# MOOSE SURVEY

# DAWSON

## EARLY-WINTER, 2008

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Yukon
Environment

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## Yukon Fish and Wildlife Branch
## TR-12-27


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The survey crew consisted of Rick Ward, Dorothy Cooley, Martin Kienzler and Matt Larsen with Yukon Environment. Pete Descoteaux (Yukon Energy Mines and Resources), James MacDonald and Ryan Peterson (Tr'ondëk Hwëch'in) participated in the survey as part of their regular work duties. Will Fellers and Rachel Hunt from the Dawson District Renewable Resources Council participated in the survey and we had numerous local observers: Gerard Cruchon, Rod Dewell, Nick Estrada, Sylvain Fleurant, Liz Foubister, Martin Owen, Sonny Parker, Tyler Taylor and Lolita Welchman.

The helicopters were ably piloted by Ben Drury, Doug Hladun, and Uli Koerner of Trans North Helicopters.





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## Key Findings

We did an early winter survey of moose in the general area of the Gold Fields, south of Dawson, in November 2008. This area receives the highest hunting pressure in the region.

- The estimated density of moose in this region remained high at 281 moose per 1,000 $km^2$. This is considerably higher than the Yukon average.
- We estimate there were 1,680 moose (range of 1,373 to 1,988 moose) in the entire survey area.
- There were 44 adult bulls for every 100 adult cows. This ratio is below the Yukon-wide average of 66 bulls per 100 cows but still sufficient to ensure that all cows are bred during the rut.
- There were 37 calves per 100 mature cows which is considered "good" but the calculated estimate of 8% yearlings is lower than we would like to see.
- The total estimated population size appeared relatively stable since 1989, despite the lower bull, yearling, and calf numbers recorded in the 4 population estimates done since then.
- Overall, reported harvest levels in the survey area were within the range of recommended rates. However, Game Management Subzones 3-07 (close to Dawson) and 3-12 (near the confluence of the Stewart and Yukon rivers) had probably experienced harvest levels over 5%, which can carry a very high risk of initiating a population decline. These subzones, and GMS 3-08, all had low bull ratios. There was an increasing trend in the number of moose taken between 2004 and 2008, which should be closely monitored in the future.

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# Introduction

We flew a moose survey to estimate the number, distribution, and age and sex composition of moose in the Dawson area in November 2008, as part of our regular schedule of monitoring moose populations. The survey area covered the general area of the Gold Fields south of Dawson, comprising Game Management Subzones (GMS) 3-07, 3-08, 3-10, 3-11, and 3-12. This area is very accessible to hunters and experiences some of the highest harvest pressure in the region.

# Study Area

### *Previous surveys*

There have been numerous surveys in different seasons and using different methods to monitor the moose population in this area (Figure 1).

#### *Census surveys*

Three intensive census surveys have been previously done to estimate the abundance or density of moose within an identified area (Figure 1). The Dawson East area (GMS 3-07 and 3-10) was surveyed in 1989 (Larsen and Ward 1991) and 1997 (Appendix 3). A larger area, called the Dawson survey area was first censused in 2002 (Environment Yukon 2003). The 2008 survey was a re-survey of this area.

#### *Early winter trend surveys*

Trend surveys were subsets of census survey areas. These were done to document changes or trends in the numbers of moose over the medium- to long-term. Because these surveys were less expensive than larger census surveys, they could be done more frequently. The Dawson East trend survey area was surveyed in 1989 (Larsen and Ward 1990), 1997 (Appendix 3), 1998 (Appendix 4) and 1999/2000 (Appendix 5) (Figure 1).

#### *Stratification surveys*

Stratification surveys are also used as an index of medium-term changes in the numbers of moose but they are done over a larger area than trend surveys. Two types of stratification survey have been flown in the Dawson region. Low-intensity stratification flights involved one flightline through the middle of each survey unit, with a search intensity of about 0.12 to 0.17 minutes per $km^2$. Intensive stratification flights involved flying 3 or 4 flightlines per survey block and had a search intensity of about 0.5 minutes per $km^2$. In the Dawson region, we did early winter intensive stratification surveys (Figure 1) in 2005 (Appendix 6) and 2007 (Appendix 7). The only low intensity stratification survey was flown in the larger Dawson region in 2000 (Appendix 5). Results from the 2000 survey are not directly comparable with other years but are useful for discussion.

In preparation for the Dawson land use planning process, there

was also a late-winter stratification survey done in 2008 over a larger area, including this survey area (Environment Yukon 2010). This survey is not comparable to the early winter surveys described here and is not discussed in this report.

### *2008 survey area*

The Dawson moose survey area covers a total area of 5,983 km$^2$ (Figure 2). The survey boundary runs from Dawson City south along the Yukon River to the Stewart River, east along the Stewart River to west of Australia Mountain, then north to about Strickland Lake; it then follows the North Klondike Highway to Dawson City.

The area is well treed with mainly spruce, poplar, and birch but extends up to alpine tundra at several points. Throughout the survey area there is a fairly extensive road and trail system to access mineral claims which are typically operating on a seasonal basis.

Large water bodies (0.5 km$^2$ or larger in size) made up about 70 km$^2$ of the total area and were classified as non-moose habitat. As with many parts of central Yukon, much of the survey area has been burned by wildland fires at some point over the last 60 years (Figure 3).

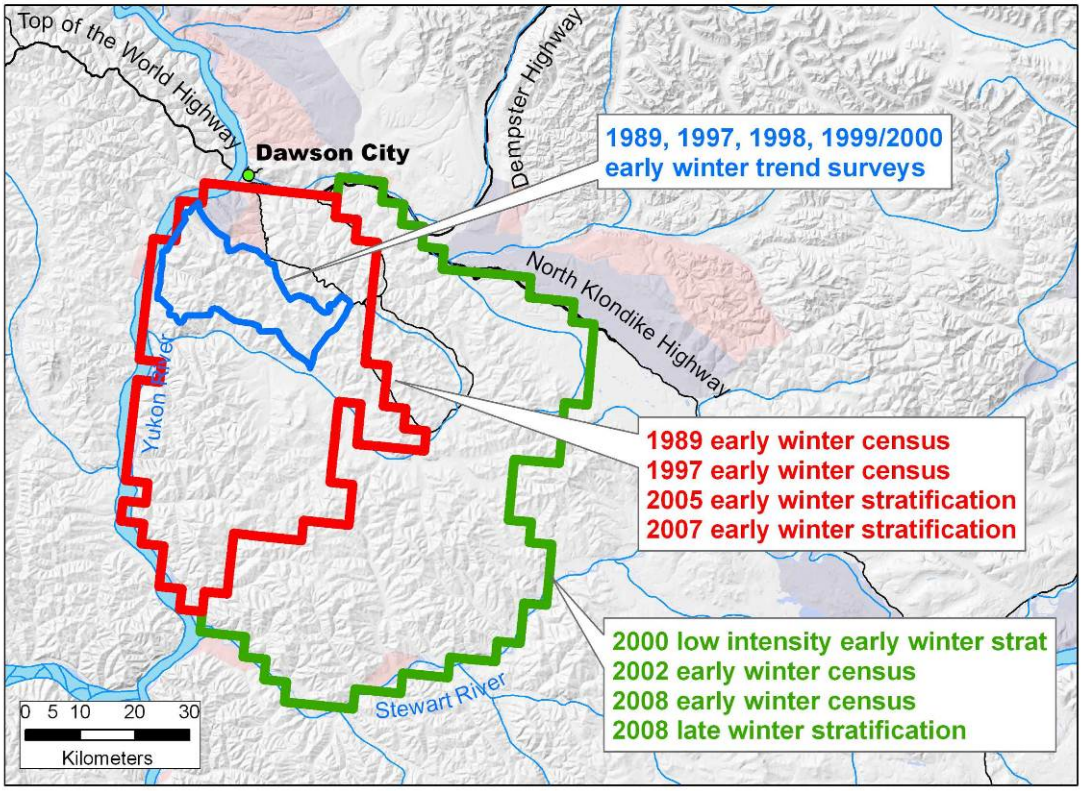


**Figure 1.** Moose surveys previously conducted in the Dawson region.

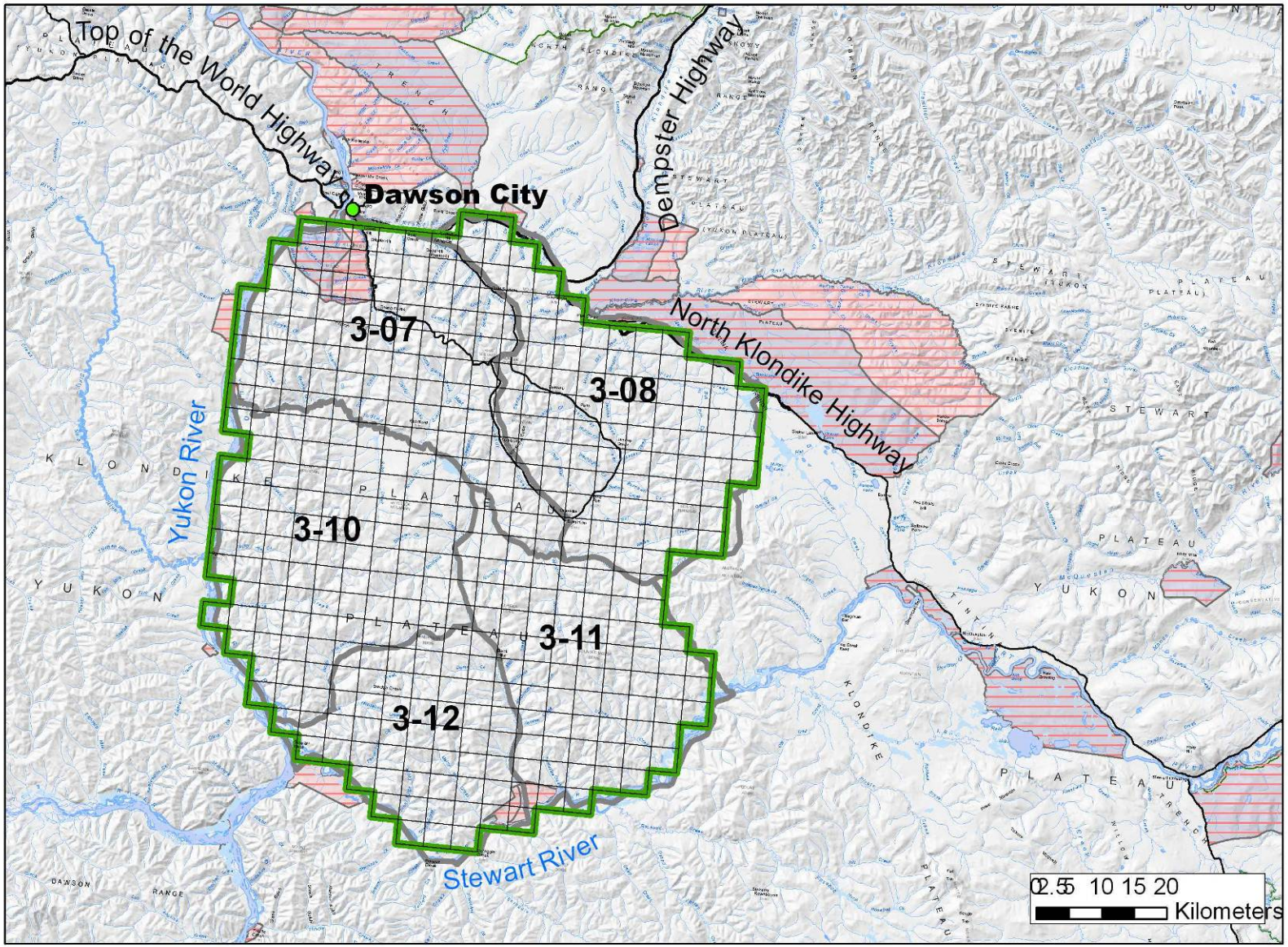


**Figure 2.** November 2008 Dawson moose survey area map showing GMS and survey grid.

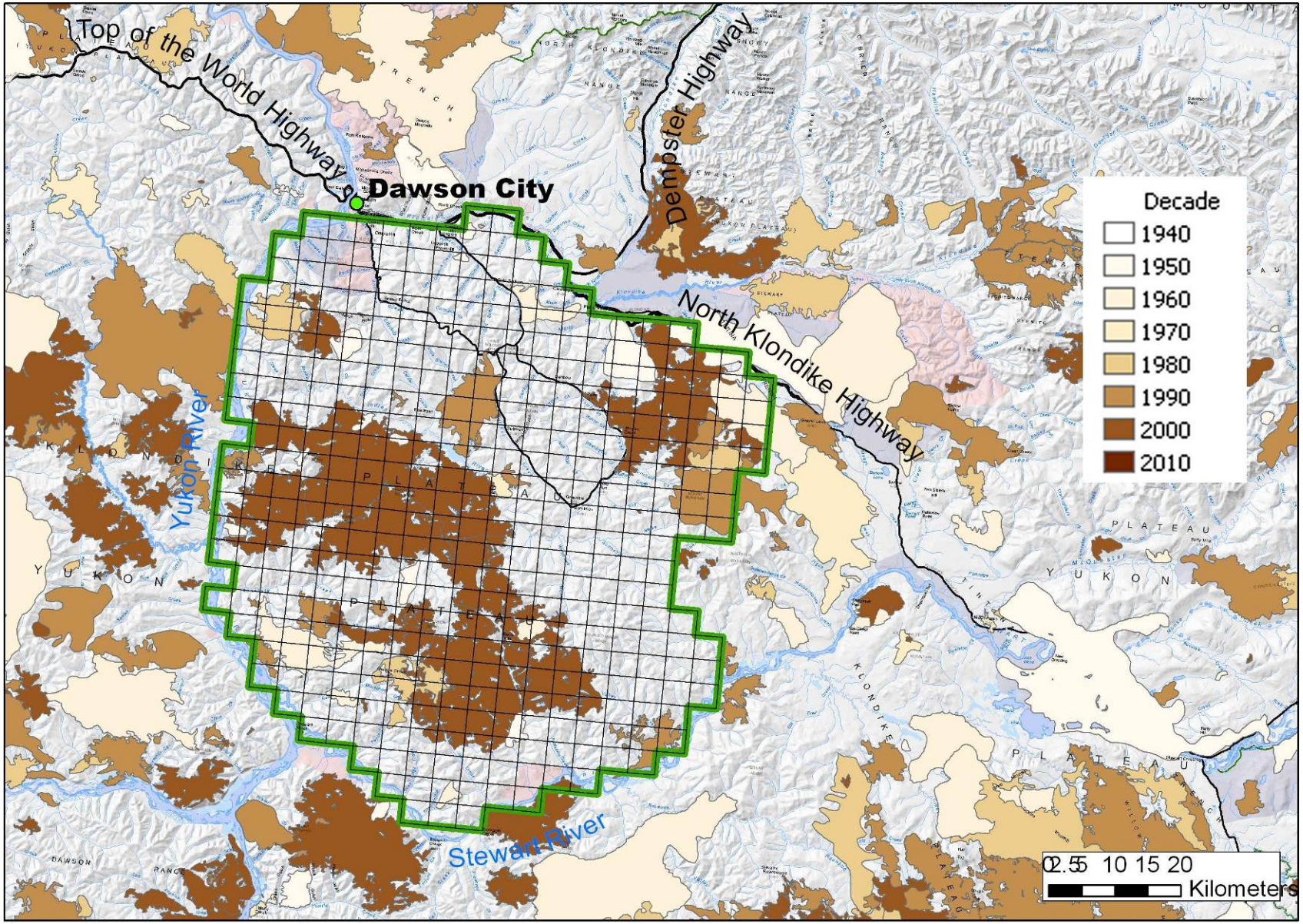


**Figure 3.** Fire history of the region.

# Methods

### *Field methods*

The technique used for this survey was a geo-spatial method (Kellie and DeLong 2006). There were several steps for the field portion of this technique.

The survey area was divided into uniform rectangular sample units called "blocks". Each block is delineated by 2 minutes of latitude and 5 minutes of longitude and encompassed between 15 and 16 $km^2$.

Each block was classified (stratified) as having either High or Low expected moose numbers, based on habitat characteristics and the presence of moose. Stratification can be done either by flying through the area (usually with a fixed-wing aircraft right before the census) or, in situations where we know a lot about the area, by reviewing past survey data and updating the classification based on recent changes in land use or forest fires . For this survey, most of the stratification phase of the census was done using existing information, although we did use some helicopter time to confirm the classification of some blocks.

