MOOSE SURVEY

WHITEHORSE NORTH

LATE-WINTER 2011

Prepared by:
Sophie Czetwertynski, Shawn Taylor,
Kieran O'Donovan, and Rick Ward

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Copies available from:

Yukon Department of Environment
Fish and Wildlife Branch, V-5A
Box 2703, Whitehorse, Yukon Y1A 2C6
Phone (867) 667-5721, Fax (867) 393-6263
Email: environmentyukon@gov.yk.ca

Also available online at www.env.gov.yk.ca

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Summary

- We conducted a late-winter survey of moose in the Whitehorse North area on 4 – 5 and 8 – 12 February 2011. The main purposes of this survey were to estimate the abundance, distribution, and age and sex composition of the local moose population.
- We attempted to count all moose in survey blocks covering approximately 31% of the area. We saw a total of 101 moose, of which 35 were bulls, 51 were cows, and 15 were calves.
- We calculated a population estimate of 383 ± 20% moose for the area, or approximately 107 moose per 1,000 km^2 of total area. This is below the Yukon-wide average of about 155 moose per 1,000 km^2 of total area.
- Long term survey results suggest that moose numbers in the area declined between 1982 and 1993 but have remained stable since then.
- We estimated approximately 29 calves for every 100 cows in the survey area. This suggests that, assuming average predation and harvest rates, survival of calves during the summer and fall of 2010 was likely sufficient to maintain a stable moose population.
- We estimated that there were approximately 70 bulls for every 100 cows in the survey area, which is a more than sufficient sex-ratio required for cows to be bred.
- Reported moose harvest by licensed hunters in the Whitehorse North survey area appears to be within normal allowable harvest limits set out in the Yukon moose management guidelines. This does not include harvest by First Nations' hunters.

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Introduction

This report summarizes the results of the late-winter survey of moose in the Whitehorse North survey area (Figure 1), conducted on 4 – 5 and 8 – 12 February, 2011. The survey was originally scheduled to be done in early-winter but lack of snow until mid November in conjunction with trying to complete 2 other surveys in the Southern Lakes region prevented us from completing this survey as originally planned.

A late winter option for completing this survey was considered based on two key assumptions:

1. Moose movement across survey area boundaries between seasons would not have a large influence on the survey result. Because moose habitats surrounding the survey area were similar to those within the survey area and because there were no known concentration areas or movement corridors we concluded that seasonal movements or habitat selection would not bias our survey results.
2. Visibility differences between habitats selected by moose in early and late winter were either minimal (due to a relatively large proportion of open canopied forests associated with the area's fire history) or could be addressed through sightability correction factors associated with the survey technique.

The main purposes of this survey were to estimate abundance, distribution, and age and sex composition of the local moose population.

Previous Surveys

This was the first late-winter moose population survey in the Whitehorse North area. Early-winter population surveys, however, were done in 1982 (Markel and Larsen 1983) and 1993 (unpublished data). These surveys generally covered a slightly smaller area than the 2011 survey. Results from the 1982 and 1993 are presented in the discussion section for comparison purposes.

Community Involvement

Moose have been a key part of First Nation peoples' subsistence lifestyle for generations and today are the most widely hunted game species by both First Nation and non-First Nation hunters.

The moose population within the Whitehorse North survey area is of interest to the Southern Lakes Wildlife Coordinating Committee (SLWCC). The SLWCC includes 6 First Nations governments as well as representatives from the governments of Yukon, British Columbia, and Canada. This committee was tasked with making recommendations to its various member governments with respect to the management of wildlife and their habitats in the Southern Lakes area and identified the need for moose population recovery efforts in the region. One of their initial focuses was to encourage the parties to improve information gathering to aid in a potential coordinated harvest management framework. The results of this survey informed the SLWCC assessment of status moose within the Whitehorse North area and contributed to the committee's recommendations

Reflecting their interest in moose management, community members represented by the Ta'an Kwach'an First Nation, Champagne Aishihik First Nations and the Laberge Renewable Resources Council participated as observers in this survey.

Study Area

The 2011 Whitehorse North survey area (3,594 km²) is located in southwestern Yukon and includes Game Management Subzones (GMS) 5-48, 5-49, and 5-50 (Figure 1). The area is bordered by the Alaska Highway in the south, the Klondike Highway in the east, and by the Mendenhall and Nordenskiold rivers in the northwest. The total habitable area for moose was estimated at 3,333 km², which excludes water bodies 0.5 km² or larger, and areas higher than 1524 m (5,000 ft). We divided the area into 215 survey blocks averaging 16.9 km².

The survey area lies within the Southern Lakes and Ruby Ranges Ecoregions (Yukon Ecoregions Working Group 2004) and is characterized by a combination of rolling topography with moderate to deeply incised valleys (750 – 1,200 m above sea level (ASL)) and mountainous terrain (1,500 – 2,100 m ASL). Treeline occurs between 1,067 and 1,220 m ASL above which shrub birch (*Betula* spp.) and willow (*Salix* spp.) are the predominant vegetation. On the lower slopes, white spruce (*Picea glauca*) and lodgepole pine (*Pinus contorta*) are the dominant tree species. Aspen (*Populus tremuloides*) is found on steep south-facing slopes often with small pockets of black spruce (*Picea mariana*) in the moister areas (Yukon Ecoregions Working Group 2004).

In 1958, fire burned approximately 80% of the area and more recently (1998) a smaller fire burned 103 km² in the north-western corner of the study area (Figure 2). Most of the burned areas have regenerated to pine and willow of varying density and composition. The majority of the area has a relatively low tree density which provides reasonable visibility for late-winter surveys.

In addition to moose, other large mammal species in the area include Dall's sheep (*Ovis dalli*), elk (*Cervus elaphus*), wood bison (*Bison bison*), woodland caribou (*Rangifer tarandus caribou*), grizzly bear (*Ursus arctos*), black bear (*Ursus americanus*), wolf (*Canis lupus*), and coyote (*Canis latrans).*

