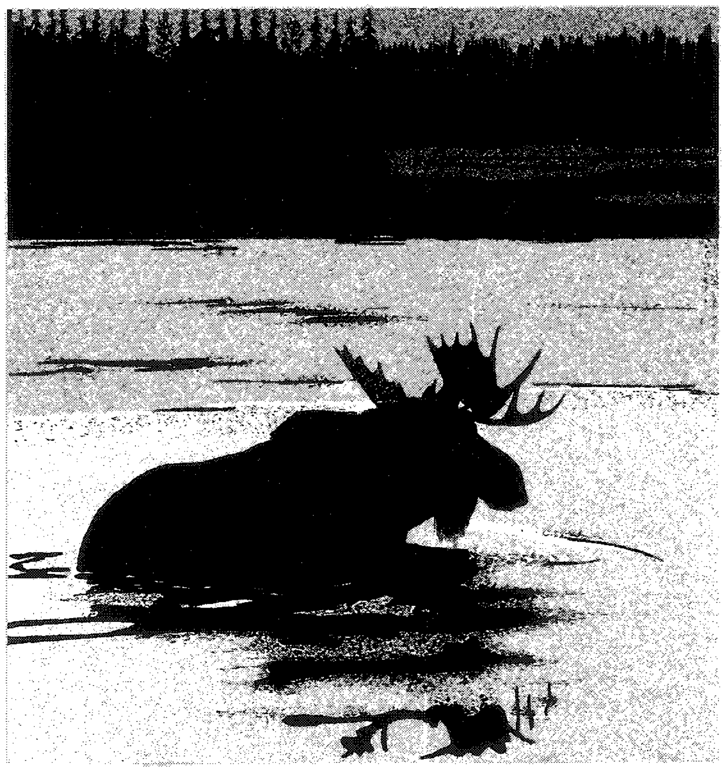
MOOSE POPULATION RESEARCH AND MANAGEMENT STUDIES IN YUKON



MOOSE POPULATION CHARACTERISTICS IN THE MAYO AND PELLY CROSSING AREAS 1988-1989

by

D.G. LARSEN
R.L. MARKEL
R.M.P. WARD

PROGRESS REPORT, 1989

MOOSE POPULATION CHARACTERISTICS IN THE MAYO AND PELLY CROSSING AREAS 1988 - 1989

D.G. Larsen

R.L. Markel

R.M.P. Ward

1989

Yukon Fish and Wildlife Branch
Department of Renewable Resources
Government of Yukon
Box 2703
Whitehorse, Yukon
Y1A 2C6

MOOSE POPULATION CHARACTERISTICS IN

THE MAYO AND PELLY CROSSING AREAS

1988 - 1989

D.G. Larsen

R.L. Markel

R.M.P. Ward

Approved: ______________________________
Director, Fish and Wildlife Branch

____
Senior Big Game Biologist

1989

Big Game Section
Yukon Fish and Wildlife Branch
Department of Renewable Resources
Government of Yukon

TABLE OF CONTENTS

ABSTRACT

Aerial surveys for moose were conducted during early and late winter (1988-1989) in the Mayo and Pelly Crossing areas. A moose density of 139 moose/1000km^2 was estimated for the Mayo area. Moose were not evenly distributed in the Mayo area in early winter, with 39% of the total population occurring in 13% of the land area. Moose distribution in late winter is even more clumped than during early winter. Moose were found at higher elevations in early winter compared to late winter. Cows with calves observed in November were at a significantly higher (P=0.004) mean elevation (932 meters) compared to cows with calves in March (739 meters). Burns were not extensively used in early winter. One potential limiting factor to moose population growth is wolf predation, with 14 moose for every wolf in the study area. Adult cows were the most abundant age and sex class (40%), followed by adult bulls (26%), calves (25%), and yearlings (10%). Moose composition was typical of other populations in the Yukon, except for a higher calf/cow ratio (61 calves/100 cows). The twinning rate in November was 14%, the highest documented in the Yukon to date. The total allowable harvest in the Mayo area was estimated to be between 0-17 moose in 1989. There are several assumptions associated with this calculation. Sixty-seven percent fewer moose were seen from the supercub compared to the helicopter, although moose were also missed from the latter. A sightability correction factor of 1.23 was calculated for helicopter surveys from moose spotted from the supercub, but missed from the helicopter. A trend survey area was established within the study area.

BACKGROUND AND OBJECTIVES

Moose priority areas in the Yukon were established in 1980 based on harvest pressure (Larsen, unpubl. data). Since then, approximately one priority area/year has been intensively surveyed (Larsen 1982; Markel and Larsen 1983, 1984, 1985, and 1988; Johnston and McLeod 1983a, 1983b; Johnston and McEwen 1984; Jingfors and Markel 1987; Jingfors 1988). To date these areas, including the present study, represent 17% of the Yukon land area and 52% of the total resident non-Indian harvest. The primary purpose of these surveys is to obtain the necessary information to manage for the conservation of moose populations in priority areas. More specifically, they provide some of the information needed to calculate the allowable harvest, which is then matched with the existing harvest levels and the future demand for moose to formulate management programs.

Moose surveys were carried out in the Mayo area in 1988, based on earlier prioritization and on a cooperative wildlife management plan with the local Indian bands initiated in 1986. A draft agreement on the management of big game in the Mayo area was jointly written by the Na-Cho Ny`a'k-Dun band and the Yukon Fish and Wildlife Branch (YF&WB). That agreement calls for the implementation of a comprehensive big game management plan by 1991. As a result, inventory programs were initiated by the YF&WB to determine moose (this study) woodland caribou (Farnell, YF&WB, Whitehorse, in prep.), and wolf (Hayes and Baer, YF&WB, Whitehorse, in prep.) densities and distributions. In addition, a habitat mapping program centered around the McArthur Sanctuary was conducted (Kennedy, YF&WB, Whitehorse, in prep.).

Prior to 1988, several moose surveys were carried out in the Mayo and Pelly areas. In February of 1976, two proposed dam sites on the Macmillan and Stewart Rivers were surveyed by Lortie and Jack (1975). In February-March of 1979, a survey was flown along the Stewart and McQuesten Rivers by Larsen (1979), and in November 1983, the Dromedary Mountain area was surveyed by Johnston and McLeod (1983b).

