MOOSE POPULATION RESEARCH
AND
MANAGEMENT STUDIES
IN YUKON

Population Dynamics and
Early Winter Habitat Utilization
by Moose *(Alces alces)*
in the South-West Yukon Territory

PROGRESS REPORT 1983

Population Dynamics

and

Early Winter Habitat Utilization

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South-West Yukon Territory

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For

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INTRODUCTION

During 1981, a moose management program was implemented in the Yukon Territory by the Renewable Resources Department of the Yukon Government. This program was initiated as a result of increased concern with the high levels of harvest of moose by white and native hunters. In addition, planned and existing industrial development and increased agricultural and recreational land-use were identified by the Yukon River Basin Study Committee as potential threats to large ungulates within the Yukon River Basin. To investigate the potential effects of hunting and industrial development on moose populations, Larsen (1982) identified six priority areas in the Yukon where scant baseline information or high hunting and land-use pressure indicated a need for a more detailed data base on moose populations.

Results of the fall 1981 moose surveys, (Larsen 1982) in the high priority area of Game Management Zone (GMZ) #7, indicated that the moose population density and productivity were much lower in this area than expected. On the basis of these data, Larsen and Kale (1982) suggested that either the hunting of moose in GMZ #7 should be restricted or the survival rate of calves increased through predator control. Since these management suggestions were based on tentative conclusions from one year's data, Larsen advocated a second year's survey in GMZ #7 during the Autumn of 1982.

Northern Biomes Ltd. was contracted by the Yukon Government to undertake

the 1982 moose surveys of GMZ #7. Specifically, the objectives of this study were:

1. to collect data on density, distribution and composition of moose in GMZ #7 for another year and derive a population estimate;

2. to assess changes in the population composition and mortality of moose in GMZ #7 between Autumn 1981 and Autumn 1982; and

3. to investigate habitat availability and use by moose during the post-rut period.

STUDY AREA

The study area is situated in the southwest Yukon Territory and is divided into two survey areas; Area One and Area Four (Figure 1). Bordered on the west by the Haines Road and on the east by the Carcross Road, the total survey area extended from the Alaska Highway south to the British Columbia border. Kusawa Lake, which is a physical barrier to moose between the two study areas, served as a natural boundary between areas One and Four.

The terrain consists of precipitous mountains rising to over 2533 meters separated by wide U-shaped valleys. Of the 11,100 square kilometers in the study area, 7,325 km^2 or 66% is habitable moose range. Treeline occurs between 1067 metres and 1220 metres. Shrub birch (Betula spp.) and willow (Salix spp.) are the predominant species in the subalpine zone extending from treeline to 1524 metres. The dominant tree species on the lower slopes are white spruce (Picea glauca) and lodgepole pine (Pinus contorta). Some paper birch (Betula papyrifera) and poplar (Populus spp.) are scattered throughout the area. There is a major burn along the northern edge of Area One and small burn areas are scattered throughout both survey areas. Oswald and Senyk (1977) provide a more detailed description of the physiography, climate and vegetation of the region.

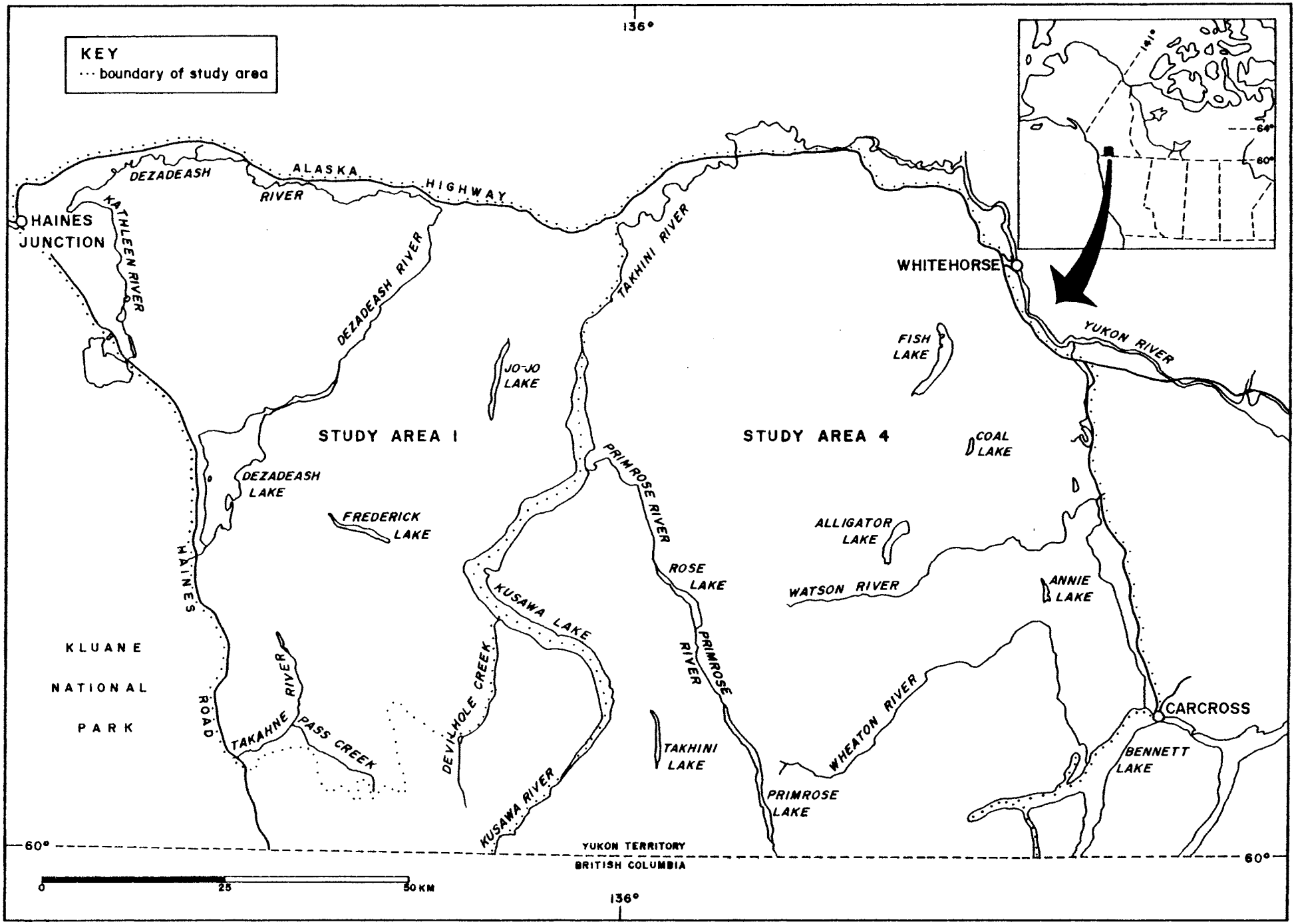

FIG.1

LOCATION OF SURVEY AREAS ONE AND FOUR OF THE SOUTH-WEST YUKON TERRITORY

WEATHER

Weather for Survey Areas One and Four is represented by weather data from the Atmospheric Environment Services weather stations at Haines Junction and Whitehorse respectively (Table 1 and 2).

