Fort Smith Moose Census
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Abstract

A moose census was conducted in the Southern Slave River Lowlands from Nov 27 to December 4 1996. The study area was 3,151.20 km^2, and contained 105 sample units. 128 moose were observed yielding a population estimate of 357 moose (± a 90% confidence interval of 62 moose, or 17.4% of the estimate), and a density of 0.11 moose/km^2.

Population size did not differ significantly ($t_{22} = 0.185$, $p > 0.40$) from a census conducted in 1986 (373 ±135.9 moose). Bull:100 cow ratio (121 bulls:100 cows) did differ significantly from 1986 (66.5 bulls:100 cows, $t_{16} = -8.756$, $p < 0.01$), Calf:100 cow ratio (36.9 calves:100 cows) did not differ significantly from 1986 (62.6 calves:100 cows, $t_{22} = 1.583$, $p = 0.07$).

Some sample units were flown twice, once with each aircraft type (Cessna 185 and an Astar B350 helicopter) to assess possible bias associated with aircraft type. Similar data will be collected during future censuses, and the results will be reported in a later publication.

No management activity is deemed to be necessary, given the consistency in population characteristics. The human harvest of moose and habitat use by moose will hopefully be the subject of future research.

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Introduction

Despite the importance of moose as a food animal in the western NWT, moose censuses have occurred sporadically, with few studies involving re-censusing of set study areas (but see Case unpubl. data, Latour 1992, Bradley et al. 1998a, b). Data on population status (i.e. increasing, decreasing, stable) is fundamental for good management, therefore having a time series of population estimates is essential.

Moose are important to the people of Fort Smith. While there has been no perceived problem with the moose population, the importance of the resource to local people warrants a population monitoring program. Also, habitat modification has occurred in the form of logging, and while logging can be beneficial to moose populations, excessive logging can eliminate the dense stands of conifers that moose need for winter cover (Stelfox 1974, Potter 1985, Payne et al. 1988, Abaturov 1992, Zablotskaya and Zablotskaya 1992). Possible future habitat modifications include the prescribed burning of prairies. In view of these activities, and considering the fact that no harvest information exists, it would be wise to monitor the population status of this valuable species.

In 1986 a moose census was conducted in the Southern Slave River Lowlands study area. The population estimate was 373 moose, with a 90% confidence interval of 36.4 (Graf and Case 1991). The objective of the current study was to estimate the size and structure of the moose population in the Southern Slave River Lowlands study area to compare with the 1986 data.

Methods

An aerial stratified random block survey was conducted using Gasaway et al.'s (1986) technique. The technique entails delineation of a study area and division of this study area into survey units (SUs). Next is a reconnaissance flight, followed by division of the survey area into strata of similar moose densities. Randomly chosen survey units within each strata are then searched thoroughly for moose. Estimates of population size are calculated for each stratum and combined to give an estimate of total population size. Sampling precision is also calculated for each stratum, then combined to give an estimate of precision for the total population estimate.

Gasaway et al. (1986) recommends that sightability correction factors be calculated for each study area to account for the differences in sightability of moose between different habitats. Sightability correction factors were not calculated for our survey, as estimating sightability is futile when moose densities are less than 0.4 moose/km^2 (Gasaway et al. 1986), as they invariably are in the N.W.T. (Graf 1992). The main purpose of our study was to determine the temporal trend in population size, and this can be done without sightability correction factors if we assume no change in sightability between the two censuses.

Study Area

The South Slave River Lowlands study area and the survey units were established in 1986 by Graf and Case (1991). The study area was 4,379 km^2 and 277 SUs in 1986, but we eliminated 99 SUs to save money, making the 1996 study area only 3,151.2 km^2 and 105 SUs (Figure 1). The eliminated SUs were within the Canadian Shield to the east, leaving the study area as alluvial plain bounded by the Little Buffalo River to the west and the Hanging Ice River to the east. Also, most of the 1986 SUs were made larger to aid in obtaining a more precise population estimate. A detailed description of the study area is given in Graf and Case (1991).

