M3126

Original - revised copy March 87.

MOOSE CENSUS IN THE LORNE-CARIBOU MOUNTAIN AREA

November, 1980

Doug Larsen
Management Biologist

Tony Nette
Management Technician

NOTE: This is a corrected copy. Previous copies had erroneous data in the calculations.

Introduction

The study area is approximately 30 miles SSE of Whitehorse and is bounded on the west by the Carcross Road; on the south by the Tagish Road; on the east by Marsh Lake and on the north by the Alaska Highway. (See map). The area is valued highly by resident moose hunters who spent 610 man days hunting here in 1978. (Nette et al 1980). It is also a valuable area to non-consumptive users due to its close proximity to Whitehorse. Numerous dwellings occur on all but the east periphery of the study area.

Part of the census area has been identified as an environmentally significant area (Theberge et al 1980) for which some degree of formal protection has been recommended.

The objectives of this study were:

1. to determine the distribution and density of moose utilizing the area during the late fall/early winter period;

2. to determine the age-sex ratios of the population; and

3. to determine the feasibility (cost and practicality) of using a random quadrant census technique in mountainous terrain.

Methods

Moose in many parts of the Yukon have a clumped distribution during this late fall/early winter period. (Personal observation). Large rutting groups of up to 62 animals have been observed in the study area. Because of the clumped distribution pattern the census area was stratified into sub-units having similar moose densities. Moose observations, track density and the quality and extent of moose habitat were the criteria used to delineate strata boundaries.

A helicopter was used to stratify and census the study area in an attempt to obtain an accurate stratification which is critical to a precise population estimate, and to improve the sightability of animals during the census.

.../2

Stratification has two main advantages; the first is that a more accurate population estimate can be obtained within a small area of homogeneous density as compared to a large area of heterogeneous density. The second advantage is that sampling effort can be directed into stratum that have high densities and thus higher variance. Intensive sampling can reduce this variance. (Gasaway 1979).

The technique used to stratify involved flying directly to areas where we expected high moose densities to occur, i.e., subalpine/alpine habitats. The boundaries of these concentrations were then mapped. After the area was high-graded, we flew a wandering pattern over the remainder of the census area looking for moose sign. Less time was spent over large areas of homogeneous mature forest habitat and more time in mosaic habitats.

Sample units (s.u.) within each stratum were drawn after all the strata had been delineated on a 1:50,000 scale map. Sample unit boundaries were based on natural terrain features within strata boundaries. S.u. size varied from 2 to 8 square miles.

Sampling intensities are dictated by financial realities and the allocation within each stratum is normally a function of the relative densities or expected variance. One of the objectives of this study was to obtain an accurate estimate of the population. To accomplish this the area was sampled as intensively as financial constraints would permit. S.u. within each stratum were numbered and randomly selected without replacement to correspond roughly to a pre-determined sampling intensity of 100%, 50%, 40% and 10% high, medium, low and extremely low strata, respectively.

A census of the randomly selected s.u.'s was accomplished by flying the entire area within the s.u., thereby obtaining 100% coverage. Search effort (min/sq. mi.) was recorded for each unit. The search pattern varied with topography but generally short, tight transects were flown within small segments of the s.u. This technique was considered an effective way to flush animals from cover and to arouse those which were bedded down. Both habitat selection and animal behaviour are known to influence visibility (Gasaway et al 1978).

.../3

Calculation of the total population estimate and variance was achieved by determining densities and variance for each stratum and then summing the estimates to arrive at the total for the census area. The population estimate for each stratum is simply an extrapolation of the observed density in the s.u.'s censused. The variance for each stratum population estimate was calculated as follows, based on Gasaway et al (1981).

$$V(\hat{T}) = A^2 \cdot \left[\frac{1}{\bar{x}^2} \cdot \frac{s^2 q}{n} \left(1 - \frac{n}{N}\right) \right]$$

Where A = total surface area per stratum

$\bar{x}$ = mean size of all su's surveyed in a particular stratum

$$s^2 q = \frac{\sum_{i=1}^{n} y_i^2 - 2r \cdot \sum_{i=1}^{n} x_i y_i + r^2 \sum_{i=1}^{n} x_i^2}{n-1}$$

y_i = number of moose in the $_i$th s.u.

x_i = number of sq. miles in the $_i$th s.u.

n = number of s.u.'s selected in a particular stratum

N = total number of s.u.'s in a particular stratum.

