MOOSE POPULATION RESEARCH AND MANAGEMENT STUDIES IN YUKON

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MOOSE POPULATION CHARACTERISTICS
IN THE NORTH CANOL AND
FRANCES LAKE AREAS,
NOVEMBER 1987

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1988

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ABSTRACT

Moose were censused in two different areas near Ross River in east central Yukon using a stratified random block technique during aerial surveys between 7-23 November, 1987. The density of moose was similar (0.19 moose/km^2) in both the North Canol and Frances Lake areas. Moose demography in both areas was characterized by excellent calf survival (64 and 69 calves/100 cows) and yearling recruitment (54 and 65 yearlings/100 cows, respectively). The large proportion of young cohorts observed suggests an expanding moose population. The timing and extent of this population growth is likely related to a concurrent wolf removal program that was initiated in 1983 on the range of the Finlayson Caribou Herd. Previous surveys of moose in the area, the timing of the wolf removal, and the unprecedented ratios of calves and yearlings observed suggest a strong relationship between reduced wolf numbers and improved calf survival and yearling recruitment in moose. Current harvest rates by native and non-native hunters remove between 7-9% of the moose population (calves excluded) in the two survey areas. Lower harvest rates (about 4%) are evident when calculated over the larger area of wolf removal. The efficiency of a helicopter versus a fixed-wing aircraft (PA-18 Supercub) was compared during the census portion of the survey. Counts of moose were identical in 5 of the 9 sample units compared and the total moose count from the Cub was within 95% of the helicopter count.

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INTRODUCTION

Between 1981-1984, moose survey efforts were concentrated in southwestern Yukon where populations were censused annually in areas of relatively heavy hunting pressure (Larsen, 1982; Johnston and McLeod, 1983; Markel and Larsen, 1983, 1984, 1985). Moose demography in these areas was characterized by low calf survivorship (6-24 calves/100 cows) and local population declines. Predation by grizzly bears and wolves appeared to be the major cause of calf and adult cow mortality (Larsen et al., 1987).

In 1986, the inventory program was extended to include additional priority areas that currently receive significant pressure from both native and non-native hunters. The objective is to gain a Yukon-wide perspective of moose population abundance, distribution, and composition which can be used to identify areas with a harvestable surplus of moose. Areas surveyed in 1986 included the Nisutlin River Valley and an area east of the Liard River and Watson Lake (Jingfors and Markel, 1987). Unlike southwestern Yukon, these areas were characterized by good calf survival and yearling recruitment (49-51 calves/100 cows and 36-37 yearlings/100 cows).

In 1987, two areas near Ross River were selected: one along the North Canol Road and the other around Frances and Finlayson Lakes, along the Robert Campbell Highway. Both areas were identified based on hunting pressure and both areas have also been under the influence of wolf control since 1983 in efforts to facilitate the recovery of the Finlayson Caribou Herd (Hayes and Farnell, 1985; Farnell and McDonald, 1988).

Reported here are moose population characteristics and harvest data from the North Canol and Frances Lake areas. The results also include a preliminary evaluation of the utility of a fixed-wing aircraft (PA-18 Supercub) during the census portion of the moose surveys.

SURVEY AREA

1. North Canol

The North Canol survey area includes parts of Game Management Subzones (GMSs) 4-39, 4-40, 4-49, 11-02 and 11-06 to 11-08 for a total of 3050 km^2. After excluding areas above 1470m (5000 feet) and water bodies larger than 1 km^2, the area of habitable moose range measured 2744 km^2, or 90% of total area. This does not include an extended stratification area of 696 km^2 in the southeastern portion of the survey area that was stratified but not censused (Fig. 1).

Following Oswald and Senyk (1977), the North Canol area is characterized by rolling upland plateaus and small mountain groups dissected by broad U-shaped valleys. Vegetation at lower elevations is dominated by open black spruce (*Picea mariana*) forest which is replaced by white spruce (*P. glauca*) and aspen (*Populus tremuloides*) on drier sites. Treeline occurs between 1350-1550m and the subalpine shrub zone is characterized by alpine fir (*Abies lasiocarpa*), willow (*Salix* spp.) and shrub birch (*Betula* spp.). Precipitation follows a pattern of moderate levels in the southwest increasing eastward and towards higher elevations in the MacKenzie Mountains. Late winter snow depths can vary from about 50 cm near Ross River to 95 cm near the NWT-Yukon border (Markel and Larsen, 1986).

The distribution, composition and relative abundance of moose along the North Canol was surveyed during fixed-wing, stratification-type flights in late fall of 1981 and late winter of 1982 (Markel and Larsen, 1986).

