Survey of moose abundance in the boreal forest around Yellowknife, Northwest Territories

Final Report to the

West Kitikmeot / Slave Study Society

Yellowknife, NT Canada

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Title: Survey of moose abundance in the boreal forest around Yellowknife, Northwest Territories. Final report to the West Kitikmeot/Slave Study.

Submitted by: Dean Cluff, Resources, Wildlife and Economic Development, North Slave Region, Government of the Northwest Territories, Yellowknife, NWT.

Summary:

A geospatial survey to estimate moose abundance was conducted in the Taiga Shield ecozone around Yellowknife and the north shore of Great Slave Lake, Northwest Territories. The survey area was 17,617 km^2 and stratified by grid cells into high and low probability of having moose. Grid cells (n=1116) were marked by 2' of latitude and 5' of longitude, representing approximately 4 km x 4 km cells at this latitude. Stratification was based on vegetation classification from satellite imagery, sighting records of moose, harvest statistics, community consultation and expert opinion (high = 412, low = 704). Strata selected for the survey (n=120 grid cells) were flown at 100 % coverage with a Cessna 185 airplane with the goal of counting every moose within a survey sample unit. In 120 grid cells surveyed, we observed 33 moose (8 bulls, 16 cows, 9 calves). An additional 35 moose (13 bulls, 13 cows, 9 calves) were observed incidentally outside the pre-selected survey grid cells. Number of moose estimated by the Geospatial method for the total survey area from all observations was 484 with a range of 352 to 617 moose based on 90% confidence intervals. Ratio of calves to cow moose was 64.5% (S.E. = 15.3%) and the bull to cow moose ratio was 71.2% (S.E. = 21.1%) based on all observations. Density of moose from all sightings was estimated at 2.75 moose/100 km^2. Density ranged from 2.0 to 3.5 moose/100 km^2 based on 90% confidence intervals of estimated moose numbers.

Acknowledgments:

Tracy Hillis (RWED) provided invaluable support with habitat analysis and stratification. Jay ver Hoef (Alaska Department of Fish & Game, Anchorage, AK) assisted throughout the planning and analysis stages of the survey. This survey benefited greatly from a workshop on moose population assessment in 2003 in Yellowknife, NWT, organized by Deborah Johnson (RWED) and facilitated by Bob Hayes (Wildlife Management Planning and Analysis, Yukon), with technical assistance from Rick Ward, (Department of the Environment, Yukon). Dave Taylor (RWED) assisted with constructing the survey grid for the NWT. Nic Larter (RWED) and Danny Allaire (RWED) provided an opportunity to participate in a similar survey along the Mackenzie River Valley in November 2003.

I thank the following people for their roles as observers and recorders: Alfred Baillargeon, Magnus Bourque, Frank Camsell, Joe Desjarlais, August Enzoe, Kevin Forrest, Dave Hare, Tracy Hillis, Margaret LeMoeul, Anatasia Mackenzie, Morris Martin, George Martin, Joslyn Oosenbrug, Eddie Paul, Charlie Sangris, Dave Taylor, Bill Turner, Bob Turner, Leon Weyallon, Janice Ziemann. Air Tindi pilots Angus Charlo, Wes Siemens, and Rob Gagné safely flew the aircraft and assisted with spotting wildlife.

I gratefully acknowledge funding for this project from the West Kitikmeot/Slave Study Society (WKSS) which received support from the Government of Canada, the Government of the Northwest Territories, and industry.

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Objectives:

- Estimate number and density of moose in the Taiga Shield ecozone of the North Slave administrative region.
- Estimate bull:cow and cow:calf moose ratios for population monitoring.

Background:

Moose are an important food source for Aboriginal hunters. Moose densities are low in the NWT, ranging from 1 to 17 moose/100 km^2 (Treseder & Graf 1985, Case & Graf 1992), and the extent of the subsistence hunt is unknown. Annual surveys of resident recreational hunters based in Yellowknife estimate their average take between 80 to 100 moose. However, not all Yellowknife recreational hunters may hunt in the North Slave Region and some of this hunting activity would occur elsewhere. Nevertheless, the human population of Yellowknife is growing and will likely result in increased hunting pressure in the region. Therefore, number of moose killed, distribution and abundance of moose, and ratio of bulls to cows and cows to calves are important parameters required to manage moose in the North Slave Region. These information gaps have been recognized in cumulative impact and monitoring program (CIMP) reports and recommendations for monitoring include population estimates of moose in all regions of the NWT and assessment of moose productivity (CIMP 2001 report, Indian and Northern Affairs Canada, Yellowknife, NT).

