2013/14 Winter Moose Survey: MU 7-35

by:

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TABLE OF CONTENTS

Executive Summary

A Stratified Random Block (SRB) aerial survey was conducted in Management Unit (MU) 7-35, west of Fort St. John. The survey was conducted December 2 through December 8, 2013 and covered the entire MU area (2,376 km^2). Snow conditions were favorable and temperatures during the survey ranged from -24°C to -5°C. The objectives of the survey were to estimate moose density, bull/cow ratios, and calf/cow ratios.

Survey methodology followed modified protocols outlined in Gasaway et al. (1986). The MU was divided into 99 Sample Units (SU) (5 x 5 km). SUs were stratified into high, moderate and low stratum based on observed moose and tracks during pre-survey stratification flights. 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.

Seven of 15 (47%) high blocks, 19 of 66 (29%) moderate blocks, and 5 of 18 (28%) low blocks were surveyed. The uncorrected moosepop estimate was 1984 ± 313 (90% Confidence Interval [CI]), the estimated bull/cow ratio was 38 ± 6.1 bulls per 100 cows and the estimated calf/cow ratio was 30 ± 3.4 calves per 100 cows. The uncorrected moose density estimate was 0.84 ± 0.13 moose per km^2. When corrected for sightability (SCF = 1.26) the estimated moose density was 1.05 ± 0.17 moose per km^2.

Management Unit 7-35 was last surveyed utilizing SRB methodology in 1996. The 1996 survey found an uncorrected moose density of 0.51 ± 0.09 moose per km^2, a bull/cow ratio of 39 ± 13.6 bulls per 100 cows and a calf/cow ratio of 25 ± 6.1 calves per 100 cows. The uncorrected moose population estimate increased 64% from 1996 to 2013, this change was statistically significant.

List of Figures

1.0 Introduction

1.1 Background

A Stratified Random Block (SRB) survey adapted from Gasaway et al. (1986) was conducted for moose in MU 7-35 of the Peace Region to monitor moose population trend and estimate demographic parameters (Figure 1). The MU has previously been surveyed in 1996 utilizing SRB methodology and 2011 utilizing distance sampling methodology. MU 7-35 is part of the North Peace Game Management Zone (GMZ). The North Peace GMZ supports the largest hunting effort and total moose harvest when compared to other GMZs in the Region.

1.2 Study Area

The study area encompassed all of MU 7-35 within the Peace Region of British Columbia. MU 7-35 is located approximately 70 km west of Fort St. John (Figure 1). The majority of MU 7-35 is within the Boreal White and Black Spruce Biogeoclimatic Zone with western high elevation areas within the Englemann Spruce – Subalpine Fir Zone (Meidinger and Pojar 1991). MU 7-35 supports both resident and non-resident licenced hunters, and provides an important source of sustenance to local First Nations.