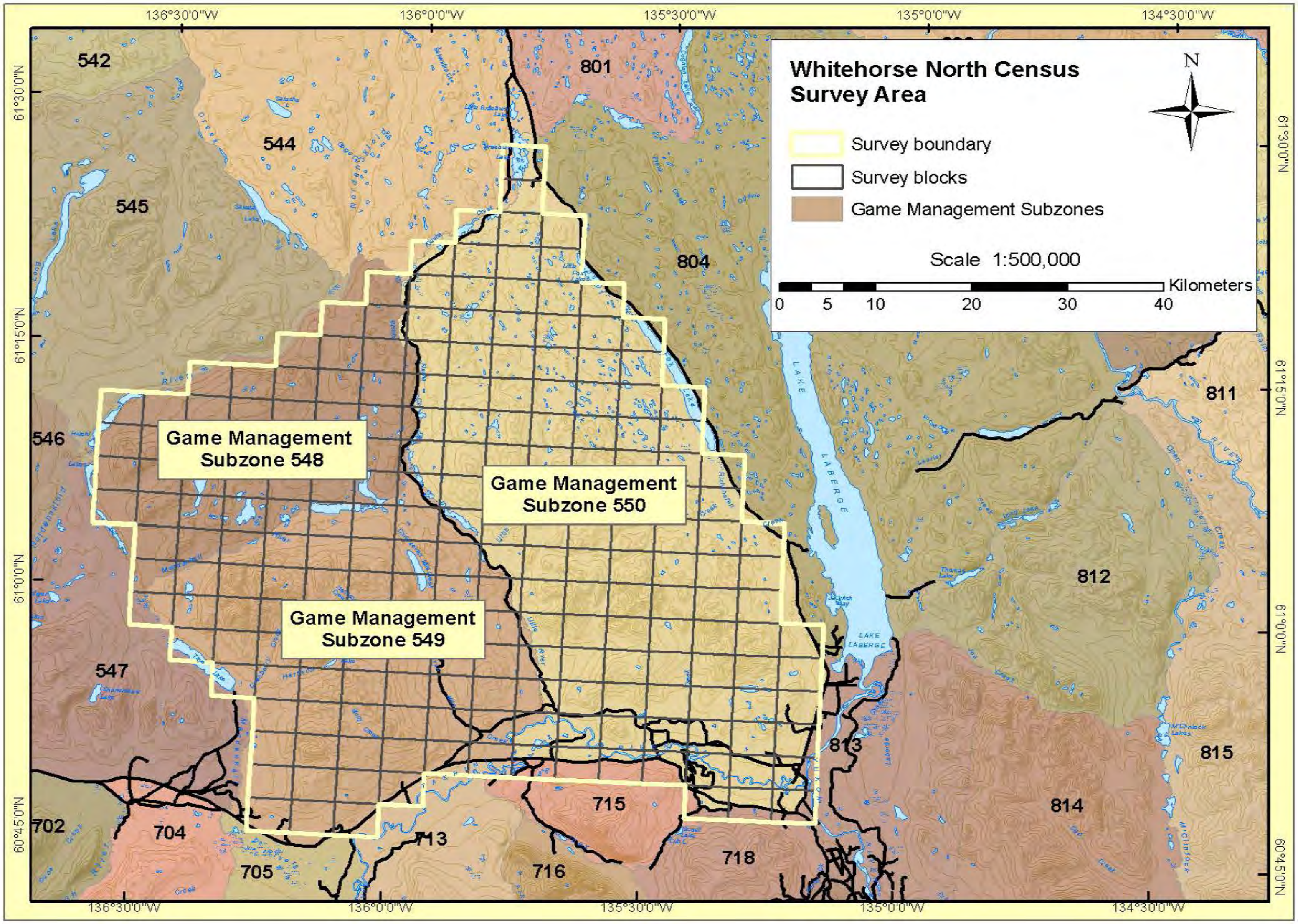

Figure 1. Whitehorse North 2011 survey area boundary and survey blocks showing Game Management Subzones.

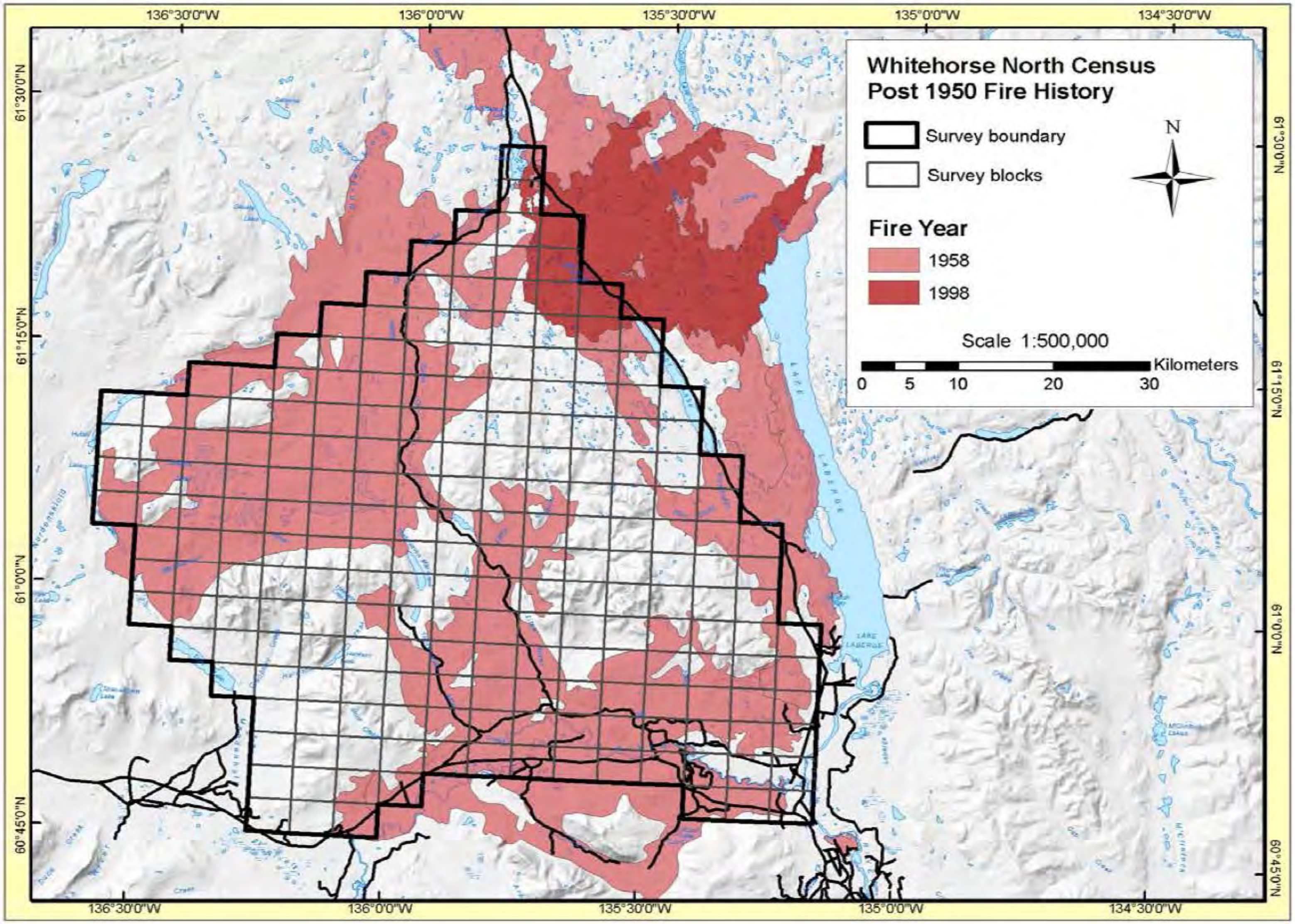

Figure 2. Whitehorse North 2011 survey area fire history.

Methods

We have adapted a relatively new survey technique, developed by Alaska Department of Fish and Game (Kellie and DeLong 2006) to survey moose. Field sampling for this technique is similar to that used in the stratified random block method (Gasaway et al. 1986) used prior to 1999, except that we count moose in rectangular rather than irregularly shaped survey blocks. Geospatial analysis allows us to use more current population estimation procedures and generally produces tighter confidence intervals than the stratified random block method.

