2002), Oberg (2001), James *et al*. (2004) and Smith (2004) all found enhanced caribou mortality near, or avoidance of, linear features in Alberta, largely due to greater use by wolves of those features.

Thus, the effects of increasing numbers of predators on the landscape are exacerbated by the declining ability of caribou to avoid portions of the landscape where predators are the most abundant. Even where forest harvesting affects the summer range rather than the (presumably limiting) winter range of elk, moose, or deer, which therefore may have limited effects on the actual numbers of those species, it may change their distribution during the summer sufficiently to increase predation upon caribou.

There have been questions as to the scale at which caribou habitat must be separated from the habitat of other ungulates to limit predation, and the answer is not yet known with certainty. The work of Apps *et al.* (in prep.) should shed light on this when completed. Wittmer (2004) and Wittmer *et al*. (in prep.) looked at whether the amount or distribution of altered habitats most strongly influenced mortality. Models show that by far the best predictor in differentiating home ranges of caribou that lived from those that were killed by predators was the amount of age class 8 and 9 forest. The home ranges of caribou killed by predators were more likely to be associated with mid-age forest and more weakly with the amount of edge to early seral forest. This suggests that raw amount, rather than distribution, of altered forest has a greater effect on caribou predation. However, the ability to disentangle configuration effects is greatly complicated by the many different configurations that a managed landscape can assume. A landscape dominated by old growth has, simplistically, just one configuration (a single patch of old forest) whereas the amount of edge in a managed landscape initially increases with logging, then may decline as more of the landscape is cut. The evidence of a weaker effect of forest configuration is not surprising because predators are highly mobile and therefore cross through (albeit with presumably lower frequency) patches of undisturbed forest within the managed landscape.

The Way Forward

The recovery implementation plan for the northern portion of mountain caribou range (Hart-Caribou Recovery Implementation Group 2005) offers a clear, coherent, and logical approach to dealing with caribou predation. In addition to addressing issues of forage and recreational access, the plan recommends the following steps (paraphrased):

- Within defined areas, maintain late-seral forests providing core habitat for mountain caribou. This is to be achieved immediately to ensure that critical areas are not further eroded.
- In the short to medium term, achieve a limit on the numbers of prey and predators on a somewhat larger landscape through enhancement of normal hunting and

trapping. If necessary, periodically use direct control of predators to prevent irruptions that cause caribou declines.

- Over the longer term achieve a shift within a relatively large, but defined portion of, the landscape from its existing disturbed state (heavily weighted toward an early and mid-seral matrix) into a state more consistent with its natural disturbance regime. This is intended to limit the numbers of other ungulates to a more natural level, as a result of reducing the amount of young forest.

It will take a number of decades to determine whether the habitat-based approach is sufficient to achieve lower predation (i.e., whether whatever levels of hunting and trapping are acceptable as normal activities in that era will keep predation on caribou to a sustainable level, given the habitat recovery that is to have happened by that time). If this is the case, continuing with that approach should allow mountain caribou to persist. If the cessation of any incremental wildlife management then proves to result in caribou declines, a decision would be made to either reinitiate such management, or to abandon recovery of mountain caribou.

The questions we face in the short term relate to: the degree to which hunting and trapping alone will be successful in keeping caribou predation to sustainable levels; how to use those tools in a targeted way that has limited impact on other resource interests; and to what extent incremental management such as periodic direct control of predators is logistically and socially feasible. Over the longer term, the major questions are whether it is possible to adequately manage the forested landscape to achieve caribou recovery with minimal or no direct intervention into predator/prey systems, and if not, the degree to which future generations are willing to manage those systems for the benefit of caribou. In a case study modelled by Lessard *et al*. (2006) either enhanced moose harvest or wolf control had similar (and strongly positive) effects on caribou density, but had limited effects on the number of moose remaining on the landscape. This indicates that wildlife-management steps required to initiate caribou population growth may have relatively modest impacts on other resource values.

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Discussion after this presentation

Statement: If I thought we were changing forest practices that would do something real for caribou, I would be willing to consider killing predators. Given this is not happening, bureaucracies have allowed one species to decline, and now you want to kill another. The public does not support this type of management.

A: We are focusing on endangered species and not looking at the habitat component. We need to look at the entire endangered ecosystem.

Q: The idea of predator control as a major solution strikes me as an engineered approach. The engineered approach results in more ecological damage and the original cause (here: excessive timber harvesting) is not solved. Let's talk about how much forest will be set aside. Why shift the focus to predator control? The buck will stop when the bureaucracies choose how much to protect. It seems the BC Ministry of Forests and Range and the companies run on their own, regardless of the science.

A: Habitat is a huge issue. Unfortunately, there is a time element to the situation that we must consider.

A: Even if we stopped forest harvesting right now, caribou would still be gone in 20 years. Habitat is a key issue over the long term, but if we fail to address the predator/prey situation in the short term, we may lose caribou before the long term arrives.

A: People buy into predator control if land use is looked after. In the Cariboo, 100,000 ha are set aside, and 50,000 ha are classed as modified harvest. Therefore, environmental groups agreed to predator control. We have to have the whole package or it won't work.

Q: What about weakening of caribou due to low food supply and then being more vulnerable to predators? Also, if we have changed the habitat and now have more prey and predators; if you reduce the number of moose then you have extra wolves that may turn to caribou instead.

A: The evidence is that caribou are not starving; there is no shortage of food. The caribou population is so low that the wolves may not encounter them. But we do not want wolves to be relying on caribou at all.

Q: Remember that the ecosystem approach will protect other species as well.

A: We all agree with that.

Q: I am concerned with the emphasis on predator control. I see that society is unwilling to change; we are still removing caribou habitat. In the southern planning process, it seemed like some people thought we could manage our way out of the problem.

We have to make drastic changes. We need to protect old growth and limit motorized recreation. In the last planning process, in 100% retention areas for the caribou recovery areas, only 2% of the Interior Cedar–Hemlock zone was protected. What is going to be done to protect this zone and limit motorized recreation?

A More than 700,000 ha have been protected in the Kootenay region since 1992. I can't argue if it was adequate. It's a three-legged stool and all the legs are important. They need to be dealt with on the appropriate levels, and consider both the long and short term.

Q: There has been too much talking around predator management. Everything has failed in the past. The wolf hunts in the past haven't worked, so why would they work now? A study in the USA focuses on hunting cougar in the same manner as you intend for hunting wolves, and it caused dispersal of cougars, making them go into more areas (where presumably the predator could encounter caribou). The same thing may happen with wolves and caribou. Is that what we want?

A: There are collared wolves, at least 20, and they are covering great distances even though they have not been hunted, so if they are hunted I don't expect this to be an issue. In the Interior Cedar–Hemlock zone, there are mandates to retain 40% of the old and natural forest. There are status-quo options that aren't enough to stem the decline.

Q: According to the GIS land-use planning etc. there is actually only 2% of old growth Interior Cedar–Hemlock zone remaining. The estimates you gave are not spatial, but random.

A: Yes, they are spatial.

Q: Not in south Selkirks…

Q: Your graphs are convincing. What about the caribou birth rates? Caribou didn't seem to respond to the cougar crash. What is known about fecundity and do they have what it takes to bounce back?

A: One calf per year makes them not fast reproducers compared to many other mammals. There are few females reproducing a given herd per year; this situation needs to be kick-started with augmentation. They increase at 5% when limiting factors are eliminated.

7. *Disturbance of mountain caribou by snowmobiles*

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The preferred late winter habitat of mountain caribou, i.e., gently sloping subalpine parkland, is also favoured by snowmobilers. There is concern that snowmobile disturbance may displace caribou into inferior habitats where they would face increased risks of avalanches, poorer foraging opportunities, increased energy expenditure, or increased predation risk.

There are numerous reports and publications that demonstrate that caribou and reindeer exhibit a fright and flight response if snowmobiles come within several hundred metres. However, there is less evidence that caribou can be displaced from important winter habitat by snowmobile disturbance.

There are several examples where telemetry data for mountain caribou indicate that they are avoiding habitats where there is intensive snowmobile activity.

In the Hart Ranges east of Prince George, the caribou winter on several discrete mountain blocks. One of those blocks, Sande Ridge, has intensive snowmobile use whereas snowmobile use is low or absent from the other blocks. During winter surveys we found no caribou on the Sande block during three of four years whereas the other blocks supported caribou in all years. In the year when some caribou were present on Sande Ridge, most of them were in areas that were not accessible to snowmobiles.

Based on the density of caribou on the blocks without snowmobiles, we would expect Sande Ridge to support 43–66 caribou. We observed no caribou in three of four years. During the fourth year there were 22 caribou on Sande ridge, but 14 of those were in areas that were not accessible to snowmobiles.

We developed a Resource Selection Function based on radio-telemetry data for caribou in the area to evaluate if the habitat on Sande Ridge was similar to the other mountain blocks that contained caribou. The proportion of poor habitat on Sande ridge was less than on most of the other blocks, and the proportion of good habitat was greater than most of the other blocks. Therefore, the absence of caribou during most years could not be attributed to poor habitat. Based on habitat quality, we would expect 53–96 caribou on Sande Ridge.

We conclude that snowmobile activity on Sande Ridge has displaced caribou from an area of good late winter habitat.

8. *Overview of climate change in British Columbia*

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http://www.for.gov.bc.ca/hre/topics/climate.htm

Introduction

We tend to view the climate as static. We recognize inter-annual variations about the mean but often assume the mean doesn't change. This is not the case; mean conditions also change, but slowly enough so that we don't notice or do not believe we need to consider this in the management of resources. This view is a result of a short-term management horizon and our inability to know what the longer-term conditions might be. This view is no longer acceptable for resource managers. Improved estimates of past and future climates are available and illustrate the need to better take account of climate variability in resource management. Climate change due to anthropogenic emissions of carbon dioxide, methane, and other "greenhouse gases" (global warming) are predicted to produce major changes in climate in the next 50 to 100 years (Flannery 2005, Hengeveldt *et al*. 2005). Although ecosystems and species have responded to past changes in climate, future responses may not be compatible with our current patterns of use or desires. Assessing future responses should help us decide on actions now to determine how best to adapt to future conditions (Spittlehouse 2005a, b).

In this article I will review past, current, and predicted future climate change. I will also present some implications of future changes for caribou and plant communities.

Past and Present Climate

The temperature regime of the northern hemisphere over the last 2,000 years (Figure 1) was a major factor in determining the ecosystems and species distributions that we see around us. There are three points of note in this figure. First, air temperatures are now warmer than anytime in the last 2,000 years and the last decade has seen eight of the warmest years on record with 2005 being the warmest. Second, the average temperature of the last decade is almost a degree warmer than the average temperature of the last 2,000 years. Third, the rate of increase in the last century has been faster than any other time in the past 2,000 years. Data for British Columbia for the last 100 years are consistent with the Northern Hemisphere data (Anon. 2002). In British Columbia, the largest increase has been seen in winter minimum temperatures with the increase being greatest in northern regions.

Possible responses in British Columbia to these changes in temperature include the retreat of glaciers, a shift in the annual hydrograph, permafrost melt, an increase in landslides in the north, and changes in fire occurrence (Anon 2002; Leith and Whitfield 1998; Clague 2003; Gillet *et al*. 2004). Responses of organisms to the worldwide climate changes have been reported (Walther *et al*. 2002; Gulledge 2006). The extent of the mountain pine beetle infestation in British Columbia has been at least partially attributed to increasing winter temperatures (Carroll *et al*. 2004).

There has not been a consistent long-term trend in precipitation. However, the last 50 years have seen changes in precipitation distribution in British Columbia with a trend for a decrease in winter precipitation and increases in spring and summer. Winter conditions are critical for the survival of caribou, particularly depth of snow (Utzig 2005). Mote *et al*. (2005) report a general decline in snowpacks over much of western North America from 1950 to 1997. This trend can be seen in the depth of snow on the ground at the end of March for the British Columbia station at Glacier, Rogers Pass, in British Columbia (Figure 2). Although there is a large inter-annual variation there has been a decline in the mean over the last 30 years

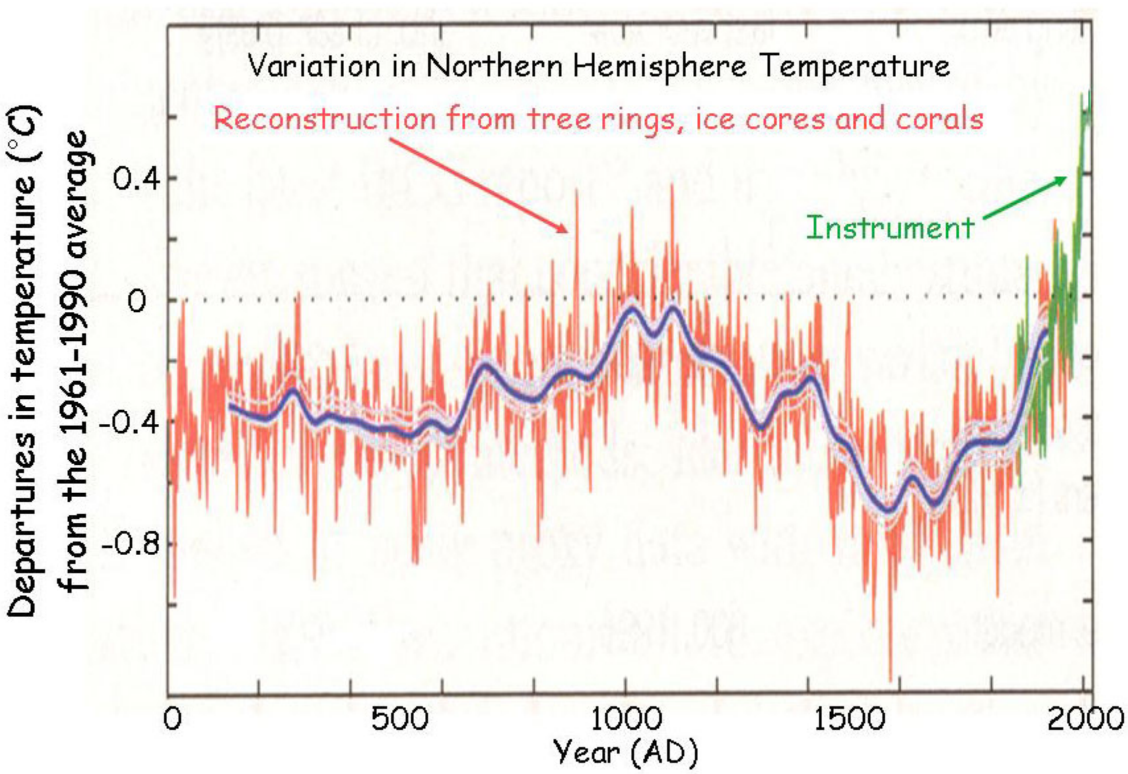

Figure 1. Variation in the annual Northern Hemisphere temperature over the last 2,000 years expressed as the difference between the 1961–90 average and the annual values. The green line on the right side of the graph shows measured data beginning at about 1900 A.D., and the red and blue line is reconstructed from tree ring ice cores and corals. The blue line is the long-term average. (Adapted from Moberg *et al*. 2005)

Continued…

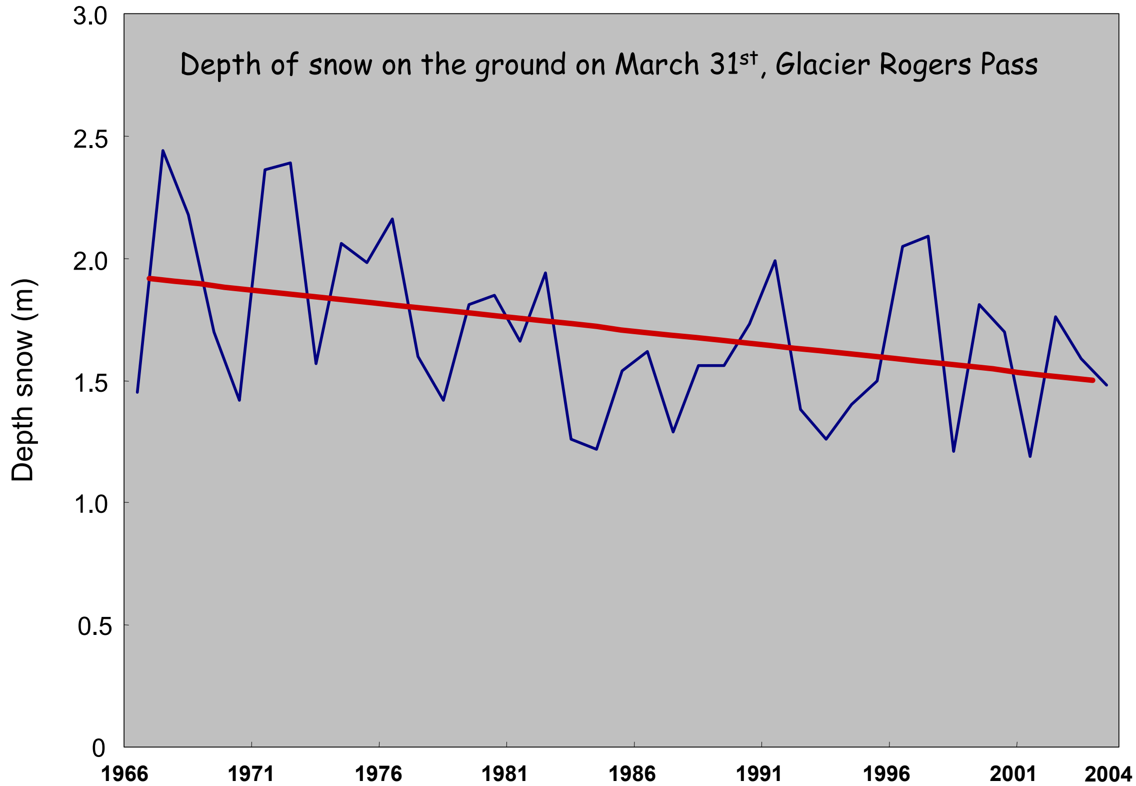

Figure 2. Depth of snow on the ground on March 31st at Glacier Rogers Pass from 1966 to 2004 (blue line) and the downward trend (red, heavier line) over this period. (Data from Meteorological Service of Canada at: http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html)

Future Climate

The effect of increases in atmospheric greenhouse gas concentrations on the future climate is of global concern (Flannery 2005; Hengeveldt *et al*. 2005). The concentration of greenhouse gases was relatively constant for much of the period show in Figure 1. For example carbon dioxide was at 280 parts per million (ppm) until the early 1800s but is now over 390 ppm (Figure 3) and is rising at about 1.5 ppm per year. Worldwide emissions of carbon dioxide from burning fossil fuel contain about seven gigatonnes of carbon, equivalent to the amount of carbon in the above ground biomass of all of British Columbia's forests. Various scenarios have been proposed to reduce emissions. All of them forecast a continued increase in the concentration of greenhouse gasses (Figure 3). Even the most optimistic scenarios result in a doubling of greenhouse gas concentrations over levels that have existed for much of the last 2,000 years or more by the end of the twenty-first century.

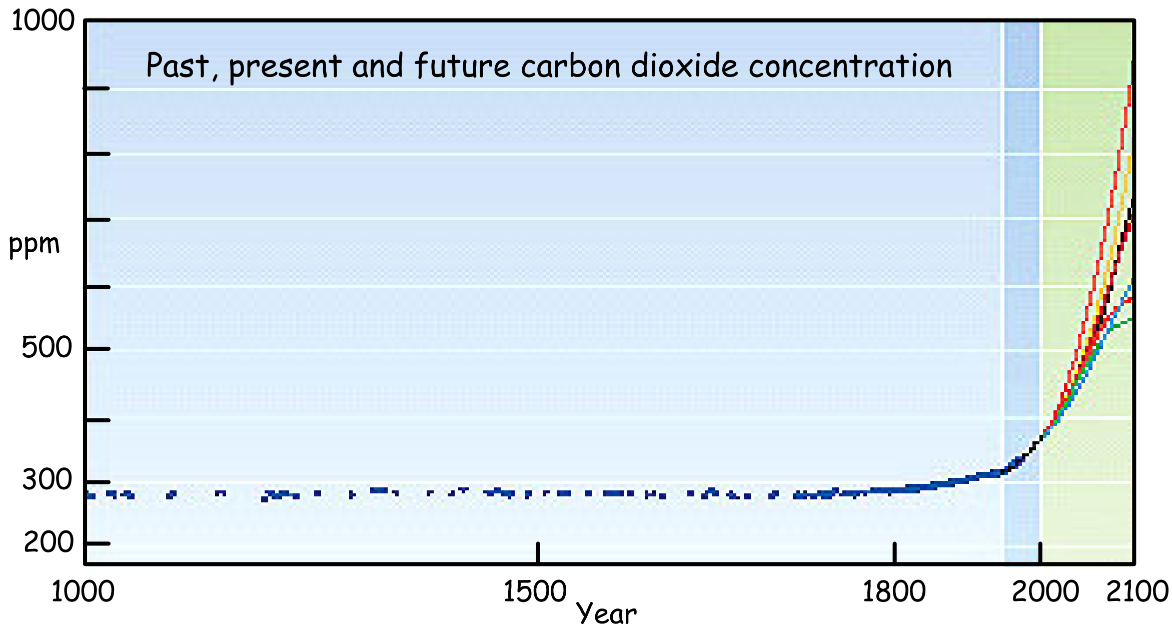

Figure 3. Past, present, and future atmospheric carbon dioxide concentrations. The range over the next century reflects the range of possible controls on reducing emissions. (Modified from Houghton *et al*. 2001.)

Climate models are used to assess the effects of the increase in greenhouse gas concentrations. The models predict that by the end of the twenty-first century, the mean annual temperature for western North America could be 2–5°C above the range of temperatures that have occurred over the last 1000 years (Flannery 2005; Hengeveldt *et al*. 2005). An increase in winter precipitation and a decrease in summer precipitation may also occur. Table 1 summarizes predicted climates for British Columbia for the 2020s and 2080s expressed as a difference from current conditions. The lower end of the range is generally for smaller increases in greenhouse gas concentrations. All scenarios have significant warming over all of British Columbia with a tendency for warming to be greatest in northern British Columbia. Summers in southern British Columbia are predicted to be drier than at present, while winters may be a little wetter. Northern British Columbia is predicted to have substantially wetter winters in the future.