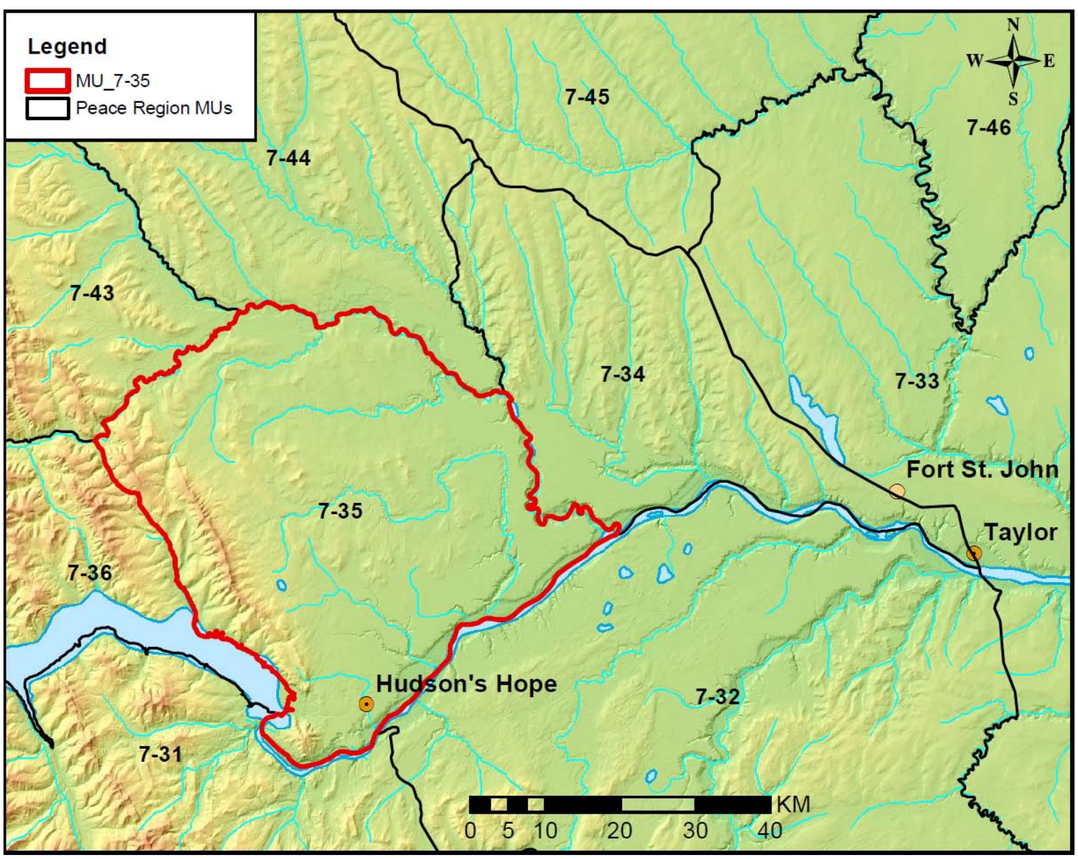

Figure 1. Location of Management Unit 7-35 in the Peace Region of BC.

1.3 Objectives

The objectives of the survey were to obtain:

1) a population density estimate for moose in MU 7-35 with a 90% CI of ±25% or lower (RISC 2002);
2) estimates of demographic parameters for the MU 7-35 moose population (bulls/100 cows, calves/100 cows).

2.0 Methods

2.1 Block delineation and stratification

The total survey area (2376km^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 99 SUs (Figure 2).

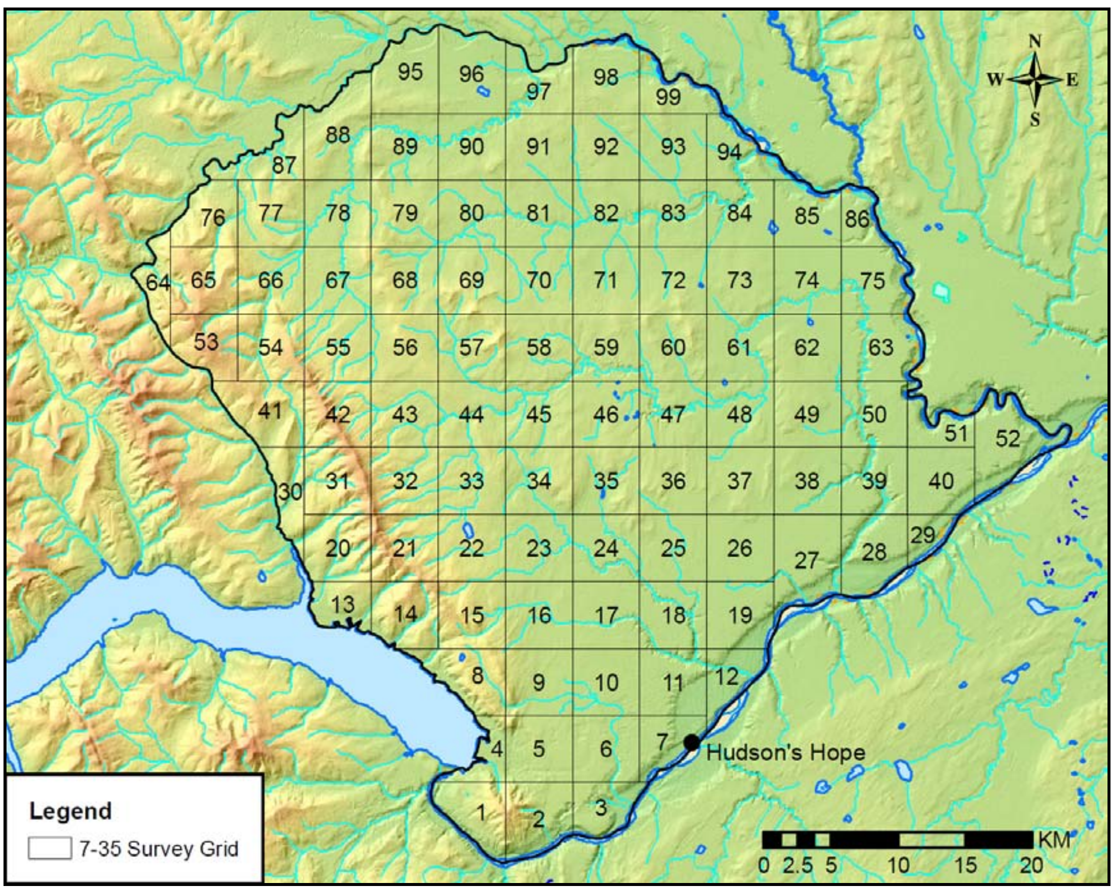

Figure 2. Survey Units located within Management Unit 7-35 in the Peace Region of BC.