The weather from Haines Junction, although representative for Area One, tends to be localized. Snow depth measurements should be regarded with caution, as local precipitation can be heavier at Haines Junction than in the surrounding area to the east. The mean monthly temperature in October 1982 was 2°C colder than the normal average, while in November, the mean temperature for 1982 was the same as the normal average (Table 1). The mean snow depth on the ground in 1982 was 9 cm deeper in October than the normal average and comparable to the normal snow depths in November (Table 1). Information on prevailing winds has yet to be compiled for 1982, however, the prevailing winds from a 19 year average (1959 to 1978) were northeasterly.

In Area Four, the 1982 mean monthly temperatures for October and November were below normal by 2.6°C and 1.3°C respectively (Table 2). Month-end snow depths were deeper than the normal averages. For example, snow depth in October was 18 cm deeper than the normal average. Prevailing winds in Area Four during October-December were from the south.

TABLE 1 Area One - Haines Junction Weather, October - December 1982. (Atmospheric Environment Service 1983)

WEATHER	1982 OCT.	1982 NOV.	1982 DEC.	NORMAL AVERAGE (1959-78) OCT.	NORMAL AVERAGE (1959-78) NOV.	NORMAL AVERAGE (1959-78) DEC.
TEMPERATURE °C						
mean, maximum	1.3	-7.3	-12.6	4.5	-7.4	-14.2
mean, minimum	-8.6	-21.1	-21.9	-6.7	-18.6	-25.9
mean, monthly	-3.7	-13.7	-17.3	-1.1	-13.0	-20.1
WIND						
average speed (Kph)				5.2	4.7	4.2
prevailing winds				NE	NE	NE
MONTH END SNOW DEPTH						
mean depth on ground (cm)	10	18.0		1	19	33

TABLE 2 Area Four - Whitehorse Weather, October - December 1982. (Atmospheric Environment Service 1982)

WEATHER	1982 OCT.	1982 NOV.	1982 DEC.	NORMAL AVERAGE (1959-73) OCT.	NORMAL AVERAGE (1959-73) NOV.	NORMAL AVERAGE (1959-73) DEC.
TEMPERATURE °C						
mean, maximum	2.4	7.3	-8.1	4.2	-7.1	-12.0
mean, minimum	-6.3	-15.2	-16.5	-3.0	-14.2	-20.5
mean, monthly	-2.0	-11.3	-12.3	0.6	-10.6	-16.3
WIND						
average speed (kph)	14.1	14.0	14.9	16.3	15.5	14.8
prevailing winds	S	S	S	SSE	S	S
MONTH END SNOW DEPTH						
mean depth on ground (cm)	21	19	21	3	16	25

METHODS

Population Estimate

Area One and Four were surveyed during 1-9 November and 11-21 November respectively. The aerial survey technique employed was a modification (Larsen 1982) of the stratified random block sampling technique designed for estimating moose populations in Alaska (Gasaway et al 1981).

Briefly, the technique involves two phases: Stratification and census. The stratification phase is a cursory survey of the entire survey area. Its purpose is to stratify sample units (S.U.) of the survey area into moose density classes, or strata. The census phase involves an intensive and thorough survey of moose from randomly selected S.U.'s within each density strata.

Prior to aerial surveys, each survey area was divided into S.U.'s which were delineated on topographical maps using natural boundaries whenever possible and averaging 14 km^2 in size. Those areas exhibiting any of the following characteristics: Above 1524m elevation, precipitous slopes or waterbodies larger than .8 km were considered uninhabitable for moose and were not surveyed. The sample unit boundaries defined in 1981 (Larsen 1982) were used in 1982. There were 232 and 278 S.U.'s in Areas One and Four respectively.

Sample units were stratified from fixed-wing aircraft (Cessna 185 and Cessna 206) flown simultaneously over different portions of the survey area. Each aircraft contained three observers plus the pilot. Surveys were flown at 90 to 100 m (a.g.l.) at 130 kph.

Four strata of moose density were identified for the two survey areas; high (>0.58 moose/km^2), medium (0.30 - 0.58 moose/km^2), low (tracks or <0.30 moose/km^2) and extremely low (absence of moose or moose tracks).

In cases where moose were observed on or near the borders of S.U.'s, the borders were redrawn to avoid the potential problem of moose movement between S.U.'s. On occasion, poor weather conditions interrupted the stratification necessitating restratification of specific sample units.

The census flights were flown immediately after the stratification flights. Two helicopters (Bell 206 or Hughes 500) each with three observers and pilot, were flown simultaneously in different sections of the survey area.

In flat terrain, short parallel transects were flown approximately .4 km apart. flight patterns in mountainous terrain often followed contour lines or circles. Surveys were flown between 30 to 150 m a.g.l. at 50 - 130 kph depending on terrain features and vegetative cover. The time spent censuring Areas One and Four was 12 and 16 hours respectively. The mean search intensity within each S.U. was 1.3 min/km^2 with a range of .7 to 2.0 min/km^2 .

Moose observations were recorded within each censused S.U. by a unique aggregation number and its location plotted onto 1:50,000 scale maps.

Moose were aged and sexed. Antlerless moose with a white vulva patch were sexed as cows and bulls were determined by the presence of antlers or antler pedicels. Male moose were further classified into yearlings and adults based on antler morphology (Dubois et al 1981). The calves were identified by body size and association with a cow.

Habitat

Habitat features were recorded concurrent with moose observations during the census phase of the survey. Two levels of vegetation information were collected. The first was a site specific classification of the dominant vegetation immediately surrounding each moose aggregation. The second was a broader classification within the S.U.'s censused. Both classifications were visually assessed. In addition, elevation and aspect were measured for each moose aggregation from 1:50,000 scale topographical maps.

To determine significant trends in moose distribution during the early winter period, Marcum and Loftsgaarden's (1980) non-mapping technique for determining habitat availability versus utilization was applied in Survey Area Four.