Industrial activity has since increased significantly in the North Slave Region, and most recently in the forested areas towards Great Slave Lake. Diamond bearing kimberlite pipes have been discovered in the Wool Bay and Drybones Bay areas and further exploration is proposed. The Yellowknives Dene First Nation, the North Slave Metis Alliance, and the Lutsel K'e Dene First Nation have expressed much concern over this proposed development because of cultural

concerns and a lack of baseline data for the area. Consequently, further studies have been requested to fill the gaps. Aboriginal groups have also expressed concern over the Tibbitt to Contwoyto winter road and its effects of increased access by the public and hunting in the area. Dogrib concerns include the effect of bison expanding their range northward because the impact on moose and caribou in the area are unknown. In the Taiga Plain, increased development for tourism has been proposed and concerns for wildlife there have been expressed. Similar concerns exist about increased presence of bison in the Taiga Plain.

The need for consistent survey techniques among regions has been recognized and a workshop on moose population assessment was held in Yellowknife in May 2003 (Hayes & Johnson 2003). The result of this workshop established the geospatial survey method as the standard for the Northwest Territories (ver Hoef 2000). This spatial technique is an extension of the "Gasaway" method developed earlier in Alaska (Gasaway et al. 1986) but with some important modifications on grid pattern, block size and eliminating need for sightability corrections. Moose spatial surveys in the Sahtu and Deh Cho were recently conducted but have not been done in the North Slave region. A preliminary framework for managing moose in the NWT was also discussed at the May workshop and several action plans evolved from this. One plan was to initiate a territorial program involving resident and aboriginal hunter observations of moose.

Community based moose monitoring

Information on numbers, age and sex of moose sighted by people on the land can be summarized annually and should provide input into analysis of calf survivorship, cow/calf, and bull/cow ratios for estimation of populations over the long-term. These data can also provide information on moose distribution and could be useful in environmental assessment process by illustrating high harvest/use areas by communities. Community based moose monitoring should

occur annually and could be an important index of moose trends between surveys. Consequently, a link between aerial surveys for moose and a community based moose monitoring program would be advantageous.

Methods:

A map of a proposed survey area for moose was developed in consultation with elders, hunters, and wildlife officers. Once the boundaries of the survey were finalized, a rectangular grid based on 2' latitude and 5' longitude (approximately 16 km^2 at this latitude) was overlain on the survey area. Grid cells were then stratified as having either high or low probability of moose. Stratification was based on sighting records of moose, harvest statistics, remotely sensed vegetation classification, community consultation and expert opinion. Final stratification consisted of vegetation classification initially and any subsequent modifications from additional information on moose abundance. About 10% of grid cells have been recommended for survey selection (Hayes & Johnson 2003).

Vegetation Classification

Stratification was based on a combination of two general methodologies. The first followed the rationale of Case and Graf (1992) such that stratification was based on the proportion of deciduous vegetation (i.e., the higher the proportion of deciduous vegetation, the higher the density of moose should be found). As such, percentage of deciduous vegetation was the primary qualifier for moose habitat. This parameter was then modified by assessing the use and availability of habitat used by moose from sightings of them during bison surveys (1994-2000) just south of the current Taiga Plains moose survey area.

Methodology for assessing use and availability were determined using methods presented by Arthur et al. (1996), wherein areas available for habitat use by an individual from one location to

the next is dependent on amount of elapsed time between successive locations. In order to account for habitat dependent bias on location precision and the possibility that animals may be selecting a mosaic of habitats rather than just the habitats in which they are found, use was defined as a circular buffer around the location at which the animal was found. Because moose locations were not assessed over varying times, the radii for measuring availability was assessed from the 95th percentile of the distance between locations for each year. Habitat used was defined as the contents of a circle centered on the site location (Rettie and Messier 2000, Hillis and Mallory 2004). Habitats selected by moose were then grouped based on the number of times moose were in the habitat type and incorporated with the proportion of deciduous vegetation. Four categories were used: High (> 10), Medium (4-10), Low (1-3) and None (0). For a two-class stratification system, the High and Medium categories were combined for the High moose stratification. Similarly, the Low, None, and any unclassified categories were combined as Low moose strata.

Community input into stratification

Moose occurrence data received from community based moose monitoring observation forms were entered into a Geographical Information Systems (GIS) database (ArcView) and assisted the identification of high and low density moose areas. Community participants were also asked to rank grid cells based on whether a moose would likely occupy that area. Positive responses were assigned a high density and negative responses were ranked as low density.

Aerial survey

Once stratified, 120 sample blocks (10.8%) were selected for the Taiga Shield ecozone survey area (17,617 km^2). Selection of grid cells were determined randomly for the first 100 cells (83%), after which the remaining 20 cells were selected non-randomly as allowed by the spatial method (ver Hoef 2000) to fill in areas that were not covered or lightly sampled from the random

selection.