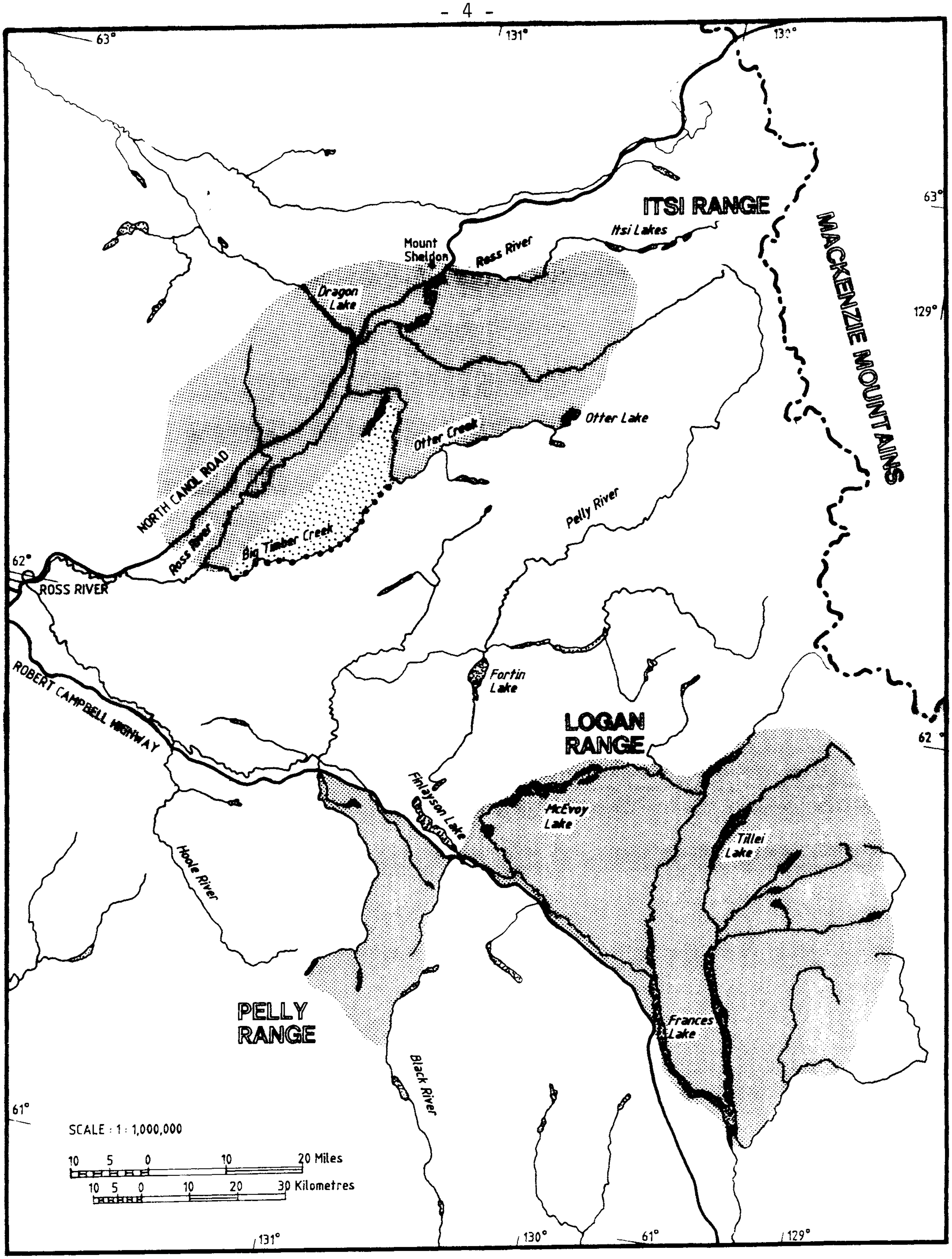

Figure 1. Location of areas surveyed for moose in November 1987.

2. Frances Lake

The Frances Lake survey area includes parts of GMSs 10-07, 11-16, 11-17, 11-20, 11-21 and 11-23 for a total area of 4936 km^2. The corresponding area of habitable moose range measured 3894 km^2 (79%). The relatively smaller proportion of habitable moose range in this area compared with North Canol is due to the presence of larger lakes (eg. Frances Lake, Tillei Lake) and more mountainous terrain (eg. Pelly Mountains in the south and Logan Mountains in the east) in the Frances Lake area (Fig. 1).

Most of the Frances survey area is located north of the Robert Campbell Highway (Fig. 1). Extensive areas with closed stands of black spruce, white spruce, and lodgepole pine (*Pinus contorta*) are common near Frances Lake and along its major drainages. A more open canopy is evident at higher, and drier, elevations where white spruce and aspen dominate. Tree line occurs between 1350-1550m (Oswald and Senyk, 1977) where large patches of shrub birch and willow can be found in protected areas, especially in the Pelly Mountains south of the highway. Precipitation is generally considered moderate and does not reach amounts similar to the heavy snow areas of the Itsi Range (Oswald and Senyk, 1977).

No systematic moose surveys have previously been done in the Frances Lake area. Some information on late winter composition of moose (calves versus adults) is available from reconnaissance-type surveys during the wolf control program in the area (Hayes and McDonald, unpubl. data).

METHODS

Aerial surveys were conducted between 7-16 November, 1987, in the North Canol area and between 18-23 November, 1987, in the Frances study area. This time period is preferred for moose surveys in Yukon due to the aggregation behaviour of moose in open habitats during, and immediately following the rut (Peek et al., 1974; Lynch, 1975; Rounds, 1978; Mytton and Keith, 1981). In addition, the ground is covered with snow by early November. Both of these factors increase moose sightability during aerial surveys (Gasaway et al., 1986). The presence of antlers on most bulls to early or mid-December facilitates the sexing of moose from aircraft.

To estimate moose abundance and composition, a stratified random block sampling technique was used (Gasaway et al., 1986). Briefly, the technique involves the stratification of blocks, or sample units (SUs), based on moose densities observed during an initial reconnaissance survey in fixed-wing aircraft (Cessna 185, Maule or similar). The stratification is followed by a census, or exhaustive search, of randomly selected SUs in each density stratum. In Alaska, the census portion is done with several PA-18 Supercubs. In Yukon, helicopters (Bell 206) have been used for the census to accommodate the windy conditions and mountainous terrain characteristic of southwestern Yukon where most earlier moose surveys were done (Larsen, 1982).

To evaluate the utility of Supercubs during moose surveys in other areas of the Yukon, one Cub (Piper PA-18 (150) Supercub) and one helicopter surveyed the same SUs during the census portion of the North Canol area. To reduce the possibility of moose movements between aircraft trials, while maintaining adequate safety margins, the Cub completed the census of a SU before the helicopter started surveying the same unit. The period between aircraft trials was kept as short as possible. In the Supercub, the pilot also acted as navigator and recorded moose observations on 1:50,000 maps while the rear-seat passenger acted strictly as an observer. Three different, experienced observers (over 800 hours of survey flying each) were used in the Supercub during the trials. In the helicopter, the front-seat passenger acted as navigator/observer while the rear-seat passengers acted as observers. The combined experience of the helicopter crew was at least as good as that of the pilot and observer in the Supercub. Search patterns during the census varied from parallel, overlapping transects and following contour lines to tight circling, depending upon the terrain and wind. The location of each moose (or group) observed was plotted and later compared for each SU surveyed by both the Supercub and helicopter.