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 Jetranger helicopter at approximately 200-400m elevation using east/west orientation. The entire row of east/west adjoining SUs were flown using a continuous transect from the eastern or western 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 north or south 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 2013 MU 7-35 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
Low	1	Old to 3 fresh	1 - 2	0 - 1
Moderate	2	4 – 8	3 - 8	2 - 4
High	3	8 – 15+	8 - 14	4 - 8
Ultra High	4	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. Eighteen SU were classified as Low, 66 moderate, and 15 high. No SUs were classified as ultra-high (Figure 3).

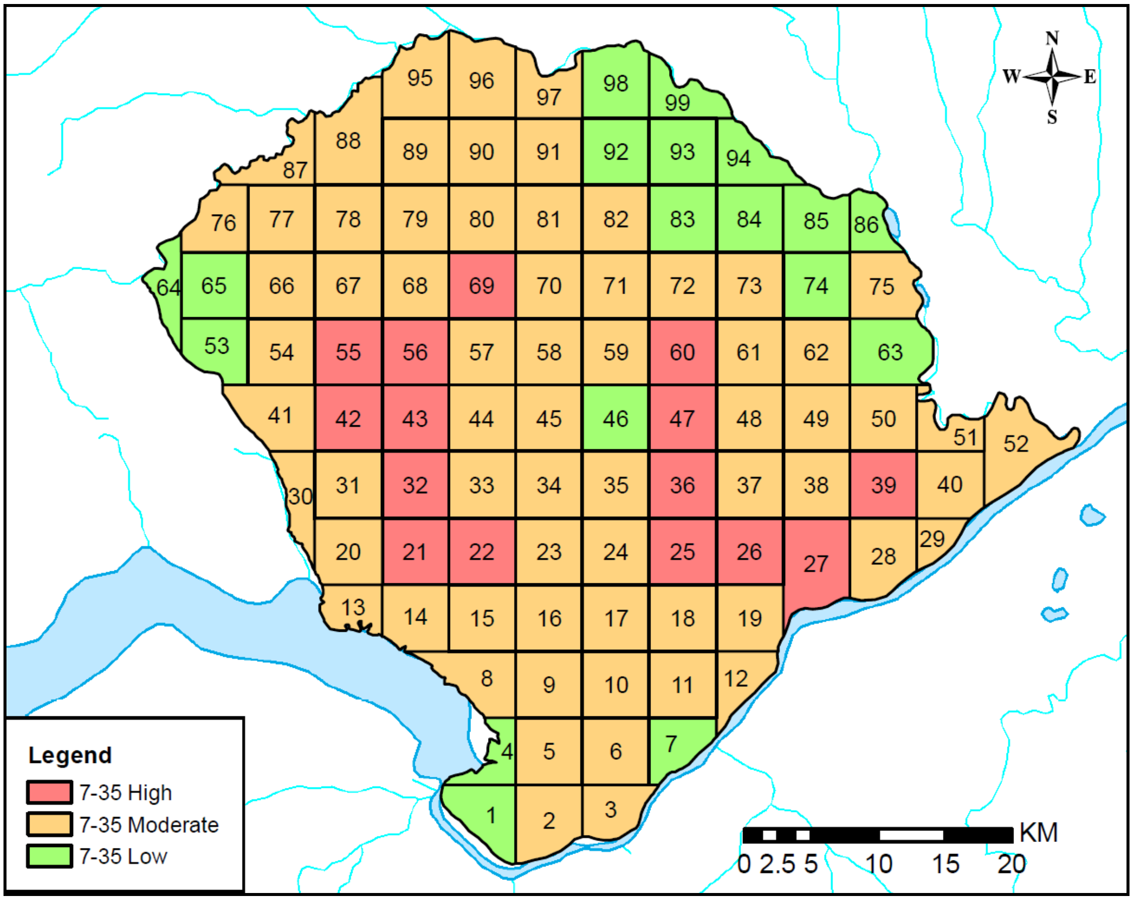

Figure 3. Stratification of Management Unit 7-35 Sample Units into low, moderate, and high expected moose density in Peace Region of BC.

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 6 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 a Bell 206 Jet Ranger helicopter. 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 sighted 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.

