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To the reader:

On October 16, 2007, government announced the Mountain Caribou Recovery Implementation Plan (MCRIP) with a goal to restore the mountain caribou population to the pre-1995 level of 2,500 animals within 20 years. One of the management actions in the MCRIP is to manage predator populations of wolf and cougar where they are preventing the recovery of mountain caribou populations. The attached document, "Estimating the short-term benefit of wolf reduction to mountain caribou herds" provides technical information on how the application of measures to reduce wolf populations can benefit recovery of various mountain caribou herds. This report was completed under contract and received internal review. Government will need to consider recommendations in the report and decide where and when they are appropriate for use. The recommendations for predator and prey management will need to be balanced with other recovery objectives and incorporated into caribou recovery activities. This document has been approved by ministry executive.

This report is a significant accomplishment and will guide government in moving forward with Mountain Caribou Recovery. For more information on Mountain Caribou Recovery in British Columbia, please visit the recovery website at:
http://www.env.gov.bc.ca/sarco/mc/index.html
If you have any questions on the attached wolf management document or Mountain Caribou recovery, please feel free to contact me (250-614-9917).

Sincerely,

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Estimating the Short-term Benefit of Wolf Management to Mountain Caribou Herds

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Prepared for:
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Victoria

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Introduction

The Mountain Caribou Recovery Implementation Plan announced by government in October 2008 authorized the use of predator management to benefit mountain caribou herds were predation was preventing recovery. The importance of predator management was re-affirmed by the Mountain Caribou Science Team in their September 2009 recommendations (SARCO 2009). Wilson (2010) presented recommendations for a predator management strategy that followed the Science Team recommendations and reflected government's recovery objectives.

The Ministry of Environment has implemented a number of actions since the October 2008 announcement aimed at reducing predation pressure on mountain caribou herds. These actions have included liberalizing hunting seasons for wolves and cougars, encouraging licensed trappers to trap wolves, removing individual cougars suspected of preying on caribou, and hiring trappers to target wolf packs in specific areas. These actions have been implemented on a trial basis to understand the feasibility and efficacy of different management actions. In general, management actions aimed at cougars have been successful while actions to reduce wolf have met with limited success. Before revising management actions aimed at reducing wolves, it is important to integrate information from recent actions with updated mountain caribou census data to estimate the potential benefits of future wolf management actions.

This report presents a management model that can be used to estimate the benefit of different levels of wolf removal on mountain caribou herds with different population characteristics. I use recent census information to predict population responses of mountain caribou herds to different intensities of wolf removal.

Methods

I developed a management model to predict the short-term population responses of mountain caribou herds to different levels of wolf removal. The predator-prey dynamics of mountain caribou populations are very complex, involving multiple predators and multiple prey (Mountain Caribou Science Team 2005); however, a simple model is useful for making coarse-level predictions, based on a number of assumptions.

Assumptions

The model assumptions were:

1. Mountain caribou herds are closed populations;
2. Wolf mortality on mountain caribou is additive to other sources of mortality;
3. All caribou >10 months of age are equally vulnerable to wolves;
4. Mortality of caribou calves <10 months old is insensitive to changing wolf populations; and,

5. Predation on mountain caribou by wolves is correlated with wolf population size.

Model Structure

The model estimates future caribou population size based on:

1. Current mountain caribou herd population;
2. Current population trend of the mountain caribou herd (lambda);
3. The proportion of adult caribou mortality caused by wolves; and,
4. The proportion of wolves removed by management actions.

I established relationships between model variables as a Bayesian Belief Network (Figure 1), which provided a number of advantages:

1. The relationships between important variables were captured visually;
2. The model allowed a mix of quantitative and qualitative information;
3. Uncertainty was accommodated explicitly and outputs were expressed probabilistically.