A sightability correction factor was determined by re-flying one randomly selected s.u. at approximately twice the intensity, and immediately following, the original survey of that s.u. Due to the cost, a correction factor was calculated only for the high stratum.

The stratification was done on November 23 with subsequent census flights on November 25, 28 and 29. Survey speed and height varied between 60-80 m.p.h. IAS and 200-400 feet AGL, respectively. Three observers and the pilot actively searched for animals. One observer recorded map locations while another observer recorded pertinent data on composition and habitat.

.../4

Moose were classified as either: adult male or female based on the presence of antlers or vulva patch; yearling males based on antler morphology; medium or large males based on antler morphology; or calves based on body size. Yearling females are assumed to occur at the same rate as yearling males in the population, therefor the yearling male count is doubled to account for all yearlings.

Habitat in which moose were observed was classified into the following gross categories: herbaceous, tall shrub, low shrub, deciduous, sparse spruce forest, spruce-pine forest, mixed forest or regenerated burn.

Results and Discussion

Four strata were identified: two high density (5.5 moose/sq. mi.) on Lorne and Lansdowne Mountains; one medium density (2.6/sq. mi.) in the Twelve Mile Creek area; two low density (2.4/sq. mi.) at the north ends of Caribou and Lorne Mountains; and one extremely low density area (0.4/sq. mi.) in the remainder of the census area (Table 1 and map).

The total population estimate at the 90% confidence level is 394 ± 66% (Table 1). Of the 394 estimated moose, nearly one half (41%) were in the low and extremely low stratum while only 26% were in the high stratum (Table 1). Therefore the assumption that the highest variance occurs in the high density areas is questionable. The highest variance, although based on a very small sample size, occurred in the extremely low strata and was due to (a) a combination of a small sample size of sub-units (3) searched relative to the total possible su (51) for the strata, and (b) the range of animals observed in those three su (0-5). This high variance in the extremely low stratum significantly changes the confidence in the overall population estimate. Although it is impossible to verify, we feel the problem was in the stratification.

For interest sake we re-calculated the data by separating the extremely low stratum from the remaining strata. This action is not totally unjustified as su were selected independently and at random within each stratum. Therefore if we can think of the area as having two populations the results are as follows:

.../5

	POPULATION I (extremely low stratum)	POPULATION II (low, medium and high strata)
V	(T_t) 113 ± 368	280 ± 38
	(T_t) 698	356
	CI ± 224%	±13.6%

Both estimates are at the 90% confidence level.

These figures are shown here purely for discussion and to emphasize the importance of proper stratification and the danger of small sample sizes. The true population estimate and variance still remains at 394 ± 66%.

If additional money was available effort would have been directed into the extremely low stratum in an attempt to reduce the high variance.

No sightability correction factor was applied to our estimates as the results of the one s.u. resurveyed at a higher (1 - ½ times) intensity revealed no additional moose. Although this was a small sample, we feel the results can be applied to the high stratum as the habitat was similar throughout. It was not feasible to obtain correction factors for other stratum as the cost would be prohibitive. We thought that it was more important to establish sightability in high density areas as we assumed that they represented a high proportion of the total population. However, as we have shown, only one quarter of the estimated population occurred in the high stratum. It may be more important to determine sightability in the less dense strata. I am confident that the number of animals missed in all habitat types was substantially reduced by using a helicopter with four observers and following the search pattern described.

A high proportion (59%) of the moose were observed at treeline, i.e. between 4,000 - 4,500 ft. (Table 2). A Chi-squared test of this data indicates that the observed distribution, according to elevation was significantly different ($X^2_6 = 105.8p \leq 0.000$) than would be expected if the distribution was homogeneous over the range of available surveyed elevations. This may, however, be a

.../6

function of better observability in open treeline habitat compared to dense forested habitat. A large proportion of the unsurveyed area was in low elevation forested habitat.

