MOOSE POPULATION RESEARCH
AND
MANAGEMENT STUDIES
IN YUKON

MOOSE INVENTORY
IN THE
SOUTHWEST YUKON

by
D.G. LARSEN

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PROGRESS REPORT

MOOSE INVENTORY IN THE SOUTHWEST YUKON

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Whitehorse, Yukon

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MOOSE INVENTORY IN THE SOUTHWEST YUKON

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Abstract: Between October and December, 1981, a moose survey was conducted over a 18,889 km^2 area in the southern Yukon, using a stratified block sampling technique. Eighteen percent of the area was censused by helicopter at an average search intensity of 1.4 min/km^2. The estimated population was 2419 ± 9.6% at 90% confidence limits. Over half of the moose range and 82% of the estimated population were located above treeline. Estimated densities varied between 1.51 moose/km^2 in the high stratum to 0.01 moose/km^2 in the extra low stratum with an overall density of .17 moose/km^2. The percentage of the estimated population in the high stratum decreased with each survey unit over a six week period. A higher percentage of the estimated calf population occurred in the low stratum than either the high or medium strata. An overall ratio of 22 calves/100 females (>24 months) was recorded. Calf mortality to 6 months of age was estimated at between 80 and 86%.

Moose (*Alces alces*) are distributed throughout the Yukon inhabiting a variety of ecotypes from boreal forest to tundra. Densities are generally highest in the south and decrease towards the north. There is, however, considerable disparity in local population densities within regions.

This variation in moose numbers combined with differences in resident hunting pressure lead to the development of six priority moose management areas in the Yukon in 1981. The short term objective of the moose inventory program was to collect density, distribution and composition data within the priority areas to assist in understanding the impact of hunting and natural population regulation. The order in which these priority areas are to be inventoried was determined by existing hunting pressure, which reflects hunter access, proximity to major settlements, and the availability of moose. The results presented in this paper are from an aerial survey conducted in one of these priority areas.

STUDY AREA

The main survey area, located in the southwest corner of the Yukon (Figure 1), is 18,889 km^2 (7293 $mi.^2$) in size and is characterized by precipitous mountains rising to over 2522 meters (8275 feet) separated by wide U-shaped valleys. Treeline occurs between 1067 meters (3500 feet) and 1220 meters (4000 feet) above sea level. Birch (Betula spp.) and willow (Salix spp.) are the dominant species in the extensive subalpine shrub zone ranging from treeline to 1524 meters (5000 feet). On the lower slopes the dominant cover species are white spruce (Picea glauca) and lodgepole pine (Pinus contorta). Some paper birch (Betula papyifera) and popular (Populus spp.) are scattered throughout. No major burns have occurred in the 1900's. A more detailed dscription of the physiography, climate and vegetation can be found in Oswald & Senyk (1977).

In addition to the main survey area, two adjacent known rutting aggregations on Lorne and Lansdowne Mountains were also survey. Large carnivores inhabiting the survey area include wolves (C. lupus), grizzly bear (U. arctos), and black bear (U. Americanus). Other large ungulates include caribou (R. tarandus), Dall sheep (O. dalli) and mountain goat (O. Americanus).