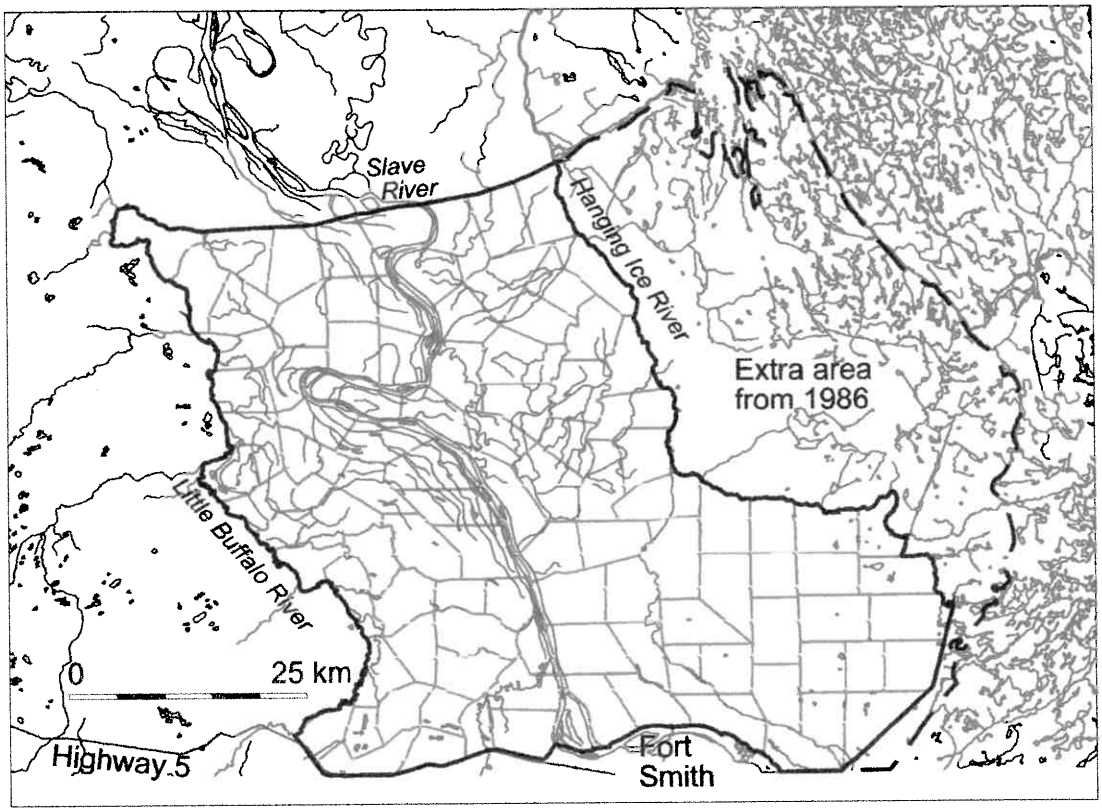

Figure 1. The South Slave River Lowlands study area, with survey unit (SU) boundaries.

Reconnaissance

The reconnaissance survey was flown at 160 km/hr and 125m altitude on November 27 and 29, 1996 (flying was not possible on November 28 due to weather). A Cessna 180 and Cessna 206 were used as the survey planes. Transects were 4 km apart and 1 km wide, resulting in 25% coverage. Navigation was aided by the use of a global positioning (GPS) receiver. A data recorder sat in the co-pilot's seat, and was responsible for recording numbers and locations of moose, as well as habitat type at each moose location. Locations were recorded on the GPS unit, downloaded to a computer, and displayed on screen to aid in stratification.

Stratification

Each SU was assigned to one of three strata: high, medium, or low. Several criteria were used for stratification: moose and track locations from the reconnaissance flight, moose locations from Graf and Case (1991), and location of 'good' moose habitat (generally willow or willow/prairie habitats) as seen on reconnaissance. Moose and track locations from our own reconnaissance outweighed the other factors, and we tried to avoid having single SUs of one stratum surrounded by SUs of another stratum.

Census

SU searches were conducted from November 28 to December 4. There was one crew searching from an Astar B350 helicopter and one crew searching from a Cessna 185 fixed wing plane. In both aircraft there was a navigator/data recorder and two observers in addition to the pilot. The fixed wing crew was assigned only to SUs that contained mostly open habitats. SUs were searched in random order until the precision of the estimate was deemed acceptable (confidence interval of 20% of the mean, calculated after each day's searching).

All moose recorded were classed by age (adults, yearlings, calves) and sex.

Temperature, wind speed, and percent cloud cover were recorded at the beginning of each SU search. Temperature and wind speed were obtained from the Fort Smith airport or the aircraft's instruments and cloud cover was visually estimated. Habitat type was recorded at two scales: within 10m, and within 250m of each moose sighting.

Data Analysis

Gasaway et al.'s (1986) techniques were used for analysing moose census data. T tests were used to test for significant differences between years for population estimates and sex/age ratios. Weather, habitat, and search effort were compared using either parametric (t-tests, anova) or non-parametric (Mann-Whitney U tests, Kruskal Wallis tests) tests depending on the distribution of the data.

Results

Reconnaissance

186 moose were seen on the reconnaissance survey (Figure 2). We used the reconnaissance data to assign 39 SUs to the high stratum, 54 SUs to the medium stratum, and 93 SUs to the low stratum. (Figure3)