Seven vegetation classes were identified in the study area: Herbaceous, shrub, conifer, shrub-conifer, deciduous-shrub, shrub-conifer-deciduous and burn. Two criteria are recommended (Neu et al 1974) when using the availability-utilization test; 1. there should be at least one expected observation in each class and, 2. no more than 20% of all classes should contain less than five expected observations. Representation of the herbaceous shrub-conifer-deciduous and burn

vegetation classes was very small, consequently these classes were excluded from the statistical analysis.

The area between 639-1524 m elevation (habitable moose range) was divided into six classes of 150 metre increments. Aspect was categorized into five classes: North, northeast (0-90); east, southeast (91-180); south, southwest (181-290); west, northwest (291-360); and flat.

In order to estimate the proportion of each habitat class (vegetation, elevation, aspect) available in the study area, 150 random points defined by military grid reference locations were selected. The vegetation class at each random point location was determined from vegetation classification maps of the East Kluane Land Use Plan (Oswald et al 1981) and the Vegetation Southern Lakes Project (Boyd et al 1983). Elevation and aspect for each random location were measured from 1:50,000 scale topographical maps.

A Chi-square goodness-of-fit test was used to determine if any significant differences occurred between the observed distribution of moose and calves (only among the classes of each habitat parameter) and the expected distribution as determined by the distribution of the random points. If the calculated Chi-square value was significant, the null hypothesis (that the observed moose followed an expected distribution pattern among the classes of a given habitat parameter) was rejected. A Bonferroni Z statistic at (1-a/2K) was then used to calculate a confidence interval to determine whether the observed moose occurred more than, less than, or in equal proportion to the parameter class's availability. The

equation (Marcum and Loftsgaarden 1980) used to construct the simultaneous confidence intervals for the use of each parameter class was:

$$P_{1i} - P_{2i} \pm z(1-\alpha/2K)\sqrt{P_{1i}(1-P_{1i})/n_1 + P_{2i}(1-P_{2i})/n_2}$$

where P_{1i} was the proportion of random points observed, P_{2i} was the proportion of moose observed while n_1 was the total number of random points and n_2 was the total number of moose observed.

RESULTS

Sampling and Search Intensity

Within the combined survey areas (Area One and Area Four), 17% of the total S.U.'s and 18% of the total area of habitable moose range was sampled (Table 3). Sampling intensity did not differ significantly between the two survey areas although in Study Area Four, all of the high strata and 80% of the medium strata were sampled, while in Study Area One, 81% of the high strata and only 40% of the medium strata were sampled. These differences are attributable to differing variances within strata. As variances of the moose population estimate within strata became acceptable, sampling effort was decreased in that stratum and transferred to strata with the highest variance. The same percentage of habitable moose range in Area One and Four was sampled this year as in 1981 (Larsen 1982).

Moose Population Estimates

Using the ratio estimator technique (Gasaway et al 1981) at a 90% confidence level, the estimated moose population was 642 $\mp$ 115, and 815 $\mp$ 165 in Areas One and Four respectively (Table 4). From the addition of these two estimates, a total population of 1457 $\mp$ 201 moose was calculated for the combined survey areas. The total estimated moose population and density within each strata in Area One and Four are presented in Table 5.

TABLE 3 Number of Sample Units (S.U.) Censused by Strata in the Combined Survey Areas, November 1982.

SAMPLE UNITS (per Strata)	STRATA High	Medium	Low	Extremely Low	Total
Total S.U.	19	35	321	135	510
S.U. Sampled	17	20	41	10	88
Percent Sampled	89	57	13	7	17
Area Sampled (km^2)	314	549	4630	1032	7325

TABLE 4 Moose Population Estimates for Area One, Four and the Combined Survey Areas, November 1982.

SURVEY AREA	ESTIMATED MOOSE POP.	90% C.I.	RANGE
Area One	642	115	527-757
Area Four	815	165	650-980
Combined Survey Areas	1467	201	1266-1668

TABLE 5 Estimated Moose Population and Density by Strata in Areas One and Four, November 1982.

	STRATA	TOTAL MOOSE	RANGE	AREA(KM^2)	DENSITY ($MOOSE/KM^2$)
Area One	High	192	192-192	122	1.6
	Medium	227	183-271	237	1.0
	Low	223	116-331	1723	0.1
	Extremely Low	0	0	1030	0
Area Four	High	256	226-286	192	1.3
	Medium	162	117-208	312	0.5
	Low	397	239-554	2907	0.1
	Extremely Low	0	0	803	0

Moose population density was calculated from the area of habitable moose range only. The density of moose was 0.21 moose/km^2 and 0.19 moose/km^2 in Areas One and Four respectively. These values represent a mean density of 0.20 moose/km^2 in the combined survey areas. Moose densities in the high and medium strata were greater in Area One than in Area Four (Table 5). No moose were observed in the extremely low strata.

Moose Population Composition

Age and sex composition of the combined moose populations within Area One and Area Four are presented in Table 6. Yearling cows and bulls (19 months old) collectively represented the smallest cohort (2.8%), while adult cows (≥30 months old) represented the largest cohort (65.9%). Calves (5-6 months old) represented 12.0% of the total population. The respective numbers of calves, yearlings (males and females), and bulls (≥30 months age) per 100 cows (≥30 months age) were 18, 4 and 29 in the combined survey areas (Table 7).

Comparisons of the moose populations in survey Areas One and Four indicated differences in the population structure. Yearling bulls represented 1.9% of the total population in Area Four, yet only 0.7% in Area One. Similarly, calves represented 15.5% of the total moose population in Area Four but only 7.3% of the moose population in Area One (Table 6). Productivity as calves/100 cows was more than twice as high in Area Four (24 calves/100 cows) than in Area One (11 calves/100 cows).

TABLE 6 Age and Sex Composition of the Estimated Moose Populations in Areas One, Four and the Combined Survey Areas, November 1982.

COMPOSITION	AREA ONE		AREA FOUR		COMBINED SURVEY AREAS	
	#	%	#	%	#	%
Yrl Bulls	3	(.7)	16	(1.9)	19	(1.4)
Adlt Bulls	142	(22.2)	138	(16.9)	280	(19.2)
*Yrl Cows	4	(.6)	17	(2.1)	21	(1.4)
Adlt Cows	444	(68.8)	518	(63.6)	962	(65.9)
Calves	49	(7.8)	126	(15.5)	175	(12.0)
Total	642	(100)	815	(100)	1457	(100)

* extrapolated using Larsen's (1982) technique

TABLE 7 Number of Calves, Yearlings and Bulls/100 Cows in Areas One, Four and the Combined Survey Areas, November 1982.