In 1988 and 1989, five different moose aerial surveys were conducted in the Mayo and Pelly Crossing areas, and are discussed in detail in this paper:

1) The primary census was flown with helicopters in November and December in two areas centered around Mayo (Mayo north [GMS's 2-57, 2-58]; Mayo south [GMS's 4-01 and portions of 4-03 and 4-04]). The objective of this survey was to determine moose distribution, density, and composition.
2) A second less intensive survey was conducted with fixed wing aircraft in December, in the Pelly Crossing area (GMS's 4-02, 4-11, and portions of 4-03 and 4-10). The objective of this survey was to determine the relative distribution of moose adjacent to the primary area, thus gaining a regional perspective of moose numbers and distribution.
3) Mayo south was resurveyed using fixed wing aircraft in February and April to determine late winter distribution of moose and over winter mortality of calves.
4) A portion of the Mayo South survey area was resurveyed in November using a piper supercub. The purpose was to establish a relatively inexpensive trend survey, which would provide the necessary data base for tracking moose population change. This information is required for proper harvest management.
5) Finally, portions of the Mayo South survey area were intensively searched with both a helicopter and supercub in November. The objective was to compare the efficiency of a less expensive supercub in finding moose with that of a helicopter.

STUDY AREA

The study area consisted of the Mayo North (MN) and Mayo South (MS) intensive survey areas and the Pelly Crossing (PC) extended stratification survey area (Figure 1). The two Mayo survey areas encompassed 5121.8 km^2 of total land area with 4852.6 km^2 of habitable moose range (2235 km^2 in MN, 2618 km^2 in MS). Habitable moose range was defined by Larsen (1982) as the area below 1524 meters, excluding large water bodies and precipitous slopes. The PC survey area encompassed 4426.9 km^2 of total land area with 4242.3 km^2 suitable for moose. Three separate survey areas were delineated in order to minimize the amount of time needed to complete a census. Prolonged survey times increase the chances of moose moving during the census, which could potentially result in double counting or missing animals. Long survey periods also increase the chances of the census being interrupted due to inclement weather, which is common in early winter.

The entire study area occurs within the Pelly River ecoregion (Oswald and Senyk 1977). The topography varies from rolling hills and plateaus throughout much of the study area with more mountainous terrain found in the southern third of the area (Kalsas, McArthur, and Macmillan Ranges).

Vegetation at lower elevations is dominated by black spruce (Picea mariana) forest, which is replaced by white spruce (P. glauca) on drier sites. Lodgepole pine (Pinus contorta) frequently invades the burnt-over areas, but is often in competition with aspen (Populus tremuloides) and balsam poplar (P. balsamifera) on wetter sites. Paper birch occurs on cooler sites. Treeline occurs around 1350-1500 m, and is characterized by a limited subalpine zone with willow (Salix spp), shrub birch (Betula spp), and alpine fir (Abies lasiocorpa). Approximately 25% (2425 km^2) of the area has been burned during the past 100 years. Burns are more common in the PC survey area (37%), followed by MS (21%) and MN (8%).

Weather data were available from two permanent stations within the study area (Elsa at 504 meters above sea level (asl), and Mayo at 814 meters asl; Environment Canada). Mean annual daily temperatures were similar (-4°c) in Elsa (1975-1985) and Mayo (1955-1987). Snowfall was substantially higher in Elsa (203 cm) compared to Mayo (131 cm), with maximum snowdepths occurring in March at Mayo and in April at Elsa. Maximum snowdepths at Elsa have averaged 84 cm (1975-1981) and 54 cm at Mayo (1968-1985).

Other ungulates and large predators occur within the study area. Caribou (Rangifer tarandus) numbers were estimated at about 200 animals during the November moose census. Sheep occur in the MacArthur sanctuary at unknown densities (J. Carey, YF&WB, Whitehorse, pers. comm.) and 95 sheep were reported on Dromedary Mountain (Nette and Merchant 1981). Wolf densities were estimated at 10 wolves/1000km^2 in late winter 1988 (Hayes and Baer, in prep.). Grizzly bears (Ursus arctos) and black bear (Ursus americanus) occur at unknown densities.

METHODS

Early Winter Surveys

Early winter aerial surveys were conducted between 5-10 November, 1988 in the MN survey area and between 18-26 November, 1988 in the MS survey area. The PC survey area was flown between 27 November and 3 December, 1988. Early winter is the preferred period for moose surveys due to the behavior of moose in aggregating in open habitats during and immediately following the rut (Peek et al. 1974, Lynch 1975, Rounds 1978, Mytton and Keith 1981, Larsen 1982, Gasaway et al. 1986), and due to the presence of snow on the ground. Both of these factors increase the visibility of moose on aerial surveys (Gasaway et al. 1986). In addition, the presence of antlers on males to late November facilitates sex identification of moose.

In the MN and MS areas a stratified random block sampling technique was used (Gasaway et al. 1986) with modifications to accommodate the terrain, weather conditions, and distribution of moose in the Yukon (Larsen 1982). Briefly, the technique involves the stratification of blocks or sample units (SUs), based on moose densities observed during an initial reconnaissance survey in a fixed-wing aircraft (Cessna 185, 206, or similar). Helicopters are then used to census a proportion of the SUs within each stratum. Sample units to be surveyed are randomly selected and searched immediately after stratification. Total counts of moose are attempted within each SU surveyed. A sightability correction factor (SCF) for moose that were unobserved from the helicopter was estimated from data collected on the aircraft comparison survey. The SCF was calculated as: total no. of moose seen from the helicopter and supercub combined - no. of moose seen from the helicopter. The actual numbers of moose present within each SU was assumed to be the total count, excluding duplicates, from the helicopter and supercub searches. This correction factor was developed after the surveys were completed.

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. Moose density was calculated based on habitable moose range. Moose observed on both the stratification and census were plotted on 1:50,000 topo maps.

Elevations for individual moose were later determined from map locations. Stratum elevation is calculated by first determining the mid-range elevation for each S.U. in the stratum (highest plus lowest elevation divided by 2), then averaging the mid-range values for the entire stratum.