The climate change scenarios can be used to assess what this might mean for vegetation communities and the animals that rely on them for food. They can also be used to evaluate how the physical environment of the animals may change. Predicted changes include the movement of species ranges northward and up in elevation with new assemblages of species occurring in space and time (Harding and McCullum 1997; Hebda 1997; Stewart *et al*. 1998; Kirschbaum 2000; Hansen *et al*. 2001).

Table 1. Future climate scenarios for 2020 and 2080 for southern and northern British Columbia presented as changes from the 1961–90 values. Data encompass predictions from eight global climate models and six emission scenarios, though there are outliers outside the ranges presented. Data are available from the Climate Change Scenarios Network (http://www.ccsn.ca).

	2020		2080	
	Temp. °C	PPT %	Temp. °C	PPT %
Southern BC				
Winter	0 to 2	-5 to 15	2 to 6	0 to 25
Spring	0.7 to 1.7	-3 to 10	2 to 6	-5 to 15
Summer	0.5 to 2	-30 to 5	2 to 7	-50 to 5
Fall	0.7 to 1.5	-5 to 5	2 to 6	-5 to 15
Northern BC				
Winter	0 to 2.5	0 to 20	2.5 to 8.5	0 to 45
Spring	0.5 to 2.5	2 to 20	2 to 8	5 to 50
Summer	0.5 to 1.5	-10 to 10	2 to 7	-15 to 25
Fall	0.5 to 2	-5 to 10	2 to 7	10 to 25

Utzig (2005) presented an evaluation of how climate change might affect caribou. In particular, he noted the importance of changes in winter snow conditions. This is illustrated by data for Glacier Rogers Pass (Figure 2). Daily temperature and precipitation data for the winter of 2001/02 were used in a snow accumulation and melt model (Spittlehouse unpublished data) to determine the daily snow depth. The potential impact of climate change was evaluated by assuming 2 and 4ºC increases in the daily temperature record and a 4ºC increase plus 10% increase in precipitation. As expected, increasing the temperature reduces the amount of snow on the ground due to snowmelt late in the year as the snowpack develops, and by earlier spring melt (Figure 4). The greater the temperature increase, the shallower the pack. Increasing precipitation offsets somewhat the effect of a temperature increase. The 4ºC warming scenario reduced depth by about 30% and the snow disappeared about a month earlier than under current conditions.

High resolution spatial data are now available for British Columbia and can be used to describe climatic regimes of vegetation zones (Spittlehouse 2006). These data are being used to evaluate the effects of climate change on the climate regimes and vegetation (e.g., Hamann and Wang 2006; Spittlehouse 2006). For example, by the 2080s a middle-of-the-road climate change scenario may result in climates at many locations equivalent to those presently found over 500 km farther south. Implications of the magnitude of such changes over a relatively short time are difficult to predict because they are well outside the range of our experiences. Vegetation will not be able to move with the climate because of the speed of change and the slow migration rate of plants. Thus, we are likely to see changes in plant community composition, increase in disturbance by fire, insects, and disease and changes in habitat quality. An increase in disturbance will likely increase the amount of early seral stage vegetation. Migration patterns of birds and animals will change. We will have to change our priorities for forest resource utilization (Spittlehouse 2005a,b).

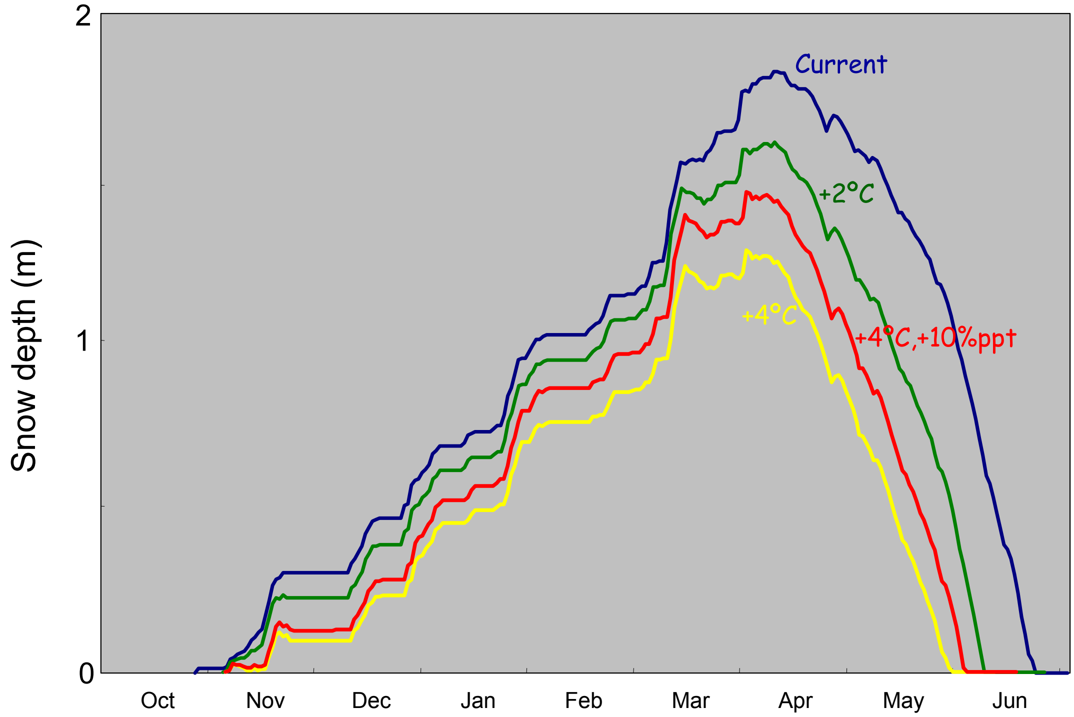

Figure 4. Simulated winter snow depth for Glacier Rogers Pass under current (winter 2001/02) temperature and precipitation (blue line) and three scenarios. The scenarios are: 2ºC warming with no precipitation change (green line), 4ºC warming with no precipitation change (yellow line), and 4ºC warming plus 10% increase in precipitation (red line).

Summary

Climate is always changing and we need to improve our ability to account for this in our resource management activities. We have seen a warming trend and changes in precipitation patterns in British Columbia over the last 100 years. Future increases in temperature due to increases in greenhouse gases will be at a faster rate than in the past and will be accompanied by substantial changes in the precipitation regimes. From the perspective of what the caribou need, we can expect a shorter snow season with shallower snowpacks, increased forest disturbance, and vegetation growing under far from optimal climatic conditions.

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ClimateBC: Your Access to Interpolated Climate Data for British Columbia.

Participants at the conference were told about Dave Spittlehouse's recent article in the Streamline Watershed Management Bulletin, published by FORREX, titled: *ClimateBC: Your Access to Interpolated Climate Data for BC.*

ClimateBC is a computer program that offers high-resolution, spatial climate data for current and future climate change scenarios. The program was developed because applying climate data in resource management often requires matching spatial scales of climate and resource databases.

Read the article at http://www.forrex.org/publications/streamline/streamline.asp
Links for downloading the program are in the article.

9. *Possible implications of climate change for mountain caribou in British Columbia*

Dr. Bruce McLellan, BC Ministry of Forests and Range, D'Arcy, BC
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No summary provided.

Readers are referred to a presentation on this topic given by Greg Utzig at the Columbia Mountains Institute conference titled *Implications of Climate Change in BC's Southern Interior Forests*, held April 26–27, 2005 in Revelstoke British Columbia. A text version of Greg's talk is available at:
http://www.cmiae.org/pdf/ImpofCCinforestsfinal.pdf see page 71.

10. *Twenty Years: The US experience with caribou recovery*

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Historically, within the United States, caribou were distributed across much of the northern tier. Within the State of Idaho, caribou were distributed several hundred miles south of the Canadian border, with the southern limit of their range being near the Salmon River.

By the late 1970s and early 1980s, caribou within the United States were confined to only a few locations. Mostly they were within the Selkirk Mountains of northeast Washington and northern Idaho, and there were occasional reports of caribou in northwestern Montana.

In the late 1970s, the destiny of caribou within Washington and Idaho became the concern of several government agencies, educational institutions, and sportsmen's groups. In response to this, the International Mountain Caribou Technical committee was formed consisting of representatives from the US Fish and Wildlife Service, the US Forest Service, the BC Ministry of Environment, the Washington Department of Fish and Wildlife, Idaho Department of Fish and Game, the University of Idaho, and the Inland Big Game Council. This organization met twice annually to share information about caribou, develop management plans, and to guide needed caribou research within the Southern Selkirks.

In 1980, the US Fish and Wildlife Service received a petition from a private citizen and from the Idaho Department of Fish and Game to list the Selkirk caribou under the *Endangered Species Act.* On January 14, 1983, the Secretary of the Interior listed the Selkirk woodland caribou population as endangered under an emergency rule. Final listing as endangered under the *Endangered Species Act* was published February 29, 1984.

The *Endangered Species Act* of 1973 (*Act*) has been noted as being perhaps the most powerful environmental protection statute ever enacted by Congress. The *Act* combines both procedural and substantive components. The procedural component requires agencies to develop information about the potential impacts of proposed actions before an agency commits to a particular course of action. The substantive component imposes affirmative obligations on federal agencies to "conserve" endangered and threatened species.

At the time of listing a species as endangered or threatened, critical habitat is frequently designated. Critical habitat designation requires completion of a socio-economic analysis of the effects of the proposed designation. Under the *Act*, critical habitat is defined as specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of Section 4 of the *Act*, on which are found those physical or biological features that are essential to the conservation of the species or which may require special management considerations or protection. Critical habitat has not been designated for the listed caribou population.

The first Caribou Recovery Plan was completed in 1984 and was approved by the Regional Director of the US Fish and Wildlife Service in 1985. This recovery planning effort was initially undertaken by the International Mountain Caribou Technical Committee as a caribou management plan, but after the listing of caribou under the *Act*, this plan was transformed into a recovery plan. This first version of the recovery plan focused primarily on these factors:

- Controlling poaching of caribou
- Minimizing accidental deaths of caribou by vehicle collisions along British Columbia Highway
- Improving habitat quality in the southern Selkirks by road closures and allowing natural succession
- Augmenting the existing herd and/or establishing a second population outside of the Selkirk Ecosystem.

The first revision of the Caribou Recovery Plan was completed and approved in 1994. The revised recovery plan focused again on maintaining the caribou population and on providing sufficient habitat to support a self-sustaining population. Additional emphasis was placed on reducing mortality and increasing the public education process. Consideration was given to a second augmentation effort within the Washington state portion of the recovery area with the intent of increasing distribution of animals and potentially initiating a third herd group within the Selkirk Mountains.

Between 1993 and 1996, the caribou population declined from 51 to 39 animals, prompting the Caribou Recovery Team to subsequently prepare an Emergency Action Plan to identify those recovery tasks considered to be of the highest priority to maintain the Selkirk Mountains woodland caribou population. The recovery team's professional opinion was that funding and implementing these tasks were essential to conserve the Selkirk caribou population. The identified tasks included: maintaining a core population of caribou through augmentation when needed; investigating and addressing the causes of caribou mortality; minimizing the adverse effects of winter recreation on caribou recovery efforts; revising caribou habitat management guidelines; and expanding the information and education marketing effort.

A five-year review of the status of federally listed species is required under Section 4 of the *Act*. This is to ensure that the classification of the species as endangered or threatened is accurate and consistent with the best scientific and commercial data that are currently available. It is also to ensure that the listing is consistent with the 1996 distinct population segment policy. The determination within the five-year review is based on five principal factors:

- The present and threatened destruction, modification, or curtailment of the species' habitat or range
- Over utilization for commercial, recreational, scientific, or educational purposes
- Disease or predation
- The inadequacy of existing regulatory mechanisms
- Natural or manmade factors affecting the species' continued existence

Currently, a five-year review for the Selkirk caribou population is in progress.

In retrospect, the overall success of the caribou augmentation efforts could have been improved had predator management (mountain lions) been conducted prior to augmentation instead of afterwards. However, following the most recent augmentation efforts in the late 1990s, predator management in the form of a more liberalized mountain lion hunting program has achieved the goal of increasing adult caribou and possibly calf survival. No documented caribou mortalities have been attributed to mountain lion predation since this management effort was initiated. Additionally, in retrospect, the opportunity to resolve some of the various issues confronting caribou recovery today could have been tackled in the past, well before the level of social and economic controversy and impacts have developed to the extent that we see today. Because experience has shown that caribou from the southern Selkirk population have moved between this ecosystem and the south Purcell ecosystem, recovery within the South Selkirk ecosystem may inadvertently influence the caribou population within the South Purcell Mountains.

Lessons Learned

Recovery strategies must be dynamic and ongoing. Recovery strategies must consider the future impact of ongoing or current activities. What may not appear to be a problem for caribou at present may turn out to be a problem in the future. Effective recovery programs require active involvement and support by management-level agency representatives as well as technical-level staff. It takes more than just a group of well-meaning biologists to recover a species.

Stakeholder participation is crucial in developing a broader base of support for recovery actions. Again, it takes more than just a group of well-meaning biologists to recover a species.

Because of the continuing low population numbers and the current distribution of caribou within the southern Selkirks, this population is still in a precarious position. It is still subject to potential future catastrophic events that could reduce population numbers significantly within a short time frame. The Recovery Team feels that this population can reach self-sustaining levels with time, but is likely to remain a "conservation reliant" species. For example, periodic future augmentations in conjunction with management of predator population will likely be needed.

11. Woodland caribou in Canada: Recovery planning under SARA

Mary Rothfels, Section Head, Recovery Secretariat, Canadian Wildlife Service, Ottawa
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No summary provided.

Information on the status of the Southern Mountain population of woodland caribou is at:
http://www.speciesatrisk.gc.ca/search/speciesDetails_e.cfm?SpeciesID=638

12. Update on woodland caribou recovery in Alberta

Dave Hervieux, Alberta Fish and Wildlife Division, Grande Prairie, AB
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No summary provided.

The Alberta Woodland Caribou Recovery Plan is available at:
http://www.srd.gov.ab.ca/fw/speciesatrisk/pdf/final_caribou_recovery_plan_photo_cover_july_12_05.pdf

13. *The British Columbia perspective: Coordination of recovery of mountain caribou*

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http://ilmbwww.gov.bc.ca/sarco/

There is much interest about the process of mountain caribou recovery. The release of the broader consultation package last fall raised concerns among many parties. In this talk I will bring you up to date on the process and how the various components will guide and inform the suite of options developed for review by government. I will also comment on changes in timelines and the rationale for this, and how the Species at Risk Coordination Office (SaRCO) will look to re-engage stakeholders.

Recovery Planning Challenges in British Columbia

British Columbia has recovery planning responsibilities unlike any other jurisdiction because of its unique and varied geography. Administratively this poses significant challenges, including:

- High volume of species at risk recovery planning requirements
- Ambitious federal schedule for posting strategies and actions
- Competing demands for limited resources
- Complex jurisdictional roles
- Commitments related to First Nations consultation
- Numerous policy and legislative instruments that are not currently well coordinated
- Dynamically complex issues (changes occur on-the-fly, mid process)
- Externally complex issues (unpredictable outcomes due to external influences like climate change)
- High social complexity (e.g., different values, principles, attitudes, and behaviours)

The Role of the Species at Risk Coordination Office

The roles of the SaRCO are:

1. Coordinating recovery planning for broad-ranging species with land-use planning implications:
    - Spotted Owl
    - Marbled Murrelet
    - Mountain Caribou

2. Developing a Species at Risk Framework for the way we manage species in British Columbia.

"Broad-ranging" means the species' habitat covers multiple regions of the province, and therefore, recovery efforts will affect regulatory and legislative regimes of multiple ministries. There will likely be significant land-use implications related to attempted recovery of these species. The role of SaRCO is limited to coordination; the BC Ministry of Environment, the BC Ministry of Forests and Range, and other natural resource sector agencies continue to retain responsibility for implementation of recovery measures.

Another principle function of the SaRCO is the development of a Species at Risk Framework. The aims of the Species at Risk Framework are to:

1. Review and make recommendations on how the province addresses species at risk issues.
2. Make recommendations on:
   - The administration, coordination, and funding of species at risk recovery activities
   - How the process for listing species and species prioritization criteria can be improved
   - A process for evaluating the success of recovery efforts and returns on investment.

The Species at Risk Framework will:

- ensure the British Columbia government acts in a coordinated manner to meet its national and international commitments to species at risk;
- ensure that species at risk recovery plans will operate in a consistent manner with provincial land management policies and practices; and harmonize with federal processes; and
- increase operational certainty for companies engaged in resource development by identifying where special operational practices may be warranted to protect or aid in recovery of a species at risk.

Mountain Caribou Recovery Process

In 2002, the British Columbia Mountain Caribou Recovery Strategy was completed. Three Recovery Implementation Groups (RIGs) were struck. However, land-use implications are broad, and there was no process in place to adopt RIG recommendations when they were put forward to government. SaRCO was established to coordinate the process provincially.

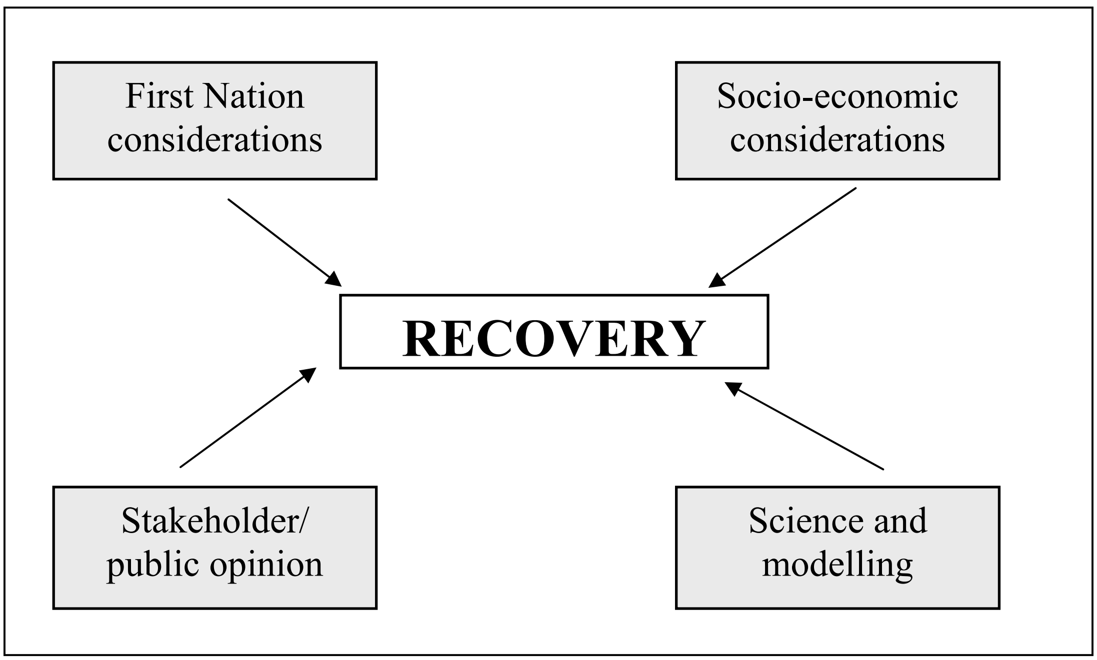
The work of the RIGs has been used in the scientific review process that SaRCO initiated. RIG participants will be consulted about science information generated and will be asked to participate in implementing interim measures. The RIGs will not be re-instated until government makes a decision on the mechanisms for implementation. The

Inter-Agency Management Committees of government will probably play a larger role and will be relying on some of the same people involved in the RIGs.

There are two major phases to the recovery process. First, develop options for government on the "what" and "where" of recovery. Second, receive direction from government regarding which options will be implemented and coordinate implementation measures.

The options will be informed by:

- Science (expert analysis by Provincial Mountain Caribou Science Team)
- Broad-scale economic cost analysis
- Public consultation and feedback
- First Nations consultation and feedback.



Science Team

In December 2004, SaRCO established a provincial Mountain Caribou Recovery Science Team. The team includes experts studying caribou in British Columbia and the US who are building a credible scientific information base to support the recovery planning process. Their first task was to endorse the recovery statement, which is:

> *"To halt the current decline in mountain caribou numbers within one generation (7 years), promote a stable-increasing population trend over the next three generations (20 years), and create ecological conditions that allow mountain caribou herds to be self-sustaining within nine generations (60 years), where ecologically feasible."*

The science team undertook literature reviews and various projects to provide a credible basis for recovery planning. Activities have included:

- Creating a situational analysis
- Habitat supply modelling and mapping
- Predator/prey dynamics, displacement, and population modelling
- Survey of experts, workshops on required management actions
- Preparing management options to meet a range of recovery levels.

The science team's current work includes:

- Mapping of management options by herd experts
- Team approval of herd expert management options.

Socio-economic Assessments

Baseline socio-economic assessments were carried out to support the work of the Recovery Implementation Groups. Broad costing on direct and indirect costs of management options to reach recovery, as recommended by herd experts, is underway. Once recovery actions have been identified, there will be consultation with stakeholders, and we will seek input from potentially affected parties on preferred measures and metrics related to socio-economic costs.

Consultation

Broad public consultation occurred during the fall and winter of 2005. Materials included draft options covering a full continuum of approaches. This was intended to stimulate frank discussion on varied perspectives. Consultation with First Nations is a critical component. This consultation is ongoing, with respect to the First Nations priority setting and timelines, but has contributed to a delay in the overall process.

The balance of the feedback supported full recovery. This consultation provided for clear record of public opinion to supplement the package for decision makers. A non-annotated record of comments will be posted to the SaRCO web site.

Keeping options open

Interim measures have included:

- Voluntary logging deferrals
- Section 16 of the *Land Act Reserve* implementing a moratorium on backcountry recreation tenures
- Local agreements with snowmobilers
- MOU with Heli-Cat Canada.

Changes in timeline of the process

The formalization of SaRCO into the new Integrated Land Management Bureau slowed this process. After the election of 2005 there was uncertainty in governance structure in the natural resource ministries, and budget allocations were stalled.

During the consultation process, there was a consistent message of "more information is needed on the southern herds." Scientists were not in agreement on how to use the modelling approach for generating maps and recommendations for management levers in the south. Time was needed to build a better consensus among scientists.

