2014/15 Winter Moose Survey: MU 7-42

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Executive Summary

A Stratified Random Block (SRB) aerial survey was conducted in Management Unit (MU) 7-42, southwest of Fort Nelson, January 9 through January 20, 2015 and covered the entire MU area (5,905 km^2). Snow conditions were favorable and temperatures during the survey ranged from -12ºC to +3ºC. The objectives of the survey were to estimate the moose density, the bull/cow ratio, and the calf/cow ratio.

Survey methodology followed modified protocols outlined in Gasaway et al. (1986). The MU was divided into 252 Sample Units (SU) (5 x 5 km). SUs were stratified into high, moderate, low, very low, and nil based on observed moose and tracks during pre-survey stratification flights. Nil SUs were excluded from the survey area. During the SRB survey moose were classified as cows, calves, and bulls. When antlers were present, bulls were further classified based on antler morphology. Moosepop (Reed 1989) was used to calculate an uncorrected population estimate and optimize the allocation of sampling effort during the survey. The Program Aerial Survey (Leban and Garton 2000) was used to calculate a Sightability Correction Factor (SCF) from vegetative cover estimates observed during the survey. The SCF was applied to the Moosepop population estimate to determine the corrected population estimate.

Twelve of 12 (100%) high blocks, 18 of 52 (35%) moderate blocks, 31 of 122 (25%) low blocks, and 10 of 59 (17%) very low blocks were surveyed. The uncorrected moosepop estimate was 1175 ± 152 (90% Confidence Interval [CI]), the estimated bull/cow ratio was 44 ± 9.9 bulls per 100 cows and the estimated calf/cow ratio was 12 ± 2.7 calves per 100 cows. The uncorrected moose density estimate was 0.20 ± 0.026 moose per km^2. When corrected for sightability (SCF = 1.20) the estimated moose density was 0.24 ± 0.033 moose per km^2.

A portion of Management Unit 7-42 has previously been surveyed in 2001, 1993, and 1989. All previous surveys covered the MU 7-42 area south of the Prophet River. In 2001 the uncorrected moose density was 0.75 ± 0.12 moose per km^2, the bull/cow ratio was 25 ± 7.4 bulls per 100 cows and the calf/cow ratio was 18 ± 3.5 calves per 100 cows. For direct comparison to previous surveys, 2015 moose population metrics were calculated for the MU 7-42 area south of the Prophet River. The uncorrected moose population density decreased 70% from 2001 to 2015, this change was statistically significant.

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1.0 Introduction

1.1 Background

A Stratified Random Block (SRB) survey adapted from Gasaway et al. (1986) was conducted for moose in MU 7-42 of the Peace Region to monitor moose population trend and estimate demographic parameters (Figure 1). The MU has previously been surveyed in 2001, 1993, and 1989. MU 7-42 is part of the Northeast Rockies Game Management Zone (GMZ). The Northeast Rockies GMZ supports diverse ungulate populations including moose, elk, thinhorn sheep, mule deer, white-tailed deer, mountain goat, woodland caribou, and plains bison.

1.2 Study Area

The study area encompassed all of MU 7-42 within the Peace Region of British Columbia. MU 7-42 is located approximately 150 km southwest of Fort Nelson (Figure 1). MU 7-42 has large areas within the Spruce-Willow-Birch and Boreal White and Black Spruce Biogeoclimatic Zones, with western high elevation areas within the Boreal Altai Fescue Alpine Zone (Meidinger and Pojar 1991). MU 7-42 supports both resident and non-resident licenced hunters, and provides an important source of sustenance to local First Nations.