In the PC survey area, fixed wing aircraft were used to stratify predetermined SU's into strata of similar moose densities. Stratification techniques, aircrafts, pilots, and survey crews were similar between the Mayo and PC survey areas. The number of moose inhabiting the PC survey area was approximated by applying density values from the two strata in the Mayo survey areas to similar strata in the Pelly area. This extrapolation assumes consistency in survey technique and visibility of moose between survey areas.

A trend survey area (275 km^2) was established between Ethel Lake and Talbot Creek in the MS area (Figure 1). A total count of moose was attempted using a supercub between 26 November and 2 December.

The aircraft comparison survey was flown in the MS area. Eight SU's from the medium stratum were searched first with a supercub (Piper PA-18), then with a helicopter. Search times were adjusted during the trials to ensure consistent search intensities between aircraft types. Two different, experienced observers (first observer with >1000 hrs. and second observer with >2000 hrs.

of survey experience) flew in the supercub. The helicopter crew consisted of one of the experienced and two less experienced observers. The period between aircraft trials was kept as short as possible (<1hr in 5 SU's, and <24hrs in 3 SU's). In the supercub, the pilot acted as navigator and recorded moose observations on 1:50,000 maps while the rear-seat passenger acted strictly as observer. The location of each moose (or group) observed was plotted and later compared for each SU surveyed, by both the supercub and helicopter.

On all early winter surveys, the number of animals in each aggregation, their age (calves, yearlings, adults), and their sex were recorded. Males were classified into yearling and adult bulls based on the size and shape of their antlers (Dubois et al. 1981). Females were differentiated from bulls by their white vulva patch and lack of antlers (Mitchell 1970). Body shape and size were used to differentiate calves form adults. Yearling cows (18 months old) could not be reliably identified in the field, but were assumed to occur in the population in equal proportions to yearling bulls.

Late Winter Surveys

Late winter aerial surveys were conducted between 25 February-1 March, and 1-3 April, 1989. In the first survey, the MS area was restratified using the same sample units, search intensity, aircraft, and pilots as in the early winter survey of the same area. Three of the six observers were new on the late winter survey. In the second late winter survey (composition count) nine SU's within the MS area were intensively searched from a supercub. Moose on both late winter surveys were plotted on 1:50,000 topo maps and classified as either adults or calves. Elevations were later determined from map locations.

Harvest

Resident, non-Indian harvest has been estimated throughout the Yukon since 1979, using a mailed hunter questionnaire (Kale 1982). Both the harvest and effort (days hunted) throughout the study area were obtained from this questionnaire. Non-resident harvest was determined from compulsory reporting by outfitters. Resident and non-resident harvest data were collected on a game management subzone (GMS) basis. It should be noted that study area boundaries did not always follow GMS boundaries (see Figure 1). As a result, the harvest data from the MS and PC survey areas may be somewhat inflated as the harvest information in these areas extended beyond the study area.

Indian harvest levels in 1987 were determined for the PC survey area through personal interviews (Quock and Jingfors, 1988). The Mayo Indian harvest is unknown.

RESULTS AND DISCUSSION

Search and Sampling Intensity

Search intensity was similar on all stratification flights regardless of the survey period, and on all intensive surveys regardless of survey period or type of aircraft (Table 1). During the early winter stratification, search intensity averaged 0.4 min./km^2 in the MN and MS survey areas. A comparable search intensity (0.3 min./km^2) was flown in both the early winter stratification of the PC survey area and the late winter stratification of the MS survey area. Because the search intensities were similar, comparisons between survey areas (Mayo and Pelly Crossing) and survey periods (early and late winter in MS) is possible.

During the early winter helicopter census of the Mayo survey areas, search intensity averaged 1.9 min./km^2 in MN and 1.8 min./km^2 in MS. These search intensities were similar to the intensive fixed-winged surveys during the trend counts (2.0 min./km^2), the aircraft comparisons (2.0 min./km^2) and late winter composition counts (2.0 min./km^2).

Sampling intensity during the early winter helicopter census of the Mayo survey areas was higher in MN (43%) compared to MS (34%, Table 2). A higher sampling intensity was required in MN due to a high variance in the population estimate in that area. Additional SU's were searched in order to reach the desired level of precision in our population estimate. Our subjective assessment was that moose were more difficult to see on the stratification flights in the northern area due to a combination of poor weather and denser vegetation cover, resulting in a poor stratification.

SU size was similar throughout the study area, averaging 25 km^2 in the MN, 26 km^2 in the MS, and 28 km^2 in the PC survey areas. The same SU's were used during all surveys carried out during 1988 and 1989.

Moose Population Characteristics

Density

The estimated number of moose in the combined MN and MS areas, in early winter 1988, was 674 ±16% (Table 3). The corresponding density was 139 moose/1000 km^2. Estimated densities were higher in the MS survey area (148 moose/1000 km^2) compared to the MN area (128 moose/1000 km^2). These densities are lower then the average density (161 moose/1000 km^2) from other areas surveyed in the Yukon, but comparable to the Liard East, Nisutlin, and Haines Junction densities (Appendix 1).

The Mayo densities are substantially higher then the 1979 late winter densities (82 moose/1000 km^2) in the Stewart and McQuesten River areas (Figure 2, Appendix 2) reported by Larsen (1979). These results suggest that the moose population may have increased over the past decade. However, caution is advised when interpreting these data as the 1979 survey was carried out at a different time of year, over only a small portion of the 1988/89 survey area, using a different survey technique (combination of transects and blocks).

Several other moose density estimates have been obtained from areas adjacent to the Mayo survey areas over the past nine years. Lortie and Jack (1975) estimated a density of 460 moose/1000 km^2 along the Stewart River, upstream from Fraser Falls (Figure 2, Appendix 2). This survey was done in late winter 1976 using a line transect survey technique. Larsen (1979) estimated 198 moose/1000 km^2 in both riparian and upland habitats in approximately the same area (between Mayo and the Hess River) in late winter 1979. These data suggest that there may have been a decrease in moose numbers between 1976-1979 upstream from Mayo.