The geospatial technique involved the following steps:

1. The survey area was divided into uniform rectangular blocks of approximately 17 km^2 in size.
2. Observers in fixed-wing aircraft flew over all the blocks, and classified (or "stratified") each block as having either high or low expected moose abundance based on local knowledge, number of moose seen, tracks, and habitat. This is called the "stratification" portion of the survey.
3. Blocks are typically selected at random within each stratum for inclusion in the steps listed below. For this survey we chose a different approach because in geospatial analysis, the variance of the estimate can be reduced more effectively by optimizing the spatial distribution of the blocks to be surveyed, rather than by increasing the sample size (Kellie and DeLong 2006). Therefore, we used a paired sampling strategy where we assigned blocks to groups based on habitat characteristics (riparian area, elevation) and expected densities (i.e. distance to road) in each stratum. We then randomly selected 2 or 3 blocks to intensively survey within each of the groups. This method allowed us to randomly sample blocks while improving area coverage, compared to randomly selecting blocks within entire strata.
4. We counted moose within the selected blocks (the "census" part of the survey) using helicopters at a search intensity of about 2 minutes per km^2. Moose were classified by age, sex, and reproductive output (number of cows with calves).

In early-winter surveys we can classify all moose seen by age (adult, yearling, or calf) and sex but in late winter it is hard to distinguish yearlings from adults because of their increased size and because bulls have lost their antlers. Therefore, in order to not bias estimates, we categorized moose into total bulls, total cows, and calves. As a result, composition and ratio results are not directly comparable to early-winter surveys.

5. To estimate the number of moose that we missed during step 4, we included a step from the stratified random block technique where we re-flew a portion of some of our selected survey blocks (approximately 25%) at twice the search intensity (about 4 minutes per km^2). This information was used to develop a "sightability correction factor" (SCF) for the high and low strata separately that we incorporated into our population estimate (Becker and Reed 1990).
6. Selection of SCF survey blocks was different for this survey. Typically, SCF blocks are selected semi-randomly by the navigator so as to fly approximately 2 per day. In this survey, we first classified the entire study area as having either high or low visibility based on the percent conifer cover calibrated by expert opinion. SCF blocks were selected randomly and in each stratum were equally divided between high and low visibility. This information was not provided to the navigator until the completion of a surveyed block. After the SCF flight was done, the crew determined if they considered the block to be a high or low visibility area.

   This information was collected for 2 purposes. First, we wanted to test the accuracy of our predicted sightability model by comparing it to the classification given by the navigator after the SCF flight. Secondly, we wanted to start developing a database of air-truthed visibility to quantitatively calibrate future habitat based sightability models. Such models will allow us to more accurately and efficiently adjust population estimates in future surveys.
7. We estimated the total number of moose in each age and sex category in the entire survey area based on the numbers of moose counted in the blocks during the census. The SCF was applied to the total number within each stratum to account for moose that we overlooked (Becker and Reed 1990).

The geospatial technique has the advantages of easier logistics, flexibility for small area estimation, and good population estimates (often with greater precision than the stratified random block method). Generally, the more blocks that are searched during the census portion of the survey (step 4), the more precise and reliable the resulting population estimate. A drawback of the geospatial method is the inability to estimate confidence intervals (CI) for ratio estimates (e.g. number of bulls per 100 cows) that have been calculated using data corrected with a sightability correction factor. Therefore, we present ratio results with the confidence interval calculated using Gasaway's (1986) method.

In the harvest section of this report, total moose abundance in each GMS (see Table 6) was estimated by multiplying the average estimated moose density in the high and low stratum blocks by the number of high and low stratum blocks per GMS respectively. This is a change from past reports where survey-area wide moose density was applied to each GMS.

Weather and Snow Conditions

Weather and snow conditions were relatively good throughout the survey, allowing us to fly consecutive days (Table 1). Temperatures were generally mild, ranging from 2°C to -14°C except for the first and last day of the census survey. Winds were mainly moderate, with a few days of strong winds throughout the survey period. We generally had complete snow coverage for reasonable tracking and sighting of moose, with only a few brown south-facing slopes.

Table 1. Summary of the 2011 Whitehorse North moose survey flight.

Team	Date	Survey Time (minutes)	SCF Time	Ferry Time	Total	Temp (ºC)	Wind (km/h)	Light
Stratification Survey								
1	Feb 4	212		49	261	-4	Calm	Bright
1	Feb 5	154		51	205	-13	Calm	Bright
	Total (min)	**366**		**100**	**466**			
	Total (hrs)	**6.1**		**1.7**	**7.8**			
Census Survey								
1	Feb 8	218	44	119	381	-20 to -18	20–24	Flat
1	Feb 9	235	14	148	397	-14 to -1	60	Flat
2	Feb 9	243	80	77	400	-1 to 0	60	Flat
1	Feb 10	200	35	117	352	-8 to -2	Calm	Flat
2	Feb 10	249	50	90	389	-5	Calm	Flat
1	Feb 11	240	55	82	377	0 to 2	30–40	Flat
2	Feb 11	254	57	93	404	-5 to 0	40	Flat
1	Feb 12	226	56	92	374	-22 to -12	10–30	Flat
2	Feb 12	247	62	117	426	-17 to -12	Calm	Flat
	Total (min)	**2112**	**453**	**935**	**3500**			
	Total (hrs)	**35.2**	**7.6**	**15.6**	**58.3**			

Results and Discussion

Stratification (Identification of High and Low Moose Density Blocks)

We stratified the study area on 4 – 5 February using a Cessna 206 aircraft with pilot and 3 observers. We flew 6.1 hours of survey time (Table 1) for an average search intensity of 0.10 minutes per km^2. The survey required 1.7 hours for ferrying to bring the total flight time to 7.8 hours.

We classified 125 (58%) of the 215 survey blocks as having high expected moose abundance and 90 (42%) as having low expected abundance of moose (Figure 3). Most of the blocks with lower expected moose numbers were located throughout the study area at higher elevations.

Census Coverage and Flight Times

Based on previous surveys we anticipated flying 30% of the area (or about 65 blocks) to achieve a population estimate with an acceptable level of precision. Because more of the area was at lower elevation, where we had a higher expectation of seeing moose in late-winter compared to early-winter (moose are generally at higher elevations in early-winter), we decided to allocate our sampling intensity unevenly. Specifically, to better account for the greater proportion of survey blocks with high expected moose abundance and the typically more variable moose numbers in these high blocks, we set out to sample approximately 60% of the blocks in the high stratum and 40% in the low stratum.

To randomly sample blocks while improving area coverage, we used expert opinion to assign blocks to groups based on habitat characteristics and expected moose densities, using a paired sampling strategy (see methods section, step 3). We divided the low stratum blocks into 10 groups of 5 –10 blocks each from which we randomly selected 2 blocks from each group (Figure 4). Similarly, we divided the high stratum blocks into 17 groups of 6 – 9 blocks from which we randomly selected 2 or 3 blocks from each group (depending on group size, Figure 5). Therefore, 90% of the blocks were selected randomly within groups and the remaining 10% of the blocks were assigned in areas with the least coverage in each stratum. We thus counted moose in 23 low stratum blocks and 43 high stratum blocks, flying approximately 31% of the total area. We flew 35.2 hours in the selected survey blocks (Table 1), resulting in a search intensity of 1.91 minutes per km^2. This, lower than average (2 minutes per km^2), search intensity was a result of the relatively low number of moose seen during the survey. Generally, late-winter surveys would require more flight time because of the extra time needed to sex animals after bulls have dropped their antlers.