(Cows ≥ 30 months age, bulls ≥ 30 months age).

MOOSE	AREA ONE	AREA FOUR	COMBINED SURVEY AREAS
Calves/100 Cows	11.0	24.3	18.6
Yearlings/100 Cows	1.6	6.4	4.2
Bulls/100 Cows	32.0	26.6	29.1

Overwinter calf mortality calculated as the difference between the estimated number of calves present in the 1981 survey (Larsen 1982) and the estimated number of yearlings present during this survey, was 79.8% for the combined survey areas. However, when considered separately, overwinter mortality (November 1981 - November 1982) of last year's calves was 94% in Area One and only 61% in Area Four.

If the moose populations from Areas One and Four are compared in terms of moose density, Area One has a higher adult cow and bull density than Area Four (Table 8). However, the density of calves and yearlings is much lower in Area One than in Area Four. Although the density of specific cohorts between the two study areas is different, we have no parametric statistical technique to verify the validity of these differences. Nevertheless, the magnitude of the differences, particularly in the calf and yearling cohorts, is likely significant.

Distribution and Group Size

Within the two survey areas, the clumped distribution of moose was reflected by their densities in each strata. Mean moose density (# moose/km^2) was 1.6, 1.0 and 0.1 in Area One and 1.3, 0.5 and 0.1 in Area Four in the high, medium and low strata respectively (Table 5). No moose were observed in the extremely low strata of either study area. In both areas, the high and medium strata represented only 12% of the habitable moose range, yet 65% of the moose in Area One and 50% of the moose in Area Four occurred within these two strata.

TABLE 8 Estimated Total Number and Relative Density of Age and Sex Cohorts of Moose Populations in Areas One and Four, November 1982. Density expressed as moose/km^2.

AGE/SEX COHORT	ESTIMATED MOOSE		RELATIVE DENSITY	
	Area 1	Area 2	Area 1	Area 2
Calves	49	126	0.016	0.030
Yearlings	7	33	.001	.007
Cows	444	518	0.143	0.123
Bulls	142	138	0.046	0.033
TOTAL	642	815	0.206	0.193

Thus, a large proportion of the moose population during the post-rut period is concentrated in a relatively small area of the available moose range.

A sample unit was arbitrarily considered as a moose concentration area if it contained a moose density of ≥ 0.3 moose/km^2. This moose density value represents a sample unit that contained anywhere from 4 to 62 moose. The size of each moose concentration was calculated from the number of moose observed during the census, or during the stratification if the S.U. was not censused.

In Area One, 19 concentrations of moose were identified representing 60% of the moose population in 9% of the habitable moose range (Table 9). In Area Four, 34 concentrations of moose contained 50% of the moose population in 13% of the habitable range. Mean moose densities in these concentration areas were 1.35 ∓ 0.97 and 0.71 ∓ 0.47 moose/km^2 in Areas One and Four respectively. The location and size of each sample unit containing a moose concentration is given in Appendix 1, however, the locations are not plotted. The absolute locations of sample units are marked on maps, stored at the Government of Yukon, Department of Renewable Resources, Resources Planning and Management Branch.

Although moose concentrated in specific areas, within these areas and throughout the study area, moose were found in varying group sizes.

TABLE 9 Moose Concentrations Occurring in Areas One, Four and the Combined Survey Areas, November 1982.

SURVEY AREA	NO. OF CONCENTRATIONS	TOTAL AREA (KM^2)	TOTAL MOOSE	% OF TOTAL AREA	% OF TOTAL MOOSE
Area One	19	290	383	9	60
Area Four	34	544	406	13	50
Combined Survey Areas	53	834	789	11	540

In Area One, 56% of the moose were in groups larger than two, with most moose occurring in the group size of 3-9 animals (Table 10). Only 38% of the moose were in groups larger than 2 in Area Four. In area Four 2% of the moose occurred in groups larger than 10 animals, whereas 22% of the moose in Area One were found in groups this size.

Calf distribution differed from the distribution of other age and sex cohorts. In both areas, the majority of calves occurred in group sizes of 2 (cow + calf) and 64% of the calves occurred in the low strata.

Comparisons in Moose Populations Between 1981-1982

Changes in the estimated size and composition of moose populations between Autumn 1981 and 1982 were most evident at the individual survey area level. Significant trends in the dynamics of the moose population in GMZ #7 were underestimated when the two areas were analyzed together. However, for comparative purposes, the results are presented for the individual survey area level and for the combined survey areas.

Area One

A significant difference was found between the size of the estimated moose population of Autumn 1981 and Autumn 1982 ($t = 17.3$, $a = .1$). The total estimated population decreased by 19% over this one year period. The number of animals in all age and sex cohorts, except adult cows, decreased from Autumn 1981 to 1982 (Figure 2). The adult cow cohort showed a slight but insignificant increase while the adult bull cohort showed a slight but insignificant decrease. The size of the calf and yearling cohorts showed significant decreases of 58% and 92% respectively. Ratios of calves, yearlings and bulls per 100 cows were

TABLE 10 Group Size as Percent of Cohort Total of the Estimated Moose Population in Areas One and Four, November 1982. (Bulls and cows include yearling moose.)

	COHORT							
	Bulls		Cows		Calves		Total	
GROUP SIZE	Area 1 n=145	Area 4 n=154	Area 1 n=448	Area 4 n=535	Area 1 n=49	Area 4 n=126	Area 1 n=642	Area 4 n=815
Solitary	27	18	16	23	0	0	17	18
Pair	19	24	24	41	70	79	27	44
3 - 9	28	52	37	35	23	21	34	36
≥ 10	26	6	23	1	7	0	22	2