Funding availability and stratification precluded a survey scheduled before March. We used two Cessna 185 aircraft simultaneously to conduct survey counts. Navigation was facilitated by the Global Positioning System (GPS) using a Garmin GPSmap 76S unit to display grid cell corners and display our GPS tracking log as we flew. This helped ensure complete visual coverage of the selected grid cell for moose in association with the type of habitat we encountered. All locations of animal sightings were recorded as GPS waypoints. Sex and age class of moose were recorded to estimate bull:cow and cow:calf ratios. Aerial survey results were entered into a spreadsheet and ArcView GIS. The spreadsheet was provided to Alaska Department of Fish and Game to enter into their web-based database for registered users to calculate population estimates.

Activities for the Year:

Consultation with hunters and elders had occurred in summer and fall 2003 in anticipation that a moose survey might be conducted in the near future. Hunters and elders had a major role in determining tarea surveyed and assisted in stratifying the survey area in to high and low probability densities of moose. Consequently, local and traditional knowledge for seasonal abundance of moose were included in this initial stratification effort. Input was received from the Yellowknives Dene First Nation (Dettah and N'Dilo), North Slave Metis Alliance, Dogrib Treaty 11 Council, and Lutsel K'e Dene First Nation.

Consultation for community-based moose monitoring began in September 2003 to brief wildlife officers at North Slave Region in Yellowknife and discuss the project with the Yellowknives Dene at their Land and Environment meeting. Consultation with Dogrib Treaty 11 Council in Rae began in October 2003. Another round of consultation occurred with Dogrib

communities in December and feedback was received on survey boundaries. Further consultation with aboriginal groups occurred in January and February 2004. Stratification was finalized by the end of February to allow the survey to begin in early March. Extensive use of habitat classification based on satellite imagery and previous moose sightings was also used to stratify the survey area. Community representatives participated in the actual survey in March as the main observers in the two planes.

Results:

The Taiga Shield moose survey area was stratified into 412 High and 704 Low strata among grid cells (total = 1116 cells). Average grid cell area was 15.928 km^2 (S.E. = 0.093 km^2, n = 1116). The survey began on 02 March 2004 as scheduled but air temperature was cold (-35EC.). Although flyable, the cold temperatures resulted in extensive frost on windows, thus severely affecting sightability. The survey was aborted after approximately one hour and the survey rescheduled the following week, given that clear skies and cold temperatures were forecast to continue until then. Flying resumed on 06 March with one plane during the afternoon when temperatures increased to about -25EC. At that temperature and above, frosting of windows was not an issue. Surveying with two planes resumed on 08 March and continued to 12 March inclusive. Only one plane was needed on 13 March to complete the survey (Appendix Table A1-1).

We observed 33 moose (8 bulls, 16 cows, 9 calves) in the 120 grid cells selected in the Taiga Shield survey. An additional 35 moose were observed outside of these cells during the survey. Therefore, 68 moose (21 bulls, 29 cows, 18 calves) were observed in total. These incidental sightings added another 29 grid cells to the total flown, although coverage in these ones was not complete. From the surveyed grid cells, the bull:cow ratio was 50:100 and increased to 56

bulls:100 cows when the incidental sightings of moose were included. Similarly, the calf:cow ratio was 56:100 and increased to 62 calves:100 cows when incidental sightings were added.

If one considers the number of moose sighted (33) and the area covered (1896.63 km^2), then a coarse density of 1.74 moose/100 km^2 is calculated. Extending this density estimate to the entire survey area, approximately 306 moose may be present. One can improve on this estimate by considering the incidental sightings of moose from outside the surveyed grid cells. In this case, the additional grid cells would not have been surveyed completely, and consequently, some moose may have been present in the grid cell and not counted. Therefore, such an extrapolation would likely be conservative. For this calculation, the additional 35 moose sighted in the 29 other grid cells were used. Therefore, 68 moose sighted in a 2,355.8 km^2 area yielded a conservative density of 2.89 moose/100 km^2. Extrapolating that to the entire survey area results is an overall estimate of 509 moose.

The number of moose in the Taiga Shield survey area was also estimated based on the Spatial Analysis (Geospatial) technique developed by Alaska Department of Fish and Game in Anchorage, Alaska. Based on the 120 pre-selected grid cells only, number of moose was estimated at 266 (S.E. = 65.8). Therefore, using 90% confidence intervals, 158 to 374 moose were estimated in the survey area (Table 2). Population ranges based on 80% and 95% confidence intervals were also estimated (Table 2). Population estimates by the Gasaway method were calculated for comparison (Table 2). Incorporating pre-selected and incidental grid cells yielded a population estimate of 484 moose (S.E. = 80.5) for the same total survey area. Using 90% confidence intervals, the number of moose is the survey area was estimated from 353 to 617 (Table 2).