Ongoing activities that will lead to decision by government

1. Confirm management options for each herd based on recommendations by herd experts, including habitat management, predator management, primary prey management, augmentation, and access management. We need to assess intensity, duration, and extent of each of these for caribou recovery.
2. Complete and post documentation from science team findings including modelling and non-annotated consultation comments to the SaRCO web site.
3. Complete the habitat modelling and work on using the model to address key uncertainties, where appropriate, such as the effect of limiting the amount of early seral habitat in certain areas.
4. Communicate recommendations to stakeholders: host community meetings.
5. Complete the consultation with First Nations.
6. Proposed recovery actions to be put forward to government, informed by the activities above.

Recommended recovery actions are expected to go to government for a decision this fall.

The web site for the Species at Risk Coordination Office can be found at:
http://ilmbwww.gov.bc.ca/sarco/

14. Ktunaxa perspective on the stewardship and recovery of mountain caribou

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http://www.ktunaxa.org/fourpillars/land/klra.html

No summary provided.

15. Mountain Caribou Project and the role of ENGOs in civil society

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John Bergenske, Executive Director, Wildsight, Kimberley, BC
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Activities of the Mountain Caribou Project and its member groups

I wanted to start by honouring everyone's work, and the time and energy you all have put into protecting and recovering mountain caribou. I also note that Dave Mattson identified the key issue in his keynote speech: without the political will to implement change, we will continue to lose caribou. Please note that I speak only for ForestEthics, not for all environmental non-government organizations, or even for all Mountain Caribou Project members.

Since the first Columbia Mountains Institute of Applied Ecology caribou conference in 2002, we have taken the position that the best way to protect mountain caribou is to protect old-growth forest habitat. We have called for a moratorium on logging and recreational activities in critical habitat, and got our start as a coalition when we coordinated an international resolution with almost one hundred organizational sign-ons. We believe that recovery is possible, and that the only scientifically, socially, morally, and economically defensible thing to do is to work to recover all herds. Partly, this is because we support an ecosystem approach. By protecting the old-growth forest ecosystem, we protect caribou and a whole group of other species and processes. We have also always been clear that we will only support predator control and management in a context of habitat protection.

We can mobilize thousands of people when action is required. Since 2002, we have helped people who care about mountain caribou protection send over 20,000 faxes to the British Columbia government. Our web site, http://www.mountaincaribou.org, links to an online action centre, as well as background information, media clippings, and issue updates. We also provide information via the websites of our individual organizations.

So far we have distributed over 12,000 of our colour brochures and we now have thousands more. Last May we published *"Staring at Extinction?"* a report that quantified for the first time which companies have the largest area of planned logging, by hectare, in mountain caribou habitat. This report was released on the eve of the Global Forest and Timber Summit in Vancouver, and was covered in full-page story in the Vancouver Sun. We learned that West Fraser is by far the largest logger of mountain caribou habitat, with Tolko and BC Timber Sales tied for second place. Based on that we did a deeper analysis of West Fraser's Forest Development Plans, and found that the situation is worse that initially identified, and that, in fact, West Fraser has 33,000 ha of logging planned in mountain caribou habitat, as defined by the Northern Recovery Implementation Group.

We have given over 100 presentations to Rod and Gun clubs, to the International Mountain Caribou Technical Committee, to environmental conferences, to allied organizations such as the Alpine Club of Canada and Mountain Equipment Coop, to schools from elementary to university, and to road shows in the US, in the Kootenays and at the coast. We've given presentations throughout the Kootenays from Fernie to Revelstoke, from Castlegar to Creston, as well as Williams Lake, Quesnel, Victoria, Vancouver, Kelowna, Canmore, Seattle, Portland, Eugene, Spokane, Sandpoint, San Francisco, Santa Cruz, Missoula, Boise, and more…We estimate we have presented directly to at least 6,000 people.

As mentioned previously, the May 2005 release of the *"Staring at Extinction?"* report led to a full-page Vancouver Sun article. In October 2005, when draft options were made public the story broke in the *Globe and Mail*, Canada's national newspaper, with a large article and photo on the front page of the British Columbia section. An Associated Press article originated with the *Spokane Spokesman-Review* and was carried by at least five additional US newspapers. CBC radio covered the story extensively. The ensuing debate in the British Columbia provincial legislature during Question Period led to a Canadian Press article that was picked up by at least nine Canadian regional newspapers. We have a clipping display here at the conference.

Market campaigning is a tool that has been used by British Columbia environmental campaigners for about 10 years.What does it mean? It means that customer companies have put in place environmental procurement policies that commit them to sourcing away from forests that are endangered, and that includes endangered species habitat. Most policies also commit them to seek out certified wood products. The Forest Stewardship Council is the only certification system that is broadly supported by environmental organizations and First Nations. The Sustainable Forestry Initiative is specifically NOT supported.

There is also downstream markets work, i.e., downstream from the logging company. For mountain caribou, this has taken the form of buyers contacting their suppliers and the British Columbia government, and encouraging them to do the right thing by the caribou. I think this kind of influence from Lowe's, which buys $1 billion worth of British Columbia forest products every year, played a role in Canfor's decisions around caribou, for example.

Upstream market activities target the investors and shareholders. This year we had a presence at the Annual General Meeting of the Toronto Dominion Bank, which is a major financer of West Fraser. We questioned why Toronto Dominion is not following the example of the major US and European banks by including environmental screening in its lending policies. We also attended West Fraser's Annual General Meeting, in Edmonton this past April.

Ongoing Activities

We are here for the long haul; we are not letting up until caribou habitat is protected and a real recovery plan is in place. We will not let what happened to the spotted owl happen to the mountain caribou in this province. We are reaching out even further, to wildlife clubs, service organizations, professionals, academics, YOU. Polling data show us over and over again that people care deeply about species, landscapes, and forests and ecosystems, and we see it as our job to provide them a method to communicate this caring in a way that leads to positive change, and by that I mean, in a way that tends to protect and nurture biodiversity and ecosystem functioning.

On that note, you can expect to see us talking about the ecosystem itself more and more, and the other species that depend on these ecosystems. Mountain caribou are, to use a cliché, albeit a valid one, the canary in the coal mine for the inland rainforest ecosystem and these interior mountains. If we don't deal with habitat needs now there are other species lined up right behind mountain caribou. We saw last night that people are thinking more and more about ecosystems and the role of animals in those ecosystems, and we will be highlighting that more and more.

We will continue to focus pressure on industry players who do not step up to the plate. It is pretty unconscionable that companies continue to ignore the science, the Northern Recovery Implementation Group (RIG) being the most egregious example of this. I talked about the pressure on West Fraser in my last section, and they can expect to feel more and more heat. But even though West Fraser is the current focus, others should not assume they are immune. It is our intention to make logging mountain caribou habitat a very poor business strategy.

We need to note that we are all shareholders in a major logging company, BC Timber Sales. As the third largest logger of mountain caribou habitat, and the largest logger of spotted owl habitat, BC Timber Sales is in dire need of reform. We believe that BCTS needs to be leading the pack by getting its operations FSC certified. At a minimum, the government's timber company needs to stop logging endangered species habitat. It is certainly not a level playing field, and is a disincentive to other companies who are going beyond the legal requirements.

16.Recovering caribou in mountain ecosystems – A forest industry perspective

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http://www.cofi.org/

No summary provided.

17.Perspectives on snowmobiling

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http://www.sledrevelstoke.com

I have been a snowmobiler for over 30 years and I have been actively involved in the Revelstoke Snowmobile Club for that period of time. I am a past Director of the BC Snowmobiling Federation. I have been involved in the caribou issues here in Revelstoke for over 20 years.

I thank you for the opportunity to speak to you today on behalf of Les Auston of the BC Snowmobile Federation (BCSF). Les is unable to be here at the conference and extends his apologies. Les was not able to free up enough time on his schedule to attend as he is on his way next weekend to Vermont to attend the ISC (International Snowmobile Congress). The ISC, held one year in Canada, the next in the U.S., bring together some 500 to 600 delegates from the snowmobile community all over the world. Even Europeans from countries such as Sweden attend.

Snowmobilers all have concerns with many of the same issues and at the International Snowmobile Congress they work together to develop strategies that will help each other deal with these issues.

The BCSF, with all the other provinces and territories of Canada, are a part of the Canadian Council of Snowmobile Organizations and, together, we have developed a National Environmental Stewardship Program, which will soon launch its information centre for all clubs to access. This center will provide many wildlife and environmental studies from across Canada and offer information that will help to educate clubs that find themselves involved in wildlife and environmental issues. It will also provide a list of people who have many years experience dealing with these types of issues. These people can offer advice to the clubs which will cut down on the response time in bringing the clubs to a higher level of understanding on many of these issues.

Snowmobiling has evolved from a machine with little old wooden skis and a motor behind it driving a belt of sorts that propelled this thing across the snow, to the type of sleds we are seeing today.

Over the years snowmobile organizations like the BCSF have worked with the different manufacturers to help develop better safety features on snowmobiles. They have improved exhaust emissions, made motors more fuel efficient, developed a four-stroke snowmobile engine, reduced noise levels, and made the machines much more reliable. The sleds now offer better riding positions, which in turn offer more comfort and better handling.

The sport has grown and we are now able to reach destinations sooner because of the many groomed and maintained trails. Technology has definitely improved the sport and this is reflected in the cost of these machines, which can now be over $14,000.

Today's snowmobilers support many businesses. Snowmobile tourism is increasing, bringing tourism dollars into many communities. Many of the rural snowbelt communities have come to depend on these dollars in an otherwise quiet time of the year. In turn, businesses now support local snowmobile clubs and help with the many projects that clubs are involved in. A strong bond has developed between these businesses and the clubs, especially on issues that may threaten riding areas.

Not only are the machines of today better, but so too are the riders. Many riders have taken BCSF or other provincial safety courses, are very avalanche aware, and have taken extensive avalanche courses. Knowing that there is still room for improvement, the BCSF is working to secure more funding to further educate young people by launching a Safety Caravan that will go out to the schools and clubs around the province. Many clubs now have a SnowPatrol division within the club and over 350 patrollers help out in the backcountry.

The Federation and its clubs have spent countless hours and many thousands of dollars educating people about voluntary closures and special management zones in some of our riding areas. Many local clubs have produced maps and brochures informing sledders of these areas; in essence, educating the snowmobiler.

Many of these special management areas have been developed with cooperation from the clubs. The clubs have played an important part in the development, implementation, and management of these areas. Clubs have dealt with local biologists and forestry personnel to develop plans that will help to sustain local caribou herds. Only after many years of hard work and, in some cases, even hard feelings between clubs and those they have worked with, have these plans been put into place. But in some cases, either the rules changed or local government personnel who were dealing with these issues moved, transferred, or resigned or a new figure appeared on the scene. While this may not pose a problem in all cases, it does in some, where the whole issue, the agreements and everything that has been put into place has to be re-argued and renegotiated. Lines drawn on maps have to, years later, be redefined when someone new comes into the picture or a government official feels their personal views are different from the first official who negotiated these agreements. In the snowmobile world, most of these issues are dealt with during the work week when most of our volunteers are at their regular jobs, making attendance at meetings very challenging. This is especially hard when someone decides that we must change the direction of the plan. More funds are required from the snowmobile community and being volunteers this again means more personal sacrifice.

Snowmobilers in British Columbia have tried to be part of the process that helps to manage caribou and caribou habitat in British Columbia. We actively participate on Recovery Action Groups (RAGs), Recovery Implementation Groups (RIGs), Technical Advisory Committees ,and are members on recovery programs. We know that some of the areas in British Columbia have had successful results while others have not, and all for various reasons.

Some people are too quick to point a finger at the snowmobile community as having a significant impact on caribou. Some even rank us at the top of the list, along with predation. Over the years many factors have entered into the picture: rural development, climate change, an increase in other ungulate ranges, and more predation; but these do not seem to rank as high as the snowmobilers on some scales. Words like “perceived” and a “possible threat” are used to focus blame in the snowmobilers’ direction. Many of these are only opinions and personal views.

In some areas of the province, with good management plans completed with involvement from ALL stakeholders, some of the herds are doing better, some are holding steady, while some are still failing. Of note is that some areas that are not doing well were closed to snowmobile use and have shown no increase in herd sizes. Some snowmobile clubs within the province have been reporting a movement of caribou from the “no ride” areas to the active snowmobile areas. This has been happening in areas such as the Quesnel Highlands, Houston, and Revelstoke. This is something we are watching very closely.

In areas where a recovery plan was developed, local users and most organizations were included in the development and implementation of these plans. These recovery plans must include all users, not just a select few. The Telkwa Herd is one of the herds that has had fairly good success with volunteer restrictions or closures of some areas. Some of the Telkwa closures are seasonal in nature; for summer and winter, both motorized and non-motorized. This project has been ongoing since 1997 and the organizations involved still meet and other interested people receive updates. Telemetry flights still happen when funds are secured and so far only in 2005 was there a bit of a short fall in funding. Funding is key to all recovery projects because without the ability to monitor the herds, we are limited in response time for mortalities. Trying to determine causes of moralities helps us understand what changes, if any, need to be addressed.

In the Quesnel Highlands things are a little different; not all users are a part of the plan. Some winter users applied for tenure in part of a critical habitat area and did receive it. Summer users are a problem because most don't belong to a club and therefore education and enforcement are seen as problems. The snowmobile clubs using this area include Williams Lake, Mica Mountain, 100 Mile House, Wells Gray, and Quesnel. They have participated in this process and with reluctance from both government personnel and snowmobilers have put voluntary closures in place. Most of the information to date has shown that predation has been the real problem, especially in this area, and money has already been spent on a wolf control program.

In the Revelstoke area the club has been actively involved in the protection of caribou habitat for over 20 years, entering into voluntary and legislated closures, refusing the government's suggestion that areas be re-opened (because we know the area and we know the type of habitat it offers), signing and producing informational brochures, and working with government to further the protection of this critical habitat. We have spent thousands of our own dollars over the years and have given countless volunteer hours, yet we continue to see our areas shrink. We have participated in two snowmobile/caribou impact studies and have yet to see the results of these studies. Our programs have been successful to the point where we are seeing close to 95% compliance by snowmobilers staying out of the restricted areas. We are not going to keep everyone out all of the time, but an acceptable level has to be reached and accepted by everyone.

We as snowmobilers are more than willing to continue our involvement in recovery projects throughout British Columbia and we believe in the efforts made by some dedicated people who believe that recovering caribou is the right thing to do. What we do not support are the continual comments made about snowmobiling as a major contributing factor for the decline of caribou in British Columbia. Working towards a common goal with reasonable demands to all involved will, at the very least, show that we are trying for a successful recovery of this species.

Presentations on Wednesday, May 31, 2006

18. Applying economics to decision making for recovery of species at risk

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Socio-economic analysis is an integral part of the decision structure for species at risk recovery planning. It is often contentious, especially its integration with biologically based science of recovery planning. This paper presents a brief overview of socio-economic analysis in a British Columbia context along with considerations for application to species at risk recovery planning.

Central to the work of economists charged with providing guidance for the use and conservation of natural resources are the tasks of pricing (valuation), allocation, and specification of property rights. In a North American context, there is a complex and varied range of public and private property rights for natural resources. Property rights are significant in that they determine both the structure of a market and the manner in which value and prices for natural resources are (or fail to be) determined. For many fish, wildlife, and plant species, especially species at risk, property rights are characterized by one or more of the following attributes:

- Markets do not exist for most species that occur largely on public land or are publicly owned—although the species' presence and abundance may be critical to many ecosystem attributes that are valued by societies. These values are unknown in a traditional market context and linkage to ecosystem functions may be poorly articulated or understood.

- The potential commercial value of a species may be unknown due to lack of information about the species and what benefits or services it may provide to humans or other ecosystem components.

- The commercial value of a species may be well articulated in markets, but such values may not be a true reflection of the species' relative abundance due to poorly specified property rights or regulations that are inconsistent with societal preferences.

- Species' habitat ranges typically ignore most administrative, economic, and political boundaries controlled by said institutions. This can further confound the ability to define values for species.

- Average values defined in markets for natural resources (such at timber) may compete directly with average species values and this is often confounded by a lack of understanding of where these averages are relative to values at the margin.

Economists attempt to work within these attributes to define values for species and/or their habitats. When this happens, there is usually an opportunity to provide an interface between multiple interests to explain the relative and marginal impacts of politics, science, societal values, and technical change that can all have influences on the value of a species.

Socio-economic analysis relies on input (data) from the work of practitioners in other disciplines—ecology, biology, sociology, psychology, forestry, fisheries, geology, recreation, geography—to name a few—as well as subsets within economics such as behavioural economics, institutional economics, and natural resource economics. In a British Columbia context, socio-economic analysis has at least a 30-year history—with early practitioners developing applications and guidelines for benefit-cost analysis e.g., Government of British Columbia 1977 and Fraser 1985).

Data and indicators such as multipliers from input-output models of the British Columbia economy have featured prominently in assessing natural resource use activities on employment, incomes, and industrial output (e.g., BC Ministry of Finance and Corporate Relations 1978 and Horne 2005). By the late 1980s in British Columbia, regional land use plans and landscape-level timber supply reviews motivated the revision and updating of applied benefit-cost analysis methods as well as the use of input-output model information to assess impacts from land use zoning and current and projected harvest levels. These methods evolved into what is now termed "multiple accounts analysis" and are at present articulated in the following guidelines documents (BC Ministry of Agriculture and Lands 2005, 2006).

As many of the more significant potential impacts of proposed recovery actions for terrestrial species tend to involve forested land, timber supply analysis can feature prominently in the socio-economic assessment. Multiple accounts analysis methods also rely heavily on the creation of a geospatial intersection (mapping overlay exercise) of all historical, existing, and potential future property rights, land use disturbances, tenures, and other land based interests and values. This "matrix" of overlapping land uses and interests forms much of the base "inventory" data for the socio-economic assessment.

In addition to methods, the guideline documents provide two key forms of guidance. The first is an assessment procedure for choosing and recommending the extent of socio-economic analysis (SEA) that needs to be undertaken. There are four options, which are: a SEA statement, a condensed SEA, a focused SEA, or a comprehensive SEA. As the names imply, they range from a few sentences to a major undertaking of time and resources usually involving several economists and other resource professionals and may take several months to a year to complete. The second is a list of key reference materials for acquiring data for analysis. One example of data that is particularly challenging to acquire is economic values. Economic values are relatively easy to quantify where the goods or services in question are traded in a market and price information is readily available. However for most species at risk there is little or no market information available. Economists have been developing methods for at least the past 50 years to define values for non-market goods and services. These methods can be categorized into two overall groups—revealed preference methods and stated preference methods.

One of the more common and longest standing revealed preference methods is the travel cost model, first reported in the literature in about 1949. The application of travel cost models estimate demand and price of a recreation activity as a function of the distance travelled to the recreation site.

Stated preference methods include a wide variety of discrete choice and "willingness-to-pay" survey instruments designed to collect data on how, and what, people value with respect to their use or non-use of non-market goods and services. Adamowicz (2004) provides an extensive overview of the history and future outlook of non-market valuation techniques and trends. As somewhat of a spin-off of the research literature comprising surveys and studies that have attempted to value non-market goods and services, is a relatively new technique called "benefit transfer." Allan and Loomis (2005) provide background and an example application of the method of benefit transfer. Essentially, due to the high costs in time and resources to collect non-market value data, the benefit transfer method seeks to estimate non-market values for a specific situation as a function of data on non-market values derived from other studies. Although intriguing and potentially significant in saving time and resources, benefit transfer methods are still being developed and are therefore not without controversy.

As long as there is demand for non-market values, these methods will continue to be improved upon and hopefully become more widely accepted and less controversial. The more significant impediment to their improvement and application are the resources (time, money, and qualified personnel) required to define values and benefits of non-market goods and services. A lack of support for acquiring information on values related to species at risk will continue to be a source of uncertainty in decision making required for implementation of species recovery plans.

On the same level of importance as the methods of socio-economic analysis for species at risk are the logistic and strategic questions that must be answered. These questions largely relate to how the process of completing the correct amount/type of socio-economic analysis "fits" with the rest of the species recovery planning process for a given species or group of species in a specific area. Ignoring this issue can render the most appropriate socio-economic analysis a waste of time if it is not properly linked to the rest of species recovery plan. The recent past American experience with the equivalent of species at risk planning (endangered species planning) offers guidance for recovery planning to incorporate ubiquitous social, economic, and political realities (see Hoffman *et al*., 1997 and Scott *et al*. 1995). A summary of points brought out from these and other references include the following for consideration:

- The fiscal implications and financing of endangered species recovery is actually a number of topics covering issues ranging from the impact of land property taxes on incentives or disincentives for owners to incorporate conservation objectives, to the market for investors to "purchase" conservation on both public and private property. Some of these ideas when put into practice are very successful, others less so. The message is that their presence or absence with respect to the recovery plan for a particular species may have relevance, and if so, can and should be addressed in the context of a socio-economic analysis. There are many positive examples of matching common interests of conservation with tax reforms and investments that have net social and economic benefits.
- The full cost of activities in species recovery plans such as resource extraction must be considered—are all of the costs of externalities included in the costs of resource extraction—and is resource extraction generating wealth? This is consistent with the requirement to measure "net resource value" as explained in the socio-economic and environmental assessment guidelines document (British Columbia Ministry of Agriculture and Lands 2006). .
- Reduce uncertainty faced by affected groups—where possible get people involved —both within government and outside interests. For more high-profile species at risk, it may be appropriate to invest in marketing and information campaigns to explain to people why species need to be preserved/recovered and possibly to align with regional and local conservation initiatives.
- A realistic assessment should be done on the costs of implementing a recovery plan, where ideally such costs should be measured against short-term and long-term recovery goals, such as an acceptable measure of the probability of species persistence over time.
- Use aspects of "ecosystem-based management" principles such as: committing resources to monitor activities where impacts/outcomes are uncertain or unknown; only extract where wealth is generated; and actively manage for all ecosystem goods and services.

Social, economic, and political realities need to be incorporated in both the method and timing of species at risk recovery planning even though it is not always obvious how this is best achieved. One of the key roles of economics is to provide tools and analysis so recovery planning can be accomplished in a transparent, efficient, and timely manner. Considering the non-biological factors will make it easier to evaluate the successes and failures of recovery efforts and will facilitate the decision-making process.

