

Evaluation of Alternative Moose Harvest Strategies in Game Management Zone 5B; East Cariboo

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Table of Contents

List of Figures	3
List of Tables	3
Introduction	4
Moose Management in the Cariboo	4
2011 GMZ 5B Population Assessment	6
I. Population Estimate	6
II. Harvest Data Analysis	8
Alternative Harvest Strategies	11
Estimating Harvest under Alternative Harvest Strategies	12
I. First Nations Sustenance and Ceremonial Needs	12
II. LEH Bull Harvest Estimates	12
III. Spike-fork Harvest Estimates	13
IV. Calf Harvest Estimates	13
V. Total Estimated Moose Harvest Under Alternative Management Strategies	13
Modeling Alternative Harvest Strategies	16
I. Population Model	16
II. Risk Analysis; Probability of Not Meeting Population Targets	17
Evaluation of Alternative Harvest Strategies	17
I. Modelling Results	17
II. Discussion	20
References	21
Appendices	23
I) Estimated Spike-Fork Harvest	23
II) Calf Harvest Estimate	24
III) First Nations Per Capita Needs from 2004-2008 Allocation	26

List of Figures

Figure 1. Game Management Zones (GMZs) within the Cariboo Region	5
Figure 2. Average resident moose hunter success rate in Game Management Zone 5B (GMZ 5B) from 2001 to 2009.....	8
Figure 3. Average resident moose hunter days per kill in Game Management Zone 5B (GMZ 5B) from 2001 to 2009.....	9
Figure 4. Total resident moose hunter harvest in Management Units 5-01 and 5-02 from 2001 to 2009.....	9
Figure 5. Total moose Limited Entry Hunt authorizations issued in Game Management Zone 5B from 2001 to 2009.....	10
Figure 6. Region 3 average spike-fork harvest related to calculated MU vulnerability and Region 5 expected spike-fork harvest using linear regression.	24
Figure 7. Region 7 average juvenile moose harvest related to average hunter days and expected GMZ 5B MU calf harvest using linear regression.....	25

List of Tables

Table 1. Stratified Random Block (SRB) estimated moose densities from surveys conducted in Game management Zone 5B (moose/km ²).	7
Table 2. 2011 Game Management Zone 5B (GMZ 5B) Moose population Estimate.....	7
Table 3. Alternative Harvest Strategies Evaluated for the Cariboo Region 2012-2016 allocation period	11
Table 4. Estimated First Nations Sustenance and Ceremonial Needs by GMZ for 2003, 2008, and 2011.....	12
Table 5. Estimated moose harvest in GMZ 5B under each evaluated alternative harvest strategy	14
Table 6. Consequence Table; expected average growth rate and relative probabilities of not meeting moose population targets under alternative harvest strategies in GMZ 5B	19
Table 7. Region 3 spike fork harvest analysis	23
Table 8. Region 5 estimated Spike-fork harvest in GMZ 5B.	23
Table 9. Area, average hunter days and average juvenile harvest in several Omineca management units.....	24
Table 10. Area, expected hunter days, and expected harvest in GMZ 5B MUs based on Region 7 data.....	25
Table 11. 1978-1982 historic calf harvest, MU corrected harvest based on season length and average annual GMZ 5B corrected calf harvest	26

Introduction

In 2010 the Ministry of Natural Resource Operations, now the Ministry of Forests, Lands and Natural Resource Operations, committed to an evaluation of alternative harvest strategies for moose in the east Cariboo area, Game Management Zone 5B (GMZ 5B), for the 2012-2016 allocation period. This document outlines the process executed by ministry staff in that evaluation. The alternative harvest strategies included examples from other regions within the province, suggestions from stakeholders, and several novel harvest strategies. A Stratified Random Block (SRB) survey was conducted in the winter of 2011 in MU 5-02C to update the current status of the GMZ 5B moose population. The alternative harvest strategies were evaluated using a moose population model to forecast the population through the 2012-2016 allocation period using the expected harvest dynamics under each alternative harvest strategy. The modelling estimated the relative risk of not meeting key moose population targets, such as sex ratio and density under each of the alternative harvest strategies.

This document will serve as the foundation for a structured decision making process involving all stakeholders to determine which moose harvest strategy should be adopted in GMZ 5B.

Moose Management in the Cariboo

Since 1993, moose harvest in the Cariboo Region has been regulated under the Limited Entry Hunting (LEH) system, with quotas for the commercial (guided) sector. The LEH and quota system is utilized where there is a requirement for an intensive harvest management regime. Under the LEH and quota system, harvestable moose are allocated between the resident and commercial sectors every three to five years. The current allocation (2009-2011) expires with the 2011 hunting season. A revised harvest allocation is required for the 2012-2016 allocation period. Moose in the Cariboo are managed following the Big Game Harvest Management and Moose Harvest Management Procedures (4-7-01.07.1 and 4-7-01.07.03 respectively).

The moose population objectives in the Cariboo Region are as follows:

- 1) Bull/Cow ratio greater than 30 bulls per 100 cows
- 2) Moose density greater than 0.4 moose per km²
- 3) Stable to increasing moose population

The allocation process initially involves assessing the status of moose populations within Game Management Zones (GMZs) to determine an Annual Allowable Mortality (AAM). In the Cariboo Region moose are managed through assessment and allocation in 4 GMZs (GMZ 5A: Cariboo Mountains, 5B: Cariboo, 5C: North Chilcotin, and 5D: South Chilcotin [Figure 1]). The supply of moose for First Nations traditional use is estimated and deducted from the overall AAM. The remainder of the AAM, the Annual Allowable harvest (AAH), is allocated between residents and commercial sectors considering the Harvest Allocation Procedures (4-7-01.03.1). Individual guide quotas are calculated based on the estimate of harvestable moose within each guide territory following the Quota Procedures (4-7-01.05.1).

GMZ population estimates are based on periodic abundance surveys (Stratified Random Block [SRB] surveys) supplemented with compositional surveys. Harvest data from the LEH hunter questionnaire is compiled and analyzed to corroborate the population estimates calculated from the survey data.

The AAH is determined using a population model as is the standard in North America for ungulate management (White and Lubow 2002). The results of the modelling are evaluated to determine the probability, under each alternative harvest option, that population objectives will not be met. The modelling results are then discussed with First Nations and stakeholders, and the Regional Manager selects an AAH considering the biological implications, First Nation concerns, and stakeholder preferences.

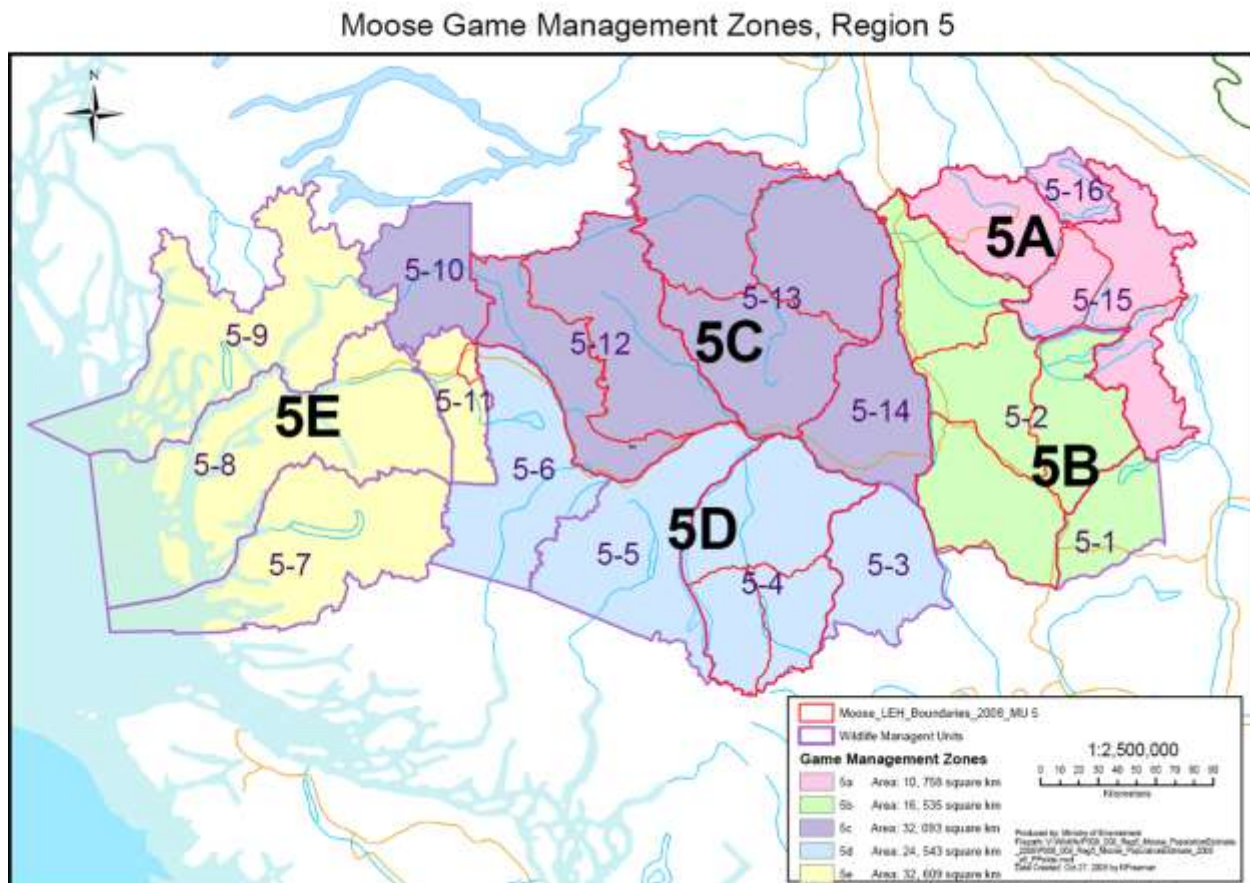


Figure 1. Game Management Zones (GMZs) within the Cariboo Region

2011 GMZ 5B Population Assessment

I. Population Estimate

The 2011 GMZ 5B population estimate was derived from the 2011 Management Unit 5-02C SRB survey (Davis 2011). The survey estimate used Idaho Aerial Survey[®] to calculate an independent Sightability Correction Factor (SCF) from vegetation cover observations made during the survey. The Idaho Aerial Survey[®] sightability correction model was modified with data from British Columbia moose sightability studies (Quayle et al. 2001, D. Heard unpublished data). The 2011 survey estimated a density of 0.51 (± 0.078) moose per km², a bull/cow ratio of 43 (± 11.6) bulls/100 cows, and a calf/cow ratio of 35 (± 8.9) calves/100 cows (Davis 2011). The prior MU 5-02C survey in 2001 estimated a density of 0.62 (± 0.088) moose per km², a bull/cow ratio of 21 (± 5.6) bulls/100 cows, and a calf/cow ratio of 45 (± 9.6) calves/100 cows (Davis 2011).