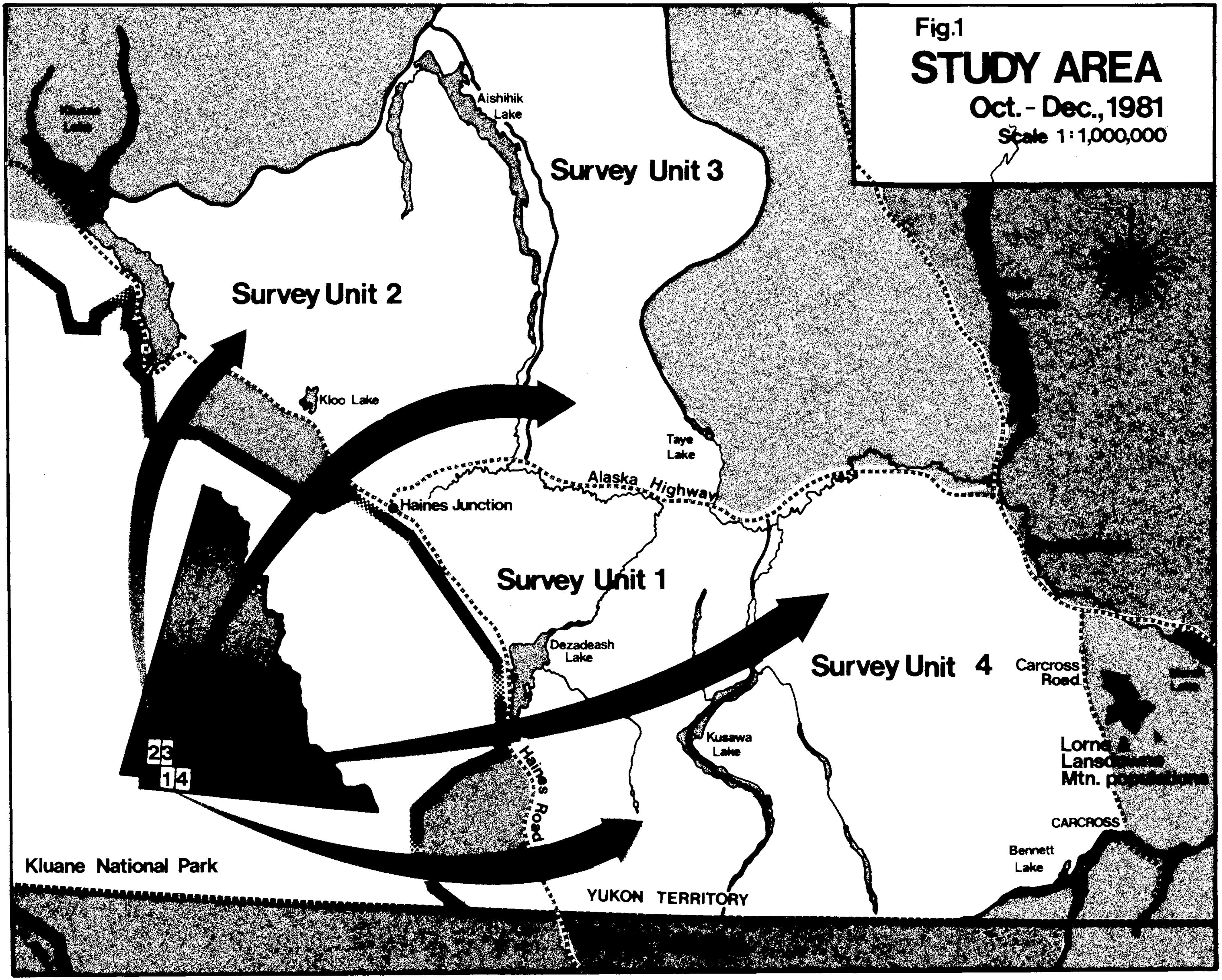


Fig.1
STUDY AREA
Oct. - Dec., 1981
Scale 1:1,000,000

METHODS

Survey Design

An aerial survey was conducted between 28 October and 4 December 1981 using a stratified block sampling technique described by Siniff & Skoog (1964), Evens et al (1966), and others. Gasaway et al (1981) modified the technique to facilitate terrain and moose distribution in Alaska. Except for minor changes, Gasaway's procedures were followed.

The main survey area was subdivided into four survey units for logistical reasons. The area above 1524 m elevation was excluded from the survey as this is the upper limit of the subalpine shrub zone. Periodic checks were made to verify the assumption that moose were not utilizing this area. Each survey unit was divided into sample units (s.u.) using natural terrain features as borders. These s.u.'s were drawn on to 1:50,000 topographical maps.

Sample units were stratified from Cessna 185 and 206 fixed-wing aircraft. In survey units 1 and 2, three strata (high, medium and low) were identified. Classification was based almost exclusively on the occurrence of either tracks or moose seen, although some minor stratum extensions were based on habitat. In survey units 3 and 4, four strata were delineated by subdividing the low stratum into a low and extra low strata. The low strata in units 3 and 4 were characterized by the presence of at least one moose or one set of moose tracks, while the extra low strata had no observed moose or tracks. The decision to sub-divide the low stratum was based on the results from the first two survey units which suggested a strong relationship between the presence or absence of moose sign in the stratification survey and the number of moose observed when s.u.'s were censused.

All census flights were done with Bell 206 and Hughes 500 helicopters flying between 30-150 m (a.g.l.) and at speeds of 50-130 km/hr. (i.a.s.) depending upon tree cover and terrain. The s.u. borders were first identified from a distance, then flown to reduce the chance of animals moving between adjacent s.u.'s. The search pattern varied from overlapping transects to tight circling. Once animals were spotted they circled to obtain age and sex information.

Two survey teams with four observers, including the pilot, were employed on both the stratification and census flights in order that the area could be covered as quickly as possible. "Stratifiers" were calibrated at the start of the survey to ensure consistency between stratifying teams. Observers on the census flights were rotated to minimize observer bias. The census of a s.u. was normally completed within 48 hours of stratification. Moose movement between s.u.'s was considered to be compensatory providing an adequate sample was obtained. S.u.'s were sampled intenstively until we felt that most moose had been seen.

Sampling effort by strata was predetermined and based on the expected direct correlation of density and sampling variance (Siniff and Skoog, 1964; Norton-Griffiths, 1975). All the high strata were censused to reduce the sampling variance in that strata to zero. The medium, low and extra low strata were censused until an acceptable level of variance was obtained, except in two of the survey units where all of the medium strata were censused. The population estimates and variance were determined for each stratum within a survey unit using a ratio estimator (Gasaway et al, 1981).

Surveys were conducted in early winter when moose would be clumped in mixed cohort groups in open habitats (Peek et al, 1974; Lynch, 1975; Rounds, 1978; Gasaway et al, 1978; Mytton & Keith, 1981; and Hauge & Keith, 1981). The presence of snow cover and the lack of foliage in the late fall greatly enhanced visibility. Previous surveys in the Yukon also have verified that the post-rut period is the best survey time.

Moose were sexed by the presence or absence of antlers. Later in the season as mature males dropped their antlers, the vulva patch and antler scars were used. Males were further classified into small bulls (yearlings) or large bulls (adults) based on antler morphology (Dubois et al, 1981, Alaska Dept. of Fish & Game, unpublished file). The female cohort were later separated into adults and yearlings based on the assumption that yearling females occur in the population in the same proportions as yearling males prior to the hunting season. The pre-hunt yearling male cohort was estimated by assuming 5% yearling males in the harvest. Calves were identified by body size.

Bergerud & Manuel's (1969) definition of an aggregation as any group of animals occuring within close proximity to one another was used throughout the survey.

Several habitat parameters including slope, aspect, elevation and dominant vegetation were recorded. The first three parameters were measured from the survey maps, while the dominant vegetation was based on a gross visual analysis of the dominant community immediately surrounding the individual animal. During analysis, habitat parameters and composition counts were weighted by the inverse of the sampling intensity.