The census phase where we actually counted moose was done by helicopter. We randomly choose blocks to fly for the census, counting a higher proportion of the High blocks and a lower proportion of the Low blocks. Blocks are ideally flown at an intensity of about 2 minutes of flight time per square kilometre. The locations of moose were mapped with a Global Positioning System (GPS) unit and whenever possible moose were classified as calves, yearlings, mature cows, or mature bulls.

To estimate the number of moose missed during the census phase, we re-flew a portion of selected High and Low blocks at about twice the intensity (about 4 minutes per $km^2$). All moose were counted again and the numbers of moose seen during the second flight were used to calculate an average "sightability correction factor" or SCF to account for the number of moose that may be missed during the standard flights.

### *Stratification*

Most of the stratification was done in the office before the field work began, using past stratification results or changes from the 1989, 1997, and 2002 population surveys and the 2000, 2005, and 2007 stratification surveys. The stratification field work took place on 12 and 14 November 2008 to confirm the classification of 83 blocks. We needed to check the initial classification either because we weren't sure of the extent of mapped forest fires or because we had made notes in previous surveys that the habitat was changing and should be checked before re-surveying. We used the census helicopter rather than a fixed-wing aircraft because there were relatively few areas that we needed to check.

### *Data analysis*

To analyze the data, we used a combination of standard Stratified Random Block (SRB, Gasaway *et al.* 1986) and the Finite Population Block Kriging (Ver Hoef 2001) methods to estimate moose population size and composition for the entire survey area. We used the SRB method to calculate interim population size, composition, and confidence interval estimates while in the field. The Kriging method has the advantages of generally providing more precise estimates of population size and composition for the entire area or sub-portions of the survey area and does not require that sample units be selected randomly for the census portion of the survey. The SRB technique, however, allows us to determine and apply a sightability correction factor to our estimated population data to allow for moose that are missed. For this survey, the Gasaway technique with a pooled sightability correction factor was used to estimate the population density over the entire survey area and the Kriging method was used to subset the data to compare a portion of the survey area to past surveys.

Over the years, the actual survey area has expanded so historic survey results cannot be compared directly. In order to compare across years, we looked at only GMS 3-07 and 3-10, the Dawson East portion of the area that has been surveyed each time.

### *Assessment of harvest levels*

To calculate the harvest rate within the survey area, we applied the mean density estimates for each of the High and Low strata to sample units in each GMS, and then recalculated the total number moose in each GMS. We used the average number of moose harvested by licensed hunters (non-First Nation Yukon residents and non-residents) in each GMS for the previous 5 years) to calculate a harvest rate by dividing the total moose harvested by the total number of moose estimated to be in that GMS.

## Weather and Snow Conditions

Conditions during the survey were good. The snow cover was complete (100%) and greater than 15 cm deep. On all but one day, we had overcast conditions resulting in flat lighting. Cloud ceilings ranged from 2,500 to 4,500 feet above sea level and temperatures ranged from -7 $^{o}$C to -25 $^{o}$C. On 16 November, the sky was clear and the light was bright, however sightability was still good.

## Results and Discussion

### *Stratification*

There were 165 blocks in the entire survey area classified as High moose density and 225 blocks were classified as Low, for a total of 390 blocks. Figure 4 shows the distribution of high and low moose abundance units throughout the survey area.

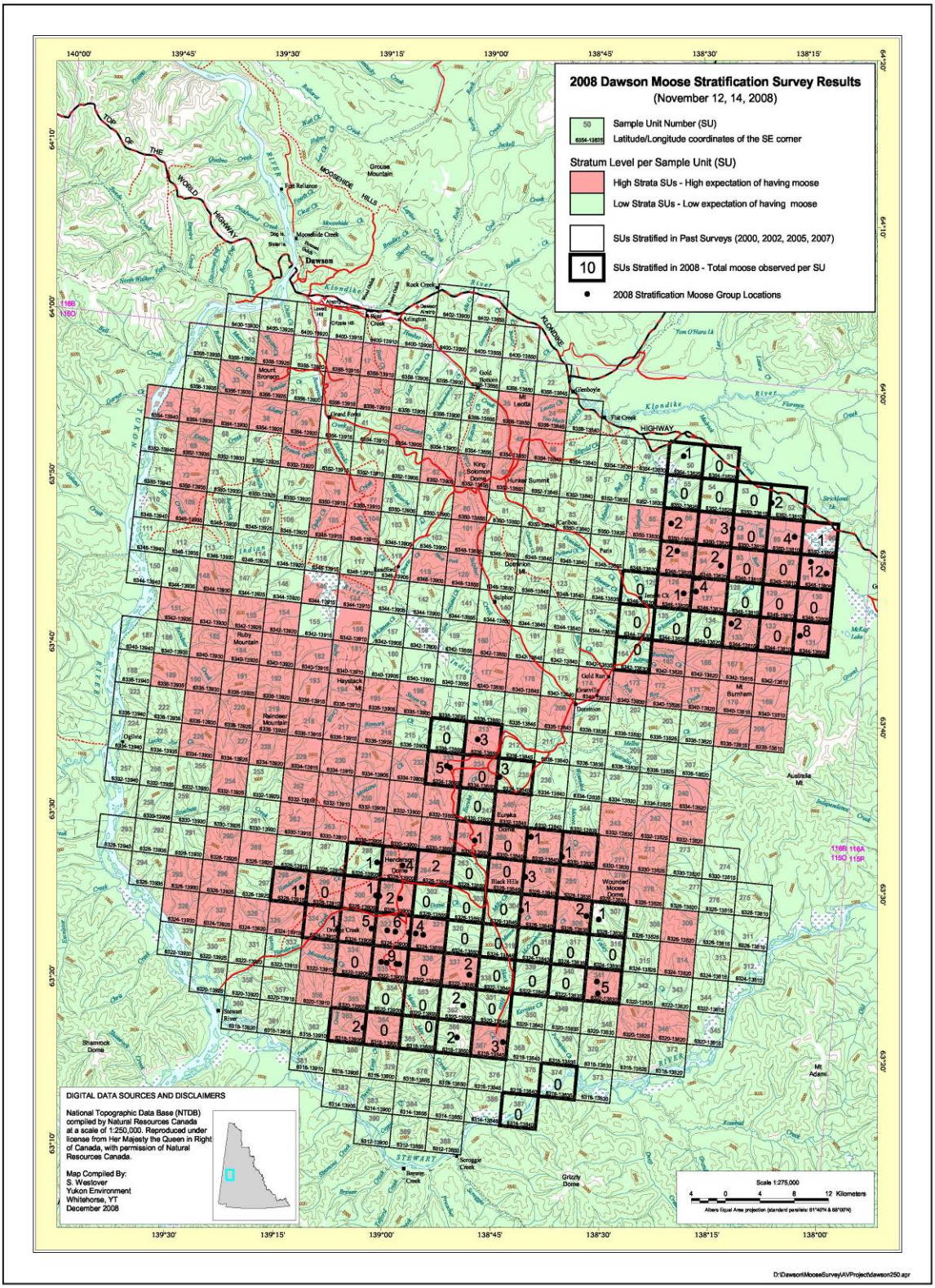


**Figure 4.** Results of the pre-survey stratification, Dawson moose census 2008 Census coverage.

The census fieldwork was done from 12 to 17 November 2008. We surveyed 40 of the High blocks and 27 of the Low blocks for a total of 67 blocks, or about 17% of the total area (Figure 5). We spent 41.8 hours of flight flying the census blocks and re-counting a portion of some survey block to calculate a sightability correction factor; plus 17.4 hours were spent ferrying to and from the survey blocks. We flew the census survey at an intensity of about 2 minutes per $km^2$, which is the ideal coverage for this type of survey. We were able to survey a good proportion of the randomly chosen blocks, both in the High and Low strata (about 24% of the total High and 12% of the total Low blocks were surveyed).

### *Observations of moose*

During the survey, we counted and classified 330 moose (Table 1).

Because the precision of population estimates derived using the geo-spatial and stratified random block population estimation techniques were similar (unpublished data), in this report we present the stratified random block results, with the pooled SCF applied. This technique allowed us to more accurately account for moose that were missed by survey crews during the survey.

We estimate that there were 1,680 ± 18% moose (for a 90% Confidence Interval of 1,373 to 1,988 moose) in the entire survey area (Table 2). This includes a 5% SCF for moose missed during the census portion of the survey. Of the 1680 animals, we estimate that there were 378 adult bulls, 858 adult cows, 130 yearlings, and 314 calves. There were approximately 44 adult bulls for every 100 adult cows, which is below the Yukon-wide average of 66 bulls per 100 cows, but above the minimum level of 30 adult bulls per 100 adult cows needed to ensure that most cows are successfully bred (Yukon Fish and Wildlife Branch 1996).

**Table 1.** Observations of moose in the Dawson survey area in November 2008.

| | Number of Blocks Counted | Number of Adult Bulls Observed | Number of Adult Cows Observed | Number of Yearlings Observed | Number of Calves Observed | Total Moose observed |
|---|---|---|---|---|---|---|
| **High Blocks** | 40 | 73 | 131 | 26 | 44 | 274 |
| **Low Blocks** | 27 | 7 | 33 | 2 | 14 | 56 |
| **Total** | 67 | 80 | 164 | 28 | 58 | 330 |

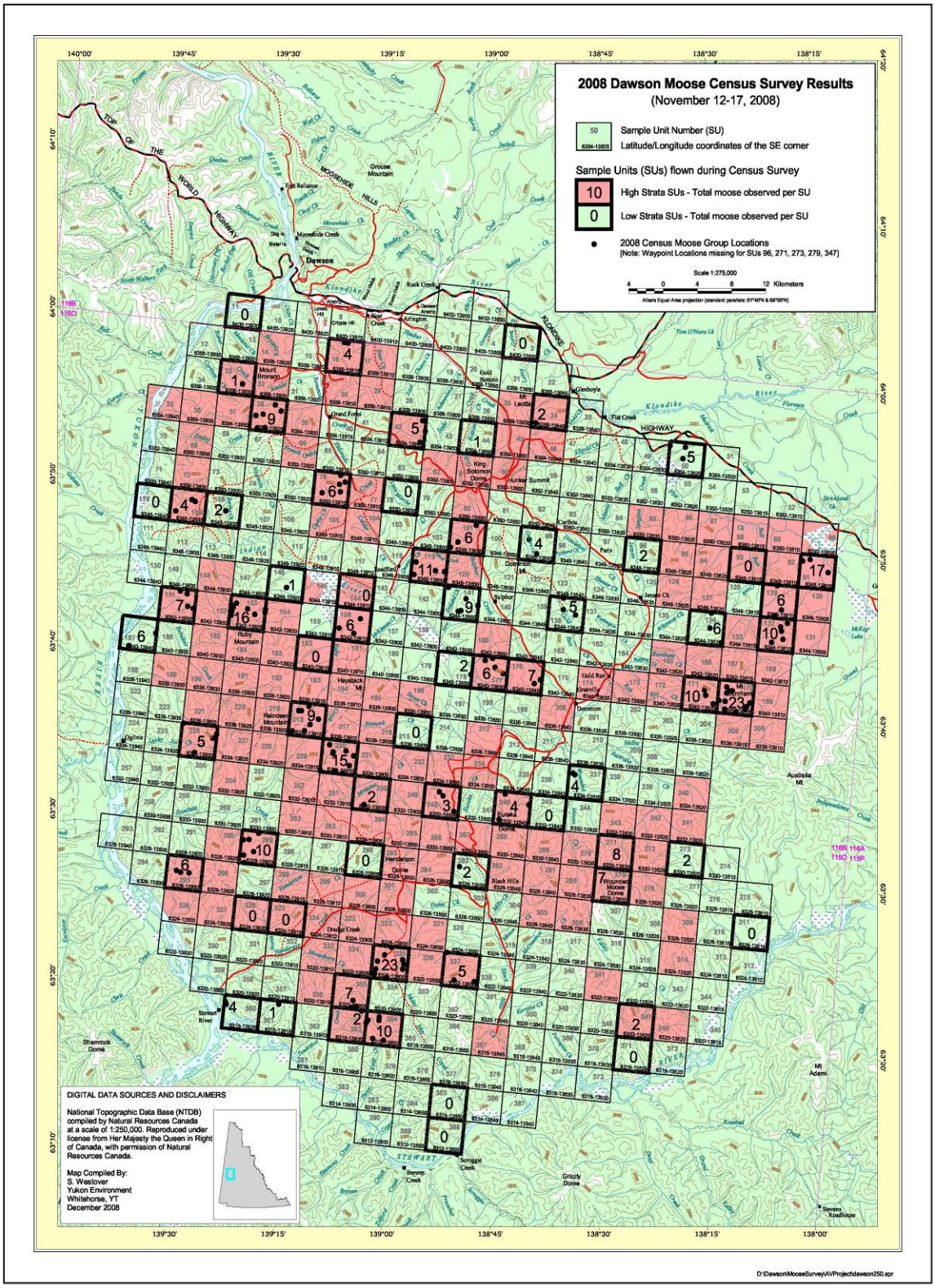


**Figure 5.** Number of moose observed in each sample unit, Dawson moose survey area, 2008.

**Table 2.** Estimated abundance and composition of moose in the Dawson survey area, November 2008.

| Estimated Abundance[a] | Best Estimate ± 90% Confidence Interval %[b] | 90% Confidence Interval Range[b] |
|---|---|---|
| Estimated Total Number of Moose | 1680 ± 18% | 1373 to 1988 |
| Adult Bulls | 378 ± 31% | 259 to 497 |
| Adult Cows | 858 ± 19% | 695 to 1022 |
| Yearlings | 130 ± 44% | 72 to 188 |
| Calves | 314 ± 27% | 230 to 398 |
| | | |
| Density of Moose (per 1,000 $km^2$) | | |
| Total Area (5982.8 $km^2$) | 281 | n/a |
| Moose Habitat Only (5912.6 $km^2$)[c] | 284 | n/a |
| | | |
| % Adult Bulls | 22 ± 22% | 17 to 28 |
| % Adult Cows | 51 ± 9% | 46 to 56 |
| % Yearlings | 8 ± 38% | 5 to 11 |
| % Calves | 19 ± 20% | 15 to 22 |
| | | |
| Adult Bulls per 100 Adult Cows | 44 ± 29% | 31 to 57 |
| Yearlings per 100 Adult Cows | 15 ± 44% | 8 to 22 |
| Calves per 100 Adult Cows | 37 ± 22% | 28 to 45 |
| % of Cow-Calf Groups with Twins[d] | 9 ± 69% | 3 to 15 |

a) Estimated numbers provided are based on a pooled "sightability correction factor" or SCF. In this survey, a SCF of 1.05 was applied to correct estimates of moose abundance for animals that were missed by the survey crews (see step 4 of methods section for a description of how the SCF is calculated).

b) A "90% confidence interval" means that, based on our survey results, we are 90% sure that the true number lies within this range of numbers. Our best estimate is in the middle of this range.

c) Suitable moose habitat is considered all areas at elevations lower than 1,524 m (5,000 ft), excluding water bodies 0.5 $km^2$ or greater in size.

d) The number of cows with 2 calves divided by the total number of cows with calves. It represents what percentage of cows that had calves, had twins.

In Yukon, adult moose die at a rate of 10 to 20% each year (Yukon Fish and Wildlife Branch 1996) so, on average, this many yearlings must enter the population each year. In general, 25 to 30 calves per 100 adult cows are needed to maintain stable populations in areas with typical adult mortality rates. The ratio of calves (37 calves per 100 adult cows) was good but the percentage of yearlings in the overall population (8%) was slightly on the low side. Overall, the population estimates did not seem to indicate a decline (Appendix 2).

Our estimated density of moose was 281 moose per 1,000 km$^2$ of total area, much higher than the Yukon-wide average of 158 moose per 1,000 km$^2$ of total area, and higher than the average density of 207 moose per 1,000 km$^2$ of moose habitat (based on the most recent data available for other surveyed areas throughout the Yukon).

### *Population trend 1989 to 2008*

Because we have done 3 types of moose surveys in the Dawson region, covering slightly different areas, we have several sets of information with which to assess the status of the population over time (see Appendix 2).

### ***Summary of census survey results***

Because census survey areas have changed over time, we can make long-term comparisons only in GMS 3-07 and 3-10, which have been part of the survey area each time. In order to make the results comparable, we present the data with no sightability correction factor (SCF) applied because a SCF was not calculated for the 2002 survey.

Between 1989 and 2002 there seemed to be a declining trend in moose abundance, but we hesitated to conclude this because we believed several conditions during the 2002 survey led to an underestimate of the population (Environment Yukon 2003). The 2008 estimate was higher than the 3 previous estimates. There were likely very similar numbers of moose in the area over time (Figure 6).