Moose observations included information on the number of animals in each aggregation, their sex and age (calves, yearlings and adults). Sex was determined by the presence or absence of antlers and vulva patch (Mitchell, 1970). Males were further classified into small bulls (yearlings) or large bulls (adults) based on antler morphology (DuBois et al., 1981; Oswald, 1982). A 35mm camera was used to document the variability in antler development among yearling bulls. Yearling cows (18 months old) could not be reliably identified in the field but were assumed to occur in the population in the same proportion as yearling bulls.

A population estimate with associated variance was determined for each stratum within the survey area using a ratio estimator (Gasaway et al., 1986). The overall population estimate, as well as composition, was obtained by adding stratum estimates and variances together. A 90% confidence interval (CI) that fell within 20% of the overall population estimate was considered an acceptable level of precision. The density of moose was calculated based on habitable moose range.

To gain a wider perspective of moose distribution and relative abundance, stratification flights in the North Canol area were extended to include an additional area neighbouring the main survey area (dotted line in Fig. 1). After all SUs in this area had been stratified by moose density, the proportion of each density stratum (low, medium or high) in the extended stratification area was then compared with the larger survey area. No extended stratification flights were flown in the Frances Lake area.

RESULTS AND DISCUSSION

Survey Design

Search and Sampling Intensity

During the fixed-wing stratification, search intensity averaged 0.44 min/km^2 in the North Canol area and 0.31 min/km^2 in the Frances Lake area. Search intensity during the census increased to a mean of 1.8 min/km^2 and 1.5 min/km^2, respectively. These search intensities are comparable to those of previous surveys (Jingfors and Markel, 1987; Markel and Larsen, 1984).

The proportion of all SUs surveyed varied from 35% along the North Canol to 22% in the Frances area (Table 1). Part of the reason for the higher sampling intensity along the North Canol was the lag time (3 days) between the initial stratification and the census, due to weather conditions. Some movement of moose likely occurred between SUs during that down time. For example, 7 of 34 (20%) SUs stratified as low density moose areas had densities during the census which more resembled mediums and highs. Consequently, a higher sampling intensity of the low density SUs was required to reach the desired level of precision. In contrast, weather conditions had improved during the Frances survey which allowed the census to be completed immediately following the stratification flights.

The size of individual SUs averaged 16.6 km^2 in the North Canol area and 17.3 km^2 in the Frances area.

Table 1. Sampling intensity by stratum and area during moose surveys, November 1987.

		Stratum			
Survey Area	Sample Units (SU)	High	Medium	Low	Total
NORTH CANOL ($2744\ km^2$)	No. of SU (%)	13(8)	30(18)	122(74)	165(100)
	SU surveyed (% sampled)	11(85)	13(43)	34(28)	58(35)
FRANCES ($3894\ km^2$)	No. of SU (%)	22(10)	33(15)	159(73)	214(100)
	SU surveyed (% sampled)	12(55)	11(33)	25(16)	48(22)

Aircraft Comparison

A total of 9 SUs, primarily of medium or high moose density, were intensively searched by the Supercub and resurveyed within 30 minutes by the helicopter (Appendix A). The mean search intensity was higher in the Supercub (2.4 min/km^2) than in the helicopter (2.0 min/km^2) largely because total coverage of a SU required more time with the fixed-wing aircraft.

The total count from the Supercub was 52 moose versus 55 moose observed by the helicopter crew. Thus, the count from the Cub was within 95% of the helicopter count. The counts of moose were similar in 5 of 9 SUs (56%). In 1 SU, the crew in the Supercub saw more moose, while in the remaining 3 SUs, the counts from the helicopter were higher. The difference in counts resulted from one aircraft missing one individual moose or one small group of moose (2-3 individuals). Given the short period between aircraft surveying the same SU, it is doubtful that movements of moose influenced the counts.

Differences in the composition of moose were also evident from the aircraft comparison (Appendix A). It is considerably easier and quicker to obtain reliable composition counts from the helicopter due to its greater maneuverability and to its ability to "flush" moose into the open where the animals can be more easily classified. This is particularly important in mid- to late November when all unantlered moose should be checked for the presence of a vulva patch before they are positively sexed. In the Supercub, this may require several passes over the same animal before a positive identification can be made. In 2 of the 9 SUs compared, there appeared to be a difference between observers by aircraft type as to what constituted a yearling bull. This is not surprising given that antler development in yearling bulls can range from short spikes to palmated antlers exceeding 75 cm (30 inches) in spread (VanBallenberghe, 1979). Consistency between observers is important and should be arrived at before the fall surveys using representative photographs or cast antlers of young bulls as reference. The diagrams by DuBois et al. (1981) are particularly useful in this respect.

In Alaska, Supercubs are routinely used during the census portion of moose surveys (Gasaway et al., 1986). In Yukon, helicopters have been preferred to fixed-wing aircraft due to their greater search efficiency and maneuverability particularly in the mountainous terrain and windy conditions of southwestern Yukon (Larsen, 1982). As less mountainous areas are being surveyed as part of the Yukon-wide moose inventory, Supercubs could become a useful complement to helicopters. At about one-fifth the cost, the Cub could be used to cover a large portion of the low density SUs that regularly represent up to 75% of the total survey area and about 50% of the total number of SUs flown (Table 1). A helicopter could then be used primarily in the medium and high moose density areas where classification of relatively large numbers of moose is necessary. Since search effort largely determines sightability (Gasaway et al., 1986), a minimum search effort of 2.5 min/km^2 should be maintained by the Supercub to ensure adequate coverage. In interior Alaska, search effort of 1.5 to 2.0 min/km^2 was required to see most moose from Supercubs during early winter (Gasaway et al., 1986).

Experienced pilots and observers are critical when relying on the Supercub for accurate counts of moose in the low density areas. These areas are often characterized by relatively heavy cover and a predominance of cow/calf pairs (Markel and Larsen, 1984; Gasaway et. al., 1986). Thus, actual sightability of moose is likely to be of more concern than is the ability to accurately classify moose in the low density SUs. Further comparisons between aircraft would be needed to ensure unbiased estimates of both moose abundance and composition.