Although the results from the various surveys which have been conducted in the Mayo region are not directly comparable due to differences in techniques, several observations can be made. First, in the past moose concentrated along sections of the Stewart River, upstream from Mayo in late winter. Data collected during February 1989 in the MS area (see Distribution section), suggest that moose in this region still concentrate in lower elevation riparian habitats during late winter. Second, moose were more abundant between Fraser Falls and the Hess River compared to downstream from the falls. Both Lortie and Jack (1975) and Larsen (1979) commented on this disparity in moose densities. Although we do not have any recent information on moose densities above Fraser Falls, Hayes (YF&WB, Whitehorse, pers. comm.) saw more moose east of Mayo than west of Mayo on late winter wolf surveys in 1988 and 1989.

The number of moose in the PC survey area in early winter 1988 was approximated at 557 moose (131 moose/1000 km^2). This density is considerably higher than the density (60 $\pm$20 moose/1000 km^2) documented for roughly the same area (Figure 2) by Johnston and McLeod (1983b). The latter survey was also conducted using a stratified random block census technique during the same time period as the 1988 survey. These data suggest that there has been an increase in moose numbers in the Pelly area on the same order as suggested for the Mayo area between 1979-1988. Contrary to these results, if moose seen/minute of stratification time is used as an indices to population change in the Pelly area, there was no difference in population size between the 1983 (0.10 moose/minute) and 1988 surveys (0.09 moose/minute, Table 4). Search intensity during the 1983 stratification (0.3 min./km^2; Johnston and McLeod 1983) was identical to the 1988 stratification. For this analysis, the entire 1983 Dromedary study area was compared to a similar area from the 1988 Pelly Crossing survey (Figure 2).

The discrepancy in the PC area is likely due to the way in which the 1988 density was estimated. As stated earlier, we have assumed that visibility and density of moose were similar in the Mayo and Pelly survey areas. If these assumptions are incorrect, the extrapolated density would also be incorrect. Our tentative conclusion is that the moose density has not changed in the PC survey area between 1979-1988.

In summary, moose density in the Mayo survey areas is currently lower than other Yukon populations. Density estimates from the Mayo and Pelly Crossing areas over the past decade have been obtained using a variety of survey techniques. These differences bring into question the comparability among surveys, which at best result in tentative conclusions about changes in density. Future surveys, using consistent techniques should be carried out in this region to determine changes in moose densities.

Distribution

Moose were not distributed evenly over the MN and MS survey areas in early winter (Figures 3 and 4). Twenty four aggregation areas (SU's with densities of $\geq$0.2 moose/km^2) contained 39% (209/542) of the total estimated moose population in the Mayo survey areas (Table 5). These areas represented only 13% of the total area. The degree to which moose distribution is clumped can be expressed as the ratio of a certain % of the population occurring in a given % of the land area. The distribution ratio (DR) will facilitate comparisons among different populations. The distribution of moose in Mayo (3.0) is typical of early winter moose populations elsewhere in the southern Yukon. Ratios range from 2.1 in the North Canol survey area (Jingfors 1988) to 6.1 in the Dromedary Mountain survey area (Johnston and McLeod 1983b).

Late winter distribution of moose in the MS survey area was more clumped compared to early winter. Fewer moose were observed during late winter stratification flights (N=99) than early winter stratification flights (N=171), however, only 7% (7/102) of the SU's were rated as medium density in late winter compared to 16% (16/102) in early winter (Figures 4 and 5).

Moose were generally found at higher elevations in early winter compared to late winter in the Mayo area. The early winter midrange elevation of all medium SU's in the MS survey area was 1021 meters compared to 780 meters in late winter. Most of the medium SU's in late winter were located along river bottoms or lower elevation upland habitats, where as in early winter, medium SU's were located primarily in upland areas (Figures 4 and 5). Cows with calves observed on stratification flights in November were at a significantly higher (P=0.004) mean elevation (932 meters) compared to cows with calves in March (739 meters).

The movement of moose into lower elevation habitats in late winter is likely in response to greater snow depths at higher elevations. Although snow depths at higher elevations within the study area were not available, maximum snow depths at Elsa (814 meters asl) have averaged 84 cm. In comparison, maximum snowdepths at Mayo (504 meters asl) have averaged 54 cm. Much of the study area is above 833 meters (2500 ft.). Snowdepths of 80 cm are considered critical to moose calf survival (Coady 1974). Both late winter surveys (25 February - 3 April) were conducted during the period of maximum snowdepths.

Moose were not common at treeline in the Mayo area with only 12% of the moose observed at ≥1350 meters during early winter surveys. This is substantially less in Mayo than the 82% documented in the southwest Yukon (Larsen 1982). The difference is most likely due to the lack of a subalpine shrub zone in the Mayo area, compared to an extensive subalpine shrub community in the southern Yukon. Moose browse (Salix spp) in the Mayo area is found along floodplains and in burns.

The importance of the existing burns to the current moose population in the Mayo area is not clear. Burns are more prevalent in the MS survey area than in the MN area and moose densities are higher (Table 3). Of the 31 moose aggregation SU's (Figures 3 and 4) only 48% (15/31) were either totally or partially within burns, however, the remaining aggregation units (52%) were in unburned areas. The seasonal use of these burns is unknown, as is the age and productivity of these areas. Very recent and very old burns may not provide suitable habitat for moose.

The lack of moose in burns in this area may be due to other factors limiting moose population growth. One potential limiting factor to moose in the Mayo area may be wolf predation. Wolf density in the Mayo area is 10 wolves/1000 km^2 (Hayes and Baer, in prep.), for a moose/wolf ratio of 14:1. Gasaway et al. (1983) suggested that in areas where there is <20 moose/wolf, predation is usually sufficient to cause a decline in moose abundance. This relationship may be confounded by the presence of alternate prey and other large predators. Sheep are not found within the Mayo survey areas, except in the McArthur Range, and caribou occur at a low density. Both bear species occur in this area and it is possible that bears are also having some affect on the population (Larsen et al. 1989a).