We have recorded a lower adult bull to adult cow ratio (Figure 7) and fewer calves in census surveys since 1989 but overall the proportion of adult bulls to adult cows is still above that needed to successfully breed cows, and the relatively low number of calves doesn't seem to have caused a population decline. It should be noted that the Game Management Subzone with the lowest bull ratio (GMS 3-07) also has the highest harvest rate of the survey area.

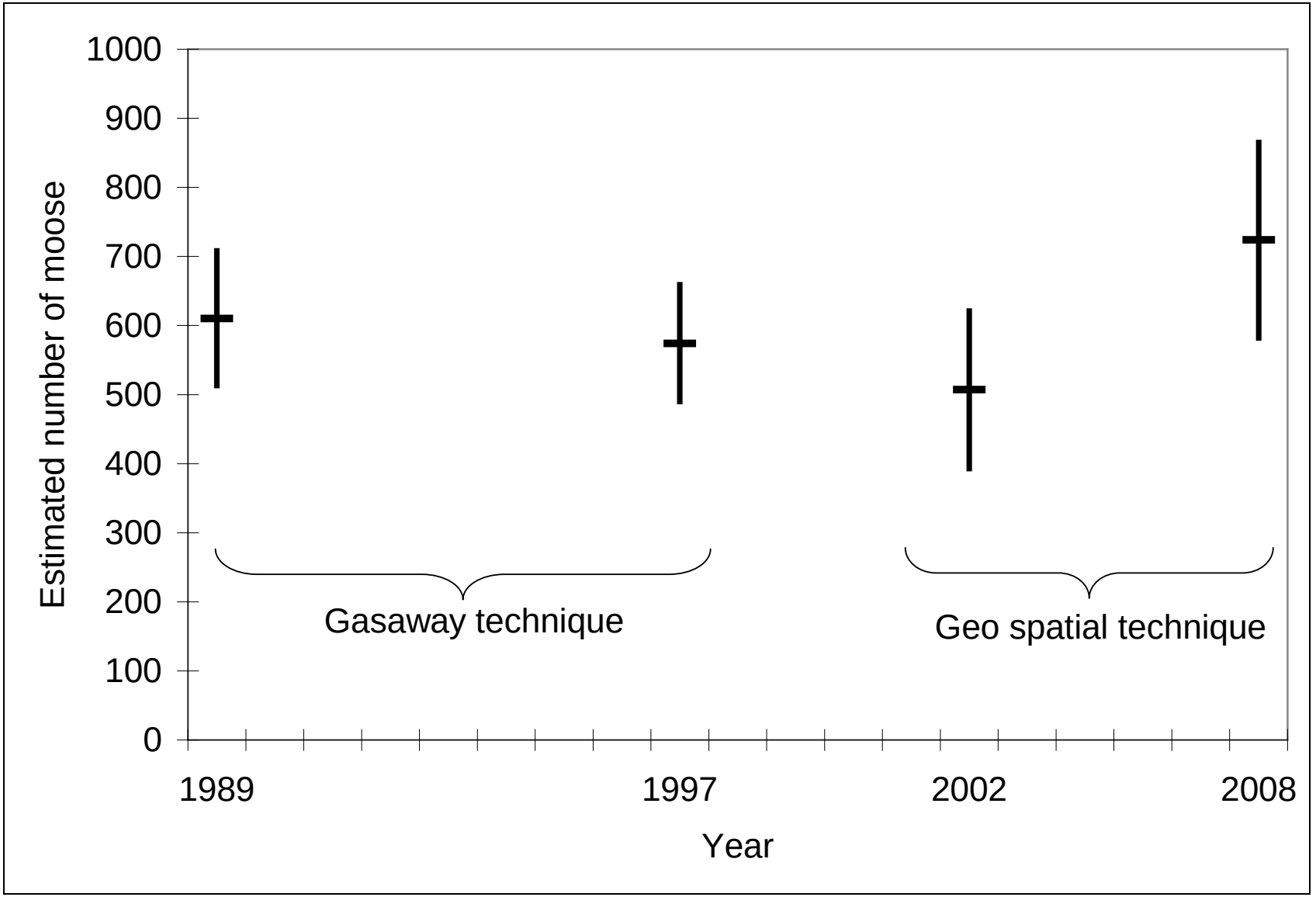


**Figure 6.** Estimated number of moose, GMS 3-07 and 3-10.

No sightability correction factor is included in the results. Error bars indicate the 90% confidence interval for the estimate.

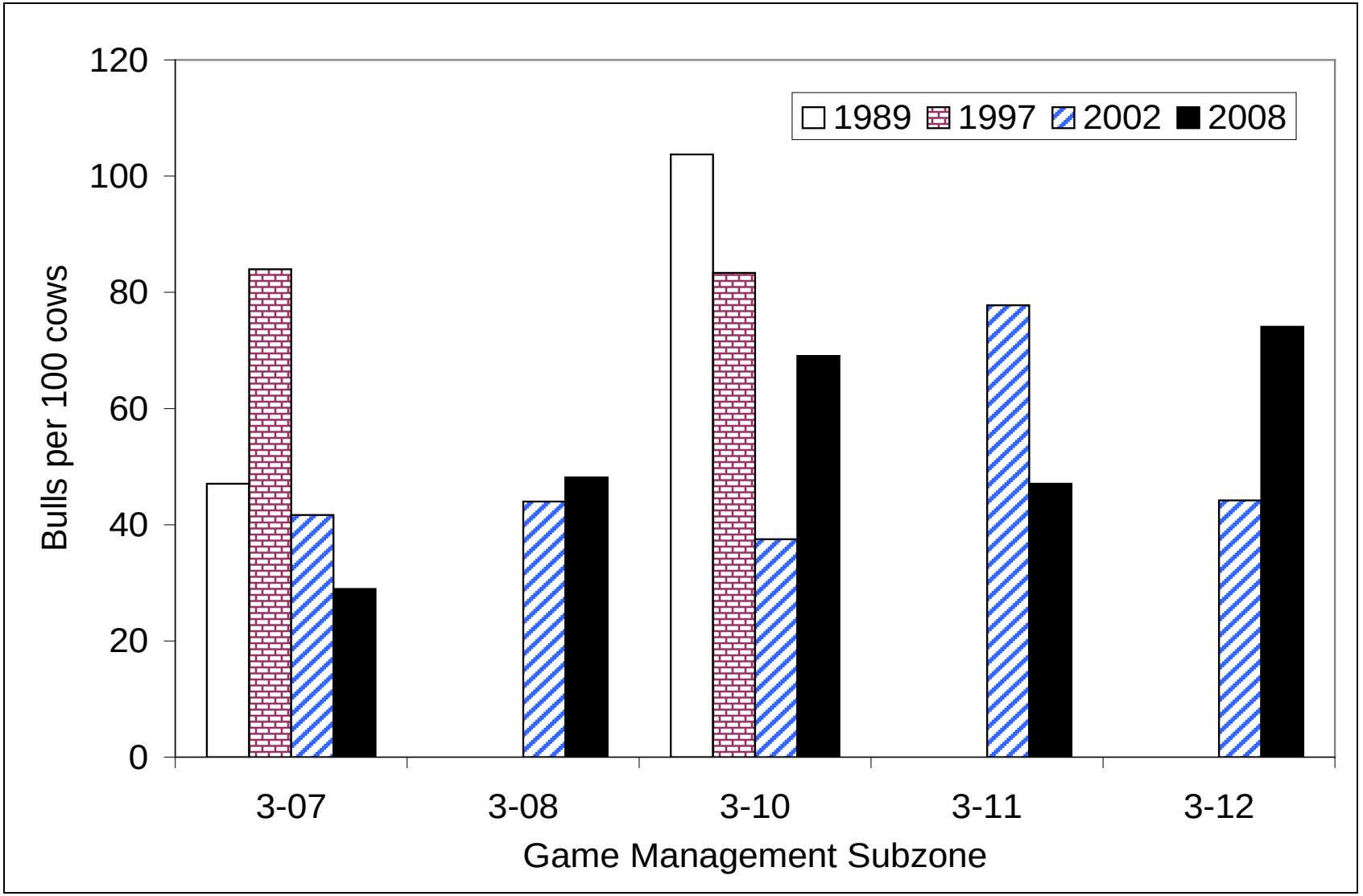


**Figure 7.** Ratio of adult bulls to adult cows in Dawson East moose census surveys, 1989 to 2008.

GMS 3-08, 3-11 and 3-12 were added to the survey in 2002. The overall ratio in the entire 2008 survey area was 44 adult bulls per 100 adult cows.

### *Summary of stratification survey results*

We did independent stratification surveys in 2000, 2005, and 2007 but we can also use the stratification phases of the 1989, 1997, and 2000 census surveys to assess the trend over the years. For the 2000 survey, we compared only the area covered by the earlier surveys (GMS 3-07 and 3-10). The 2002 and 2008 census surveys used past survey stratification results, so no new stratification information was collected.

The search intensity during the 2000 stratification survey was much lower than that of the other survey years (Appendix 5); therefore we must use the results of that survey with caution. The overall trend for the other 4 surveys indicates a relatively stable population (Figure 8).

### *Summary of trend survey results*

The number of moose seen during the Dawson East trend surveys in the late 1990s was higher than the number seen in 1989, indicating a growing population. The census surveys and stratification surveys, however, showed little change in the number of moose (Figure 9, Appendix 4, Appendix 5, Appendix 6).

### *Harvest le*

### *vels*

From 2004 to 2008, an average harvest of about 29 moose per year was reported by Yukon resident and non-resident hunters in GMS 3-07, 3-08, 3-10, 3-11 and 3-12 (which comprised the 2008 survey area) (Figure 10). The reported harvest increased over the 5-year period; licensed resident harvest in 2008 was the third highest harvest ever reported. There are no commercial outfitters in this area. The non-resident harvest was by Canadians hunting with a Yukon resident holding a Special Guide Licence. Harvest information from First Nation hunters was not available.

Between 2004 and 2008 licensed resident hunters harvested moose at a rate of 1.9% per year (Table 3) over the entire survey area. However, both GMS 3-07 and 3-12 experienced relatively high harvest rates of about 3% of the estimated number of moose within their boundaries.

When First Nation harvest data is not available, we generally assume that First Nation harvest equals the harvest by licensed residents. If that assumption is correct, then the harvest rates for GMS 3-07 and 3-12 would be 5.9% and 4.9% respectively. When the known moose deaths from road kills are also considered, the overall mortality rates in these GMS are even higher. Mortality rates in excess of 5% can carry an unacceptably high risk of initiating a population decline (Yukon Fish and Wildlife Branch 1996).

GMS 3-07 is in the area immediately south of Dawson City in the Gold Fields, which probably accounts for the relatively high harvest. GMS 3-12 is on the east

side of the Yukon River and north of the Stewart River, making it relatively accessible to hunters. Both of these areas have always seen high levels of hunting activity. In GMS 3-07 the bull to cow ratio was low at about 29 adult bulls per 100 adult cows. A ratio of 30 adult bulls per 100 adult cows is the minimum we would like to see to ensure adult cows are being bred (Yukon Fish and Wildlife Branch 1996).

### *Other wildlife sightings*

In addition to the 330 moose we counted during the 2008 survey, we also observed 65 moose outside of the blocks that were surveyed, or just outside of the survey boundary. The total number observed during the entire survey period was 395 moose.

During the survey, we also recorded observations of other wildlife. One caribou was located southwest of Mt. Bronson. A total of 41 wolves were seen in 4 groups, the largest was a pack of 21 wolves along the Indian River. We also recorded 5 lynx, 1 owl, and 1 red fox.

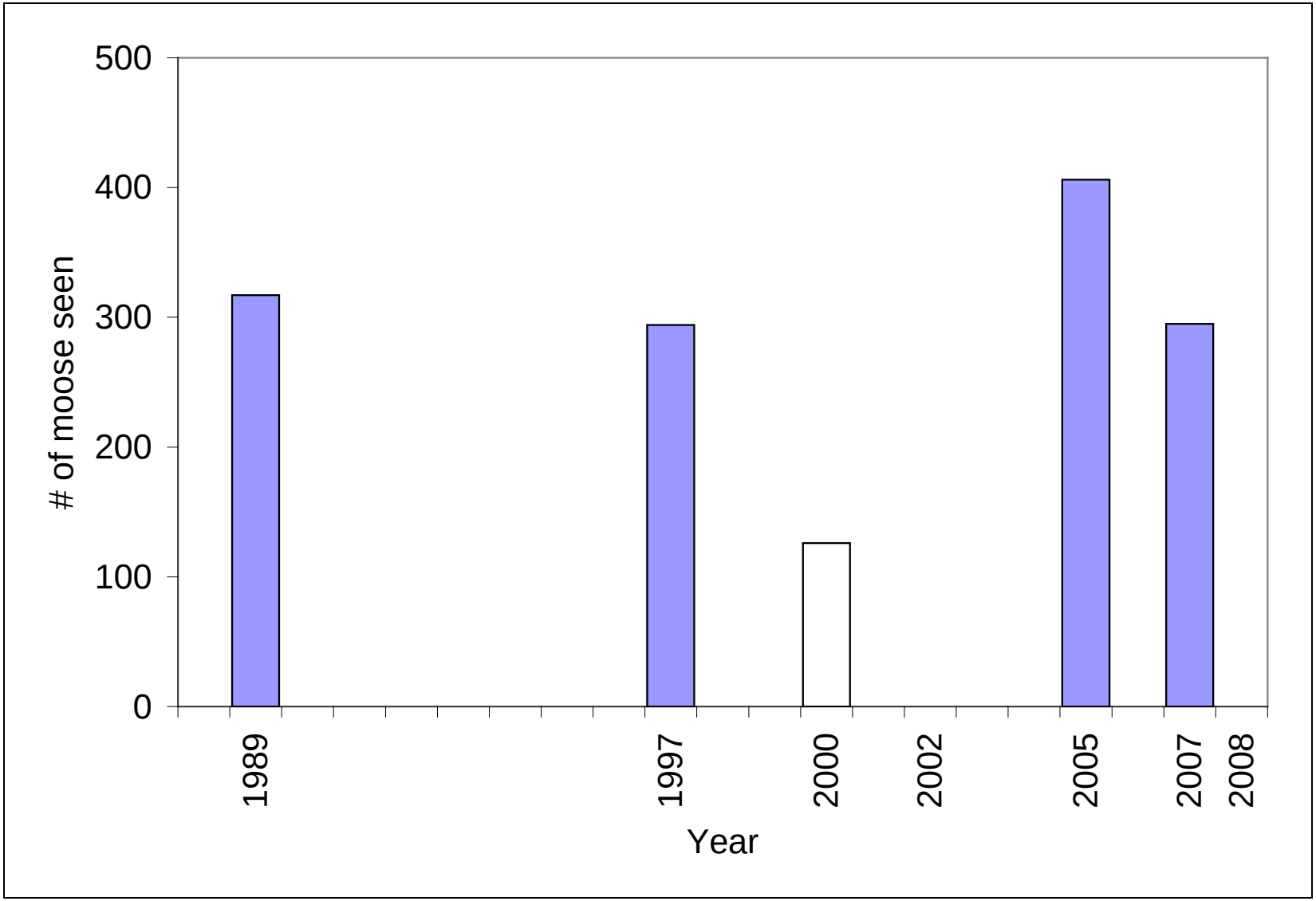


**Figure 8.** Number of moose seen during early-winter stratification surveys in the Dawson East survey area.

Results of these surveys are used as an index of trend between large census surveys. The 2000 survey result should be used with caution. No stratification flights were done for the 2002 or 2008 census surveys (see text).