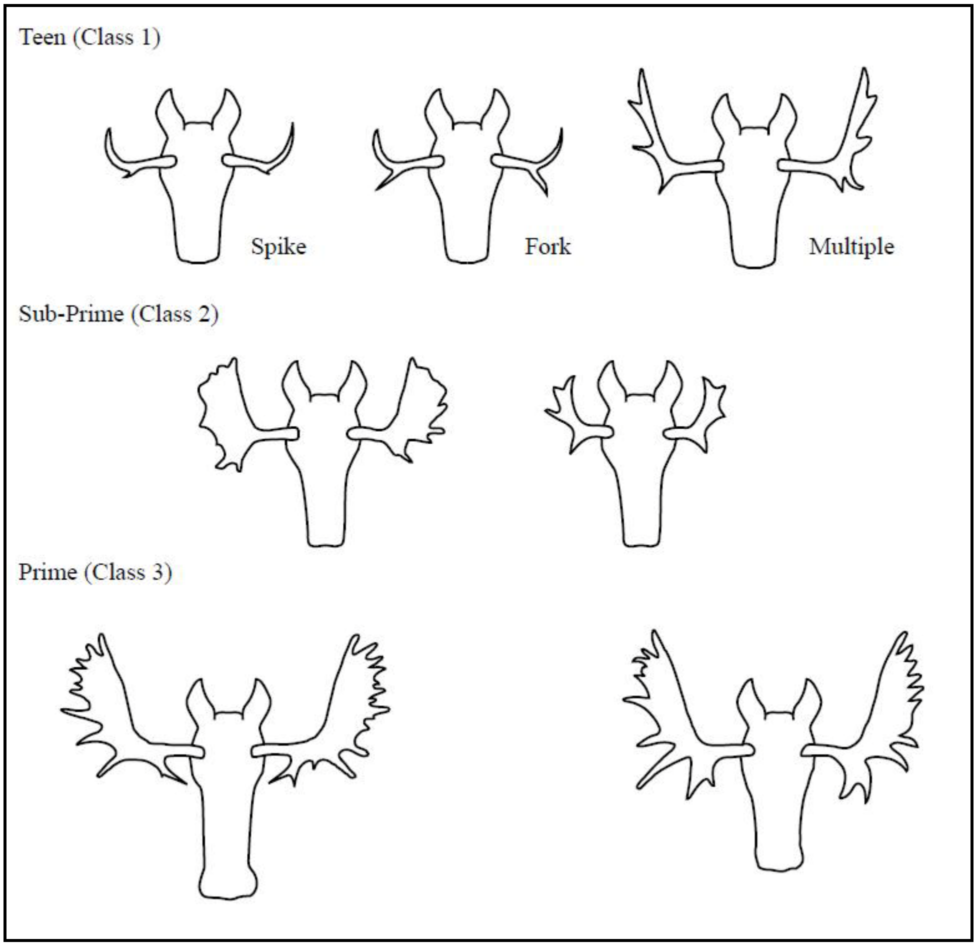

Figure 4. Classification of antlered moose during the 2013 Management Unit 7-35 moose survey (from Oswald 1997).

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 1996 7-35 moose survey estimate and the 2013 survey estimate following procedures outlined in Gasaway et al. (1986). The uncorrected estimates were used for comparison as the 1996 moose population estimate was not corrected for sightability.

The 2013 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:

$$\text{VarYF} = ([\text{SCF}]^2 * \text{VarY}) + \text{VM} + \text{VS}$$

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 on December 2 and December 3, 2013. The SRB survey was completed from December 5 through December 9, 2013 and involved helicopter flights on 5 days. Seven of 15 (47%) high SUs were surveyed, 19 of 66 (29%) moderate SUs were surveyed, and 5 of 18 (28%) low SUs were surveyed for an overall effort of 31% (Figure 5).

Overall search intensity was 1.8 min/km^2, with 2.1 min/km^2 for high SUs, 1.8 min/km^2 for moderate SUs, and 1.4 min/km^2 for low SUs. SU search intensity was moderately correlated to the total number of moose seen in each SU (R^2=0.52). Temperature during the survey ranged from -24 to -5ºC. 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).