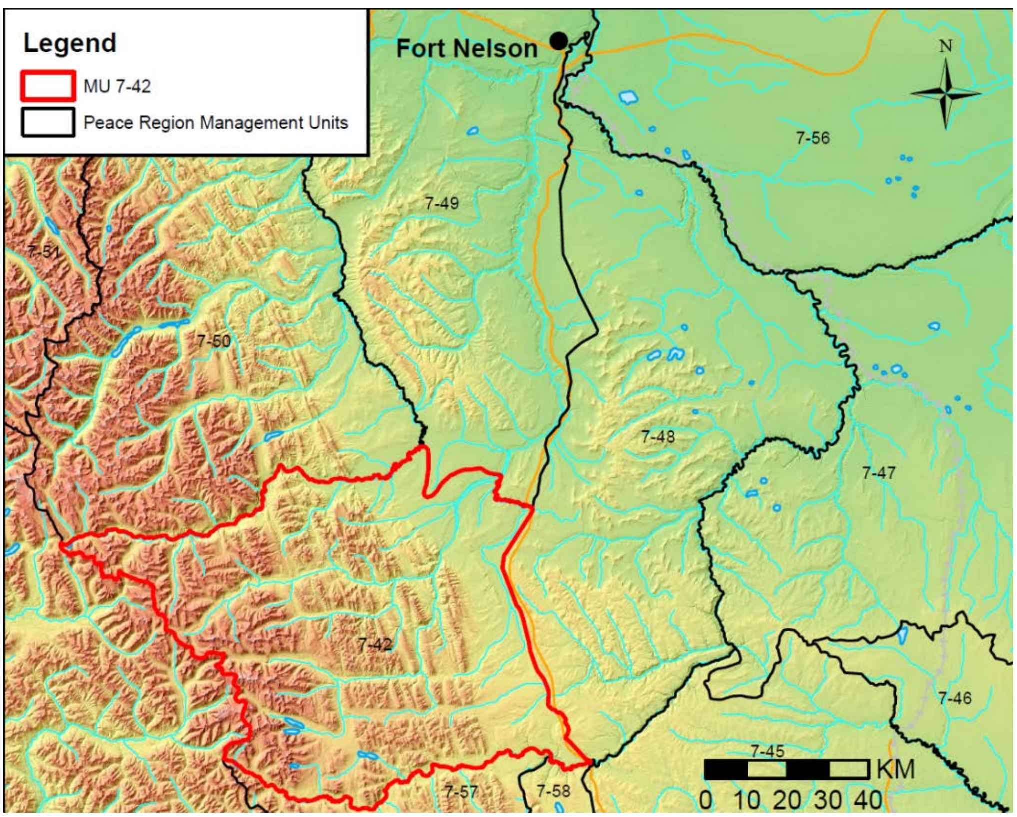

Figure 1. Location of Management Unit 7-42 in the Peace Region of BC.

1.3 Objectives

The objectives of the survey were to obtain:

1) a population density estimate for moose in MU 7-42 with a 90% CI of ±25% or lower (RISC 2002);
2) estimates of demographic parameters for the MU 7-42 moose population (bulls/100 cows, calves/100 cows).

2.0 Methods

2.1 Block delineation and stratification

The total MU 7-42 area (6,066 km^2) was divided into 5 km by 5 km sample units ($25km^2$) following regional standards for SRB surveys (Thiessen and Baccante 2012). Edge sample units (SU) which overlapped the MU boundary were clipped by the MU boundary. Small, adjoining edge SU were amalgamated were appropriate in an attempt to minimize the variation in SU size. The finalized survey grid resulted in 252 SUs (Figure 2).

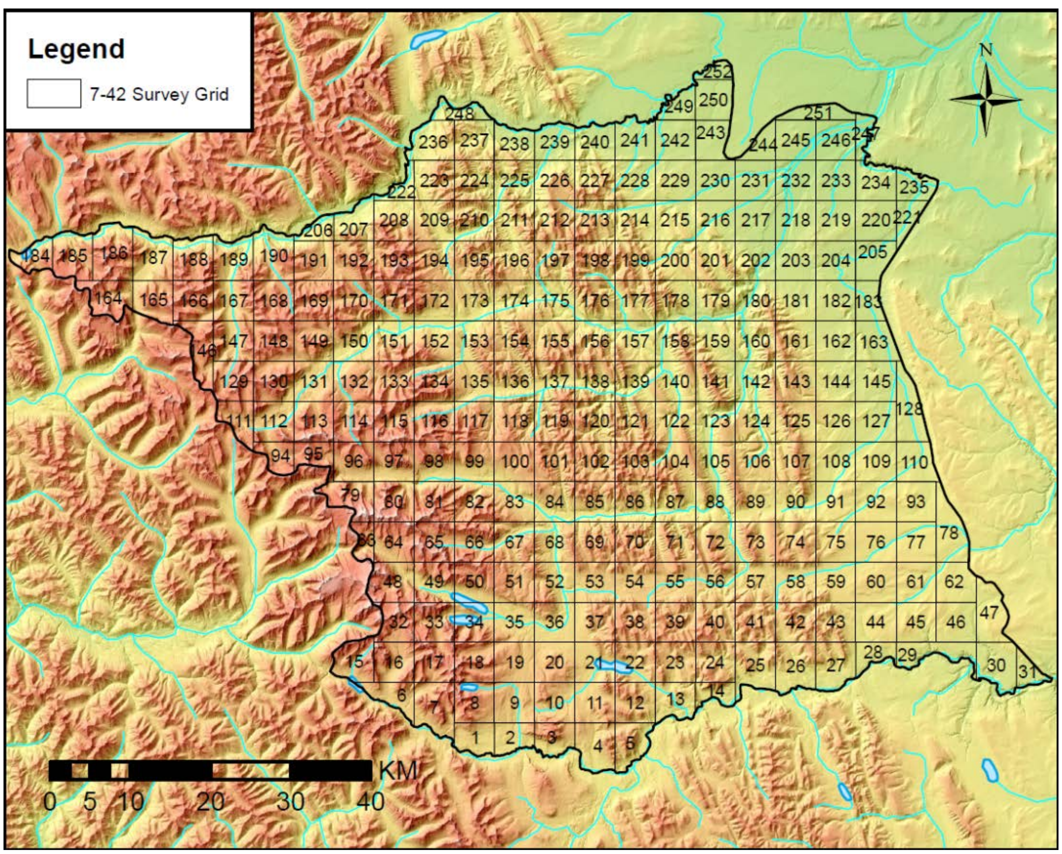

Figure 2. Sample Units (blocks) located within Management Unit 7-42 in the Peace Region of BC.