Population Characteristics and Distribution

North Canol Area

The estimated number of moose in the North Canol area was 516 $\pm$ 17% (90% C.I.) which corresponded to a mean density of 0.19 moose/km^2 (Table 2). This density is higher than that found during the previous year in the Nisutlin area (0.13 moose/km^2) and Liard East (0.14 moose/km^2) but lower when compared to the Whitehorse South area (0.29 moose/km^2; Jingfors and Markel, 1987) or the Teslin Burn (0.41 moose/km^2; Markel and Larsen, 1985).

Adult cows made up 35% and bulls were 23% of the estimated population, with a corresponding adult sex ratio of 66 bulls/100 cows (Table 2). Calves represented 23% of the total population while yearlings accounted for 18%, or 24% if calves are excluded from the total ("net productivity" - Simkin, 1974). When calculated as a ratio to adult cows ($\geq$ 30 months), the results indicate very high calf survival (64 calves/100 cows) and yearling recruitment (54 yearlings/100 cows). The proportion of cows with twins to all cows with calves (twinning rate) was 10% (4/42). In 1986, comparative twinning rates were only slightly higher in the Nisutlin (12%) and Liard East areas (13%; Jingfors and Markel, 1987). No other comparative data on twinning rates are available from Yukon.

Table 2. Moose population abundance and estimated composition in the North Canol area, November 1987.

Parameter	Stratum High	Stratum Medium	Stratum Low	Total (90% C.I.)	% of Total
A. Abundance					
Estimated total moose	142	141	232	515 ± 17%	-
Density (moose/km²)[a]	0.61	0.27	0.12	0.19	-
B. Composition					
Adult bulls (≥ 30 mo.)	49	40	32	121 ± 23%	23%
Adult cows (≥ 30 mo.)	33	54	96	183 ± 22%	35%
Yearlings (18 mo.)[b]	40	14	42	96 ± 27%	18%
Calves	23	33	60	116 ± 24%	23%
					100%
Bulls/100 cows (≥ 30 mo.)	148	74	33	66 ± 27%	-
Yearlings/100 cows	139	26	44	54 ± 31%	-
Calves/100 cows	70	61	63	64 ± 14%	-

[a]Density is calculated based on habitable moose range.

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

The large proportion of young cohorts is different from observations made during earlier moose surveys in the same area. Stratification-type surveys flown in November 1981 and March 1982 recorded calf proportions of 11% and 8%, respectively, with 26 calves/100 cows observed in November (Markel and Larsen, 1986). While these surveys likely underestimated the proportion of cows and calves in the population (Gasaway et al., 1986), the results are sufficiently different to suggest that calf survival has improved in recent years.

Moose were widely distributed throughout the North Canol survey area with local concentrations at higher elevations near south-facing burns and in the subalpine shrub zone (Fig. 2). About 70% of all moose observations were made in areas located above 1050 m (3000 feet). High and medium moose density areas were particularly common in the high elevation areas west of the North Canol Road and east of Lewis Lake, as well as near Jackfish Lake (Fig. 2). A similar pattern of early winter moose distribution was also observed in November 1981 (Markel and Larsen, 1986). In contrast, surveys in late winter (March 1982) showed that most moose had moved down into the lower lying areas and concentrations were found in the southwestern end of the survey area, particularly along the Ross River drainage (Markel and Larsen, 1986). This seasonal movement of moose, from post-rutting areas at higher elevations to low-lying forested wintering areas, usually occurs in December and January in response to increasing snow depths (Coady, 1974). In the case of the North Canol Road, snow depths can double from the south end (51 cm) to the north end (95 cm) along the NWT-Yukon border (Markel and Larsen, 1986). By February or March, most moose have moved out of the higher elevation areas east of Lewis and Sheldon lakes and concentrations are common along the major drainages, particularly the lower parts of the Ross River in the southern end of the survey area. (Farnell, pers. comm.).