GMZ 5B can be divided into two portions based on the average moose density from past SRB surveys: the historically low density portion containing MUs 5-01 and 5-02A (1994-2011 average density = 0.26), and the historically high density portion containing MUs 5-02B, 5-02C, and 5-02D (1994-2011 average density = 0.48) [Table 1 and Table 2]. To calculate the 2011 GMZ 5B population estimate, the 2011 MU 5-02C SRB survey density was extrapolated to the entire GMZ, maintaining the historic density ratio between the low and high density areas. MU 5-02C is within the historically high density portion of GMZ 5B, therefore we extrapolated the estimated density from the 2011 survey of 0.51 moose per km² to the 9284km² of suitable moose habitat within the high density portion of the GMZ (Table 2), for an estimate of 4735 moose. We maintain the ratio between the historic densities (0.26 to 0.48) to calculate an estimated 2011 density for the low density portion of GMZ 5B of 0.279 moose per km². Extrapolating this density out to the 5485km² of suitable moose habitat in the low density portion of the GMZ, gives a 2011 estimate of 1530 moose. Adding the low and high density area estimates together gives a total moose population estimate in GMZ 5B for 2011 of 6265 (Table 2).

The 2011 GMZ 5B moose estimate of 6265 moose is a decrease of 7% from the 2008 GMZ 5B moose estimate of 6727 moose. The moose population composition estimates were made by applying the sex and recruitment ratios estimated during the 2011 MU5-02C SRB survey (43 bulls/100 cows and 35 calves/100 cows). The 2011 calculated composition for the GMZ 5B moose population is 1514 bulls, 3519 cows, and 1232 calves. The 2008 estimated GMZ 5B composition was 1410 bulls, 3721 cows, and 1596 calves.

Table 1. Stratified Random Block (SRB) estimated moose densities from surveys conducted in Game management Zone 5B (moose/km²).

Year	5-01	5-02A	5-02B	5-02C	5-02D
1994				0.50	
1995					
1996	0.43	0.09	0.65		
1997				0.28	
1998		0.26			
1999					0.67
2000	0.32		0.59		
2001		0.22		0.62	
2002					
2003					
2004					0.13
2005					
2006			0.39		
2007					
2008					
2009					
2010					
2011				0.51	

Table 2. 2011 Game Management Zone 5B (GMZ 5B) Moose population Estimate

	Low Density MUs (5-01 and 5-02A)	High Density MUs (5-02B, 5-02C, and 5-02D)	Game Management Zone 5B
Average Density 1994-2011	0.26	0.48	
Estimated 2011 Density	0.28	0.51	0.42
Total Suitable Moose habitat (km ²)	5,485	9,284	14,769
2011 Estimated Moose	1530	4735	6265

II. Harvest Data Analysis

Resident harvest data from 2001-2009 was compiled and graphed to visualize any trends in the harvest data. Non-Resident data was not utilized due to concerns relating to specific factors influencing the harvest success of guided hunters (e.g. reports from guides that many clients choose only to harvest “trophy” animals and pass on smaller bulls). The average resident success rate (total moose killed divided by the total number of hunters) in GMZ 5B has decline from approximately 48% in early 2000s to approximately 30% in the late 2000s (Figure 2). The average hunter days per moose kill in GMZ 5B has increased from approximately 13 days per kill in early 2000s to approximately 24 days per kill in the late 2000s (Figure 3). Hunter days per kill is inversely equivalent to a measure of Catch per Unit Effort (CPUE). Hatter (2001) found that CPUE tends to underestimate an ungulate population’s actual rate of decline. As such, the increase in hunter days per kill from 2001 to 2009 (equivalent to a decrease in CPUE) is strong support for the conclusion that the moose population on GMZ 5B is in decline. The total resident moose harvest in Management Unit (MU) 5-02 decreased from approximately 350 in the early 2000s to less than 250 in the late 2000s, while total resident harvest in MU 5-01 stayed relatively stable at approximately 75 from 2001 to 2009 (Figure 4). Total Limited Entry Hunting (LEH) authorizations issued in GMZ 5B have remained relatively stable at an average of 1060 from 2001 to 2009 (Figure 5). Overall the resident harvest history supports the evaluation of a declining moose population in GMZ 5B.

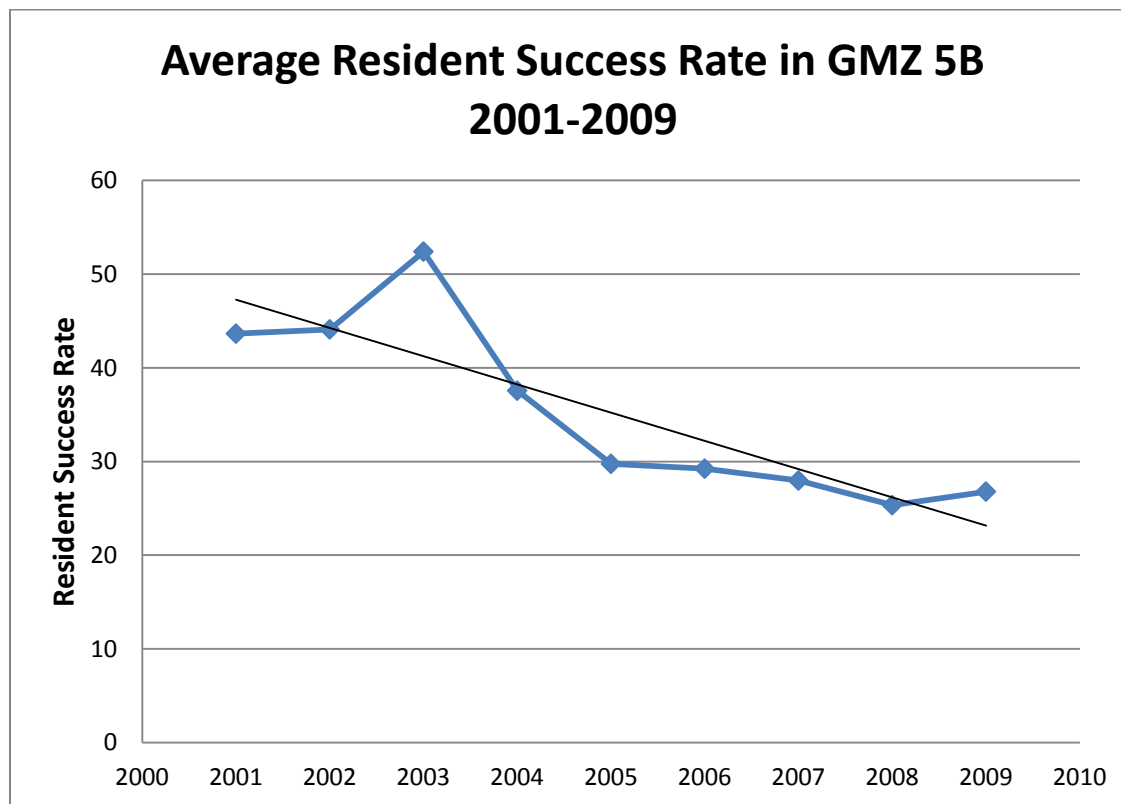


Figure 2. Average resident moose hunter success rate in Game Management Zone 5B (GMZ 5B) from 2001 to 2009