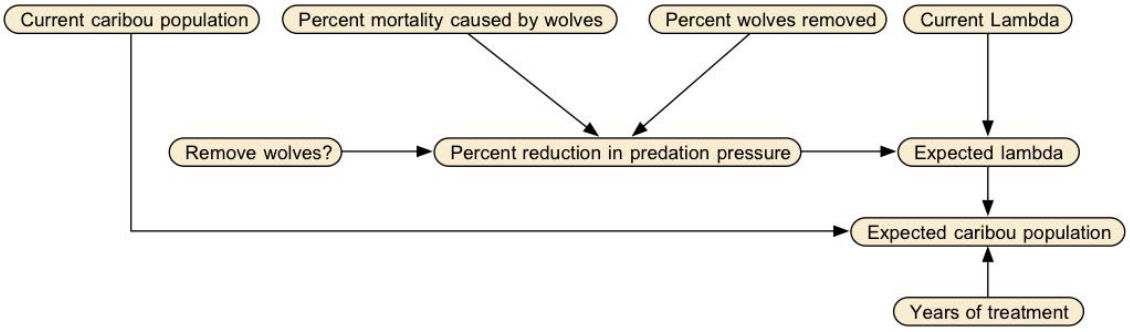

Figure 1. Model to predict the benefit to mountain caribou herds of wolf removal. The model was developed as a Bayesian Belief Network.

The model relies on three calculations:

Percent Reduction in Predation Pressure

This is calculated as the joint probability of the percent mortality caused by wolves and the percent wolves removed.

Expected Lambda

Expected lambda is calculated from the following equation:

*expected lambda = current_lambda + (1.15 – current_lambda) * percent_reduction_in_predation_pressure*

In other words, the expected lambda calculation assumes that the maximum intrinsic rate of increase of mountain caribou herds is 1.15 (equal to 15 calves/100 caribou in March surveys). The difference between 1.15 and the current lambda is the current adult predation rate. This rate is reduced by the percent reduction in predation pressure and added to the current lambda to generate the expected lambda.

Expected Caribou Population

The expected caribou population is calculated from the following equation:

*expected_caribou_population = current_caribou_population * e ^ (expected_lambda – 1) * years*

Model Parameters

Mountain caribou herd sizes were collated from 2008-2010 census information. Lambda was calculated from the change in herd populations since 2006 (Hatter 2006) and averaged over 2-4 years, depending on the year of the most recent survey.

The proportion of adult caribou mortality caused by wolves was estimated by geographic region:

1. 0-25%: South Selkirks and Purcell South;
2. 25-50%: other Kootenay and Revelstoke herds, Groundhog; and,
3. 50-75%: Wells Gray, Cariboo and Hart ranges herds.

The proportion of wolves removed by management actions was estimated to be 0-25% for trapping and hunting and 90-100% for aerial removal.

The model allows runs of 1, 3 and 5 years; however, only results for 5 years were generated for this report.

Results

Post-2006 survey data were available for 11 mountain caribou herds. I generated 5-year population estimates for 10 of these herds, excluding the Hart Ranges where widespread wolf reductions are considered infeasible (Figure 2). Original data used to develop the figures are presented in the Appendix.

