Moose (*Alces alces*) Population Dynamics in the Dromedary Mountain Area, Central Yukon Territory

by

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EXECUTIVE SUMMARY

Through the sponsorship of Anaconda Minerals Company and the Government of Yukon, Northern Biomes Ltd. conducted aerial moose surveys in the Dromedary Mountain area of the central Yukon Territory. The study objectives were; to collect baseline information on the size and composition of the moose population during early winter; to assess early winter moose habitat; to define potentially sensitive areas for moose in the area of Anaconda's exploration activities, and to document incidental observations of other wildlife species.

Surveys were conducted from 1-8 December 1982, at a time of year when moose were aggregated and the ground was snow-covered - both factors increasing the visibility of moose by aerial observers. The survey method employed incorporates a stratified random block design which allows for a high degree of precision in the population estimate. This survey method has been successfully employed by Northern Biomes, as well as by the governments of the Yukon and Alaska.

The estimated moose population in the Dromedary Mountain area was 228 $\pm$ 80 moose. Within the 3700 km^2 survey area, this represents a density of .06 moose/km^2 or 1 moose per 16 km^2. Compared to moose densities in the southern Yukon and interior Alaska (estimated using the same sampling technique) the moose density in the Dromedary Mountain area is low. The population composition was comprised largely of cows (65%). Bulls represented 22% of the population, calves represented 10%, and yearlings represented 1%.

Aggregation areas, defined as sample units where the moose density exceeded .3 moose/km^2, represented 2.7% of the survey area and accounted for 17% of the total moose population. The average density within the seven aggregation areas was .6 moose/km^2. Two of the aggregation areas coincide with areas of Anaconda's mineral exploration activities.

Most moose occurred below or at treeline at elevations of 793 - 1249 m asl. Thirty-five percent of the population occurred in the 'shrub-deciduous' vegetation type and 32% occurred in the 'shrub-conifer'. Moose were most common on flat terrain and slopes exposed 181^{o}-270^{o}. Comparing the use of a habitat feature by moose against its availability, it was found that moose used elevations of 793 - 944 m more than expected and elevations of 457 - 639 m less than expected. No exposures were utilized more than expected, yet slopes exposed to 91^{o}-180^{o} and 271^{o}-360^{o} were used less than expected.

Large wildlife mammals other than moose observed in the survey area include woodland caribou and Dall's sheep, of which 28 and 49 were observed respectively.

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Wayne Kale and Ken Gerow assisted with data analysis. Valuable editorial comments were provided by Cathy McEwen. Cathy Macpherson drafted all figures and Kelly Wilkinson typed this report.

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INTRODUCTION

Moose (Alces alces) in the Yukon Territory are a relatively abundant, indigenous wildlife species. Although cursory studies of moose have been undertaken (Lortie and Jack 1975, Foothills 1977, Foothills 1978a, Foothills 1978b), until recently little was known of the actual size or composition of moose populations within the Territory. In the past two years, the Government of Yukon (Larsen 1982) and Northern Biomes Ltd. (Johnston and McLeod 1983a) have conducted intensive moose population inventories in the southern Yukon. However, these studies have been restricted to the south-west and south-central Yukon Territory. Their results and subsequent conclusions can not be extrapolated to represent moose populations in other areas of the Territory.

Anaconda Minerals Company, active in the Dromedary Mountain region of the central Yukon, expressed concern to the Yukon Government for wildlife in the area of their exploration activity. As little was known about wildlife populations in the Dromedary Mountain area, a number of specific wildlife studies were initiated by Anaconda Minerals Company. Northern Biomes Ltd. was contracted to conduct an inventory of moose in the Dromedary Mountain area. This specific study was to provide baseline data on the resident moose population, prior to the discussion of the effects of exploration activity on the population.

The objectives of the moose inventory in the Dromedary Mountain area were to:

1. Collect baseline information on the size and composition of the early winter moose population.

2. Assess early winter habitat use by moose.
3. Define potentially sensitive areas for moose in the area of exploration by Anaconda Minerals Company.
4. Document incidental observations of other wildlife species.

In fulfilling the objectives of the study, Northern Biomes Ltd. employed a survey technique which allows a high degree of precision in the estimation of a wildlife population. The technique has been successfully tried and tested in Alaska (Gasaway et al 1981) and the Yukon (Larsen 1982). In addition, the technique compliments other recent indepth moose inventories in the Yukon (Larsen 1982, Johnston and McLeod 1983a, Johnston and McLeod 1983b).