Ratio of calves to cow moose was 0.623 (S.E. = 0.212) for the entire survey area based on the pre-selected grid cells (Table 3). This ratio increased slightly to 0.645 (S.E. = 0.153) when

incidental observations were included. Similarly, the ratio of bulls to cow moose increased from 0.578 (S.E. = 0.217) using pre-selected survey grid cells to 0.712 (S.E. = 0.211) when incidental observations were included (Table 3).

Discussion:

This survey was the most extensive ever done for the Taiga Shield ecozone north of Great Slave Lake. The first survey recorded in this area was an aerial transect survey east of Yellowknife in March 1962 in response to demands for hunting opportunities for resident, non-aboriginal hunters (Kuyt 1962). In that survey, 13 moose were observed in total along eight line transects spaced 12.8 km apart. Approximately, 968 km of line transects were flown then that resulted in an estimated coverage of 386.6 km^2. A smaller, more intensive survey (96 km^2) was conducted the following day in the Hearne Lake area. Although results of the 1962 survey suggested an estimate of about 380 moose when extrapolated to the 11,305 km^2 census area of interest, the author was not confident in this result given a number of errors and uncertainties (Kuyt 1962).

Subsequent to this, a survey for moose was conducted north of Yellowknife in a 4,332 km^2 area between Gordon Lake and Wecho River in November 1989 (Case & Graf 1992). Only 20 moose were sighted in this survey and a population estimate, based on the stratified block design of Gasaway et al. (1986), was 99 moose (S.E.= 56 moose). Moose densities were low in the 1989 survey, ranging from 3 to 10 moose per 100 km^2 in the low and medium stratification areas. When the zero moose stratification was included (4,332 km^2 total survey area), the average density of moose fell to 2 moose/100 km^2.

Although these two previous surveys were relatively small and 27 years apart, they do support this 2004 survey that moose densities are low in the Taiga Shield ecozone in the Yellowknife

area. Moose densities elsewhere in the boreal forest of the NWT are somewhat higher and may average about 9 moose/100 km^2 although higher densities have been reported for smaller areas (Treseder and Graf 1985).

Bull:cow and calf:cow ratios in March 2004 were surprisingly high, at least for late winter. In Alberta, a pre-hunting season bull:cow ratio of 40:100 is desirable and a post season ratio of 32 bull per 100 cows is acceptable (Alberta Sustainable Resource Development, Northern Moose Management Program, Progress Report , 12 August 2002). Consequently, 50 bulls per 100 cows in the surveyed cells for the Taiga Shield, and upwards to 72 bulls per 100 cows with the incidental sightings are encouraging.

The calf:cow ratio at 56 calves per 100 cows (62 calves:100 cows with incidental sightings) suggests reasonably strong calf survival. Indeed, three sightings of a cow with twins contributed to the high ratio. The density of black bears and resident wolves may be lower in the Taiga Shield than elsewhere. An influx of wolves occurs in late fall and winter when wolves follow the migratory barren-ground caribou (Bathurst herd) into winter ranges. However, an abundance of barren-ground caribou and perhaps a preference for them by wolves over moose, are likely contributing factors. Bison were sighted in the survey area and represent a new species for the ecozone. What implications bison may have on the moose population is uncertain.

The harvest of moose for the area is poorly documented but some hunting does occur by both aboriginal and resident hunters. Adopting a community-based harvesting monitoring program as initiated in the North Slave in the 2003/04 season should help address this gap. Indeed, such hunter based monitoring has proven effective elsewhere in monitoring population size and reproductive rate (Ericsson and Wallin 1999).

This survey occurred in March when bull moose have dropped their antlers and consequently classification errors may increase. Classifying male moose based solely on the presence of a bell

is not definitive as females have them too, although not as long or robust. Scheduling the survey in November would likely negate this error, although other considerations arise. A survey in mid to late November would be restricted by day length, given a 7-hour span between sunrise and sunset in mid-November compared to 11 hours in early to mid-March. Amount of frozen ground would also influence moose distributions and their use of closed habitats. Snow depth would be minimal in November but ground coverage would be complete by then for good sightability.

Use of fixed wing aircraft (Cessna 185) for this survey was practical given the relatively sparseness of tree cover. Aircraft were also able to adapt to situations where tree cover was thick and required tighter survey lines. Employing two aircraft concurrently allowed the survey to be completed with a week and mitigated against unforeseen weather delays. Smaller area surveys may wish to use one plane if experienced observers are limited.

Stratification for this survey was preliminary and heavily based on vegetation classification from satellite imagery, although local input was used. Local input was not comprehensive for the entire survey area and therefore vegetation classification maps were required. The next survey will now benefit from observations from this 2004 survey, a re-stratification effort based on these local sightings, community-based moose monitoring, and new information. Nevertheless, stratification efforts for the 2004 moose survey were successful. At worst, the survey represents a minimum count and therefore a conservative estimate of minimum moose density in the Taiga Shield ecozone. Good baseline information was obtained for moose in the Taiga Shield prior to the onset of significant development and ecological pressures.