The SUs were classified into strata based on moose and track observations made during pre-survey stratification flights. Stratification flights were flown using a Bell 206 Jet Ranger helicopter at approximately 200-400m elevation using north/south orientation. The entire row of north/south adjoining SUs were flown using a continuous transect from the southern or northern edge in a continuous manner to the opposite edge of the survey area. Stratification transects were flown at 2.5 km intervals starting 1.25 km from the west or east SU edge. Thereby, two passes were completed for each 5x5 SU with a search distance of 1.25km out either side of the aircraft. Two observers in the rear of the aircraft monitored the number of moose and moose tracks seen during each pass through a SU and assigned a value to the SU pass based on the rating system in outlined in Table 1.

Table 1. Stratification rating system for the 2015 MU 7-42 moose survey.

Stratum Rating	Value	Tracks	Moose Seen (-15°C)	Moose Seen (+1°C)
Nil	0	Zero, with 0% chance of containing moose	0	0
Very Low	1	Zero or few old, with a low chance of containing moose	0	0
Low	2	Old to 3 fresh	1 - 2	0 - 1
Moderate	3	4 – 8	3 - 8	2 - 4
High	4	8 – 15+	8 - 14	4 - 8
Ultra High	5	Abundant (25+)	15 - 20+	9 - 13+

The stratification flights resulted in four stratification values being assigned for each SU (one per side per pass). Stratification values were averaged to assign each SU to a stratum. For SUs containing large areas of alpine and rock, only areas evaluated to possibly contain moose were observed. For SUs in which two passes were not completed, stratum rankings were determined utilizing expert judgement. Seven SU were classified as nil, 59 as very low, 122 as low, 52 as moderate, and 12 as high. No SUs were classified as ultra-high (Figure 3). SUs classified as Nil were excluded from the survey area.

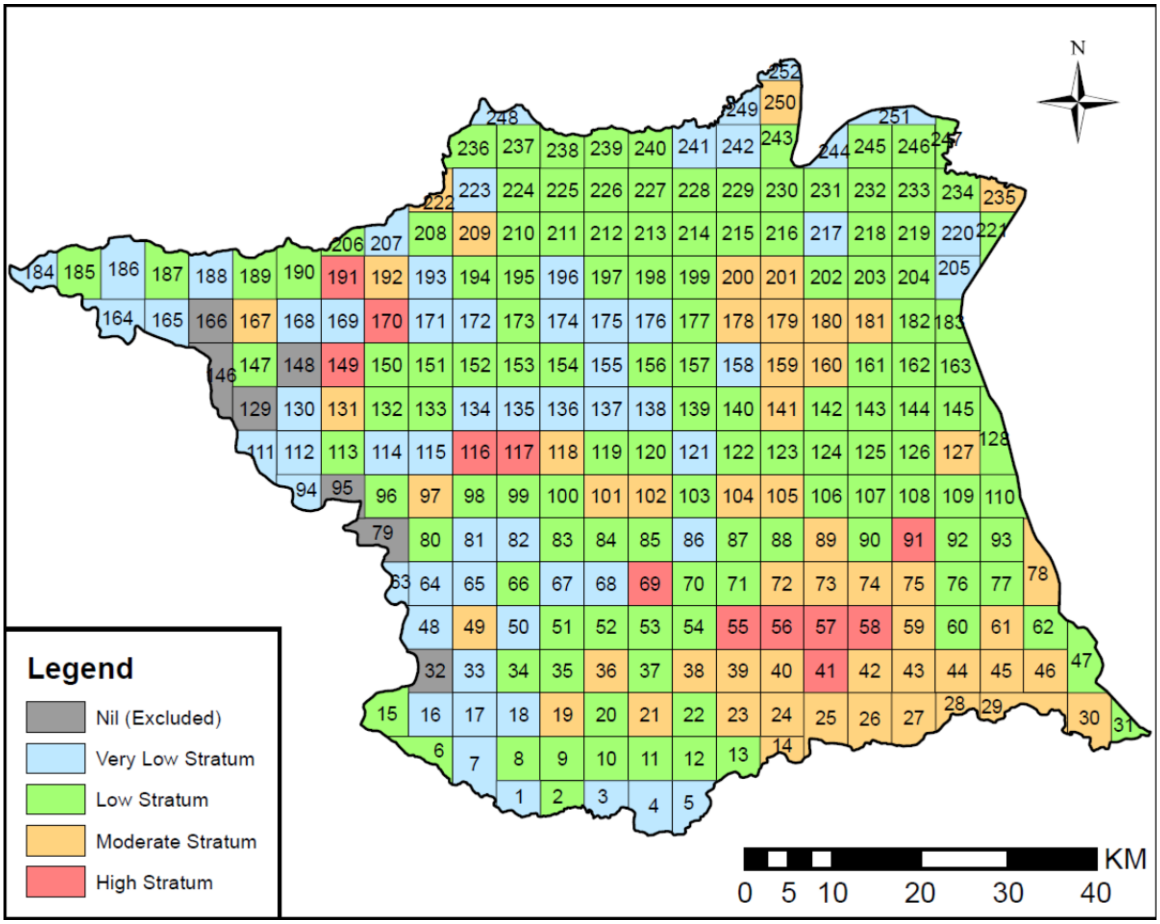

Figure 3. Stratification of Management Unit 7-42 Sample Units into nil, very low, low, moderate, and high expected moose density.