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Discussion after Mark's presentation

Q: Multiple accounts methods are flawed or misleading. In the 1990s we heard scare tactics that if we reduced the AAC it would lead to loss of jobs. Please avoid using scare tactics for caribou issues.

A: What is driving a lot of the current economy is resource extraction; not only oil and gas. The forest industry has faced enormous changes balancing the demand side and interaction between consumers and other values in the forests. Another important factor (consider mountain pine beetle) is technological change. As an economist you need to account for technological change, but how do you do this? We will use some of those methods for mountain caribou, but we will modify the methods to better suit caribou. One thing I wanted to get across is that we are weak on the value (benefit) side and that we need to move forward this as well.

Q: About the chart in your presentation that showed increasing wealth causing decreased environmental degradation—this doesn't make sense to me.

A: Wealthy countries can afford to clean up their messes. If you look at power generation in wealthy countries, it is cleaner than in developing nations.

Q: Are the baseline studies that you spoke about for caribou available to us?

A: Yes, Leo DeGroot has them.

19. *An interdisciplinary approach to problem solving: Applications for the twenty-first century*

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We used the policy sciences as an organizing framework for a series of three workshops with stakeholders in the Banff-Bow Valley region on "Interdisciplinary problem solving in grizzly bear conservation and management." In recent years, bear conservation in this region has been hindered by acrimonious disputes about scientific knowledge and its application in management. The workshops introduced the policy sciences as a means of thinking more effectively about problems, and encouraged participants to use these new skills to find innovative solutions to the problems of grizzly bear conservation. We set the stage for the workshops by conducting a Q-method study of stakeholders' existing views about the problems of bear management and possible solutions. Each of the workshops then addressed a different component of the policy sciences framework:

- Problem Orientation, in which participants learned to construct more comprehensive and useful problem definitions.
- Social Process Mapping, in which participants identified key variables in the political and administrative context for bear conservation.
- Decision Process Mapping, in which participants evaluated the strengths and weaknesses of the existing decision-making processes (including how conservation science is used in decisions), and recommended alternatives for improvement.

We discussed the design and outcomes of the workshops and assessed their effectiveness in integrating knowledge to find common ground for grizzly bear conservation.

For more information

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Discussion after Mike's talk

Q: Who gets to participate in the process?

A: Everybody. The vocal critics of our science didn't want to participate. Some people did not want to participate because the process takes so much time.

Q: I see problems coming into the implementation stage, e.g., funding etc.

A: We do wrestle with this, but it is easier to allocate resources when many people want it and have agreed with the decision.

Q: What are the costs associated with making decisions in this way?

A: The main cost is time. Personally, I find it excruciatingly slow. The facilitator can be expensive as they have to work hard and it is a stressful job.

20. Western governance and species at risk policies? An awkward proposition

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In this presentation, I addressed three questions:

1) Why should we protect and recover species at risk of extinction?
2) How is British Columbia doing in terms of species at risk protection and recovery?
3) What is preventing better protection and recovery in British Columbia and elsewhere?

The short answers are that, first, biodiversity is an essential environmental condition for humanity in the long term, and the global rapid loss of species due to anthropogenic causes is threatening humanity. Second, the British Columbia government is infamous for its lack of protection of provincially listed species at risk, especially as compared to the Canadian federal government which is doing comparatively well at both protecting and recovering federally listed species at risk. Also, the British Columbia government has no independent legislation for recovery planning. And finally, the central problem with species at risk protection in western nations is that they cater to the short-term preferences of the current electorate who, on average, prefer the economic gain to be had from natural resource extraction over the conservation of species' habitats. At the same time, western governments are not authorized to accommodate the interests of future generations, but future generations will have to bear the worst consequences of biodiversity loss.

Or, to condense these short answers even further, we the people, the electorate of British Columbia, have misidentified the importance of biodiversity and have failed to elect a government that would place sufficient, intergenerationally just, priority on species conservation over economic interests. It is not in our best interests to practise sustainability.

Why should we protect and recover species at risk?

Species at risk represent a deeper phenomenon: the rapid, global loss of biodiversity. So we first need to ask "Exactly what is biodiversity?" and "Why is it so important for humanity?" Even among conservation biologists the answers to these questions have remained somewhat elusive until recently. Most of the conservation biology literature still describes biodiversity as the sum of the world's species, of the genes within species, and of the different types of ecosystems. The value of biodiversity is still described in similar terms: as the sum of the value of the useful bits and pieces, either now or in the future. But this is the value of biological resources, both now and in the future, not the value of biodiversity itself.

Among the world's five to 30 million species only a few hundred are currently useful to humans directly, and in the future perhaps a few thousand additional species might be useful. Even if we were to go wild with our estimates and say that 100,000 species might someday be useful, we cannot account for the direct utility of the vast majority of the world's species.

The conservation biology literature also suggests there are indirect reasons for conserving biodiversity. Potentially useful species live in ecosystems alongside their neighbouring species, and therefore we should conserve those neighbouring species too. There is some truth to this argument, but we also know from experience that many species can be annihilated from an ecosystem without adversely affecting potential resource species in the short term. The literature also points out that ecosystems provide us with "ecosystem services" such as the assimilation of air and water pollution, water storage, and carbon sequestration. Human economies are fully dependent on these ecosystem services; we cannot do without them. Again, this is true, but we also know that many species can be lost from ecosystems without noticeable or meaningful losses in ecosystem services in the short term. So in the short term, most of the world's species are economically useless in either a direct or indirect sense.

But thinking about biodiversity in an economic sense is misplaced from the start. Biodiversity is not simply the sum of nature's bits and pieces, nor can we value it in these terms. Instead, biodiversity is a concept at a higher logical plane. Biodiversity is an emergent property of the biosphere; it is an environmental condition. More importantly, it is an essential environmental condition for humanity because it is necessary for the maintenance of biological resources in the long term. Biodiversity provides the evolutionary conditions required to keep humans well stocked with biological resources ad infinitum. Put differently, this means that biodiversity is the source of biological resources upon which humans depend.

We can compare biodiversity to other large and equally essential environmental conditions. The annual orbit of the Earth around the Sun and the steady rate of solar influx are two examples. If either one of these conditions were to change slightly, we might be able to adapt. The world would grow a little colder or a little hotter, and some nations would experience worse effects than others. But it is possible that humanity could adjust. A sudden and major change in either one of these environmental conditions, however, would spell disaster for humanity; we would either freeze or burn to death. We need not concern ourselves with these doom-and-gloom scenarios. We can depend on the Earth maintaining its same old orbital trajectory, and we can depend on the Sun for a steady rate of light energy.

We are just as dependent on the source of biological resources—biodiversity—in the long term, but we are facing not just a slight change in this environmental condition; humans are precipitating the sixth major mass extinction event of all time. At five times deep in the geological past, most of the species on the planet suddenly went extinct for largely unknown reasons. It took evolution tens of millions of years to repopulate the planet with species after each event. We do know the cause of the fifth event, which happened 65 million years ago. A large asteroid collided with the Earth instantly creating the Gulf of Mexico and blocking out the sunlight. Most of the world's species, including the dinosaurs, were wiped out. The current extinction event is nearly as fast in ecological terms. Mostly by way of altering, fragmenting, or destroying species' habitats, humans are the cause of the sixth major mass extinction event.

Why should we protect and recover species at risk of extinction? We now have the answers: biodiversity as a whole is an environmental condition that provides humanity with biological resources in the long term, and the human-caused current mass extinction event is eroding that environmental condition. Species at risk simply represent the edge of that wave of extinction. A failure to protect and recover species at risk is a failure to protect humanity in the long term.

How well is British Columbia doing in terms of the protection and recovery of species at risk?

We need to start with a distinction. Many people refer to "listed" species. But in Canada we have two kinds of lists. Governments and some non-government organizations (NGOs) list species in what I call "scientific lists." These rate each listed species in terms of the degree of risk of extinction, such as endangered, threatened, special concern, and so on. But these scientific lists are for information only; they do not commit governments to protecting or recovering the listed species. In addition to these scientific lists, most provincial governments, and the federal government also, list species in what I call "legal lists." These are the lists of species at risk that governments are legally committed to protecting to some extent and, in some cases, to recovering as well.

The federal Committee on the Status of Endangered Species in Canada (COSEWIC) lists those species it has assessed. This is the national scientific list. To protect and recover any one of these COSEWIC-listed species, the federal government must first accept a species under the *Species at Risk Act* (*SARA*), the national legal list. So far, the federal government has accepted 96.3% of COSEWIC's 516 assessed endangered, threatened, special concern, and extirpated species. In so doing, the federal government has committed itself to protecting and recovering these species as stipulated in *SARA*.

The BC Conservation Data Centre, which is part of the provincial government's Ministry of Environment, is the provincial scientific listing body and has listed 1367 equivalent species, i.e., equivalent to COSEWIC's endangered, threatened, special concern, and extirpated species.[1] But in sharp contrast to the federal government's performance in the species at risk arena, the British Columbia provincial government has legally listed only 3.1% of these species. Four species are listed under the *British Columbia Wildlife Act* and 40 are listed under program called the "Identified Wildlife Management Strategy" (IWMS) which is component of British Columbia's *Forest and Range Practices Act*[2] (two species are common to both legal lists).

This exceptionally poor performance leaves the British Columbia provincial government vulnerable to a host of national and international punitive actions.[3]

To make the comparison complete, however, we should note that the federal government has less at stake in legally listing species under *SARA* because under the *Constitution Act*, 1867, most of the land in Canada is under the jurisdiction of the provinces. As a result, protecting species' habitats can have, and does have, direct economic consequences for provincial governments, whereas for the federal government, in most cases, the consequences are less.

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[1] COSEWIC and the BC Conservation Data Centre both define "species" as "[a]ny indigenous species, subspecies, variety, or geographically or genetically distinct population of wild fauna and flora" (COSEWIC 2004).
[2] Subsequent to the CMI Conference on 'Multidisciplinary Approaches to Recovering Caribou in Mountain Ecosystems' in May 2006, the provincial government added an additional 30 species under the IWMS.
[3] For more details, see Wood, P.M. and L. Flahr. 2004. Taking endangered species seriously? British Columbia's species-at-risk policies. *Canadian Public Policy* 30(4): 381-400.

<u>What is preventing better protection and recovery of species at risk in western nations?</u>

Western governments enact and implement public policies that, in theory at least, are intended to promote the best interests of the public, and the term “public” is narrowly interpreted as the existing citizens within a geopolitical boundary, such as Canada or British Columbia. By definition, this interpretation of the “public” excludes the interests of those people who are citizens of other provinces or nations, and it excludes the interests of future generations. This narrowly defined role of western governance explains why governments are reluctant to protect and recover species at risk.

Why are the interests of these other people, including future people, excluded from government policy-making even though their interests may be affected by the loss of biodiversity? This takes us to a central precept of democracy. Democracy is a relatively recent phenomenon in history. With minor exceptions, the world had been, and still partly is, ruled by kings, queens, emperors, shoguns, and other dictators. And as the British historian, Lord Acton, noted, “Absolute power corrupts absolutely.” To get around the tyranny of dictators, democracy puts power in the hands of those who will be ruled, i.e., citizens themselves by way of votes. Putting the power of state in the hands of the people means that a government is authorized by its respective public to promote the interests of that public in particular. Not other publics. Unless that particular public wants its government to extend benefits to others, it is not authorized to do so.

The *Canada National Parks Act* and the *Species at Risk Act* are two notable exceptions to this general theme of a limited set of beneficiaries. The *Canada National Parks Act* specifically states that national parks are for the benefit of not only the present generation of Canadians, but for future generations too. And the *Species at Risk Act* could be interpreted as Canadians’ collective desire not to pass along a biologically impoverished nation to future generations. But in both cases, it is the generous preferences of the current public that the government has accommodated, not the interests of future generations directly.

Despite these two exceptions, the general trend is clear; most provinces are performing poorly in the protection and recovery of species at risk, and the provinces have constitutional jurisdiction over most of the land in Canada, including most of the species on them. The reason for the trend is clear too. In most cases, species face extinction because of habitat loss caused by human economic development, including resource extraction in species’ habitats. When it comes to a choice between conserving a species’ habitat and developing that same habitat for economic gain, development almost always comes out the winner. Why? Because provincial governments, acting (in theory) in the best interests of their respective publics, assume that people prefer to maintain their economic prosperity over the conservation of species.

The Upshot

What can governments do about species at risk? Not much. On the one hand, a legitimate government is largely restricted to implementing what the majority of its citizens prefer, which is economic development, even if simultaneously, species are driven to extinction, which is unjust to future generations. On the other hand, if a government were to fully protect and recover species at risk, which would be intergenerationally just, it would also be acting illegitimately because it would be overriding the preferences of its citizens.

There is a way around this dilemma. If enough citizens were to make it clear to their respective governments that they are willing to sacrifice some prosperity to protect biodiversity for the sake of future generations, i.e., if we were willing to live sustainably, then governments could legitimately respond by enacting and implementing sufficient species at risk policies.

Discussion after Paul's talk

Q: I object to people saying that everyone is responsible. I think that it is only sectors of the public that are at fault.

A: Governments average preferences so as to make a decision and the majority wins, so there are always people who are not happy with what we are doing.

Q: If British Columbia continues to fail miserably, what can the federal government do, because they should be obliged to fix British Columbia's inadequacy?

A: In the constitution, there is a provision (a loophole) (the clause is Peace, Order, and Good Governance) where the federal government could intervene and force protection. The federal government's willingness to do this is in the courts right now, regarding the spotted owl. An organization is taking the federal government to court to force them to intervene when British Columbia couldn't do what is needed.

Q: What is the role of the media? How can we encourage the media to bring out the right messages? Humans don't like to hear negative things and won't listen, so what do we do?

A: Put the journalism students with the conservation students. Write about conservation issues and their solutions. It is important to focus on success as well as the doomsday issues.

21. Fostering stewardship behaviour – A role for outreach in caribou recovery

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In the spirit of multidisciplinary approaches, the social science realm offers potentially valuable applications to species at risk recovery processes, including an endeavour as complex as that of woodland caribou in mountainous ecosystems. Specifically, there are lessons to be learned from the fields of environmental psychology, communications, extension, outreach, community-based social marketing, market research, and evaluation research. Understanding what is required to effect caribou recovery in terms of human behaviour change may challenge assumptions about what one considers to be priority actions.

Recovery of species at risk, such as caribou, is part of environmental management. Effective environmental management depends on, among other things, an ethic and practice of environmental stewardship, or caring for the environment with both present and future generations in mind. Aldo Leopold described it as having an "ecological conscience."

The term "stewardship" is a very old one. First Nations across the globe have cared for and promoted certain ecosystems or seral stages through periodic prescribed burns or other management actions. There are references to stewardship in both the Old and New Testaments of the Bible and there is an entire movement related to "caring for creation." The Old English roots of the word mean "the person who looked after the King's pigs." The concept of stewardship has evolved to mean actively caring for something for the public good, such as resources held in common like the air, the water, and the wildlife that move through an area. The term often implies voluntary action and shared responsibility.

The key to stewardship is getting enough people to care for the environment. This requires a change in culture and the values, norms, and actions of society—cultural evolution. There are already changes taking place in terms of how society views the use of forest fires as a tool for ecological restoration in national parks, and on views regarding the introduction of alien species like the bull frog. We need to consider what cultural evolution will be needed to recover caribou in mountainous areas.

Four forces drive cultural evolution—social diffusion, leadership, ideation, and persistence.

Social diffusion is how new ideas, innovations, attitudes, and norms permeate society; how they are passed from one individual to the next, from one generation to the next, from one community to the next, until the shared information is integrated into the culture as "common sense." This can be greatly aided by **leadership**, where individuals adopt and promote these new ideas, innovations, attitudes and norms, breathe life into them, and model the new way of thinking, doing, or being.

To change culture, society needs new ideas, innovations, and attitudes. **Ideation**, the capacity to generate new ideas, and the individuals who have that particular strength, should be appreciated. There needs to be **persistence** of these new ideas, innovations, and attitudes in order for the change to stick and the culture to evolve.

Cultural evolution depends on people. People, and their systems and behaviours, are complex. To effect change, one must understand the culture of one's audiences (geographic/organizational) and their potential for change (engagement levels).

What do you know about your audiences/clients?

- Who are the customers, practitioners, information users, or decision makers?
- What is their culture like? (geographic, organizational)
- What is their potential for engagement and change?
- Why might they resist change? (barriers)
- How to they want to receive the information?

What do you know about the effectiveness of your product or message?

- What does your audience think about the product, or the information?
- What adjustments do you need to make to meet their expectations?

Early adopters are important (social norms and diffusion) You need to identify the innovators and engage them in the process, understand what type (level and content) of information they need,and what format will usable for them. You must understand why they may already be open to change, or will resist change, and what barriers may be in their way.

According to change theory, there are four main strategies one can use to effect change, whether for individuals, organizations, or groups. One can employ power, persuasion, instruction/re-education, and/or facilitation strategies. One can use power, coercion, or force by enacting and enforcing laws and regulations, or by taking legal action. When a problem isn't recognized or considered important yet, one may use persuasion, which consists of reasoning, urging, and inducing. Instruction/re-education helps to create awareness and involves the target audience in solution building. Facilitation disseminates information to a target audience that agrees change is needed. Knowing what influences change within individuals and organizations, as well as understanding more about one's clients and audiences will help one to decide which strategy, or combination of strategies, to use.

The key is to find the right place to intervene; to find the points of change that may be influenced through communication. The objective is to enhance any driving forces and neutralize, or manage, any restraining forces. One needs to identify what may be causing resistance and adapt communications to work with one's audience to address/solve those problems. Individuals and groups could have a variety of barriers to change, including cultural, social, organizational, and/or psychological barriers.

Outreach is a mechanism for cultural evolution. The whole idea of outreach is to spread a belief or practice, to inform and engage individuals and groups, to share knowledge, to generate and apply expertise, to educate, and to thus foster a change in human behaviour.

Social science research findings indicate that increasing awareness and understanding is only one (albeit a very important) component of how to address priority issues and accomplish objectives. We also need to provide and adopt tools and other support mechanisms to foster a stewardship ethic.

To do this, there are two key outreach methodologies that could be employed: extension, and community-based social marketing. Rarely can approaches, tools, or strategies stand alone.

The **extension approach** focuses on two-way communication and relationship building with target stakeholders. It is a field of education practice founded on the principles of empowering and involving one's clients in problem solving. It is client focused, with the agency's role to provide tools through information that will address problems the stakeholders themselves have identified. It is focused on outcomes and how to reach them.

The **community-based social marketing** approach has intellectual roots in disciplines such as psychology, sociology, political science, communication theory, and anthropology. Its practical roots stem from disciplines such as advertising, public relations, and market research, as well as the work and experience of social activists, advocacy groups, and community organizers. Community-based social marketing is a proven tactic, based on social science research. The tools can be appropriate for situations in which there is no initial relationship with clients, where motivation to adopt, learn, or hear messages is low, or when there is a low level of awareness of one's message or issue.

Extension planning helps us focus on creating change to achieve goals. Three tools that can be applied are:

- Establishing Outcomes: Helps focus on desired change
- Using Bennett's Hierarchy of Evidence: Identifies the change we seek
- Developing Logic Models: Identifies where one can make the most difference.

Establishing Outcomes: Outcomes or results state the ultimate effect you want to have or the change you want to make. Each outcome should have clearly defined measures. Outcome objectives should be written in active language, be detailed and SMART: Specific, Measurable, Achievable, Relevant, and Time-bound.

Using Bennett's Hierarchy of Evidence: To define meaningful change, plan and assess outcomes using Bennett's ladder, which identifies the type of change are we looking for and links it to evaluation. Changes become more meaningful as one moves up the scale from changes related to one's resources and activities (Internal, Process) through changes in knowledge, behaviors, policies and, ultimately, conditions (External, Outcomes).

Figure 1 shows the flow of program effects or changes from those that are internal to the program (Levels 1–3) to those that are external to the program (Levels 4–7).

Figure 1: Bennett's Hierarchy of Evidence (Bennett 1975 & 1979)

Level		
7	**End Result: What is the long term impact of your program?** Conditions/Impacts: changes in the human, economic civic, biological conditions. Answers the question: Why are you doing this?	**OUTCOME**
6	**Action: Changes in behaviour, practice, decisions, policies, and social action.** Answers the question: Why are you doing this?	
5	**KASA changes: Changes in Knowledge, Attitude, Skills and Aspirations** Answers the question: What happens?	
4	**Reactions: Changes in perceptions. How did stakeholders react to the product/event? Were they satisfied? Was it appealing? Did they perceive any immediate benefits?** Answers the question: What happens?	**PROCESS**
3	**Involvement: How many stakeholders participated? Who participated?** Answers the question: Who is affected by our activities and outputs?	
2	**Activities: What activities were involved (content, subject, method, and techniques)?** Answers the question: How do we achieve our objectives? What do we do?	
1	**Inputs: What resources were expended on the project?** Answers the question: How much time, money, and or staff resources were used?	

Bennett's ladder illustrates how changing human knowledge and behaviors ultimately can lead to changes in biological conditions. External change outcomes are:

- Level 7: End result—long-term conditions (biological, social)
- Level 6: Application—medium term
- Level 5: KASA—short-term changes in **K**nowledge, **A**ttitudes, **S**kills, and **A**spirations (see Table 1).

Table 1. KASA changes

Change Type	Changes in the Clients
Knowledge	Have clients changed their awareness, understanding, and/or problem-solving ability?
Attitudes	Have clients changed their interest in ideas or practices that were part of the content of the product?
Skills	Have clients changed their verbal or physical abilities? Learned new skills? Improved performance? Which skills? Which abilities?
Aspirations	Have clients selected future courses of action or made decisions based on the content of your product? In which areas?

Developing Logic Models or Logical Frameworks: Logical frameworks encourage a form of program development that integrates measures for evaluation and accountability (at the core of a results-based approach). They help find the place where one can make the most difference for behavior change. Logic models are an excellent tool that document how "what you do" links to desired results. They link goals and objectives to activities. The progression of change documented from Levels 1–7 (Bennett's Hierarchy) provides the early footprints of a logical framework or logic model. The main elements connect through a series of "if–then" relationships.