The two adjacent rutting aggregations on Lorne and Lansdowne Mountains were surveyed by helicopter monthly between August and December, 1981. The objective of these surveys was to determine the timing and utilization of traditional high density rutting areas.

RESULTS

Sampling and Search Intensity

A total of 14,515 km^2 (77%) of the survey area was below 1524 meters elevation and considered habitable moose range. This area was subdivided into 1011 s.u. averaging 14.35 ± 0.13 km^2 in size. When stratified there were 38 (4%) high, 80 (8%) medium, 608 (60%) low and 285 (28%) extra low s.u.'s (Table 1). The overall sampling intensity was 18% with 100% of the high strata, 58% of the medium, 11% of the low, and 9% of the extra low being sampled.

TABLE 1 Habitable moose range (land area below 1524 m) and sampling intensity by strata in the main survey area. October-December, 1981

	Strata				
	High	Med	Low	Extra Low	Total
Number of s.u.	38	80	608	285	1001
Number of s.u. sampled	38	46	66	27	177
% of s.u. sampled	100%	58%	11%	9%	18%

Search intensity (excluding ferry time) averaged 0.29 min./km^2 during the stratification and 1.4 min./km^2 during the regular census. There was no appreciable difference in search intensity between strata during the census.

Population Estimate, Density and Distribution

The estimated population for the main survey area was 2419 ± 9.6% with 90% confidence limits (Table 2). The composition of this population was estimated to be: males 703 ± 88, females 1438 ± 142 and calves 280 ± 61 at the 90% C.I. (Table 3).

TABLE 2 Moose population estimates by stratum for the main survey area, October-November, 1981.

Stratum	Total	90% C.I.	Range	C.O.V.*
High	873	0	878- 878	0.0%
Medium	703	101	602- 804	14.4%
Low	809	207	602-1017	26.6%
Extra low	30	37	0- 67	122.0%
Total	2419	232	2189-2653	9.6%

*Coefficient of variation - standard deviation expressed as a percentage of the mean.

TABLE 3 Moose population estimates by age/class type in the main survey area, October-December, 1981.

	Total	90% C.I.	Range	C.O.V.*
Males	703	88	615- 791	12.5%
Females	1438	142	1296-1581	9.9%
Calves	280	61	219- 341	21.7%
Total	2419	232	2189-2653	9.6%

The density varied considerably between strata with 1.51 moose/km^2 in the high; 0.60 in the medium; 0.09 in the low; and 0.01 in the extra low stratum. The overall density was .17 moose/km^2. The estimated density ranged from 0.27, 0.12, 0.11, and 0.19 moose/km^2 in survey units 1 through 4, respectively. The number of moose observed during the census varied from 1.01, 0.49, 0.09, to 0.01 moose/min. in the high through extra low strata respectively, with an average of 0.40 moose/min. survey time.

The estimated population for the main survey area was equally distributed between the high (36%), medium (29%), and low-extra low (34%) strata (Figure 2), however, the high and medium strata comprised only 12% of the area. The proportional use of these strata varied, with the low showing increasing use and the high decreasing over the time interval of the survey. The proportion of the estimated population in the high and medium strata combined decreased from 81% in survey unit 1 to 65%, 58%, and 54% in units 2, 3 and 4, respectively. This trend was consistent for each age/sex group although the magnitude was greatest for the adult male and calf cohorts (Figure 3). This movement out of the high density areas following the rut in mid-October was also documented in the Lorne and Lansdowne Mountain populations (Figure 4).

Composition

An analysis of the population composition revealed differences in the calf/female ratio between survey units (Table 4) and strata (Table 5). An overall ratio of 22c/100 females (>24 mo.) was recorded with variations from 17-28c/100 females occurring between survey units. Nearly one-half (48%) of the calf population was in the low stratum, with a decreasing proportion in both the medium and high strata.

Fig. 2

PERCENT FREQUENCY OF THE ESTIMATED MOOSE POPULATION (all age/sex groups) BY SURVEY UNIT & STRATUM IN THE SOUTHERN YUKON SURVEY AREA (Oct.-Dec. 1981)