2.2 Survey Methods

The survey utilized a stratified random block (SRB) survey design adapted from Gasaway et al. (1986) and Oswald (1982).

SUs to be flown were selected randomly from each stratum using the Microsoft Excel® random number generator. After the third day of surveying when approximately 5 SUs from each stratum had been surveyed, further survey effort was allocated to each stratum utilizing the allocate function of the program MOOSEPOP (Reid 1989). The program allocates additional survey effort to minimize overall variance based on results collected to that time.

Survey flights were conducted at low altitude (40m – 100m) and low airspeed (80 to 120 km per hour) using Bell 206 Jet Ranger helicopters. Two survey crews in separate helicopters operated concurrently to minimize the time interval between stratification and survey completion. Nine parallel transects were flown over each surveyed SU at 500m intervals starting 250m from the SU edge. Search distance for the 3 observers was 250m out from both sides of the helicopter.

Moose were classified into calves (moose <1 year old), adult cows (females >1 year old), and adult bulls (males >1 year old). When antlers were present, bulls were further classified based on antler morphology following Oswald (1997) [Figure 4]. Other species seen during the survey (mule deer, white-tailed deer, and elk) were documented but not classified by sex or age.

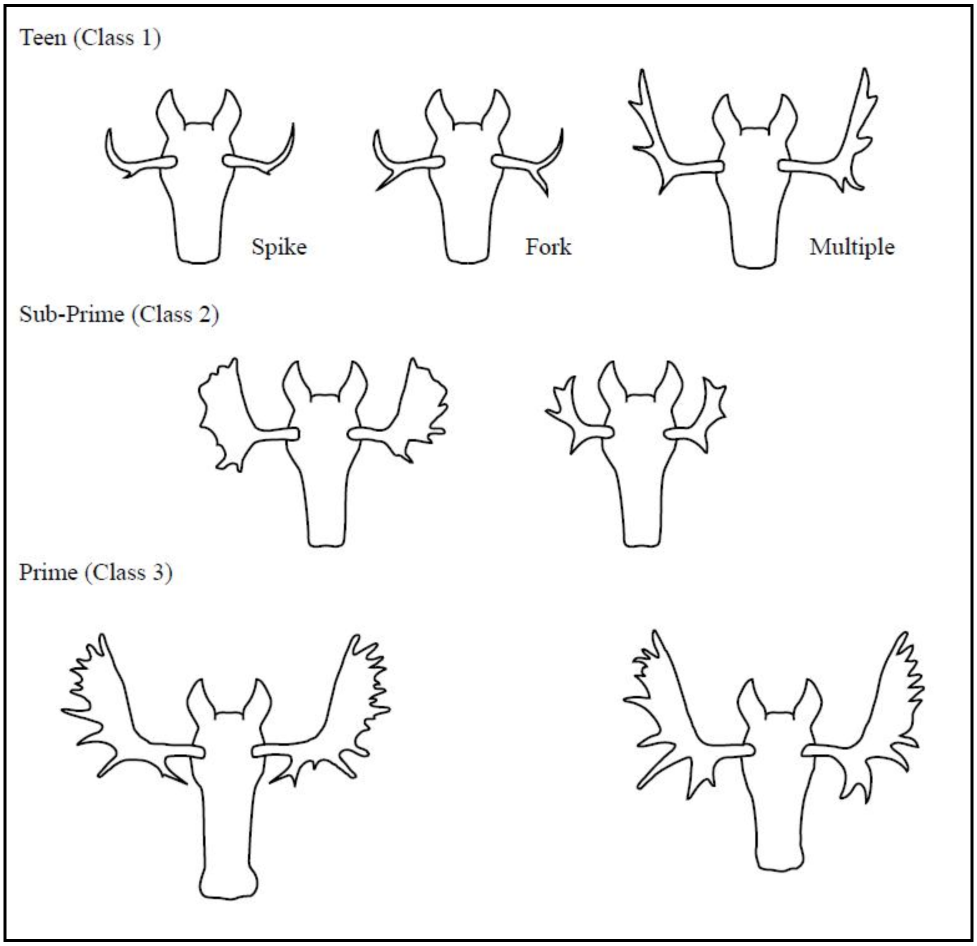

Figure 4. Classification of antlered moose during the 2015 Management Unit 7-42 moose survey (from Oswald 1997).

When moose were located, the helicopter was positioned to allow accurate determinations of the number and classification of the moose. Cows were distinguished from bulls using cow-calf aggregate behavior, presence of vulva patch, lightness of color, and absence of antler scars (Oswald 1982). Percentage of vegetative cover was determined by estimating the proportion of ground area obscured by vegetation within a 10m radius of the first moose sighted from a moose group (Anderson 1994). See Appendix 1 for example vegetative cover diagrams used during the survey. After gathering required information the helicopter continued along transect.

Navigation was accomplished using real-time flight following on a GPS equipped Apple IPad utilizing GIS Pro software. Satellite imagery, hill-shade mapping, and SU boundaries were preloaded into GIS Pro to facilitate accurate navigation.