Moose were observed most frequently (67%) in sparse spruce forest, part of which had been burned and regenerated. The remainder of the animals (20%) were in spruce-pine forest and in tall and low shrub (13%) communities.

Table 2. Distribution of Moose by Elevation in the Lorne-Caribou Mountain area, November, 1980

Elevation (ft.)	% of Censused Area	No. of Moose Observed
2000 - 2500	9	0
2600 - 3000	3	0
3100 - 3500	10	13
3600 - 4000	22	33
4100 - 4500	29	120
4600 - 5000	20	36
5000+	7	0
TOTAL	100%	202

During the first part of the survey adult males were identified by the presence of antlers, assuming that no antler drop had occurred. However, during the latter part of the survey, from November 28 on, a close examination for antler scars on antlerless adults revealed that 19% of the large males were antlerless. A correction factor was then applied to the adult counts during the first part of the survey.

The composition of the observed population varies between stratum (Table 3) with the most obvious difference occuring within the calf cohorts, i.e. 8% of the high stratum population and 15% of the remaining strata were calves. The medium, low and extra low were combined due to small sample sizes within

.../7

individual stratum.

This data suggests that cows with calves are avoiding high density areas. This is probably a function of habitat as high density areas are characterized by open subalpine willow communities while the remaining area is either heavily or sparsely forested. This could be enterpreted as a predator related strategy or simply a behaviour to protect their calves from potential injury during rutting battles.

The estimated yearling cohort makes up 12% of the population while calves represent 13% of the population. If these figures are real and if the population dynamics are stable, very little natural mortality occurred between the ages of .5 and 1.5 years. The only other explanation would be if cows with calves were not observed in the medium, low and extra low strata.

A calf ratio of 27:100 females (2 years +) and a twinning rate of 5% (based on the number of cows with calves) indicates a low to moderate calf production and/or survival rate to the fall. A sex ratio of 58 males:100 females is indicative of a lightly hunted population.

The only accurate hunting statistics at this time are from the 1978 season. The estimated harvest by resident hunters for that year was 18 animals. There is no harvest by non-residents in this area and the native harvest is uncertain but thought to be about 8 - 10 animals annually. This represents a moderate (28/393 = 7%) rate of mortality due to hunting pressure. However, there is cause for concern as most (60%) of the resident hunting pressure occurs in the south half of the area. Because of the limited access I suspect most of that havest occurs in the Twelve Mile Creek and Caribou Mountain area.

If we assume a 15% natural mortality rate, for the sake of argument, for the adult cohort and if the objective is to maintain the population at its present level, the yearling cohort must be able to compensate for this mortality. Based on our data there are not sufficient yearlings (12%) to replace adults at a rate of 15%. Again, if the hunting pressure was distributed over the entire area, the effects would not be as serious. Therefore it is likely that local pockets of moose, mainly in the southern part of the study area, are

.../7

being overharvested, while the remainder of the area is either lightly harvested or not hunted at all.

Of course these conclusions hinge on the accuracy of a 15% natural mortality rate and on a 12% yearling cohort. This mortality rate would seem reasonable based on studies in Isle Royal (Peterson) where a 13% rate was documented and in Alaska where Gasaway ( ) reported 13-17% natural mortality.

Although we have made no attempt to quantify the predator population, incidental observation indicate that one large (14) pack of wolves and a minimum of 8 grizzly bears inhabit the census area.

The extent of browse has only been noted incidentally, however, browing is so extensive in some areas that only decadent forms of the preferred browse species (*salix* and *betula*) remain.