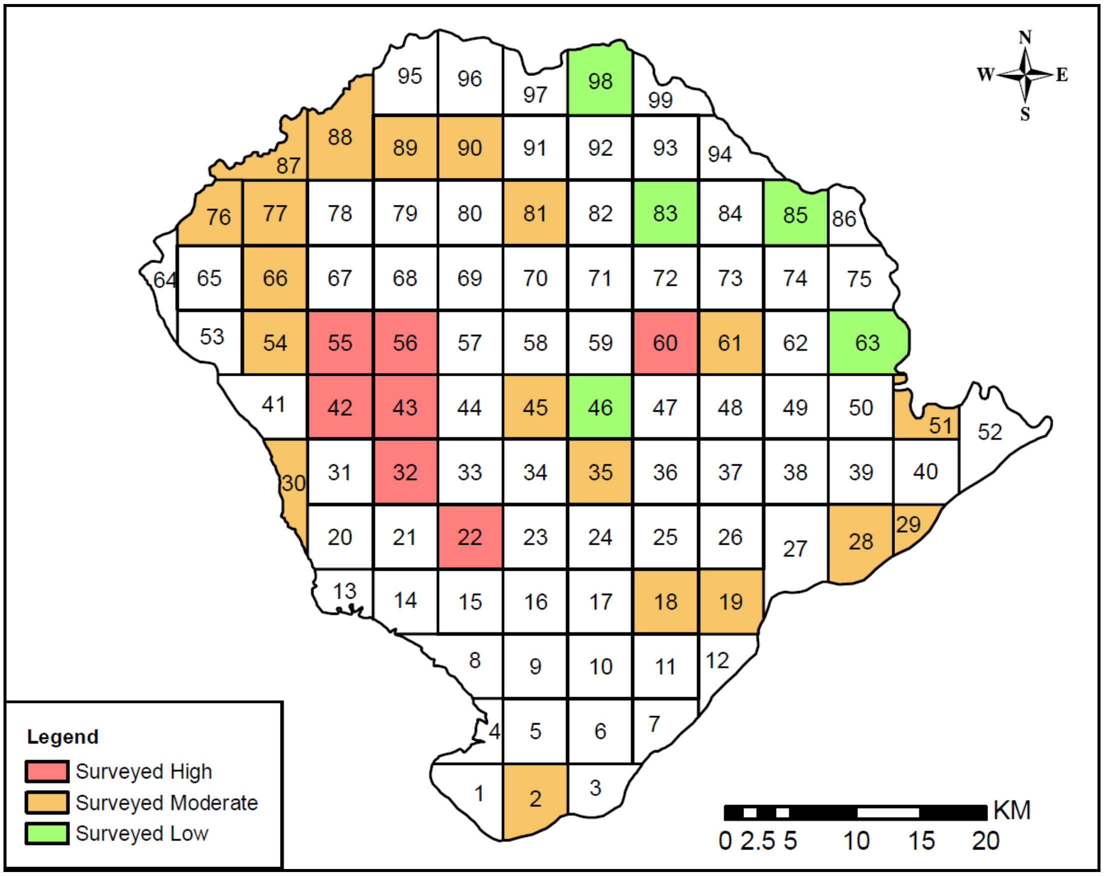

Figure 5. Sample Units surveyed during the December 2013 moose survey in Management Unit 7-35.

Fort St. John airport average snow depth during the survey was 176% of the 1990 to 2013 average (Environment Canada). Early December snow depth at the Fort St. John airport is highly variable (see appendix 2). Snow depth estimated from the helicopter ranged from 20 to 40cm and was not considered to be abnormally impacting moose mobility (Kelsall and Prescott 1971).

3.2 Population size, density and composition

A total of 676 moose were observed during the survey composed of 148 bulls, 410 cows, 115 calves, and 3 unclassified moose. Average group size was 1.71 with a maximum group size of 8 moose. The observed bull/cow ratio was 36 bulls per 100 cows and the observed calf/cow ratio was 28 calves per 100 cows (Table 2).

Table 2. Observed bulls, cows, and calves by stratum during the December 2013 moose survey in Management Unit 7-35.

	Survey Stratum		
	High	***Moderate***	***Low***
Number of Bulls	63	79	6
Number of Cows	205	187	18
Number of Calves	43	65	7
Number of Moose	313	332	31

The uncorrected (for sightability) total moose estimate for MU 7-35 was 1984 ± 313 which equates to an estimated density of 0.84 ± 0.13 moose/km^2. The estimated bull/cow ratio was 37.6 ± 6.1 bulls per 100 cows and the estimated calf/cow ratio was 30.1 ± 3.4 calves per 100 cows. The calculated SCF was 1.26 which resulted in a corrected total moose estimate of 2501 ± 405 and a corrected density estimate of 1.05 ± 0.17 moose/km^2.

Eighty four percent of sighted bulls had antlers and were classified by antler configuration (Figure 4). Of the classified bulls, 39% were Class I, 40% were Class II, and 21% were Class III (Table 3).