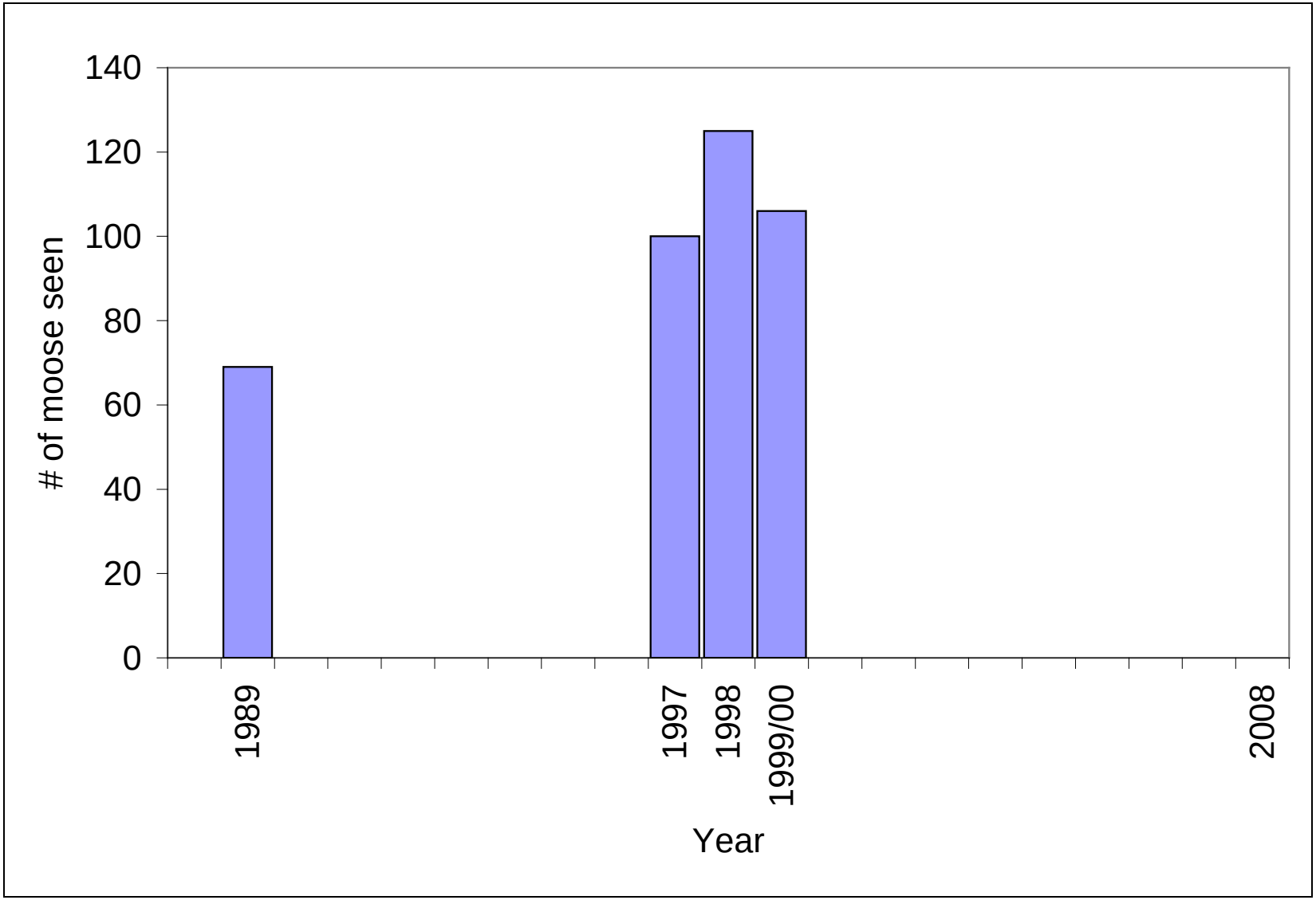


**Figure 9.** Number of moose seen during early-winter trend surveys in the Dawson East survey area.

Results of these surveys are used as an index of trend between large census surveys.

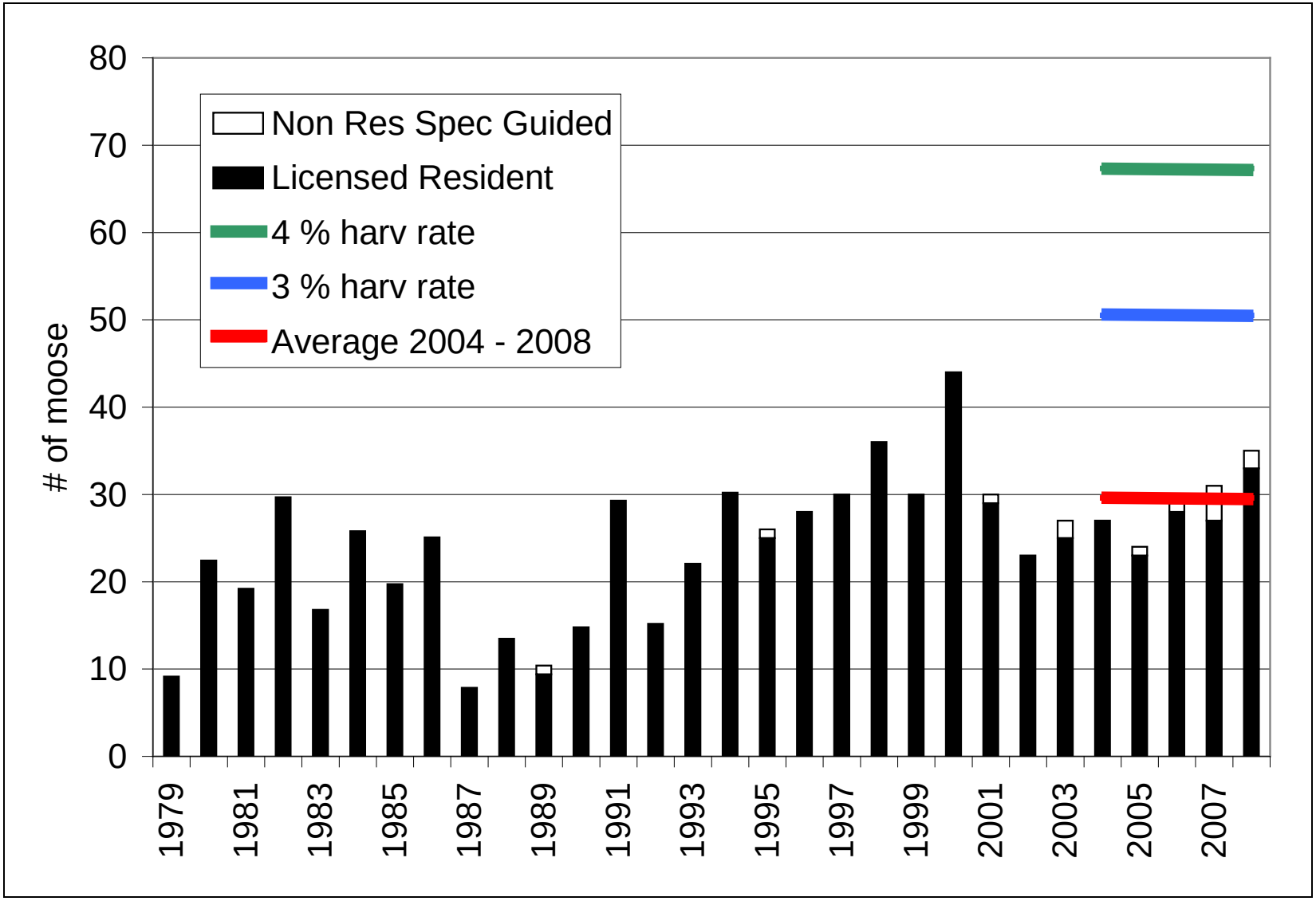


**Figure 10.** Annual moose harvest by licensed hunters in the 2008 Dawson moose survey area (GMS 3-07, 3-08, 3-10 to 3-12).

**Table 3.** Average annual (2004-2008) reported moose harvest and allowable harvest for the 2008 Dawson survey area by Game Management Subzone (GMS).

| GMS | GMS area ($km^2$) | Estimated density [1] (moose/ 1000 $km^2$) | Total estimated number of moose | Average Resident harvest | Average non-resident harvest | Average total licensed harvest | Harvest rate [2] (% of total population) | 3% Allowable Annual Harvest | 4% Allowable Annual Harvest |
|---|---|---|---|---|---|---|---|---|---|
| 3-07 | 1244.1 | 265 | 329.7 | 9.8 | 0 | 9.8 | 3.0 | 9.9 | 13.2 |
| 3-08 | 1382.3 | 270 | 373.2 | 4.4 | 0 | 4.4 | 1.2 | 11.2 | 14.9 |
| 3-10 | 1403.4 | 330 | 463.1 | 4.2 | 0.4 | 4.6 | 1.0 | 13.9 | 18.5 |
| 3-11 | 1123.9 | 260 | 292.2 | 4.2 | 0.2 | 4.4 | 1.5 | 8.8 | 11.7 |
| 3-12 | 834.0 | 270 | 225.2 | 5.0 | 1.0 | 6.0 | 2.7 | 6.8 | 9.0 |
| **Total** | **5987.7** | **281** | **1683.4** | **27.6** | **1.6** | **29.2** | **1.9** | **50.6** | **67.3** |

[1]Based on 2008 Dawson moose survey results

[2]Does not include harvest by First Nation hunters

## Conclusions and Recommendations

We estimate there were about 1,680 moose in the Dawson survey area in November 2008. Overall, numbers of moose in the survey area appear to be similar to those recorded during previous surveys since 1989. The estimated density was about 281 moose per 1,000 km² of total area, which was much higher than the Yukon-wide average of 158 moose per 1,000 km² of total area.

The adult bull to cow ratio and the number of calves in the Dawson East Comparison Area (GMS 3-07 and 3-10) was lower than in 1989. Over the entire survey area, however, the bull to cow ratio was still sufficient to ensure that adult cows are bred during the rut, and the number of calves did not indicate the start of a population decline.

The average reported moose harvest by licensed hunters (2004-2008) was 1.9% of the population; however this does not include harvest by First Nation hunters. If we assume First Nations harvest was the same as licensed hunters, then the overall harvest rate would be about 3.5%.

Harvest in GMS 3-07 and 3-12 was particularly high. If we assume First Nation harvest was the same as licensed hunters', then the harvest rate in these 2 subzones would be about 5.9% and 4.9% respectively. Generally, harvest in excess of 5% of the total population can carry a very high risk of initiating a population decline.

Harvest in the survey area has been generally increasing since 2000.

If the increasing harvest trend continues, combined with the low bull to cow ratio recorded for GMS 3-07, then we will be increasingly concerned about a potential population decline in the area. Annual assessments and of harvest trends are needed and updated population information will be needed to inform these assessments.

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# APPENDIX 1. Detailed results of 2008 survey

Summary of the 2008 Dawson moose survey, and comparison with results from 1989, 1997 and 2002 surveys of the western portion (GMS 3-07, 3-10) of the 2008 study area. No sightability correction factor is included in results.

| | Entire Area | | Dawson Comparison Area (GMS 3-07, 3-10) | | | |
|---|---|---|---|---|---|---|
| **POPULATION CHARACTERISTICS** | **2002** | **2008** | **1989** | **1997** | **2002** | **2008** |
| Survey Technique/Analysis | Geo-Spatial (updated) | Geo-Spatial | SRB/MoosePop | SRB/MoosePop | Geo-Spatial (updated) | Geo-Spatial |
| Estimated Abundance[1] | | | | | | |
| Total Moose (90% Confidence Range) [2] | 1001±18% (822-1181) | 1580±16% (1321-1839) | 610±16% (513-708) | 574±15% (490-659) | 507±22% (393-621) | 724±20% (582-865) |
| Density (moose per 1000 km$^2$ of Habitat) | 169 | 267 | 238 | 224 | 195 | 279 |
| Density (moose per 1000 km$^2$ of Total | 167 | 264 | 238 | 224 | 192 | 273 |
| Estimated Composition (90% Confidence | | | | | | |
| Mature Bulls ($\geq$ 30 months) | 214±28% (153-274) | 359±29% (254-464) | 141±27% (103-180) | 162±23% (124-199) | 97±36% (62-131) | 166±34% (110-222) |
| Mature Cows ($\geq$ 30 months) | 540±20% (430-649) | 817±16% (684-951) | 217±18% (177-257) | 237±16% (198-276) | 280±25% (210-350) | 360±19% (291-429) |
| Yearlings (Approx. 18 months) | 92±44% (52-132) | 123±40% (74-172) | 88±27% (65-112) | 91±42% (53-130) | 41±57% (18-65) | 52±54% (24-80) |
| Calves ($\leq$ 12 months) | 152±22% (119-184) | 299±25% (224-374) | 164±24% (125-203) | 85±28% (61-108) | 81±26% (60-101) | 138±26% (102-174) |
| Unknown | 3±129% (0-7) | - | - | - | - | - |
| Estimated Population Ratios (90% Conf. | | | | | | |
| Mature Bulls per 100 Mature Cows | 40±29% (28-51) | 44±33% (29-58) | 65±30% (46-85) | 68±29% (48-88) | 35±38% (21-48) | 46±39% (28-64) |
| Yearlings per 100 Mature Cows | 17±46% (9-25) | 15±43% (8-22) | 41±33% (27-54) | 39±47% (20-57) | 15±60% (6-24) | 14±58% (6-23) |
| Calves per 100 Mature Cows | 28±23% (22-34) | 36±28% (26-47) | 76±18% (62-90) | 36±24% (27-44) | 29±28% (21-38) | 38±31% (26-50) |
| Mature Bulls: Percent of Total Population | 21±25% (16-27) | 23±22% (18-28) | 23±21% (18-28) | 28±18% (23-33) | 19±33% (13-26) | 23±26% (17-29) |
| Mature Cows: Percent of Total Population | 54±16% (45-62) | 52±21% (41-62) | 35±13% (31-40) | 41±15% (35-47) | 55±19% (44-65) | 50±26% (37-63) |
| Yearlings: Percent of Total Population | 9±40% (5-13) | 8±37% (5-11) | 14±25% (11-18) | 16±35% (10-22) | 8±54% (4-12) | 7±51% (4-11) |
| Calves: Percent of Total Population | 15±22% (12-18) | 19±23% (15-23) | 27±13% (23-30) | 15±21% (12-18) | 16±27% (12-20) | 19±24% (14-23) |
| Unknown: Percent of Total Population | <1±130% (0) | - | - | - | - | - |
| Twinning Rate (%) | 2±136% (0-5) | 9±61% (4-15) | 28±19% (23-34) | 6±69% (2-11) | 3±108% (0-7) | 6±109% (0-14) |

| | Entire Area | | Dawson Comparison Area (GMS 3-07, 3-10) | | | |
|---|---|---|---|---|---|---|
| **SURVEY CHARACTERISTICS** | **2002** | **2008** | **1989** | **1997** | **2002** | **2008** |
| Stratification | | | | | | |
| Survey Dates | Nov.27-29, 2000[v] | Nov.12, 14, 2008 | Oct. 23-27, | Nov. 4-6, 1997 | Nov.27-29, 2000 | Drylab Strat – not flown |
| Total Survey Area ($Km^2$) | 5983 | 5983 | 2565 | 2565 | 2647[vi] | 2647[vi] |
| Habitable Moose Range in Survey Area | 5913 | 5913 | 2565 | 2565 | 2595 | 2595 |
| Total Flight Time used during Stratification | 852 | 328 (E burn areas only) | 2119 | 1629 | Not Avail. | N/A (drylab) |
| Survey Time used during Stratification | 704 | 207 (E burn areas only) | 1702 | 1328 | Not Avail. | N/A (drylab) |
| Search Intensity (min. per $Km^2$) | 0.12 | 0.03 (E burn areas) | 0.66 | 0.52 | Not Avail. | N/A (drylab) |
| Number of Moose Seen | 311 | 117 (E burn areas only) | 317 | 294 | 126 | N/A (drylab) |
| Moose Seen per Minute | 0.44 | 0.57 (E burn areas) | 0.19 | 0.22 | Not Avail. | N/A (drylab) |
| Census | | | | | | |
| Survey Dates | Nov.28-Dec 6, 2008 | Nov.12-17, 2008 | Oct.27-30 1989 | Nov. 6-10 1997 | Nov.28-Dec.6 2002 | Nov.12-17, 2008 |
| Number of Sample Blocks Searched | 69 | 67 | 30 | 30 | 26 | 33 |
| Area Searched ($Km^2$) | 1059 | 1028 | 930 | 933 | 398 | 505 |
| Percentage of Habitable Moose Range | 18 | 17 | 36 | 36 | 15 | 19 |
| Total Flight Time used during Census | 4401 | 3151 (excludes SCF) | 2664 | 2645 | Not Avail. | Not Avail. |
| Survey Time used during Census (min.) | 2640 | 2108 (excludes SCF) | 1796 | 1913 | 1037 | 1031 |
| Search Intensity (min. per $Km^2$) | 2.49 | 2.05 | 1.93 | 2.05 | 2.61 | 2.04 |
| Number of Moose Seen | 259 | 330 | 346 | 309 | 111 | 157 |
| Moose Seen per Minute | 0.10 | 0.16 | 0.19 | 0.16 | 0.11 | 0.15 |

i. To allow for comparison across years, no sightability correction factor is included in estimates provided. Any differences between the total estimated moose abundance and the sum of the estimated composition numbers for the 2002 results is due to the nature of the Kriging or geo-spatial population estimation method.

ii. This means that we are 90% sure that the true number of moose in the area lies within the range of moose numbers given in the brackets.

iii. To account for yearling cows that cannot be identified from the air, the total number of yearlings is assumed to equal 2x estimated number of yearling bulls in the population.

iv. Twinning Rate = the number of cows with 2 calves divided by the total number of cows with calves.

v. 2000 stratification data used to stratify 2002 Dawson survey area.

vi. Dawson Comparison area was slightly larger in 2002 than in past years because of the lat/long grid used.