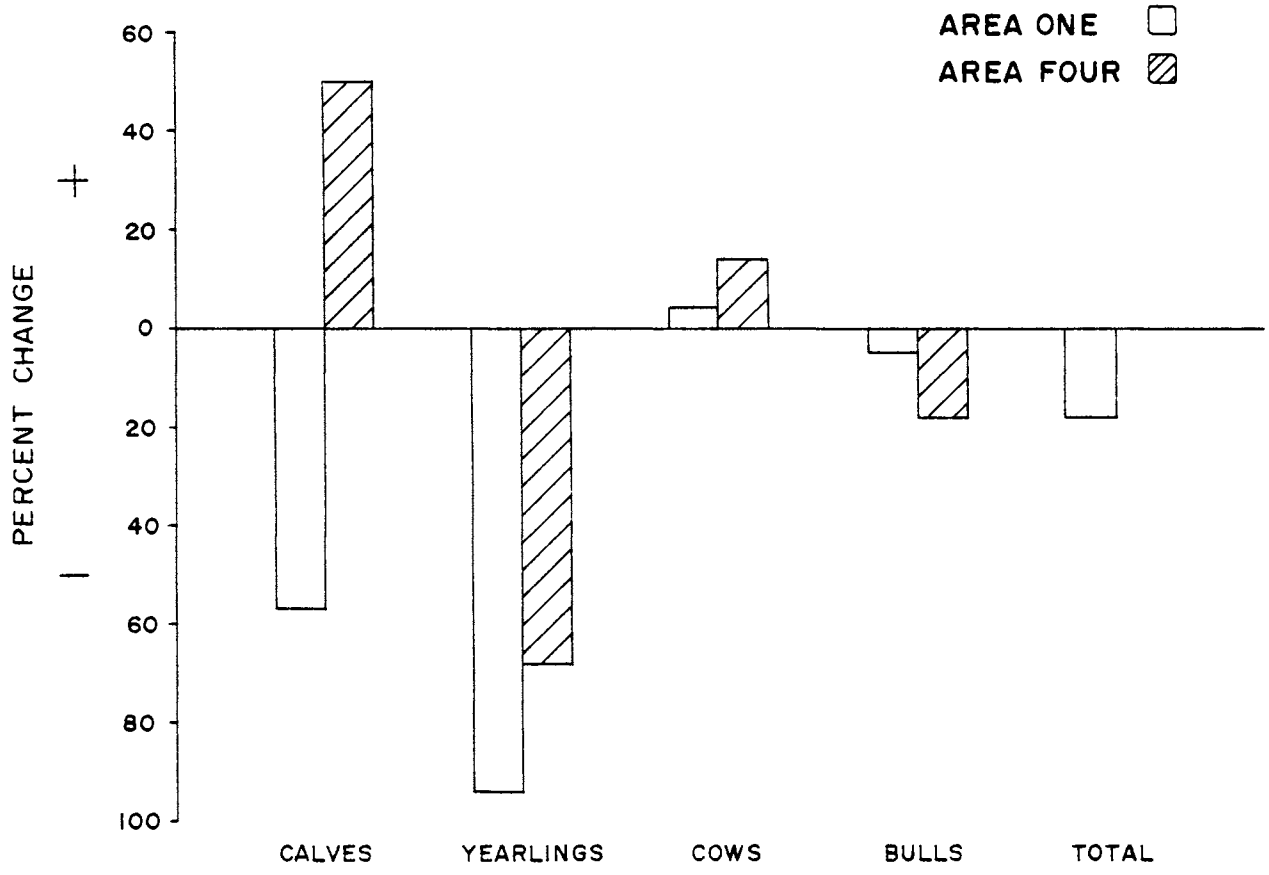

Fig. 2
PERCENT CHANGE IN COHORT SIZES OF MOOSE FROM 1981 TO 1982 IN AREAS ONE AND FOUR

lower in 1982 than 1981. The greatest decrease occurred in the number of yearlings per 100 cows (Figure 3).

Area Four

No significant difference was evident in the size of the estimated moose population between 1981 and 1982 in Area Four. There was, however, a decline in the number of yearlings and adult bulls between the two years (Figure 2). The apparent stability of this population is attributable to increases in the size of the cow and calf cohort. The calf cohort increased by 50%. As expected from the increased number of calves, the ratio of calves per 100 cows increased, while the ratio of yearlings and bulls per 100 cows decreased 73% and 33% respectively (Figure 3).

Combined Survey Areas

When both areas were analyzed together, the overall moose population showed a decline of only 9% between Autumn 1981 to Autumn 1982. All cohorts, with the exception of adult cows, showed declines from 1981-1982. The bull, calf and yearling cohorts declined 12%, 13% and 80% respectively. The size of the adult cow cohort increased by 8%.