2.3 Data analysis

The program MOOSEPOP (Reid 1989) was used to calculate an uncorrected (for sightability) estimate of survey area moose density, total moose, and estimates of bull/cow and calf/cow ratios. Confidence Intervals (CI) for each estimate were calculated using MOOSEPOP. All reported CIs are at 90% confidence unless otherwise stated.

A Student's t-test was used to test for a significant change between the 2001 7-42 moose survey density estimate and the 2015 survey density estimate (2001 survey area) following procedures outlined in Gasaway et al. (1986). The uncorrected estimates were used for comparison as the 2001 moose population estimate was not corrected for sightability.

The 2015 total moose estimate and density estimate were corrected for sightability using a Sightability Correction Factor (SCF) calculated using the program Aerial Survey. The program utilizes percent vegetative cover estimates recorded during the survey to correct for moose missed during the survey. The sightability model is derived from moose sightability trails conducted in the Thompson and Omineca Regions (Quayle et al. 2001 & Herd unpublished). A variance for the corrected moose estimate was calculated using the following equation:

$$VarYF = ([SCF]^2 * VarY) + VM + VS$$

where VarYF is the variance of the corrected estimate, SCF is the Sightability Correction Factor, VarY is the variance of the uncorrected estimate, VM is the variance of the model, and VS is the variance of the sightability. VarY is calculated by the program MOOSEPOP while SCF, VM, and VS are calculated by the program Aerial Survey.

3.0 Results

3.1 Search effort and conditions

Stratification flights were carried out January 9 through January 12, 2015. The SRB survey was completed January 13 through January 20, 2015 and involved helicopter flights on all 8 days. Twelve of 12 (100%) high blocks were surveyed, 18 of 52 (35%) moderate blocks were surveyed, 31 of 122 (25%) low blocks were surveyed, and 10 of 59 (17%) very low blocks were surveyed for an overall effort of 29% (Figure 5).

Temperature during the survey ranged from -12 to +3ºC. Skies were clear to overcast during the survey and survey conditions were generally "good" as defined by the RISC standards for moose surveys (RISC 2002). Snow depth estimated from the helicopter ranged from 10 to 60cm and was not considered to be abnormally impacting moose mobility (Kelsall and Prescott 1971).

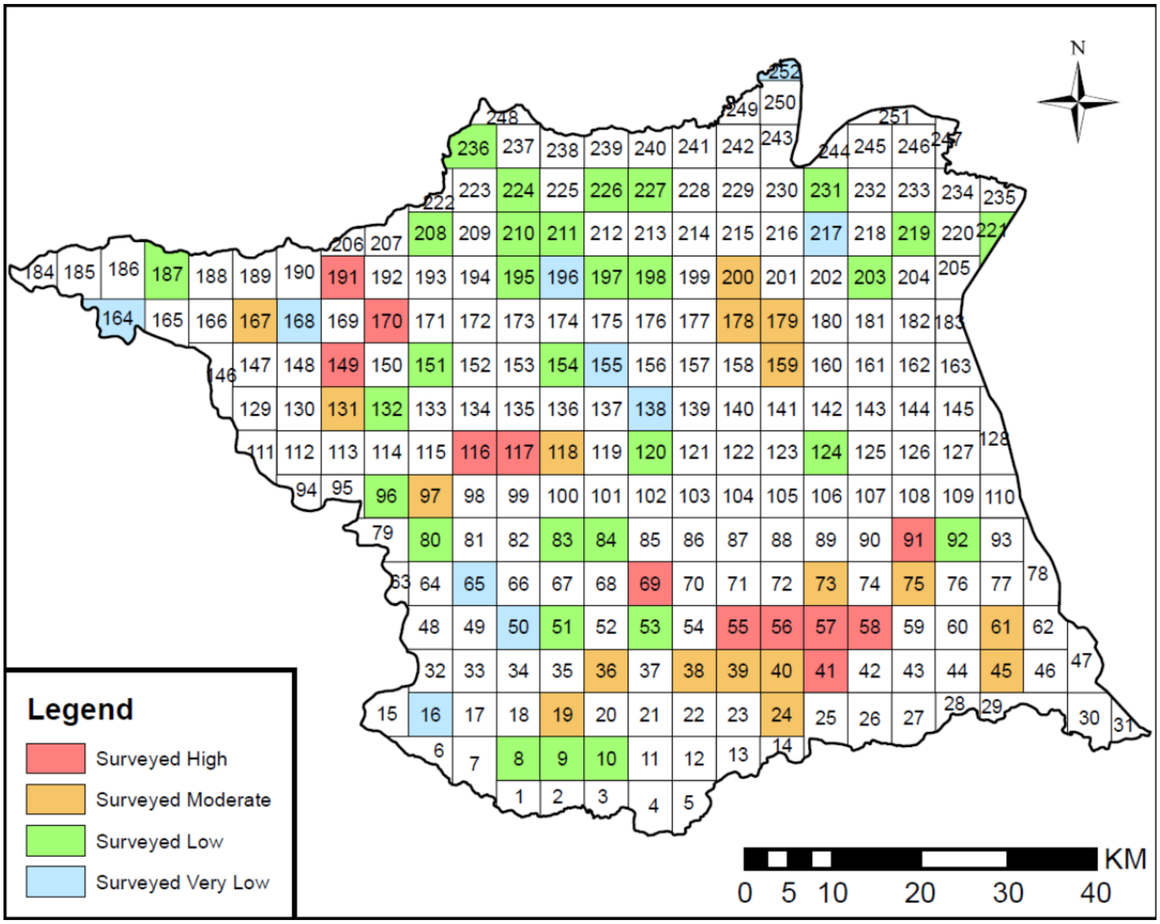

Figure 5. Sample Units surveyed during the January 2015 moose survey in Management Unit 7-42.