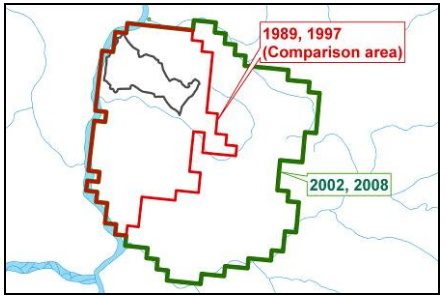
vii. 2000 stratification data used to stratify 2002 Dawson survey area.

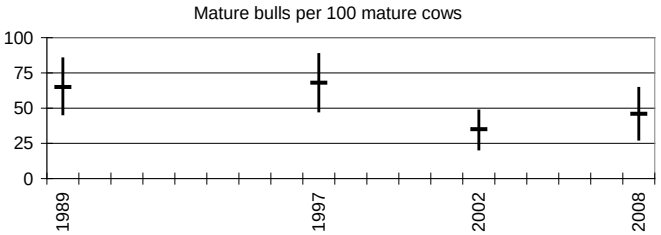
viii. Dawson Comparison area was slightly larger in 2002 than in past years because of the lat/long grid used.

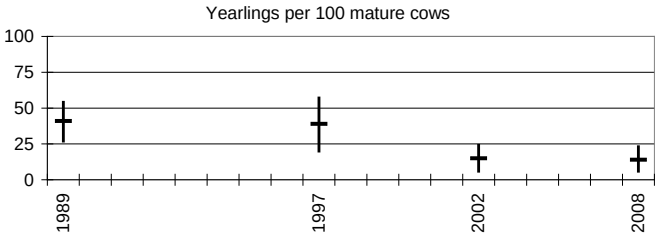
# APPENDIX 2. Summary of all surveys

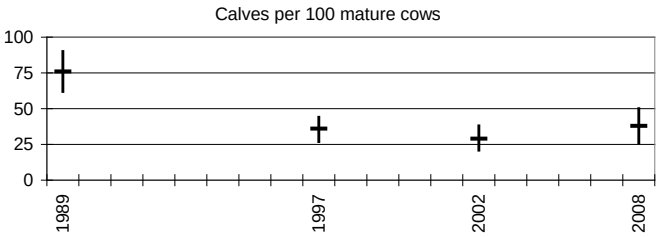
## POPULATION CENSUS SURVEYS

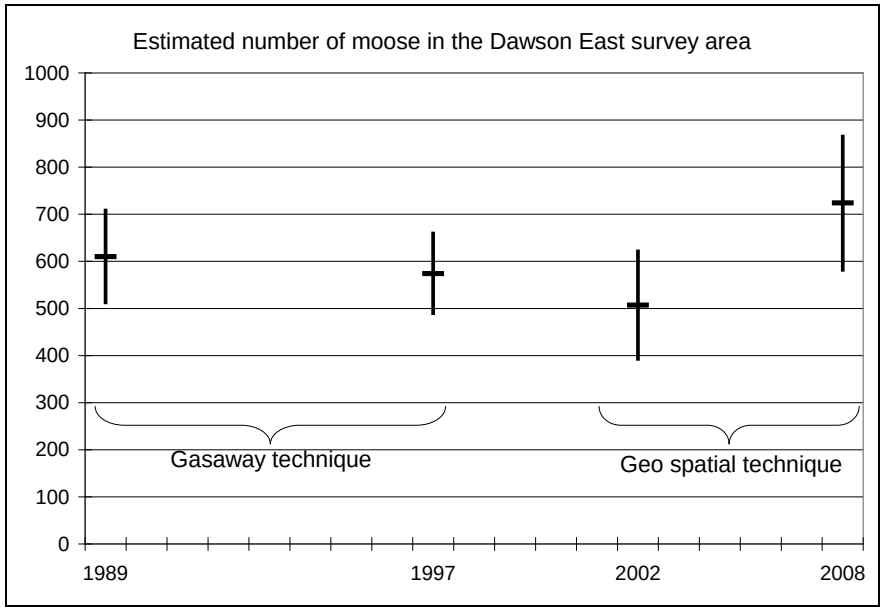
- estimate of population size (abundance)
- done in early winter therefore we have composition information
- 2 phases: stratification and census
- to compare all areas, we need to subset the 2002 and 2008 surveys to compare only the same area counted in 1989 and 1997 (Comparison Area**)**



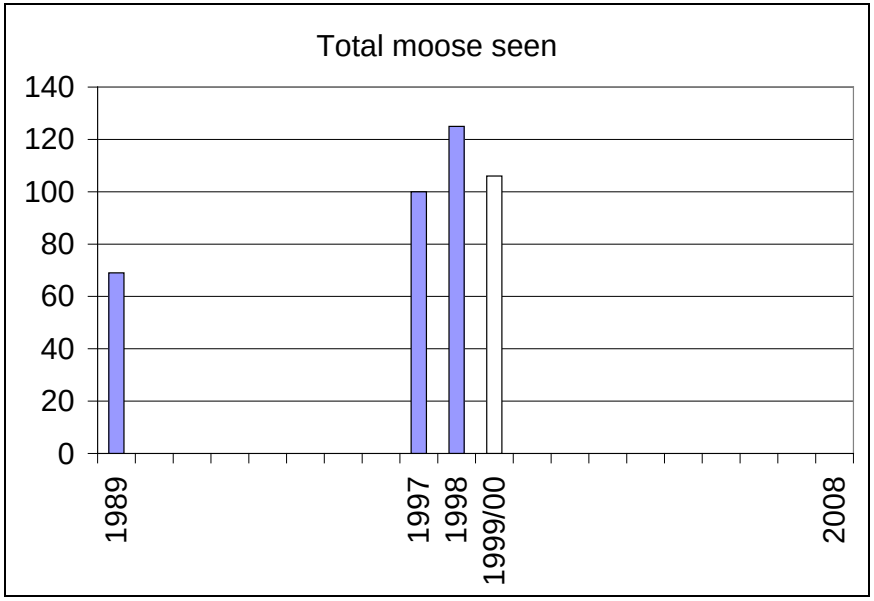



BOTTOM LINE: Little change in the estimated number of moose.

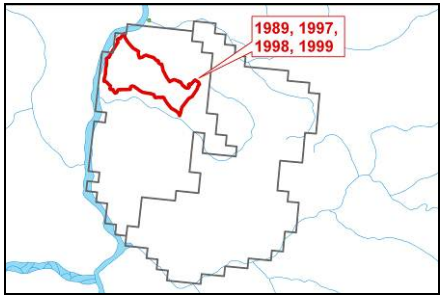
Lower mature bull to mature cow ratio, but still enough to breed.

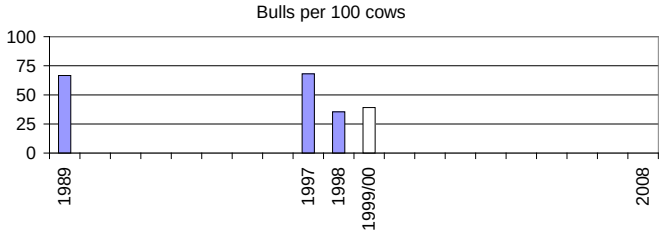
Low ratio of yearling and calves to mature cows but doesn't seem to result in a declining population.

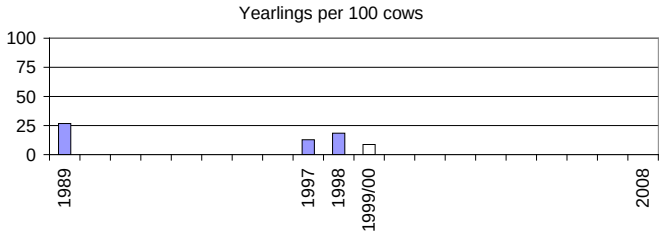


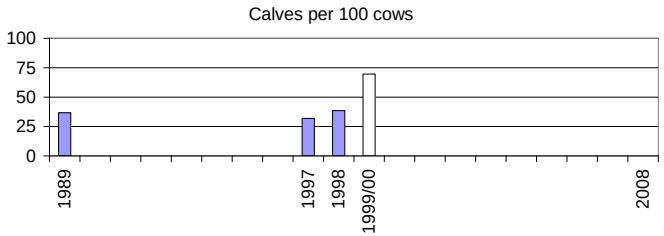

## TREND SURVEYS

- index of population trend
- done in early winter therefore we have composition information
- the 1999/00 survey was done later than usual (January) therefore results should be considered with caution
- we no longer do these surveys





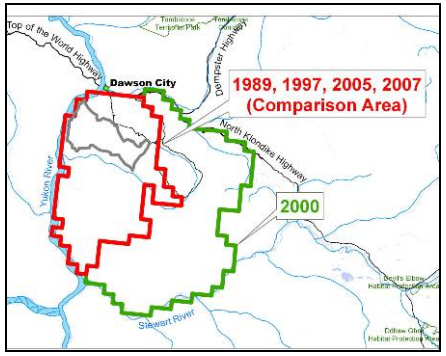



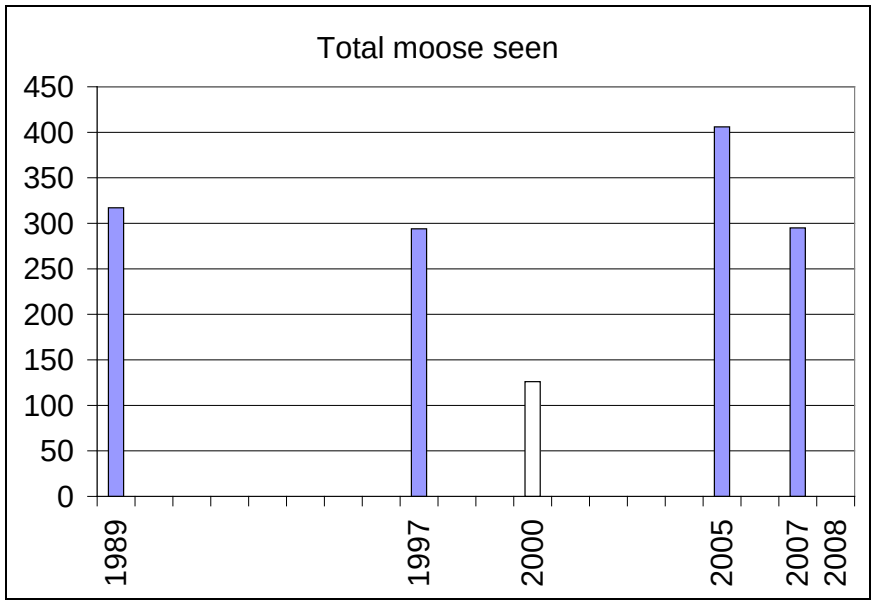



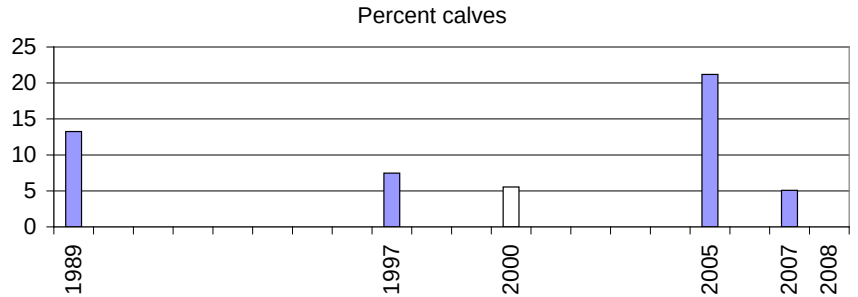

BOTTOM LINE: Indicate more moose and better population characteristics in the late 1990's than in 1989 – inconsistent with the census surveys.

## STRATIFICATION SURVEYS

- index of population trend
- can be done in early winter (we get composition information) or late winter (no composition, only adult/calf information)
- we can also use the stratification phase of early winter census surveys
- to compare all areas, we need to subset the 2000 survey to compare only the same area counted in 1989 and 1997 (Comparison Area)
- again, the 2000 survey results are questionable (see text)
- the stratification phases of the 2002 and 2008 census surveys were 'drylab' stratification and are not comparable to these surveys.






BOTTOM LINE: Little change in number of moose seen.

Percent calves lower than we like to see but census results do not show a population decline.

# APPENDIX 3. 1997 Dawson Moose Survey Results Summary

We did a moose count in the Dawson gold fields area in early November, 1997. The area we surveyed ran from Hunker Creek in the east, to the Yukon River and from Henderson Creek in the south, running north to the Klondike Highway (see the attached map). It covered a total of about 2565 square kilometers (about 990 square miles). We did a moose count in this area once before in 1989.

A description of how we do moose counts is presented in the Yukon Government publication entitled "Yukon Moose". To receive a copy of this publication contact your local Department of Renewable Resources Field Services Office or the Department of Renewable Resources Moose Management Unit at 10 Burns Road, Whitehorse; phone (867) 667-5787. Two local First Nations members, Darren Kormendy and Michael Mason worked with us on the moose count. The results of the survey are reported in attached table.

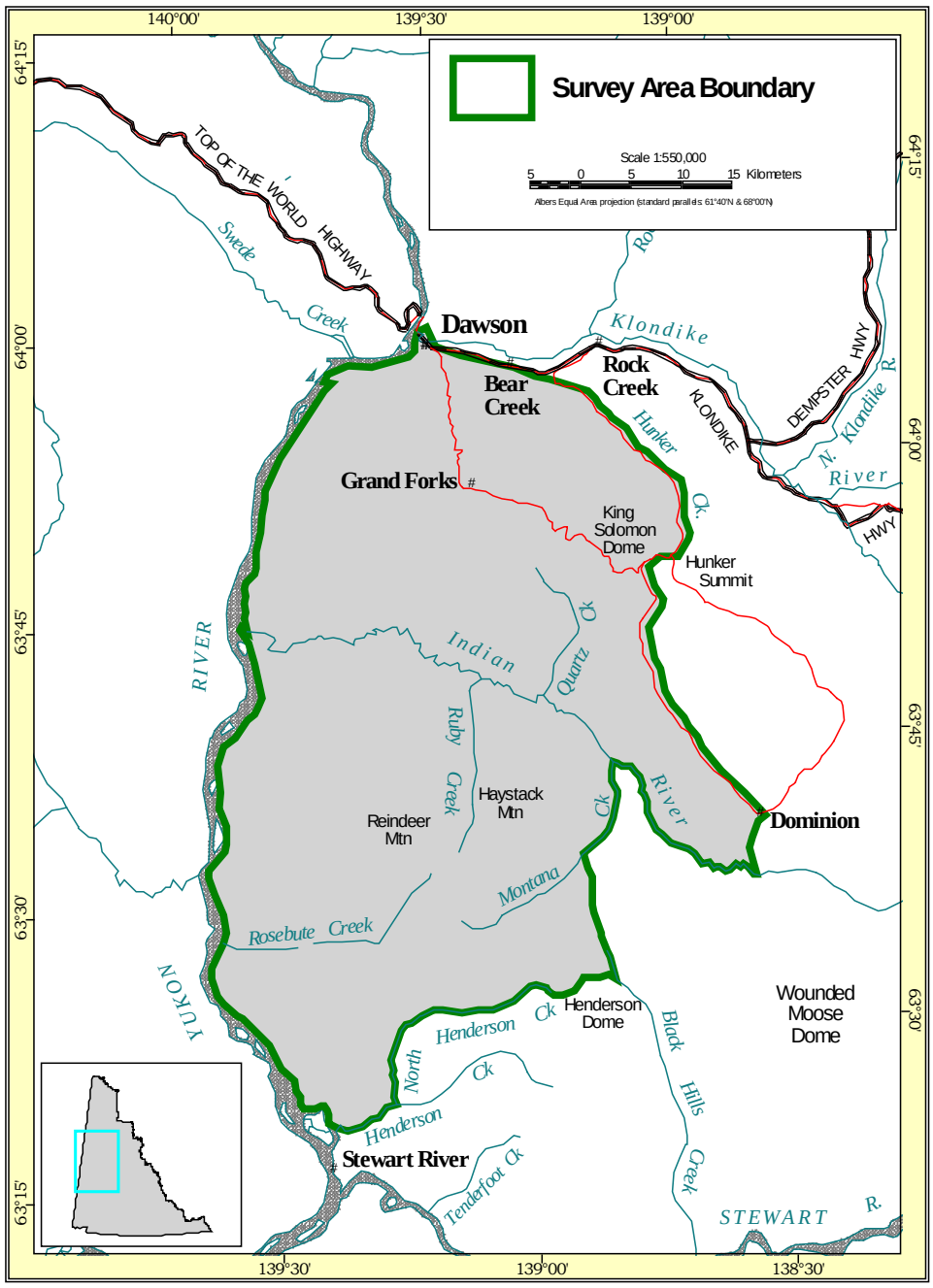
We estimate that there were about 626 moose (average density = 244 moose for every 1000 $Km^2$) in the survey area in 1997. This moose abundance is high by Yukon standards. Similar size areas around Mayo and Whitehorse would have about half as many moose (120 to 130 moose for every 1000 $Km^2$). In contrast, however, a similar size area around Finlayson Lake would probably have about 865 moose (337 moose for every 1000 $Km^2$).