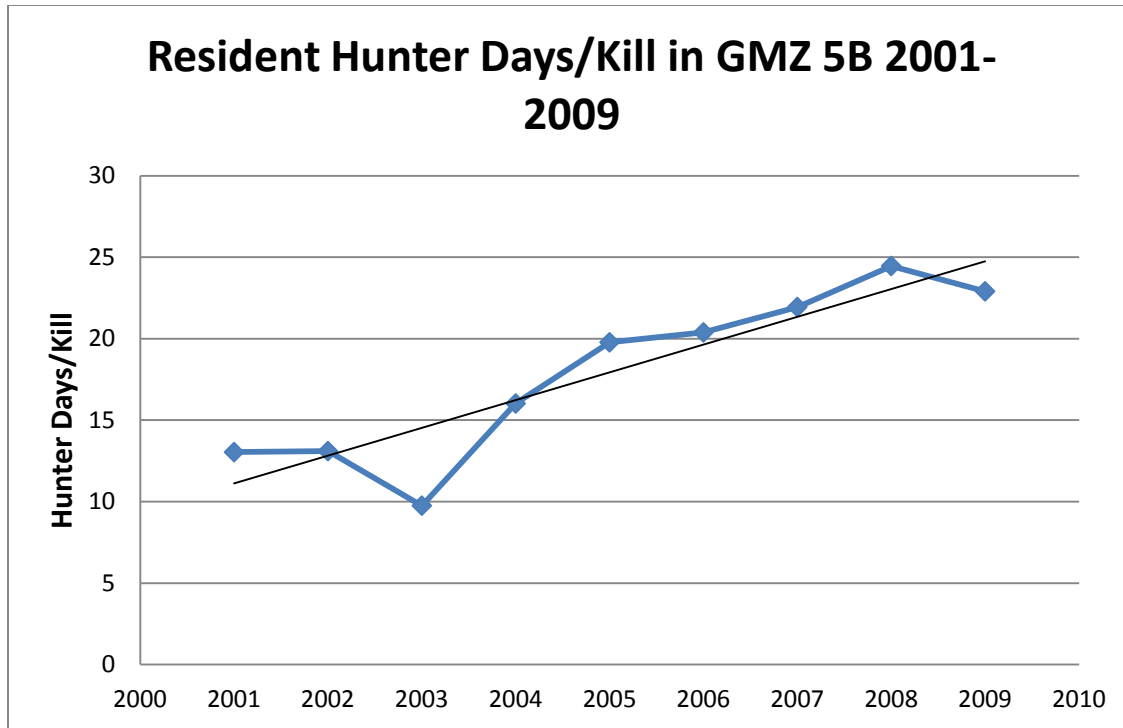


Figure 3. Average resident moose hunter days per kill in Game Management Zone 5B (GMZ 5B) from 2001 to 2009

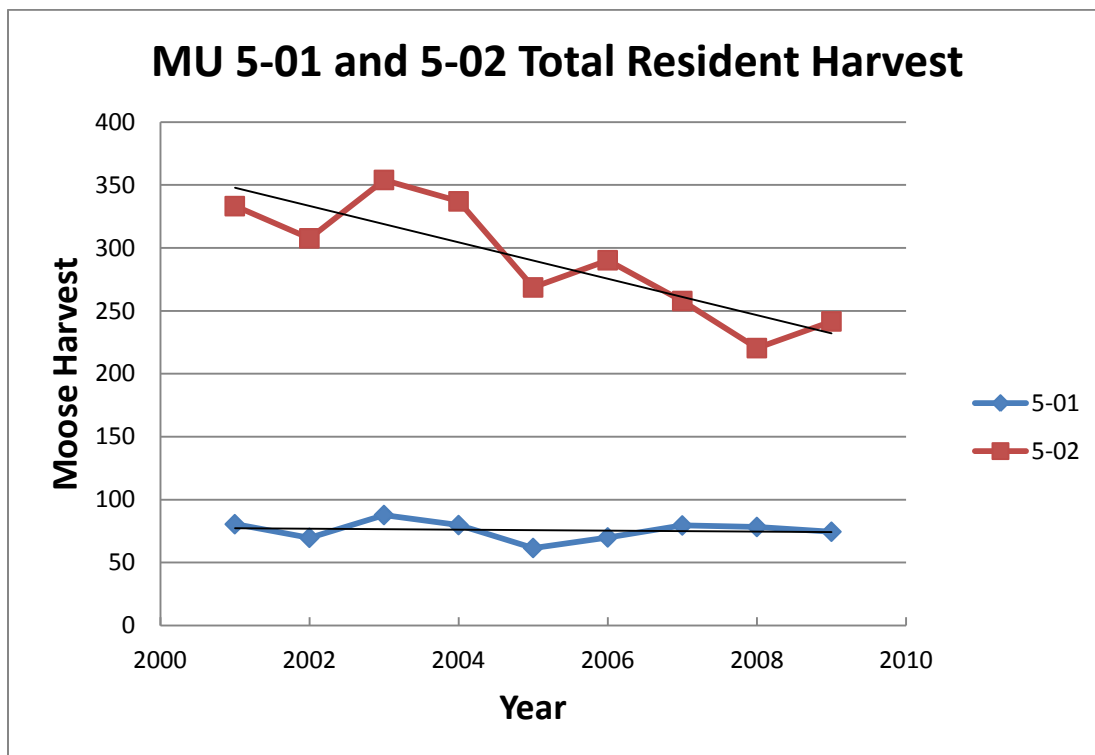


Figure 4. Total resident moose hunter harvest in Management Units 5-01 and 5-02 from 2001 to 2009

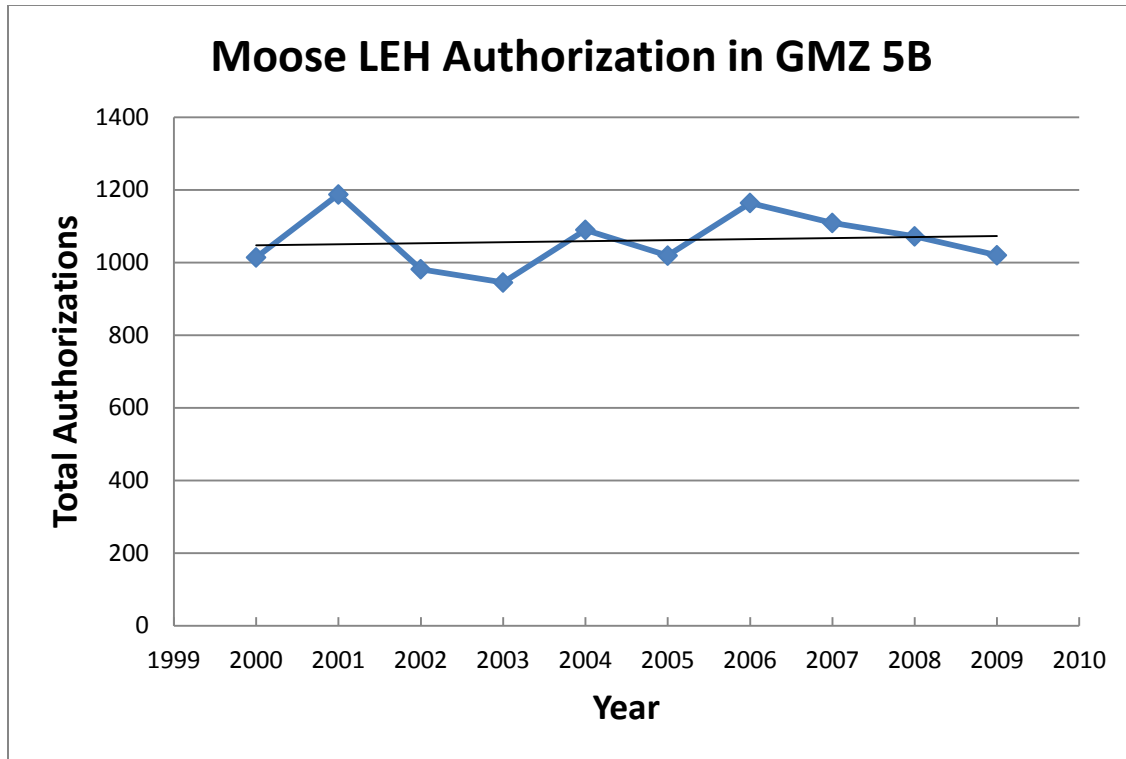


Figure 5. Total moose Limited Entry Hunt authorizations issued in Game Management Zone 5B from 2001 to 2009

Alternative Harvest Strategies

Currently licensed moose harvest in GMZ 5B is limited to LEH bulls only for resident hunters and bull only quotas for guide outfitters. First Nations harvest is not regulated. Eleven additional harvest strategies were chosen to be evaluated as possible alternatives to the current harvest strategy. Alternative harvest strategies modelled included examples from other regions in the province, stakeholder suggestions, and several novel harvest strategies.

Table 3 lists the twelve harvest strategies that were evaluated (including status quo) and a description of the associated regulations and seasons.

Table 3. Alternative Harvest Strategies Evaluated for the Cariboo Region 2012-2016 allocation period

Alternative Harvest Strategy	Description
1. Status Quo	LEH Bull harvest only
2. Status Quo +10%	LEH Bull harvest only (Inc AAH by 10% over status quo)
3. Status Quo +20%	LEH Bull harvest only (Inc AAH by 20% over status quo)
4. Status Quo -10%	LEH Bull harvest only (Dec AAH by 10% from status quo)
5. Status Quo -20%	LEH Bull harvest only (Dec AAH by 20% from status quo)
6. Full Omineca Model	Add open spike-fork season: Sept 10 – Nov 5 Add open calf season: Oct 10 – Oct 25 Add LEH antlerless season: Oct 10 – Oct 25 Reduce LEH bull AAH by estimated spike-fork harvest
7. Omineca Model minus LEH antlerless harvest	Add open spike-fork season: Sept 10 – Nov 5 Add open calf season: Oct 10 – Oct 25 Reduce LEH bull AAH by estimated spike-fork harvest
8. LEH Bulls plus early open Spike-fork season	Add open spike-fork season: Sept 10 – Oct 14 Reduce LEH bull AAH by estimated spike-fork harvest
9. LEH Bulls plus late open Spike-fork season (Region 3 model)	Add open spike-fork season: Oct 15 – Nov 15 Reduce LEH bull AAH by estimated spike-fork harvest
10. Spike-fork open season only	Add open spike-fork season: Sept 10 – Nov 15 Eliminate LEH bull authorizations
11. Spike-fork open season and calf open season only	Add open spike-fork season: Sept 10 – Nov 15 Add open calf season: Oct 10 – Oct 25 Eliminate LEH bull authorizations
12. Scientific collection of reproductive tracts	Maintain LEH bull harvest only or add spike-fork season Add late season (Nov-Dec) cow harvest at low rate (1%)
TEST No Licensed Harvest	Only estimated FNs harvest is applied in model
TEST No Human Harvest	No human harvest is applied in model. Test to estimate population productivity in the absence of human harvest

Estimating Harvest under Alternative Harvest Strategies

I. First Nations Sustenance and Ceremonial Needs

First Nations consultation is ongoing and the GMZ 5B estimate of First Nations needs is preliminary and could very likely change by the final determination of AAH and allocations in November 2011. Individual bands were contacted with letters requesting updated First Nations needs data for sustenance and ceremonial purposes.