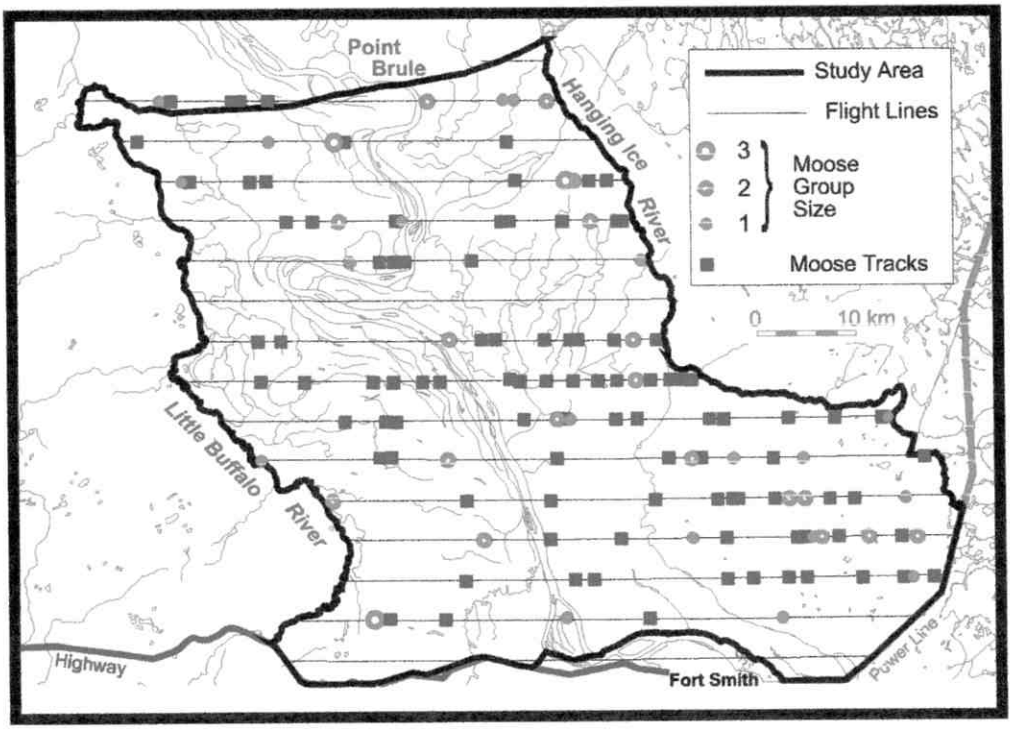

Figure 2. Location of moose and moose tracks seen on reconnaissance flights.

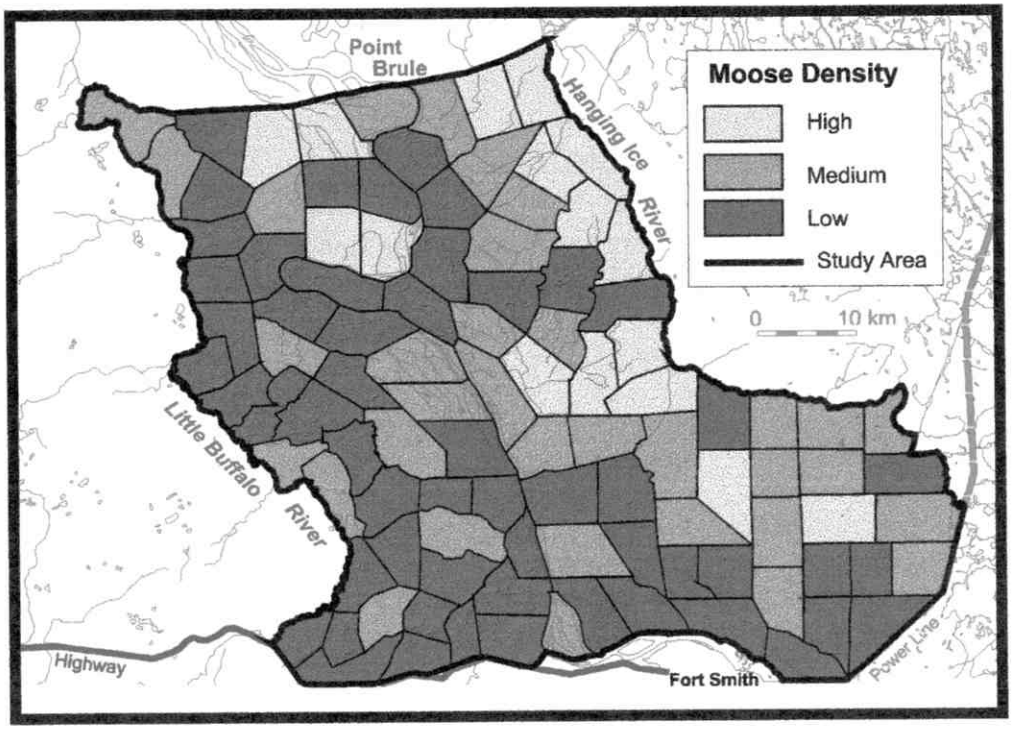

Figure 3. Strata as delineated by reconnaissance flights.

Population Estimate

We counted 128 moose (Figure 4) and calculated a population size of 357.2 moose, which corresponds to a density of 0.11 moose/km^2. The precision of the census, expressed as a 90% confidence interval, was 62.2, or 17.42% of the estimate. The coefficient of variation (a second measure of precision) was 10.16 (Table 1).