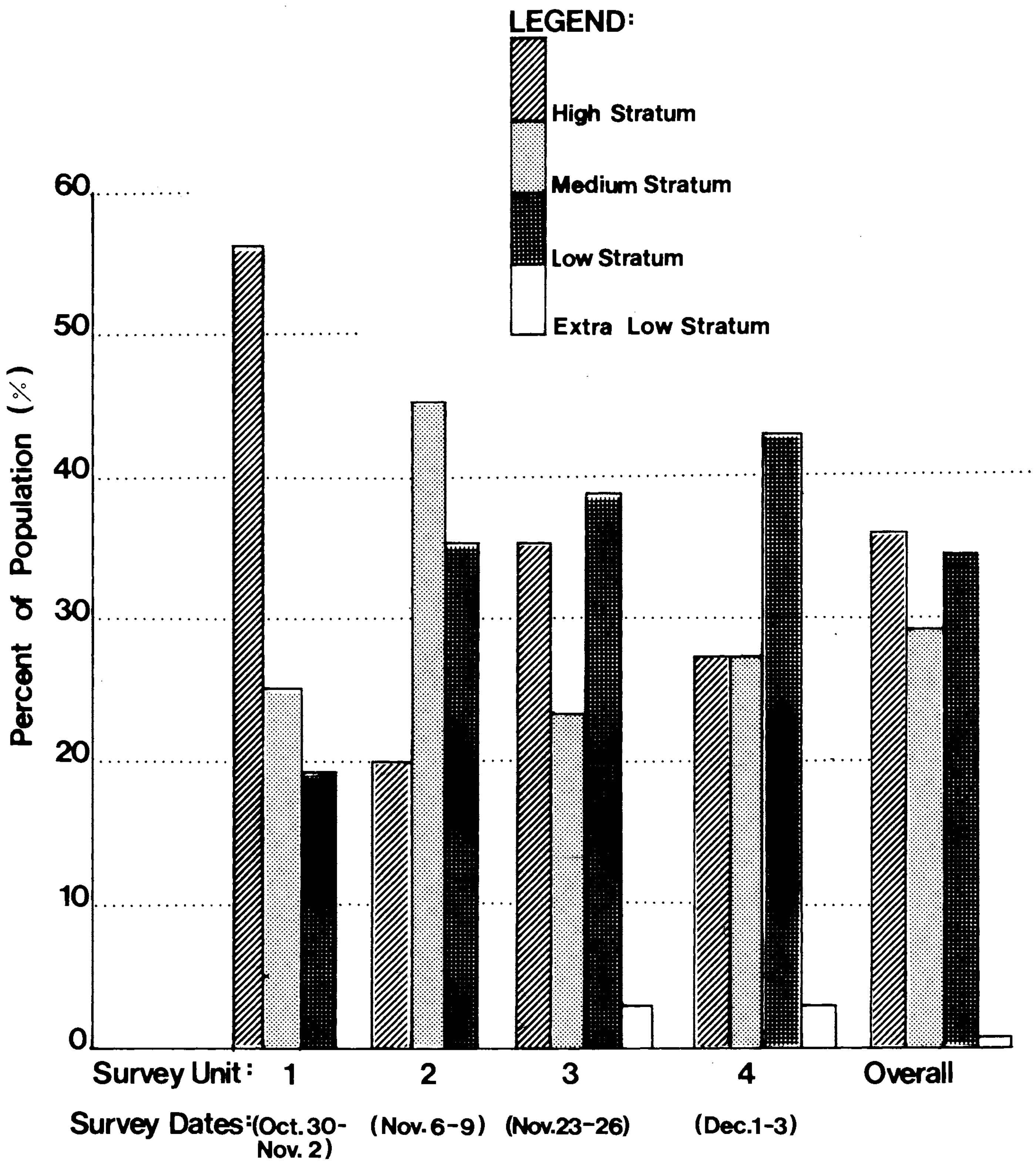


Fig. 3

PERCENT FREQUENCY OF AGE-SEX GROUPS BY STRATUM & SURVEY UNIT IN THE SOUTHERN YUKON SURVEY AREA, OCT.-DEC.1981.