STUDY AREA

The Dromedary Mountain study area is situated in the south-central Yukon Territory (62^{o} 50'N lat., 134^{o} 45'W long.), approximately 220 km north of Whitehorse (Figure 1). Lying within the Pelly River Ecoregion, the general area is characterized by vegetated rolling hills and plateaus divided by deeply incised broad valleys, boreal forest, and discontinuous widespread permafrost (Oswald and Senyk 1977).

The study area is drained by the Pelly and MacMillan Rivers, tributaries of the Yukon River. Most of the 3700 km^2 area ranges in elevation from 609 m to 1220 m asl, with Dromedary Mountain and two other mountains rising above 1524 m asl. Treeline occurs between 1057 m - 1372 m asl.

White spruce (Picea glauca) and black spruce (Picea mariana) comprise most of the forest cover. Lodgepole pine (Pinus contorta) is less common, representing a young seral community in former burn areas. Paper birch (Betula papyrifera) is common on cooler sites and aspen (Populus tremuloides) and balsam poplar (Populus balsamifera) occur on disturbed sites. The subalpine area is covered extensively with shrub birch (Betula sp.) and willow (Salix spp.) while subalpine fir (Abies lasiocarpa) is encountered at treeline.

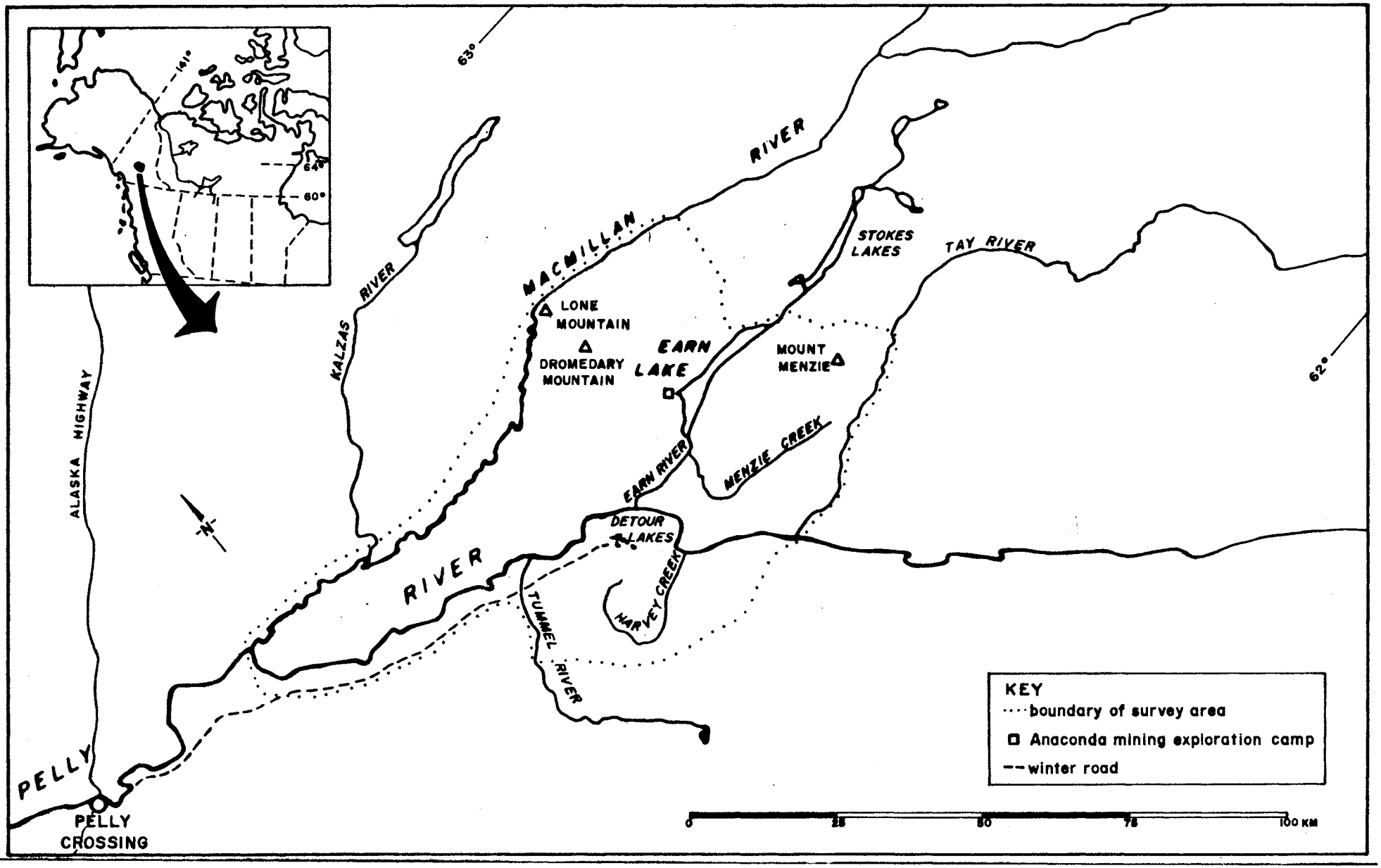

Figure 1. Location of the Dromedary Mountain Study Area in the Central Yukon Territory, December 1982.