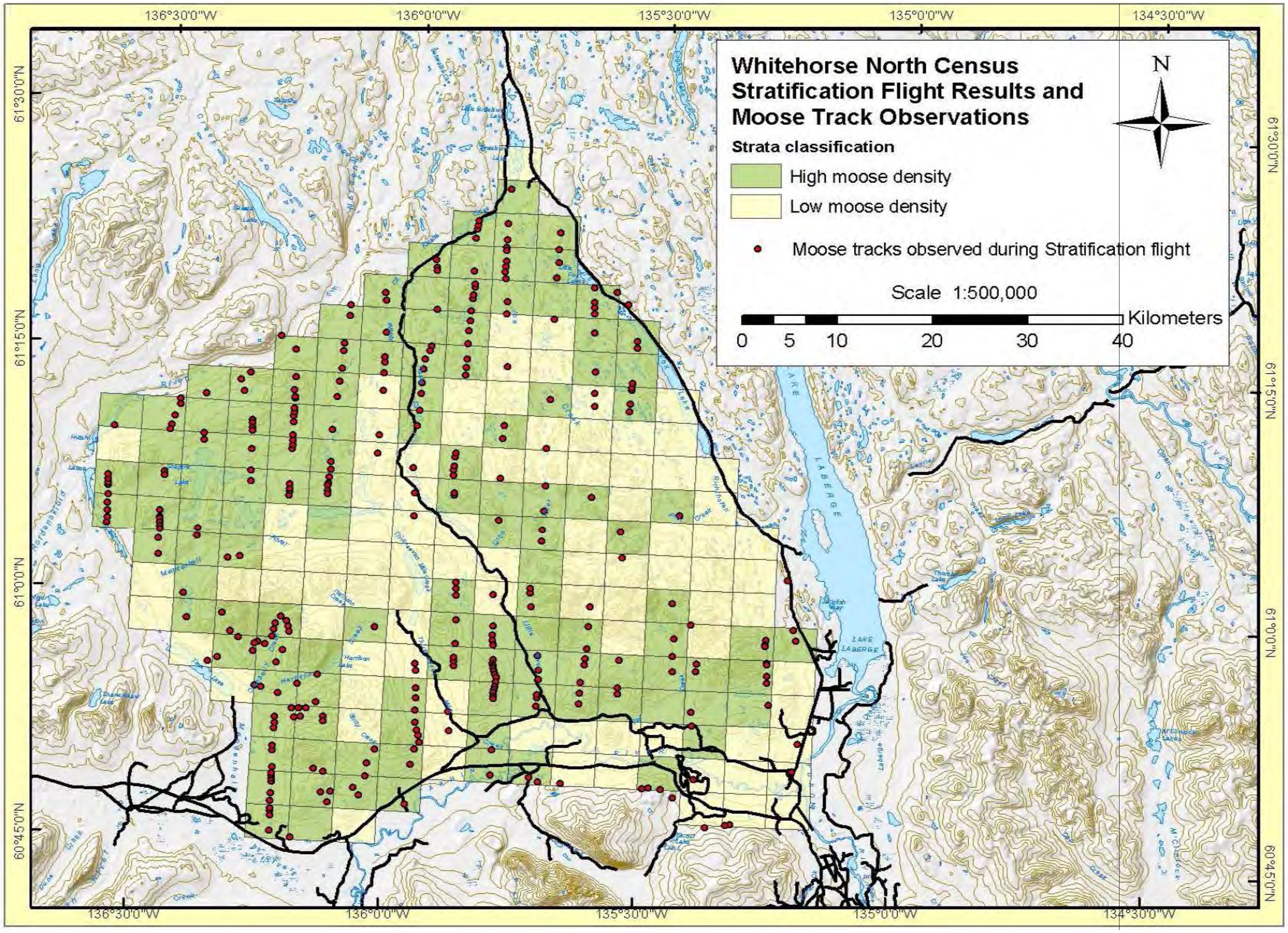

Figure 3. Stratification of the 2011 Whitehorse North moose survey area.

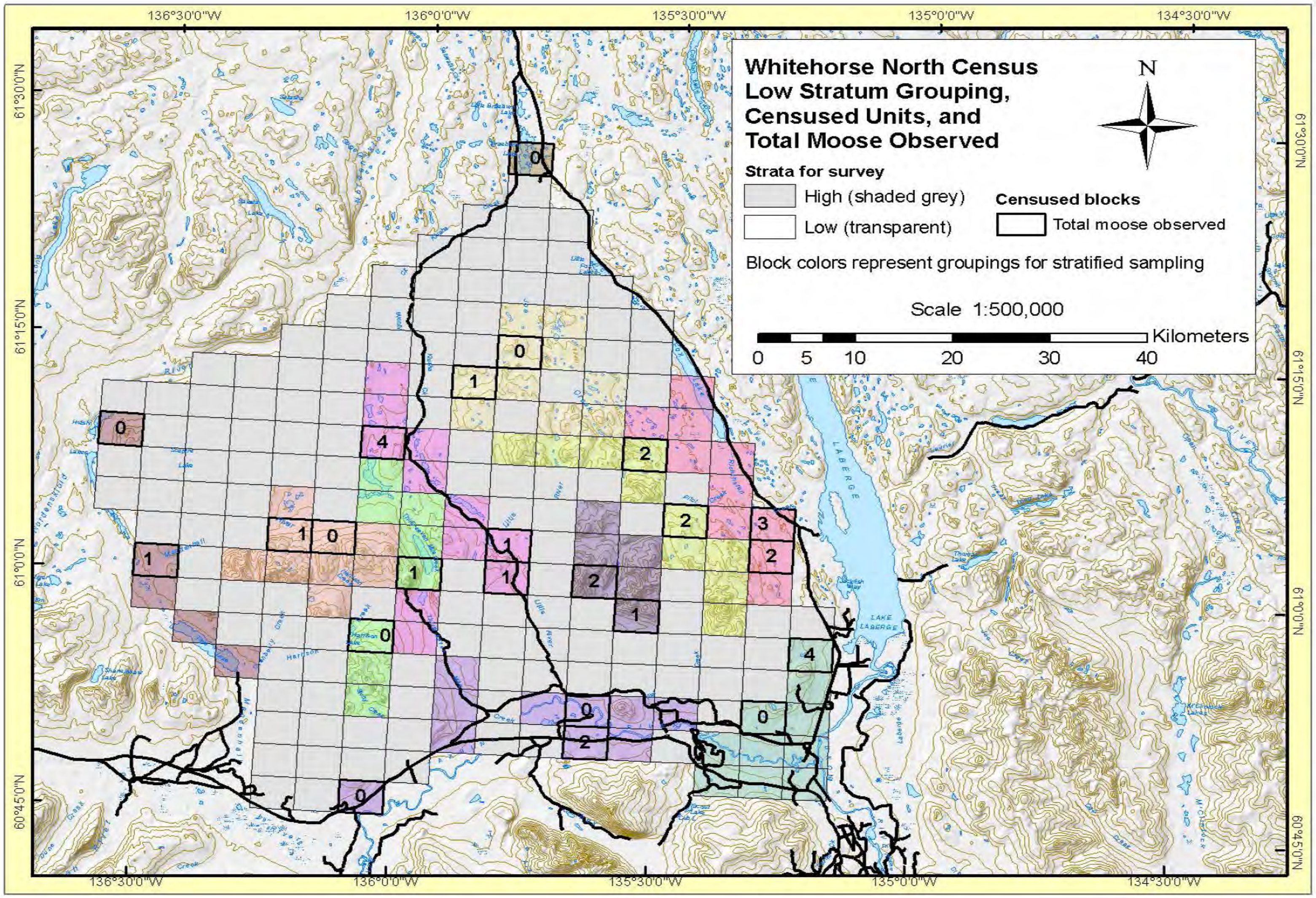

Figure 4. Whitehorse North 2011 low stratum grouping and stratified sampling.
Shaded colors represent groupings within which blocks to be sampled were randomly selected. Numbers represent the total number of moose observed within sampled blocks.