Distribution of moose in the PC survey area in early winter followed the same pattern as seen in the Mayo survey (Figure 4). Ten percent (15/150) of the

SU's in the Pelly area in 1988 were classified into the medium stratum (Appendix 3), compared to 12% in the combined Mayo areas in 1988 (Table 2). The midrange elevation of all medium SU's in Pelly was 1052 meters compared to 1021 in MS. Johnston and McLeod (1983b) reported that 70% of the moose observed in the Dromedary area in early winter were between 793-1249 meters.

Moose did not concentrate along the Pelly and Macmillan Rivers during early winter in 1983 or 1988. Both Johnston and McLeod (1983b), and our study, identified only two medium SU's along these rivers. These results are in disagreement with comments made by Lortie and Jack (1975) on the extensive utilization of the Pelly and Macmillan floodplains by rutting moose. There are several potential reasons for this discrepancy. First, the lowland moose population may have been more abundant in the early 1970's compared to now. This is contrary to previous findings (see Density section). Second, moose may move out of the floodplains after rutting (late October) and into upland habitats. Dispersal does occur after the rut (Larsen 1982), but in the southwest Yukon moose typically move from higher to lower elevations. Third, Lortie and Jack (1975) obtained their information through ground observations of only the floodplain area. It is possible that the majority of the population in 1975 also inhabited the uplands and only a relatively small proportion used the floodplain. Even moderate to light use of the floodplain areas, over generations of moose, would leave a substantial amount of cumulative sign.

As in the Mayo area, it appears that moose historically concentrated in the Pelly and Macmillan river valleys in late winter. Lortie and Jack (1975) estimated 123 moose (805 moose/1000 km^2) along the Pelly floodplain between the Macmillan and the Tummel Rivers. Further evidence that moose concentrate in riparian areas during late winter is the number of moose seen/minute of flight time. Johnston and McLeod (1983) and this study found 0.09 and 0.10 moose/minute of flight time respectively during early winter surveys of the area while Lortie and Jack (1975) reported 0.35-0.72 moose/minute of flight time during late winter surveys of the Pelly and Macmillan floodplains (Table 4).

Composition

Adult cows were the most abundant age and sex class in the combined Mayo survey areas in early winter (40% of the population), followed by adult bulls (26%), calves (25%), and yearlings (10%, Table 3). The corresponding ratios were 68 bulls, 24 yearlings, and 61 calves/100 cows (≥30 mo.).

Some differences in composition between survey areas were noted. Adult bulls comprised a higher proportion of the total population in the MS survey area (31%) compared to the MN area (19%, Table 3). However, the ratio of bulls/100 cows was not significantly different between areas because of the wide CI around the estimates (59 ±45% and 76 ±30%). The bull/cow ratios in both areas were well above the minimum 30 bulls/100 cows being managed for in the Yukon (YF&WB internal management strategies). Ratios of 47 bulls/100 cows in the southwest Yukon had no measurable effect on pregnancy rates or the timing of calving (Larsen et al. in prep.). Bull/cow ratios in Mayo were the same or higher then the average (59 bulls/100 cows) for other moose population in the Yukon (Appendix 1).

Yearling/cow ratios in the combined Mayo areas (24 yearlings/100 cows) were similar to the average 23 yearlings/100 cows) found for other moose populations in the Yukon (Appendix 1). Yearling recruitment appeared to be higher in MN (42 yearlings/ 100 cows) compared to the MS area (11/100). This difference may be partially the result of small sample sizes, especially in the MS area. In that survey area the estimated 17 yearlings for the entire population was based on three yearling males observed during the census. If even one yearling was missed during the census, the ratio would change dramatically. Caution is advised when interpreting ratios based on small samples. Yearling/cow ratios from the trend survey (MS area) were similar (28 yearling/100 cows) to ratios from the combined Mayo areas (Appendix 4).

Calf production and/or survival to 6 months of age was high in the survey area in 1988, with 61 calves/100 cows ≥30 mo. (Table 3). Calf/cow ratios were similar in both MN and MS survey areas. This ratio exceeds all others in the Yukon which have been documented to date (Appendix 1), except the North Canol/Frances Lake areas where there has been extensive wolf control (Farnell and McDonald, 1988). The twinning rate (cows with twins/cows with calves) of 14% (9/63) for the Mayo survey areas is also the highest early winter twinning rate recorded in the Yukon (Appendix 1).

Over winter calf survival appears to be high in the MS survey area in 1988-1989. The proportion of calves recorded on the February and April 1989 surveys (23% and 25%, Table 6) were similar to the proportion of calves estimated in the MS area in early winter (23%, Table 3). These were also similar to calf percentages recorded by Larsen (1979) in late winter along the Stewart River (17-21%), but higher than other late winter surveys in this region (Appendix 2). These results suggest that over winter calf survival was high in 1988/1989, and also infers that over winter calf survival may have been high over the past decade.

A closer examination of the calf survival information suggests that survival may not have been as high as the data indicated. It is possible that all late winter surveys overestimated the proportion of calves in the population. This could occur if cows with calves were more visible in late winter compared to early winter. Visibility may be increased if cows with calves were forced to concentrate into areas with less snow while single adults remained dispersed. As concentrations or groups of animals are easier to spot from the air, cows with calves could be overestimated while single adults could be underestimated. Based on the late winter distribution of moose in the MS area, moose were concentrated in lower elevation SU's, typically in or adjacent to riparian habitats (Figure 5). The late winter composition survey was conducted in the river valley because moose were more abundant there (figure 6). Although this survey was more intensive than the late winter stratification survey, it may have still overestimated the proportion of calves in the overall population if cows with calves were concentrated in these survey units.

In summary, the composition of the Mayo moose population was typical of other populations, except for the high number of calves in both early and late winter. We believe that the early winter estimates are accurate, but that the late winter estimates may be biased. If overwinter calf survival was high, as indicated by high proportions of calves in the population, since 1979 (Appendix 2, and this study), then we would expect higher densities of moose than were recorded in 1988 (139 moose/1000 km^2), unless high calf survival has been offset by high adult mortality. If this occurred, the result would be no net gain to the population. We do not have information on adult mortality rates from this area. Another possible explanation is that the high calf crops documented in both 1979 and 1989 were real, but atypical of the average long term calf production/survival for this area.