Links with Parallel Studies:

Community based moose monitoring

A community based moose monitoring program began in September 2003 with the Yellowknives Dene First Nation and Treaty 11 Band Council, in response to concerns of a lack of baseline data in the area for monitoring. The approach followed methods of community ground-based monitoring established by Mark O'Donoghue in Mayo, Yukon. The program consists of a hunter observation questionnaire asking for observations on what a hunter might see while out hunting or other land-based activities. The questionnaire asks for hunters to report on number of moose seen, gender, age class, weather, habitat, and location where sighted. In order to maintain confidentiality, a 10 x 10 km^2 grid overlain on a 1:1 million scale map of the North Slave Region was created to record information submitted. These observations will assist aerial surveys of moose abundance and group composition in the region.

A companion moose survey was conducted in the Taiga Plain ecozone west of the North Arm of Great Slave Lake, 18-19 March 2004. The Taiga Plain ecozone has a higher density of moose than the Taiga Shield given habitat preferences for moose and the lack of extensive rock outcrops typical of the PreCambrian Shield in the latter. The survey areas are adjacent to each other but separated by the North Arm of Great Slave Lake. Habitat differences are significant enough that a separate survey was desired. Together, the two surveys will provide important baseline information for population trends and management of moose in the North Slave administrative region of the NWT.

Training Activities and Results:

There was no formal training proposed as part of this survey, however, given that some observers in the plane were inexperienced, daily briefings were given outlining ways to help classify moose into sex and age classes. A briefing pamphlet that graphically outlines these techniques is now planned to facilitate classification of moose for future surveys. A half day

briefing workshop before the workshop has also been suggested for future surveys.

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Table 1. Summary of moose sightings during the Taiga Shield moose survey, North Slave Region, Northwest Territories, March 2004. Surveyed grid cells totaled 120 from 1116 possible. Incidental sightings occurred over an additional 29 grid cells.

	bulls		lone	cow with	cow with	total non-	total
	small	large	cow	1 calf[a]	2 calves[b]	calf moose	moose
surveyed grid cells	3	5	8	7	1	24	33
incidental	7	6	6	5	2	26	35
total sightings	10	11	14	12	3	50	68

[a] number indicates each occurrence of a cow with 1 calf; for number of moose, double the count to include the calf

[b] number indicates each occurrence of a cow with 2 calves; for number of moose, triple the count to include the calves

Table 2. Moose population estimates including calves for the Taiga Shield survey area March 2004. Area of interest for the survey was 17,617 km^2 from which 1116 grid cells (approx. 4 km x 4 km) were established. Of these cells, 412 were stratified as high moose density and the remaining 704 were considered low density.

Pre-Selected Grid Cells Only (no incidental sightings); Strata Count: High = 69 cells, Low = 51 cells; Total Area = 1896.7 km^2

Moose Counted		Population		Confidence Interval			Estimation
High	Low	Estimate	SE	80%	90%	95%	Method
24	9	266	65.8	182 – 350	158 – 374	137 – 395	Geospatial
24	9	267	65.7	182 – 352	158 – 377	137 – 398	Gasaway

Pre-Selected & Incidental Grid Cells; Strata Count: High = 81 cells, Low = 68 cells; Total Area = 2355.8 km^2

Moose Counted		Population		Confidence Interval			Estimation
High	Low	Estimate	SE	80%	90%	95%	Method
39	29	484	80.5	381 – 588	352 – 617	327 – 642	Geospatial
39	29	498	82.2	392 – 604	361 – 634	335 – 661	Gasaway

Table 3. (a) Ratio of calves to cow moose and (b) bulls to cow moose estimated for the entire Taiga Shield survey area March 2004 calculated by the geospatial method from surveyed grid cells. Area of interest for the survey was 17,617 km^2 from which 1116 grid cells (approx. 4 km x 4 km) were established. Of these cells, 412 were stratified as high moose density and the remaining 704 were considered low density.