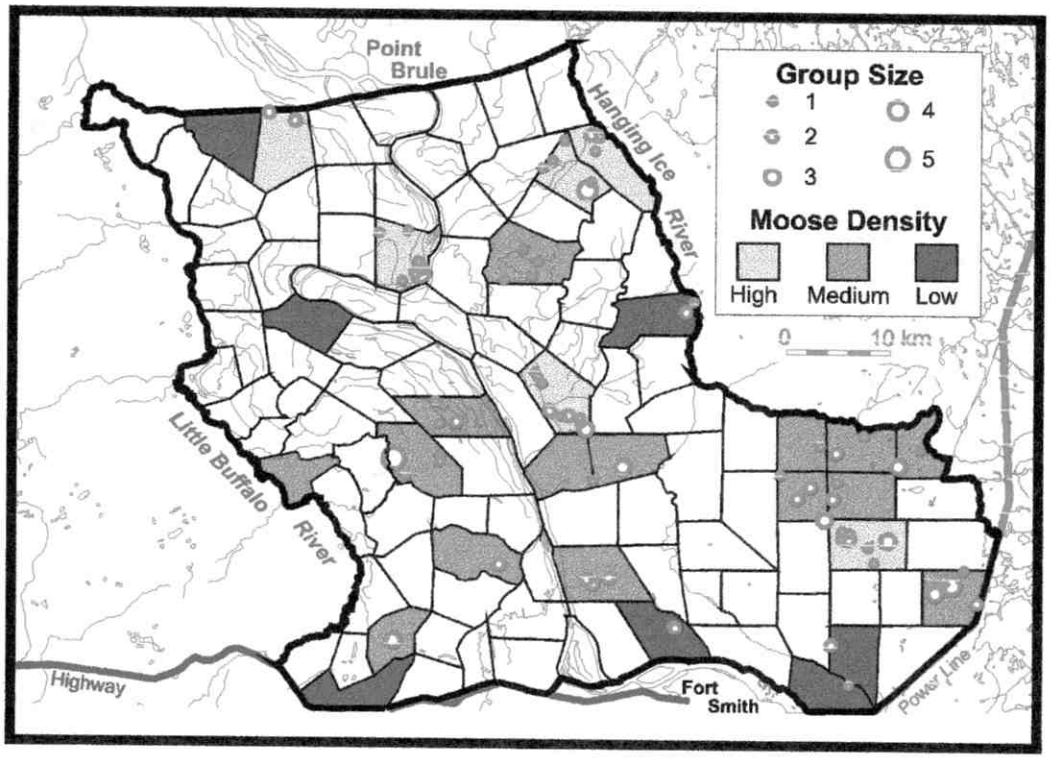

Figure 4. Location of moose seen during SU searches.

Table 1. Moose population size and density for the South Slave River Lowlands study area, 1996.

Strata	High	Medium	Low	Total
Total area (km^2)	533.5	1064.2	1553.5	3151.2
Area surveyed (km^2)	201.24	453.21	207.28	861.73
Total SUs	16	34	55	105
#SUs surveyed	6	15	7	28
%SUs surveyed	38	44	13	27
Moose seen	51	69	8	128
Density (/km2)	0.25	0.15	0.04	0.11
Population Estimate	135.2	162.0	60.0	357.2
Variance	299.71	538.44	479.91	1318.06
Degrees of freedom	5	14	6	23
Coefficient of variation				10.16
90% C.I. (% of population estimate)				17.42%

Population Estimates: 1986 vs. 1996

There was no significant difference in estimated population size between 1986 and 1996 (Table 2). Degrees of freedom were calculated according to Gasaway et al. (1986). Also, data from 1986 is a subset of the original data, corresponding to the 1996 study area (Figure 1). The slight difference in area of the two study areas is due to differences in measurement method (manual planimeter measurement of topographic maps in 1986 vs. GIS software measurement of digitised topographic maps in 1996).

Table 2. Comparison of census results: this study vs. corresponding SUs from Graf and Case (1991).

	1986	**1996**
Total Area (km^2)	3150	3,151.20
Area Surveyed (km^2)	671.8	861.73
% of Total Area Surveyed	21.3	27
Total # SUs	178	105
#SUs Surveyed	31	28
#Moose Seen	122	128
Population Estimate	373	357.2
Density	0.12	0.11
Variance	6,008.4	1,318.06
Degrees of freedom	15	23
90% C.I. (% of population estimate)	36.4	17.42
t test		$t_{22} = 0.185, p > 0.40$

Sex and Age Ratios: 1986 vs. 1996

The estimated 1996 bull:100 cow ratio was 121, the calf:100 cow ratio was 36.9, the yearling:100 total bulls ratio was 3 and the twinning rate was 3.4 (Table 3). The only significant difference was in the bull:100 cow ratios; 1996 had almost twice the bull:100 cow ratio that 1986 had (Table 3).

Table 3. Moose population characteristics for the Fort Smith study area in 1986 and 1996.