Aircraft Comparison

Overall, significantly (P=0.009, paired T test) fewer moose were seen (67% less) from the supercub (N=49) then the helicopter (N=73), (Appendix 5). However, the helicopter crew did not observe all the moose seen by the supercub crew. Forty individual moose were seen by both the helicopter and supercub crews, 9 more moose were observed by only the supercub crew, and 33 more moose were observed by only the helicopter crew. The composition data collected from the two aircraft types was not significantly different (P>0.05 Chi square analysis), although a higher proportion of adult males (31% vs 23%) and a lower proportion of calves (18% vs 23%) were seen from the supercub (Appendix 4). The mean search intensity was similar between the supercub (2.0 min./km^2) and helicopter (2.2 min./km^2) trials.

Differences in the number of moose seen from the two aircraft types is most likely due to the flushing effects of the helicopter on moose. Because helicopters are more maneuverable then supercubs, the search pattern consist of shorter transects and frequent circling. This increased activity and the noise created by the helicopter blades while turning causes moose to move around. Because moving objects are easier to spot from the air, we would expect higher counts from a helicopter. The differences in composition from the two aircraft types can be explained by the fact that adult males are more visible than other age/sex groups because of their size and presence of large antlers. Gasaway et al. (1986) reported that bulls were more easily seen then cows, based on experimental searches using radio-collared moose. Calves may be less visible than other age/sex groups because they are small and often stand next to the cow. If sightability is lower in a supercub compared to a helicopter, calves would be underestimated more frequently from supercub surveys.

Our results differ from those reported by Jingfors (1988). In that study, similar counts were made between helicopter and supercub crews. Jingfors also reported fewer calves on the supercub trials compared to the helicopter, although the difference was not significant. Differences between the two experiments can not be explained by observer experience, snow conditions, search intensity, weather conditions, moose density, or survey technique. The only potential differences were pilot experience and cover type. An inexperienced pilot (on moose surveys) was used in our study while an experienced pilot (7 years on moose surveys) was used by Jingfors. The pilot contributes substantially to the super cub surveys as there are only two people in the aircraft. Cover types may have also differed between study areas. Vegetation comparisons between study areas were not made. Cover has been reported as an important factor influencing moose sightability (LeResche and Raush 1974, Novak 1981, Gasaway et al. 1986).

Our results indicate that both moose density and composition are more accurately assessed from a helicopter, compared to a supercub. In addition to the increased observability, helicopters are preferred over fixed-winged aircraft for the following reasons (Larsen 1982).

1) Helicopters are more maneuverable, and thus safer, in mountainous terrain and windy conditions. Both are common in the southern Yukon and are often encountered in the rest of the Yukon.

2) Navigation is easier from a helicopter compared to a supercub for two reasons. First, helicopters are more maneuverable, allowing the navigator to accurately identify and constantly maintain contact with SU borders. Second, in the helicopter, one person concentrates on navigation while the others concentrate on searching for moose. In the supercub, either the pilot or the

observer must both navigate and search. Navigating is demanding, therefore, either the pilot or observer are not likely to be very efficient at their respective tasks. As well, moose are plotted on a 1:50000 map, demanding that the navigator know their location at all times. If not, the observer or pilot must stop searching for moose to determine their location. During this time, moose are not being searched for out of one side of the aircraft.

3) Classification of animals is easier in helicopters, as the aircraft can stop temporarily to accurately determine the sex and age of an animal. Classification becomes more difficult when large groups of moose are encountered or when moose are found in dense vegetation. In the Yukon moose are typically clumped in distribution.

4) Both fatigue and boredom can be reduced by periodically landing in a helicopter. This is not always an option in a supercub, unless you are willing to fly some distance to suitable landing areas. Rest periods must be kept to a minimum as there are limited suitable daylight hours (3-5 hrs.) in Nov./Dec. for surveying.

5) With a lower observability of moose from a supercub compared to a helicopter, a larger sightability correction factor (S.C.F.) would be required to compensate for unobserved moose from the supercub. To obtain a meaningful S.C.F., there must be sufficient numbers of moose present. Gasaway et al. (1986) recommends that there be at least one moose/mi^2 (390 moose/1000 km^2) before attempting a SCF. Using this criteria, the low density stratum in the Mayo study area would not be suitable, and the medium stratum would be marginal for determining a S.C.F. Therefore, in low density populations it would be difficult to obtain a useful S.C.F. Low density populations are common in the

Yukon. If a correction factor can not be obtained, the census technique which results in the highest observability should be used (i.e. helicopter).

6) Qualifications of a supercub crew (pilot and observer) must be higher, compared to a helicopter crew. The supercub observer must have better qualifications as there is only one set of eyes compared to three in the helicopter. As well, air sickness is a greater problem when flying in a supercub, compared to a helicopter. If the observer is feeling sick, his concentration level will be lower and fewer moose are detected. Because of the size of the areas covered each year it is necessary to hire additional staff for the moose surveys. Our experience in the past has been that it is often difficult to consistently find highly qualified observers from year to year. The pilots qualifications and attitude towards the surveys is also more critical when using a supercub compared to a helicopter. In the helicopter, the additional observers can compensate for the lack of pilot enthusiasm. Our experience has also been that there are only a few suitable cub pilots in the Yukon, and they are not always available.

The major advantage of the supercub is that is costs approximately one fifth that of a helicopter. However, these cost savings must be carefully weighed against the trade offs discussed above.

The aircraft comparison results indicated that not all moose were observed from the helicopter. If we assume that the combined count of individual moose seen on both helicopter and supercub flights represented the actual number of moose in the eight SU's, then the helicopter crew missed 11% (9/82) of the moose. These unobserved moose can be used to estimate a S.C.F. for the rest of the survey area. Based on these data, a S.C.F. of 1.23 (82/73) was calculated.

Trend Counts

Eighty-three moose (302 moose/1000 km^2) were observed on the trend survey in the MS area (Figure 6, Appendix 4). Most of the moose (95%) were observed in five of the ten SU's, which made up the trend area. The majority of these SU's were within a 1969 burn. Population composition was similar between the trend count (Appendix 4) and the MS survey areas (Table 3), although there were a higher proportion of yearlings on the trend survey (10%) compared to the MS estimate (4%).