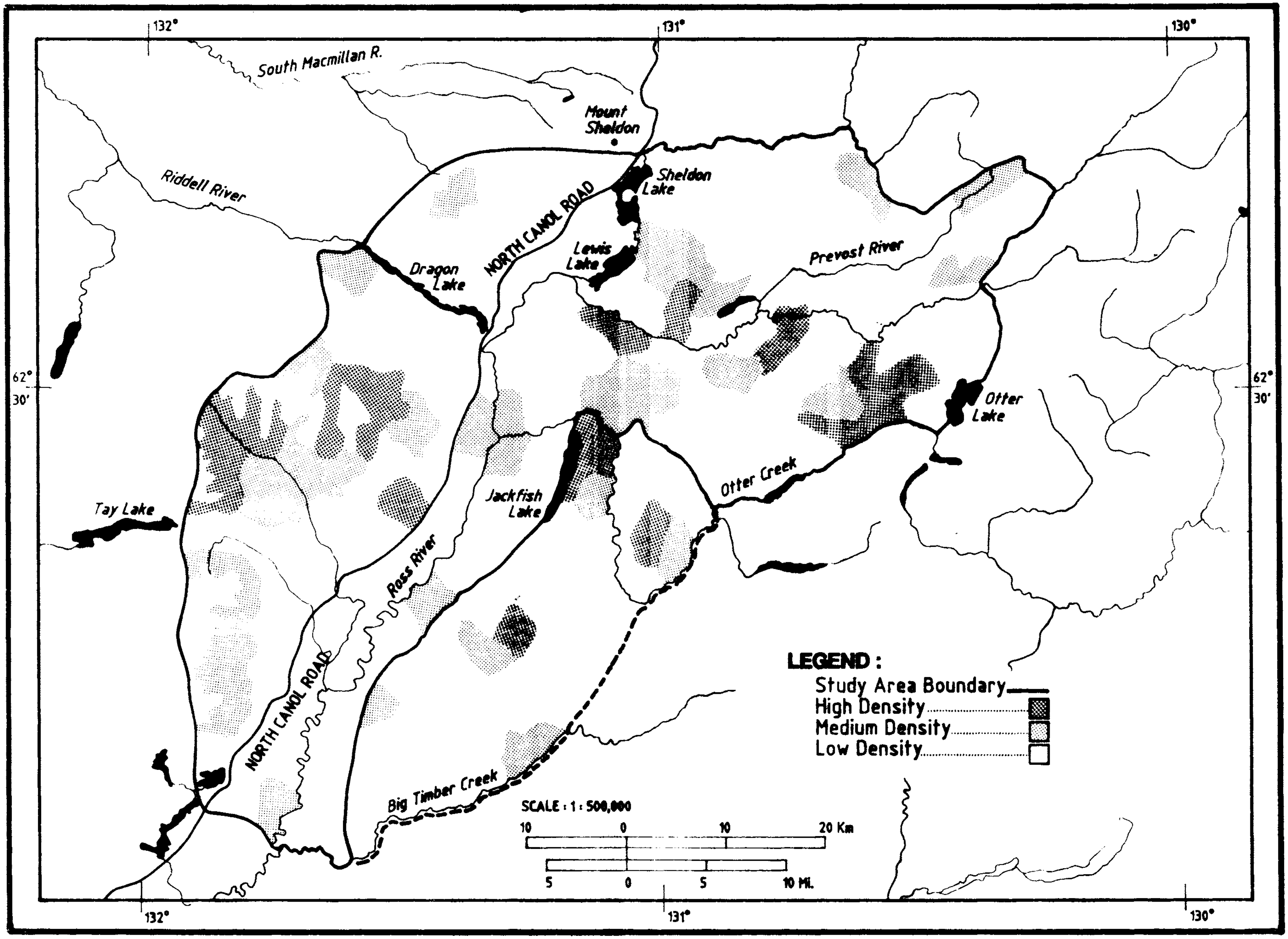

Figure 2. Distribution of moose in the North Canol area, November 1987. Dashed line indicates outer boundary of extended stratification area.

In addition to the North Canol survey area (2744 km^2), an adjacent area (696 km^2) bounded in part by Big Timber Creek (Fig. 2) was included during the stratification, but not the census, to compare relative distribution and density of moose over a larger area. The proportion of high and medium density SUs was somewhat smaller in the adjacent area (21%) than in the larger survey area (26%). However, the estimated density of moose was similar between areas (0.18 versus 0.19 moose/km^2; Appendix B).

Frances Lake Area

The estimated number of moose in the Frances Lake area was 741 ± 16% (90% C.I.) with a mean density of 0.19 moose/km^2 (Table 3). This density was identical to that found in the North Canol survey area (Table 2).

The proportion of adult bulls in the population was estimated at 19% and cows were 34% (Table 3). The adult sex ratio was 55 bulls/100 cows. Calves were more common (24%) than adult bulls. This was also the case with the yearling cohort that represented 22% of the total estimated population, or 29% if calves were excluded. When expressed as a ratio to adult cows, there were 69 calves/100 cows and 65 yearlings/100 cows. Of 67 cows with calves classified, only 3 had twin calves resulting in a twinning rate of 5%.

With the exception of twinning rate, the productivity indices from the Frances and North Canol areas are the highest recorded in the Yukon and are suggestive of expanding populations. The relatively low incidence of twin calves observed may partially be due to the large proportion of young cows in both areas. It is possible that many of the parous cows were breeding for the

Table 3. Moose population abundance and estimated composition in the Frances Lake area, November 1987.

Parameter	Stratum High	Stratum Medium	Stratum Low	Total (90% C.I.)	% of Total
A. Abundance					
Estimated total moose	350	211	180	741 ± 16%	-
Density (moose/km^2)[a]	0.83	0.35	0.06	0.19	-
B. Composition					
Adult bulls (≥ 30 mo.)	85	38	20	143 ± 25%	19%
Adult cows (≥ 30 mo.)	115	60	80	255 ± 18%	34%
Yearlings (18 mo.)[b]	70	56	40	166 ± 36%	22%
Calves	80	57	40	177 ± 21%	24%
					100%
Bulls/100 cows (≥ 30 mo.)	74	63	21	55 ± 37%	-
Yearlings/100 cows	61	95	50	65 ± 41%	-
Calves/100 cows	70	95	50	69 ± 11%	

[a]Density is calculated based on habitable moose range.

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

first time and, therefore, more likely to produce a single calf than twins. Studies from other areas have shown that fecundity is lowest among first-time breeders (Markgren, 1969; Saether and Haagenrud, 1983).

As was the case along the North Canol, moose in the Frances survey area were widely distributed throughout the area particularly at higher elevations and near south-facing burns (Fig. 3). About 75% of all moose were found in areas located above 1050m (3500 feet). Local concentrations of moose were found in the burns adjacent to Anderson Creek, and in the higher elevation areas north of the Finlayson River, as well as near Grass and North Lakes south of Finlayson Lake.

Unlike the mountainous terrain in southwestern Yukon where large post-rut aggregations of moose can be seen (Larsen, pers. comm.), the mean group size in both the North Canol and Frances areas was relatively small: 2.0 moose ± 0.3 (S.E.).

The earliest date of antler drop observed in the males was 12 November when one adult bull was seen without antlers. On the same date, a yearling bull was observed with a single antler.