Weather

Generally the study area is characterized by a continental climate with mean January temperatures of -27 to -35°C and a mean annual temperature of -4 to -7°C (Oswald and Senyk 1977). Specific weather information for the study area has been extrapolated from the Mayo weather station, 100 km northwest of Dromedary Mountain. Ground snow depth in 1982 was normal, with 19 mm recorded on December 30. The mean temperature in November was normal at -17.6°C yet the December mean temperature of -19.7°C was slightly warmer than normal (Atmospheric Environment Service 1983).

METHODS

Population Estimate

The aerial moose survey of the Dromedary Mountain area was conducted over an eight day period from 1-8 December 1982.

The technique employed for obtaining the moose population estimate was similar to the stratified random block sampling technique described by Gasaway et al (1981) incorporating modifications by Larsen (1982). This technique was chosen as it minimizes bias in the population estimate and gives a measure of the precision of the population estimate. Its use in Alaska (Gasaway et al 1981) has proven very successful for most terrain and habitats occupied by moose in Alaska which is very similar to the terrain in the Yukon Territory.

Moose inhabit a variety of ecotypes from boreal forest to subalpine. Early winter or the post-rut period is the most successful time of the year for obtaining an accurate moose population estimate. It is during this time that the clumped nature of the post-rut moose aggregations and their location in the more open, snow-covered subalpine habitat enhance their visibility by observers. However, the technique allows only a point estimate of habitat use and distribution during the period of the survey. Habitat use and distribution of moose cannot be extrapolated to other times of the year from this technique.

Briefly, the population survey technique involves two phases: stratification and census. Stratification involves a cursory aerial survey of the entire study area. Its purpose is to stratify the sample units (S.U.) of the

study area into similar moose density classes or strata. The census is a thorough count of moose within randomly selected S.U.'s from each density stratum.

Prior to the aerial survey, the study area was divided into S.U.'s averaging 13.5 km^2 in size. The S.U. boundaries were drawn onto 1:50,000 scale topographic maps using physiographic and physiognomic features (river drainages, lakes, ridges, peaks and treeline) wherever possible. Effort was made to draw boundaries which encompassed homogeneous moose density habitats. Waterbodies greater than .8 km^2, areas above 1524 m and extremely precipitous slopes were excluded from the survey area, as these areas are essentially uninhabited by moose.

During stratification, two fixed-wing aircraft (Cessna 185 and Cessna 206) were flown simultaneously while stratifying different sections of the study area. Each aircraft contained three experienced observers plus the pilot. Passes over each S.U. were made at 90 to 100 m above ground level (agl) at a speed of 130 kph. The stratification phase required 19.5 hours of air time (at a rate of .33 min/km^2) over a five-day period. During two of the five days uncooperative weather conditions prohibited any flying.

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.

From the stratification flights the S.U.'s were classified into respective strata on the basis of their observed moose density. For the Dromedary Mountain

area, three moose density strata were identified: medium (≥2.0 moose/km^2), low (tracks or < 2.0 moose/km^2) and extremely low (absence of moose or moose tracks).

The census flights were flown immediately after the stratification using two Bell 206 helicopters, each with three observers plus pilot. The two helicopters worked simultaneously in different parts of the study area.

At the start of each S.U. census, the boundaries were clearly identified. In flat terrain, short transects were flown across the S.U. at approximately .4 km intervals,while in mountainous terrain, the flight paths often followed contours generally moving downslope until the S.U. was completely surveyed. During the census, the helicopters were flown between 30 - 150 m agl and at speeds of 50 - 130 kph depending on weather conditions and topography. The mean time spent within each S.U. was 20 minutes with a mean search intensity of 2.5 minutes/km^2.

Within S.U.'s censused, each observed group of moose was assigned a unique number and the group's location was plotted onto a 1:50,000 scale topographic map. Bull moose were sexed by the presence of antlers, or if antlers were not present, by the antler scars. When antlers were present, males were further classified into yearlings and adults based on antler morphology (Dubois et al 1981). Cows were sexed and identified by the presence of a white vulva patch. Calves were identified by body size and association with a cow.