To build a logic model, begin by describing your situation. Include identifying the assets that you may have to accomplish your program, including in-kind, partnerships, materials, etc. that already occur and are available. Articulate your assumptions. Assumptions are validated with research and experience and should be re-evaluated often. Often programs fail because of inaccurate or overlooked assumptions. Consider external and internal components. What are the "driving forces" within the situation or the things that will help to increase the willingness of the client group/audience to make the desired change, or enhance your ability to create the change? What are the "restraining forces" that will reduce the willingness for change, or your ability to create change?

Then, define the program you want to model. Begin "at the end" by articulating the goals being sought, the outcomes or results. Use statements of mission and vision if available. What is your overall, long-term, ultimate outcome? What changes in the human, economic, and biological condition do you want? Use change words: reduce, increase, and improve. Now identify a medium-term outcome necessary to reach the long-term outcome. What changes in behavior, practices, decisions, policies, or procedures do you want? Use an action/change word: adopted, employed, or implemented. Then identify a short-term outcome necessary to reach the medium-term outcome. What changes in Knowledge, Attitudes, Skills, or Aspiration do you want? Use an action/change word: recognize, understand, motivate, believe, or desire.

Then, go back "to the middle." What are the major activities being undertaken to accomplish those goals? What are the immediate benefits or effects expected from the activity? What do these benefits lead to? (Intermediate outcomes) Do immediate and long-term outcomes connect to the goals? Link a possible activity (or activities) that would contribute to the short-term learning outcome and the input or resources that would be required to achieve it. At this point, identify the outputs (what we do—activities, and who we reach—audiences). Lastly, figure out what inputs are required (what we invest—time, money, partners, equipment, facilities, and materials).

Six elements in logic modelling can be linked back to Bennett's Hierarchy:

1. Situation analysis: The problem or issue that the program is to address.
2. Inputs: Resources, contributions, and investments provided in response to the situation.
3. Outputs: Activities, services, events, and products that reach people and users.
4. Outcomes: Results or changes for individuals, groups, agencies, communities, and/or systems.
5. Assumptions: Beliefs and values we have about a program, the people, the environment, and the way we think a program will work.
6. External influences: The environment in which the program exists (biophysical environment, political environment, background and experiences of stakeholders, socio-economics, global markets, media influences, and changing policies and priorities).

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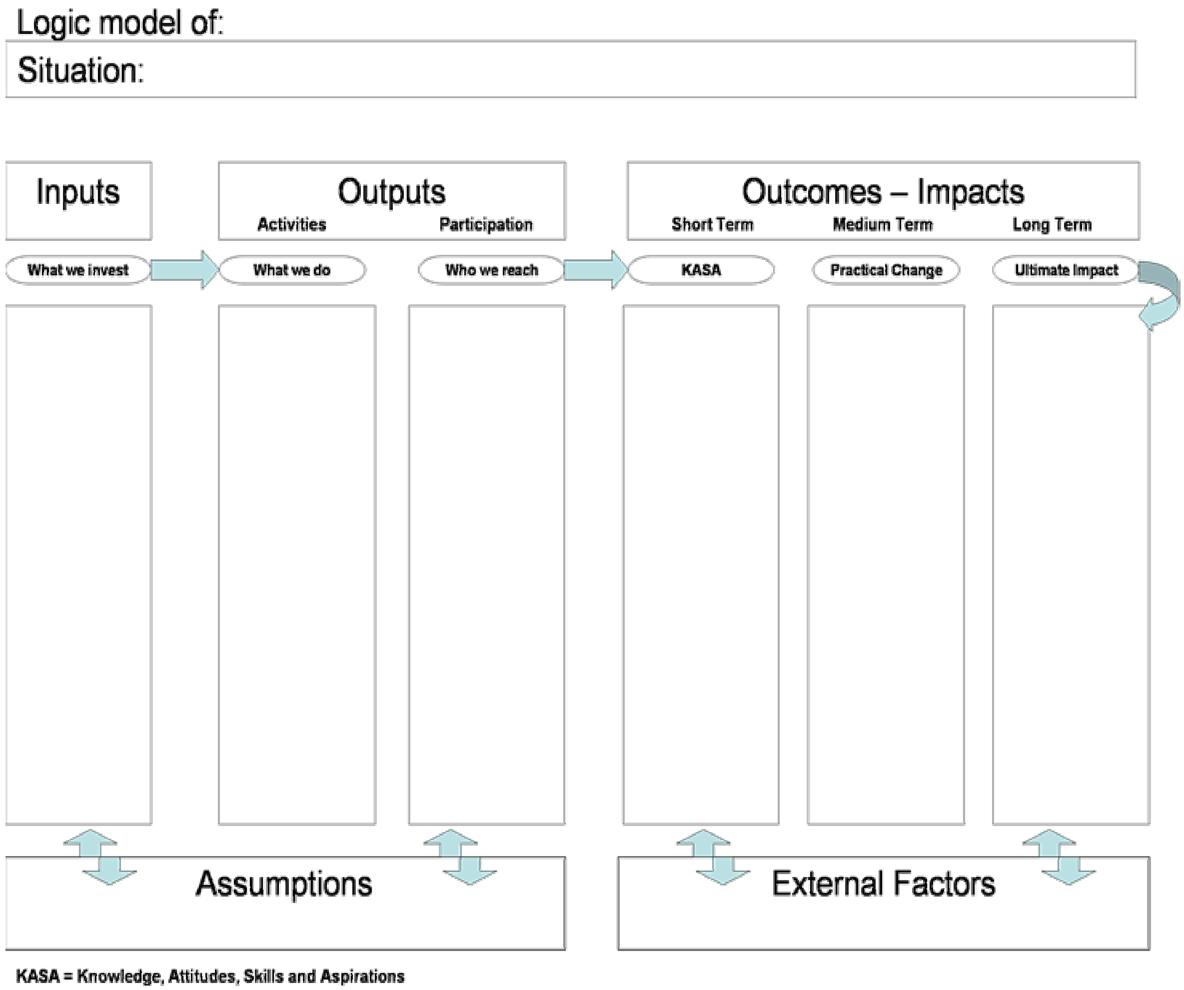

Figure 2. Sample Logic Model

Community-based social marketing

Commercial marketing is a process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational objectives. It is often thought of as being designed for profit, for example, how to position a company to garner the most market share.

The key characteristic that distinguishes social marketing from commercial marketing is its purpose; that is, the benefits accrue to the individual or society rather than the marketer's business. Social marketing disciplines include education, marketing and advertising, anthropology, and social psychology. It's been found to be very effective in changing people's behaviour. Successful examples are anti-smoking and safe sex campaigns.

Community-based social marketing reflects the need to understand the psychology of the people you're trying to reach and to be sensitive to addressing their perceptions. The basic lesson is that research shows that information campaigns do not work in changing behaviour. Information is necessary, but not sufficient, to change behaviour. We need to be much more client-focused and to better understand the psychology of our clients and stakeholders (McKenzie-Mohr and Smith 1999).

Everyone makes decisions for what seem like good reasons to them. Information is sometimes a barrier, but often people know what they should do, they may even believe they should do it. But they're not doing it because of other factors such as peer pressure, convenience, cost, etc. A better understanding of what clients and stakeholders see as barriers to engaging in stewardship, and the benefits they think they derive from their current practices, can offer insights that help design programs to reduce barriers and increase the incentives.

This is all about knowing one's audience. The community-based social marketing approach involves conducting social science research to determine the barriers and benefits associated with a particular desired behaviour by a particular target audience. This could be anything from studying the barriers and benefits associated with various stewardship actions and voluntary restrictions by members of snowmobile clubs to reduce disturbance of caribou, or perhaps to voluntary compliance by a forest company with regulations related to Ungulate Winter Range under the *Forest and Range Practices Act*.

Often groups begin by developing communication strategies, messaging, and events without having any idea as to what really "drives" people's behaviour. Groups often market a cause, product, or service without knowing their target market, a costly and strategic error. McKenzie-Mohr and Smith (1999) identify five steps in community-based social marketing:

1. Identify the problem and the specific behaviour change needed.
2. Identify barriers and benefits to a specific behavioural change.
3. Develop a strategy that uses tools that are shown to be effective in altering behaviour.
4. Pilot the strategy.
5. Evaluate the strategy.

Step three includes six tools of behaviour change practised in community-based social marketing, which are outlined in Table 2: Removing external barriers, providing incentives, inspiring commitment, using prompts, creating new social norms, and communicating effectively.

Table 2. Six tools of behaviour change practiced in community-based social marketing (adapted from McKenzie-Mohr and Smith 1999).

Tool Type	Best Practices
Removing External Barriers	• Identify barriers. • Plan how to overcome them. • Study other similar situations to see how others overcame similar barriers. • Assess if you have resources to address barriers.
Providing Incentives	• Closely pair the incentive and the behaviour. • Use incentives to reward positive behaviour. • Make the incentive visible. • Be cautious about removing incentives. • Prepare for people's attempts to avoid the incentive. • Carefully consider the size of the incentive. • Use non-monetary incentives.
Inspiring Commitment	• Written over verbal. • Ask for public commitments. • Seek commitments in groups. • Actively involve the person. • Use existing points of contact to obtain commitments. • Don't use coercion! • Help people view themselves as environmentally concerned.
Using Prompts	• Make the prompt noticeable. • Make the prompt self-explanatory. • Present the prompt close to the action. • Use prompts to encourage people to engage in positive behaviours.
Creating New Social Norms	• Develop community or societal norms which support stewardship. • Make the norm visible. • Use personal contact to reinforce norms.
Communicating Effectively	• Use captivating information. • Know your audience. • Use a credible source. • Frame your message. • Carefully consider threatening messages. • Decide on a one-sided versus two-sided message. • Make your message easy to remember. • Provide personal or community goals. • Emphasize personal contact. • Provide feedback.

In summary, human behaviour change is the key to achieving caribou recovery. Outreach is a mechanism to foster behaviour change. Outreach entails not just communication, but engagement. By using methods of extension and community-based social marketing, including behaviour change tools, one can increase the effectiveness of outreach. One needs to plan ahead by defining outcomes first, and then planning how to reach them. One needs to understand and deal effectively with barriers perceived by stakeholders, then demonstrate the benefits of caribou recovery and provide incentives to effect change.

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Discussion after Jenny's talk

Q: These methods are too slow. This is why the environmental community has adopted methods more on the coercion side as they are more effective.

A: I think we need to be adaptive and use different tools in different situations. I think that it is important to make relationships, as quick actions have not worked in the past. Sometimes you need to use more enforcement actions but you also have to build relationships to avoid going from problem to problem.

Q: Sustainability is a good concept that industry has co-opted and now it appears everywhere.

A: Plagiarism is a compliment. Some companies are trying to do the right thing and they are borrowing your language.

Q: Most changes in outlook come from a change in heart. How do your methods incorporate this?

A: Outreach is not just about giving information. It is about personal interaction with human beings; not just reading information.

22. Towards comprehensive and transparent use of ecological information in decisions about recovery

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Introduction

The ideas that I present are not inherently science; they are about the collection of scientific information for the purpose of making decisions supporting recovery of mountain caribou in British Columbia. However, no decision about recovery of mountain caribou will be made either. Rather, the focus is on a process for insuring good properties of decision making. Making decisions is an activity in which we engage so frequently that it can be common to ignore the process and procedures used. However, decisions about recovery of caribou are of a critical nature and should involve a formal, science-based approach; we cannot afford to be wrong.

There are some common properties about good decisions. They are comprehensive, current, transparent, functional, probabilistic, and measurable. Decisions with these properties have numerous benefits, especially when there is uncertainty about outcomes. Comprehensiveness allows us to contemplate all possible solutions (i.e., management actions) to a problem. Transparency builds trust and accountability. Representation of systems in a functional way allows for selective dissection of the problem, including analyses focused on sensitivity. Being probabilistic (i.e., including measures of uncertainty) allows for risk assessment. Measurable parameters allow for monitoring, feedback, and adaptation.

With this background about good decisions, the Mountain Caribou Science Team (henceforth the team, or simply, we) wanted to draw from previous data collection and our collective understanding about mountain caribou and their habitats in a manner that would allow for:

- equitable and systematic comparison of habitat across the range of mountain caribou;
- transparency in how habitats were evaluated,
- functional relationships to the extent that management options and ecological limitations could be dissected;
- queries about past, current, or possible future habitat values, and,
- assessments of the relative probability of recovery success.

Study Area and Background

Our study area was essentially a collection of land-use planning units. We used these units because we considered that any resulting policy recommendations would be stratified and applied on the basis of formal land-use planning designations. Our selection of land-use planning units wholly enclosed:

- the range currently used by mountain caribou;
- adjacent range used by non-caribou ungulates to the extent that was judged to capture potential ecological interactions between caribou and these other ungulates and/or their predators; and,
- at least a portion of the historic range that may encompass recoverable habitat.

The area extended over approximately 15 million hectares from the headwaters of the Parsnip River in north-central British Columbia, south to the border of British Columbia and the United States, and enclosed most of the interior wet-belt forests of British Columbia.

We found more than 20 references to studies of varying types and extents that focused on describing habitat for mountain caribou within our study area. The habitat maps resulting from these studies could be categorized as either those developed from resource selection functions (RSF) or from Wildlife Habitat Relationships (WHR, otherwise known as capability/suitability maps). However, the team considered this mapping to be insufficient for making good decisions about recovery of caribou for a variety of reasons:

RSFs

- tend to be conducted on relatively sparse data sets;
- cannot be extrapolated beyond the "experience" (i.e., temporal and spatial characteristics) of inputs; and,
- were not functionally complete and hence difficult to dissect.

WHRs:

- did not provide complete coverage of the study area extent;
- were not transparent; and,
- would have been time consuming and expensive to complete.

Neither of the mapping methods explicitly incorporate comprehensive consideration of threats to caribou habitat and therefore do not directly lend themselves to any formal or structured decision-making process. More generally, the "real-life" decisions about caribou recovery are complex and have a number of inherent characteristics that make such traditional habitat modelling unlikely to be of value. "Solution characterization" can become intractable in traditional analytical approaches to complex decisions because usually:

- there are many conflicting "fuzzy" goals or objectives;
- they lack specificity on decision variables;
- there is uncertainty as to the boundaries on decision variables;
- we lack knowledge on some cause-effect relationships;
- some of our knowledge is qualitative only;
- there are stochastic elements and a probability of some unforeseen consequences; and,
- there is an underlying dynamic that causes much of the above to vary over time.

For these reasons we chose to use Bayesian Belief Networks (BBNs) as a way to capture current knowledge and data concerning the habitat ecology of mountain caribou. Bayesian modelling is not new to ecology and has proven useful when "solution characterization" has proven intractable. Bayesian modelling is probabilistic and can therefore include data and other sources of information even if either is incomplete. Results are characterized by measurable uncertainty, which allows for risk assessments and other forms of decision analysis. The approach therefore is consistent with at least some properties of structured decision making and forwards a problem-solving technique to support critical decisions about recovery of caribou.

Methods

BBNs are a series of nodes and linkages, where nodes represent environmental correlates, disturbance factors, and response conditions (Figure 1). In this application for example, we predict how the state or condition of environmental inputs determines the resulting state of seasonal range for caribou. Nodes are linked by probabilities. Input nodes are environmental correlates that, when linked by conditional probabilities, function to predict the state or outcome of a resultant node through the use of posterior probabilities (i.e., each state of the resultant node has some probability or likelihood of occurring conditional on the state of the input nodes). Some input nodes, which we refer to as "management levers," can represent environmental correlates that are dynamic either through unmanaged or managed disturbance.

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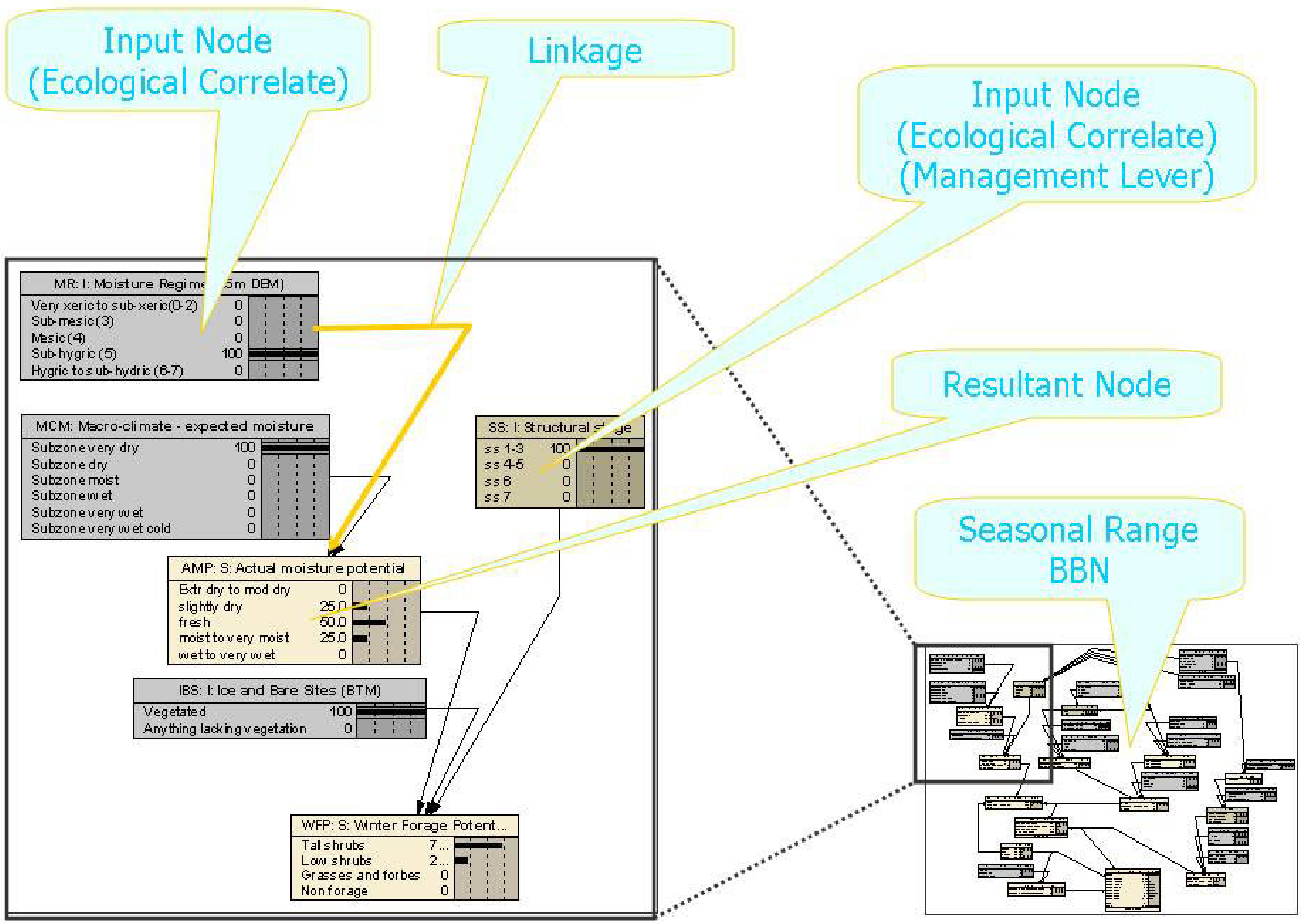

Figure 1. A depiction of a seasonal range Bayesian Belief Network (BBN) and its component parts of input nodes for ecological correlates and management levers, and linkages among the inputs to resultant nodes.

Beginning in January of 2005, we constructed BBN models of caribou range in three phases of work accounting to 12 months contact time. We held four professionally facilitated workshops with caribou herd experts, and used Netica (version 2.17, Norysys Systems Corp., Vancouver, British Columbia) to design seasonal range BBNs. We used ArcView 3.2 (ESRI, Redlands, California) and Microsoft Access 2000 (Microsoft Corp., Redmond, Washington) to construct and manage case files of environmental correlates taken from 1 ha cells in the study area (15,116,423 ha). Case files (i.e., one file for each BBN) were lists of records (i.e., one record for each cell in the study area) containing columns (i.e., one column for each input node) specifying the condition or state of environmental correlates.

We simplified and expedited data processing by dividing the study area into 12 analysis units ranging in size from 903,000 ha to 1,622,000 ha and by dedicating a PC to each analysis unit. We used Netica in batch mode to process case files before preparing modelled results in Access for display in ArcView and analysis in SAS (SAS Inst. Inc., Cary, North Carolina). We displayed seasonal range values on maps as the expected value from the Seasonal Forage Usefulness node (i.e., the probability of a state multiplied by the state value, summed across all states) where this node represented the percentage of maximum forage potential that was available for use by animals. BBNs were applied to the study area and selected results were presented in a fifth workshop to demonstrate successful function of the modelling process and to begin the process of data and algorithm validation. We used feedback from herd experts to correct data management errors, modify BBN design, and adjust parameters prior to preparing Alpha level BBNs. Alpha BBNs were then applied to the study area and results from three areas were reviewed by three herd experts having site-specific knowledge of the review areas. Errors that were considered to be consistent across the review were corrected and the resulting Beta level BBNs were then reapplied to the study area.

Application of the Beta BBNs was conducted assuming two management scenarios: (a) current landscape conditions and (b) landscapes that could have existed under assumed conditions of natural disturbance. The latter was a hypothetical condition estimated by simulating landscape disturbance over 400 years (in order to remove the current footprint of historic management) from current conditions using a Spatially Explicit Landscape Event Simulator (SELES). We mimicked assumed conditions of natural disturbance based on parameters for patch size and return intervals for natural wildfires obtained from the Biodiversity Guidebook. Although yet to be completed, multiple simulations of the natural disturbance scenario would allow for a calculation of a range of conditions within which we'd target, for example, the managed range condition for caribou.

Results

The mountain caribou model is a suite of seven individual BBNs which produce 16 spatial layers depicting four seasonal range values for caribou, summer and winter range values for four non-caribou ungulates, summer and winter estimates of combined potential predation rates from grizzly and wolverine, and summer and winter estimates of search rate adjustment for potential predation from cougar and wolves (Figure 2). In summary, there were 18 inputs to the BBNs, coming from seven sources of digital information (Table 1).