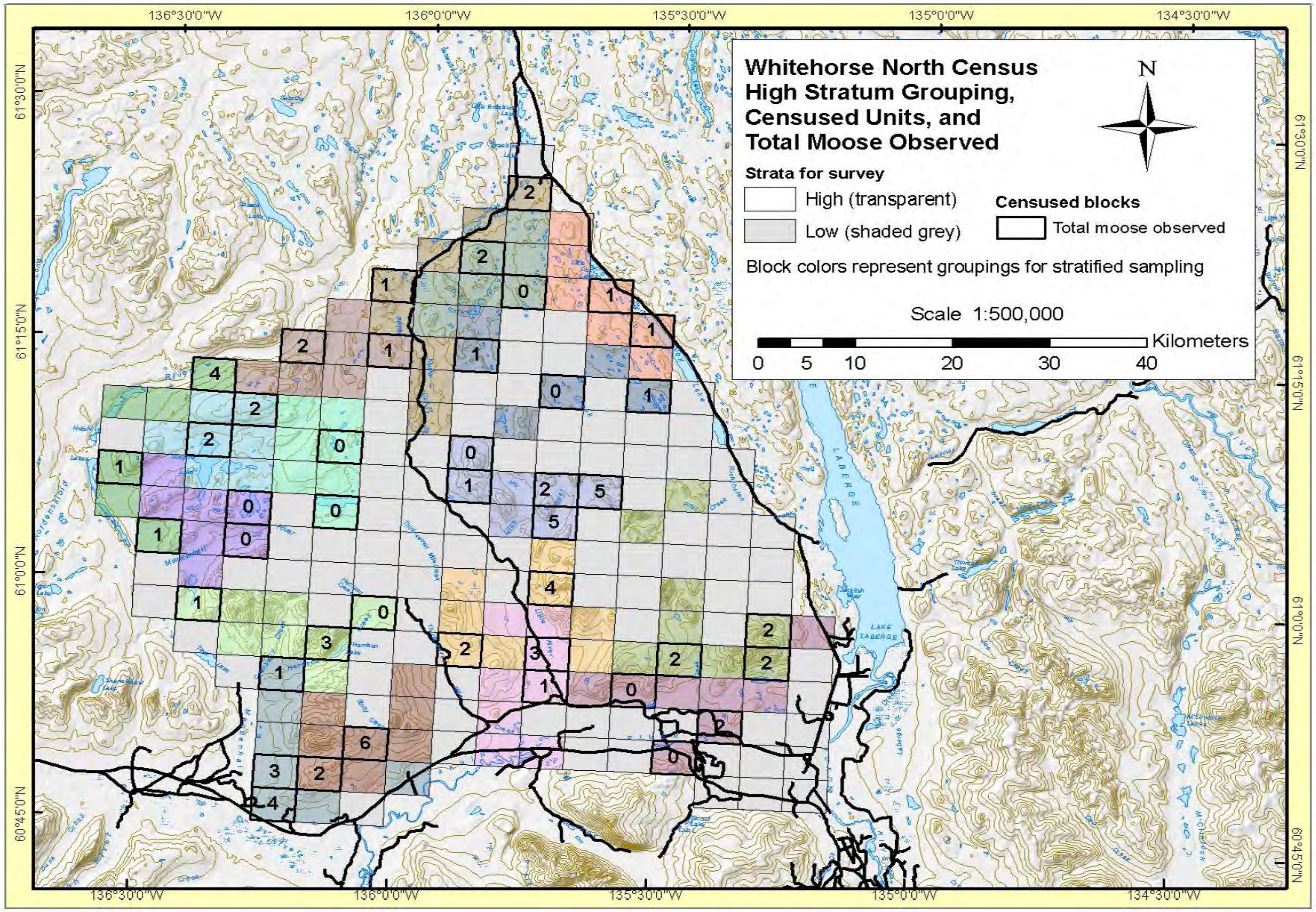

Figure 5. Whitehorse North 2011 high stratum grouping and stratified sampling.
Shaded colors represent groupings within which blocks to be sampled were randomly selected. Numbers represent the total number of moose observed within sampled blocks.

Another 7.6 hours were used to estimate sightability in a total of 28 SCF blocks flown in the high and low strata. This resulted in a search intensity of 3.86 minutes per km^2, close to our target of 4 minutes per km^2. Ferry time to the Braeburn fuel cache and Whitehorse totalled 15.6 hours (Table 1). Total flight time (survey and ferry time combined) was 58.3 hours.

Sightability Correction Factor (SCF) Calculation

In many of the blocks chosen for SCF calculations we saw no moose during the initial census flights nor during the intensive SCF flights (71% of low stratum and 79% of high stratum SCF blocks). We therefore had to modify the SCF value calculations needed to estimate the moose population in the study area.

The mathematical equation used to calculate the SCF value (Gasaway et al. 1986) is sensitive to the number of moose in an SCF survey area and does not weight each SCF flight equally. This results in SCF blocks with many moose having a disproportionately high influence on the SCF value, which “swamps” the influence of SCF flights where no moose were seen during the standard and intensive searches (i.e. no missed moose). Because not missing moose during the survey should have an influence on the sightability correction factor (Becker and Reed 1990), we converted 5 of the SCF flights from 0 observed during the standard flights and 0 missed during the intensive searches (no missed moose) to values of 1 moose observed in both the standard and intensive searches (no missed moose). The result of this change was an increase in the influence (percent change in the SCF value from an individual SCF flight) of not missing any moose in an SCF flight where there were no moose observed from 0.02% to 3.2%. In the future, surveys should not have more than 35% of the SCF flights with no animals observed in either the standard or intensive searches. This should prevent any one SCF flight from contributing disproportionately to the final SCF value. This recommendation does not rule out that a sensitivity analysis should be conducted before using the SCF value to adjust population parameter estimates (see below). We caution that this data manipulation is not ideal and we advise adhering to the recommendations mentioned to avoid this issue in future low moose density survey area.

We also tested the sensitivity of the SCF values in each stratum by calculating the influence of each individual SCF flight on the final SCF value. We flew 14 SCF flights in each stratum and therefore decided that if any individual SCF flight influenced the final SCF value by more than 25%, it should be considered an outlier and removed from the dataset. As a result, we removed data from 1 SCF flight in the low stratum that influenced the SCF value by 29%. Final SCF values (1.25 in the high stratum and 1.0 in the low stratum) were then applied separately to each stratum to obtain final sightability corrected estimates (Becker and Reed 1990).

Visibility Prediction Results

One goal of this survey was to develop a visibility model using the percent conifer cover value from the Earth Observation for Sustainable Development (EOSD) GIS layer available for the study area. Our intent was to test the potential of using a forest canopy cover-based sightability model for future surveys to reduce the time and cost allocated to SCF flights. The cut-off between high and low visibility was decided by expert opinion (Figure 6). Overall, the model accurately predicted 100% (6 of 6) high visibility SCF areas and 64% (9 of 14) low visibility areas as classified by observers during the survey. These results suggested that it is worthwhile for navigators to continue to collect landscape visibility data for future model development and assessment, particularly since it can be done at no additional cost.

Observations of Moose

We counted a total of 101 moose within the survey blocks (Table 2). We observed an average of 102 moose for every 1,000 km² in the high abundance blocks, and 73 moose per 1,000 km² in the low blocks.