Habitat

Habitat features were recorded concurrently with each moose observation during the census phase. Two levels of vegetation information were collected. The first level was site specific in which the dominant vegetation immediately surrounding each moose aggregation was noted. The second, more general level of classification encompassed the vegetation of the entire S.U. In addition, the elevation and aspect of each moose observation location were measured from the topographical survey maps.

Each habitat parameter (vegetation, elevation, aspect) was divided into respective classes. To determine the early winter habitat use of moose in the Dromedary Mountain area, the percent occurrence of moose in each habitat class was calculated.

In addition, a non-mapping technique for determining habitat availability versus its utilization (Marcum and Loftsgaarden 1980) was applied in the Dromedary Mountain area to determine significant patterns in moose distribution with respect to elevation and aspect. The vegetation classes were eliminated from this analysis since vegetation classification maps for this area do not yet exist. In order to estimate the proportion of habitable moose range available in each elevation and aspect class, 110 random points defined by grid reference locations within the study area boundaries were selected. Elevation and aspect for each of the random locations was measured from 1:50,000 scale topographical maps.

A Chi-square goodness-of-fit test was performed on each habitat parameter to determine if there was any significant difference in the observed distribution of moose among the respective habitat classes and the expected distribution, as determined by the random points.

If the Chi-square value was significant, the null hypothesis (that moose followed an expected distribution pattern) was rejected. The Bonferroni Z statistic 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 habitat class's availability.

The equation used to construct the simultaneous confidence intervals was:

$$P_1 i - P_2 i \pm Z(1-\alpha/2K)\sqrt{P_1 i(1-P_1 i)/n_1 + P_2 i(1-P_2 i)/n_2}$$

where $P_1 i$ was the proportion of random points observed, $P_2 i$ was the proportion of moose observed, n_1 was the total number of random points, and n_2 was the total number of moose observed (Marcum and Loftsgaarden 1980).

RESULTS

Sampling Intensity

After the stratification of the entire study area, a total of 49 S.U.'s were censused to derive the moose population estimate (Table 1). Variance in the moose estimate was highest in the low strata, thus the greatest amount of sampling effort was devoted to that strata where 37 S.U. were censused. Proportionately, 100% of the medium strata, 18% of the low strata and 11% of the extremely low strata were sampled. Among all strata, 19% of the S.U.'s were censused. Regardless of the stratum, all S.U.'s were sampled with similar intensity averaging 1.5 minutes of search time/km^2.

Population Density

A population of 228 ± 80 moose was estimated for the Dromedary Mountain area (Table 2). This represents a small population relative to other moose populations in areas of similar size in the southern Yukon (Larsen 1982, Johnston and McLeod 1983a). The density of moose in the Dromedary Mountain area was 0.06 ± 0.02 moose/km^2, or 1 moose per 16 km^2 of habitable moose range. Confidence intervals associated with the total moose estimate and particularly confidence intervals around individual cohort estimates are considerably wider than obtained in surveys of moose elsewhere in the Yukon (Larsen 1982, Johnston and McLeod 1983a, Johnston and McLeod 1983b). However, the small size of the moose population precludes a population estimate of greater precision given the sampling technique, time available, and cost constraints.

TABLE 1 Total Area of Habitable Moose Range and the Number of Sample Units Censused by Strata in the Dromedary Mountain Area, December 1982.

	STRATA			
	Medium	Low	Extremely Low	Total
Total S.U.	7	210	46	263
Censused S.U.	7	37	5	49
% S.U. Censused	100	18	11	19
Total Area (km^2)	97	2872	579	3548
Censused Area (km^2)	97	491	54	642
% of Area Censused	100	17	9	18

TABLE 2 Estimated Total Number, Density and Composition of Moose in the Dromedary Mountain Area, December 1982. Confidence interval for yearlings was not calculated.

	BULLS	COWS	YEARLINGS	CALVES	TOTAL
Total Number	55	149	2	22	228
90% CI	36-76	98-213	-	2-41	147-308
Relative CI (%)	36	42	-	91	35
Density (moose/km^2)	.016	.042	.001	.006	.064
Age/Sex Composition (%)	24	65	1	10	100

Age and Sex Structure

During the actual census of S.U., moose were classified either as yearling bulls, adult bulls, cows or calves. To estimate the number of yearling cows in the population, it was assumed that yearling cows were represented in equal proportion to yearling bulls. Subtraction of the estimated number of yearling cows from the total number of cows observed, yielded the number of adult cows. Adult cows and adult bulls represented 89% of the moose population. Adult cows alone represented 65% of the population. Yearlings, including males and females, represented 1% while calves represented 10% of the population (Table 2).