(a)

Moose Counted[1]		Ratio Estimate		Confidence Interval			Grid
calves	cows	(calves/cow)	SE	80%	90%	95%	Cells[2]
7+2	12+4	0.623	0.212	0.351 – 0.895	0.274 – 0.973	0.207 – 1.039	NI
11+7	18+11	0.645	0.153	0.449 – 0.842	0.393 – 0.898	0.345 – 0.946	P+I

(b)

Moose Counted[1]		Ratio Estimate		Confidence Interval			Grid
bulls	cows	(bulls/cow)	SE	80%	90%	95%	Cells[2]
5+3	12+4	0.578	0.217	0.300 – 0.856	0.221 – 0.935	0.153 – 1.003	NI
10+11	18+11	0.712	0.211	0.442 – 0.983	0.366 – 1.059	0.299 – 1.126	P+I

[1] Count is separated as numbers of moose counted in High and Low grid cells respectively.
[2] NI = not incidental; P+I = Selected & Incidental

Figure 1. Stratification of the Taiga Shield ecozone moose survey area in the North Slave region around Great Slave Lake, NWT. Probability of occurrence of moose for each grid cell is classified as either high (red labels) or low (green labels). Grid cells are 2' latitude by 5' longitude and averaged approximately 16 km^2. The total survey area was 17,617 km^2.

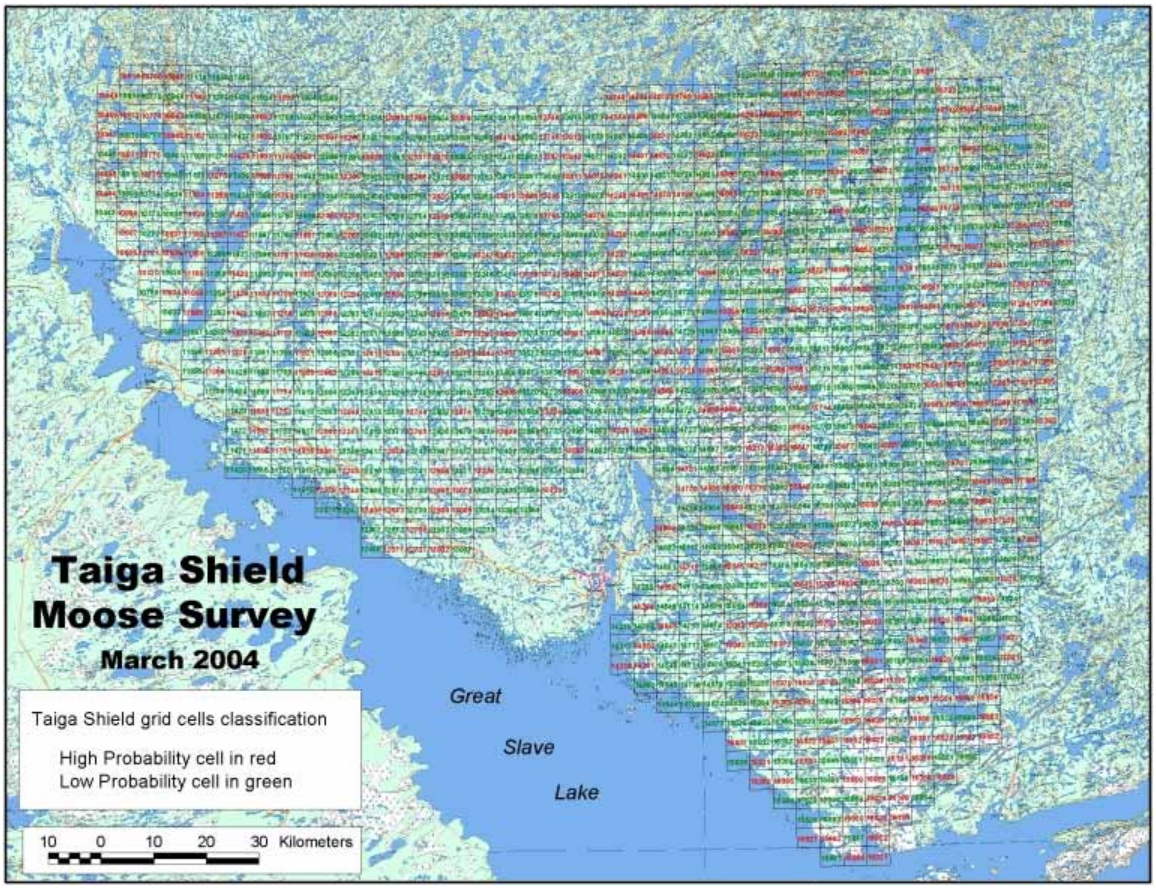


Figure 2. Grid cells flown in the Taiga Shield ecozone moose survey area in the North Slave region around Great Slave Lake, NWT.