First Nations technical workshops are planned to be held at each community throughout August and September 2011 to inform First Nations about current moose population status in the Cariboo, and to inform First Nations of the allocation exercise the Ministry is undertaking. The Ministry will again request updated First Nations needs information.

For the last allocation period (2009-2011) estimates of First Nations needs were based on community specific estimates of per capita need developed for the 2004-2008 allocation period. For 2011, we have revised the First Nations requirements based on the 2004-2008 per capita estimates. We applied the estimated per capita need from 2004-2008 to the current number of registered band members to calculate an updated estimate of need for each band. Total First Nation's estimated need in the Cariboo rose from 1020 moose to 1070 moose from 2008 to 2011. Total First Nation need was then divided into GMZ specific need based on traditional use information, and estimated harvest locations. For more information on how per capita estimates were developed refer to Appendix III.

Table 4. Estimated First Nations Sustenance and Ceremonial Needs by GMZ for 2003, 2008, and 2011

GMZ	2003 Estimated Moose Needs	2008 Estimated Moose Needs	2011 Estimated Moose Needs
5A	27	28	29
5B	186	190	199
5C	564	575	603
5D	223	227	239
Total	1000	1020	1070

The First Nations harvest estimate of 200 animals in GMZ 5B was included into the estimated moose harvest under each of the twelve evaluated harvest strategies. First Nations harvest is assumed to be non-selective as information to divide First Nations harvest into bulls, cows, and calves is unavailable. Therefore, First Nations harvest is applied using modelled composition ratio estimates (42 bulls/100 cows and 35 calves/100 cows).

II. LEH Bull Harvest Estimates

The LEH bull harvest is regulated by altering the number of LEH authorizations issued in each MU. For the evaluation of alternative harvest strategies, the resident LEH bull harvest will be reduced by the estimated spike-fork harvest to ensure that total bull harvest does not exceed the calculated AAM for bulls.

The 2008 combined resident and non-resident AAH for GMZ 5B was 473 bulls. For the status quo alternative harvest strategy, the AAH was reduced to 440 bulls to account for the 7% decrease in the moose population estimate from 2008 to 2011.

III. Spike-fork Harvest Estimates

The expected spike-fork harvests in GMZ 5B under alternative harvest strategies 6 through 11 (Table 3) were estimated using data from the Region 3 spike-fork season. Region 3 spike-fork harvest was found to have a high correlation between the average spike-fork harvest in a Management Unit (MU) and the MU's calculated vulnerability ($R^2=0.96$; Appendix I). MU vulnerability was defined as the road density (road km per km²) multiplied by the percentage of the MU in early seral stage (<1.5m in height) multiplied by a hunter effort ranking (0-1499 hunter days = 1, 1500-2499 = 2, 2500-3499 = 3, and 3500-5000 = 4). Only Region 3 MUs close to or adjacent to GMZ 5B were used in the analysis (MUs 3-27 through 3-31, 3-37 & 3-38). Comparable MU vulnerabilities were then calculated for MUs within GMZ 5B. Road density and percentage early seral were calculated using geomatic information in a comparable process to that used for Region 3 MUs. Hunter effort was estimated from the one year spike-fork open season that was implemented in the east Cariboo in 2004. From the GMZ 5B MU vulnerabilities we used linear regression to estimate the expected spike-fork harvest within each MU (Appendix I). It is estimated that the September 10 to November 5 spike-fork season would result in approximately 170 spike-forks being harvested in GMZ 5B. In the early open spike-fork season (Sept 10 – Oct 14) it is estimated that 125 spike-forks would be harvested, and in the late spike-fork season (Oct 15 – Nov 15) approximately 90 spike-forks would be harvested. Under the Spike-fork only open season (LEH bull harvest removed) it is estimated that approximately 200 spike-fork moose would be harvested. Refer to appendix I for more information on the calculations of expected spike-fork harvest in GMZ 5B.

IV. Calf Harvest Estimates

The expected calf harvest under the October 10 – October 25 open season was estimated from the Omineca Region juvenile harvest data. Average juvenile harvest in Region 7 MUs was found to be highly correlated to average hunter effort in those MUs ($R^2=0.89$; Appendix II). We used linear regression to calculate the expected GMZ 5B calf harvest using the expected hunter effort in each of the GMZ 5B MUs. Using Region 7 data, we estimate an expected calf harvest of approximately 310 in GMZ 5B. This estimate was corroborated by a secondary estimate of expected calf harvest calculated from historic calf harvest during the late 1970s to early 1980s open calf season in Region 5. The historic calf harvest estimates were corrected for differences in season lengths to estimate an Oct 10 – Oct 25 open calf season harvest of approximately 290 calves (Appendix II). A harvest of 300 calves was used in the evaluations as a best estimate of the expected calf harvest.

V. Total Estimated Moose Harvest Under Alternative Management Strategies

The total moose harvest under each alternative management strategy was calculated by combining the estimates of harvest for each component of moose population under each of the evaluated alternative harvest strategies (Table 5). The estimated harvest to each component of the moose population was utilized as a parameter for the population modelling and evaluation of each alternative harvest strategy.

Table 5. Estimated moose harvest in GMZ 5B under each evaluated alternative harvest strategy

Harvest Strategy	Description	Resident and NR AAH	Open Spike-Fork	Open Calves	LEH Antler-less	First Nations Harvest (non-selective)	Total Moose Harvest
1. Status Quo	Maintain LEH bull moose only. Typically 4 authorization time periods: Sept 10-30, Oct 1-14, Oct 15-31, Nov1-15.	440	0	0	0	200	640
2. Status Quo +10%	“ “ “ “	484	0	0	0	200	684
3. Status Quo +20%	“ “ “ “	528	0	0	0	200	728
4. Status Quo -10%	“ “ “ “	396	0	0	0	200	596
5. Status Quo -20%	“ “ “ “	352	0	0	0	200	552
6. Full Omineca Model	Reduce LEH Bull authorizations Add open spike-fork season Sept 10-Nov 5 Add open calves from Oct 10- Oct 25 Add LEH antlerless Oct 10-Oct 25	~270	170	300	106	200	1045
7. Omineca Model minus LEH antlerless harvest	Reduce LEH Bull authorizations Add open spike-fork season Sept 10-Nov 5 Add open calves from Oct 10- Oct 25	~270	170	300	NO	200	940
8. LEH Bulls plus pre-rut open Spike-fork season	Reduce LEH Bull authorizations Add open spike-fork season Sept 10-Oct 14	~315	125	0	0	200	640
9. LEH Bulls plus post-rut open Spike-fork season	Reduce LEH Bull authorizations Add open spike-fork season Oct 15-Nov 15	~350	90	0	0	200	640
10. Spike-fork open season only	Eliminate LEH bull authorizations Add open spike-fork season Sept 10 – Nov 15	0	200	0	0	200	400

Harvest Strategy	Description	Resident and NR AAH	Open Spike-Fork	Open Calves	LEH Antler-less	First Nations Harvest (non-selective)	Total Moose Harvest
11. Spike-fork open season and calf open season only	Eliminate LEH bull authorizations Add open spike-fork season Sept 10-Nov 15 Add open calf season Oct 10-Oct 25	0	200	300	0	200	700
12. Scientific collection of reproductive tracts	Maintain LEH bull only or add spike-fork season Add late season (Nov-Dec) cow harvest at low rate (1%)	440	Y/N	0	35	200	675
Test No Licensed Harvest	Only estimated First Nations harvest is applied in model	0	0	0	0	200	200
Test No Human Harvest	No human harvest is applied in model	0	0	0	0	0	0

Modeling Alternative Harvest Strategies

I. Population Model

We used a stage structured dynamic population model similar to White and Lubow (2002) to forecast the moose population through the 2012-2016 allocation period. The start of the modelling year was early winter (after licensed harvest). A wounding loss of 15% was applied to the licensed harvest. The First Nations harvest was then removed and winter natural mortality was applied. Calves were recruited into early winter (post-hunt) populations based on surveyed calf/cow ratios. The model is described by the following equations:

$$N_{m,t+1} = (N_{m,t} - F_{m,t})S_m + \alpha(N_{j,t} - F_{j,t})S_{jw} - H_{m,t}$$

$$N_{f,t+1} = (N_{f,t} - F_{f,t})S_f + [(1 - \alpha)(N_{j,t} - F_{j,t})]S_{jw} - H_{f,t}$$

$$N_{j,t+1} = R * N_{f,t+1}$$

where $N_{i,t}$ is the number of individuals in stage i (m , adult male; f , adult female; j , juvenile) at time t ; α is the proportion of juveniles that are male (assumed to be 50%); $F_{i,t}$ is the number of individuals harvest by First Nations from stage i at time t ; $H_{i,t}$ is the number of individuals harvested by non-First Nations from stage i at time t ; S_i is the natural (non-hunting) survival rate for stage i ; and R is the juvenile recruitment rate (juveniles/female in the early winter population). It should be noted that in the above equations, S , S_{jw} , and R , were treated as annually randomly varying demographic rates.