As an index of productivity and relative stability of the population (with respect to other documented moose populations), the number of adult bulls, yearlings (males and females), and calves were standardized as the number per 100 cows. The calculated numbers then were 37, 1, and 15 bulls, yearlings and calves respectively per 100 cows.

Spatial Distribution

During the post-rutting and early winter period, a large proportion of a moose population may aggregate into mixed age and sex groups in relatively small areas (Peek et al 1974). These small geographical areas, defined here as aggregation areas, were arbitrarily delineated in this study by the specific S.U.s' boundaries, in which a density of at least 0.3 moose/km^2 occurred. Aggregation areas represent areas in which, for extrinsic and intrinsic behavioural reasons, moose concentrate. Sociability of moose is presented as

the relative occurrence of moose into groups of single, paired, or 3-9 animals. Groups are defined as moose, whose close proximity to one another, implied some social interaction.

Aggregation Areas

A total of 7 aggregation areas were identified in the study area (Table 3). Moose density within aggregation areas averaged 0.6 moose/km^2, a density 10X greater than the average moose density for the entire study area. Absolute numbers of moose within aggregation areas ranged from 4 to 15 moose and averaged 8.7 moose. Aggregation areas represented merely 2.7% of the total survey area, yet contained 17% of the total moose population. The age and sex composition of these moose aggregations differed from the composition of the entire population. In the aggregation areas there were proportionately fewer cows (58% vs 65%) and calves (7% vs 10%) and more bulls (35% vs 25%) than in the entire population.

Locations of aggregation areas are plotted in Figure 2. Specific moose aggregations which occurred in the vicinity of mineral exploration activity by Anaconda Minerals Company are aggregations #178 and #211. These two aggregations, one located on the north side of Dromedary Mountain between 762-1067 m asl and the other between Dromedary Mountain and Crystal Peak on the Dromedary Creek Valley, contained 5 and 15 moose respectively (Table 3). Other aggregations occurred along the floodplain of the MacMillan River (#145 and #184), adjacent to Mount Menzie at an elevation of 1067-1372 m asl (#108), 10 km east of Crystal Peak in an old burn (#221) and 5 km south of the MacMillan River in an area of sloughs and open boreal forest (#78).

TABLE 3 Total Number and Density of Moose Occurring in Aggregation Areas in the Dromedary Mountain Area, December 1982. Aggregation areas are S.U.'s with 0.3 moose/km^2.

LOCATION (S.U.)	AREA OF S.U. (km^2)	TOTAL MOOSE	DENSITY ($moose/km^2$)
78	10.6	4	0.4
108	9.1	4	0.4
145	18.4	5	0.3
178	14.8	6	0.4
184	12.4	15	1.2
211	18.9	15	0.8
221	12.2	12	1.0
TOTAL	96.4	61	
MEAN	13.8	8.7	0.6