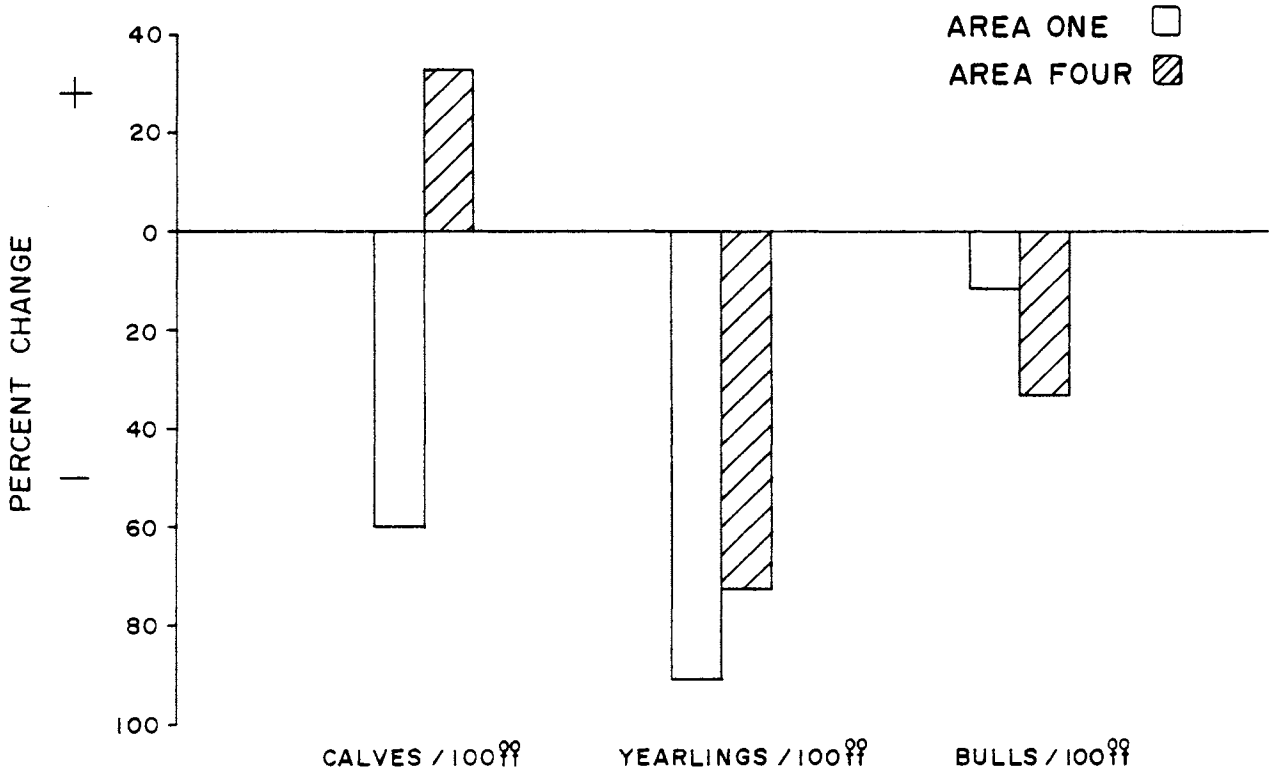

FIG. 3
PERCENT CHANGE IN THE RATIO OF CALVES, YEARLINGS AND BULLS PER 100 COWS FROM 1981 TO 1982 IN AREAS ONE AND FOUR

Mortality Rates

To investigate potential changes in the levels of mortality between Autumn 1981 and Autumn 1982, and between survey areas, the estimated mortality of calves was calculated from parturition to age 6 months, parturition to age 18 months, and from age 6 months to age 18 months.

Mortality rates for calves from parturition to age 6 months and age 18 months were calculated using the mean value from two potential reproductive rates. Reproductive rates were calculated from the mean in-vitreo pregnancy rates of 38 cows live-captured by Yukon Government biologists in Area Four during March 1983. A low reproductive rate of 1.21 calves/cow was calculated from cows known to have at least one calf or twins and a high reproductive rate of 1.31 calves/cow was calculated from cows known to have one calf or twins or strongly suspected of having twins (Larsen, pers. com.).

In this analysis, we have assumed that reproductive rates were similar for cows during 1981 and 1982 and similar for all age classes ($\geq$19 months) of cows. In addition, we have assumed no mortality of adult cows between the Spring of giving birth and the Autumn surveys of each respective year.

The estimated mortality of calves from parturition to age 6 months was 10% higher in Area One and 5% lower in Area Four in 1982 than in 1981 (Table 11). Over the two years, the mean mortality rate of calves to age 6 months was 83.6% $\mp$ 5.9% for the combined survey areas. Rates of mortality for calves born in Spring 1981 to age 18 months was slightly higher in Area One than in Area Four (Table 11).

TABLE 11 Estimated Number and Mortality Rates of Calves at Parturition, 6 Months, and 18 Months of Age in Areas One and Four, for 1981 and 1982.

COHORT	NO. OF MOOSE			
	Area One		Area Four	
	1981	1982	1981	1982
Calves at Parturition	686	711	738	831
Calves age 6 months	119	50	84	126
Calves age 18 months	99	8	102	33
Mortality to 6 months	82.7%	93.0%	88.6%	84.8%
Mortality to 18 months		98.8%		95.5%
Mortality between 6-18 months		93.3%		60.7%

Calculated from the combined survey areas, the mean mortality rate of calves from parturition to age 18 months, was 96.4 ∓ 3.0%. Mean mortality rates of calves overwintering from Autumn 1981 to Autumn 1982 (age 6 months to age 18 months) was 77 ∓ 23%. This mortality rate was 33% higher in Area One than in Area Four.

Habitat

Habitat utilization by moose was measured by two methods. In both Areas One and Four, the number of moose within each habitat class was expressed as a percentage of the total moose within the study area. Although this gives the overall distribution of moose among the habitat classes, it does not allow any measure of the habitat availability versus its utilization by moose. To investigate habitat availability - utilization, Marcum and Loftsgaardens' (1980) non-mapping technique was employed. This technique was used on data from Area Four only.

Distribution of Moose Among Habitat Classes

The distribution of moose within the vegetation classes indicated that, in both study areas, the majority of moose occurred in shrub willow or birch (Table 12). Similarly, the distribution of calves among the vegetation classes was clumped with most calves occurring in the shrub class (Table 12).

In both Areas One and Four, moose occurred in all elevation classes between 762 and 1524 m (Table 13). No moose were observed at elevations lower than 761 m.

TABLE 12 Distribution of Moose and Calves Among Vegetation Classes in Areas One and Four, November 1982.

	VEGETATION CLASS	% OF TOTAL MOOSE Area One	Area Four
All Moose	Shrub	69.9	70.4
	Shrub-Conifer	25.1	24.6
	Conifer	5.0	5.0
	Shrub-conifer-deciduous	0	0
	TOTAL MOOSE	642	815
Calves	Shrub	72.4	65.6
	Shrub-Conifer	27.6	27.8
	Conifer	0.0	6.6
	Shrub-conifer-deciduous	0	0
	TOTAL CALVES	49	126

TABLE 13 Distribution of Moose and Calves Among Elevation Classes in Areas One and Four, November 1982.

	ELEVATION CLASS (m)	% OF TOTAL MOOSE Area One	Area Four
All Moose	639-761	0	0
	762-944	10.2	3.2
	945-1097	17.0	5.9
	1098-1249	35.8	20.5
	1250-1402	29.7	46.6
	1403-1524	7.3	23.8
	TOTAL MOOSE	642	815
Calves	639-761	0	0
	762-944	4.0	0.0
	945-1097	30.6	12.8
	1098-1249	32.7	26.2
	1250-1402	30.2	39.2
	1403-1524	2.5	21.8
	TOTAL CALVES	49	126

The majority of moose in Area One (66%) and Area Four (67%) occurred at elevations between 1098-1402m - elevations corresponding to the subalpine shrub class. More moose occurred at higher elevations in Area Four than in Area One. Distribution of calves among the elevation classes was similar to that of all moose.

The distribution of moose among the aspect classes was dissimilar between the two areas (Table 14). The majority of moose were on E, NE and S, SE slopes in Area Four, while in Area One, most moose occurred on S, SE and N, NW slopes. Few moose were recorded on flat terrain. The majority of calves occurred on N, NW slopes and N, NE slopes in Areas One and Four respectively.

Habitat Availability - Utilization in Area Four

From the locations of 150 random points, habitat availability was measured for vegetation type, elevation and aspect (Table 15). The predominant vegetation were the shrub and shrub-conifer classes (78%). Only 8% of the area was below 761 m elevation while over 60% of the area was above 1098 m (excludes uninhabitable moose range above 1554 m). The 1098 m contour roughly parallels the ecotone between the conifer and shrub classes. All classes of aspect were approximately equal in availability.

The utilization of the different vegetation classes by moose was non-random. Moose occurred in the shrub class significantly more than expected according to the class's availability (Table 16). The shrub-conifer and conifer classes were used significantly less than their availability.