The model derived initial randomized estimates of the population and composition based on estimates and Standard Errors (SEs) from the survey data. Annual recruitment rates were randomly drawn from a lognormal distribution of historic calf/cow ratios taken from all previous surveys conducted in the GMZ. Randomly varying annual survival rates were drawn from a beta distribution (range between 0 and 100%). The survival rates for males and females were estimated from annual harvest rates and the expected and observed population estimates from 2004, 2008 and 2011 using Microsoft[®] Solver (least-squares technique). The survival rates were “best estimates” in the sense that they produced good agreement between the previous and current population estimates. A Coefficient of Variation (CV) of 10% was applied to the adult male survival rate, 7.5% to female adult survival and 15% to calf winter survival in order to calculate the SDs needed for the beta distribution. The applied CVs represented our best understanding of variation in moose survival rates from the published literature (Bangs et al. 1989, Larsen et al. 1989, Modafferi and Becker 1997, Bertram and Vivion 2002). Juvenile overwinter survival was assumed to be 90% of adult female survival.

Density dependence was not integrated into the model because we estimated that moose in GMZ 5B were not approaching density dependence. Wang et al. (2009) has shown that density dependence in northern ungulates is low in the presence of large predators. Messier (1994) estimated that North American moose would stabilize at a density of ≈ 2.0 moose/km² in the absence of predators and hunting harvest. The study area contains abundant predator populations including black bear,

grizzly bear, and wolf. The average density of moose within GMZ 5B was 0.42 moose/km² and was assumed to be below habitat capacity. Secondly we limited model forecasting to a short, 5 year, time period to limit the risk that density dependent effects would have an impact on the forecasted populations.

To test the influence of density dependence on the GMZ 5B moose population a secondary model was constructed which integrated density dependence. We ran two separate scenarios for the Omineca alternative harvest model: 1) the moose population was near habitat carrying capacity (K) (K=7,000), and 2) the moose population was near maximum sustainable yield (K=10,000). The two alternative scenarios did not demonstrate significantly different results from the modelling results excluding density dependence.

II. Risk Analysis; Probability of Not Meeting Population Targets

Microsoft Excel[®] add-in PopTools version 3.0 (Hood 2008) was used for the Monte Carlo simulation analysis to assess the relative risk that future (2016) GMZ moose populations would not meet population performance targets under the varying alternative harvest strategies. We identified thresholds for each population performance target and used the Monte Carlo analysis to calculate the probability of being below these threshold values. The threshold values were based on the Cariboo Region moose population objectives and are consistent with both the Big Game Harvest Management and Moose Harvest Management procedures: a minimum 30 bulls/100 cows post-hunt in 2016, a minimum 0.40/km² moose density in 2016, and a population size in 2016 that is at least 80% of the population size in 2012. We also calculated the expected average growth rate (λ). A separate model run was conducted for each tested alternative harvest strategy. The Monte Carlo procedure ran 10,000 iterations of the stochastic population model. The procedure counted the number of times that the outcome values were less than the threshold values thereby calculating the conditional probability¹ that the population objective would not be met. A consequence table was constructed to summarise the Monte Carlo analysis and portray the tradeoffs between alternative harvest strategies and the associated risks of not meeting population objectives.

Evaluation of Alternative Harvest Strategies

I. Modelling Results

Results of the population modelling under each alternative harvests strategy are provided in Table 6. This table lists the estimated annual total moose harvest under each alternative harvest strategy, the relative probability of not meeting three moose population performance targets in 2016, and the expected average yearly growth rate (λ). As an example, alternative harvest strategy 1 (status

¹ "The probabilities calculated from the risk analysis are considered "conditional probabilities" as the calculated probabilities are dependent upon the variance assumed in the demographic survival rates (based on literature values, and not measured). However, these probabilities can be considered to be relative to each other in that they allow direct comparison between different scenarios (e.g. if scenario #1 had a conditional probability of 60% of not achieving a threshold value, and scenario #2 had a 30% conditional probability, then the model can be used to indicate that scenario #1 carries about twice the risk of not achieving the threshold value as does scenario #2).

quo) has an expected annual total moose harvest of 640 animals. The modelling estimates that the Status Quo harvest strategy has a 51% probability of having less than 30 bulls per 100 cows in 2016, a 62% probability that the moose density will be less than 40 moose per 100 km² in 2016, and a 41% probability that the 2016 moose population will be less than 80% of the starting 2012 moose population. The status quo moose harvest strategy has an expected average growth rate (λ) of 0.959. λ is a measure of the annual rate of change for a population. If λ is less than 1 the population is declining, if λ is greater than 1 the population is increasing.

The modelling exercise used to evaluate the alternative harvest strategies in GMZ 5B was executed using the best science and information available under the circumstances but limitations to the modelling and potential biases must be acknowledged. Some important ones are: inventory data limitations and variation, natural variation in calf recruitment, changes to natural predation rates, changing access and vulnerability to harvest, changing winter severity, and accuracy of harvest estimates.

Table 6. Consequence Table; expected average growth rate and relative probabilities of not meeting moose population targets under alternative harvest strategies in GMZ 5B

Harvest Strategy	Description	Total Annual Moose Harvest (Res+NR+FN)	Probability Bull/Cow <30/100	Probability Density <40/100km ²	Probability Final Pop <80% of Starting Pop	Expected Average Annual Growth Rate (lambda)
1. Status Quo	Maintain LEH bull moose only. Typically 4 authorization time periods: Sept 10-30, Oct 1-14, Oct 15-31, Nov1-15.	640	51%	62%	41%	0.959
2. Status Quo plus 10%	“ “ “ “	684	64%	65%	47%	0.950
3. Status Quo plus 20%	“ “ “ “	728	73%	68%	53%	0.944
4. Status Quo minus 10%	“ “ “ “	596	39%	59%	35%	0.967
5. Status Quo minus 20%	“ “ “ “	552	27%	56%	29%	0.975
6. Full Omineca Model	Reduce LEH Bull authorizations. Add open spike-fork season Sept 10-Nov 5 Add open calves from Oct 10- Oct 25 Add LEH antlerless Oct 10-Oct 25	1045	67%	86%	88%	0.843
7. Omineca Model minus LEH antlerless harvest	Reduce LEH Bull authorizations. Add open spike-fork season Sept 10-Nov 5 Add open calves from Oct 10- Oct 25	940	71%	80%	79%	0.887
8. LEH Bulls plus pre-rut open Spike-fork	Reduce LEH Bull authorizations. Add open spike-fork season Sept 10-Oct 14	640	52%	64%	43%	0.957
9. LEH Bulls plus post-rut open Spike-fork	Reduce LEH Bull authorizations. Add open spike-fork season Oct 15-Nov 15	640	51%	62%	41%	0.959
10. Spike-fork open season only	Eliminate LEH bull authorizations, add open spike-fork season Sept 10 – Nov 15	400	2%	46%	12%	1.004
11. Spike-fork open season and calf open season only	Eliminate LEH bull authorizations, add open spike-fork season Sept 10-Nov 15 Add open calf season Oct 10-Oct 25	600	10%	68%	53%	0.938
12. Scientific collection of reproductive tracts	Maintain LEH bull only or add spike-fork season Add late season (Nov-Dec) cow harvest at low rate (1%)	675	50%	66%	48%	0.948
Test: No Licensed Harvest	Test: no resident or non-resident harvest	200	0%	29%	1%	1.040
Test: No Human Harvest	No human harvest to test productivity of moose population	0	0%	14%	0%	1.073

II. Discussion

From the updated population estimate and the supporting harvest data analysis, there is strong evidence that the GMZ 5B moose population has declined since the early 2000s. The modelling suggests that maintaining the status quo moose harvest has a high likelihood of not meeting key moose population targets such as density and sex ratio. The GMZ 5B target AAM (resident and non-resident AAH and estimated FN harvest) has averaged 9% of the total moose population during the 2004 and 2008 allocation periods. Due to the slight increase in estimated First Nation's needs for 2011, the AAM under the Status-Quo harvest strategy would equal approximately 10% of the moose population for 2012. Hatter (1999) has previously calculated that the sustainable harvest rate for moose in British Columbia averages 7%. Other regions in southern British Columbia (e.g. Region 3) report average harvest rates of approximately 5-7% of the moose population (D. Jury personal communication 2011). The AAM under alternative harvest option 5 (Status Quo minus 20%) would equal approximately 9% of the moose population and has relatively lower probability of not meeting moose population objectives in 2016.

The 2011 moose population estimate shows a decline in the number of cows and a substantial reduction in the number of calves from the 2008 moose population estimate. The estimated number of bulls in GMZ 5B has gone up from approximately 1400 bulls in 2008 to approximately 1500 in 2011. This suggests that it has not been licensed harvest driving the decline in the moose population, but instead mortality of antlerless animals. The reduction in calf recruitment from 2001 to 2011 and the anecdotal reports of increases in predator populations in the GMZ could be contributing to the decreasing moose population. Reproductive females are the most important component of an ungulate population for growth and stability. The GMZ 5B moose population is a productive moose population with the potential for growth as shown under the modelled "no human harvest" test which showed a potential λ of 1.07, or a growth rate of 7% per year. Based on current management objectives, none of the scenarios indicated that a female harvest by resident hunters would be sustainable. Decision makers must weigh the tradeoffs between the increased biological risk and the increased hunting opportunity that antlerless seasons provide.

