Survey of moose abundance in the boreal forest around Rae-Edzo, Northwest Territories

Final Report to the

Cumulative Impact Monitoring Project

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Summary:

A geospatial survey to estimate moose abundance was conducted in the Taiga Plain ecozone near Rae-Edzo and the west shore of the North Arm of Great Slave Lake, Northwest Territories. The survey area was 7,669 km^2 and was stratified by grid cells into high and low density probability of having moose. Grid cells (n=479) 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 = 314, low = 165). Strata selected for the survey (n=60 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 the 60 grid cells survey we observed 30 moose (11 bulls, 14 cows, 3 unclassified & 2 calves). We observed an additional 19 moose (7 bulls, 10 cows, 2 calves) incidentally but outside the surveyed grids. Number of moose estimated by the Geospatial method for the total survey area and based on all sightings was 306 with a range of 213 to 398 moose based on 90% confidence intervals. Ratio of calves to cow moose was 15.9% (S.E. = 5.6%) based on all observations. Density was estimated at 3.99 moose/100 km^2 based on the Geospatial point estimate for the total survey area for all sightings.

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Tracy Hillis (RWED) provided invaluable support with the 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 assistant 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.

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Objectives:

- Estimate the number and density of moose in the Taiga Plain ecozone of the North Slave administrative region.
- Estimate the bull:cow and cow:calf 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, Yellowknife recreational hunters do not restrict themselves to the Taiga Shield ecozone surrounding the city. Rather, resident moose hunting activity may also occur in the Taiga Plain ecozone south of Rae-Edzo and beyond. Furthermore, the human population of Yellowknife is growing and this will likely result in increased hunting pressure in the region. Therefore, number of moose killed, distribution and abundance of moose, and the 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 they recommend 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 the increased presence of bison in the Taiga Plain.

The need for consistent survey techniques among the 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 spatial 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 the 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 of these plans 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. This 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. The 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 the vegetation classification initially and any subsequent modifications from additional information on moose abundance.

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 utilized by moose from information collected of moose during bison surveys (1994-2000) just south of the current Taiga Plains moose survey area.

Methodology for assessing use and availability were determined using the methods presented by Arthur et al. (1996), wherein the areas available for habitat use by an individual from one location to the next is dependent on the 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 95^{th} 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 for by moose were then grouped based on the number of times moose were in the habitat type and this was combined 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

Data received from the community based moose monitoring observation forms was entered into a Geographical Information Systems (GIS) database (ArcView) and assisted the identification of high and low density moose areas. Community participants were 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, 60 sample blocks were selected for the Taiga Plain ecozone survey area (7,669 km^2). Selection of grid cells were determined randomly for the first 50 cells (83%), after which the remaining 10 grid 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.

We used two Cessna 185 aircraft simultaneously to conduct the 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 ArcView GIS and provided to Alaska Department of Fish & Game to calculate a population estimate.

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 the area 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), the North Slave Metis Alliance, the Dogrib Treaty 11 Council, and the Lutsel K'e Dene First Nation.

Consultation for the 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 the Dogrib Treaty 11 Council in Rae began in October 2003. Another round of consultation occurred with the Dogrib communities in December and feedback was received on survey boundaries. Further consultation with aboriginal groups occurred in January and February. 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 area. Community representatives participated in the actual survey in March as the main observers in the two planes.

Results:
The Taiga Plain moose survey area was stratified into 314 High and 165 Low strata among grid cells (total = 479 cells). Average grid cell area was 16.049 km^2. The survey began on 18 March 2004 and was completed after the next day (Appendix Table A1-1).

We observed 30 moose (11 bulls, 14 cows, 3 unclassified moose & 2 calves) in the 60 grid cells selected in the Taiga Plain survey. An additional 19 moose were observed outside of these cells during the survey. Therefore, 49 moose (18 bulls, 24 cows, 3 unclassified, 4 calves) were observed in total (Appendix Table A3). These incidental sightings added another 17 grid cells to the total, although coverage in these ones was not complete.

From the surveyed grid, the bull:cow ratio was 78:100 and decreased slightly to 75 bulls:100 cows when the incidental sightings of moose were included. The calf:cow ratio was 14:100 and increased to 16 calves:100 cows when incidental sightings were added.

A coarse density estimate of moose of 3.13 moose/100 km^{2}can be easily calculated if one considers the number of moose sighted (30) and the area covered (959.80 km^2). Extending this density estimate to the entire survey area, approximately 240 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, we use the additional 19 moose that were sighted in the 17 other grid cells. Therefore 49 moose sighted in a 1,232.36 km^2 area yielded a conservative density of 3.98 moose/100 km^2. Extrapolating that to the entire survey area results is an overall estimate of 305 moose.

The number of moose in the Taiga Plain survey area estimated by the Spatial Analysis (Geospatial) technique was 241 moose (S.E. = 60.6) based on the 60 pre-selected grid cells only. Incorporating all the sightings (from within 77 grid cells), the population was estimated at 306 moose (S.E. = 56.1). Therefore, using 90% confidence intervals, 213 to 398 moose were estimated for the total survey area (Table 2).

Ratio of calves to cow moose was 0.132 (S.E. = 0.060) for the entire survey area based on the pre-selected grid cells (Table 3). This ratio increased to 0.159 (S.E. = 0.56) when incidental observations were included. The ratio of bulls to cow moose was 1.051 (S.E. = 0.435) for pre-selected grid cells but decreased to 0.801 bulls to cows (S.E. = 0.263) when incidental observations were included (Table 3).