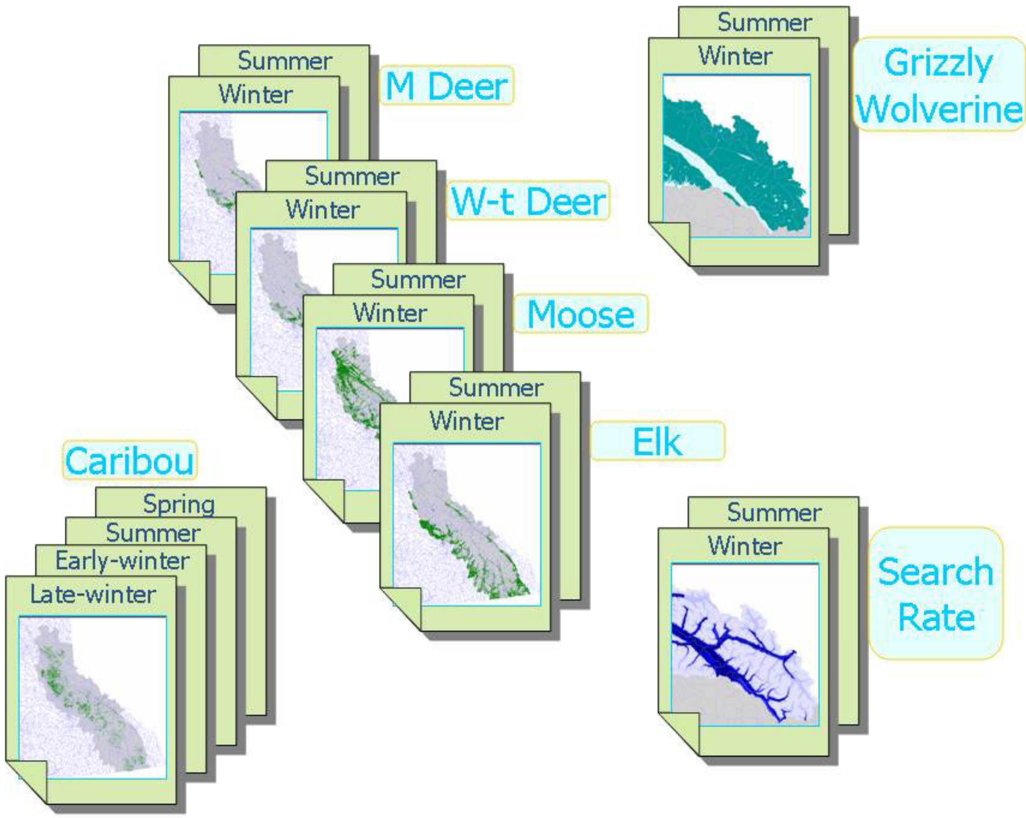

Figure 2. A depiction of the spatial layers output from a suite of Bayesian Belief Networks characterizing range value for selected ungulates in southeastern British Columbia.

The project is now at a stage where experts need to address the beta-level map results and confirm that the BBNs produce results meeting their expectations and understanding of the ecological system including the characterization of threats to caribou habitat. This validation should be conducted while realizing that we cannot expect our representation of the caribou range ecology to be perfect. It is sometimes difficult to articulate what we know in measurable terms and so we can expect error. Also, what we think we know comes from temporally and spatially specific observations, which, when coupled with observations of other related but different knowledge, can sometimes lead to unexpected results. If the BBNs begin to build an information basis for recovery decisions, and we think they do, they also show us how little we do know. In cases where data, information, or knowledge is limited, BBNs represent hypotheses about ecological relationships. Advantages of stating these research hypotheses include the ability to use sensitivity analysis to rank research questions. The statements also build transparency in how collected data will be used to address management decisions.

Table 1. Ecological correlates, their measures, and data sources used as inputs to a suite of Bayesian Belief Networks characterizing range value for selected ungulates in southeastern British Columbia.

Ecological Correlate	Measure	Data Source
Snow Zones	Mean annual snow	Biogeoclimatic
Seasonal Temperature Zones	Mean seasonal degrees	
Snowmelt Zones	Ecological variant	
Soil Moisture Zones	Ecological variant	
Open Landscape Zones	Alpine areas	
Age (old structure) Zones	Ecological variant	
Basic Human Activity	Towns/Industrial sites	Baseline Thematic Mapping
Non-vegetative Zones	Landform classes	
Vegetation Age	Age classes	Forest Cover
Non-productive Forest Class	NP classes	
Forest Canopy Closure	%	
Forest Canopy Fullness	Species	
Forest Crown Structure (lichens)	Species	
Spatial Density of Water bodies	Lakes & dl-rivers	
Spatial Density of Roads	Any road	Government data
Caribou Herd Areas	Harmonic mean range	Caribou relocations
Grizzly Density	#/1000 km2	Adams and Lofroth 2004
Wolverine Habitat Values	High & moderate	Hamilton *et al*. 2004

Future Work

Work in the future will include focus on verifying the BBNs and use of the verified BBNs to ask both strategic and operational questions, the results of which will be used to support decisions about recovery of mountain caribou in British Columbia. Verification tasks could include an evaluation of:

- the spatial accuracy of range predictions using previously collected relocations of radio-collared animals and/or more qualitative comparisons to other habitat maps (Figure 3); or
- the amount of current range seasonally and regionally within the study area.

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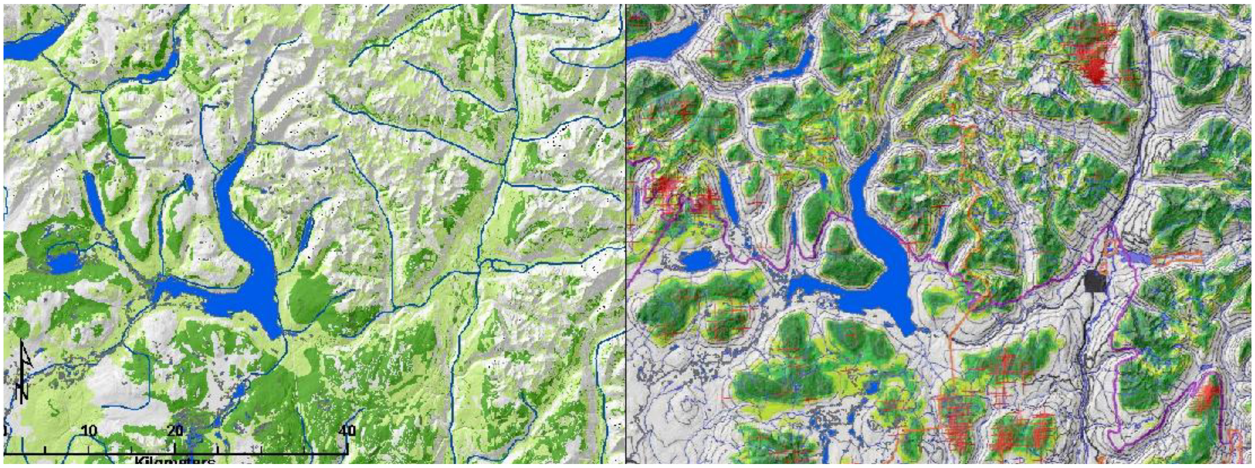

Figure 3. Example outputs from a Bayesian Belief Network (left) and a resource selection function (right) used to evaluate late winter range condition for woodland caribou near Murtle Lake in British Columbia.

Use of the verified BBNs could include asking questions about:

- historic trends in habitat value using reconstructed data inputs from an era when caribou populations were relatively more healthy than they are currently;
- relative comparisons of threats to range characteristics (forage degradation, displacement by human activity, predation) across the study area;
- relative comparisons of the amount of seasonal range existing under current conditions to those expected under natural disturbance conditions; and
- relative comparisons of the amount and rate of habitat recovery that could be expected within the study area.

These kinds of comparisons were used to build an information basis for recovery of caribou in north-central British Columbia, the basis of which were simulated trends in habitat under a hypothetical management scenario (Figure 4). Following field verification, we also used the BBNs to identify ungulate winter ranges for caribou in both the Mackenzie and Ft. St. James Forest Districts.

Continued…

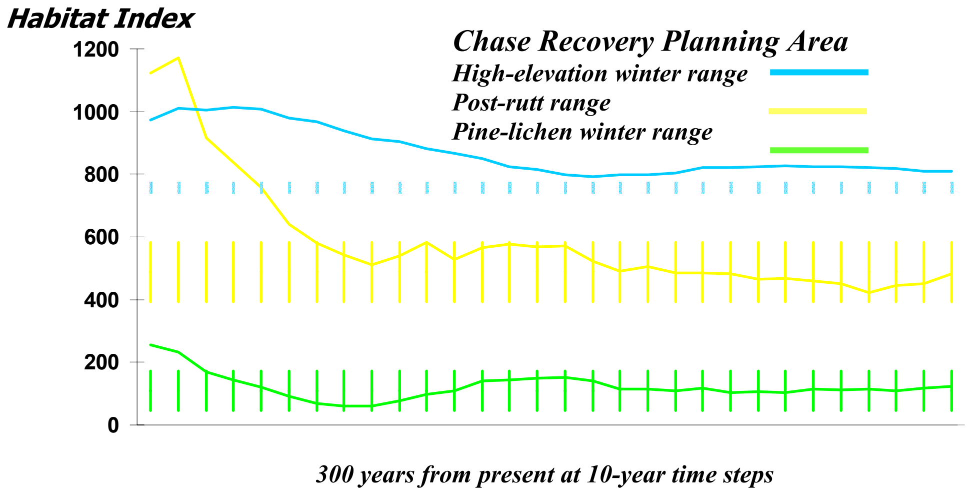

Figure 4. Simulated trends in habitat (habitat index) for woodland caribou in the Chase recovery planning area of north-central British Columbia. Simulations were made using Bayesian Belief Networks implemented under proposed caribou recovery policy (solid lines) and under assumed conditions of natural disturbance (latter plotted as vertical bars representing the range of results from multiple simulations).

Conclusions

Our use of BBNs was not intended to replace other forms of research, data collection, or empirical modelling but rather to collate any, and all, forms of knowledge regarding caribou, their habitat, and threats to caribou habitat. BBNs can be used to collate this knowledge in a transparent and comprehensive manner that allows for gaming with potential recovery options under conditions of uncertainty. Together, the transparency and the ability to assess risk of certain actions allow us to hold decision makers accountable for the decisions made and places the decision process clearly within a context of adaptation and continual improvement.

Acknowledgements

I would like to acknowledge the contributions to this work from many scientists who have studied mountain caribou and in that capacity provided herd-specific, expert judgment on the fundamental relationships describing caribou habitat ecology: Wayne Wakkinen, Guy Woods, Trevor Kinley, Greg Utzig, Dennis Hamilton, Steve Wilson, Bruce McLellan, Rob Serrouya, Dale Seip, Jim Young, John Surgenor, and Harold Armleder. Contributions from other domain specialists came from: Kevin Jardine, Pat Field, Cindy Pearce, Ian Hatter, Mark Zacharias, Clayton Apps, Rick Ellis, Eric Valdal, Randy Sulyma, and Dan O'Brien. Much of the model application was conducted by Wildlife Infometrics staff: Line Giguere, Viktor Brumovsky, Robin McKinley, and

Jackie Caldwell. Funding for the study came primarily from the Species at Risk Coordination Office of the BC Ministry of Agriculture and Lands, and the BC Ministry of Forests and Range. Much of the material for the discussion came from the following reports:

McNay, R.S. 2006. Preliminary calibration of a habitat supply model for mountain caribou in British Columbia: Interim Progress Report. Wildlife Infometrics Inc., Mackenzie, BC. Wildlife Infometrics Inc. Report No. 190. 63pp.

McNay, R.S., B.G. Marcot, V. Brumovsky, and R. Ellis. In Review. A Bayesian approach to evaluating habitat for woodland caribou in north-central British Columbia. Can. J. For. Res. xx:xxxx-xxxx.

McNay, R.S., C. Apps, S. Wilson, T. Kinley, D. O'Brien, and G. Sutherland. 2006. Use of habitat supply models to establish herd-based recovery targets for threatened mountain caribou in British Columbia: Year 2 Progress Report. Wildlife Infometrics Inc., Mackenzie, BC. Wildlife Infometrics Inc. Report No. 180. 92pp

23. Caribou population augmentation: Treatment or triage?

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Introduction

Over the years I have heard many comments about the success or failure of caribou transplants to the South Selkirk populations. Most people seem to understand caribou transplants as one of a suite of treatments available to recover caribou populations. In general, since the population has not recovered by most measures, the transplants are considered a failure. I presented a different view of the reason for transplants. In addition, I briefly discussed the history of the South Selkirk herd transplants and the reasons behind the population trajectory over the past 20 years. I discussed the augmentation options available and finished with a short discussion on the status of proposed South Purcell population augmentations.

Treatment or Triage?

Triage (def.)

- A process in which things are ranked in terms of importance or priority.
- Dealing with the highest risk situations first.

Treatment (def.)

- Administration or application of remedies.
- The usual methods of dealing with a given situation.

The three-legged stool description of the methods being employed to recover mountain caribou populations includes maintaining and improving habitat, managing human disturbance impacts, and managing predator/prey relationships. Others have spoken about the ways in which these treatments need to be employed to maintain mountain caribou populations. I want to stress that these are remedies to the problems our mountain caribou suffer. The last ditch (triage) efforts undertaken to prevent the final extirpation of a population are transplants and direct predator control. I don't expect these efforts to recover our populations; they are the efforts needed to keep the population in place long enough to allow the treatments to work.

Why Augment?

One of the often quoted gems of wisdom in the conservation field is Aldo Leopold's (1966) statement "To keep every cog and wheel is the first precaution of intelligent tinkering." Keeping a viable population in place in each of our current populations is, in my opinion, "…keeping every cog and wheel."

Caribou are gregarious, normally found in groups of four to six, but often can gather in groups of up to 30 animals. Transplanted animals in the South Selkirks integrate quickly with the existing population when given the opportunity. The opportunity for introduced animals to learn from the existing population is an important reason to keep a population alive.

A second reason to augment is the accelerated growth curve that results from a short series of introductions. Figure 1 shows the consequences of successful introduction of only 10 animals every two years in a series of three and six transplants. Clearly the greater growth that occurs with a larger base population is valuable.

A third reason is simply to move a population away from the ravages of random events that normally spell doom for a small population. A single avalanche can kill a population of six, but is highly unlikely to kill a population of 60.

The biggest reason of all, in my opinion, is that it is politically much harder to re-establish a population than it is to keep it in place. In most cases, a few years with caribou extirpated and the whole topic of re-establishment fades from view.

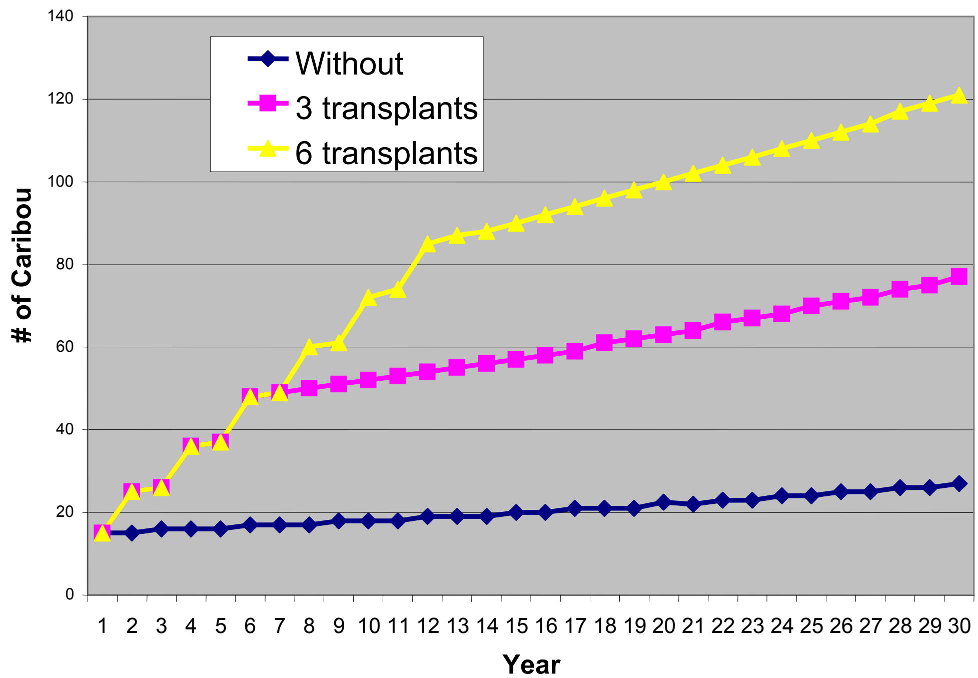

Figure 1. Caribou population growth (2% growth rate).

History of South Selkirk herd augmentation

Six transplants of 103 caribou have taken place since 1987 and the population has increased from about 25 animals to about 35 animals. The ups and downs during that period have been instructive. The first three transplants in the late 1980s succeeded in raising the population from about 25 to about 50. The population was stable during the early 1990s as deer, elk, and cougar populations were increasing. A second round of transplants took place beginning in 1996, but despite the input of 43 caribou the population declined to about 32 by 2000. Research (Katnik 2002; Robinson *et al*. 2002) puts the blame on cougars as the direct cause of this decline The decline was related to the large increase in cougar prey, the white-tailed deer, and the subsequent rapid decline in the white-tailed deer population following the terrible 1996/97 winter. Since 1998, the cougar population has declined, the white-tailed deer population has built up again, and the caribou population has stabilized. Figure 2 shows the results of census work over the past years as well as the trajectories expected at various times over the past 20 years.

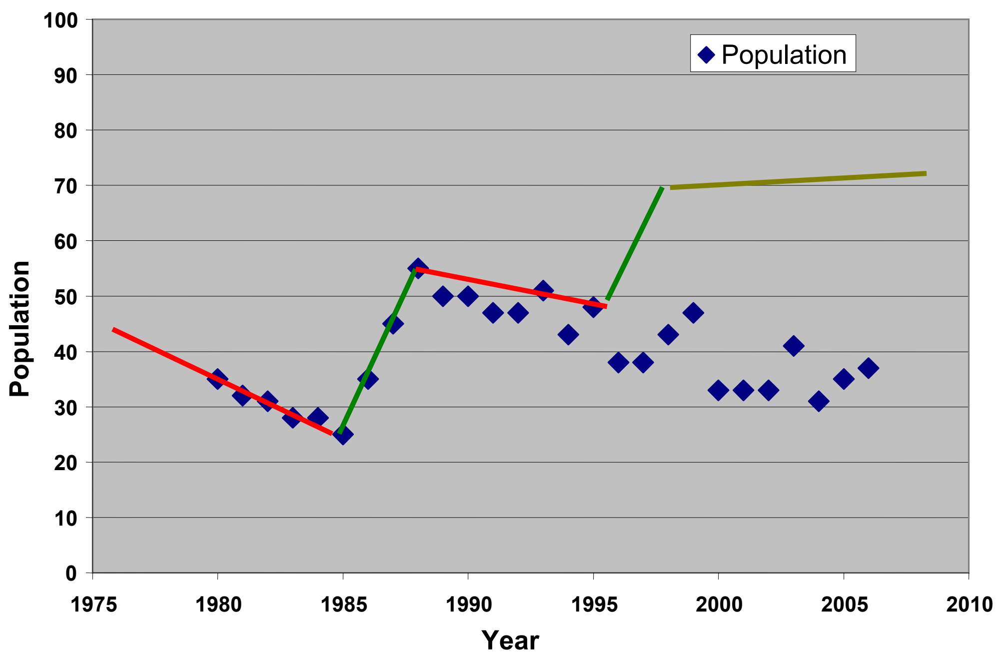

Figure 2. South Selkirks caribou population.

Almack (2000) noted that the survivorship of the transplanted caribou was poor in the first year after transplantation, but rose to the same level as the existing population after that. In fact, in the spring of 2006 there were still at least seven of the original 42 transplants alive and reproducing in the South Selkirks. The VHF radio collars of these transplants are still functioning and they are still being monitored every two weeks (Clarke 2006).

Augmentation Methods

Wild Capture and Immediate Release

- Used in all South Selkirk transplants
- Planned for South Purcell transplants
- Inexpensive
- Speedy
- Relatively successful
- High initial mortality
- Disease problems minimized

Wild Capture and Delayed Release, Post-calving

- Untested
    - attempted on first Idaho release
    - animals escaped pen
- Expensive
- Provides adaptation time
- If held until post-parturition, may result in much greater calf survival
- Potentially greater disease problems
- Very similar to local capture and release, but animals are not locally adapted.

Permanent Captive Herd and Release Offspring

- Simpson and Terry (2001) identified three categories of issues
    - Capture and rearing site issues
    - Release and monitoring issues
    - Release site suitability issues
- Not implemented because of:
    - High cost
    - Lack of site
    - Animal health and safety
    - Lack of source of maternal animals
- Untested method; there are huge questions around survival potential of naïve offspring

Maternity Pen

- Undertaken successfully in Yukon 2002–2004
- Chisana caribou project (Oakley and Mead-Robins 2004)
- Requires annual capture and containment of existing animals; risk of injury and death during initial capture and transport
- Containment problems with animals—fencing in very high snow zones is problematic
- Potential of disease introduction
- Expensive

- Raised calf survival to 60–80% from 10–15% (to August)

Animals from Existing Game Farms
- Very few animals in captivity
- Disease concerns
- Captive animals are currently in US
- Expensive
- Naïve young release animals may not survive—untested

In summary, a range of augmentation methods exist and there is now some experience with the methods. The greatest experience gap is with release of naïve offspring without their mothers. Work is needed to find out whether nine-month-old calves are gregarious enough to join with an existing herd and whether an existing herd will accept them well enough to allow them to adapt to a wild environment. Of course there are other issues to deal with, including habitat quality, predation, recreation management, First Nations consultations, finding suitable source populations, and, as always, the money to do the work.

South Purcell population augmentation

Attempts were made to transplant caribou to the South Purcells during 2001 to 2005 period, but no transplant was attempted. The issues that have delayed an augmentation are many, but the three main problems were concerns about source population viability, First Nations concerns at the source population in the Itcha Illgachuz Mountains, and concerns about the suitability of release area to support caribou, including habitat quality, predation levels, and recreation management controls. Everyone involved wanted to be sure that the problems that caused the declines had been resolved and that we did not "waste" the animals being released.