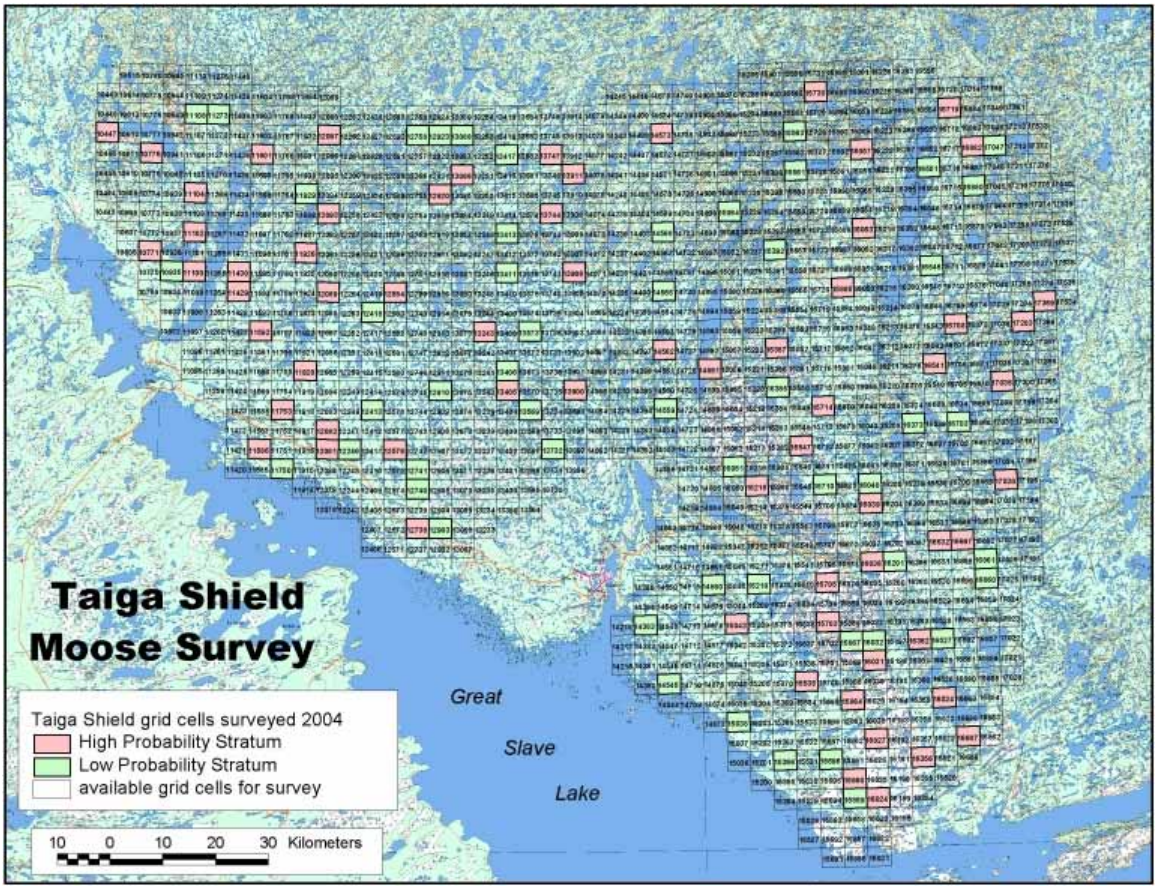
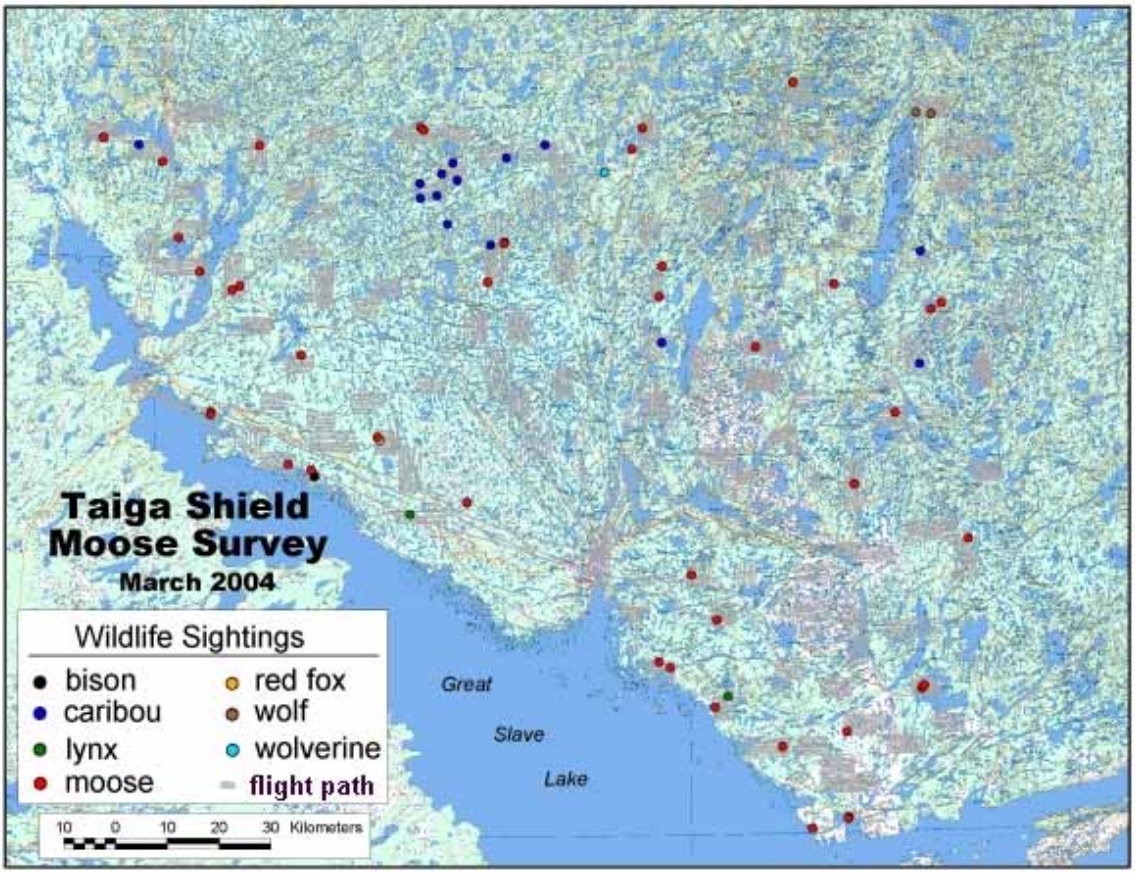