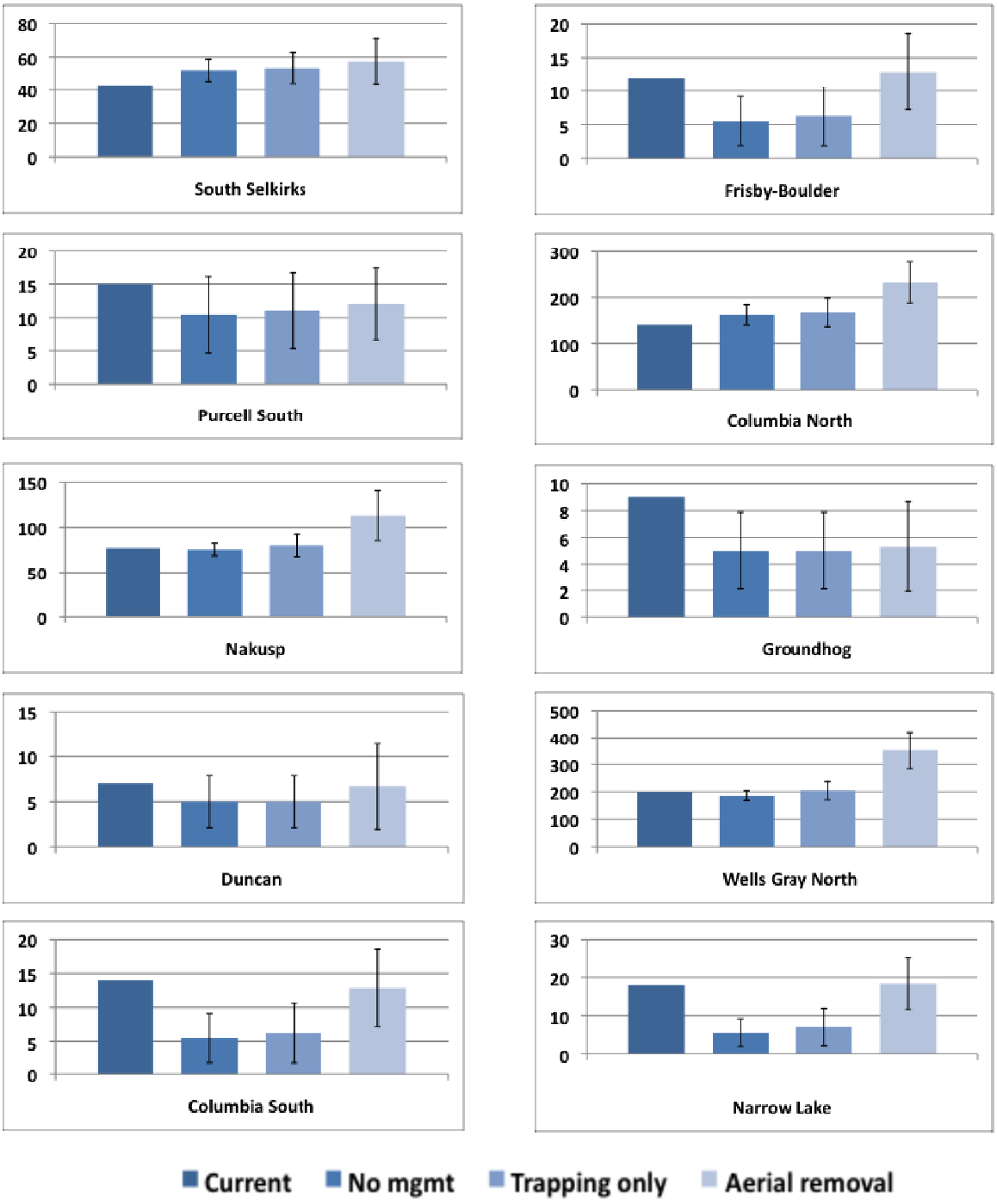

Figure 2. 5-year projected mountain caribou herd populations, based on different wolf control options. Error bars are ± standard deviation.

Discussion

The effectiveness of wolf management is predicted to vary by herd size and current population trajectory. Those herds with a lambda closest to 1.0 or above, and/or those where wolves are responsible for a significant proportion of adult caribou

mortality, are expected to benefit the most from wolf reductions. Very small herds benefit little because they are generally experiencing very rapid population declines and reducing wolves without additional action is insufficient to generate a population increase within 5 years.

Aerial removals generated higher caribou population estimates than hunting and trapping in all herd areas, although the magnitude of the difference varied. Little benefit was derived in the southernmost herds where wolves are not responsible for a significant proportion of mountain caribou mortality. Hunting and trapping in these areas could be sufficient to maintain low wolf numbers.

Wolf reductions are expected to generate the greatest benefit to mountain caribou in the largest and most stable herds analyzed; namely, Wells Gray North, Columbia North, and Nakusp. However, these herds are also associated with the largest ranges and the most wolf packs and a large number of wolves would need to be removed.