The introduction of a spike-fork seasons appears biologically feasible, given the spike-fork harvest is monitored and LEH bull harvest target is reduced by the number of spike-fork moose harvested. The total bull harvest (spike-fork plus LEH harvest) can be controlled by manipulating the number of LEH permits issued dependant on the level of spike-fork harvest. An open spike-fork season would allow any interested hunter the opportunity to hunt moose without the requirement to be drawn for an LEH. An open spike-fork season will result in addition hunting opportunity and more hunters participating in the Region 5 moose hunt, with little biological risk to the population. The open spike-fork season east of the Fraser in 2004 resulted in roughly 3 times the hunter days and almost 3 times the hunters than average for the previous 5 years (1999-2003). Decision makers will have to consider potential adverse effects of an open spike-fork season including overcrowding and the potential to mistakenly harvest a 3 point or larger animal in error under the spike-fork season. Any consideration of a spike-fork season in GMZ 5B would also require in-depth consultation with First Nations communities in the area.

One criticism of the current Region 5 moose harvest strategy is that it allows older female moose, past their reproductive years, to survive and compete for resources that could go to younger productive animals. Heard et al. (1997) showed that pregnancy rate in central British Columbia moose does not decline until 13 years of age and older. They also found that moose 13 years of age and older make up a small portion of the cow population (<8%). We feel that the level of First Nations harvest and natural predation is sufficient to prevent older females from becoming a large portion of the population and thereby reducing population productivity. This assessment is supported by the observed decrease in the cow population in MU 5-02C from 2001 to 2011, and the decrease in the estimated cows in the GMZ from 2008 to 2011. An option to test this assumption would be the scientific collection of a small portion of the cow population in late November or December to assess the age, condition, and pregnancy rates for the cow population in GMZ 5B. This would require Compulsory Inspection of all harvested cows to attain the required samples.

Moose harvest management in the Cariboo has been a controversial topic in recent years due to the high importance all stakeholders in the region place on moose hunting and harvest. Despite any particular stakeholders' opinion, all seem to agree that the conservation of Cariboo Region moose is of top priority to ensure ample opportunity for future hunters.

References

- BANGS, E. E., T. N. BAILEY, and M. F. PORTNER. 1989. Survival rates of adult female moose on the Kenai Peninsula, Alaska. *Journal of Wildlife Management* 53:557-563.
- BERTRAM, M. R., and M. T. VIVION. 2002. Moose mortality in eastern interior Alaska. *Journal of Wildlife Management* 66:747-756.
- BOERTJE, R. D., M. A. KEECH, D. D. YOUNG, K. A. KELLIE, and C. T. SEATON. 2009. Managing for elevated yield of moose in interior Alaska. *Journal of Wildlife Management* 73:314-327.
- DAVIS, LARRY. 2011. Rose Lake (MU 5-02C) 2011 winter moose inventory. Unpubl. BC Forests, Lands and Natural Resource Operations. Williams Lake, British Columbia.
- GASAWAY, W. C., S. D. DUBOIS, D. J. REID, and S. J. HARBO. 1986. Estimating moose population parameters from aerial surveys. *Biology Paper No. 22*, University of Alaska, Fairbanks, Alaska.
- HATTER, I. W. 1999. An evaluation of moose harvest management in central and northern British Columbia. *Alces* 35:91-103.
- HATTER, I. W. 2001. An assessment of catch per unit effort to estimate rate of change in deer and moose populations. *Alces* 37:71-77.

- HAYES, R. D., R. FARNELL, R. M. P. WARD, J. CAREY, M. DEHN, G. W. KUZYK, A. M. BAER, C. L. GARDNER, and M. O'DONOGHUE. 2003. Experimental reduction of wolves in the Yukon: ungulate responses and management implications. *Wildlife Monographs* 152:1-35.
- HEARD, D., S. BARRY, G. WATTS, and K. CHILD. Fertility of female moose (*Alces alces*) in relation to age and body composition. *Alces* 33:165-176.
- LARSEN, D. G., D. A. GAUTHIER, and R. L. MARKEL. 1989. Causes and rate of moose mortality in the southwest Yukon. *Journal of Wildlife Management* 53:548-557.
- LUKACS, P. M., G. C. WHITE, B. E. WATKINS, R. H. KAHN, B.A. BANULIS, D. J. FINLEY, A. A. HOLLAND, J.A. MARTENS, and J. VAYHINGER. 2009. Separating components of variation in survival of mule deer in Colorado. *Journal of Wildlife Management* 73:817-826.
- MESSIER, F. 1994. Ungulate population models with predation: a case study with the North American moose. *Ecology* 75:478-488.
- MODAFFERI, R. D. and E. F. BECKER. 1997. Survival of radiocollared adult moose in lower Susitna River valley, southcentral Alaska. *Journal of Wildlife Management* 61:540-549.
- STALBERG, M. 2001. 2001 – Rose Lake (5-02C) winter moose inventory. Unpubl. BC Ministry of Environment. Williams Lake, British Columbia.
- WANG, G., N. T. HOBBS, S. TWOMBLY, R. B. BOONE, A. W. ILLIUS, I. J. GORDON, and J. E. GROSS. 2009. Density dependence in northern ungulates: interactions with predation and resources. *Population Ecology* 51:123-132.
- WHITE, G. C., and B. C. LUBOW. 2002. Fitting population models to multiple sources of observed data. *Journal of Wildlife Management* 66:300-309.

Appendices

I) Estimated Spike-Fork Harvest

Table 7 outlines the Region 3 spike-fork harvest data linking average spike-fork harvest (2006-2008) with MU calculated vulnerability (road density*% of MU in early seral*hunter effort ranking). Only MUs close to or adjacent to GMZ 5B were used in the analysis. Average spike-fork harvest in the Region 3 MUs was found to be highly correlated with the MU calculated vulnerability ($R^2=0.959$; Figure 6).

Linear regression was used to calculate the expected spike-fork harvest in Region 5 MUs. MU vulnerability was calculated for each of the GMZ 5B MUs using methods comparable to those used to calculate the Region 3 MU vulnerabilities. Expected moose hunter days were estimated from the 2004 open spike-fork season east of the Fraser in Region 5. Road density and the percentage of the MU in early seral were calculated using geographical information systems. Table 8 outlines the estimated MU vulnerability for GMZ 5B MUs and the resulting estimate of spike fork-harvest.

Table 7. Region 3 spike fork harvest analysis

MU	MU Area (km ²)	Total road length (km)	Road density (km of road/km ²)	3 year average SF harvest 06-08	3 yr avg total harvest 06-08	3 yr avg moose hunter days 06-08	Hunter effort ranking	% of MU <1.5m	Overall MU vulnerability
3-38	1685	2594	1.54	2	8.3	443	1	16	24.9
3-37	1871	2808	1.50	3	8	966	1	12	17.3
3-31	2128	3202	1.50	5	20	878	1	15	21.9
3-30	3060	5176	1.69	27	50.7	4333	4	15	103.4
3-29	2301	3009	1.31	6	17.3	2136	2	13	34.6
3-28	1163	1876	1.61	16	33	2192	2	25	79.7
3-27	1676	3402	2.03	10	16.7	1423	1	23	45.8

Table 8. Region 5 estimated Spike-fork harvest in GMZ 5B.

MU	MU Area (km ²)	Total road length (km)	Road density (km of road/km ²)	Estimated spike-fork Harvest	3 yr avg total harvest 06-08	Estimated moose hunter days	Hunter effort ranking	% of MU <1.5m*	Overall MU vulnerability
5-01	2478	4296	1.73	34	77.4	4000	4	20	138.7
5-02A	4049	8221	2.03	18	32.5	1600	2	19	77.2
5-02B	3463	5374	1.55	27	85.8	4500	4	18	111.7
5-02C	3282	8609	2.62	35	45.9	3000	3	18	141.6
5-02D	3246	8384	2.58	55	75.7	5000	4	21	216.9
GMZ 5B	16518	34884	2.11	170	317.3	18100			