The purpose of the trend survey area is to collect information annually on moose density and composition that can be used as an indices to potential changes in the overall population. If changes are detected, a more extensive survey would be conducted for verification. Therefore the trend surveys supplement the more intensive population surveys which will be conducted less frequently (3-5 years). The trend surveys are considerably less expensive than the larger surveys (Appendix 6).

In addition, trend surveys could be used in an experimental design to determine the effects of future hunting or development on a moose population. Two trend areas would have to be established, one in an undisturbed area (control) and the other in an experimental area. The trend area in Mayo is located in a heavily hunted GMS which has the potential for increased hunting and other activities. We propose to establish another trend area in the McArthur sanctuary as a control.

Moose harvest and estimated allowable harvest levels

The resident non-Indian and non-resident moose harvest for the study area (reported harvest) is summarized in Table 7. The non-resident harvest occurred only in GMS's 4-10 and 4-11 (Figure 1), while the resident harvest occurred throughout the study area, except the McArthur Sanctuary.

The reported harvest was low throughout the study area between 1979-1987 with a mean annual harvest of 6 moose in MN, 9 in MS, and 2 in the PC survey areas (Table 7). These harvest levels have remained fairly consistent over the past 9 years. Likewise, resident non-Indian harvest intensity (kills/1000 km^2) was low throughout the study area, with similar intensities found in both Mayo survey areas (2.5 and 2.8) and a slightly low intensity in the Pelly survey area (1.3).

The days effort required for each moose killed by residents (success rate) was high in the North and South Mayo areas (49 and 51 days respectively), but considerably lower in the Pelly area (17 days). The success rate fluctuated widely in both Mayo areas and remained consistent in Pelly (Table 7). These fluctuations are due to small sample sizes, for example, in Mayo north in 1987, 179 days were spent for one moose (179 days/moose). If only one more moose was shot, the success rate would be half (90 days/moose). Caution is advised when interpreting success rates based on small harvest levels. Recognizing this problem, there were no obvious trends in the success rate information.

The harvest data from the study area suggest that the availability of moose has not changed since 1979. Most of the moose harvested, and the hunting effort, occurred in the Mayo survey areas, however, moose were easier to find in the Pelly area.

The current allowable harvest (C.A.H.) for the study area can be estimated if several assumptions are accepted. First, the management objective is to maintain a stable population at the 1988 density (managing for increased moose densities is not an objective). Second, the annual natural survival of yearlings and adults is between 85%-90%. Using the formula: C.A.H. = ([{adults + yrlgs} x adult and yrlg. survival rate] - adults), the estimated C.A.H. for the MN and MS survey area combined (excluding the McArthur Sanctuary), in 1989 was between 0-17 moose (0-4 moose/1000 km^2 total land area, Appendix 7), The range in the C.A.H. reflects the two adult survival rates.

Several things should be considered when interpreting this data. First, the adult and yearling survival figures were based on survival rates from the south west Yukon (89%, Larsen et al. 1989), east central Alaska (80%, Gasaway et al. 1983) and eastern Alaska (94%, Gasaway et al. 1988). Although rates were consistent between these studies, the survival rates in the Mayo area may deviate from this pattern. If they do, the allowable harvest would change. Second, the C.A.H. is primarily a function of the number of yearlings in the population in 1988. Based on the large proportion of calves in both the November 1988 and the April 1989 censuses, the number of yearlings in November 1989 may be substantially greater than compared to November 1988. If this occurs, then there should be a greater harvestable surplus the following year. If yearling recruitment fluctuates from year to year, an average recruitment rate must be determined. Third, the C.A.H. was not consistent between the MN and MS survey areas (Appendix 7). Because of the lower number of yearlings in MS, there is no surplus in that area, however, in MN the surplus is between 15-26 moose. Fourth, if there is an allowable harvest, it must be distributed proportional to the moose densities in the area. For example, if the 17 surplus moose in the MS area were taken from a small portion of the study area, that area would be overharvested.

The C.A.H. for the Pelly area can not be determined from data collected in that area. However, if we assume the Pelly moose population is similar in density and composition to the MS area an allowable harvest can be approximated. Based on a C.A.H. of between 7-11 moose/1000 km^2 in MS, there would be between 31-49 surplus moose in the Pelly survey area. We emphasize that PC moose density and composition must be similar in the Mayo area for this extrapolation to be valid.

The C.A.H. in the PC area can be compared with recent harvest levels to determine if the population has been overharvested. This could not be done in the Mayo areas as we do not know the Indian harvest. However, because there were no surplus moose in the MS area (based on our calculations and assumptions) any harvest (Indian or non-Indian) would be an overharvest. The mean annual (1979-1987) non-Indian harvest in the Pelly Crossing area was 1.3 moose/1000 km^2 (Table 7). Based on the 1987 Native harvest study, 23 moose were also killed by Indians in this same are for a harvest intensity of 5.2 moose/1000 km^2. The total harvest for the Pelly survey area is 5.5 moose/1000 km^2. This rate is below the C.A.H. (7-11 moose/1000 km^2) approximated for this area.

RECOMMENDATIONS

1. The big game management agreement initiated in 1986 between YF&WB, and the Na-Cho Ny'A'K-Dun band should be further developed in light of recent information on moose, caribou, and wolves. As part of management plans to be produced, species specific objectives (i.e. population targets) and strategies to achieve those objectives should be jointly developed with both the Indian and non-Indian groups of this area.
2. Continue to seek information on Indian harvest levels from both local band members. This information is crucial to understanding changes in moose composition and density, and in determining appropriate harvest levels.
3. Allowable harvest levels should be determined by: a) estimating the average annual adult natural mortality through a radio-collared sample of the population, and b) estimating the average annual recruitment through yearly trend surveys and periodic (3-5 yrs.) intensive surveys.
4. Non-Indian harvest levels, especially in the Mayo south survey area, should continue to be monitored closely over the next few years. This information should be compared to yearling recruitment from the annual trend surveys to determine if the population is being overharvested.
5. The existing trend survey area should be expanded to include a second area within the McArthur Sanctuary. The latter area would be used as a control against which comparisons could be made with populations exposed to development or heavy hunting pressure.
6. Survey techniques should be kept consistent from year to year. This applies to both the trend and census surveys. If techniques are not consistent, temporal comparisons may be confounded.
7. In the future, late winter surveys should be both intensive and extensive. If not, composition and distribution data may be biased.