During my tenure as a BC Ministry of Environment wildlife biologist responsible for implementing the augmentation, I argued that there had been sufficient change in the protection of habitat quality and quantity, recreation management, and predation management to move forward with a transplant. I continue to believe that while these "treatments" implemented largely in the past five years need time to work, now is the time for "triage," or we will lose the population completely, along with any support needed to re-establish a population in the future. Recent population census work (Kinley 2006) indicates that no caribou were found in the south Purcell–central Purcell area, which is the area we planned to locate the transplanted animals. The time for talk on this specific issue is over; we need to complete this augmentation to prevent complete loss of the South Purcell populations.

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Discussion after Guy's presentation

Q: For the total population over the whole province, in the end would there be enough animals to transplant from one population to another? If there are negative impacts from taking animals out of a population, would it be better to leave the animals alone, even if it means the smaller populations may disappear?

A: The goals of recovery are to maintain populations and distribution. We dn't want to influence a source population adversely, but if they are a sustainable herd then there is an overall benefit.

A: Source populations are not "mountain" caribou.

24. Mountain caribou recovery efforts in British Columbia: 1976 to present

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> *"Conservation of mountain caribou has a long history in British Columbia, beginning at least seventy years ago with efforts to control overharvest through stricter hunting regulations. Even the importance of habitat in maintaining healthy caribou population was investigated more than forty years ago, and the role of predation was first explored over twenty years ago. Recent conservation efforts have focused on the effects of timber management on mountain caribou and their habitat."*
>
> Bill Harper, RPBio
> Endangered Species Specialist, Wildlife Branch
> BC Ministry of Environment, Lands and Parks
> May 1997

Early recovery efforts for Mountain Caribou are summarized by Ritcey (1976), Bergerud (1978), Stevenson and Hatler (1985), MCMF (1994, 2001), McKinnon (1996), Pacquet (1997), Simpson *et al*. (1997) and Robertson (1997). These efforts, as they pertain to the eventual development of a provincial Mountain Caribou Recovery Strategy, are summarized below.

Ritcey, 1976

Mountain caribou planning was initiated regionally in the 1970s. The first caribou management plan was prepared by Ralph Ritcey in July, 1976 for Region 3 (Ritcey 1976). Much of the focus was on the identification of important habitats, modification of forest management practices, and protection of core habitat areas. The science supporting this approach was based on early field studies by Ritcey and Edwards during the 1950s and 1960s, primarily within what is now referred to as the Wells Gray South population.

Bergerud, 1978

The status and management of caribou in British Columbia was reviewed in 1978 by Dr. Tom Bergerud. Bergerud believed that the province's caribou population declined from a high point in about 1970 when there may have been 20,000 to 25,000 animals in the province, and argued that the decline resulted from low calf recruitment and overhunting. Predation was considered to be the cause of low calf recruitment while overhunting resulted in part from increased hunter access to caribou ranges. Although Bergerud did not address habitat management issues in detail, his report helped to trigger the need for further research on mountain caribou and their habitat.

Stevenson and Hatler, 1985

The first comprehensive review on the status of woodland caribou and their relationship to forestry practices in southern and central British Columbia was undertaken by Stevenson and Hatler (1985). Stevenson and Hatler reviewed the status of forest management planning, the potential impact of the timber supply in Timber Supply Areas on caribou, and current policies for habitat protection in caribou areas. They developed a framework to help managers view caribou management considerations in a broad geographic context, and recommended the designation of three caribou population centres as high-priority management areas: one centred around Tweedsmuir Park, one centered around Wells Gray Park, and one between Prince George and the Alberta border. Stevenson and Hatler were probably the first to recommend a provincially coordinated caribou plan.

Mountain Caribou in Managed Forests Program, 1994 and 2001

The Mountain Caribou in Managed Forests (MCMF) program was initiated by Ken Child, the regional wildlife biologist in Prince George in 1988. The key question addressed by MCMF was: "Can forest stands be managed, through silvicultural systems and habitat enhancement techniques, so as to sustain both timber harvest and caribou habitat over the long term?" The goal of the program was to produce integrated solutions for managing for mountain caribou and timber in southeastern and east-central British Columbia.

The preliminary results of MCMF activities were summarized in "Mountain Caribou in Managed Forests – Preliminary Recommendations for Managers" by Stevenson *et al*. (1994). The recommendations were based upon information collected from several adaptive management trials in what is currently referred to as the Hart Ranges and North Caribou Mountain populations. Some additional work was conducted in the Quesnel Highlands (North Wells Gray population).

A second report by the MCMF was published as "Mountain Caribou in Managed Forests: Recommendations for Managers" by Stevenson *et al*. (2001). This report focused on management of winter ranges and described an approach to habitat management that has the potential to maintain the structural qualities that allow caribou to use their entire winter range area to forage and to avoid predators. The Mountain Caribou Technical Advisory Committee made extensive use of this information in developing the Mountain Caribou Recovery Strategy

McKinnon, 1994

Greg McKinnon, with the Habitat Protection Branch in Victoria, formed a provincial committee to start working on a Mountain Caribou Strategy for British Columbia. While the strategy was never completed, an abbreviated version of its content was presented at the Sixth North American Caribou Workshop in 1994, and later published in the journal *Rangifer* (McKinnon 1996). McKinnon noted that successful implementation of a mountain caribou management strategy would require the active participation of the BC Ministry of Forests and Range.

Towards a Mountain Caribou Management Strategy, 1997

The responsibility for completing the Mountain Caribou Strategy shifted from the Habitat Protection Branch to the Wildlife Branch in 1997. Bill Harper, the Endangered Species Specialist, oversaw the development of two documents that laid the groundwork for the provincial strategy. These were "Toward a Mountain Caribou Management Strategy for British Columbia – Background Report" prepared by Pacquet (1997), and a more technical document "Towards a Mountain Caribou Management Strategy for British Columbia – Habitat Requirements and Subpopulation Status" by Simpson *et al*. (1997).

The backgrounder was targeted towards the general public with the purpose of highlighting mountain caribou, their habitat needs, and their conservation concerns. The "Habitat Requirements and Subpopulation Status" document summarized the current understanding of caribou habitat requirements, management issues, and identified 13 local populations of mountain caribou based on existing research and inventory.

Draft Mountain Caribou Conservation Strategy, 1997

Bill Harper formed a Mountain Caribou Management Team (MCMT) and hired a consultant to prepare a provincial Mountain Caribou Conservation Strategy (Robertson 1997). The conservation strategy recommended dividing the 13 local populations into "Immediate Emphasis" and "Long-term Emphasis" groups for the purpose of negotiation of habitat protection prescriptions. It also set a provincial population target for Mountain Caribou at a level 50% higher than the existing estimate. The strategy recommended that the existing MCMT be expanded to include an Implementation Committee, whose principal responsibility would be to direct, administer, and budget for the Mountain Caribou Conservation Strategy. The Implementation Committee was to be given direction by the existing inter-ministry Forest Practices Code Steering Committee. It also recommended that the Implementation Committee establish a subcommittee called a Joint Working Group, which would negotiate habitat protection for mountain caribou in the province. None of these recommendations were implemented, and the strategy was never released.

Mountain Caribou Research Committee

A Mountain Caribou Research Committee was established sometime during the mid 1980s or early 1990s. Committee meetings were informal and no specific documents have been produced by the committee. The primary purpose was to gather caribou researchers together in order to exchange information, prioritize research needs, and recommend techniques. Bruce McLellan was one of the key organizers of this committee. A small research committee comprised of Bruce McLellan, Heiko Wittmer, Trevor Kinley, and Clayton Apps still meets.

Mountain Caribou Technical Advisory Committee

The Mountain Caribou Technical Advisory Committee (MCTAC) was formed shortly after the completion of the draft 1997 Mountain Caribou Conservation Strategy. MCTAC was asked to redraft the strategy and to provide a more balanced conservation strategy that reflected a greater spectrum of stakeholders. In May 2000, the Committee on the Status of Endangered Wildlife (COSEWIC) designated mountain caribou (along with 13 other British Columbia populations within the Southern Mountains National Ecological Area) as nationally threatened. The Mountain Caribou Technical Advisory Committee (MCTAC) became the recovery team and altered the current version of the conservation strategy it was developing in order to conform to the Recovery of Nationally Endangered Wildlife (RENEW) guidelines for a recovery strategy. The provincial Mountain Caribou Recovery Strategy was released in Sept. 2002 (MCTAC 2002).

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25. Hart and Cariboo Mountains Recovery Action Plan

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The Hart and Cariboo Mountains recovery area includes the mountain caribou herds east of Prince George and south to Kamloops. This area contains about 1,600 of the 1,900 mountain caribou in British Columbia. The Recovery Implementation Group (RIG) has produced and submitted a Recovery Action Plan for this area.

The RIG adhered to a terms of reference that recognized the following:

- The objective is to develop a plan that will lead to the recovery of caribou, not to make trade-offs with other resource interests that are incompatible with recovery.
- Members participate as advocates for caribou recovery, not as advocates for their agency or organizations.
- Recommendations are based on a review of the best available scientific information.
- Decisions are based on consensus regarding the scientific information.
- Dissenting opinions based on a differing interpretation are reported.

The RIG believed that the major limiting factor of caribou was predation, but that excessive levels of predation were related to natural and human-caused environmental change that enhanced early seral ungulates, and led to increased predator numbers.

The objective of the Recovery Action Plan is to establish a viable self-sustaining population of mountain caribou within the recovery area. This means that habitat conditions will be restored to allow caribou populations to maintain themselves without the need for ongoing management actions such as predator/prey management.

There is some concern that this objective may not be feasible because the colonization of central British Columbia by moose, and ongoing climate warming, may have created conditions where mountain caribou can only be maintained in the future if we are prepared to manage predator numbers. However, the RIG decided that we can not be certain if recovery to a self-sustaining population is feasible until we have largely reduced the human-caused impacts, and monitored the response of the caribou herds.

The primary component of the Recovery Action Plan is a map of critical habitat, with recommendations regarding activities that are compatible with caribou recovery. The RIG evaluated the existing habitat protection for mountain caribou within each region, and recommended modifications where necessary. Throughout most of the recovery area, subalpine forests and alpine are the most important habitats in all seasons. However, low elevation cedar–hemlock forests are also critical habitat in some areas, especially in the North Thompson.

Within the Prince George Forest District, the existing caribou habitat zones were considered appropriate, but it was recommended that the areas available for partial cutting should become no-harvest zones. Although partial cutting can maintain lichens for caribou, the risk of predation is likely enhanced by the roads and creation of early seral conditions.

Within the Cariboo Region, the existing caribou habitat zones were slightly modified, but the primary change was the recommendation that partial cutting zones become no-harvest zones.

Within the North Thompson, additional areas of core habitat were delineated, and all core habitat was recommended to be no-harvest zones.

The management objective for core critical habitat in all regions is no forest harvesting or road building.

In addition to core habitat, the RIG recognized that management of adjacent habitat was also important to maintaining a predator/prey system that was compatible with caribou recovery. Those adjacent areas were also delineated and classified as matrix habitat, where the objective is to manage habitat to prevent unnaturally high levels of other ungulate prey species and their associated predators.

The RIG recognized that until habitat has recovered, some herds may require temporary management of the predator/prey system. Use of hunting to reduce other ungulate species to numbers that would be expected after the amount of early seral forest has been reduced to natural levels was recommended for all areas. Predator control was recommended as a temporary measure for any herds that are showing a consistent decline, especially small herds.

The RIG concluded that snowmobile activity can displace mountain caribou from core winter habitat and that snowmobiling should be restricted to a limited amount of core caribou habitat. The RIG produced a map of areas where snowmobiling can occur. Snowmobiling should be prohibited in all other areas of core caribou habitat.

The RIG concluded that heli-skiing is compatible with caribou recovery in most areas if the operators make efforts to avoid caribou. However, heli-skiing should be prohibited in areas of high caribou density where the probability of encounters is great. The RIG produced a map of areas where heli-skiing should be prohibited.

There were several dissenting opinions to the general consensus:

- Some believed that there is enough evidence to conclude that it is not feasible to establish self-sustaining populations, and that we should be accept the need for permanent predator control.
- Some believed that establishing a self-sustaining population may be feasible, but that the socio-economic cost of managing predation in a matrix habitat

exclusively with habitat management would be too great, and that we should implement a combination of habitat management and ongoing predator/prey management.
- Some believed that the prohibition of heli-skiing in some areas was unnecessary because operators could effectively avoid caribou.
- Some believed that some restriction of snowmobiling was justified, but that the restrictions in the RIG were too severe.
- Some believed that based on the precautionary principle, all snowmobiling and heli-skiing within core habitat should be prohibited.

The Recovery Action Plan was submitted to government in August 2005.

26. Approaches for North Kootenays

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No summary available.

27. Recovery approaches – Southern Kootenays

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The "southern Kootenays" generally refers to three subpopulations of mountain caribou—South Selkirks (SS), Purcells-South (PS) and Purcells-Central (PC); the latter two are often grouped as the South Purcells. While not normally considered part of the southern Kootenay planning area, I also discussed the Nakusp (NK) and Duncan (DU) subpopulations (collectively, the Central Selkirks group). Uncorrected counts for 2006 were nine in DU, 78 in NK, 41 in SS, 16 in PS and zero in PC, i.e.,the Purcells-Central subpopulation may now be extirpated. These numbers represent ongoing declines for DU, NK and PC, short-term stabilization following declines during the 1990s for PS, and short-term stabilization following ongoing fluctuations related to translocations and declines during the 1980s and 1990s for SS.

Most of the recovery approaches suitable for these herds are similar to those described for the Cariboo-Hart planning area and for the northern Kootenays. However, some factors unique to this area may result in slightly different actions being necessary. Some of these are listed below.

- These are all small, isolated populations. While historically there was almost certainly some degree of genetic and demographic flow between DU and NK, SS and PS, and PS and PC, and likely at least limited movement beyond that, there has been no strong evidence of recent interchange among resident animals. The exception has been the movement of animals translocated to the SS during the 1980s and 1990s, some of which moved to PS and NK and even returned in some cases to the SS. This shows that while the tradition of movement among herds has been largely lost, the landscape is still permeable to caribou. Protecting linkages between the subpopulations will be needed, although it is not completely clear what level of protection is required or where caribou will travel.
- There is variable use of low-elevation habitat, both among and within subpopulations. Caribou of DU and NK make regular use of the Interior Cedar–Hemlock zone (ICH) during early winter and spring. Those of SS and PS use it much less, though some animals periodically occur at lower elevations in all seasons except late winter, and it is believed that there was historically greater use of the ICH. Caribou of PC appear to use lower elevations only in crossing valley bottoms between high-elevation sites.
- There is a longer history of human impacts here than on most other parts of mountain caribou range. Some impacts have therefore become well established. However, some of the impacts are so old (such as pre-1900 fires) that forests disturbed then are now reaching a mature stage. Thus, over the next few decades, there will be a lot of forest reaching a point of being potentially valuable to caribou.

- The predator/prey system is more complex here in the sense that there are more cougars, elk, and white-tailed deer than farther north (though generally fewer moose and wolves). In addition, forest harvesting within mountain caribou range has little effect on the winter range of elk, deer, and moose, at least for PC, PS, and SS, because their winter ranges do not overlap with those of caribou. In those locations, forest disturbance is more of an issue with respect to changing the summer distribution, rather than numbers, of the primary prey species. In general, managing the predator/prey system will require addressing more factors in the southern Kootenays than elsewhere.

Some of the most immediate needs within the southern Kootenays are as follows:

- Translocations will definitely be required to initiate recovery in PC, almost certainly in DU and SP, and most likely in SS also.
- Caribou population and distribution goals must be formalized. To date, any legally mandated recovery actions have not been based on firm targets, so it is unclear what they will achieve. With population targets in place, it would be much easier to delineate appropriate caribou habitat protection zones, determine guidelines for them, establish wildlife management criteria, and identify any recreation conflicts.
- Caps on the prey base and predator populations within specified areas are required if caribou populations are to not only stabilize, but grow. Within certain wildlife management units, this may involve preventing growth or inducing reductions through hunting of several predator and prey species, or potentially periodic direct control of cougars or wolves. In addition, winter-range enhancements for elk, deer, and moose which occur in major valley bottoms need to be located carefully. The summer migration of ungulates using these locations should be to areas where caribou do not occur.

Over the longer term these populations will need to be connected to each other and to those farther north (Monashee-South, Columbia-South, and Kinbasket-South) if the probability of persistence is to be maximized. I submit that persistence and recovery will also require a continuation of the shift now underway from a paradigm of maximizing other resource values (timber, wildlife numbers, and recreation) to one of optimizing those values so that the ecosystem moves closer toward its natural disturbance regime and natural complement of wildlife species.

28. Conference observations

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This summary is not intended to serve as a record of the conference, but is merely some impressions after two intensive days with 32 detailed presentations. It seemed appropriate to provide these during the brief closing session.

What the scientists appear to be telling us

The habitat needs of mountain caribou are sufficiently known from the current research, and the core habitats of our herds have been mapped.

The herds are continuing to decline, particularly in the south, with two or three appearing to be extirpated, and with only the northern-most herds appearing to be stable.

The life strategy of mountain caribou, of dispersion in old-growth forests to avoid predation, seasonal altitudinal migration following food supply, and use of lowland areas briefly for early spring maternal nutrition, is being challenged by changing conditions. Changes include:

- the shrinkage and fragmentation of the old-growth forest habitat, most particularly at the lower elevations, but continuing even at higher elevations, reflecting ongoing resource extraction and the creation of road networks that favour predator access to the herds;
- the long-term migration of moose and proliferation of elk and deer in the early seral areas created by humans and fire are bringing caribou into contact with wolves and cougars to an increasing extent, leading to elevated predation and reductions in herd replacement rates, sometimes to below zero;
- predation has become the proximate cause of most mortality;
- existing caribou habitat management guidelines are not working, as evidenced by continuing decline of caribou populations; and
- climate warming appears to be accentuating this overall process, particularly for the southern herds.

Food supply does not appear to be limiting at this time, but could become a factor in areas affected by the mountain pine beetle.

Physical disturbances by motorized recreation can displace herds from otherwise viable habitats, depending on intensity of use. While important, this appears to be a secondary stress factor.

Some herds may be in areas that are so fragmented and disturbed that the conditions are likely to render recovery efforts infeasible for establishing viable, self-sustaining population levels.

<u>Recovery actions proposed</u>

There are a limited number of recovery actions that can be taken to restore herds and their essential habitats:

- Provide habitat conditions favourable to caribou over their whole range–working at the landscape level, involving unfragmented core old-growth forest habitat, along with connections among the larger areas to provide movement throughout the seasons.
- Manage areas peripheral to core habitat, limiting the amount of early seral habitats, to restrict as much as possible the juxtaposition of competing ungulates and their predators.
- Structurally design land and forest use to provide cover, corridors, and access to the winter lichen supply in landscapes managed for resource extraction.
- Isolate herds from large concentrations of moose, deer, and elk so as to limit the incidental predation, particularly from wolves and cougar.

In the short run what is required is:

- aggressive conservation of the remaining old-growth forest as an essential precautionary move pending more design intensive alternatives;
- manipulation of predator/prey balances in proximity to vulnerable herds, to give them relief from intensive predation while herd numbers are built up;
- augmentation of herds by transplants where such additions are consistent with habitat capacity and exposure to predators;
- limitation of access and disturbance by motorized recreation in the core habitats of the herds;
- aareful and continuous monitoring of herd condition and assessment of the effectiveness of short term measures undertaken; and
- application of measures that are tailored to the circumstances of each herd and its regional ecology and land use context.

<u>Tools available for recovery action</u>

A variety of tools are available for designing and implementing recovery action:

- Accumulated caribou science, field studies, habitat models, and direct observation of the behaviour of existing herds
- Application of the legal provisions of the *Endangered Species Act* (*ESA*) in the US; *Species at Risk Act* (*SARA*), *Wildlife Act*, Identified Wildlife Management Strategy (IWMS) and the *Forest Range and Practices Act* (*FRPA*) in British Columbia

- Engagement of the members of Recovery Implementation Groups (RIGs) in formulating publicly acceptable action plans and contributing to problem solving as implementation is undertaken
- Communication procedures to inform and engage the wider public, mobilize public support for distasteful short-term measures with economic, social, or environmental impacts
- Preparation of recovery options that are sufficiently documented to mobilize political will, enable informed decisions to be made, and garner funding support
- Development of decision models, consistent with the emerging field of policy science, that foster a productive relationship between civil society, civil institutions, and objective science.

Framing the recovery debate

It is one thing to invite the public to consider the fate of a single species and another to engage on the issue of biodiversity as a whole. It is likely that the existence of any single species, even a charismatic one like caribou, may not be able to stand against the combined short-term economic interests of many stakeholders, particularly if the decisions are to be influenced by urban populations. The urgency of the biodiversity agenda has to be framed as "maintaining the life support system of the planet," which is a scale that can justify the taking of costly actions because of necessity. Biodiversity has to be put alongside such major planetary conditions such as solar energy input, the integrity of the ozone layer, the earth's orbit around the sun, or the global temperature—the conditions that favour all life on earth. The individual species, taken as "bits" does not get at the implications of the "sixth major extinction" that humans are said to be rapidly engineering out of ignorance of the implications.

The main issues that need to be resolved

Recovery action, while recognized as biologically urgent, is constrained by socio-economic choices, rather than by any remaining lack of scientific knowledge about the needs of caribou. It is the management of the consequences of recovery action on stakeholder interests that is most in need of attention:

- The wages of the conservation effort are most evident in the economic costs of habitat protection: reduced timber supply, reduced access to resources, and increased cost of resource development, with implications for revenue to the crown, profitability of resource firms, employment, and public recreational access to crown land.
- Achieving the fair and equitable distribution of the costs and benefits among stakeholders who must bear or enjoy them.
- Mobilization of the political will to decide, fund, and manage recovery actions and, where necessary, to expropriate interests and compensate.
- Dealing with a public distaste for killing of predators or targeting of other ungulate species for reduction.

In the long run, to make a place for caribou and other elements of biodiversity, we must be able to develop a value-balanced, stewardship-oriented economy and the civil society institutions and public processes that will support decision making using objective science. As we seek a balance of values, decisions will need to be made that provide for the equitable distribution of costs and benefits. It is about the management of people to create room for other species and their habitats. It is about keeping the planetary life support system intact for current and future generations.

Active residual concerns

Recovery delayed is recovery denied. While the social debate is being conducted the herds are dwindling and disappearing and we are not taking enough precautionary actions at a sufficient scale.