Distribution and Abundance of Moose

Moose were widely distributed throughout the survey area, and we found them in a variety of habitats. Based on our census counts, we estimate that there were a total of 383 ± 20% moose in the survey area (Table 3). Estimates were obtained using the geospatial software and include a stratum-specific sightability correction for moose missed during the census portion of the survey.

The estimated density of moose in the survey area was 107 per 1,000 km² of total area (Table 3). This is substantially lower than the Yukon-wide average of about 155 moose per 1,000 km² of total area.

Table 2. Observations of moose during the February 2011 survey in the Whitehorse North survey area.

	High Blocks	Low Blocks	Total
Number of Blocks Counted	43	23	66
Total Bulls Observed*	21	14	35
Total Cows Observed*	40	11	51
Number of Calves Observed	12	3	15
Total Moose Observed	73	28	101

* Yearling cows and bulls cannot always be reliably distinguished from adults in late winter; therefore, younger animals are combined with adults for a total count.

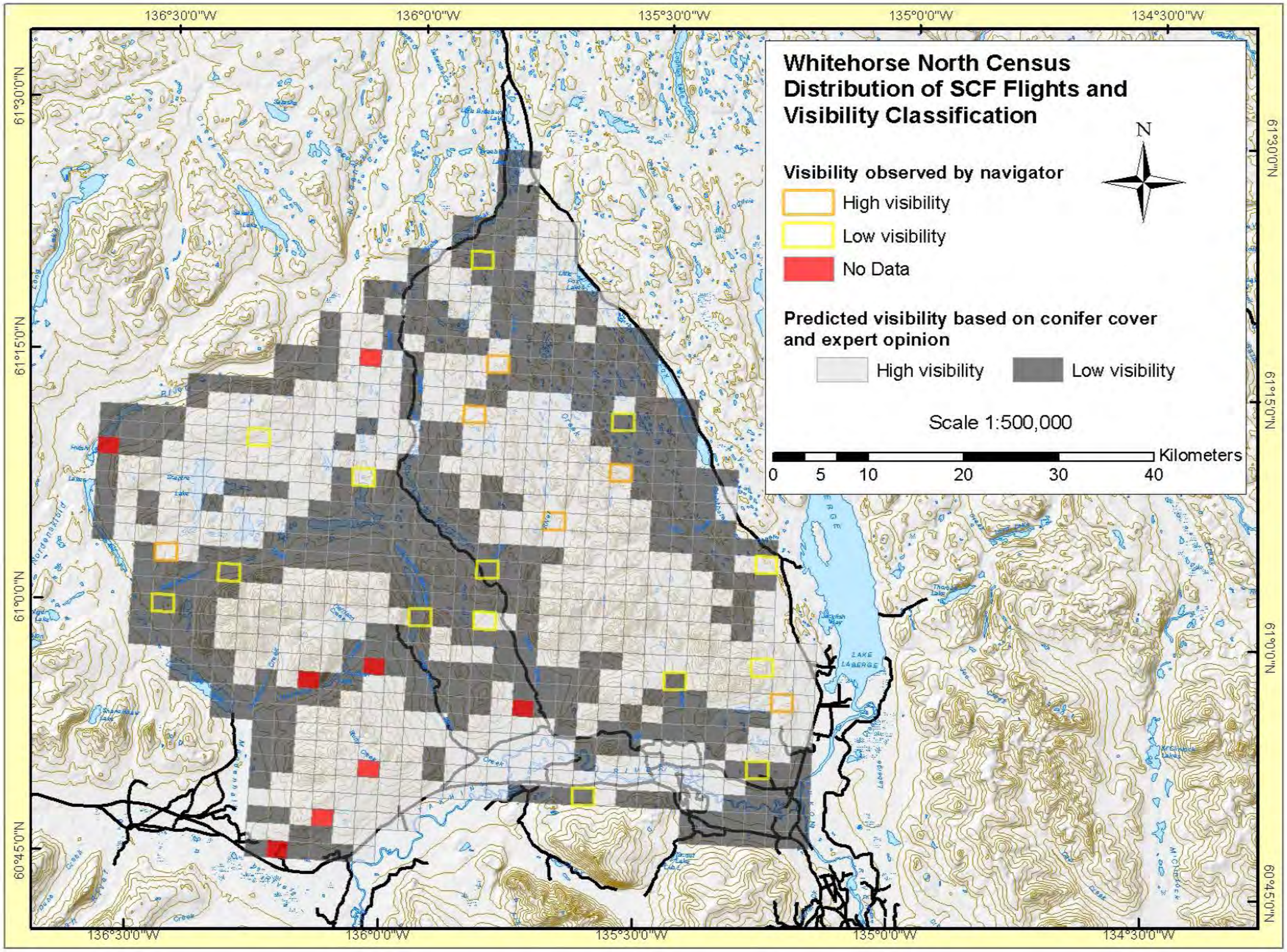

Figure 6. Whitehorse North 2011 survey area visibility model prediction based on percent conifer cover.

Ages and Sex of Moose

As mentioned in the methods section, one limitation of the geospatial method is the inability to calculate confidence intervals for population composition ratio estimates based on data where a sightability correction factor has been applied. As a result, we present ratio results (Table 4) with the SCF confidence interval calculated following Gasaway (1986).

It is important to note the ratios presented in Table 4 cannot be compared directly with ratios typically presented for early-winter survey results because in late winter we could not distinguish yearlings from the adult segment of the population. Consequently ratios for this survey were calculated relative to the *total* estimated number of bulls and cows in the population (e.g. calves per *total* cows versus calves per *adult* cows).

As is typically the case with Yukon moose populations, cows were the largest segment (50%) of the total estimated Whitehorse North moose population in 2011 (Table 4).

Bulls made up 35% of the 2011 total population estimate. This translates to approximately 70 total bulls for every 100 total cows in the survey area (Table 4). Although we do not know the exact number of *adult* bulls and cows, we can assume that the sex-ratio of yearlings is approximately equal. Therefore, this value is well above the minimum level of 30 *adult* bulls per 100 *adult* cows set out in our Yukon Moose Management guidelines to ensure that the majority of adult cows are bred during the rut (Environment Yukon *in prep*.).

Calves represented about 15% of the total estimated Whitehorse North moose population in 2011, for an estimated 29 calves for every 100 *total* cows (Table 4). This represents a higher proportion of calves in the population than a ratio of 29 for every 100 *adult* cows, as might typically be reported from early-winter survey results. In general about 25 – 30 calves per 100 *adult* cows are considered sufficient to maintain stable moose populations in areas with typical mortality rates (Environment Yukon *in prep*.). Calf survival to late-winter, therefore, was moderate-to-good in the 2011 survey area.

Table 3. Estimated abundance of moose in the Whitehorse North survey area in February 2011.

Estimated Abundance	Best Estimate ± 90% Confidence Interval (%)*	Estimates within 90% Confidence Interval (Range)
Estimated Total Number of Moose**	383 ± 20%	306 – 460
Total Bulls	132 ± 32%	90 – 175
Total Cows	187 ± 24%	143 – 231
Total Calves	56 ± 37%	35 – 77
Density of Moose (per 1,000 km^2)		
Total Area (3594.0 km^2)	107	
Moose Habitat Only (3333.2 $km^{2)}$***	115	

* 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.