Our 1997 estimate of moose abundance is a little lower than our 1989 estimate of about 691 moose in the same area. However, there were probably about the same number of moose in the area in 1997 as there were in 1989 ($P>0.05$). The lower estimate in 1997 is most likely due to small errors associated with the way we do our moose counts. It would be very expensive to make our moose counts accurate enough to pick up small changes like this.

Of the estimated 626 moose in the area in 1997, 258 were mature cows, 176 were mature bulls, 100 were yearlings (male and female combined) and 92 were calves. These numbers are within the range that we would expect in a healthy, stable to slowly increasing moose population.

The Dawson gold fields area can probably sustain a harvest of about 25 moose per year. Resident hunters reported harvesting an average of 9 moose per year between 1992 and 1996. There are no big game outfitters in the area but 1 moose was taken in 1995 by a non-resident who was being guided by a resident under a special guiding permit. We do not have information on the moose harvest by First Nations in this area.

In summary, moose abundance in the Dawson gold fields area is above average and appears to be stable. The reported moose harvest is well within sustainable limits but we do not know how many moose First Nations members harvest in the area each year.




**Map 1. 1997 Dawson East Moose Survey Area**

**Table 1. Summary of 1989 and 1997 Dawson Gold Fields Survey Results**

| POPULATION CHARACTERISTICS | 1989[1] | 1997[2] |
|---|---|---|
| Estimated Abundance (90% C.I.) | | |
| Total Moose | 691 (536-847) | 626 (522-730) |
| Density (Moose per 1000 $Km^2$) | 270 | 244 |
| Estimated Composition | | |
| Mature Bulls ($\geq$ 30 months) | 160 | 176 |
| Mature Cows ($\geq$ 30 months) | 245 | 258 |
| Yearlings (Approx. 18 months) | 100 | 100 |
| Calves | 186 | 92 |
| Estimated Ratios | | |
| Mature Bulls per 100 Mature Cows | 65 | 68 |
| Yearlings per 100 Mature Cows | 41 | 39 |
| Calves per 100 Mature Cows | 76 | 36 |
| Mature Bulls: % of Total Population | 23% | 28% |
| Mature Cows: % of Total Population | 35% | 41% |
| Yearlings: % of Total Population | 14% | 16% |
| Calves: % of Total Population | 27% | 15% |
| Twinning Rate | 28% | 6% |
| **SURVEY CHARACTERISTICS** | | |
| Stratification | | |
| Survey Dates | Oct. 23 - Oct. 27 | Nov. 4 - Nov. 6 |
| Area searched ($Km^2$) | 2565.1 | 2565.1 |
| Time used in search (minutes) | 1702 | 1328 |
| Search Intensity (min. per $Km^2$) | 0.66 | 0.52 |
| Moose seen | 317 | 294 |
| Moose seen per minute | 0.19 | 0.22 |
| Census | | |
| Survey Dates | Oct. 27 - Oct. 30 | Nov. 6 - Nov. 10 |
| Area Searched ($Km^2$) | 929.7 | 932.8 |
| Percentage of total area searched | 35.6% | 36.4% |
| Time used in search (minutes) | 1796 | 1913 |
| Search Intensity (minutes per $Km^2$) | 1.93 | 2.05 |
| Moose seen | 346 | 309 |
| Moose seen per minute | 0.19 | 0.16 |

1. Sightability Correction Factor of 1.13 incorporated in population estimates

2. Sightability Correction Factor of 1.09 incorporated in population estimates

# APPENDIX 4. 1998 Dawson Moose Trend Survey Summary

We did a moose population trend count in a 429 square kilometer area south of Dawson between November 27 and December 1, 1998. The survey area runs from King Solomon Dome in the east, to just north of Baker Creek on the Yukon River. From there, it runs south along the Yukon River to Jim Creek, and then angles east to the intersection of Quartz Creek and the Indian River (see attached map). We started doing moose trend counts in this area in 1997.

We plan to do a count in this area every year to follow changes in moose numbers. We call this type of survey a *moose population trend survey*. It is intended to provide a low-cost alternative to our more accurate, but much more expensive regional surveys, which are conducted about every 5 to 7 years. This 1997 trend survey area lies within the Dawson regional survey area that we surveyed in November 1989 and 1997. The information provided by trend surveys is particularly important in areas where moose are subject to high levels of predation, hunting, and land-use activities, because possible declines in moose populations can be detected at an earlier stage.

To conduct a moose trend count we select a small, representative portion of a regional intensive survey area. We fly this smaller area with a fixed-wing aircraft, and the location, age and sex of moose found is recorded on maps. A more detailed discussion of how we do moose trend surveys is given in the Yukon Government publication entitled "Summary of Yukon moose population trend survey results 1988 and 1989". To receive a copy of this publication contact your local Department of Renewable Resources Field Services Office or the Department of Renewable Resources Moose Management Unit at 10 Burns Road, Whitehorse; or phone: 867-667-5787.

We counted a total of 125 moose during the 1998 Dawson trend survey. Sixty-five were mature cows, 23 were mature bulls, 12 were yearlings, and 25 were calves (Table 1). These numbers are generally characteristic of a stable or slowly increasing moose population. The ratio of 39 calves for every 100 cows observed during the trend is a little higher than the 30 calves for every 100 cows normally considered necessary to maintain a stable moose population. The 35 mature bulls for every 100 mature cows is lower than the Yukon average but should be sufficient to ensure that all cows are bred during the rut.

This is only the second year that we have done trend surveys in this area. A minimum of about 5 years data are generally needed before trends in moose population abundance and composition can be determined with confidence. It is interesting to note, however, that 25 more moose were observed in the area in 1998 than in 1997 (Table 1). Calves and yearlings also made up a larger proportion of moose observed in 1998. Although the area's moose population could not have increased by 25 percent in one year, this may support our observation, based on 1997 and 1998 population composition, that moose numbers are likely stable or increasing slowly. Again, additional years of data will be needed to confirm the trend.

Table 1. Summary of 1997 and 1998 Dawson Trend Survey Results.

| **POPULATION CHARACTERISTICS** | **1997** | **1998** |
|---|---|---|
| Observed Abundance | | |
| Total Moose Seen | 100 | 125 |
| Observed Composition | | |
| Mature Bulls (≥ 30 months) | 32 | 23 |
| Mature Cows (≥ 30 months) | 47 | 65 |
| Yearlings (Approx. 18 months) | 6 | 12 |
| Calves | 15 | 25 |
| Observed Ratios | | |
| Mature Bulls per 100 Mature Cows | 68 | 35 |
| Yearlings per 100 Mature Cows | 13 | 19 |
| Calves per 100 Mature Cows | 32 | 39 |
| Mature Bulls: % of Total Population | 32 | 18 |
| Mature Cows: % of Total Population | 47 | 52 |
| Yearlings: % of Total Population | 6 | 10 |
| Calves: % of Total Population | 15 | 20 |
| **SURVEY CHARACTERISTICS** | | |
| Survey Dates: | Nov. 21, 23-25 | Nov. 27 – Dec. 1 |
| Area Searched ($Km^2$): | 428.6 | 428.6 |
| Time used in search (minutes): | 869 | 888 |
| Search Intensity (min. per $Km^2$) | 2.03 | 2.07 |

# APPENDIX 5. 1999/2000 Dawson Moose Trend Survey Summary

We did a moose population trend count in a 429 square kilometer area south of Dawson in late January, 2000. The survey area runs from King Solomon Dome in the east, to just north of Baker Creek on the Yukon River. From there, it runs south along the Yukon River to Jim Creek, and then angles east to the intersection of Quartz Creek and the Indian River (see attached map). We started doing moose trend counts in this area in 1997.

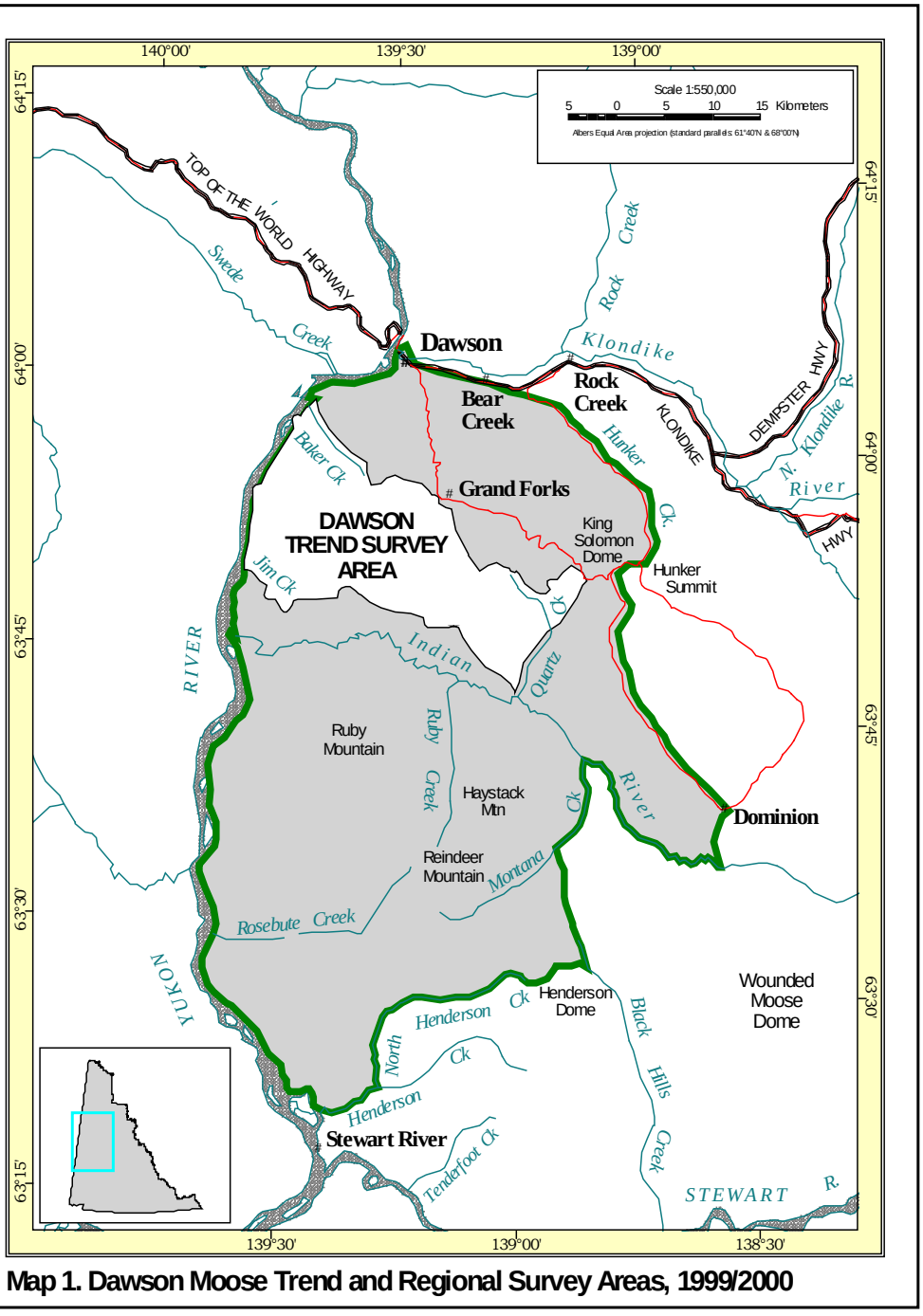
We plan to do a count in this area every year to follow changes in moose numbers. We call this type of survey a *moose population trend survey*. It is intended to provide a low-cost alternative to our more accurate, but much more expensive regional surveys, which are conducted about every 5 to 7 years. This 1997 trend survey area lies within the Dawson regional survey area that we surveyed in November 1989 and 1997. The information provided by trend surveys is particularly important in areas where moose are subject to high levels of predation, hunting, and land-use activities, because possible declines in moose populations can hopefully be detected at an earlier stage.

To conduct a moose trend count we select a small, representative portion of a regional intensive survey area. We fly this smaller area with a fixed-wing aircraft, and the location, age and sex of moose found is recorded on maps. A more detailed discussion of how we do moose trend surveys is given in the Yukon Government publication entitled "Summary of Yukon moose population trend survey results 1988 and 1989". To receive a copy of this publication contact your local Department of Renewable Resources Field Services Office or the Department of Renewable Resources Moose Management Unit at 10 Burns Road, Whitehorse; or phone: 867-667-5787.

Poor weather conditions and aircraft availability during the 1999 field season prevented us from flying the Dawson trend survey until late January 2000. Between January 25-28, we counted a total of 106 moose in the trend survey area. Twenty-three were mature cows, 9 were mature bulls, 2 were yearlings, 16 were calves, and 56 were of unknown age or sex (Table 1). The high number of unclassified animals is due to the timing of the survey. A large number of the bulls had already dropped their antlers, making it difficult to determine the sex and age of animals counted. Only those bulls observed with antlers or pedicle scars were classified as mature or yearling bulls.

Because so many moose could not be classified (53% of the total counted) the population composition and ratios of mature bulls, yearlings, and calves per 100 mature cows are unreliable, and cannot readily be compared with past trend survey data. Total numbers of moose counted over the three years has been reasonably consistent, however, and suggests a fairly stable population.

This is only the third year that we have done trend surveys in this area. A minimum of about 5 years data are generally needed before trends in moose population abundance and composition can be determined with confidence.




**Map 1. Dawson Moose Trend and Regional Survey Areas, 1999/2000**

Table 1. Summary of 1997, 1998, and 1999/2000 Dawson Trend Survey Results.

| **POPULATION CHARACTERISTICS** | **1997** | **1998** | **1999/2000[1]** |
|---|---|---|---|
| Observed Abundance | | | |
| Total Moose Seen | 100 | 125 | 106 |
| Observed Composition | | | |
| Mature Bulls (≥ 30 months) | 32 | 23 | 9 |
| Mature Cows (≥ 30 months) | 47 | 65 | 23 |
| Yearlings (Approx. 18 months) | 6 | 12 | 2 |
| Calves | 15 | 25 | 16 |
| Unknown Age/Sex | - | - | 56 |
| Observed Ratios | | | |
| Mature Bulls per 100 Mature Cows | 68 | 35 | 39 |
| Yearlings per 100 Mature Cows | 13 | 19 | 9 |
| Calves per 100 Mature Cows | 32 | 39 | 70 |
| Mature Bulls: % of Total Population | 32 | 18 | 8 |
| Mature Cows: % of Total Population | 47 | 52 | 22 |
| Yearlings: % of Total Population | 6 | 10 | 2 |
| Calves: % of Total Population | 15 | 20 | 15 |
| Unknown Age/Sex: % of Total Pop. | - | - | 53 |
| SURVEY CHARACTERISTICS | | | |
| Survey Dates: | Nov. 21, 23-25 | Nov. 27 - Dec. 1 | Jan. 25-28, 2000 |
| Area Searched ($Km^2$): | 428.6 | 428.6 | 428.6 |
| Time used in search (minutes): | 869 | 888 | 860 |
| Search Intensity (min. per $Km^2$) | 2.03 | 2.07 | 2.01 |

[1] In the 1999/2000 season, the survey was conducted in late January instead of November. Due to the timing of the survey, moose were difficult to age and sex because a large proportion of the bulls had already dropped their antlers. Moose were counted as mature bulls or yearlings only if they had antlers or pedicle scars. The observed number of adults and yearling moose are under-represented for this year, making the observed ratios of mature bulls, yearlings and calves per 100 mature cows unreliable.