TABLE 14 Distribution of Moose and Calves Among Aspect Classes in Areas One and Four, November 1982.

	ASPECT CLASS	% OF TOTAL MOOSE Area One	Area Four
All Moose	0-090 (E,NE)	14.3	36.3
	91-180 (S,SE)	30.5	27.5
	181-290 (W,SW)	21.2	15.7
	291-360 (N,NW)	26.5	19.0
	Flat	7.5	1.5
	TOTAL MOOSE	642	815
Calves	0-090 (E,NE)	8.6	42.9
	91-180 (S,SE)	29.8	22.4
	181-290 (W,SW)	20.0	12.2
	291-360 (N,NW)	41.6	20.3
	Flat	0	2.2
	TOTAL CALVES	49	126

TABLE 15 Availability of Vegetation, Elevation and Aspect Classes in Area Four, as Determined by 150 Random Points. Availability as percent of total area.

VEGETATION	%	ELEVATION (m)	%	ASPECT (o)	%
Shrub	45	639-761	8	0-090 (E,NE)	21
Shrub-deciduous	4	762-944	12	91-180 (S,SE)	17
Shrub-conifer	37	945-1097	17	181-290 (W,SW)	18
Conifer	14	1098-1249	21	291-360 (N,NW)	24
		1250-1402	20	Flat	20
		1403-1554	23		

Similarly, calves used the shrub class significantly more and the shrub-conifer-deciduous class significantly less than the class's availability (Table 17).

There was a significant difference between the observed and expected distribution of moose among the elevation classes. Moose occurred at elevations between 1250-1402m more than expected according to the class's availability (Table 16). The lower elevations (639-1097m) were used less than might have been expected from their availability. Similar trends were noted for calves although calves did occur in 945-1097m range in proportion to that class's availability (Table 7).

Moose occurred on north-northwestern slopes significantly more than expected from the class's availability. Flat areas were used less by moose than expected. The remaining aspect classes were found to be used as habitat by moose in equal proportion to their availability (Table 16). A similar trend in use of aspect classes was noted for the calf cohort (Table 17).

TABLE 16 Total Moose - Utilization of Vegetation, Elevation and Aspect Classes in Area Four, November 1982.

VEGETATION		ELEVATION (m)		ASPECT (o)	
Shrub	>	1250-1402	>	291-360 (N,NW)	>
Conifer	<	639-761	<	Flat	<
Shrub-Conifer	<	762-944	<	0-090 (E,NE)	=
Shrub-Deciduous	=	945-1097	<	91-180 (S,SE)	=
		1098-1249	=	181-290 (W,SW)	=
		1403-1554	=		=

Key: > used more than expected according to class's availability
< used less than expected according to class's availability
= used in proportion to class's availability

TABLE 17 Calves - Utilization of Vegetation, Elevation and Aspect Classes in Area Four, November 1982.

VEGETATION		ELEVATION (m)		ASPECT (o)	
Shrub	>	1250-1402	>	291-360 (N,NW)	>
		639-761	<		
Shrub-conifer-deciduous	<	762-944	<	Flat	<
Shrub-conifer	=	945-1097	=	0-090 (E,NE)	=
Conifer	=	1098-1249	=	91-180 (S,SE)	=
		1403-1524	=	181-290 (W,SW)	=

Key: > used more than expected according to class's availability
< used less than expected according to class's availability
= used in proportion to class's availability

DISCUSSION

Population Dynamics

Changes in the dynamics of the estimated moose populations between Autumn 1981 and 1982 were most evident at the survey area level. Although a mean population decline of 9% was estimated for moose in the combined survey areas, in reality, this decline in moose occurred entirely in Area One and was an actual decline of 19%. No decline was evident in the estimated moose population of Area Four. However, in both areas, changes occurred within the population profile between 1981 and 1982.

Changes in the profile of the moose population in Area One appear to be attributable to the high mortality of calves and yearlings, and to a lesser extent, the mortality of adult bulls. Although the mean mortality rate of calves to age 6 months is high, similar values have been recorded in other studies. Mortality rates of 88% were estimated for calves 6 months of age in the central Yukon Territory (Johnston and McLeod 1983). A stable (or declining) moose population in northern Alberta had mortality rates of calves (to 6 months of age) ranging from 65% to 84% (Hauge and Keith 1981) while an expanding moose population in central Alberta had mortality rates of only 35% (Mytton and Keith 1981). Hauge and Keith (1981) suggested that the most important difference between a stable moose population and an increasing population, is the level of calf survivorship.

Overwinter mortality of calves up to 12 months of age was extremely high in this study, averaging 95% over the two survey areas.

Gasaway et al (1983) reported overwinter mortality rates of calves in Alaska ranging from 54 to 95%. In northern Alberta, Hauge and Keith (1981) noted mortality rates of 73% for overwintering calves.

Although both the mortality rates for calves and yearlings are high in this study, we do not know if this is a brief phenomenon or if it is within the normal ranges of mortality for moose in Southern Yukon. The results of Larsen's (1982) study and this study, suggest that moose population dynamics in the southern Yukon Territory, particularly the mortality of calves and yearlings, can be highly variable. Similar variability in mortality rates of calves and yearlings has been noted by Caughley (1977) for ungulates in general.

Habitat Availability - Utilization

During this study, moose were found at high elevations in the shrub vegetation class on N, NW facing slopes, in greater proportion than the availability of these areas. As treeline occurs at 1067-1220 m, these elevations where moose were heavily distributed represent the subalpine vegetation zone, comprised largely of shrub willow and shrub birch. Willow is the preferred and predominant forage of most moose populations (Bryant and Kuropat 1980) and has a high in vitro digestibility (Oldemeyer et al 1977). High quality forage is particularly important in early winter to bulls who must replenish body reserves expended during the rut.

High quality winter forage is critical to moose survival and its availability is limited by snow depth (Le Resche 1974 , Coady 1973, Telfer 1970, Formozov 1969) which both covers browse and impedes mobility of moose. Rolley and Keith (1980) found deep snows and the duration

of winter cold affected subsequent moose productivity. Snow cover was suspected to be responsible for most of the calf mortality during two winters in Alaska (Le Resche 1974).

The distribution of moose on north exposures in greater proportion than the availability of north slopes could be a function of numerous factors; shelter from the south, southeasterly prevailing winds, browse quality and browse availability. In contrast, Proulx (1983) found moose did not prefer a particular exposure during winter in southern Quebec.