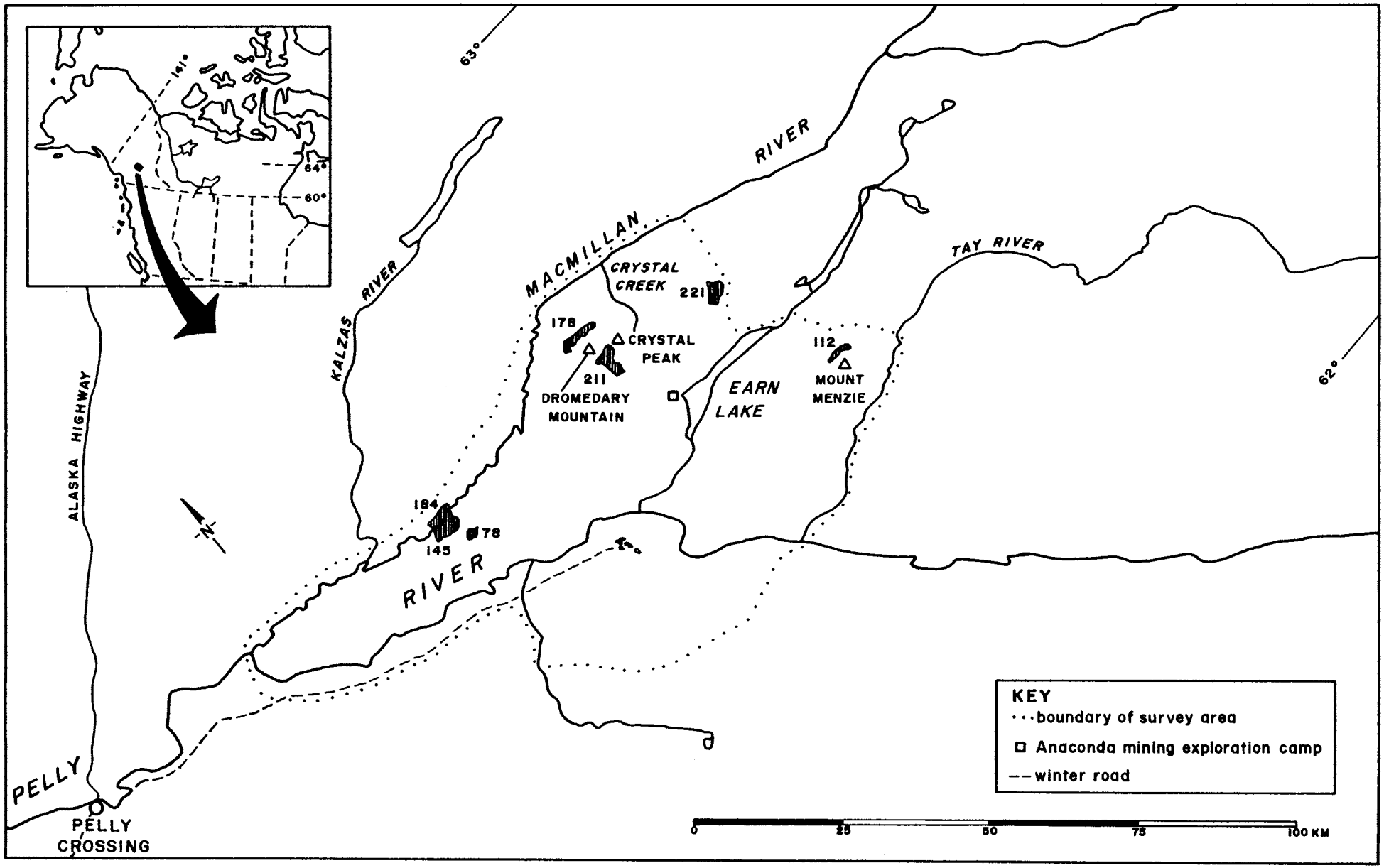

Figure 2. Aggregation Areas of Moose in the Dromedary Mountain Study Area, December 1982.

Group Size

All moose including moose in aggregation areas, were either solitary or associated in small social groups (Table 4). Calves were associated only with their respective mothers. Cows, including cows with calves, occurred predominantly (81%) as pairs or as single animals. Bulls occurred most often (50%) as single animals. Overall, only 17% of the moose population occurred in groups larger than 3 moose. The largest group observed was 4 mature bulls.

Habitat Use

In general, moose in the Dromedary Mountain area occupied areas of medium to low elevations rather than the higher elevations above 1250 m asl (Table 5). Most moose (70.6%) occurred at elevations between 793-1249 m asl. Calves were most common at elevations between 793-944 m asl. Cows and bulls used six of the seven elevation classes, unlike calves which used only four of the seven classes (Table 5).

The most commonly used vegetation classes by moose were 'shrub-deciduous' and 'shrub-conifer' (Table 6). Differences in the use of the vegetation types are evident among the different sexes and ages. Calves were most common (68%) in the 'shrub-deciduous'. Similarly, cows were common in this vegetation category, yet used the entire range of vegetation types available (Table 6). Bulls were most common in the 'shrub-conifer'.

Forty percent of the moose occupied flat areas and 37% occurred on slopes exposed at 181^{o}-270^{o} (Table 7). These values reflect the predominant use of these exposures by both bulls and cows. Calves were also most common (59%)

TABLE 4 Relative Group Size of Moose by Age and Sex in the Dromedary Mountain Area, December 1982.

GROUP SIZE	BULLS* (n=56) %	COWS* (n=150) %	CALVES (n=22) %	TOTAL (n=228) %
Solitary Moose	50	38	0	36
2 Moose	31	43	100	46
3-9 Moose	19	19	0	17

* includes yearling moose

TABLE 5 Distribution of Moose By Age and Sex Among the Available Elevation Classes in the Dromedary Mountain Area, December 1982.