Discussion:

This survey was the first ever done for the Taiga Plain ecozone west of Great Slave Lake. Two surveys of moose occurred in the Yellowknife area over the last 42 years (Kuyt 1962, Case & Graf 1992). In the former survey, 13 moose were observed in 8 line transects spaced 12.8 km apart. The estimated coverage was 386.6 km^2. Although the results of the 1962 survey suggested an estimate of about 380 moose for the entire 11,305 km^2 area of interest, the author was not confident in this result given a number of errors and uncertainties (Kuyt 1962).

The second moose survey in the Yellowknife area was conducted north of the city 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 North Slave Region and certainly for the Taiga Shield ecozone. Moose densities in the Taiga Plain ecozone 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).

The bull:cow ratios in the March 2004 survey was 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, 78 bulls per 100 cows in the surveyed cells for the Taiga Plain, or similarly, 75 bulls per 100 cows with the incidental sightings are encouraging.

The calf:cow ratio of 13 calves per 100 cows (16 calves:100 cows with the incidental sightings) suggests poor calf survival. Indeed, no sightings of a cow with twins were recorded in this survey. In November 2004, a transect based aerial survey for boreal wood caribou (*Rangifer tarandus caribou*) conducted provided similar results for moose sighted. In this November survey, 60 incidental sightings of moose were recorded and totalled 99 moose (36 bulls, 47 cows, and 16 calves). Among these were three occurrences of a cow moose with twin calves.

Bison (*Bison bison athabascae*) were sighted in several areas during the March (and November) survey and appear to be expanding their range. What implications bison may have on the moose population is uncertain, but increased predation on moose by wolves (*Canis lupus*) might be a factor if bison attract or maintain wolves in the area. The density of black bears (*Ursus americanus*) and resident wolves may be higher in the Taiga Plain than elsewhere. Bears, especially grizzly bears (*U. arctos*), are a significant mortality source for calf moose in the first few weeks of life (Ballard et al 1991). Although black bears may have less proportional impact, they likely kill many newborn calves. Indeed, black bears have been observed chasing moose calves and following pregnant cow moose persistently in mid-May presumably in anticipation of the cow moose calving (A. Helmer, pers. comm.. Hay River, NWT).

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 as such may increase classification errors by observers. 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 that there is an 11-hour span between sunrise and sunset in early to mid-March compared to 7 hours in mid-November. The degree of frozen ground would also likely influence moose distributions and their use of closed habitats. Snow depth would be minimal in November but ground coverage should be complete by then to allow good sightability.

The use of fixed wing aircraft (Cessna 185) for the survey was practical given the relatively sparseness of the 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 mitigates 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. However, local input was not comprehensive and vegetation classification maps were the default. 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, the stratification effort for the 2004 moose survey was successful. At worst, the survey represents a minimum count and therefore a conservative estimate of minimum moose density in the Taiga Plain ecozone. However, I believe we have established good baseline information on moose in the Taiga Plain 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 the Treaty 11 Band Council, in response to concerns of a lack of baseline data in the area for monitoring. The approach followed the 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 on land activities. The questionnaire asks for hunters to report on the 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 the data 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 Shield ecozone north of Great Slave Lake in early March 2004. The Taiga Shield ecozone likely has a lower density of moose than the Taiga Plain given the habitat preferences for moose and the extensive rock outcrops typical of the PreCambrian Shield in the former. The survey areas are adjacent to each other but separated by the North Arm of Great Slave Lake, however the 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.

Literature Cited:

Arthur, S.M., B.F.J. Manly, L.L. McDonald, and G.W. Garner. 1996. Assessing habitat selection when availability changes. Ecology 77:215-227.

Ballard, W.B. J.S. Whitman, and D.J. Reed. 1991. Population dynamics of moose in south-central Alaska. Wildlife Monographs No. 114.

Case, R., and R. Graf. 1982. A moose survey stratified by using Landsat TM data, north of Great Slave Lake, NWT, November 1989. Government of the Northwest Territories, Department of Renewable Resources, Manuscript Report No. 59.

Ericsson, G. and K. Wallin. 1999. Hunter observations as an index of moose *Alces alces* population parameters. Wildlife Biology 5:177-185.

Gasaway, W.C., S.D. DuBois, D.J. Reed, and S.J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biological papers of the University of Alaska, Number 22. 108 pp.

Graf, R.P. 1992. Status and management of moose in the Northwest Territories, Canada. Alces Supplement 1: 22-28.

Hayes, R.D. and D. Johnson. 2003. NWT workshop on moose population assessment. May 15 and 16, 2003. Yellowknife, NT

Hillis, T.L. and F.F. Mallory. 2004. Ecology of woodland caribou, *Rangifer tarandus caribou*, in northwestern Ontario: responses to habitat fragmentation. Laurentian University, Sudbury, ON

Kuyt, E. 1962. Aerial survey of moose in the area east of Yellowknife, NWT, 1962. Unpublished Canadian Wildlife Service report 62-27, Edmonton, Alberta.

Rettie, W.J., and F. Messier 2000. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. Ecography 23:466–478.

Treseder, L. and R. Graf. 1985. Moose in the Northwest Territories – a discussion paper. Government of the Northwest Territories, Department of Renewable Resources, Manuscript Report No. 13.

ver Hoef, J. 2003. A spatial moose survey estimation method. Unpublished report submitted to the NWT workshop on moose population assessment. 4pp.