SUMMARY

1. The estimated moose population, calculated using a stratified random block design of aerial surveys, was 642 ∓ 115 and 815 ∓ 165 in Areas One and Four respectively. Moose densities were .206 and .193 moose/km^2 in Areas One and Four respectively.

2. A significant decline (19%) occurred in the moose population in Area One between Autumn 1981 and Autumn 1982. This decline was partially attributable to low recruitment into the yearling cohort and high mortality of calves. No decline was noted in Area Four.

3. Composition of the estimated moose population for the combined survey areas was 12% calves, 3% yearlings, 66% cows and 19% bulls. Calves represented 15% of the total moose population in Area Four and only 7% of the population in Area One.

4. Within the survey areas, moose concentrated in specific localities. In Area One, 60% of the moose occurred in 9% of the habitable range. In Area Four, 50% of the moose occurred in 13% of the habitable range.

5. A non-mapping technique for comparing habitat availability and utilization was employed to determine the early winter distribution and use of vegetation, elevation and aspect by moose and calves. Results showed that the moose were distributed disproportionately among the classes of each habitat parameter in Area Four.

6. The majority of moose and the calf cohort occupied areas above treeline at elevations between 1250-1401 m dominated by shrub vegetative cover on north, northwest aspects. It is apparent that physical environmental factors such as the north-south direction of the major valleys, prevailing winds from the south and southeast, and snow conditions, intereact and affect the distribution of moose.

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A P P E N D I C E S

APPENDIX 1 Size and Location of Moose Concentrations in Areas One and Four, November 1982. Sample units with densities 0.39 moose/km^2 are arbitrarily considered as moose concentrations. Locations of sample units are on file at Dept. Renewable Resources, Y.T.G. Total moose represents the census value* or stratification value if not censused.

SAMPLE UNIT #	AREA (KM^2)	TOTAL MOOSE	DENSITY (MOOSE/KM^2)
1-43	13.4	7*	0.5
1-48	11.4	6*	0.5
1-51	9.5	5*	0.5
1-53	15.0	10*	0.7
1-71	11.4	12*	1.0
1-75	9.0	22*	2.4
1-85	20.9	16*	0.8
1-100	20.3	46*	2.3
1-102	22.7	23*	1.0
1-105	18.8	7	0.8
1-108	10.1	37*	3.7
1-114	22.2	41*	1.8
1-121	11.9	40*	3.4
1-150	18.3	21*	1.2
1-167	9.8	4*	0.4
1-202	11.6	14*	1.2
1-203	15.2	22*	1.4
1-209	20.1	28*	1.4
1-213	18.6	22*	1.2
4-39	22.1	25*	1.1
4-40	25.3	31*	1.2
4-41	16.0	8*	0.5
4-45	16.5	19*	1.2
4-47	13.1	5*	0.4
4-63	15.2	6*	0.4
4-66	14.7	14*	1.0
4-67	19.9	18*	0.9
4-75	18.1	7	0.4
4-77	25.5	62*	2.4
4-78	13.2	18*	1.4
4-79	13.4	7	0.5
4-84	15.2	6	0.4
4-87	13.6	7	0.5
4-91	13.9	5	0.4
4-119	17.5	10	0.6
4-122	18.6	6	0.3
4-150	9.8	15	1.5
4-156	14.4	7*	0.5
4-161	19.9	7	0.4

.....cont'd.

APPENDIX 1 (cont'd)

SAMPLE UNIT #	AREA (KM^2)	TOTAL MOOSE	DENSITY (MOOSE/KM^2)
4-166	12.6	6	0.5
4-171	12.1	5	0.4
4-195	19.4	6	0.3
4-210	16.8	17*	1.0
4-213	16.5	10	0.6
4-232	10.1	5*	0.5
4-234	13.9	7*	0.5
4-241	14.7	16*	1.1
4-244	20.8	11*	0.5
4-245	15.7	5*	0.3
4-247	15.5	6*	0.4
4-264	14.4	6*	0.4
4-274	11.6	16*	1.4
4-277	14.4	7*	0.5

APPENDIX 2 Area One - Mammals Observed Incidentally During Aerial Surveys, November 1982. Location of sitings may be obtained upon request from Dept. of Renewable Resources, Government of Yukon.

SPECIES	SEX/AGE COMPOSITION				LOCATION
	Female	Male	Imm.	Total	(Sample Unit #)
Coyote (*Canis latrans*)				1	165
Wolf (*Canis lupus*)				11	73
				5	144
				3	224
				1	53
Red fox (*Vulpes vulpes*)				1	61
				1	76
				1	94
				1	120
				1	230
Grizzly bear (*Ursus arctos*)	1		2	3	100
Wolverine (*Gulo gulo*)				1	25
Dall's sheep (*Ovis dalli*)		3		10	96
		2		6	103
				3	155
				5	217
				7	27

APPENDIX 3 Area Four - Mammals Observed Incidentally During Aerial Surveys, November 1982. Location of sitings may be obtained upon request from Dept. of Renewable Resources, Government of Yukon.

SPECIES	SEX/AGE COMPOSITION Female	Male	Imm.	Total	LOCATION (Sample Unit #)
Coyote				1	117
Wolf				7	145
				4	35
				1	178
				2	243
Red fox				1	1
				1	8
				1	78
				1	181
				1	264
Wolverine				1	61
				1	208
Elk (Cervus elaphus)				1	20
Caribou (Rangifer tarandus)	1	1		2	47
				3	134
				23	195
Mountain Goat (Areamnos americanus)				1	126
Dall's sheep				6	18
				2	36
				24	47
				8	62
				18	66
				7	73
				24	74
				3	87
	7	2		9	90
	1		6	7	123
		2		2	159
		1		1	206
		1		1	261

APPENDIX 4 Area One - Raptors Observed Incidentally During Aerial Surveys, November 1982.

SPECIES	NUMBER SITED	LOCATION (Sample Unit #)
Northern Goshawk (*Accipiter gentilis*)	1	36
Gyrfalcon (*Falco rusticulus*)	1	76
	1	82
	1	209
	1	85
Peregrine Falcon (*Falco peregrinus*)	1	189
Great Horned Owl (*Bubo virginianus*)	1	1
Hawk Owl (*Surnia ulula*)	1	66

APPENDIX 5 Area Four - Raptors Observed Incidentally During Aerial Surveys, November 1982.

SPECIES	NUMBER SITED	LOCATION (Sample Unit #)
Bald Eagle (*Haliaeetus leucocephalus*)	1	17
Gyrfalcon	1	8
	1	30
	2	150
Hawk Owl	1	211


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