The extended Species at Risk Coodination Office (SaRCO) process to assemble the necessary components to enable political decision making appears to be taking precedence over enough direct action on the ground to forestall ongoing losses.

Postponement of stakeholder engagement, particularly standing down the RIGs, is running the risk of losing the practical consensus of people that need to be in active agreement with the when, where, and what of eventual actions.

The smaller herds are continuing to decline to levels where accidents of circumstance would be sufficient to eliminate them. In the meantime, resource development—industrial, commercial, and recreational—is continuing to fragment or overlap caribou core habitat, thus reducing the supply to be employed in recovery.

Climate change is accelerating, adding stress factors to the equation that, while major in the long term, are beyond direct and present recovery action.

Some stakeholders find the short-term potential of predator or prey reductions to be repugnant while the biologists see the killing of predators and reduction of competing ungulates as an essential step to strengthen herds while longer term habitat measures are taken. Other stakeholders find the idea of reserving large tracts of mature timber repugnant for economic reasons. Both tools appear to be necessary.

Conclusion

The necessary strategies for recovering mountain caribou herds are already well enough known to define the basic actions. The main problem is developing the social agreement around the values involved and the fair distribution of costs and benefits when saving a threatened species demands foregoing some economic or popular uses of resources.

We cannot afford to lose the moral advantage of taking this task seriously by letting the public consensus-building languish while we study the minute details of caribou biology. Large strokes are needed on the habitat canvas as precautionary measures and we must begin some of the inevitably distasteful short-term actions to restrict motorized access in core habitats and to deal with the impact of predation.

Marshalling the objective science, the public agreement, and the political decision making is taking too long. We are talking and analyzing while the herds are winking out. Saving a threatened species such as mountain caribou is symbolic of the overall process of human society development and our capacity to maintain a diverse ecology while indulging in the proliferation of our own economic interests. If we must fail in recovering some of the smaller herds, let it not be because we "fiddled while Rome burned."

Posters and Displays

The following people brought posters or displays about their work related to recovery of mountain caribou. Abstracts describing their work are included if they were provided. Email addresses are provided for each presenter for people who would like to follow up with questions.

1. *Recovery process for south Jasper caribou*

Mark Bradley, Jasper National Park, Jasper, AB
mark.bradley@pc.gc.ca

2. *Mountain caribou management in the Okanagan/Shuswap LRMP*

Jim Cooperman, Shuswap Environmental Action Society, Chase, BC
jcoop@ribaa.ca

LRMP Direction

The population of mountain caribou in the Okanagan Shuswap Land and Resource Management Plan (OSLRMP) area has been steadily declining as a result of habitat loss due to logging and increased predation, exacerbated by the increase in roads and cutblocks, which attracts other ungulates and more predators. The OSLRMP (approved in 2000) created a large Resource Management Zone for caribou, which included a 9,900-hectare Total Harvestable Land Base Reserve (THLB) in which logging would be deferred. In addition, the plan includes an Old Growth Management Area (OGMA) budget of 9,500 hectares of THLB from four landscape units that could be used to protect caribou habitat.

Final decisions regarding caribou management were deferred pending the results of a research program designed to:

- examine relationships between forest management activities and relative use of Interior Cedar–Hemlock (ICH) and Engelmann Spruce-Subalpine Fir (ESSF) biogeoclimatic zones by caribou (e.g., the need for reserves);
- identify opportunities for forest management practices to supply suitable attributes for caribou habitat;
- review subalpine forest use by caribou and its importance;
- examine timber types within the caribou habitat and their use by caribou (what specific forest/alpine forest types attributes are used by caribou, e.g., forest structure, openness, lichen, etc.); and
- examine the predation aspect (wolf population correlation with caribou population dynamics).

The plan stipulates that if the research shows a need for permanent reserves, the impact to the THLB would be incremental to OGMA placement.

Mountain Caribou Research

Due to government cutbacks, the research has been funded and largely directed by the forest industry through the Okanagan/Shuswap Innovative Forestry Society, and thus there are concerns that this research will be used to increase opportunities for logging instead of increasing protection for caribou. The latest research report (March 31, 2006) recommends a 25% size reduction and revised boundaries for the caribou Resource Management Zone based on radio-collar tracking information and aerial surveys. It also includes recommendations for caribou retention; however there are concerns that some of these draft retention areas overlap existing OGMAs and are placed in the non-THLB, including parks, thus reducing the amount that was meant to be placed in the THLB (initial analysis indicates that the recommendations show approximately 3,600 hectares of the THLB budget in the non-THLB and 500 hectares are in existing OGMAs).

The research does indicate there is potential that future snowmobile activity could be detrimental to the large numbers of caribou that use the Mt. Grace–Kirbyville area.

The latest research report states:

> *"Since the Okanagan-Shuswap LRMP recommended 9,900 ha of THLB retention area for caribou, this means that within caribou habitat, 21.9% of the THLB will be allocated for caribou retention."*

This is not accurate, as the OSLRMP provided the option of at least 40% retention and more is available now due to the mountain pine beetle epidemic.

The next step should be for a committee of the OSLRMP table to use the research work to guide the placement of the THLB OGMA budget, as well as the 15,000 hectares of non-THLB budget and to determine how much incremental protection is needed and where these additional reserves should be located.

3. Caribou Range Restoration Project

Brian Coupal, Caribou Range Restoration Project, Grande Prairie, AB
bcoupal@br-inc.com

The increasing accumulation of linear corridors (seismic lines, roads, and pipelines) is an issue of concern in integrating industrial development with caribou conservation in Alberta. Caribou populations are declining in several ranges in Alberta and accumulating developments appear to be one of the factors. Linear corridors can influence caribou habitat effectiveness in a number of ways. Research has demonstrated that wolves have faster travel rates on seismic lines, and also that caribou tend to use habitat near roads and seismic lines less than expected, likely in response to wolf traffic and human activity on the lines. Linear corridors also provide increased access into traditional caribou habitat by alternate prey species such as moose and deer, which then can bring more predators into the area. These corridors also provide increased public access that can result in increased mortality from hunting, prevent regrowth on linear disturbances, and increase disturbances to caribou.

The goal of the Caribou Range Restoration Project is to speed the recovery of linear disturbances (roads, seismic lines, and pipelines) and other human developments, so that their negative effects on woodland caribou, and other sensitive wildlife species, are lessened and eventually eliminated. Specific objectives are to promote the regrowth of native vegetation on human disturbances, reduce the benefits of linear disturbances to wolves (and other predators) and humans, and revegetate disturbances so that they are no longer avoided by caribou, and no longer act as a barrier to caribou movement.

4. Revelstoke Snowmobile Club information

Tom Dickson, Revelstoke Snowmobile Club, BC
Web site of the Revelstoke Snowmobile Club: http://www.sledrevelstoke.com

5. Environmental stewardship

Jenny Feick, Environmental Stewardship Division, BC Ministry of Environment, Victoria, BC
jenny.feick@gov.bc.ca

Jenny brought four poster titles:

- Environmental Stewardship Division stewardship outreach project
- Stewardship outreach survey of Environmental Stewardship Division staff
- Environmental Stewardship Division outreach strategy
- Outreach principles

6. Measuring stress in reindeer: The importance of field validation

Nicola Freeman, MSc candidate, Centre for Applied Conservation Research
University of British Columbia, Vancouver, BC
Nicola.freeman@gmail.com

Human disturbance has been identified as a potential threat to the persistence mountain caribou (*Rangifer tarandus caribou*), but non-invasive techniques to measure stress in free-ranging caribou have yet to be developed. We validated a fecal glucocorticoid assay for mountain caribou using an adrenocorticotropin hormone (ACTH) challenge experiment, conducted on captive reindeer exposed to natural fluctuations in weather in northeast British Columbia, Canada. We measured cortisol concentration in feces of four female and four male reindeer before and after injection of ACTH and a saline control. Adrenal profiles revealed differences in response to ACTH injection by gender and in response to variation in weather. With weather effects controlled statistically, females exhibited a peak in fecal cortisol excretion nine to eleven after ACTH injection, but not after injection with saline. Males responded to weather similarly to females, but did not respond to saline or ACTH injection. We suggest that fecal glucocorticoid assays could be used to track biologically meaningful changes in adrenal activity of *Rangifer tarandus*, but that their application to free-ranging animals will require that study designs assess effects of anthropogenic stressors and consider the potential influence of extreme weather events. Further tests are needed to understand if glucocorticoid profiles vary with gender and lag time in free-living mountain caribou.

7. *Habitat supply as a paradigm for planning recovery of caribou in north-central British Columbia*

Line Giguere, Wildlife Infometrics, line.giguere@wildlifeinfometics.com
Dr. Scott McNay, Wildlife Infometrics, scott.mcnay@wildlifeinfometrics.com
Mackenzie, British Columbia

Woodland caribou (*Rangifer tarandus caribou*) populations are in decline throughout much of their range. With increasingly rapid industrial, recreational, residential, and agricultural development of caribou habitat, tools are required to make clear, knowledgeable, and explainable management decisions to support effective conservation of caribou and their range. We developed a habitat-supply model based on a series of Bayesian Belief Networks to evaluate conservation policy scenarios applied to caribou seasonal range recovery areas. We demonstrated the utility of the networks to articulate ecological understanding among stakeholders, to clarify and explicitly depict threats to seasonal range values, and to show how simulated forecasts of spatially-explicit seasonal range values can be assessed against landscape potential and compared to range values under assumed conditions of natural disturbance. These tools and the habitat comparisons they can provide have created opportunities to operationally define and measure conditions for recovery of caribou in north-central British Columbia. Decisions about recovery of caribou are therefore transparent, measurable, and made with an understanding of risk.

8. Caribou recovery and wildland protection in the US Whitefish and Purcell Mountains

Dave Hadden, Montana Wilderness Association, Bigfork, Montana
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http://www.wildmontana.org

Conservationists and wildlife management agencies recognize that climate change and motorized backcountry recreation have led to decline of mountain caribou across the U.S. – Canada borders of Montana and British Columbia over recent decades. North of the border, mountain caribou have experienced a rapid decline occurring over the past eight years. In Montana, mountain caribou have not been consistently sighted since the 1970s in the Whitefish Range (McDonald Range of southeast British Columbia). In the Purcell Mountains of northern Montana, mountain caribou continue to be sighted on an *ad hoc* basis (Tim Thier, pers. comm.) as lone individuals of British Columbia herds. The Montana Department of Fish Wildlife and Parks (MDFWP) has considered reintroducing mountain caribou into the Whitefish and Purcell Mountain Ranges but recognizes that a successful transplant would require an intact population across the international border (Jim Williams, pers. comm.). MDFWP's has postponed consideration of such efforts until British Columbian populations recover.

Montana-based conservation organizations, such as the Montana Wilderness Association (www.wildmontana.org) and Yaak Valley Forest Council (www.yaakvalley.org), recognize the importance of maintaining and improving secure habitat along the international border as a component of eventual population restoration.

9. Mountain caribou 2006 survey results and subpopulation trends

Ian Hatter, Terrestrial Ecosystem Science Section, BC Ministry of Environment, Victoria, BC
ian.hatter@gov.bc.ca

Tables from Ian's poster are included in the text summary of his oral presentation; please refer to the first presentation summary in this document.

10. Revelstoke ecosystem map (PEM)

Colleen Jones, Environmental Stewardship Division, BC Ministry of Environment, Victoria, BC
colleen.jones@gov.bc.ca

11. *Caribou forage* and *An arboreal lichen model*

Doug Lewis, Ecosystems Division, BC Ministry of Environment, Kamloops, BC
doug.w.lewis@gov.bc.ca

Doug brought two posters, titled:

- Caribou forage use of partial cut stands in the north Thompson Valley
- Developing an arboreal lichen model to assess the relative availability of lichen forage for caribou in natural and managed Engelmann spruce–subalpine fir forests

12. *Areas proposed for protection in mountain caribou recovery programs*

Colleen McCrory, Craig Pettitt, Valhalla Wilderness Society, New Denver, BC
vws@vws.org
www.vws.org

13. *Core caribou habitat spatially mapped (forest retention areas)*

Dieter Offermann, Downie Timber, Revelstoke, BC
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http://www.downietimber.com/

When the Committee on the Status of Endangered Species in Canada (COSEWIC) listed the woodland caribou as "threatened," Downie Timber Ltd. decided to assist in the recovery of the Revelstoke mountain caribou herd by spatially mapping the legal Revelstoke Higher Level Plan Order (RHLPO) caribou forest retention requirements and identifying the areas which would benefit caribou the most. The methodology we used was based on a local statistical multi-scale and multi-seasonal caribou habitat model, which existed for the project area (Apps et al. 2001). This model has been published in the *Journal of Wildlife Management 65(1): 65-77* titled *"Scale-Dependent Habitat Selection by Mountain Caribou, Columbia Mountains, BC".* The scale and resolution of the model was fairly large so a smaller stand level scale was developed. To achieve this, empirical data (telemetry) was analyzed by software used to estimate home range areas using minimum convex polygons or kernel contours. These polygons were configured so that the highest quality habitat was identified for early and late winter caribou habitats. Only that portion of the polygon that overlapped with the medium or high habitat suitability mapping of the Apps model contributed towards the RHLPO retention requirements. The intersection of the Apps model with the home range formed the basis of spatially mapping the caribou retention areas through a GIS process.Adjustments were made to account for past logging history, wildfires, slope, etc. Using this methodology, the "core" caribou habitat within the RHLPO caribou line work, which represents approximately 51% of the crown forested land base, was spatially mapped for Downie

Timber Ltd. operating area, in addition to the entire Revelstoke Timber Supply Area. This "core" caribou habitat was spatially depicted upon a set of 50,000 scale color orthophoto rectified maps for each landscape unit and also onto a composite color Landset 7 satellite image at the 250,000 scale and are available in digital form (shape files).

Downie has incorporated this product into our forest management planning and Forest Stewardship Plans, which means that cutblocks are not planned within spatially identified "core" caribou habitat. The Integrated Land Management Bureau (ILMB) is currently incorporating this work into a new file and into the Revelstoke HLP Reporting Suite to be made available on the Kootenay Spatial Data Partnership web site. Downie Timber Ltd conducted the project with funding assistance from the Forest Investment Account,the ILMB, Kozek Sawmills Ltd., and BC Timber Sales. A registered professional biologist conducted the biology work

14. Forest Practices Board information

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15. Monitoring of snowmobile activities in caribou habitat in the Quesnel Highlands

Geoff Price, Environmental Stewardship Division, BC Ministry of Environment, Williams Lake, BC
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In 2000, mountain caribou became red listed provincially and were nationally designated as "threatened." There are 13 mountain caribou subpopulations identified within British Columbia (Simpson 1997). The Cariboo Region includes the Barkerville, Wells Gray North, and a portion of the North Cariboo Mountains subpopulations. Backcountry recreation activities, snowmobiling and heli-skiing in particular, are considered to be a major conservation concern due to the potential for displacement of caribou from their winter habitat.

To address this issue, two subsequent voluntary multi-year agreements were entered into with the local snowmobile clubs from Quesnel, 100 Mile House, and Williams Lake, and the BC Ministry of Agriculture and Lands and the BC Ministry of Environment. A monitoring plan (beginning in the winter of 2002–2003) was included in this agreement to collect baseline data on snowmobile use in the Voluntary Closure Zones and Caution Zones as identified and mapped by the BC Ministry of Sustainable Resource Management. Voluntary closure zones were defined as areas of critical caribou habitat and were to receive no snowmobile activity. Caution zones were defined as areas of sensitive caribou habitat that remained open to snow mobile activity. The first three years of this monitoring program focused on the compliance of back country recreationalists within the voluntary closure zones (Price 2003; Price 2004; and Price 2005). This fourth and final year of the program was directed towards monitoring use of both mountain caribou and snow machines in and around caution zones throughout the study area.

Recovery strategies for mountain caribou often incorporate a combination of recreational zoning, modified timber harvest strategies, access limitation, and predator and moose management. The report produced by the Mountain Caribou Technical Advisory Committee (MWLAP 2002), information from the regional Recovery Implementation Group (RIG), and the establishment of the provincial Species at Risk Coordination Office (SaRCO) in October 2004 have combined to initiate an aggressive, science-based process for developing mountain caribou recovery options. Detailed recovery options are to be delivered by the Species at Risk Coordination Office (SaRCO) in the fall of 2006.

16. Mountain caribou aerial art, media clippings

Dave Quinn, Wildsight, Kimberley, BC
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http://www.wildsight.ca

17. Strategic planning tools for mountain caribou conservation

Joe Scott, Conservation Northwest, Bellingham, Washington
jscott@conservationnw.org
http://www.conservationnw.org

18. Determining sustainable levels of cumulative effects for boreal caribou: A management model

Troy Sorensen, Fish and Wildlife Division, AB Ministry of Sustainable Resource Development, Edson, AB
troy.sorensen@gov.ab.ca

Project by: Troy Sorensen, Philip D. McLoughlin, Dave Hervieux, Elston Dzus, Jack Nolan, and Bob Wynes

Direct and indirect effects of industrial development have contributed, in part, to the threatened status of boreal ecotype caribou (*Rangifer tarandus caribou*) in Alberta and Canada. Our goal was to develop a model that would allow managers to identify landscape-scale targets for industrial development, while ensuring functional habitat for sustainable caribou populations. We examined the relationship between functional habitat loss resulting from cumulative effects of natural and anthropogenic disturbance, and finite rate of increase, λ, for six populations of boreal caribou in Alberta, Canada. We defined functional habitat loss according to two variables for which we had a priori reasons to suspect causative associations with λ: 1) percentage area of caribou range within 250 meters of anthropogenic footprint, and 2) percentage of caribou range disturbed by wildfire within the last 50 years. Multiple regression coefficients for both independent variables indicated significant effects on λ. The two-predictor model explained 96% (R^2) of observed variation in λ among population units ($F_{2,3} = 35.9$, $P = 0.008$). The model may be used to evaluate plans for industrial development in relation to predicted wildfire rates and goals for caribou population growth rates.

19. Revelstoke Caribou Sighting Project

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http://www.rcfc.bc.ca/
See also: http://www.cbfishwildlife.org/surveys/caribou_form.php

The Revelstoke Caribou Sighting Project was conceived by the Revelstoke Caribou Committee as a means of obtaining the help of the public—in particular, forest workers, wilderness recreationalists, commercial recreation operators, and others—in detailing where mountain caribou and their predators are. The committee also felt that it would raise local awareness about caribou issues. The project was implemented in early 2004.

Sighting Network

Caribou sighting forms are distributed around the community and people encouraged to submit sightings using the paper form or through a web-based form (http://www.cbfishwildlife.org/surveys/caribou_form.php). Forms are returned to one of the designated drop-offs, faxed, or completed online. Revelstoke Community Forest Corporation or Mustang Powder Lodge personnel enter the information into a Caribou Sightings Project spreadsheet.

Data

The information is made available for scientists and land managers. Land managers such as forest planners have used the information in planning retention areas and seasonal timing of forest operations. Scientists may use the information to provide infill for the VHF and GPS collar data and obtain anecdotal evidence of caribou or predator behaviour. A hotline has been set up so that sightings of dead caribou can be quickly relayed to the appropriate scientist for investigation (scavengers quickly eliminate evidence that could help scientists deduce cause of death).

Many interesting observations have been made, but here are a few highlights:

- A lone caribou has been accompanying a herd of elk. This caribou was sighted in 2003 and 2004.

- A small group of caribou was observed over several days wandering south from the Columbia North herd's range to the Downie/Mt. Revelstoke herd's range. Mixing of these herds is thought to be rare.
- A herd of 50 caribou was spotted near Downie Loop in spring 2005. In the spring of 2006, another large herd was spotted at the same location.

20. Tracking Extreme Snowpack Fluctuations Affecting the Survival of Mountain Caribou near Revelstoke, BC

Dr. Mindy Brugman, Pacific Storm Prediction Centre, MSC, Environment Canada
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Deep winter snow packs are notorious in the Columbia Mountains. In this paper, snow pack variations near Revelstoke, BC are examined using historical and proxy data to understand the relationship to mountain caribou survival. The local caribou are unusual because they have adapted by surviving typically dramatic winter snowfalls in several ways. Research has shown that this caribou species (known as the "arboreal lichen-winter-feeding ecotype" Hatter *et al,* 2004) effectively uses the thick snow packs to reach tree lichen even when the ground forage is deeply buried by about 2 to 20 metres of snowfall. In addition, the most extreme snow packs can bury and kill the arboreal lichen leading to starvation if the caribou do not adapt and/or move elsewhere until the lichen regenerates – which may take several years.

Controlling factors for heavy snowfall in the Columbia Mountains include changes in Pacific Storm Track trajectories, the type of storm (i.e. cold low or "Pineapple Express") and abundance of precipitable water, strength and direction of upper level winds, and the timing and strength of Arctic air outbreaks. To build critically deep snow packs in the Columbia Mountains repeated heavy snowfalls must occur while maintaining cool moist conditions, and typically this situation must persist in the alpine habitat of the caribou from late fall and through mid-winter. Just the right balance of moist subtropical sourced inflows aloft colliding with cool unstable air over the region is essential. If the southwesterly jet stream is too strong (greater than 60 knots at mountain top) the heaviest precipitation will shift eastward and may even skip into Alberta leaving the Revelstoke area surprisingly dry. Alternatively, extended periods of cold arctic air related to the presence of a stubborn Rex Block over western North America often causes Pacific moisture to divert elsewhere (California and Alaska) and typically lead to low snow packs over the Columbia Mountains. Heavy winter snow packs lead to positive glacial balances and ice advance in the region. Thus historical data may be augmented using glacial records to go back in time creating a proxy record of extreme snowfall accumulation in the region. The impact of nearby man-made lakes on local temperature and snowfall records is suggested.

Various climate indices are used to test tracking potential climate drivers for the region. Results indicate ENSO-type fluctuations may provide a reasonable way to track heavy snowfall variations and the potential for extreme winter conditions affecting mountain caribou survival near Revelstoke. The natural climate/weather fluctuations suggest a cool-moist La Nina-type period may be on the doorstep and persist for several decades. Still, models suggest man-induced global warming has the potential to be quite significant and may further reduce winter snow packs and adversely affect the mountain caribou in this region unless effective adaptation occurs or is allowed.