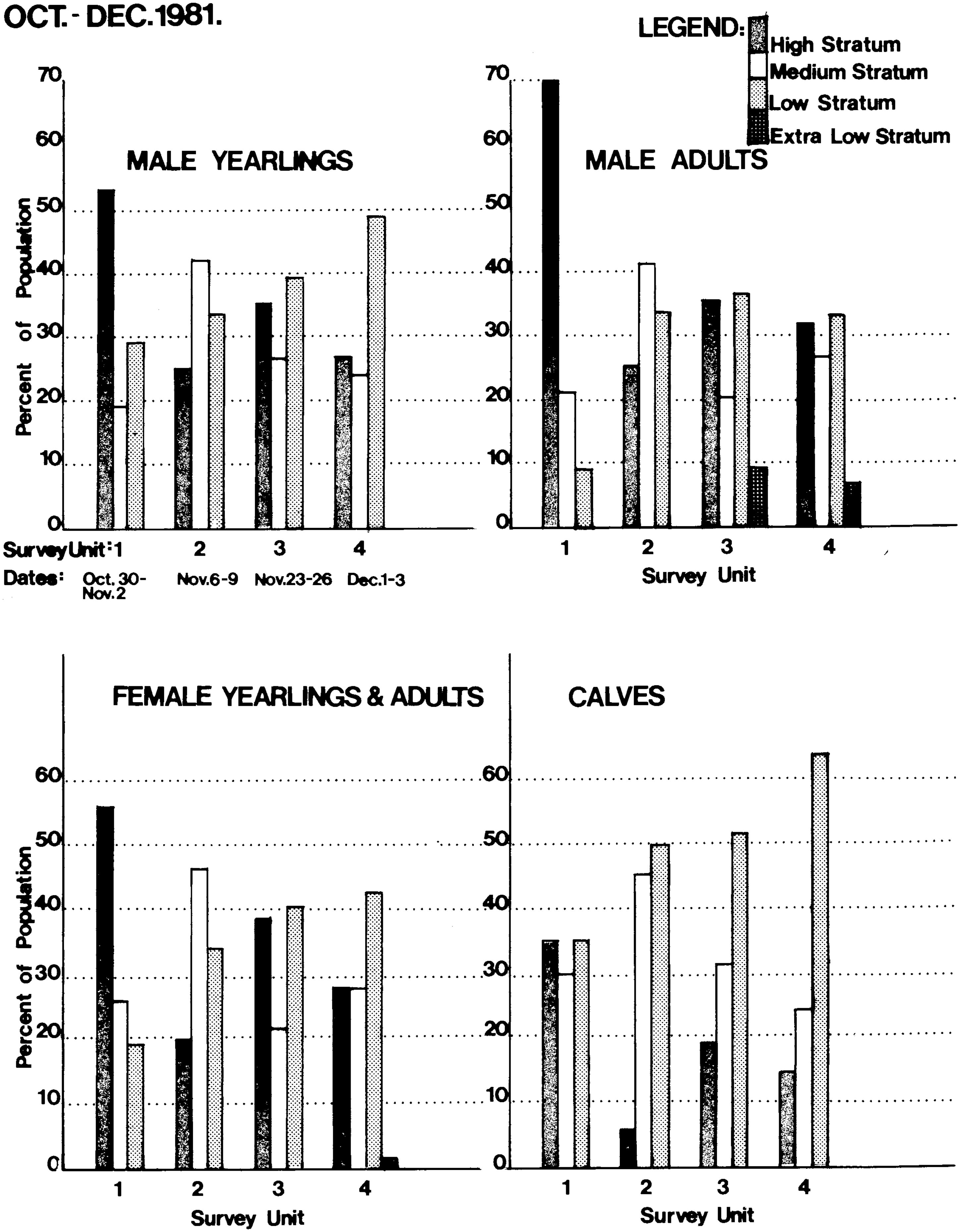
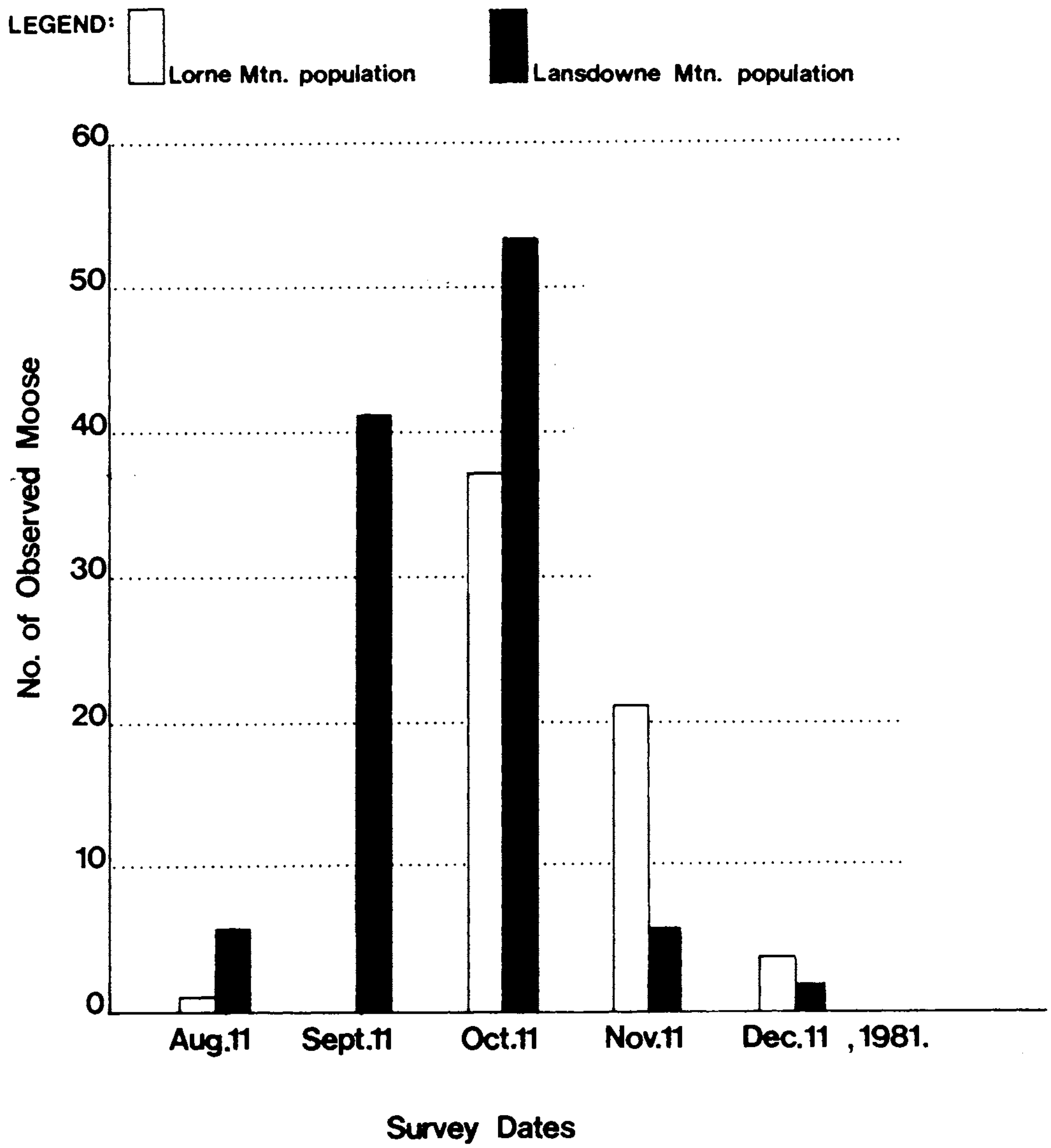


Fig. 4

OBSERVED HIGH STRATUM MOOSE POPULATION IN TWO AREAS ADJACENT TO THE OCT.-DEC.,1981 SOUTHERN YUKON CENSUS AREA



Calf mortality to 6 months of age was estimated by calculating the potential birth rates (calves born/female) of females 24 mo. and females ≥36 mo. in 1981. The number of females ≥36 mo. was estimated assuming that the proportion of 24 mo. females was similar to the proportion of yearling females in the fall survey. Two hypothetical birth rates were applied to each age group representing the range of values reported from studies conducted in the western Canadian provinces and the State of Alaska. The values for 24 mo. females were .57c/female (Mytton & Keith, 1981) and 1.11c/female (Gasaway et al, 1981, in review) and for females ≥36 mo. 1.16c/female (Gasaway et al, 1981, in review) and 1.67c/female (Mytton & Keith, 1981). Under the high productivity scenario, 2041 (1115 females 36 mo. x 1.67) + (161 female 24 mo. x 1.11) calves would have been produced at parturition in 1981. Under the low productivity scenario 1385 (1115 x 1.16) + (161 x .57) calves would have been produced. A calf population of 280 was estimated for the study area. Therefore, the estimated calf mortality to 6 months was between 80 and 86%.