	Number Seen		
	1986	1996	
Total moose	122	128	
Total cows	46	47	
Lone cows	21	32	
Cows w/1 calf	20	13	
Cows w/2 calves	5	2	
Total calves	30	17	
Total bulls	44	63	
Yearling bulls	9	2	
	Ratios		
	1986	1996	t test
Bulls:100 cows (w/yearlings)	**66.51 + 34%**	**120.7 + 34%**	**$t_{16} = -8.756$, $p < 0.01$**
Calves:100 cows (w/yearlings)	62.57 + 39%	36.93 + 41%	$t_{22} = 1.583$, $p = 0.07$
Yearlings:100 bulls	20.89 + 73%	3.01 + 96%	$t_{17} = 2.007$, $p = 0.03$
Cows w/twins:100 cows	11.40 + 85%	3.41 + 97%	$t_{17} = 1.377$, $p = 0.09$

Weather: 1986 & 1996

No significant difference could be found between the years (MW Rank Sum Test), for cloud cover (T = 937.5, df=26,36, p= 0.09) and wind speed (T = 697.0, df=25,38 p= 0.15). Temperature did vary among years (T = 1191.5, df=25,38, p <0.01).

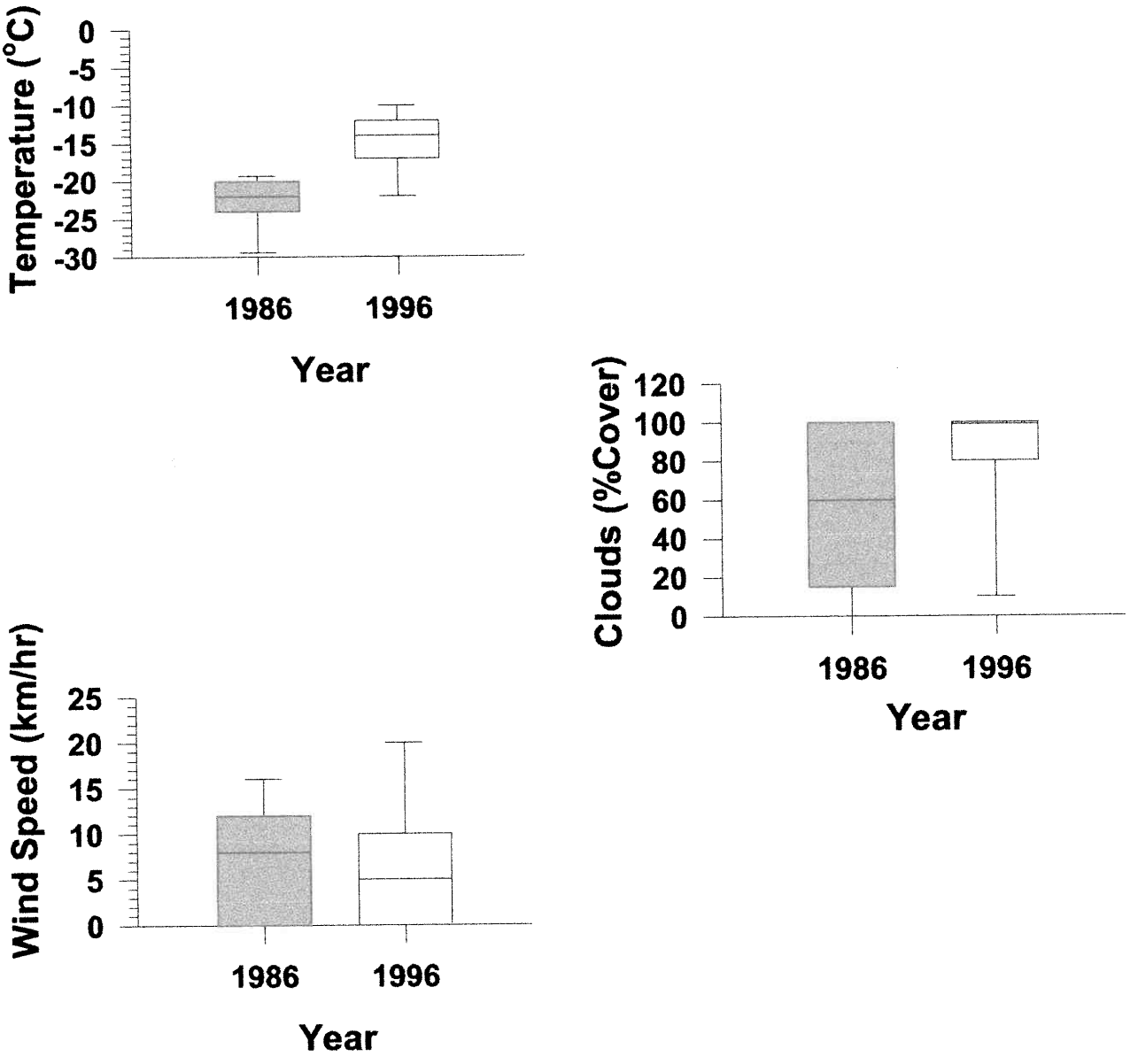

Figure 5. Weather experienced during SU searches.