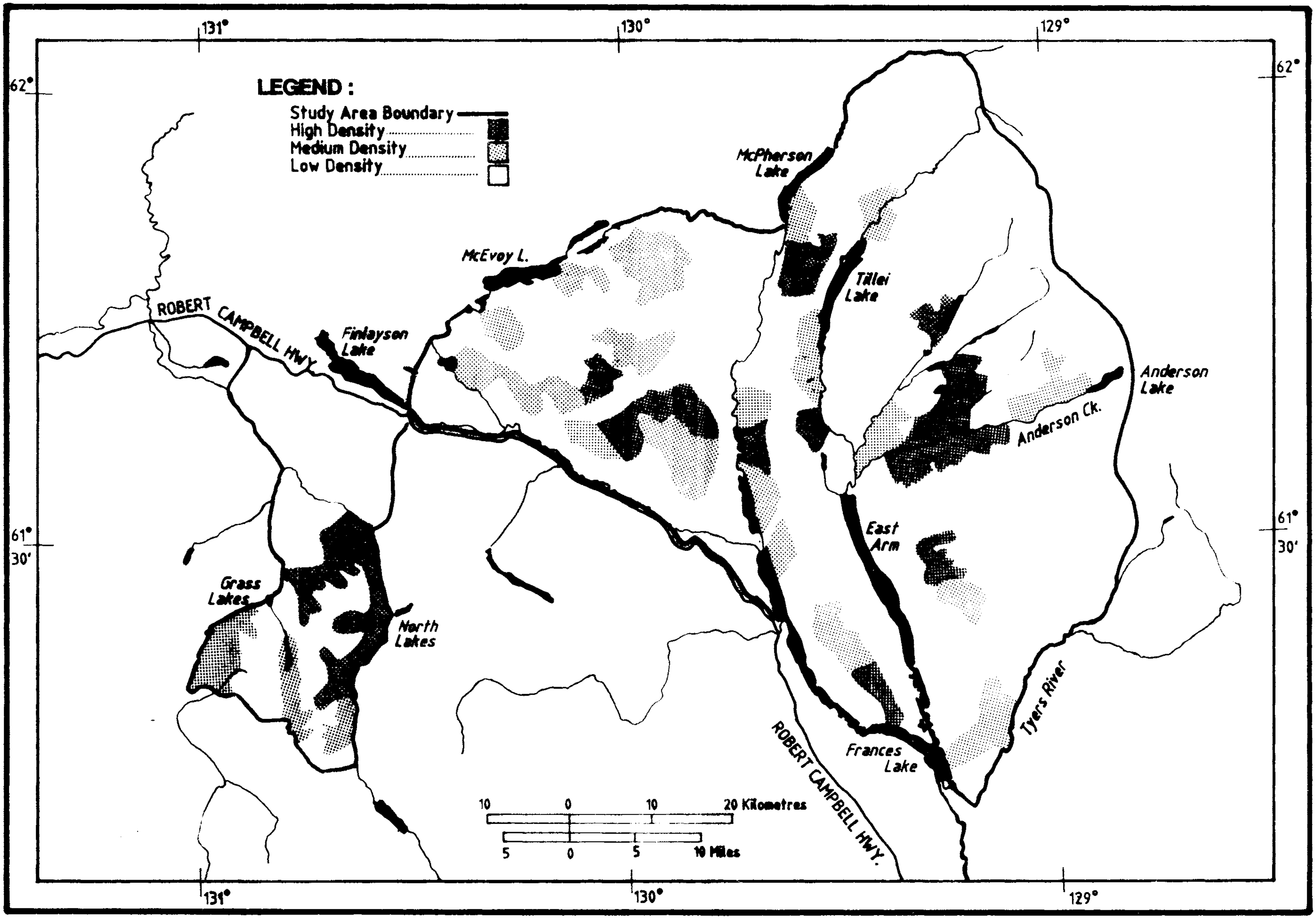

Figure 3. Distribution of moose in the Frances Lake area, November 1987.

Effects of Wolf Reduction

The Finlayson wolf removal program was initiated in 1983 to reverse the declining trend of the Finlayson caribou herd (FCH). Between 1983 and 1987, a total of 357 wolves were removed from the approximately 20,000 km^2 range of the FCH and the resulting wolf densities declined from about 12 wolves/1000 km^2 (Hayes and Farnell, 1985) to about 2 wolves/1000 km^2 (Farnell and McDonald, 1988). The most dramatic response in the demography of the FCH was noted during fall composition counts in 1984 when the proportion of calves in the population had increased from 15% to 21% and calf/cow ratios increased from 34 in 1983 to 44 calves/100 cows in 1984 (Farnell and McDonald, 1988). Most of the wolves were removed in 1983 and 1984 (n=211) when moose were the most frequently observed prey in wolf stomachs examined (Hayes and Farnell, 1985). Long term collections of radio cesium (C_s 137) samples from wolves (n=140) show moose were important to most wolves at the periphery, and outside, of the core caribou winter range (Hayes, pers. comm.).

Another dramatic response in caribou calf survival was observed during fall composition counts in 1987 when the proportion of calves increased from 20% to 25% of the FCH (Farnell, pers. comm.). This increase could be due to a cohort surge of breeding females from 1984 which is consistent with our observations of moose demography.

The demography of moose in the Frances and North Canol areas indicate excellent calf productivity and survival for at least the last two years. Some moose composition data collected in March of 1986 and 1987, in conjunction with the Finlayson wolf removal program, suggest that 1985 was also a year of good calf survival. Hayes and McDonald (unpubl. data) incidentally classified moose as adults or calves during low-level wolf survey flights in a fixed-wing aircraft (Supercub or Maule). In March 1986, they observed 143 moose of which 45 (31%) were classified as calves. Of all cows accompanied by calves, 24% had twin calves. The following spring (March 1987), calves represented 25% of all moose seen (44/178) and the observed twinning rate was 17%. All observations of moose were made within the primary area of wolf control (Farnell and McDonald, 1988) which includes all of the Frances moose survey area and a portion of the North Canol area, east of the road (Fig. 1).

The incidental observations during March 1986 and 1987 suggest higher calf percentages and twinning rates than were observed during the comprehensive survey in November 1987. The large proportion of younger females in 1987 may have influenced twinning rates. However, more importantly, moose surveys done in late winter (Feb./March) do not provide unbiased estimates of composition (Gasaway et al., 1986) especially if the survey is not designed specifically for moose. Thus, the incidental observations suggest good calf survival but they cannot be used to accurately describe spring composition of moose.