# APPENDIX 6. 2005 Dawson East Moose Stratification Survey Summary

We surveyed approximately 2647 square kilometers ($km^2$) in the Dawson East moose survey area (see Map 1) between November 8th and 12th, 2005. Large water bodies made up about 52 $km^2$ of the total area and were classified as non-moose habitat. The survey was conducted to provide current information on moose distribution and relative abundance as part of our planned regular monitoring of population trend in the area. Observations of other wildlife and habitat changes were also recorded.

We used a total of 24.4 hours (20.9 hrs search time + 3.5 hrs ferry time to/from the Dawson airport) to complete the survey. This provided an average search intensity of 0.47 minutes/$km^2$, within the normal range for this type of survey. An additional 4.1 hours was required to mobilize and demobilize the aircraft from Whitehorse. The survey was flown using a Maule M-7 aircraft with one pilot and 3 passengers. Martin Kienzler (Yukon Department of Environment) was the survey leader/navigator and Yukon Government staff and community members acted as observers (see Acknowledgements section).

Weather and snow conditions were excellent during the survey. Snow cover was complete throughout the survey area, and the trees and brush were covered with snow and / or thick frost. Not only did moose stand out against the snow, but disturbed areas (where frost and snow had been knocked off of vegetation) allowed us to easily identify areas where they would be located from quite a distance. Temperatures were consistently between -25° C on the ground in the morning, and warmed up to about -17° C during the day and at higher elevations during the flight. Skies were generally overcast to partly obscure with occasional light snow, producing cloudy-bright light conditions which are optimal for wildlife surveys.

### Population Abundance and Composition - 2005:

We counted a total of 406 moose (320 adults and 86 calves) in the survey area (Table 1). Whenever possible, observed moose were classified as cows (196), adult bulls (100), yearling bulls (12), or calves (86). Moose that could not be identified with certainty (12) were recorded as unknown sex and/or age. Dividing the total number of moose seen by

our search time produces a sighting rate of 0.32 moose seen per minute. Using the number of moose seen per minute and the regression equation developed by Ward et al. (2000) we estimate an average density of 272 (90% C.I. $\pm$72) moose/1000 km$^2$ (Table 1).

Population composition information derived from stratification surveys frequently has wide margins of error. We therefore limit our discussion to adults and calves. Calves made up 21% of moose observed during the 2005 survey. If this accurately reflects recruitment and harvest is held within allowable limits, it should be sufficient to maintain a stable to slowly increasing moose population.

## Population Trend - 1989 to 2005:

We can compare our 2005 survey results with those from past stratification surveys at several different levels. First, the total number of moose seen during the 2005 survey was substantially higher than that recorded during prior stratification surveys of the same area (Table 1). This is in spite of the fact that search intensity (minutes flown/km$^2$) during the 2005 survey was similar to or lower than that used during the 1989 and 1997 surveys of the same area (Table 1). Due to a different stratification method used, search intensity during our 2000 stratification of the area was substantially lower (~0.12 min. /km$^2$).

We can correct for differing search intensities by comparing the number of moose seen per minute of survey time. Similar to total numbers of moose seen, the moose sighting rate was substantially higher in 2005 (0.32 moose/min.) than during earlier surveys (Table 1). In contrast to our comparison of total numbers seen, however, the moose sighting rate was slightly higher in 1997 (0.22 moose/min.) than in 1989 (0.19 moose/min.). Search time is not available for the 2000 stratification of the area so we can not calculate a moose sighting rate for that survey.

A final assessment of moose abundance and population trend can be done using density estimates derived using moose sighting rates and the regression equation developed by Ward et al. (2000). The resulting density estimates mirror our comparison of sighting rates but have the advantage of providing confidence intervals allowing statistical analysis. While total numbers of moose seen and moose sighting rates during our 1989, 1997, and 2005 stratification surveys suggest an increasing trend in moose abundance, density estimates derived from these surveys are not significantly different

(P>0.1). This reduces the reliability of conclusions based on numbers of moose seen that moose abundance is increasing in the area. In addition, results from intensive census surveys of the Dawson East area conducted in 1989, 1997, and 2002 suggest that moose abundance in the area has in fact declined (Table 1). As with densities derived from stratification surveys, however, densities calculated from past intensive surveys were not significantly different (P>0.1). A more detailed discussion of past intensive population survey results and methods are given in the 2002 Dawson moose survey summary report (Yukon Renewable Resources 2002).

Between-year differences in moose sighting rates and abundance estimates from stratification surveys may be at least partially due to varying survey conditions, moose distribution and changes in habitat. We do not have reliable records of survey conditions during the 1989 and 1997 stratification surveys, but as previously noted, weather conditions and survey timing (November 8th to 12th) were optimal during the 2005 survey. Fresh snow and excellent light conditions meant the moose could be spotted from a considerable distance. Sightability was also enhanced in 2005 by the clumped distribution of moose. Many of the moose were still in post-rut aggregations in relatively open sub-alpine habitat, or in willow thickets at the headwaters of creeks. The huge forest fire that burned through the area in 2004 had the further effect of concentrating moose by reducing suitable habitat to high draws and creeks, where there remained adequate willow thickets amidst large tracks of thoroughly burned-out hillsides.

Differences in survey conditions and methods may also be responsible for the apparent large decline in moose abundance between our 1997 and 2002 intensive population surveys (Yukon Renewable Resources 2002). Survey timing (late October and early November) and snow conditions (complete ground cover) were good during the 1989 and 1997 surveys. In contrast, the 2002 survey did not begin until November 28 and extended through to December. Post-rut moose aggregations may have begun to break down by that time. While the 1989 and 1997 surveys were conducted using helicopters with a pilot and three observers, the 2002 survey was done using small fixed-wing aircraft with a pilot and only one observer. In addition, an extended warm period shortly after the start of the 2002 survey resulted in marginal snow cover with many patches of bare ground showing. These differences undoubtedly led to reduced sightability. Although sightability correction factors were developed and applied for the 1989 and 1997 surveys, none is available for the 2002 survey so the significance of these factors can not be assessed.

## Harvest:

Based on moose densities from past and current intensive surveys that have been extrapolated to Game Management Subzones (GMS 3-07, 3-10) that lie within the Dawson East survey area; the total population for this area has been estimated at 622 moose (Table 2). Assuming this is accurate, the current average estimated total annual harvest appears to be at or above the maximum allowable limit (Table 2). We normally set the allowable total annual harvest at 3% to 4% of the total estimated moose population in the area. This would mean the maximum allowable harvest for the entire survey area is 26 moose per year. The estimated average total annual harvest (assuming the First Nation harvest equals the residents non-First Nations harvest) in this area was 27 moose per year, 4.3% of the total estimated moose population.

The high harvest rate is of even more concern in the most accessible portion of the area. The total estimated harvest in Game Management Subzone 3-07 averaged 20 moose per year, nearly double the maximum allowable annual harvest of 12 moose per year (Table 2). Harvest rates of this magnitude run a significant risk of initiating a population decline. Extensive forest fires in the area increase this risk by concentrating moose in the remaining patches of available habitat making them vulnerable to over-exploitation. Moose are also much more visible when they move into these burned areas further increasing their vulnerability.

## Summary and Recommendations:

In conclusion, stratification surveys in 1989, 1997 and 2005 suggest an increasing population trend, while intensive population surveys conducted in 1989, 1997 and 2002 suggest a declining trend. Differing survey conditions and methods are likely at least partially responsible for the variability in estimates of abundance and population trend. These estimates of abundance are not statistically different, however, and if any change in abundance has occurred, it probably does not exceed 25% of our original 1989 population estimate. Additional monitoring will be required to confirm this speculative conclusion. Our current monitoring schedule calls for the Dawson East moose survey area to be resurveyed in 2007. The current high estimated harvest rate in the area remains a concern as it creates a significant risk of initiating a population decline.

## Other Wildlife Sightings:

We observed little sign of species, other than moose, during the 2005 survey. While conditions were almost ideal for observing moose, they were not good for seeing tracks. One pack of 5 wolves and their tracks were observed along a ridge between Jim and Bertha creeks, and a moose kill was seen at the south end of Soda Creek near King Solomon Dome.


## Acknowledgements:

Gerd Mannsperger, chief pilot of Alpine Aviation (Yukon) Ltd. provided safe and efficient flying during the survey. We thank Willy Fellers of the Dawson Renewable Resources Council, and Dawson community members: Sylvain Fluerent, Dennis Dunn, Clayton Hunt, and Francis Poulin for acting as observers during the survey. Finally, we thank Dorothy Cooley, Russel Oborne, Shawn Hughes and Alice McCulley (Yukon Department of Environment), for making time in their busy schedules to take part in the survey.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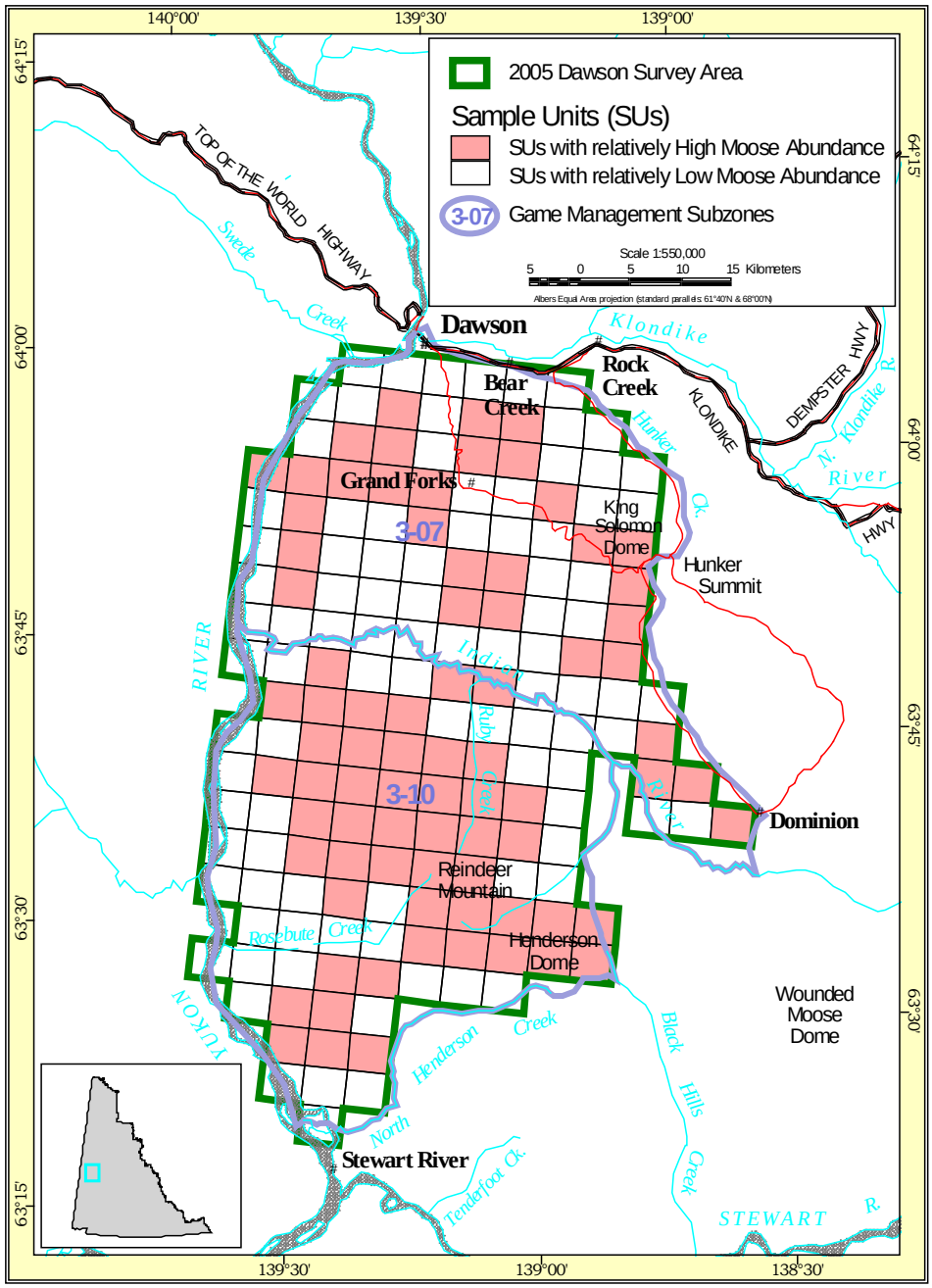


**Map 1. 2005 Dawson East Moose Stratification Survey Results**

**Table 1. Summary of Moose Stratification Survey Characteristics and Results from the 2005 and past surveys (1989, 1997, 2000) of the Dawson East Moose Survey Area (Game Management Subzones 3-07 and 3-10).**

| Survey Year | 1989 | 1997 | 2000 | 2005 |
|---|---|---|---|---|
| **Stratification Survey Characteristics:** | | | | |
| Survey Dates: | 23-37 Oct. | 4-6 Nov. | 27-29 Nov. | 8-12 Nov. |
| Survey Area ($km^2$) | 2565 | 2565 | 2595 | 2595 |
| Survey Time (total minutes flown during survey) | 1702 | 1328 | N/A | 1256 |
| Search Intensity (minutes flown per $km^2$) | 0.66 | 0.52 | 0.12[1] | 0.47 |
| **Moose Numbers seen during Stratification surveys:** | | | | |
| Adults | 275 | 272 | 119 | 320 |
| Calves | 42 | 22 | 7 | 86 |
| Total Moose | 317 | 294 | 126 | 406 |
| Number of Moose seen per minute | 0.19 | 0.22 | N/A | 0.32 |
| **Estimated Moose Density (moose/1000 $km^2$ $\pm$ 90% C.I.):** | | | | |
| Density calculated from Stratification survey results[2] | 177$\pm$72 | 199$\pm$72 | N/A | 272$\pm$72 |
| Density estimated from Intensive Census survey results | 270$\pm$61[3] | 244$\pm$41[3] | 179$\pm$44[4] | N/A |
| Percent calves | 26[3] | 15[3] | 16[4] | 21 |

[1] Approximate: reflects search intensity used during stratification of larger Dawson survey area

[2] Calculated using number of moose seen per minute and the regression equation developed by Ward et al. (2000)

[3] From intensive census surveys where a pooled Sightability Correction Factor (SCF) is incorporated

[4] From Dawson East subset of 2002 census of larger Dawson survey area with no SCF applied

**Table 2. Average Annual (2000-2004) Reported Moose Harvest and Allowable Harvest Summary for the 2005 Dawson East Moose Survey Area (Game Management Subzones 3-07, 3-10)1**

| Game Management Subzones | Total Estimated Number of Moose | Average Annual Moose Harvest (2000-2004) | | Maximum Allowable Annual Harvest[3] | Current Harvest Rate (% of Total estimated population) | |
|---|---|---|---|---|---|---|
| | | Reported[1] | Estimated[2] | | Reported[1] | Estimated[2] |
| 3-07 | 292 | 10 | 20 | 12 | 3.4% | 6.8% |
| 3-10 | 330 | 4 | 7 | 13 | 1.2% | 2.1% |
| **TOTAL** | **622** | **14** | **27** | **26** | **2.3%** | **4.3%** |

[1] Does not include harvest by First Nations' members

[2] Includes First Nation harvest. First Nation harvest assumed to equal that of resident non-first nation hunters

[3] Based on 4% of total estimated moose population in game management subzones that lie within the survey area

# APPENDIX 7. 2007 Dawson East Moose Stratification Survey Summary

We surveyed approximately 2647 square kilometers ($km^2$) in the Dawson East moose survey area (see Map 1) between November 11th and 14th, 2007. Large water bodies made up about 52 $km^2$ of the total area and were classified as non-moose habitat. The survey was conducted to provide current information on moose distribution and relative abundance as part of our planned regular monitoring of population trend in the area. Observations of other wildlife, habitat and tracks were also recorded.

We used a total of 30.1 hours (25 hrs search time + 5.1 hrs ferry time to/from the Dawson airport) to complete the survey. This provided an average search intensity of 0.57 minutes/$km^2$, within the normal range for this type of survey. The survey was flown using two Cessna 206 aircraft with one pilot and 3 passengers each. Dorothy Cooley and Martin Kienzler (Yukon Department of Environment) were the survey leaders/navigators; and Yukon Government staff, Tr'ondëk Hwëch'in and local community members acted as observers (see Acknowledgements section).