*%MU <1.5m in height adjusted downward to account for lake area

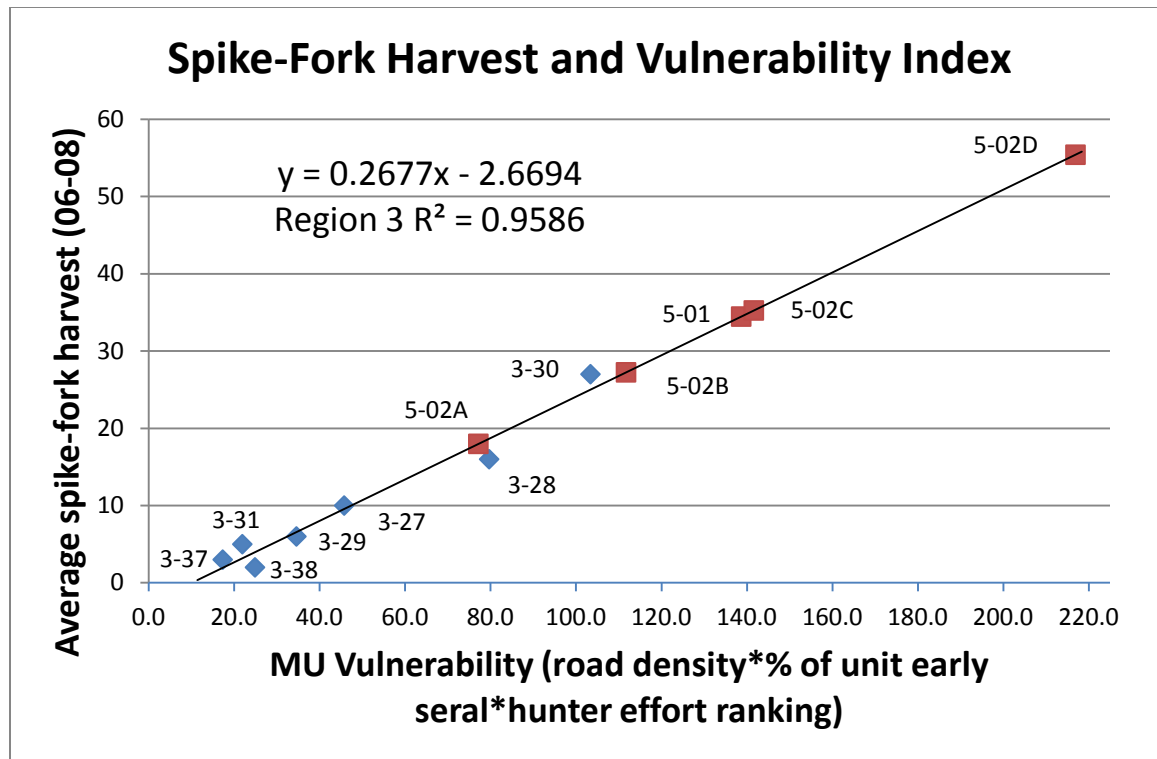


Figure 6. Region 3 average spike-fork harvest related to calculated MU vulnerability and Region 5 expected spike-fork harvest using linear regression.

II) Calf Harvest Estimate

Two separate methods were used to estimate expected calf harvest under the Omineca model. The first method used juvenile harvest data from several Omineca MUs close to or adjacent to GMZ 5B. Average juvenile harvest in Region 7 MUs was found to be highly correlated with average hunter days (Figure 7). Linear regression was then used to estimate expected calf-harvest in GMZ 5B MUs based on expected hunter effort in GMZ 5B MUs (Table 10). The Region 7 method estimates an Oct 10-Oct 25 calf harvest of 309 animals.

Table 9. Area, average hunter days and average juvenile harvest in several Omineca management units.

MU	Area (km ²)	Average Hunter Days (2003-2006)	Average Juvenile Harvest (2003-2006)
7-7	3002.86	1341.25	7.5
7-8	1934.02	1234	8
7-9	1751.93	972.5	5
7-10	1563.14	1792.25	22.75

Table 10. Area, expected hunter days, and expected harvest in GMZ 5B MUs based on Region 7 data.

MU	Area (km2)	Expected Hunter Days	Estimated harvest based on R7 data
5-01	2478	4000	70
5-02A	4049	1600	17
5-02B	3463	4500	81
5-02C	3282	3000	48
5-02D	3246	5000	93
GMZ 5B total	16518	18100	309

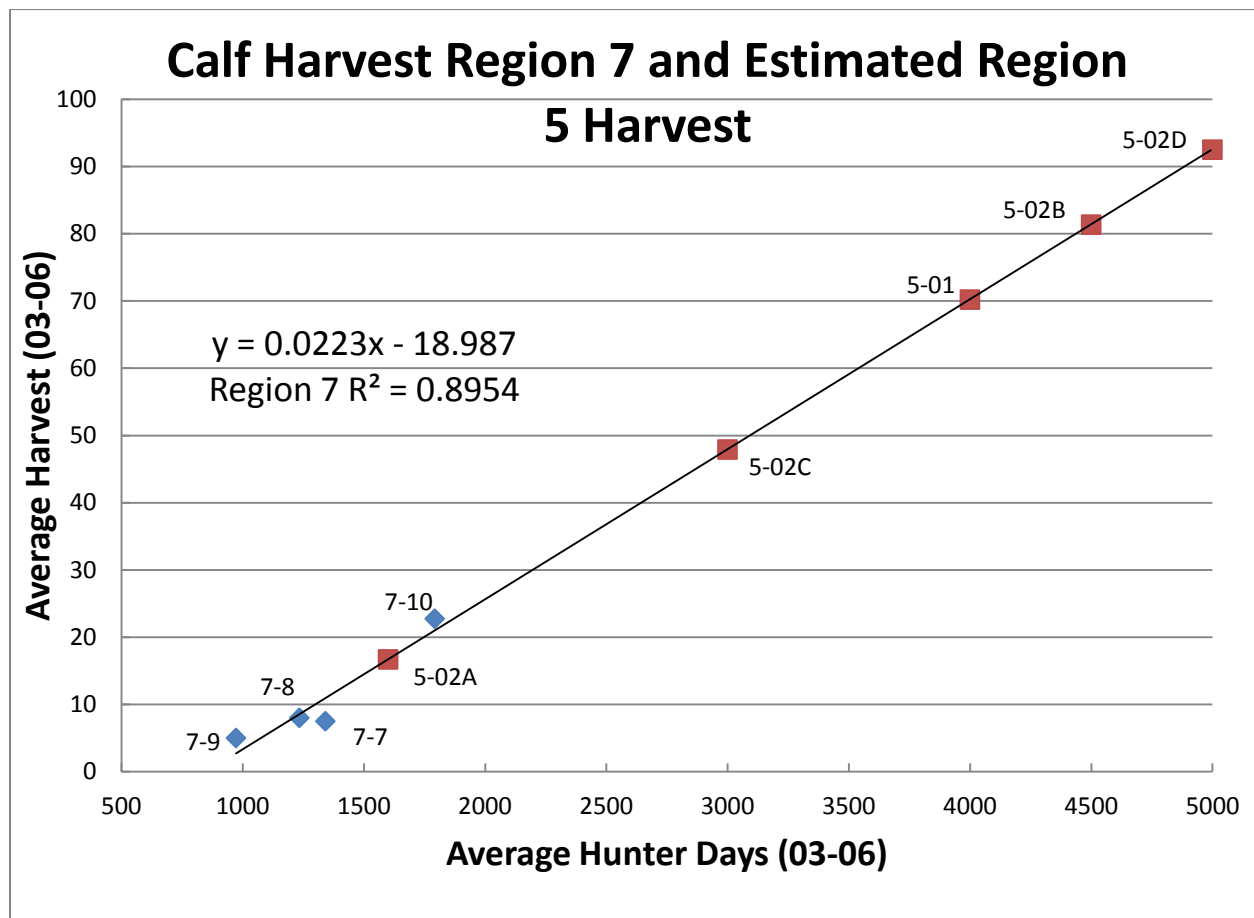


Figure 7. Region 7 average juvenile moose harvest related to average hunter days and expected GMZ 5B MU calf harvest using linear regression

The second method used harvest data from the open calf season in Region 5 during the late 1970s and early 1980s. The historic seasons were much shorter than the proposed 16 day Oct 10 to Oct 25 season, so an extrapolation factor was applied to the historic harvest to correct the estimates to the

longer proposed season (Table 11). This method estimated a calf harvest of 293 animals under an Oct 10 - Oct 25 season.

Table 11. 1978-1982 historic calf harvest, MU corrected harvest based on season length and average annual GMZ 5B corrected calf harvest

Year	MU	Season Length (days)	Harvest	Extrapolation Factor	Corrected MU Harvest	Corrected GMZ Harvest
1978	5-01	5	10	2.6	26	142
	5-02	9	77	1.5	115.5	
1979	5-01	5	39	2.6	101.4	314
	5-02	9	142	1.5	213	
1980	5-01	5	21	2.6	54.6	265
	5-02	7	105	2	210	
1981	5-01	5	30	2.6	78	252
	5-02	5	67	2.6	174.2	
1982	5-01	5	47	2.6	122.2	491
	5-02	5	142	2.6	369.2	
Average annual GMZ 5B corrected calf harvest:						293

III) First Nations Per Capita Needs from 2004-2008 Allocation

The following work was completed for the 2004-2008 allocation period, and is the basis for the current estimates of FNs harvest requirements.

Within the Cariboo Region, although First Nations sustenance needs for moose are large, they are poorly known. Only four harvest surveys have been completed by First Nation communities with additional harvest survey information available from the Ulkatcho First Nation Natural Resource Center for 2000-2002 (see Table 1).

Table 1. First Nation moose harvest data

First Nation Band	Year of Survey	Harvest Estimate	Corrected Estimate	Estimated Need
Esketemc (Alkali Lake)	1995	27	?	36
Canoe Creek	1996	25	?	Not Met
Lhoosk-uz (Kluskus)	1997	40		40
Ulkatcho	1996	151	167	280
Ulkatcho	2000	70	?	?
Ulkatcho	2001	151	?	?
Ulkatcho	2002	65	?	?
Ulkatcho	2003	?	172	?

The most reliable statistic currently available for First Nation communities is the number of registered members for each Band. As a result, for this analysis, moose sustenance needs have been correlated to Band size for most of this rationale. Estimates of Band size utilized in 1998 and new estimates from October 2003 have been incorporated into the analysis (see Table 2). In 1998 harvest estimates were generated from a combination of harvest surveys, Band size and Conservation Officer estimates of use by First Nations. The following background explains how harvest needs were determined for the 2004-2008 allocation period.