The link established between reduced wolf numbers and improved calf survival in the FCH (Farnell and McDonald, 1988) can also be argued for in the case of moose. The timing of the wolf removal, the unprecedented levels of moose calf survival and yearling recruitment observed in recent years, and the potential moose consumption rates by wolves as inferred from other areas in the Yukon (Hayes and Baer, 1986) suggest a causative relationship between reduced wolf numbers and enhanced moose population growth. A 2- to 4- fold increase in calf and yearling survival was also noted by Gasaway et. al. (1983) following wolf removal in interior Alaska.

As part of the recently initiated native harvest survey, hunters were also asked about their perception of changes in game abundance over time (Quock and Jingfors, in prep.). A majority of Ross River hunters felt there are now more moose and caribou and less wolves than there were ten years ago. This is in sharp contrast to other communities in the Yukon where the overwhelming sentiment suggested fewer ungulates and more predators now than before. There seems to be little doubt that the wolf control program has influenced the perception of Ross River hunters.

Hunter Harvest

The estimated annual harvest of moose by non-native resident hunters between 1978-1986 averaged 22 moose in the North Canol area and 26 moose in the Frances Lake area (Table 4). While some of the GMSs included in Table 4 include areas that extend beyond those surveyed, most of the actual harvest is believed to have occurred near areas of easy access that were part of the survey area, including North Canol and Campbell Highway, Dragon Lake, Sheldon Lake, and Frances Lake. Assuming similar harvest rates in 1987, the resident sport harvest would have removed 5% (22/(515-116+22); Table 2) of the pre-hunt population of moose (excluding calves) in the North Canol area. Similarly, the resident harvest would have removed 4% (22/(741-177+22); Table 3) of the Frances Lake moose population. The highest annual moose harvest was recorded in 1981 for the North Canol area (31), and in 1978 and 1980 for the Frances area (45; Table 4). Hunter questionnaire data indicate a trend of less hunter effort (measured in days hunting) required to successfully harvest a moose in both survey areas since 1982-83. For example, the mean number of hunter days per moose in the Frances area declined from 45 in 1983 to 23 hunter days/moose

Table 4. Estimated number of moose harvested by native and non-native hunters in Game Management Subzones (GMSs) surveyed for moose in 1987.

	Estimated non-native harvest 1978-1986[a]				Reported native harvest 1987[b]	
	Residents		Non-residents			
Survey Area	Mean	Range	Mean	Range	Ross River	Watson Lake
North Canol (GMS 4-39, 4-40, 4-49, 11-02, 11-06 to 11-08)	22	14-31(22)	3	0-7(0)	15	0
Frances Lake (GMS 10-07, 11-16, 11-17, 11-20, 11-21, 11-22, 11-23)	26	15-45(22)	1	0-6(6)	1	15

[a]Numbers in parentheses are the estimated harvests in 1986.

[b]Numbers of moose taken in the survey areas during 1987 by Status Indians from Ross River and Watson Lake. The sample includes over 90% of all known hunters in the two communities.

in 1986. The improved hunter success is likely a result of increased moose numbers in combination with more fly-in hunting and less road hunting. Since 1982, the harvest in the Frances area has remained between 15-30 moose annually partly due to the closing of the Cyprus Anvil mine in Faro where most of the hunting pressure originated from in the early 1980's (P. Rodgers, pers. comm.).

The Faro lead-zinc mine was re-opened in 1985 and in 1988, a gold mine on the Ketza River (Canamax), near Ross River, will go into production. These developments, coupled with a recent staking rush in the Ross River area, will likely result in increased resident pressure on moose. This pressure will be accelerated by a dispersal of hunters away from GMZ 7 and 9 in southwestern Yukon where more hunting restrictions may become necessary to facilitate the recovery of local moose populations. An influx of resident hunters along the North Canol and Robert Campbell Highway was evident during the 1987 hunting season (D. Lindsey, pers. comm.).

The non-resident harvest of moose has been relatively minor to date (Table 4). In the North Canol survey area, moose have been taken almost exclusively from one GMS (4-40). In the Frances area, no moose were reported taken between 1978-1983. In 1986, 6 moose were harvested from one GMS (10-07).

Efforts to collect information on the native harvest of moose were begun in Ross River and Watson Lake in 1987 (Quock and Jingfors, in prep.). Hunters from both these communities regularly use the Robert Campbell Highway and the North Canol Road for moose hunting. In 1987, 15 moose were reported taken along the North Canol Road by native hunters from Ross River (Table 4). The total reported native harvest from Ross River was 37 moose in 1987. The

Frances area was primarily used by natives from Watson Lake and the reported harvest along the Robert Campbell Highway was 15 moose (Table 4). The total reported moose harvest by natives in Watson Lake was 43 moose in 1987. Of the total reported harvest from both communities, 19% (13/67) was made up of cow moose. Most of the moose were harvested in September (25%) and November (25%) by Ross River hunters and in September (31%) and August (18%) by hunters from Watson Lake.

When combined, the native and non-native harvest removed a minimum of 9% (40/439) of the adult and yearling moose in the North Canol survey area, and at least 7% (43/607) of the moose in the France Lake area.

In addition to being asked for their current harvest, native households were also asked to estimate their annual consumption of moose meat (Quock and Jingfors, in prep.). In Ross River, 70 households with a total of 239 persons reported using on the average, 70 moose per year. This corresponds to 1 moose per household or 1 moose for every 3 persons each year. Slightly lower consumption rates were recorded in Watson Lake where 65 moose were used by 259 persons in 82 native households (0.8 moose/household/year or 4.0 persons/moose/year).

While the reported native harvest for both communities is considerably lower than the estimated average annual consumption of moose meat, it is important to remember that the data only include harvest for one year. Furthermore, it is likely that some hunters are underreporting their actual harvest for fear of enforced controls. This bias can only be eliminated through the establishment of trust and the acceptance of the need for reliable harvest data among hunters, fieldworkers, and managers. Several years data, similar to that from the resident hunter questionnaire (Table 4), are necessary to detect trends and to place confidence on the harvest estimates.