ELEVATION CLASS (m)	BULLS (n=56) %	COWS (n=150) %	CALVES (n=22) %	TOTAL (n=228) %
457-639	20	9	9	12
640-792	5	16	27	14
793-944	14	36	55	33
945-1097	38	11	9	17
1098-1249	12	27	0	20
1250-1402	0	1	0	1
1403-1524*	11	0	0	3

*areas beyond 1524 m asl not surveyed

on flat terrain, yet tended to also use slopes exposed at 91^{o}-180^{o}.

A more comprehensive analysis of habitat utilization incorporating the relative availability of the habitat, indicated significant differences in the use of elevation and aspect by moose relative to the habitat's availability (Table 8). Moose utilized elevations between 793-944 m more than expected according to the elevation class's availability, while elevations between 457-639 m were used less frequently than expected. All other elevation classes were used in equal proportion to their availability.

Slopes exposed at 271^{o}-360^{o} and 91^{o}-180^{0} were used less frequently than expected, while the remaining exposures were used in equal proportion to their availability.

TABLE 6 Distribution of Moose by Age and Sex Among the Available Vegetation Classes in the Dromedary Mountain Area, December 1982.

VEGETATION CLASS	BULLS (n=56) %	COWS* (n=150) %	CALVES (n=22) %	TOTAL (n=228) %
Shrub	27	8	5	13
Deciduous	11	4	0	5
Conifer	7	16	0	12
Shrub-Conifer	52	25	27	32
Shrub-Deciduous	3	43	68	35
Other	0	4	0	3

* includes yearlings

TABLE 7 Distribution of Moose by Age and Sex Among the Available Aspect Classes in the Dromedary Mountain Area, December 1982.

ASPECT (o)	BULLS (n=56) %	COWS (n=150) %	CALVES (n=22) %	TOTAL (n=228) %
0-90	0	7	9	6
91-180	2	9	27	9
181-270	43	39	5	37
271-360	18	6	0	8
Flat	37	39	59	40

TABLE 8 Utilization of Aspect and Elevation by Moose in the Dromedary Mountain Area, December 1982.

ASPECT (o)	UTILIZATION	ELEVATION (m)	UTILIZATION
		457-639	<
0-90	=	640-792	=
91-180	<	793-944	>
181-290	=	945-1249	=
291-360	<	1250-1402	=
Flat	=	1403-1524	=

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

A moose density of 0.06 moose/km^2 as found in this study is very low. Moose population studies in other areas of the Yukon Territory, in Alaska and northern Alberta, report considerably higher population densities. In the Haines Junction - Whitehorse area of the Yukon Territory, the moose density during fall 1981 was 0.17 moose/km^2 ranging from .11 to .27 moose/km^2 among four individual survey areas (Larsen 1982). Similar densities of moose were noted during surveys of two of these areas in 1982 (Johnston and McLeod 1983a). Moose densities documented in northern Alberta ranged from 0.18 to 0.24 moose/km^2 over a 3 year study period (Hauge and Keith 1981). In the interior of Alaska, between the years 1954 to 1978, moose densities ranged from 0.2 moose/km^2 to 1.5 moose/km^2 (Gasaway et al 1983).

As no previous fall population estimates have been made of moose in the Dromedary Mountain area, we do not know if this moose population has traditionally been at such a low density. However, we do know from surveys conducted by Lortie and Jack (1975) that high concentrations of moose occur along the Pelly and MacMillan river valleys in late winter. They estimated 123 moose wintering in riparian habitat along the Pelly River from the Tummel River to the mouth of the MacMillan River, and an additional 55 moose on the MacMillan River from its confluence with the Pelly River, upriver approximately 32 km. These numbers represented a density of 5.3 moose/km^2. Although these moose estimates represent extrapolated values using a different aerial survey technique than ours, the corresponding high densities signify the importance of the area as late-wintering habitat for moose.

The low density of moose in the Dromedary Mountain area may be related to the relatively low number of calves and yearlings in the population. Both their relative numbers and indices of calves and yearlings per 100 cows are much lower than the respective values from the southern Yukon (Larsen 1982, Johnston and McLeod 1983a). However, even in the southern Yukon, the percent of calves and yearlings in the population and the number/100 cows are much lower than expected in comparison with moose populations in Alaska and Alberta.

Larsen (pers. com.) suggested that predation of calves and yearlings by wolves or bears may be causing high mortality rates, thus depressing the size of moose populations in the southern Yukon. A similar trend may be occurring in the Dromedary Mountain area. Although wolves and bears may be causing high mortality rates, there is evidence to suggest (unpublished data from Kluane National Park 1974-1981) that the average reproductive rates for moose in the Yukon are generally low (Larsen 1982). Perhaps a number of environmental factors (poor forage quality and severe winter conditions), or higher than normal hunting pressure combined with the normally high calf and yearling mortality, have had a synergistic effect in the past 2-3 years, thus causing a recent, widespread decline in moose populations in the Yukon.