3.2 Population size, density and composition

A total of 484 moose were observed during the survey composed of 125 bulls, 319 cows, 39 calves, and 1 unclassified moose. Average group size was 1.52 with a maximum group size of 7 moose. The observed bull/cow ratio was 39 bulls per 100 cows and the observed calf/cow ratio was 12 calves per 100 cows (Table 2).

Table 2. Observed bulls, cows, and calves by stratum during the January 2015 moose survey in Management Unit 7-42.

	Survey Stratum			
	High	***Moderate***	***Low***	***Very Low***
Number of Bulls	34	54	36	1
Number of Cows	130	115	68	6
Number of Calves	19	10	8	2
Number of Moose	183	180	112	9

The uncorrected (for sightability) total moose estimate for MU 7-42 was 1175 ± 152 which equates to an estimated density of 0.20 ± 0.026 moose/km^2. The estimated bull/cow ratio was 44 ± 9.9 bulls per 100 cows and the estimated calf/cow ratio was 12 ± 2.7 calves per 100 cows. The calculated SCF was 1.20 which resulted in a corrected total moose estimate of 1413 ± 194 and a corrected density estimate of 0.24 ± 0.033 moose/km^2.

3.4 Incidental Species

Moose were the focal species of this survey. Other species observed were counted and recorded but not classified. Deviations from transects would not be made for incidental species.

During the course of the survey 7 mule deer, 483 elk, 94 caribou, 31 bison, 25 mountain goat, and 113 stone's sheep were sighted. Fourteen wolves in three separate groups were sighted during the survey.

4.0 Discussion

Management Unit 7-42 has previously been surveyed for moose in 1989, 1993 and 2001 (Figure 6). Comparisons between the 2015 results and the previous survey results were made utilizing the 1989, 1993, and 2001 survey area (MU 7-42 area south of the Prophet River). The previous SRB surveys did not attempt to correct for moose missed during the survey, therefore, comparisons between the 2015 results and previous survey results are made using uncorrected estimates. From 2001 to 2015 the uncorrected moose density estimate has decreased approximately 70%. This decrease was statistically significant determined using a two-tailed student's t-test ($t[20]=7.55$, $p<0.001$).

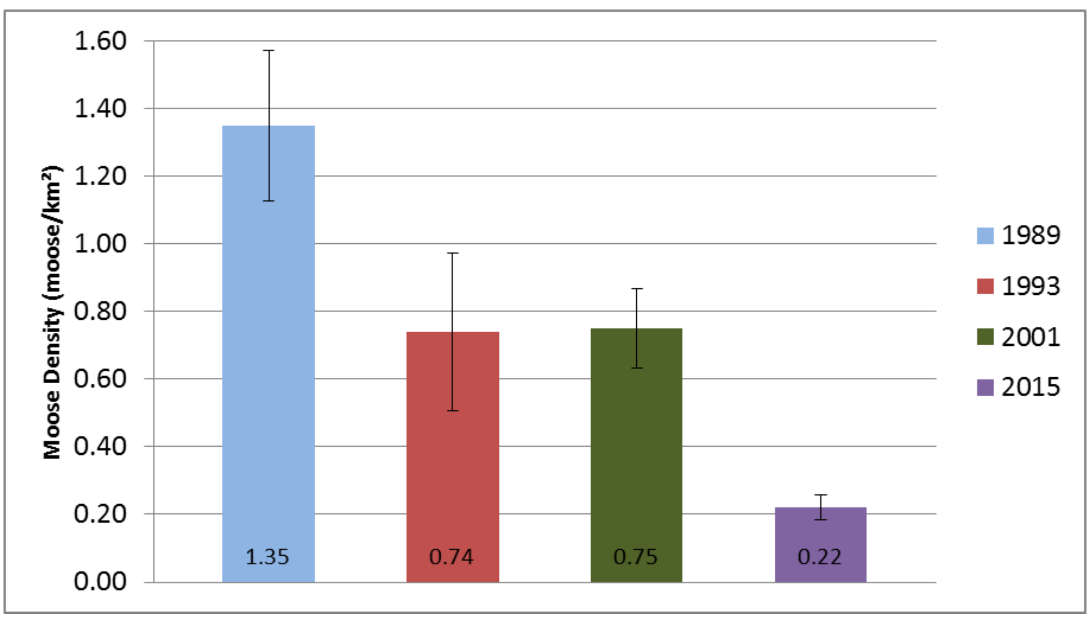

Figure 6. 1989, 1993, 2001 and 2015 uncorrected moose density estimates from surveys conducted in Management Unit 7-42 (area south of Prophet River). Error bars represent 90% confidence intervals.