Habitat

At the fine habitat scale (within 10m of each moose group) 96% of the moose sightings were in relatively 'open' habitats (Figure 6). At the coarse habitat scale (within 250m of each moose group) only 70% of the sightings were in open habitats (Figure 7). When the two scales were considered together (i.e. immediate:general), only 4% of sightings were in 'forested:forested', 41% were in 'open:forested' and 55% were in 'open:open'. There were no moose in 'forested:open habitats.

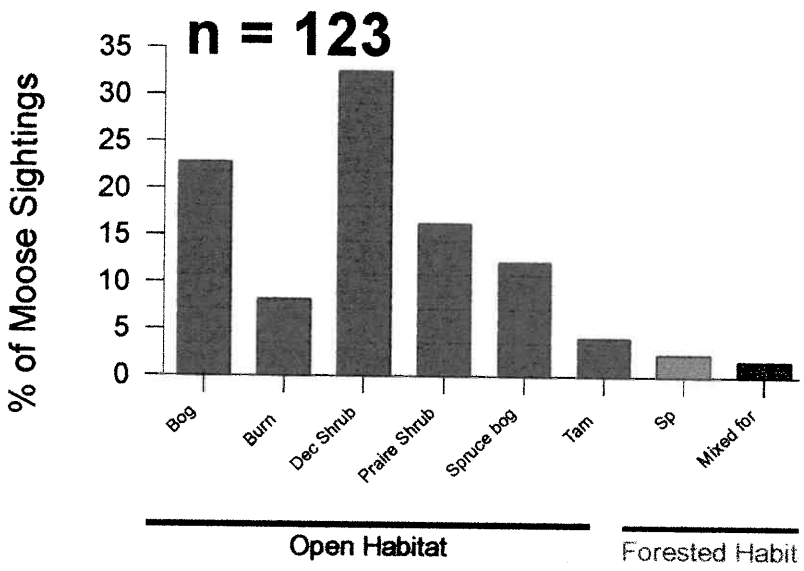

Figure 6. Habitat type within 10m of moose sighting.

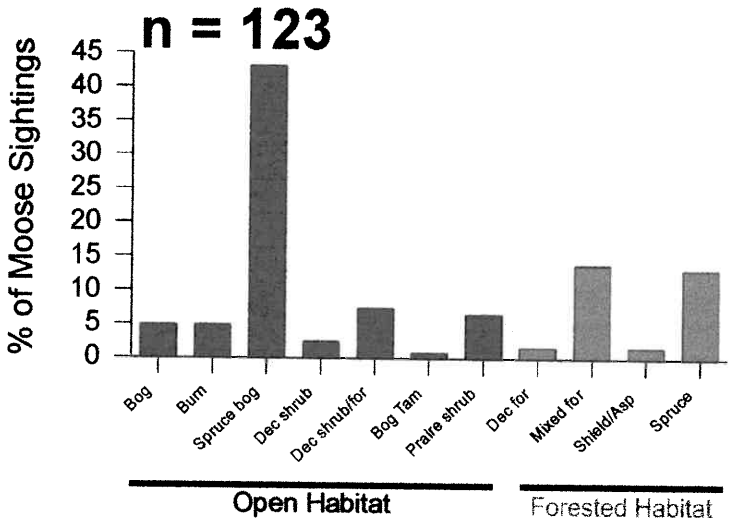

Figure 7. Habitat type within 250m of moose sightings.

Search Effort

We could find no relationship between search effort and number of moose seen per SU for the helicopter crew in any of the three strata, indicating that our search effort was adequate (Figure 8). For the fixed wing crew, sample sizes within each strata were inadequate for analysis.

Effort in 1996 was significantly greater than in 1986 for the high ($t_{12} = -5.04$, $p < 0.01$) , medium ($t_{23} = -5.72$, $p<0.01$) and low density stratum ($t_{24}=-5.29$, $p<0.01$).(Figure 9). There was no relationship between effort and success in 1986 for the high and the low density strata, but there was a significant relationship for the medium density strata, albeit a very weak one ($R^2 = 0.27$, $P = 0.01$).

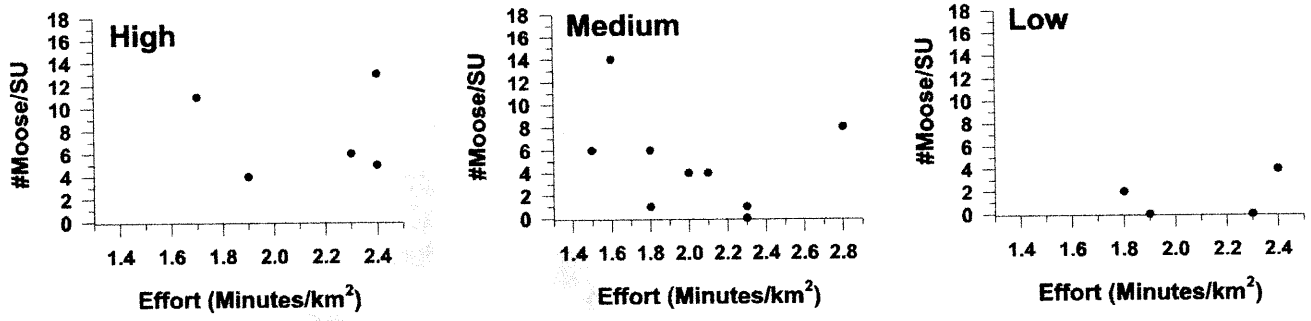

Figure 8. The relationship between search and success for the helicopter crew.