If we assume that the low productivity and density of moose in the Dromedary Mountain area is a reflection of a recent population decline, and if we further assume that a larger moose population is beneficial (in terms of the Yukon Government's management objectives), then any further perturbations to moose productivity, such as exploration activities, may be cause for concern. Early winter concentrations of moose do occur in the vicinity of mineral ex-

ploration activity, however the effects of exploration activity on moose productivity or distribution is not known. Additionally, we do not know if moose occur in the Dromedary Mountain area during the time Anaconda Minerals Company is active in the area. Further studies are needed to determine if this population of moose is indeed in a decline phase and whether exploration and development activities could be a detriment to the stability of the population in the long term.

LITERATURE CITED

Atmospheric Environment Service. 1983. Department of Environment Canada, Whitehorse.

Dubois, S., W. Gasaway, D. Roby. 1981. Aerial classification of bull moose on antler development. Unpubl. Rept. Alaska Department of Fish and Game, Fairbanks.

Foothills Pipe Lines (Yukon) Ltd. 1977. Winter ungulate surveys along the proposed Foothills Pipeline Route (Yukon). Prep'd. by Beak Consultants Limited. 23 p.

Foothills Pipe Lines (Yukon) Ltd. 1978a. Summer-Fall mammals studies 1977, Alaska Highway Pipeline Route. Prep'd. by Beak Consultants Limited. 23 p.

Foothills Pipe Lines (Yukon) Ltd. 1978b. Yukon winter ungulate studies 1978, Alaska Highway Pipeline Route. Prep'd. by Beak Consultants Limited. 17 p.

Gasaway, W., S. Dubois and S. Harbo. 1981. Estimating moose abundance and composition. Alaska Department of Fish and Game Manual, Fairbanks, Alaska. 62 p.

Gasaway, W., R. Stephensen, J. Davis, P. Sheperd and O. Burris. 1983. Interrelationships of wolves, prey and man in Interior Alaska. Wildl. Monogr. 84. 50 p.

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

Johnston, W.G. and H.A. McLeod. 1983a. Population dynamics and early winter habitat utilization by moose (Alces alces) in the South-West Yukon. Prepared by Northern Biomes Ltd. for the Yukon Territorial Government. 53 p.

Johnston, W.G. and H.A. McLeod. 1983b. Population dynamics and habitat distribution of Moose (Alces alces) in the Yukon River Basin Drainage. Prepared by Northern Biomes Ltd. for the Yukon River Basin Study. In prep.

Larsen, D.G. 1982. Moose inventory in the southwest Yukon, Alces 18: 142-167.

Lortie, G. and J. Jack. 1975. The Granite Canyon Dam proposal. A preliminary ecological reconnaissance of the impoundment area. Dept. of Renewable Resources, Yukon Territorial Government.

Marcum, C.L. and D.O. Loftsgaarden. 1980. A non-mapping technique for studying habitat preferences. J. Wildl. Manage. 44(4): 963-968.

Oswald, E.T. and J. Senyk. 1977. Ecoregions of the Yukon Territory, Can. For. Serv. 115 p.

Peek, J.M., R.E. LeResche and D.R. Stevens. 1974. Dynamics of moose aggregations in Alaska, Minnesota and Montana. J. Mammol. 55(1): 126-137.

APPENDICES

APPENDIX 1 Dromedary Mountain Area - Mammals Observed Incidentally During Aerial Surveys, December 1982. Location of sitings may be obtained upon request from the Yukon Government's Department of Renewable Resources.

SPECIES	NUMBER SITED	LOCATION (S.U.#)
Red Fox (*Vulpes vulpes*)	1	125
	1	146
	1	184
Dall's Sheep (*Ovis dallii*)	3	20
	3	22
	7	28
	1	29
	6	90
	2	153
	20	171
	7	172
Woodland Caribou (*Rangifer tarandus*)	2	36
	4	109
	15	113
	3	196
	4	240

APPENDIX 2 Dromedary Mountain Area - Raptors Observed Incidentally During Aerial Surveys, December 1982.

SPECIES	NUMBER SITED	LOCATION (S.U.#)
Northern Goshawk (*Accipiter gentilis*)	1	13
Gyrfalcon (*Falco rusticolus*)	1	9
	1	118
Great Grey Owl (*Strix nebulosa*)	1	182
	1	203