The technique of using randomly selected s.u. with natural terrain boundaries is a practical approach which eliminates many of the concerns with alternate sampling techniques, e.g. boundary location, double counting and large sightability bias. Population estimates would be more accurate in a larger study area as more s.u.'s could be sensused. This is the one drawback using this technique in a small study area. The disadvantages of the sampling technique are far outweighed by the advantage of reducing sightability bias which is ususally more significant than sampling bias. The cost of the census, including stratification, cost $6,336.00 or $16/sq. mile.

Acknowledgement

A portion of this project was funded by Dr. J. Theberge, University of Waterloo.

LORNE 1980

PARAMETER	STRATUM HIGH	MEDIUM	LOW	EL	Total (90% CI)
A. ABUNDANCE					
EST. TOTAL MOOSE	116	131	46	113	406 ± 61%
DENSITY (moose/km²)[a]	~~6.1~~	~~2.7~~	~~2.4~~ .38		~~1.06~~ .41
B. COMPOSITION					
Adult bulls (≥ 30 Months)	29	38	8	16	91 ± 51
Adult cows (≥ 30 Months)	54	62	19	32	177 ± 59
YEARLINGS (18 mo)[b]	14	15	11	32	72 ± 111
CALVES	9	17	8	32	66 ± 155
Bulls /100 cows (≥ 30Months)	45	60	43	50	51 ± 39
Yearlings /100 cows (≥ 30months)	27	24	57	100	41 ± 165
Calves /100 cows (≥ 30 months)	14	27	43	100	37 ± 93

[a] Density is calculated based on habitable moose range

[b] Yearling males are assumed to equal yearling females in number

REFERENCES

Gasaway, W.C., DuBois, S.D., Harbo, S.J., and Kelleyhouse, D.G., 1978, "Preliminary Report on Accuracy of Aerial Moose Surveys", 14th North American Moose Conference and Workshop, p. 32.

Gasaway, W.C., Harbo, S.J., DuBois, S.D., 1979, Moose Survey Procedures Development Vol. III, Progress Report Proj W-17-11 Alaska Department of Fish and Game.

Gasaway, W.C., DuBois, S.D., Harbo, S.J., 1981, Estimating moose abundance and composition - Draft, Alaska Dept. of Fish & Game.

Theberge, J.B., Nelson, J.G., Ferge, T., 1980, "Environmentally Significant Areas of the Yukon", Canadian Arctic Resources Community, Yukon Series, Research monograph four, 34 pp.

Nette, T., Larsen, D., Kale, W., 1980, "Yukon Moose Harvest Data for 1978 with a Summary of Historical Information", Yukon Wildlife Branch Files.

APPENDIX

INFORMATION ON SUBUNITS

S.U.	Area (sq. mi.)	Density Moose (sq. mi.)	Search Effort (min)	Observation Rate (Moose/min)	Animals s = small m = medium l = large	Elevation (ft.)
L-1	3.16	2.5	28	0.3	1 female	4,000
					1 female; 1 calf	4,100
					1 female	4,200
				9	1 female; 1 calf	4,300
					1 female; 1 calf; 1 (s)	4,400
L-2	3.83	2.1	21	0.4	3 females	4,300
					1 female; 2 male (1) 1 male (s)	4,400
					1 male (1)	4,500
EL. 49	5.02	0.4	30	0.1	1 male (s)	3,400
					1 female	3,800
Lorne High Startum	10.81	7.7	77	1.1	2 females	4,100
					5 females; 2 calf	
					1 male (s)	4,200
					10 female; 1 calf	4,300
					4 female; 1 calf	
					2 male (1)	4,400
				93	24 female; 2 calf	
					12 males (1);	
					3 males (s)	4,500
					4 female; 1 calf	
					2 male (1)	4,600
					4 felames	4,700
					2 male (1);	
					1 male (s)	4,800
M-1	4.44	2.3	17	0.6	1 female	4,000
				10	3 female; 6 male (1)	4,800
EL 47	8.24	NA	20	NA	Nil	