** Estimated numbers provided are based on a Not Pooled "sightability correction factor" or SCF. In this survey, a SCF of 1.25 was applied to the High stratum and an SCF of 1.00 was applied to the Low stratum to correct the estimate of moose abundance for animals that were missed by the survey crews (see step 5 of methods section for a description of how the SCF is calculated).

*** 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.

Table 4. Estimated composition of the moose population in the Whitehorse North survey area in February 2011.

Estimated Population Ratios	Best Estimate ± 90% Confidence Interval (%)*	Estimates within 90% Confidence Interval (Range)*
% Total Bulls	35% ± 25%	26–44%
% Total Cows	50% ± 14%	43–57%
% Calves	15% ± 29%	10–19%
Total Bulls per 100 Total Cows	70 ± 38%	43–96
Calves per 100 Total Cows	29 ± 32%	20–39
% of Cow-calf Groups with Twins	7% ± 140%	0–17%

* 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, and that our best estimate is in the middle of this range.

Population Status

Although results of previous early-winter surveys are not directly comparable to this survey they are useful for general discussion. When first surveyed in 1982 there were an estimated 533 ± 22% (90% C.I.) moose in the area, or 167 moose per 1,000 km^2 of habitable area (Table 5). By 1993, estimated abundance had declined significantly (T test; $P<0.005$) to about 292 ± 26% moose, for an estimated density of 92 moose per 1,000 km^2 of habitable area. Results from our 2011 survey (no SCF applied) indicate that there were about 316 ±12% moose in the area, suggesting that moose abundance has remained relatively stable since 1993.

Calf survival was low during the 1982 survey (6 calves/100 total cows) and above average to good during the 1993 and 2011 surveys (46 and 30 calves per 100 total cows respectively).

The estimated proportion of total bulls in the Whitehorse North area has fluctuated substantially since it was first surveyed in 1982, when there were about 45 total bulls per 100 total cows in the area (Table 5). When resurveyed in early-winter 1993 the ratio was 116 total bulls per 100 total cows. It is uncommon for there to be more bulls than cows in Yukon moose populations. In only 5 of more than 70 census surveys done throughout Yukon since 1981 have we seen more bulls than cows. During the 2011 late winter survey there were 71 total bulls per 100 total cows. The reason for the large variation is not known but possible explanations could be related to the size and composition of the total harvest or to differential habitat use by bulls and cows that may have affected sightability.

Table 5. Results of the 2011 late-winter, and 1982 and 1993 early-winter moose surveys in the Whitehorse North area.

Survey Year	**2011**	**1993**	**1982**
Survey Timing	Late-Winter	Early-Winter	Early-Winter
Survey Method	Geospatial[3]	Stratified Random Block	Stratified Random Block
	(Helicopter Aircraft)	(Fixed-wing Aircraft)	(Helicopter Aircraft)
Estimated Abundance[2]			
(90% Confidence Range)[4]			
Total Moose	316 ± 12% (278–355)	292 ± 27% (215–370)	533 ± 22% (418–648)
Total Bulls (≥ 18 months)	109 ± 29% (78–141)	128 ± 34% (85–172)	158 ± 26% (117–199)
Total Cows (≥ 18 months)	154 ± 16% (130–178)	110 ± 33% (74–147)	353 ± 27% (258–447)
Calves (≤ 12 months)	45 ± 32% (31–60)	51 ± 28% (37–66)	22 ± 65% (8–37)
Unknown age/sex	-	3 ± 88% (0–5)	-
Estimated Population Composition[2]			
(90% Confidence Range)[4]			
Total Bulls / Total Cows	71 ± 33% (48–94)	116 ± 32% (80–153)	45 ± 32% (30–59)
Calves / Total Cows	30 ± 30% (21–39)	46 ± 30% (33–60)	6 ± 66% (2–11)
Total Bulls / Total Population	35 ± 28% (25–44)	44 ± 17% (36–51)	30 ± 22% (23–36)
Total Cows / Total Population	48 ± 15% (41–55)	38 ± 16% (32–44)	66 ± 10% (59–73)
Calves / Total Population	14 ± 30% (10–19)	18 ± 25% (13–22)	4 ± 62% (2–7)
Unknown age and sex / Total Pop.	-	1 ± 92% (0–2)	-
% of Cow-Calf Groups with Twins[5]	7 ± 131% (0–15)	12 ± 78% (3–21)	0
Density of Moose (per 1,000 km^2)[2]			
Total Area	93	Not Avail.	~149
Moose Habitat only[6]	101	92	167
Total Area (km^2)	3392.4	Not Avail.	~3587.0
Habitable Area (km^2)[6]	3137.6	3187.8	3184.1

[1] Because of differences in survey area, methodology and timing (see text) results are not directly comparable between surveys.

[2] No sightability correction (SCF) was developed for the 1982 Whitehorse North survey. To allow for better comparison across years, no SCF is included in estimates provided for 1993 and 2011.

[3] For Geospatial data, the difference between total estimated numbers of moose and the sum of total bull, cow and calf numbers is because individual age/sex classes are unlikely to exhibit the same spatial correlation as that found in the sum of all observed moose in sampled units. The two sums may differ as a result.

[4] 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.

[5] Twinning Rate = 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.

[6] 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.

Harvest

Reported moose harvest (1979 – 2010) in the Whitehorse North survey area (GMS 5-48, 5-49, and 5-50) has ranged between 2 and 19 moose per year (Figure 7). Fluctuations in harvest were greater in the 1980s and early 1990s than in the past 10 years. In the 5 years prior to the survey an average of 6.2 moose per year were reported harvested (Table 6).

The current average annual reported harvest rate is 1.7% of the 372 moose estimated for these GMS (Table 6). These numbers do not, however, include harvest by First Nations' hunters. In the absence of harvest information for First Nations' hunters, we generally assume that their harvest is about equal to that of licensed resident non-First Nation hunters.

If we make this assumption for First Nation harvest, then the total estimated average annual harvest rate (including First Nation hunters) increases to about 3.3% of the estimated moose population. If the unreported harvest added is also bulls, then this is within the annual allowable harvest rates of 3% to 4% that we generally set for stable moose populations of average density (Environment Yukon *in prep.*).

Within individual game management subzones estimated average moose harvest rates, adjusted for assumed First Nation harvest, are also below allowable limits in GMS 5-48 (1.4%), with only GMS 5-50 (3.7%), and GMS 5-49 (4.0%) near or at the 4% maximum allowable limit. Harvest rates in excess of 5% can carry an unacceptably high risk of initiating a population decline (Gasaway et al. 1992). As a general rule, moose harvest should be managed conservatively in the absence of reliable harvest data.

Given that the Whitehorse North moose population is well below the average density for the Yukon, has not shown an increase since previous surveys, and has no precise estimate of the First Nation harvest, there is reason to be concerned over the status of moose in this area. Concern is heightened due to the survey area's close proximity to the urban centers of Whitehorse and Haines Junction, and easy access via the Alaska and Klondike Highways and Dawson Trail in GMSs 5-49 and 5-50.