Table 2. Estimates of moose sustenance requirements by Band for the 1999 – 2003 and 2004 - 2008 moose allocations within the Cariboo Region

Band	1998 Band Population estimate	Estimated Moose Needs (1998)	Band members/ moose (1998)	2003 Band Registered Members	Registered Members/ moose (2003)	Estimated Moose Needs (2003)
Canoe Creek	545	25	21.8	610	17	36
Alkali Lake	603	36	16.8	719	17	42
Canim Lake	481	20	24.1	545	9	61
Soda Creek	282	30	9.4	337	9	37
Williams Lake	396	42	9.4	483	9	54
Kluskus	150	25	6.0	178	7	25
Nasko	261	44	5.9	297	7 (6.8)	44
Red Bluff	109	10	10.9	133	7	19
Toosey	201	20	10.1	261	7	37
Alexandria	135	14	9.6	148	7	21
Alexis Cr.	496	80	6.2	599	7	86
Anaham	1111	120	9.3	1373	7	196
Stone	304	50	6.1	358	7	51
Nemiah	350	25	14.0	373	7	53
Ulkatcho	683	180	3.8	862	4.8	180
Nuxalk	1140	20	N/A	1346	N/A	20
High Bar	?	?	N/A	64	N/A	2
Heiltsuk	1874	20	N/A	2067	N/A	0
Totals	9,121	779		10,753		964

The Ulkatcho First Nation sustenance requirements remain the same (180 moose) as set for the previous allocation period or equate to one moose for every 4.8 registered Band members.

- The traditional territory of this Band overlaps an area where moose are more plentiful than mule deer.
- A harvest survey has been completed for the Band which suggests that moose are used more for sustenance than deer:
 - Ulkatcho Band corrected harvest estimate – 117 deer/167 moose or 0.7/1
- A moose population survey completed in a portion of MU 5-12-B (traditional territory of the Ulkatcho Band) suggests that moose populations have increased from 580 moose in 1997 to 1,310 moose in 2002. The total moose harvest (or lack of) in the area is likely having an influence on the increase suggesting sustenance needs of the Ulkatcho Band may have been overestimated in 1998.
- Although the resident harvest target is being met the success rate of moose Limited Entry Hunt authorization holders is one of the lowest for the Region within MU 5-12-B suggesting low numbers of bull moose in accessible areas. The average for 1999-2002 was 27%.
- Feedback from the Ulkatcho Band suggests their minimum actual use for the four years there is information averages 109 moose (estimate not corrected for households missed) well below the identified 1998 sustenance need of 180. Although it must be remembered that this lower value is a minimum it is much closer to the Band member per moose ratio of the Kluskus and Nasko Bands:
 - Minimum Ulkatcho Band ratio – 683 members/109 moose or 6.3/1.
- Feedback from the Ulkatcho Band regarding a harvest survey being completed in November, 2003 suggests that the moose sustenance need is approximately equal to the value used in 1998. Using the same value results in the following identified need:
 - Ulkatcho Band – 180 moose/year

With the exception of the Ulkatcho First Nation the Carrier-Chilcotin & Tsilhqot'in Bands sustenance requirements equate to one moose for every seven registered Band members.

- The traditional territories of these Bands overlap areas where moose are relatively plentiful and in some cases so are mule deer.
- A harvest survey has been completed for one Band which suggest that moose are used more for sustenance than deer:
 - Kluskus Band harvest estimate – 7 deer/40 moose or 0.2/1
- A moose population survey completed in MU 5-13-A (traditional territory of the Anaham Band) suggests that moose populations have declined from 2,194 moose in 1998 to 1,524 moose in 2003. The total moose harvest for the area is likely influencing the decline and sustenance needs of the Anaham Band may have been underestimated in 1998.
- Feedback from two of the Bands suggest the 1998 requirements for the Kluskus Band (25 moose) and the Nasko Band (44 moose) may still be appropriate thus they have been used as a benchmark. This approximated a registered member/ moose ratio of 7/1:
 - Kluskus Band ratio – 178 members/25 moose or 7.1/1.
 - Nasko Band ratio – 297 members/44 moose or 6.8/1.
- Utilizing a registered member/moose ratio of 7/1 for the Nasko Band would only allow for an estimated harvest of 42 moose, two below the estimate from 1998. As a result the value utilized was adjusted up slightly to the old estimate of 44 to insure the estimate was not less than the value from 1998.

- No quantitative feedback was received from seven of the nine Bands in this grouping. As a result, the needs of all the Bands in this group were aligned with the Kluskus and Nasko Bands registered members to moose ratio (7 members/ moose). This results in the following identified needs:
 - Kluskus – 25 moose/year
 - Nasko – 44 moose/year
 - Red Bluff – 19 moose/year
 - Toosey – 37 moose/year
 - Alexandria – 21 moose/year
 - Alexis Creek – 86 moose/year
 - Anaham – 196 moose/year
 - Stone – 51 moose/year
 - Nemiah Valley – 53 moose/year

The Canim Lake, Soda Creek & Williams Lake Bands sustenance requirements equate to one moose for every nine registered Band members.

- The traditional territories of these three Bands overlap areas where mule deer and moose are both relatively plentiful.
- Harvest surveys have not been completed for any of these Bands.
- Although no quantitative feedback has been received from the individual Bands there was feedback suggesting the 1998 estimates were low. As a result the needs of the three Bands were aligned with those of the Band with the highest moose to registered members ratio. This resulted in the following identified needs:
 - Canim Lake – 61 moose/year
 - Soda Creek – 37 moose/year
 - Williams Lake – 54 moose /year

The Canoe Creek & Alkali Lake Bands sustenance requirements equate to one moose for every seventeen registered Band members.

- The traditional territories of these two Bands overlap areas where mule deer are much more plentiful than moose.
- Harvest surveys suggest a much higher use of deer for sustenance than moose.
 - Canoe Creek Band harvest estimate – 69 deer/25 moose or 2.8/1
 - Alkali Lake Band harvest estimate – 97 deer/27moose or 3.6/1
- Harvest surveys have been completed for both Bands although feedback from the Canoe Creek Band suggests that requirements may have been underestimated. The harvest surveys completed in the mid 1990's suggested that the Canoe Creek Band required one moose for every 22 members (545 members/25 moose = 22) and the Alkali Lake Band one moose for every 17 members (603 members/36 moose = 17). As a result the Canoe Creek Band sustenance requirements for moose have been increased to align with those of the Alkali Lake Band. This results in the following identified needs:
 - Canoe Creek Band – 36 moose/year
 - Alkali Lake Band – 42 moose/year

The Nuxalk and High Bar Bands sustenance requirements are based on feedback from the individual Bands during the consultation process.

- Feedback from these bands suggests a very small moose sustenance requirement in relation to the size of the Band. As a result it is impractical to correlate sustenance requirements with the number of registered Band members and needs were calculated based on discussions with individual Bands.
- Although feedback from the Nuxalk Band suggests a smaller need than was estimated in 1998 the requirement was not reduced as it was considered low based on feedback from the Ulkatcho First Nation who overlap their traditional territory. This results in the following identified needs:
 - Nuxalk Band – 20 moose/year
 - High Bar Band – 2 moose /year

All other Bands are assumed to have a sustenance requirement of zero moose for the 2004-2008 allocation period.

- All other Bands have traditional territories that are peripheral to the interior portion of the region where recreational hunting takes place.
- The sustenance needs of the Heiltsuk Band have been reduced from 20 in 1998 to zero in 2003 as their traditional territory is peripheral to areas with recreational hunting for moose. However, it is acknowledged that this Band may be harvesting moose within coastal Management Units of the region (i.e. MU's 5-08 and 5-09) for sustenance purposes.

Summary

The rationale utilized in this analysis increases the estimated moose harvest needs for 12 Bands, estimates for four Bands remain the same, the estimate for one Band is reduced and one Bands requirement has been added into the analysis. Total sustenance estimates for moose were increased from 779 in 1998 to 964 in 2003 or by 185 animals or a total of 24% (see Table 3). The rationale for the Band that received a lower estimate of sustenance need was because of the fact that their traditional territory is peripheral to the area where recreational moose hunting occurs in the Region. Overall, there is an increase in the estimated sustenance requirements for each Game Management Zone or Management Unit where recreational hunting occurs.

Table 3. Summary of moose sustenance estimates by Management Unit

Management Unit	1998 Estimate	2003 Estimate
GMZ 5a	20	27
GMZ 5b	158	168
GMZ 5c	452	564
GMZ 5d	145	182
MU 5-11	4	5
MU 3-31	N/A	18
Total	779	964

With limited accurate harvest survey information available this analysis brings more consistency to the approach used to calculate sustenance need by Band. Hopefully as more harvest surveys are completed a more reliable method can be employed. As the sustenance estimates are based on limited feedback from First Nation Bands and the method of estimating needs for most Bands is rudimentary there is some risk that sustenance needs for some Bands are underestimated. On the other hand, there is also a chance that the needs of some Bands are overestimated, particularly for the Bands that have traditional territories that allow for harvesting of sizable numbers of both moose and deer. It is assumed that these risks somewhat balance out and that the overall increases by Game Management Zone recognize the increase in First Nation populations in the Region and account for any possible increased sustenance need.

Moose population modelling for the new allocation period suggests that the overall moose population is stable to increasing in each Game Management Zones 5a, 5b, 5c and 5d. This suggests that current estimates of First Nation sustenance harvest and harvest levels for resident and non-resident hunters are allowing for maintenance of the Regions moose population. However, current First Nations harvest levels may not be equivalent to their actual need.

Although almost any new First Nation harvest information would improve determining moose sustenance needs, of priority is obtaining a better estimate for Bands that use a sizable number of both moose and deer for sustenance. This would include the Canim Lake, Soda Creek and Williams Lake Bands. Also the Toosey, Alexandria, Anaham and Stone Bands may be more suited to this grouping as their traditional territories have an abundance of both moose and mule deer.