S.U.	Area (sq. mi.)	Density Moose (sq. mi.)	Search Effort (min)	Observation Rate (Moose/min)	Animals s = small m = medium l = large	Elevation (ft.)
Lansdowne						
	8.11	4.3	20	1.8	1 female; 1 calf	3,900
					1 female	4,000
					2 female	4,100
					1 female; 4 males (1)	4,200
					7 females; 3 males (1);	
				H-33	1 male (s)	4,300
					1 female; 1 male (s)	4,400
					3 male (1); 1 female	4,500
					1 male (1)	4,600
					2 female; 1 calf	4,800
					2 females	5,000
M8	2.96	4.7	25	0.6	3 females; 1 calf	4,100
					5 females; 2 calf	4,200
				14	1 female; 1 calf	4,400
					1 male (1)	4,500
M6	5.86	3.1	42	0.4	1 female	3,500
					1 female; 1 male(s)	3,200
					1 female; 3 males (1)	3,800
					1 female; 1 calf	
				m 18	2 males (1)	3,900
					2 males (1)	4,000
					1 female	4,100
					1 female	4,300
					2 females; 1 male (s)	4,400

S.U.	Area (sq. mi.)	Density Moose (sq. mi.)	Search Effort (min)	Observation Rate (Moose/min)	Animals s = small m - medium 1 = large	Elevation (ft.)
M5	8.05	3.2	35	0.7	5 females	3,100
					1 female; 1 calf	3,300
					2 females; 1 calf	3,500
					1 female	3,600
					1 female; 3 males (1); 1 male (s)	3,700
					1 female; 1 male(s)	3,800
					2 females	3,900
					2 males (1)	4,000
					1 male (1)	4,100
					1 female; 1 calf	4,300
M4	4.65	0.7	24	0.1	2 female; 1 calf	3,700
18	5.21	1.0	17	0.3	1 male (1)	3,900
					2 females; 2 calf	3,700

m - 25

m - 3

EL - 5

SEX/AGE Composition _____ SA.

ratum	SU (mi^2) AREA SIZE	Adult BULLS	COWS (≥1.5yr)	(≥2.5)	YRL BULLS	total YEARLINGS	CALVES	TOTAL (ex. calves)	TOTAL total
H.	10.8	18	53	48	5	10	7		83
	8.1	11	18	16	2	4	2		33
	AREA 18.9								
	SU 2								
Med	5.9	7	8	6	2	4	1		18
	8.1	6	14	12	2	4	3		25
	3.0	1	9	9			4		14
	4.7		2	2			1		3
	4.4	6	4	4					10
	AREA 49								
	SU 9								
Low	3.2		5	4	1	2	3		9
	3.8	3	4	3	1	2			8
	AREA 19								
	SU 6								
EL	8.2								0
	5.0		1	-	1	2			2
	5.2	1	2	2			2		5
	298 AREA								
	SU 51								

TABLE 1. Moose Census Data for the Lorne-Caribou Mountain Area, November, 1980.

Sample Unit	STRATUM							
	Extremely Low		Low		Medium		High	
	Moose (No.)	Area (mi^2)	Moose (No.)	Area (mi^2)	Moose (No.)	Area (mi^2)	Moose (No.)	Area (mi^2)
1	0	8.2	9	3.2	18	5.9	~~75~~ 83	10.8
2	2	5.0	8	3.8	25	8.1	~~29~~ 33	8.1
3	5	5.2			14	3.0		
4					~~23~~	4.7		
					10	4.4		
Sample Totals	7	18.4	17	10.0	~~69~~ 70	26.1	~~104~~ 116	18.9
area per stratum (mi^2)	298		19		49		19	
total s.u. possible per stratum	51		6		9		2	
% of strata area censused	6%		53%		53%		100%	
Estimates								
Moose/mi^2	0.4		2.4		2.6		5.5	
estimated total moose	113		46		130		*104	
% of total estimated population	29%		12%		33%		26%	
Variance for each strata	6988		30		327		0	

Population estimate $(\hat{T}_t) = 394$

Population variance $V(\hat{T}_t) = 7345$

Confidence level = 90%
Upper CI = 654
Lower CI = 133 (the true lower CI is 197 i.e., moose observed)
CI = 66% of the population estimate

*observed number of moose