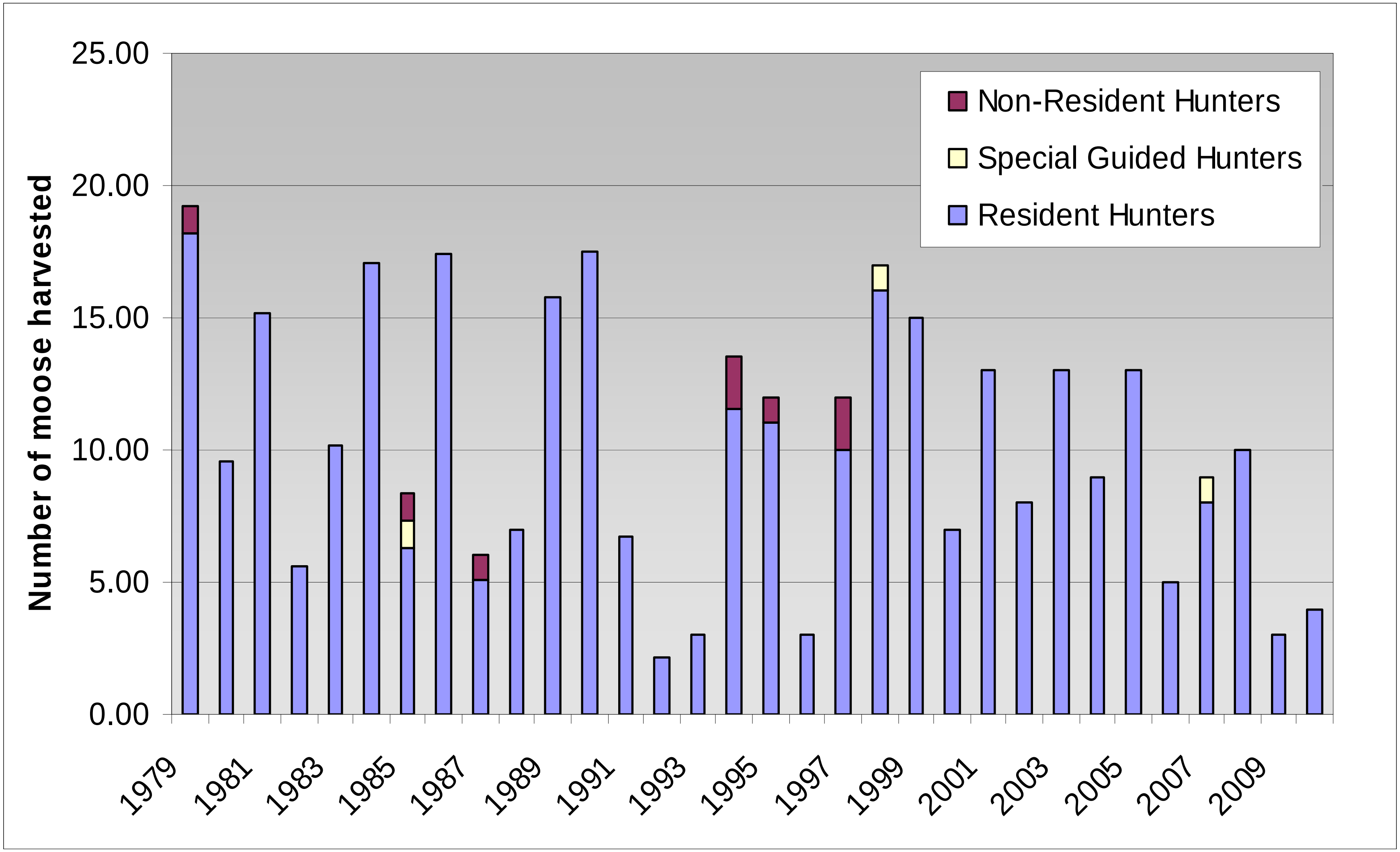

Figure 7. Annual reported moose harvest (1979–2010) in the Whitehorse North Survey area (Game Management Subzones 5-48, 5-49. and 5-50). Does not include harvest by First Nations members.

Table 6. Average annual (2006–2010) reported moose harvest[1] and allowable harvest for the 2011 Whitehorse North Moose Survey Area: Game Management Subzone (GMS) 5-48, 5-49, and 5-50.

GMS	GMS Area (km^2)	Estimated Density[2] (moose/ 1000 km^2)	Total Estimated number of Moose	Average Resident Harvest	Average Non-Resident Harvest	Average (Special Guided) Harvest	Average Reported Harvest (2006–2010)	Current Harvest Rate (% of total population)	2% Allowable Annual Harvest	3% Allowable Annual Harvest	4% Allowable Annual Harvest
5-48	700.9	120	84.1	0.6	0.0	0.0	0.6	0.7	1.7	2.5	3.4
5-49	1038.6	105	109.1	2.2	0.0	0.0	2.2	2.0	2.2	3.3	4.4
5-50	1783.0	100	178.3	3.2	0.0	0.2	3.4	1.9	3.6	5.3	7.1
Total	**3522.5**[3]	**105.5**[3]	**371.5**[3]	**6.0**	**0.0**	**0.2**	**6.2**	**1.7**	**7.4**	**11.1**	**14.9**

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

[2] Based on 2011 Whitehorse North Moosepop SCF Not Pooled moose survey results.

[3] Small differences in total area, average estimated moose density, and total estimated number of moose presented in Table 5 for the Whitehorse North entire survey area, versus Table 6 above, are due to differences in Game Management Subzone and survey area boundaries (see Figure 1).

Other Wildlife Sightings

In addition to the 101 moose we counted during the survey, we also observed 30 moose outside of the survey blocks that were surveyed, or just outside of the survey boundary. One dead moose was also located northeast of Little River that appeared to have broken its leg in a crevasse.

Other ungulates recorded during the survey included 47 bison in 8 groups during the stratification flight and 139 bison in 10 groups during the census flights. Two elk (1 was a bull) were observed during the stratification flight and 37 elk (15 were bulls) were counted during the census survey. One dead bull elk with a collar was also located near Stony Creek Camp just outside of the study area.

Two groups of sheep (10 and 3 animals) were located in the vicinity of Pilot Mountain during the stratification flight and 3 groups (10, 16, and 5 animals) were observed in the Sifton Range and Thirty-seven Mile Lake area during the census. Eleven caribou in 2 groups (6 and 5 animals) were located near Stony Creek Camp and a total of 29 mule deer were counted in the southeastern corner of the study area during the census flights.

Other wildlife observed included 1 wolf on the north end of Little River during the stratification flight and 2 lone wolves, 2 lone coyotes, 1 lynx, and 2 red foxes during the census flights.

Conclusions and Recommendations

- Previous and current survey results, recruitment and harvest data in the 2011 Whitehorse North survey area suggest a stable moose population.
- We estimate that there are about 383 moose in the 2011 Whitehorse North survey area. The estimated density was approximately 107 moose per 1,000 km^2 of total area, which is below the Yukon-wide average.
- Long term survey results suggest that moose abundance in the area declined between 1982 and 1993 and has remained stable since then.
- Survival of calves to late-winter was likely sufficient to maintain a stable moose population.
- The ratio of total bulls to total cows in the entire survey area was similar to the Yukon-wide average for areas that have previously been surveyed, and well above the number generally considered sufficient to ensure that adult cows are bred during the rut.
- Reported moose harvest in the 2011 Whitehorse North survey area is currently within the normal annual allowable harvest rate recommended for stable moose populations of average density. First Nation harvest, however, is not available and total estimated harvest for all hunters may be near, at or possibly over the maximum 4% allowable annual harvest level in Game Management Subzones 5-49 and 5-50.
- In the absence of complete harvest data, we should closely monitor the status and harvest of the moose population, particularly in the more accessible regions of the Whitehorse North survey area.

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