Survey conditions during the 2007 survey were good with a few areas of marginal snow. Snow cover was mostly complete throughout the study area, although in some areas snow depth was quite shallow which created a mosaic of covered and uncovered areas. Good frost-cover of vegetation occurred in some places. Temperatures were consistently between -15o C on the ground in the morning and warmed up to about -7o C during the day and at higher elevations during the flight. Warmer temperatures helped in keeping the windows of the aircraft clear. Skies were typically overcast to partly obscure with occasional light snow.

### Population Abundance and Composition - 2007:

We counted a total of 295 moose (280 adults and 15 calves) in the 2007 survey area (Table 1). Whenever possible, observed moose were classified as cows (174), adult bulls (86), yearling bulls (16), or calves (15). Moose that could not be identified with certainty were recorded as unknown sex and/or age. Dividing the total number of moose seen by our search time produces a sighting rate of 0.20 moose seen per minute. Using the number of moose seen per minute and the regression equation developed by Ward et al. (2000) we estimate an average density of 185 (90% C.I. $\pm$72) moose per 1000 $km^2$ (Table 1).

Population composition information derived from stratification surveys frequently has wide margins of error. We therefore limit our discussion to adults and calves.

## Population Trend - 1989 to 2007:

We can compare our 2007 survey results with those from past stratification surveys at several different levels. First, the total number of moose seen during the 2007 survey was considerably lower than that recorded in 2005 (27% lower), but similar to numbers observed during the 1989 and 1997 stratification surveys of the same area (Table 1). Calf numbers were particularly low, making up only 5% of moose observed during the 2007 survey, compared to 15 to 26% of the total population in previous surveys (Table 1). A continuation of low calf recruitment similar to that observed in 2007 would be indicative of a moose population in decline. Generally, at least 15% calves are needed to maintain a stable moose population. However, a single year of low calf recruitment may simply be the result of poor weather conditions during or immediately after calving. Relatively low calf recruitment was also recorded in the Carmacks and Quiet Lake areas in 2007. Additional monitoring in the coming years will be required to determine whether the Dawson east area is experiencing chronic low calf recruitment that would result in a decline in the local moose population.

Search intensity (minutes flown per $km^2$) in 2007 was higher than that used in 2005 but similar to or lower than that recorded during 1989 and 1997 stratification surveys (Table 1). Due to a different stratification method used, search intensity during our 2000 stratification of the area was substantially lower (~0.12 min. /$km^2$). We can correct for differing search intensities, however, by comparing the number of moose seen per minute of survey time. Similar to total numbers of moose seen, the moose sighting rate was substantially lower in 2007 (0.20 moose/min.) than 2005 (0.32 moose/min.), but similar to earlier surveys (Table 1). In contrast to our comparison of total numbers seen, however, the moose sighting rate was slightly higher in 1997 (0.22 moose/min.) and 2007 (0.20 moose/min.) than in 1989 (0.19 moose/min.). Search time is not available for the 2000 stratification of the area so we can not calculate a moose sighting rate for that survey.

A final assessment of moose abundance and population trend can be done using density estimates derived from moose sighting rates and the regression equation developed by Ward et al. (2000). The resulting density estimates mirror our comparison of sighting rates but have the advantage of providing confidence intervals allowing statistical analysis. Estimated moose density per year suggests that the population has

remained relatively stable since 1989 (Table 1). The spike in moose abundance in 2005 could have been due to exceptionally good survey conditions which resulted in higher than average sightability (see below). Density estimates derived from these surveys are, in fact, not significantly different (P>0.1). Although stratification surveys are potentially useful for monitoring population trend over a period of time, the imprecision of the estimates and variability in survey conditions and resulting sightability makes it risky to predict population trend based on just two years. The relatively low precision of this type of survey makes it insensitive to relatively small changes in moose abundance in the short term.

Between-year differences in moose sighting rates and abundance estimates from stratification surveys may be at least partially due to varying survey conditions, moose distribution and changes in habitat. We do not have reliable records of survey conditions during the 1989 and 1997 stratification surveys, but as described in the 2005 report (Yukon Fish and Wildlife Branch 2005), the fresh snow, excellent light and weather conditions, and survey timing were optimal for observing moose during the 2005 survey. This may have contributed to the high moose sighting rate and resulting relatively high estimated moose density.

Unlike the previous survey, light and survey conditions in 2007 were good to somewhat marginal. Low snow depths left some areas uncovered and overcast skies and light snow may have hampered the ability to track or spot moose at a distance. This could have contributed to the low moose sighting rate in 2007. The reason for low calf numbers in 2007 however, is uncertain. As in 2005, many of the moose in 2007 were still in post-rut aggregations in relatively open sub-alpine habitat, or in willow thickets at the headwaters of creeks. The large tracts of burned area from the 2004 fire appears to still have the effect of concentrating moose in high draws and creeks, where there remains adequate willow thickets amidst large tracks of thoroughly burned-out hillsides.

Results from intensive census surveys of the Dawson East area conducted in 1989, 1997, and 2002 suggest that moose abundance in the area has declined (Table 1). A more intensive early-winter survey will be required to assess the trend for this population. As with densities derived from stratification surveys, densities calculated from past intensive surveys were not significantly different (P>0.1). A more detailed discussion of past intensive population survey results and methods are given in the 2002 Dawson moose survey summary report (Yukon Renewable Resources 2002).

Differences in survey timing, methods and sightability may also be responsible for the apparent large decline in moose abundance between our 1997 and 2002 intensive population surveys (Yukon Renewable Resources 2002). Survey timing (late October and early November) and snow conditions (complete ground cover) were good during the 1989 and 1997 surveys. In contrast, the 2002 survey did not begin until November 28 and extended through to December. Post-rut moose aggregations may have begun to break down by that time. While the 1989 and 1997 surveys were conducted using helicopters with a pilot and three observers, the 2002 survey was done using small fixed-wing aircraft with a pilot and only one observer. In addition, an extended warm period shortly after the start of the 2002 survey resulted in marginal snow cover with many patches of bare ground showing. These differences undoubtedly led to reduced sightability. Although sightability correction factors were developed and applied for the 1989 and 1997 surveys, none is available for the 2002 survey so the significance of these factors can not be assessed.

**Harvest:**

Moose densities from past and current intensive surveys are used to calculate the total estimated number of moose per Game Management Subzone (GMS). Given past survey results in the Dawson region, the total population for the Dawson East survey area (GMS 3-07, 3-10; Map 1) has been estimated at 622 moose (Table 2). We normally set the allowable total annual harvest at 3% to 4% of the total estimated moose population in an area. This would mean the maximum allowable harvest for the entire survey area is about 25 moose per year (Table 2). The current estimated average annual harvest (assuming the First Nation harvest equals the residents non-First Nations harvest) in this area is 23 moose per year, or 3.7% of the total estimated moose population (Table 2). Assuming this is accurate, the current estimated total annual harvest appears to be very close to the maximum allowable limit.

The overall average harvest rate has declined in the Dawson East area since the last survey in 2005. At that time, the five-year average annual estimated moose harvest (2000-2004) was 27 moose, for a harvest rate of 4.3%. There is still a concern, however, for the high harvest rate in the most accessible portion of the survey area (GMS 3-07). The total current average estimated harvest in GMS 3-07 is 17 moose per year, for an average harvest rate of about 6% of the total estimated population (Table 2). Harvest rates of this magnitude run a significant risk of initiating a population decline. Recent extensive forest fires in the area may have increased this risk by concentrating moose in

the remaining patches of available habitat, making them vulnerable to over-exploitation. Moose are also much more visible when they move into these burned areas, further increasing their vulnerability.

## Summary and Recommendations:

Overall, stratification surveys in 1989, 1997, 2005 and 2007 suggest a stable moose population in the Dawson east area. In contrast, intensive population surveys conducted in 1989, 1997 and 2002 suggest a declining trend. Differing survey conditions and methods are likely at least partially responsible for the variability in estimates of abundance and population trend. These estimates of abundance are not statistically different, and if any change in abundance has occurred, it probably does not exceed 25% of our original 1989 population estimate. Additional monitoring will be required to confirm this speculative conclusion. Our current monitoring schedule calls for an intensive survey to be conducted in the Dawson East moose survey area in the fall of 2008. The estimated harvest is currently close to maximum allowable limits. The high estimated harvest rate in the northern portion of the survey area (GMS 307) remains a concern and creates a significant risk of initiating a population decline.

## Other Wildlife Sightings:

Species other than moose were also observed during the 2007 survey. One pack of 6 wolves was recorded north of Haystack Mountain. Various sightings were made along the Indian River, including one fox west of the junction with Quartz Creek and one wolverine northwest of the mouth of Ruby Creek. One porcupine was seen at the very south end of the study area; and although no deer were observed during the survey, deer tracks were noted along Henderson Creek southwest of the junction with North Henderson Creek. Incidental sightings of moose outside of the study area include five moose located in the region between the Indian River and Montana Creek, and one moose was seen northeast of the Bear Creek community. The total number of moose observed in (295) or outside (6) of the study area during the entire survey period was 301.

**Acknowledgements:**

Jim Healy, pilot for Whitehorse Air Services and Craig Untershute, chief pilot of Great River Air provided safe and efficient flying during the survey period. We thank Cholena Smart of the Dawson Renewable Resources Council for providing observer names and for participating in the study. We also thank Ryan Peterson of the Tr'ondëk Hwëch'in First Nation and Dawson community members: Gerard Cruchon, Sylvain Fleurent, Sebastian Jones, Alice McCulley, Steven Kormendy, and Dustin Phillips for acting as observers during the survey. Finally, we thank Dorothy Cooley, Martin Kienzler, Torrie Hunter, Kirby Meister and Shawn Hughes (Yukon Department of Environment), for making time in their busy schedules to take part in the project.

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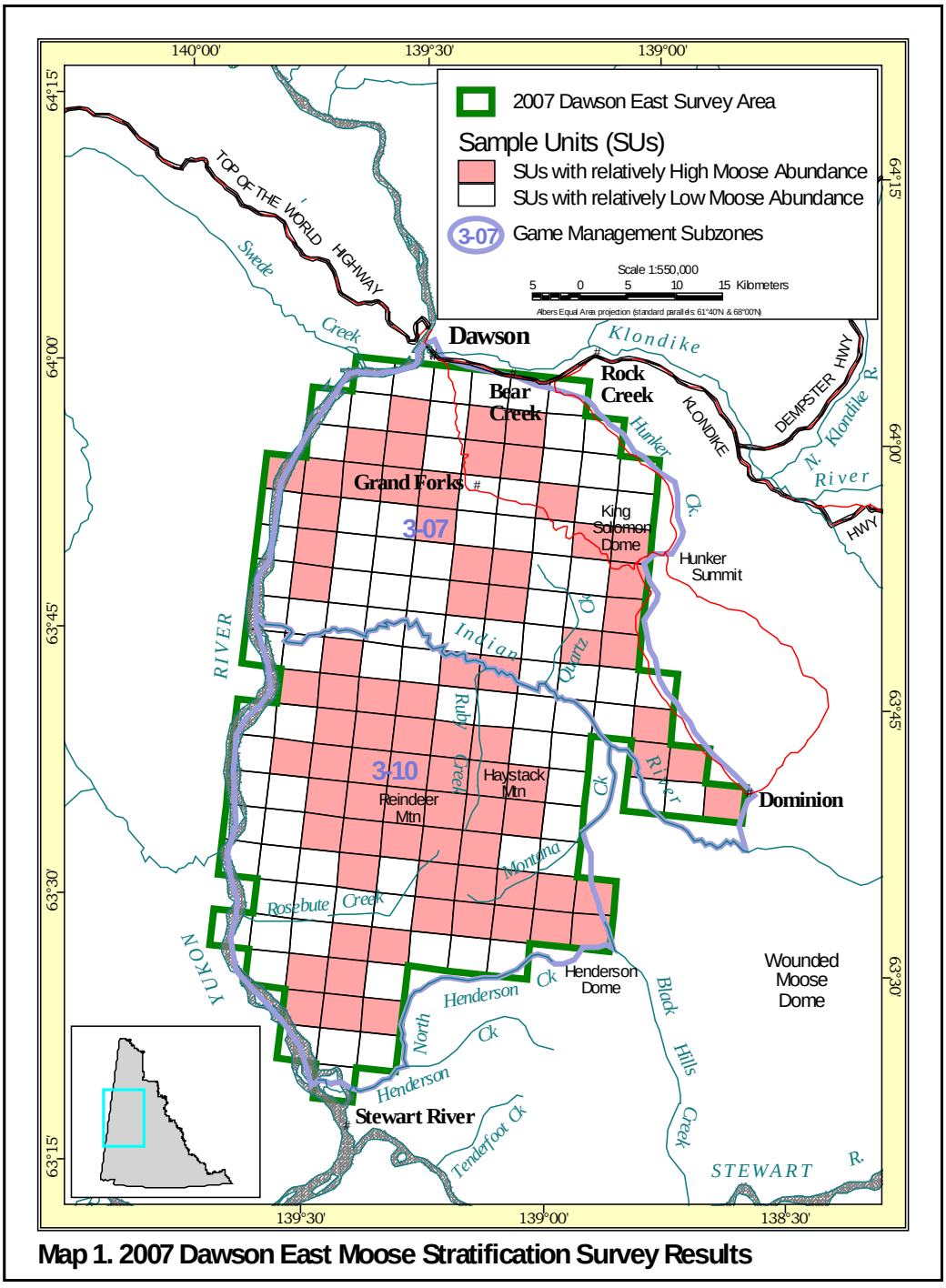


**Map 1. 2007 Dawson East Moose Stratification Survey Results**

**Table 1. Summary of Moose Stratification Survey Characteristics and Results from the 2007 and Past surveys (1989, 1997, 2000, 2005) of the Dawson East Moose Survey Area (Game Management Subzones 3-07 and 3-10).**

| Survey Year | 1989 | 1997 | 2000 | 2005 | 2007 |
|---|---|---|---|---|---|
| **Stratification Survey Characteristics:** | | | | | |
| Survey Dates: | 23-37 Oct. | 4-6 Nov. | 27-29 Nov. | 8-12 Nov. | 11-14 Nov. |
| Survey Habitable Area ($km^2$) | 2565 | 2565 | 2595 | 2595 | 2595 |
| Survey Time (total minutes flown during survey) | 1702 | 1328 | N/A | 1256 | 1497 |
| Search Intensity (minutes flown per $km^2$) | 0.66 | 0.52 | 0.12[1] | 0.47 | 0.57 |
| **Moose Numbers seen during Stratification surveys:** | | | | | |
| Adults | 275 | 272 | 119 | 320 | 280 |
| Calves | 42 | 22 | 7 | 86 | 15 |
| Total Moose | 317 | 294 | 126 | 406 | 295 |
| Percent calves | 26[3] | 15[3] | 16[4] | 21 | 5 |
| Number of Moose seen per minute | 0.19 | 0.22 | N/A | 0.32 | 0.20 |
| **Estimated Moose Density (moose/1000 $km^2$ ± 90% C.I.):** | | | | | |
| Density calculated from Stratification survey results[2] | 177±72 | 199±72 | N/A | 272±72 | 185±72 |
| Density estimated from Intensive Census survey results | 270±61[3] | 244±41[3] | 179±44[4] | N/A | N/A |

[1] Approximate: reflects search intensity used during stratification of larger Dawson survey area

[2] Calculated using number of moose seen per minute and the regression equation developed by Ward et al. (2000)

[3] From intensive census surveys where a pooled Sightability Correction Factor (SCF) is incorporated

[4] From Dawson East subset of 2002 census of larger Dawson survey area with no SCF applied

**Table 2. Average Annual (2002-2006) Reported Moose Harvest and Allowable Harvest Summary for the 2007 Dawson East Moose Survey Area (Game Management Subzones 3-07, 3-10)**

| Game Management Subzones | Total Estimated Number of Moose | Average Annual Moose Harvest (2002-2006) | | Maximum Allowable Annual Harvest[3] | Current Harvest Rate (% of Total estimated population) | |
|---|---|---|---|---|---|---|
| | | Reported[1] | Estimated[2] | | Reported[1] | Estimated[2] |
| 3-07 | 292.4 | 8.4 | 16.8 | 11.7 | 2.9% | 5.7% |
| 3-10 | 329.8 | 3.4 | 6.4 | 13.2 | 1.0% | 1.9% |
| **TOTAL** | **622.2** | **11.8** | **23.2** | **24.9** | **1.9%** | **3.7%** |

[1] Does not include harvest by First Nations' members

[2] Includes First Nation harvest. First Nation harvest assumed to equal that of resident non-first nation hunters

[3] Based on 4% of total estimated moose population in game management subzones that lie within the survey area