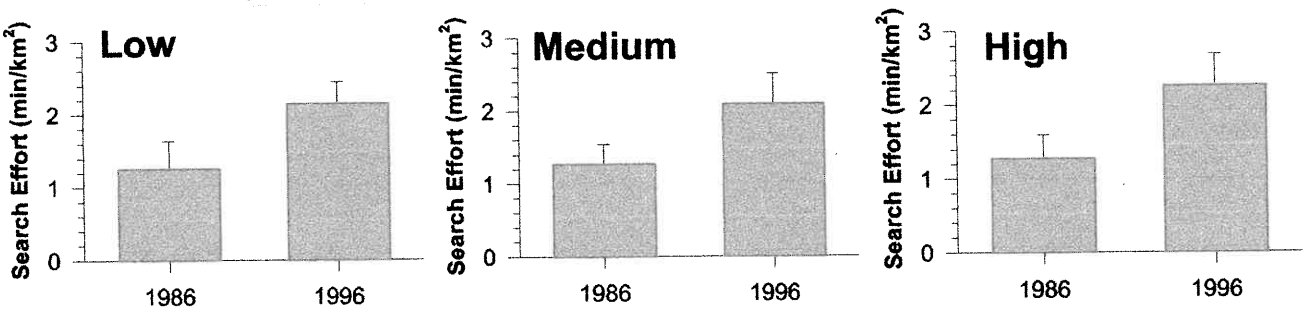

Figure 9. Search effort compared between 1986 and 1996.

Technique: Fixed Wing vs. Helicopter

Although the sample sizes were too small for statistical testing (the fixed wing did not fly enough SUs in each strata), a subjective examination of the data reveals no difference in search success between the fixed wing and helicopter crews (Figure 10).

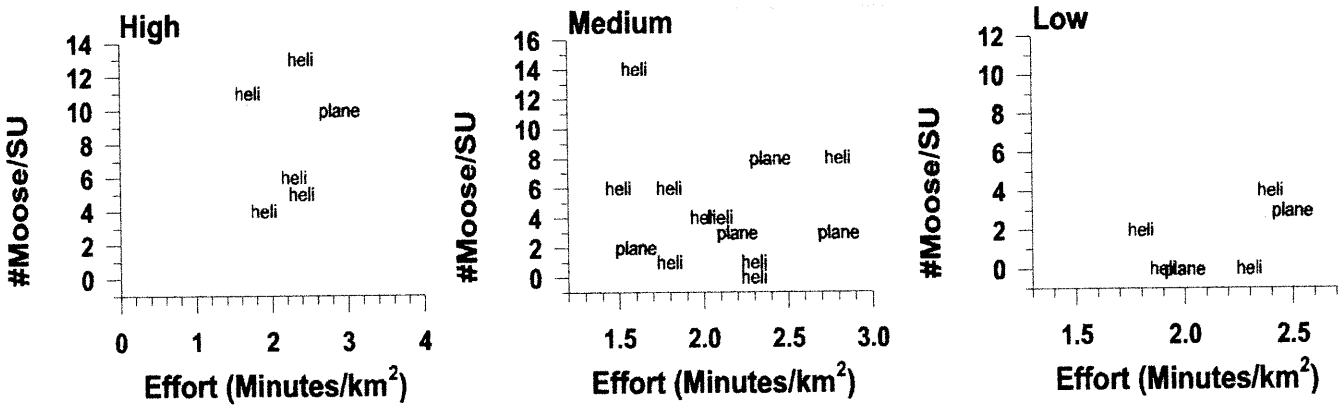

Figure 10. The relationship between search effort and success for the fixed wing and the helicopter crews.

Discussion

Possible Sources of Bias

When comparing two or more censuses, it is important to recognise the potential for contrasting conditions to introduce bias. Three potential sources of bias were examined: search effort, weather, and technique.

Search effort was significantly greater in 1996 compared to 1986 (Figure 9). The number of moose counted in each SU did not correlate well with search effort however, therefore search effort was therefore probably adequate in both years.

Severe weather can force moose into cover, making detection difficult. Weather was similar between the two censuses except for temperature; 1986 was warmer than 1996. Since moose were found mostly in open habitats in 1996 (Figures 6 & 7), the colder temperatures had evidently not been severe enough to send the moose into cover. Weather therefore probably did not bias our results.