Projected Population Growth

Given the similarity of moose population characteristics between the North Canol and Frances Lake survey areas, a population estimate for the entire Finlayson wolf removal area (20,000 km^2; see Farnell and McDonald, 1988) can be extrapolated. An average density of 0.19 moose/km^2 over the habitable moose range (assume 85% habitable; see Survey Area) results in an estimate of 3230 moose in November 1987.

The composition of this population can be approximated using weighted averages from the two survey areas (Tables 2 and 3). Thus, we assume adult bulls represented 21%, adult cows 35%, yearlings 21%, and calves 23% of the total moose population. To evaluate its growth potential, we concentrate on the breeding population and compare yearling recruitment in the spring with adult and yearling mortality from hunting and natural causes, including predation.

An estimate of mortality due to hunting can be derived by including harvest estimates from the remaining GMSs that make up the total wolf removal area (10-06 to 10-08, 11-08 to 11-10 and 11-15). Since the moose survey areas were delineated based on hunting pressure, inclusion of the additional GMSs that are not used as heavily by hunters, only serves to lower the rate at which the total population is currently being harvested. Combining native harvest estimates from 1987 (38 moose) with non-native harvest figures from 1986 (53 moose) yields an annual harvest of about 90 moose or 3.5% (90/2577) of the estimated population of adults and yearlings. A current harvest rate of 4% appears reasonable.

Information on natural mortality rates of adults and yearlings can only be inferred. However, the following points suggest current mortality rates are likely low, and similar, for both yearlings and adults:

1. High observed calf survival and yearling recruitment in moose. The inverse relationship between calf recruitment and adult/yearling natural mortality, as demonstrated for caribou by Bergerud (1978), would suggest mortality rates of less than 5% as <u>calf</u> recruitment exceeds 22%. In our moose population, yearlings represented 27% (678/2487) of all moose 18 months old or older in the fall.

2. Low wolf numbers and, likely, low bear numbers. If we assume a fall population of 3230 moose, 3500 caribou and about 80 wolves (R. Farnell, pers. comm.), the resulting ratio of 84 ungulates/wolf would be considered well above critical limits to allow for growth in the prey population base (Gasaway et al., 1983). Following wolf reduction on the Tanana Flats in Alaska, Gasaway et al. estimated a 0 to 7% mortality rate among young and prime-aged radio-collared moose (1-10 years old). In comparison, mortality rates of yearling and adult moose in southwestern Yukon are thought to range between 5-10% annually (D. Larsen, pers. comm.). Bear numbers in the Finlayson area are not known, but given the unusually high productivity indices in both moose and caribou, bear predation does not likely limit current moose population growth.

To keep our estimates of population growth on the conservative side, we therefore assume natural mortality rates of adults and yearlings in our model population to be in the 5-10% range. By comparing natural and hunting mortality to recruitment, we end up with a potential growth rate of between 13-18% annually. These estimates appear low when compared with rates of increase documented for other moose populations under light predation and hunting (15-30%; VanBallenberghe, 1983). However, by Yukon standards, the growth potential of the moose population in the Finlayson area must be considered encouraging.

RECOMMENDATIONS

1. At current harvest levels, no restrictions are necessary in order to maintain a stable moose population in the area. Growth of the population can be facilitated by encouraging hunters to select young (yearling or 2-year-old) bulls.

2. To verify population trend, further surveys of both moose and wolves in the Finlayson area are needed. Wolf control is scheduled to continue until the spring of 1989 and caribou surveys have been recommended for 1990 and 1994 (Farnell and McDonald, 1988). Another moose survey in 1992 would allow a 5- year interval between population estimates which should be long enough to detect a trend in the moose population. Concurrent with these ungulate surveys, wolf numbers should also be monitored to document the timing and extent of recovery following the period of wolf control.

3. A Supercub should be used, in combination with helicopters, to further test its utility for surveying low density areas during the annual moose surveys.

4. Continued monitoring of the native and non-native harvest should be encouraged, particularly in view of increased mining activity in the area. A game check station should be considered at the Ross River ferry crossing between August-September to monitor the North Canol harvest.

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Appendix A. Comparison of Moose Observations in Similar Sample Units (SUs) from a Helicopter Versus a Fixed-Wing Aircraft, 12-13 November 1987, North Canol area.

		Fixed-wing (PA-18 Supercub)							Helicopter (Bell 206B)						
					Composition							Composition			
					Bull							Bull			
SU no.	SU type[a]	Search intensity (min/km^2)	No. of groups obs.	Total moose obs.	Ad.	Yrlg.	Cow	Calf	Search intensity (min/km^2)	No. of groups obs.	Total moose obs.	Ad.	Yrlg.	Cow	Calf
67	Med.	2.1	2	6	3	1	2		2.0	3	9	3	1	3	2
88	Med.	4.4	4	8	1	1	3	3	2.7	4	8	1	1	3	3
98	High	2.2	4	6		1	3	2	1.9	5	7		1	4	2
114	Med.	1.8	2	5			2	3	2.1	2	5			2	3
115	Low	2.5	0	0					1.4	0	0				
117	High	2.9	10	19	5	3	9	2	2.5	10	19	6	4	8	1
134	High	2.7	2	6	4	2			1.9	3	7	5		1	1
118	Med.	1.7	2	2			2		2.2	0	0				
123	Med.	1.5	0	0					1.3	0	0				
	Mean	2.4							Mean 2.0						
	Total		26	52	13	8	21	10	Total	27	55	15	7	21	12

[a]Refers to moose density from stratification flights.

Appendix B. Moose Density Estimate from an Extended Stratification Area Adjacent to the North Canol, November 1987.

	Stratum			
Parameter	High	Medium	Low	Total
No. of SUs	4	5	33	42
Area (km^2)	64.5	83.9	555.1	703.5
Est. density[a] (moose/km^2)	0.61	0.27	0.12	
Est. no. of moose	39	23	67	129[b]

[a]Assumed to be similar to the North Canol survey area (Table 2).

[b]Corresponds to a density of 0.18 moose/km^2.