Historical calf/cow ratios from the adjacent Kluane National Park were compared to the present study. In the Park, early winter helicopter surveys have been conducted in selected areas since 1974. The average ratio (1974-1981) reported for the Park was 18c/100 female (≥ 12 mo.) with a range of 11-26c/100 female (unpublished, Kluane Park files). The present study recorded 19c/100 female (≥ 12 mo.) indicating that the present low calf crop was a recent one year phenomena.

An overall ratio of 49 males/100 females was documented for the main survey area but varied considerably between survey units with a high of 70 males/100 females in unit 3 and a low of 42 males/100 females in unit 1. These differences reflect the level of the predominantly male (80%) harvest in the study area (Table 6).

TABLE 4 The estimated moose population composition by survey unit, October-December, 1981.

	Survey Unit				
Composition	1	2	3	4	Total
Yrl male	48 (6.0%)	29 (6.7%)	26 (6.9%)	49 (6.0%)	151 (6.2%)
Ad Male	151 (19.0%)	118 (27.2%)	113 (30.0%)	170 (20.7%)	551 (22.8%)
Yrl Female*	51 (6.3%)	30 (6.9%)	27 (6.9%)	53 (6.4%)	161 (6.7%)
Ad Female	426 (53.7%)	219 (50.5%)	172 (45.9%)	459 (56.4%)	1276 (52.7%)
Calves	119 (15.0%)	38 (8.7%)	39 (10.3%)	84 (10.3%)	280 (11.6%)
TOTAL	795 (100.0%)	434 (100.0%)	377 (100.0%)	815 (100.0%)	2419 (100.0%)
c/100 females (>24 mo.)	28	17	23	18	22
Male (>1 yr.)/ 100 female (>1yr.)	42	59	70	43	49

*assuming an equal represenation of yrl male and female in the population and correcting for hunting mortality of yrl male.

TABLE 5 The estimated moose population composition by strata in the main survey area, October-December 1981.

	Strata				
Composition	High	Medium	Low	Extra Low	Total
Yrl male	54 (36%)	39 (26%)	57 (38%)	0 (0%)	151 (100%)
Ad Male	231 (42%)	149 (27%)	151 (27%)	20 (4%)	551 (100%)
Yrl Female*	57 (36%)	41 (26%)	60 (38%)	0 (0%)	158 (100%)
Ad Female	474 (37%)	391 (30%)	403 (32%)	10 (1%)	1279 (100%)
Calves	62 (22%)	83 (30%)	134 (48%)	0 (0%)	280 (100%)
TOTAL	878 (36%)	704 (29%)	806 (34%)	30 (1%)	2419 (100%)
c/100 females (>24 mo.)	13	21	33	0	22
Male (>1 yr.)/ 100 female (>1yr.)	54	44	45	200	49

*assuming an equal represenation of yrl male and female in the population and correcting for hunting mortality of yrl male.

TABLE 6 Estimated average (1979-1980) harvest* by survey units in the main survey area.

	Survey Unit				
	1	2	3	4	Total
Estimated population	794	437	376	814	2419
Estimated average harvest (1979-1980)	68	25	18	93	204
% of population harvested	8.6	5.7	4.8	11.4	8.4
Male/100 female observed	42	59	70	43	49

*Renewable Resources Files

A higher male to female ratio was recorded also in the high stratum compared to either the medium or low strata (Table 5).

Antler drop was first recorded on the 26 November with 1.4% of the mature males without antlers. By the 4 December 14.9% had shed their antlers.

Group Size

The estimated mean group size of 2.6 ± 0.1 at 90% C.I. was recorded, with no significant difference between survey units. Groups of 3-9 animals were most common with 34% of the estimated population occurring in this class (Table 7). Seventy-eight percent of the calves were in solitary cow/calf groups. The largest group observed was 63 animals.

A positive relationship existed between mean group size and elevation in the first survey unit (October), while a negative relationship occurred in the last survey unit (December) suggesting that groups at higher elevations following the rut move down slope as winter approached (Figure 5).

Fig. 5

ESTIMATED MEAN GROUP SIZE BY ELEVATION FOR SURVEY UNITS 1 (OCT.) & 4 (DEC. 1981)