Figure 3. Wildlife sightings observed during the Taiga Shield ecozone moose survey area 02-13 March 2004 in the North Slave region around Great Slave Lake, NWT.



Appendices:

Appendix 1. Aircraft Use

For the spatial survey method, at least 10 % of the area should be surveyed and a minimum of 60 grids cells must be sampled. Because the Taiga Shield survey area is large (it includes the areas of interest to the Yellowknives Dene, Dogrib, and some of the Tibbitt to Contwoyto winter road), many more grid cells need to be surveyed. The identified Taiga Shield survey area encompassed 17,617 km^2 (1116 grid cells), therefore a survey of about 120 grid cell is desired. About 10-12 cells can be sampled/plane/day, on average.

Table A1. Summary of aircraft use for the Taiga Shield moose survey 02-13 March 2004, based out of Yellowknife, NT

Taiga Shield Moose Survey 2004 Aircraft Use

date	Plane #	C-185	time charge	fuel charge	air time	flight time	mileage
02-Mar	1	PHO	$457.08	$67.08	1.2	1.3	156
	2	WXI	$342.81	$50.31	0.9	1.1	117
06-Mar	1	WXI	$1,447.42	$212.42	3.8	4.0	494
07-Mar	1	PHO	$1,447.42	$212.42	3.8	4.0	494
08-Mar	1	PHO	$2,856.75	$419.25	7.5	7.7	975
	2	WXI	$1,523.60	$223.60	4.0	4.2	520
10-Mar	1	WXI	$2,704.39	$396.89	7.1	7.3	923
	2	PHO	$3,085.29	$452.79	8.1	8.5	1053
11-Mar	1	WXI	$2,771.78	$406.78	7.2	7.6	946
	2	PHO	$3,313.83	$486.33	8.7	9.1	1131
12-Mar	1	PHO	$3,199.56	$469.56	8.4	8.8	1092
	2	WXI	$1,095.82	$160.82	2.9	3.2	374
13-Mar	1	ZIX	$952.25	$139.75	2.5	2.7	325
			$25,198.00	$3,698.00	66.1	69.5	8600

Appendix 2 - Expenditures and Source of Funds

Funding for this survey was provided by WKSS (44,000), although $4,000 of that total was provided by the Tibbitt-to-Contwoyto Winter Road Joint Venture. However, some savings were realized from efficient flying coverage of the survey area, a competitive air charter contract, and fewer additional observers than expected. A summary of budget expenditures follows.

Table A2. Taiga Shield moose survey expenses.

Item	*Cost*
Aircraft: 2 Cessna 185 ($362.56/hr x 69.5 hrs)	$25,198.00
Fuel: AvGas	$ 3,698.00
Wages: various community reps @ $200/day	
Treaty 11:	$ 300.00
Yellowknives Dene:	$ 805.00
North Slave Metis Alliance:	$ 1,000.00
Lutsel K'e:	$ 1,120.00
Yellowknife residents:	$ 100.00
Accommodation	
NSMA	$ 141.24
Lutsel K'e	$ 282.48
Lutsel K'e airfare	$ 560.76
GPS equipment: 2 GPSmap 76S plus accessories	$ 1,456.83
Field Equipment (batteries, food)	$ 183.68
Software	$ 171.00
Community-based monitoring gas certificates	$ 1,000.00

	$35,856.99
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