The only difference in technique between the two censuses was the use of a fixed wing aircraft to search SUs in 1996. Small sample size prevented a statistical comparison of search success between aircraft, but subjectively there appeared to be no difference (Figure 10). To better quantify the relationship between aircraft type and sightability, we flew 2 SUs twice, once with each aircraft. A sample size of two is much too small to enable us to come to any conclusions, but we will continue to gather similar information in the future and we will present these data in a later publication.

Habitat

The most frequently used habitat was deciduous shrubs. Although habitat availability was not measured, on a subjective basis deciduous shrub habitat appeared to be a relatively minor component of the landscape, indicating that the moose were selecting this habitat. We us this data only as evidence of proper timing of the survey; later in winter, moose will tend to move to areas of dense timber, decreasing sightability (Gasaway et al. 1986).

Population Density

The 1996 population density of 0.11 moose/km^2 is almost identical to that reported for 1986 in Graf and Case (1991). This density is at the high end of the range for N.W.T. moose, (Table 4) but low compared to other northern areas. Hawley and Antoniak (1983) found a much lower density of moose in the Slave River Lowlands (0.05 moose/km^2), but they did their count in February, when cold temperatures and greater snow depths can cause moose to gather in conifer stands, thus lowering sightability (Gasaway et al. 1986).

Population Characteristics

The 1996 calf:100 cow ratio of 37 is at the low end of the range reported for moose in the N.W.T. and is also lower than the ratio of 63 reported for 1986, though not significantly so in the statistical sense (Tables 3, 4). Statistical power was not great for this test however (less than 0.60 for alpha set to 0.05 and beta set to 0.20), so more sampling should have been done to be sure of the drop in cow:calf ratio.

Table 4. Population characteristics reported for N.W.T. moose populations. Only block surveys are included.

Location	Year	Density	CV	Calf:100 Cow	Author
Fort Wrigley	1982	0.03	n/a	n/a	Hawley, V. and R. Antoniak, 1983.
Slave River Lowlands	1981	0.04	n/a	n/a	Hawley, V. and R. Antoniak, 1983.
Inuvik	1986	0.05	0.04	44	Stenhouse and Kutney, unpubl. in Graf, R. 1992.
Slave River Lowlands	1980	0.05	n/a	n/a	Hawley, V. and R. Antoniak, 1983.
Slave River Lowlands	1982	0.05	n/a	n/a	Hawley, V. and R. Antoniak, 1983.
Liard Valley	1980	0.06	n/a	n/a	Hawley, V. and R. Antoniak, 1983.
Inuvik	1986	0.06	0.15	25	Jingfors and Kutney, 1989.
Liard Valley	1986	0.07	0.22	100	Case, R., unpubl. data.
Fort Providence	1994	0.07	0.08	32	Bradley, et al 1998a.
Liard Valley	1981	0.10	n/a	n/a	Hawley, V. and R. Antoniak, 1983.
South Slave River Lowlands	**1986**	**0.12**	**0.20**	**63**	**Graf, R., and R. Case, 1991.**
South Slave River Lowlands	**1996**	**0.11**	**0.10**	**37**	**Bradley and Kearey, This study**
Liard Valley	1985	0.12	0.17	81	Case, R., unpubl. data.
Fort Good Hope	1984	0.13	0.1	61	Jingfors, et al, 1987
Liard Valley	1979	0.13	n/a	31	Donaldson and Fleck, 1980
Norman Wells	1984	0.15	0.11	44	Jingfors, et al, 1987
Norman Wells	1992	0.15	0.19	57	Latour, 1992.
Liard Valley	1994	0.16	n/a	32	Bradley et al, unpubl. data
North Slave River Lowlands	1988	0.16	0.10	69	Graf, R., and R. Case, 1992
North Slave River Lowlands	1995	0.15	0.12	33	Bradley et al, 1998b
Norman Wells	1995	0.17	n/a	56	Veitch et al., 1997.
Fort Providence	1991	0.17	0.14	55	Shank, C. 1991. Unpubl. data.

Conclusions and Recommendations

1) The moose density in the southern Slave River Lowlands has remained stable over the past ten years. With two data points, there is now a better baseline for assessing possible population changes in the future.

2) We have made a start in quantifying potential bias in using fixed wing aircraft in place of helicopters. The next moose census in the N.W.T. should also include flying some SUs twice to add to our sample size.

3) The calf:100 cow ratio of 37 is quite low, but our sampling was not adequate to be sure of a decline, and since the population has remained stable there is probably no cause for alarm.

4) Although there is no acknowledged standard for census interval in the N.W.T., 10 years is probably too long. Five years may be a good compromise for a census interval in the absence of any pressing management or conservation concern.

5) Currently, knowledge of the human harvest of moose in the Slave River Lowlands is nil. A harvest study would yield valuable information on one of the causes of mortality in the Slave River Lowlands population.

6) With all of the ongoing and possible future habitat changes (logging, prescribed burning), a knowledge of moose habitat use in the Slave River Lowlands would be very valuable to the community and to the Department of Resources, Wildlife & Economic Development. GPS radio collars would provide habitat use data on a scale comparable to that available from landsat remote imagery.

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