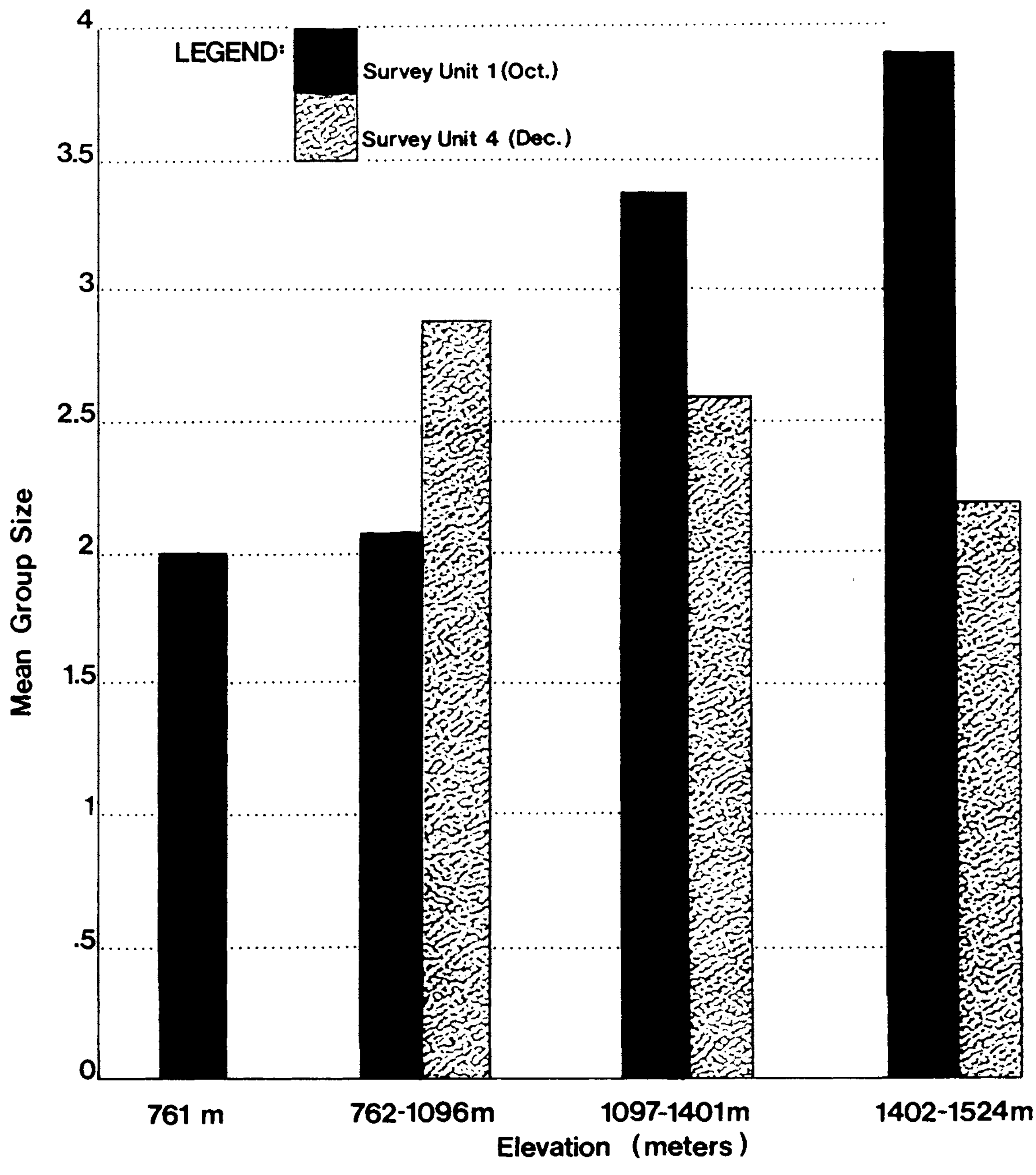


TABLE 7 Group size by composition of moose in the main survey area, October-December, 1981.

	Composition				
	yrl male	adult male	female	calves	Total
Solitary	32 (22%)	90 (16%)	177 (12%)	0 (0%)	299 (12%)
Pair	26 (17%)	116 (21%)	433 (30%)	218 (78%)	794 (33%)
3-9	56 (37%)	193 (35%)	510 (36%)	51 (18%)	811 (34%)
10	37 (24%)	152 (28%)	317 (22%)	10 (4%)	515 (21%)
TOTAL	151 (100%)	551 (100%)	1437 (100%)	280 (100%)	2419 (100%)

Habitat Use

Fifty-three percent of the moose range and 82% of the estimated population was located at or above treelines, i.e. >1067 m elevation. The shrub dominated community was the most commonly occupied by all age/sex groups, with 79% of the estimated population occurring in this type (Table 8). The moose population was equally distributed over all aspects with the exception of low use of north-facing slopes. Cows with calves primarily used southfacing slopes, while adult males were found mainly on eastfacing slopes.

TABLE 8 Habitat use (% by cohort) of moose in the southern Yukon survey area, October-December, 1981.

	Yr. Male	Adult Male	Female	Calves	Overall
Vegetation					
Shrub	80%	79%	79%	79%	79%
Shrub-conifer	13	16	14	14	14
Shrub-deciduous	0	0	1	1	1
Mixed	0	1	2	0	1
Unspecified	0	1	1	0	1
Elevation					
0-1066 m (Boreal)	23	14	20	18	18
1067-1401 (Subalpine)	48	60	58	65	59
1402-1524 (Apline)	29	26	22	17	23
Aspect					
N	14	17	11	7	12
E	22	32	26	17	26
S	18	15	26	32	24
W	16	18	16	20	17
Flat	30	18	21	24	21

Cost

The survey cost, including personnel, aircraft rental, fuel, and accommodation, was \$106.9 thousand or \$7.35/km^2 of moose habitat or \$44/ estimated moose (Table 9). Rental of aircraft (51% helicopter and 14% fixed wing) contributed most to the overall cost while labour added 26% to the total budget.

TABLE 9 Cost of the October-December, 1981 moose survey in the southern Yukon.