Table 3. Antler classification of observed bulls during the December 2013 moose survey in Management Unit 7-35.

	Antler Classification			
	Class I	***Class II***	***Class III***	***Unclassified***
Number of Bulls	47	48	26	27

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 92 mule deer, 8 white-tailed deer, 9 unclassified deer, 48 elk, and 12 stone's sheep were sighted. Three wolves in two separate groups were sighted during the survey.

4.0 Discussion

Management Unit 7-35 has previously been surveyed for moose in 1996 and 2011 (Figure 6). The 2011 survey was conducted by industry contractors using distance sampling methodology (Webster 2011). Comparisons between the 2013 results and the 2011 results were not made due to differing methodology and survey area inconsistencies. The 1996 SRB survey did not attempt to correct for moose missed during the survey, therefore, comparisons between the 2013 results and 1996 results are made using uncorrected estimates. From 1996 to 2013 the uncorrected moose density estimate has increased approximately 64%. This increase was statistically significant determined using a two-tailed student's t-test (t[37]=3.61, p=0.001).

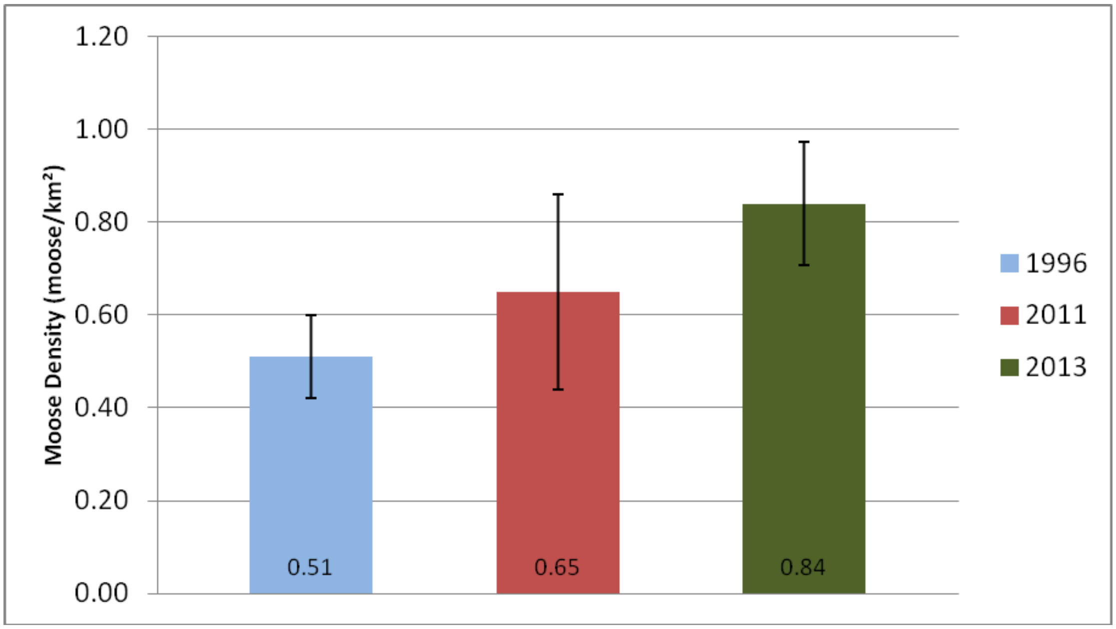

Figure 6. 1996, 2011 and 2013 uncorrected moose density estimates from surveys conducted in Management Unit 7-35. Error bars represent 90% confidence intervals. 1996 and 2013 surveys utilized stratified random block methodology while the 2011 survey utilized distance sampling methodology.

A SCF was applied to the 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 2013 MU 7-35 corrected moose density estimate of 1.05 moose per km^2 is well above the recent average for moose surveys conducted across British Columbia (G. Kuzyk, personal communication, March 2014).

The 2013 moose population estimate has increased by approximately 64% from the 1996 population estimate, although, 17 years have elapsed between surveys making inferences about current trends difficult. If the 2011 moose density estimate is comparable to the SRB results, it appears that the moose population in MU 7-35 is currently increasing.

The 2013 MU 7-35 estimated bull/cow ratio (37.6/100) has decreased slightly from the 1996 estimate, although it remains 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).

The proportion of class III bulls sighted during the 2013 MU 7-35 moose survey (21%) compared favorably to the 2011 MU 7-32 moose survey in which 13% of classified bulls were identified as class III (Thiessen and Baccante 2012).