Removal of wolves from very small herds, such as the Columbia South, Frisby-Boulder and Narrow Lake, might be sufficient to stabilize populations but additional management actions will be required to significantly increase herd sizes. Wolf reductions are predicted to generate little benefit for the Groundhog herd, although the benefit is higher if we assume that wolves have been responsible for >25-50% of adult caribou mortality during the past four years. The Duncan herd is very small and its population trajectory is uncertain; as a result, there is little confidence in the small benefit predicted from wolf reductions. The southernmost herds (South Selkirks and Purcell South) benefit the least from wolf reductions because wolves are not responsible for a significant proportion of caribou mortality in these areas.

Conclusions

The results of the modelling exercise suggest that:

1. The benefit of wolf reductions will be limited in most very small herds, although removal of most wolves might be sufficient to reduce or halt population declines;
2. The largest and most stable herds are likely to benefit the most from wolf reductions but the number of wolves that would need to be removed to derive the benefit would be much higher than for small herds; and,
3. Aerial removal is more effective than trapping in all herd areas. Where wolves are responsible for a small proportion of caribou mortality, hunting and trapping might be sufficient to maintain low wolf numbers.

Literature Cited

Hatter, I. 2006. Mountain caribou 2006 surveys results, subpopulation trends and extinction risk. BC Ministry of Environment, Victoria.

Mountain Caribou Science Team. 2005. Mountain caribou in British Columbia: a situation analysis. http://www.env.gov.bc.ca/sarco/mc/files/Mountain_Caribou_Situation_Analysis.pdf

SARCO (Species at Risk Coordination Office. 2009. A review of management actions to recover mountain caribou in British Columbia. http://www.env.gov.bc.ca/sarco/mc/files/Final_ST_Report_23Feb10.pdf

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Appendix

Mountain caribou herd populations and projections under different wolf management scenarios.

Herd	2006 (Hatter 2006)	Current	Years after 2006	lambda	P(mortality due to wolves)	No mgmt	SD	Trapping only	SD	Aerial removal	SD	Notes
South Selkirks	37	43	4	1.04	0-25%	52.2	6.5	53.6	9.2	57.6	13.5	
Purcell	20	15	4	0.94	0-25%	10.4	5.8	11.0	5.7	12.0	5.4	
South Purcell	0	0										
Central Nakusp	85	77	4	0.98	25-50%	75.7	7.0	80.3	12.3	113.3	27.6	
Duncan	9	7	4	0.94	25-50%	5.0	2.9	5.0	2.9	6.7	4.7	
Monashee	8	7	2	0.94	25-50%							
Columbia	29	14	3	0.83	25-50%	5.5	3.6	6.3	4.4	12.9	5.7	
South Frisby-Boulder	19	12	2	0.82	25-50%	5.5	3.6	6.3	4.4	12.9	5.7	
Columbia North	138	140	4	1.00	25-50%	161.9	21.8	167.3	30.7	232.0	44.7	
Kinbasket	2	3	2	1.25	25-50%							
Groundhog	30	9	4	0.83	25-50%	5.0	2.9	5.0	2.9	5.3	3.4	
Wells Gray South					50-75%							
Wells Gray North	210	200	4	0.99	50-75%	187.0	18.0	205.0	33.0	353.0	68.0	Junction, Stevenson and Horsefly blocks
Allen Creek	33											Assume this is rolled into Wells Gray
Barkerville	51	50	0		50-75%							Most recent survey was

Herd	2006 (Hatter 2006)	Current	Years after 2006	lambda	P(mortality due to wolves)	No mgmt	SD	Trapping only	SD	Aerial removal	SD	Notes
												2006
North Cariboo Mts	267	265	0									Most recent survey was 2006
George Mtn	0	0			50-75%							
Narrow Lake	40	18	4	0.86	50-75%	5.5	3.6	7.0	4.9	18.4	6.8	
Hart Ranges	717	560	4	0.95								Too large to feasibly remove a large proportion of the population