In 2015, a SCF was applied to the MU 7-42 uncorrected moose estimates to correct for moose missed during the survey. It has previously been shown that a considerable proportion of moose within a survey area are not sighted during a survey and, as a result, surveys which do not correct for unsighted moose substantially underestimate the actual number of moose in the survey area (Anderson and Lindzey 1996 & Quayle et al. 2001). The 2015 MU 7-42 corrected moose density estimate was 0.24 moose per km^2. This is well below the average moose density found during recent surveys in the Peace Region.

The 2015 MU 7-42 (south) estimated bull/cow ratio (39.8/100) has increased from the 2001 estimate and is well above the Provincial recommended minimum of 30 bulls/100 cows (Figure 7). The current bull/cow ratio is considered well above levels which could negatively impact pregnancy rates or conception timings (Thomson 1991, Schwartz et al. 1992).

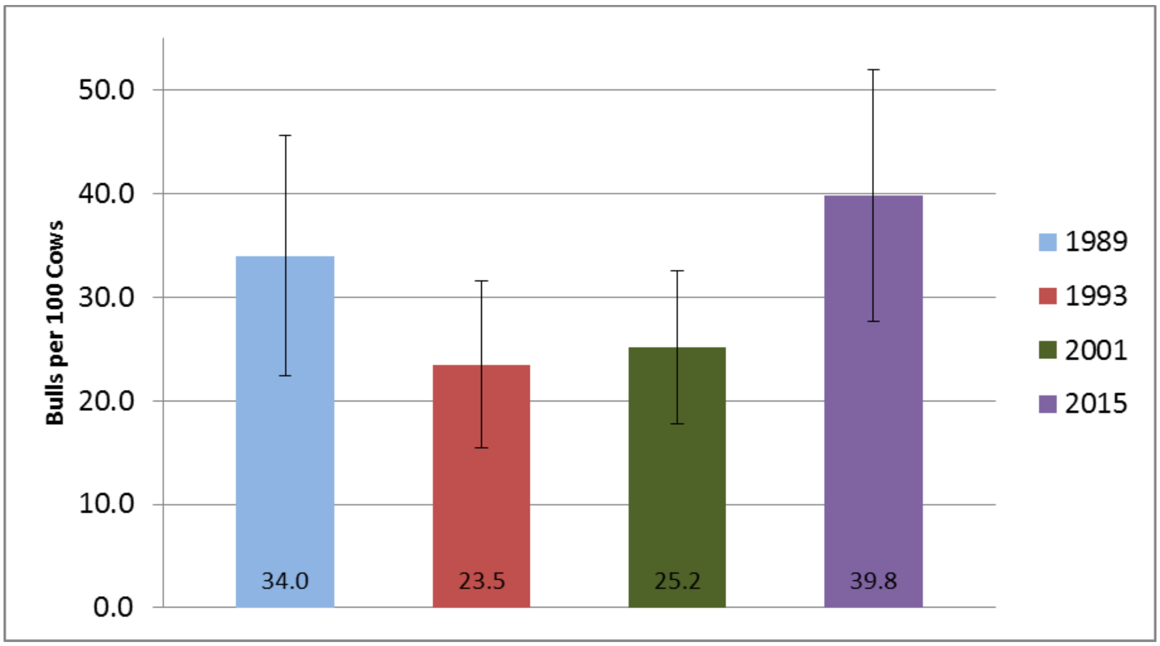

Figure 7. 1989, 1993, 2001 and 2015 estimated bull/cow ratios from stratified random block surveys conducted in Management Unit 7-42 (south of Prophet River). Error bars represent 90% confidence intervals.

The calf/cow ratio in MU 7-42 has decreased steadily from 1989 to 2015 (Figure 8). Calf survival, and consequently the winter calf to cow ratio, is greatly influenced by predation. Several studies have estimated that predation accounts for up to 80% of calf mortality in the first year of life (Franzmann and Schwartz 2007). The 2015 7-42 (south) calf/cow ratio of 10.9/100 is not considered sufficient recruitment to support a stable moose population and suggests high levels of predation are occurring in MU 7-42.