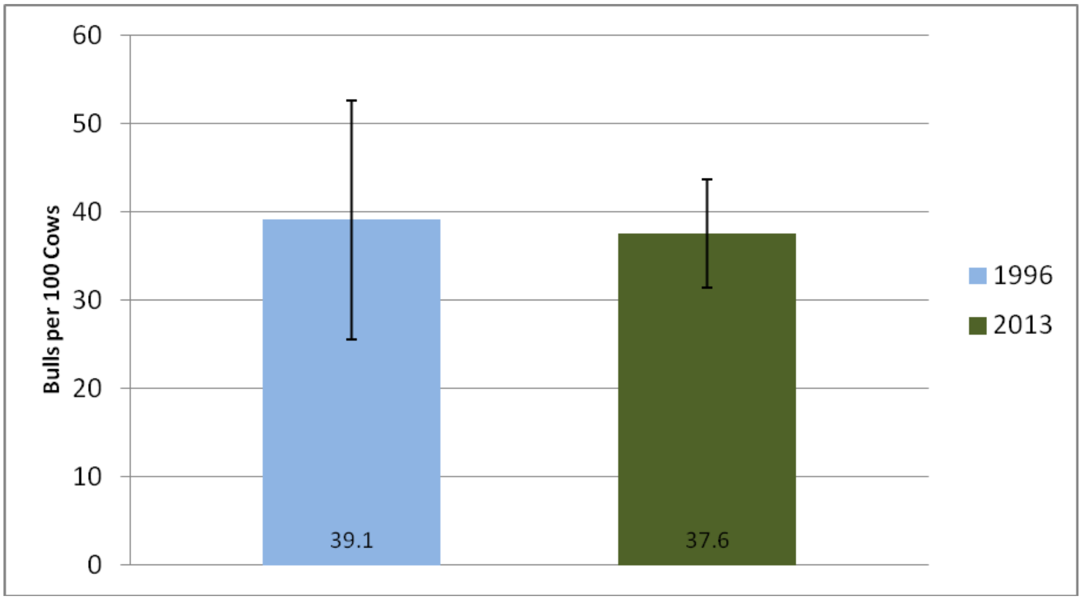

Figure 7. 1996 and 2013 estimated bull/cow ratios from stratified random block surveys conducted in Management Unit 7-35. Error bars represent 90% confidence intervals.

The calf/cow ratio in MU 7-35 was higher in 2013 than in1996 (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). A calf to cow ratio above 30 calves per 100 cows generally indicates sufficient recruitment to support a stable moose population provided adult mortality is not abnormally high.

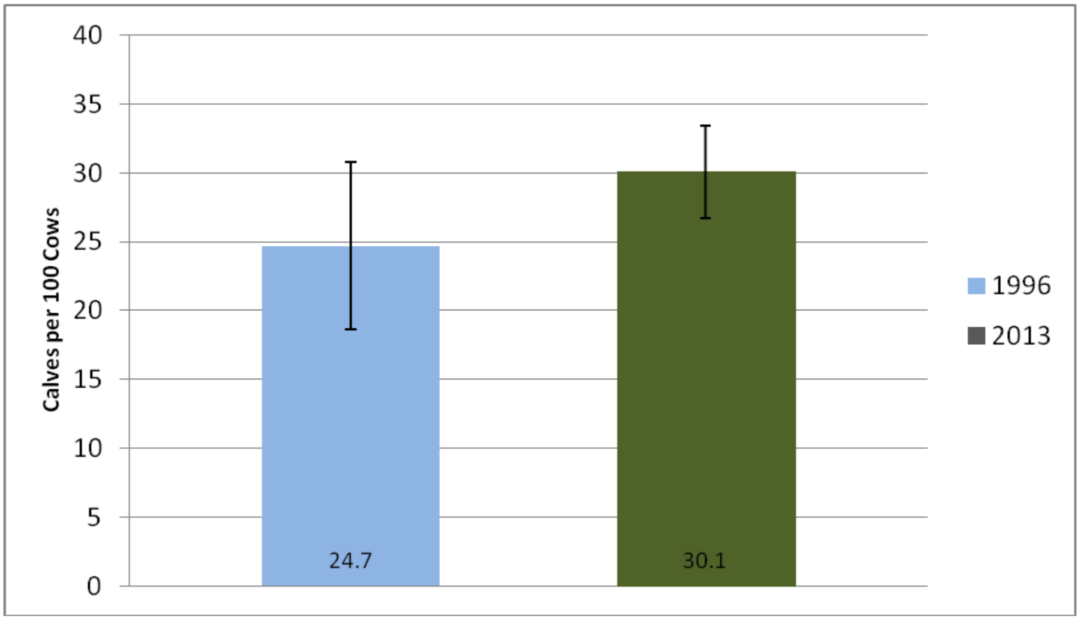

Figure 8. 1996 and 2013 estimated calf/cow ratios from stratified random block surveys conducted in Management Unit 7-35. Error bars represent 90% confidence intervals.