	Cost x 1000	% Total
Aircraft		
Fixed wing (stratification)	$ 15.8	15%
Helicopter (census)	54.9	51
Personnel		
Stratification flights - 33 man days	2.5	2
Census flights - 45 man days	3.4	3
Map preparation - 109 man days	8.2	8
Analysis and report - 180 man days	13.5	13
Food and lodging	4.5	4
Maps	1.1	1
Miscellaneous - vehicle transportion, office supplies, telephone, etc.	3.0	3
TOTAL	$ 106.9	100%

DISCUSSION

The stratified block sampling technique proved well adapted to clumped distribution of moose and the adverse weather conditions experienced during this survey. Helicopters were preferred during the census phase to fixed-wing aircraft for the following reasons.

1. less time is wasted in turning compared to fixed-wing aircraft thus maximizing search effort and increasing the visibility of moose;
2. helicopters tend to flush animals which may go undetected by fixed wing aircraft;

3. manoeuverability in mountainous terrain and under windy conditions is good and thus safter than a fixed wing aircraft;
4. navigation and composition counts are easier from a slow moving aircraft; and
5. fatigue and boredom can be reduced by periodically landing for rests.

Smaller s.u. than recommended by Gasaway et all (1981) were used as a larger number of small, more homogeneous s.u. should reduce the confidence interval of the population estimates. As well, boundaries are easier to identify resulting in the accurate plotting of sightings. Movement between these smaller s.u.'s was minimized by conducting the census immediately following the stratification.

No sightability correction factor was determined during this survey for the following reasons:

1. It became evident early in the survey that the majority of the population was at or above treeline. Gasaway et al (1981) have reported 100% counts of radio collared moose in subalpine habitats in Alaska. These surveys were conducted from fixed-wing aircraft at survey intensities of 1.5 to 1.9 min./km^2 during the post rut period. The search intensity recorded during this study was 1.4 min./km^2.
2. The survey design and search intensities would minimize the number of moose missed in forested areas. Again, Casaway et al (1981) saw 85% of the moose in spruce-dominated habitats. They reported an overall observer efficiency 88% in all habitat types during early

winter surveys at a 1.5 to 1.9 min./km^2 survey intensity. Mytton & Keith (1981) also reported an observer efficiency of 88% on moose surveys flown with a helicopter in forested habitat in Alberta. Their estimate also was based on the observation of radio equipped animals during early winter surveys.

3. The feasibility of determining a sightability correction factor in forested areas with sparse numbers of moose was questioned. Even if it could have been determined, the cost would be prohibitive.

4. For most management purposes a slight error on the conservative side is acceptable.

Biologists often have the tendency to "high grade" populations or search only high density areas during aerial surveys in an attempt to stay within budgets and at the same time obtain an adequate sample. Serious biases in composition estimates could result if variations in calf:female and female:male ratios exist between strata as shown in these results. Several authors including Peek et al (1974); Rounds (1978); Gasaway et al (1981); and Mytton & Hauge (1981) also have reported on this variation in composition between areas of different densities. The observation of cow:calf groups avoiding high density and/or open habitat areas is consistent throughout these reports.

The variation in composition data between survey units in this study emphasizes the danger in developing common management strategies for large management units. Management programs should be tailored to smaller areas, i.e. survey units.

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REFERENCES

BERGERUD, A.T. and F. MANUEL. 1969. Aerial census of moose in central Newfoundland. J. Wildl. Mange. 33(4): 910-916.

DUBOIS, S., W. GASAWAY, D. ROBY. 1981. Aerial classification of bull moose on antler development. Unpubl. Alaska Dept. of F & G files.

EVANS, C.D., W.A. TROYER and C.J. LENSINK. 1966. Aerial census of moose by quadrat sampling units. J. Wildl. Manage. 30(4): 767-776.

GASAWAY, W.C., S.D. DUBOIS, S.J. HARBO and D.G. KELLEYHOUSE. 1978. Preliminary report on accuracy of aerial moose surveys. Proc. 14th N. Am. Moose Conf. and Workshop. Halifax, Nova Scotia.

GASAWAY, W.C., S.D. DUBOIS and S.J. HARBO. 1981. Estimating moose abundance and composition. Alaska Dept. of Fish and Game Manual. Fairbanks, Alaska. 62pp.

GASAWAY, W.C., R. STEPHENSON, J. DAVIS, P. SHEPHERD and O. BURRIS. 1982. Interrelationships of Prey, Man, and Wolves in Interior Alaska. Draft. (under review Wildl. Monographs).

HAUGE, T.M. and L.B. KEITH. 1981. Dynamics of moose populations in Northeastern Alberta. J. Wildl. Manage. 45(3): 573-597.

LYNCH, G.M. 1975. Best timing of moose surveys in Alberta. Proc. 11th N. Am. Moose Conf. and Workshop. Winnipeg, Manitoba.

MYTTON, W.F. and L.B. KEITH. 1981. Dynamics of moose populations near Rochester, Alberta, 1975-1978. Canadian Field Naturalist. 95(1): 39-49.

NORTON-GRIFFITHS, M. 1975. Counting animals. Serengeti Ecological Monitoring Programme, Publ. No. 1.

OSWALD, E.G. and J.P. SENYK. 1977. Ecoregions of Yukon Territory. Fisheries and Environment Canada, Pacific Forest Research Centre, Victoria, B.C.

PEEK, J.M., R.E. LERESCHE and D.R. STEVENS. 1974. Dynamics of moose aggregations in Alaska, Minnesota, and Montana. J. Mamm. 55(1): 126-137.

ROUNDS, R.C. 1978. Grouping characteristics of moose (Alces alces) in Riding Mountain National Park, Manitoba. Canadian Field Naturalist. 92(3): 223-227.

SINIFF, D.B. and D.O. SKOOG. 1964. Aerial censusing of caribou using stratified random sampling. J. Wildl. Manage. 28(2): 391-401.

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