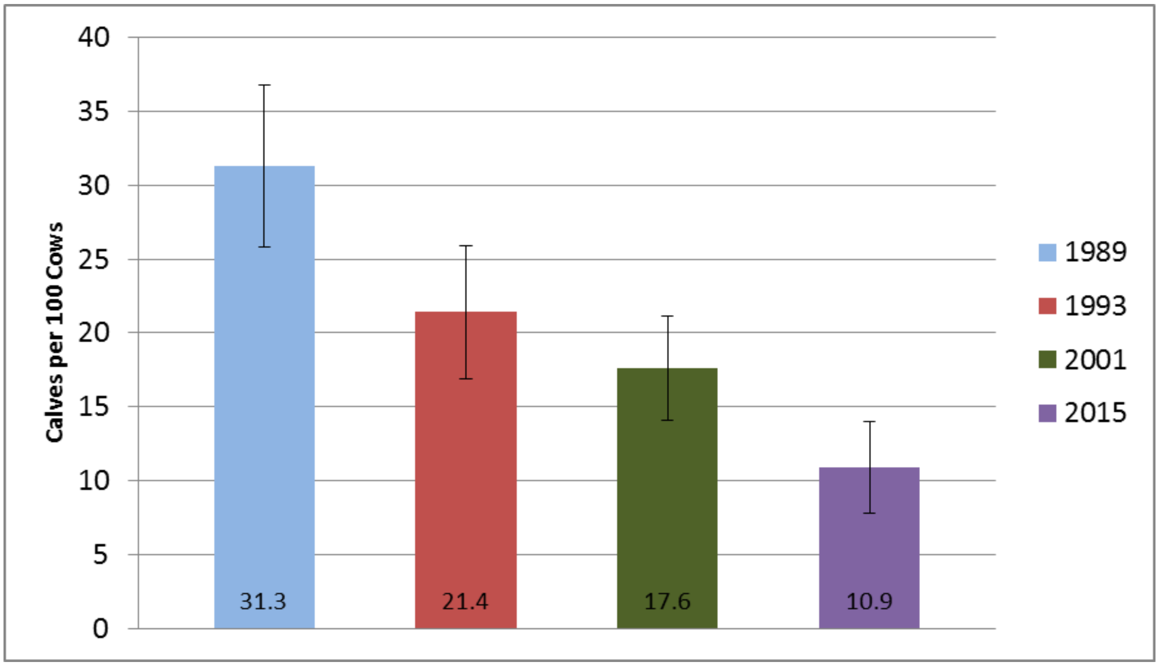

Figure 8. 1989, 1993, 2001 and 2015 estimated calf/cow ratios from stratified random block surveys conducted in Management Unit 7-42 (south of Prophet River). Error bars represent 90% confidence intervals.

There is a trend of decreasing moose population density in MU 7-42 from 1989 to 2015. The 2015 MU 7-42 estimated moose density south of the Prophet River is only 16% of the density estimated in 1989. MU 7-42 has a history of active predator management including poisoning in the 1960s, and '70s and aerial removal and sterilization programs in the 1980s and 1990s. The active predator management in MU 7-42 likely led to increased moose densities through the 1980s and 1990s. Gasaway et al. (1992) compared the moose densities from 36 surveys conducted throughout Alaska and the Yukon. They found an average moose density of 0.15 moose per km^2 in areas where predation was thought to be a major limiting factor while they found an average moose density of 0.66 moose per km^2 in areas where predation was not thought to be a major limiting factor. Licenced harvest in MU 7-42 is limited to bulls only. Licenced harvest from 2008 to 2012 has averaged 98 bulls per year or 7% of the 2015 correct moose population estimate. This is generally considered a conservative harvest rate as supported by the high 2015 estimated bull to cow ratio. Access to the Management Unit 7-42 is limited through access restrictions associated with the Muskwa Kechika Management Area. Considering the conservative licenced harvest and limited access, it is suggested that increased natural predation has led to the substantial decrease in the MU 7-42 moose population from 1989 to 2015. This conclusion is supported by the extremely low estimated calf to cow ratio which is an indicator of heavy natural predation (Franzmann and Schwartz 2007).

Parasitism by ticks was not noticed during the survey, although, symptoms of tick infestation may not have been noticeable in January. Symptoms of tick infestation typically begin in late February and are most severe in March-April prior to the adult ticks dropping off of the host moose (Franzmann and Schwartz 2007). Infection by parasites, specifically winter ticks (*Dermacentor albipictus*), can directly and indirectly lead to moose death. Tick infections can contribute to moose mortality as a result of increased exposure to the weather, increased energy expenditure, reduced vigilance for predators, and increased susceptibility to other pathogens (Franzmann and Schwartz 2007).

The aerial stratification method utilized for this survey appeared to accurately identify relative SU moose densities. The analysis show excellent separation between the average moose density for each stratum. The very low stratum had an average density of 0.04 moose per km^2, the low stratum had an average moose density of 0.15 moose per km^2, the moderate stratum had an average density of 0.40 moose per km^2, and the high stratum had an average density of 0.61 moose per km^2. The 2015 MU 7-42 survey variance was relatively low when compared to other surveys conducted in the Peace which utilized GIS stratification methods (Thiessen and Baccante 2012 & Lirette 2013a).

It is recommended that an aerial stratification method be used in favor of a GIS stratification method for future surveys conducted in MUs where high variation in SU moose densities are expected. It is also recommended that 3 or more stratum be used during stratification.

A helicopter was chosen over a fixed wing for stratification due to previous experience during the 2013 MU 7-31 moose survey in which a fixed wing aircraft was utilized for stratification (Lirette 2013b). Maintaining optimal height for stratification was more difficult in a fixed wing aircraft when compared to a helicopter, particularly in mountainous terrain where frequent altitude changes are required. As well, it is the author’s opinion that low level aerial stratification can be completed with a higher level of safety using a helicopter, particularly in terrain where sudden course reversals in narrow valleys may be required.

Using real-time tracking in geospatial software with the survey grid uploaded into the software allowed the surveyors to navigate effectively, verify complete coverage of SU, and allowed accurate determination of whether moose near SU boundary were in or out of the SU. It is recommended that all future surveys in the Region utilize similar portable GIS navigation software.

6.0 Acknowledgements

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8.0 Appendix

Appendix 1. Example percent vegetative cover examples used during the 2013 7-44 moose survey. Examples taken from Unsworth et al. 1994.