Parasitism by ticks was not noticed during the survey, although, symptoms of tick infestation likely would not be noticeable during early winter. 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 low stratum had an average density of 0.24 moose per km^2, the moderate stratum had an average density of 0.74 moose per km^2, and the high stratum had an average density of 1.79 moose per km^2. The 7-35 overall 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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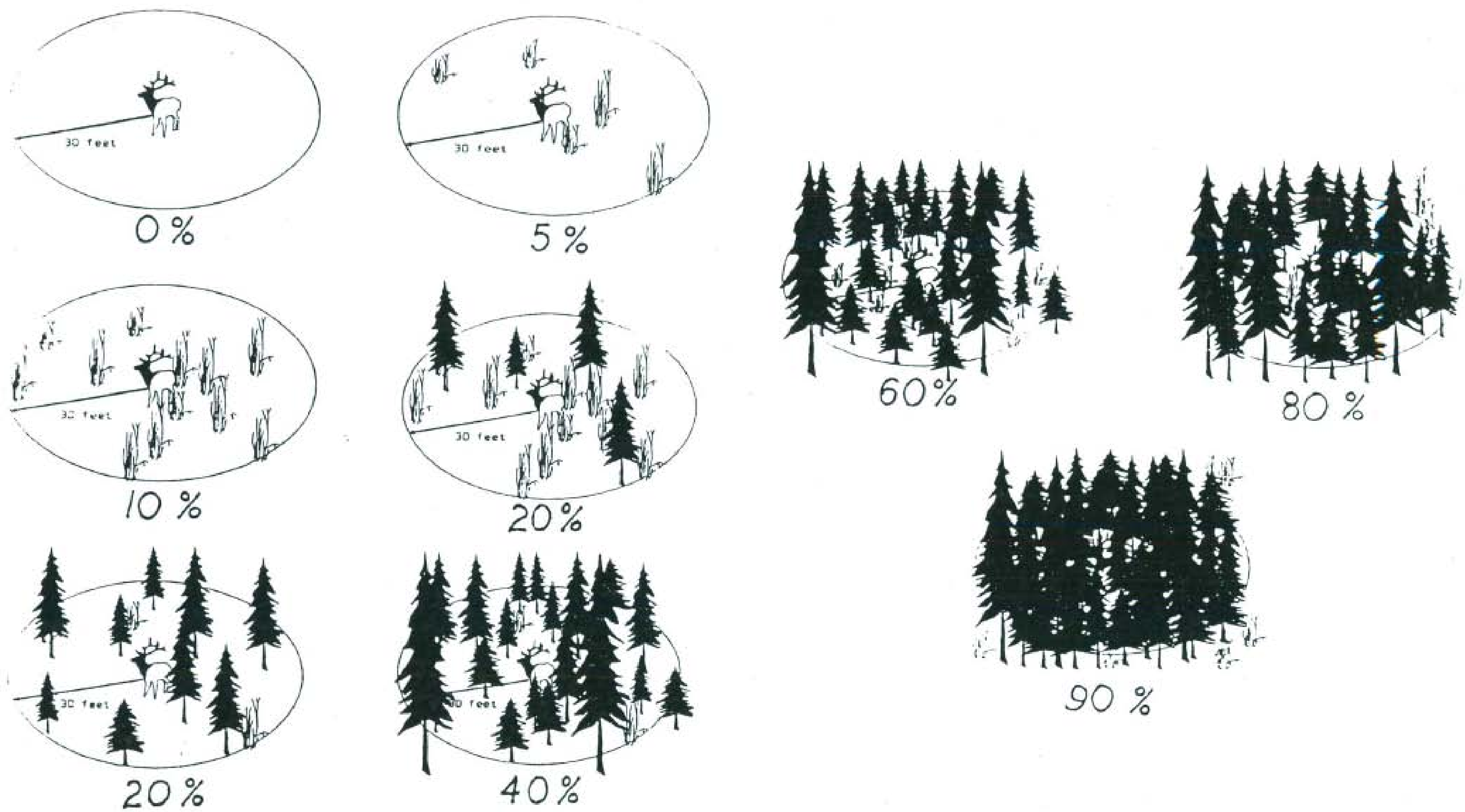
8.0 Appendix

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



Appendix 2. Average snow depth (Dec 2 – Dec 9) at the Fort St. John airport from 1990 through 2013.