8. A sightability correction factor should be determined in future surveys in areas with moderate to high moose densities. A S.C.F. is likely not feasible to determine if densities are <390 moose/1000 km^2 (Gasaway et al. 1986, personal observations). In areas where it is not feasible, the moose population will be underestimated. As a result, recommended harvest levels for these populations would be conservative.
9. The use of supercubs on moose surveys should be restricted to trend counts, until further experiments are conducted to assess the efficiency of the cub vs helicopter in a variety of terrains, cover types, and using different pilots.
10. A study of the relationship between moose and habitat in the Mayo/Pelly areas should be carried out to idenfity key habitat areas and types. The availability of browse, elevation and aspect could be compared to the existing distribution of moose to determine preference for specific habitat types. As part of a browse study, the suitability of burns could be assessed. Location data from the early winter moose survey could be used in a habitat utilization study, however, additional information at different times of year would be required for a thorough analysis.
11. If trend surveys over the next few years continue to indicate high calf survival with continued low moose densities, studies should be implemented to determine the rate and causes of moose mortality in order to identify the major limiting factors to moose population growth.
12. The above recommendations for future programs in the Mayo and Pelly Crossing areas should be discussed, revised if necessary, and jointly implemented by YF&WB and the Bands. If there is no interest or cooperation from the Bands on these recommended programs, they should not be implemented.

ACKNOWLEDGEMENTS

We would like to thank Kevin Bowers, Pam Braun, Ken Frankish, Val Loewen, Frances Naylen, Jennifer Staniforth, Ron Sumanik, and Wayne Williams for providing technical assistance during the surveys. Although the weather didn't cooperate, everyone managed to retain their enthusiasm and sanity. We would also like to thank the Na-Cho Ny'a'k-Dun Band for providing us with the following observers: Billy Germaine, Gerald Buyck, and Dave Lucas. As well, the Selkirk Band provided us with Edward Johnson and Alex Joe as observers. To our pilots, Tom Hudgin (AeroKon), Ray Harvats (AeroKon), Tom Pasetka (AeroKon), Bruno Meili (Capital Helicopters), and Delmar Washington (Capital Helicopters) we extend our appreciation for a job well done.

LITERATURE CITED

Coady, J.W. 1974. Influence of snow on behavior of moose. Nat. Can. (Que) 101: 417-436.

Dubois, S. W. Gasaway and D. Ruby. 1981. Aerial classification of bull moose on antler development. Unpubl. report. ADF&G, Fairbanks, Alaska. 5 pp.

Farnell, R. and J. McDonald. 1988. The demography of Yukon's Finlayson caribou herd, 1982-1987. Progress report. Internal report, Yukon Fish and Wildlife Branch, Whitehorse. 54 pp.

Gasaway, W.C., R.O. Stephenson, J.L. Davis, P.K. Shepher, and O.E. Burris. 1983. Interrelationships of wolves, prey, and man in interior Alaska. Wildl. Monogr. 84: 1-50.

___________, S.D. DuBois, D.J. Reed, and S.J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biol. Papers of Univ. of Alaska. Number 22. 108 pp.

Jingfors, K. 1988. Moose population characteristics in the North Canol and Frances Lake areas, November 1987. Yukon Dept. Renewable Resources, Whitehorse. 35p.

___________, and R.L. Markel. 1987. Abundance and composition of moose in the Whitehorse south, Nisutlin, and Liard east areas, Nov. 1986. Internal Report, Yukon Fish and Wildlife Branch, Whitehorse. 22 pp.

Johnston, W.G. and H.A. McLeod. 1983a. Population dynamics and early winter habitat utilization by moose (Alces alces) in the southwest Yukon. Prepared by Northern Biomes Ltd. for Yukon Fish and Wildlife Branch, Whitehorse.

__________ and __________. 1983b. Moose population dynamics in the Dromedary Mountain area, central Yukon Territory. Internal report, Yukon Fish and Wildlife Branch, Whitehorse. Prepared by Northern Biomes Ltd. Whitehorse, 31 pp.

______________ and C.A. McEwen. 1984. Moose abundance and habitat use in Liard west, Yukon during early winter 1983. Internal report, Yukon Fish and Wildlife Branch, Whitehorse. Prepared by Northern Biomes Ltd. Whitehorse, 43 pp.

Kale, W. 1982. Estimation of moose harvest of "smaller" management units in the Yukon. Alces 18: 116-141.

Larsen, D.G. 1979. Winter moose surveys GMZ 3-4 and a review of moose hunting seasons - 1979. Internal report, Yukon Fish and Wildlife Branch, Whitehorse.

__________. 1982. Moose inventory in southwest Yukon. Alces 18: 142-167.

_________, D.A. Gauthier, R.L. Markel. 1989a. Causes and rates of moose mortality in the southwest Yukon. J. Wildl. Manage. 53: In Press.

________, ____________, __________, and R.D. Hayes 1989b. Limiting factors on moose population growth in the southwest Yukon. Internal report, Yukon Fish and Wildlife Branch, Whitehorse. 96pp.

LeResche, R.E. and R.A. Rausch. 1974. Accuracy and precision of aerial moose censusing J. Wildl. Manage. 38:175-182

Lortie, G. and J.Jack. 1975. The Granite Caynon dam proposal - a preliminary ecological reconnaissance of the impounded area. Internal report, Yukon Fish and Wildlife Branch, Whitehorse.

Lynch, G.M. 1975. Best timing of moose surveys in Alberta. Pages 141-153 in Proc. 11th North American Moose Conf. and Workshop, Winnipeg.

Markel, R.L. and D.G. Larsen. 1983. Southwest Yukon moose survey results. Nov. 1982. Internal Report, Yukon Fish and Wildlife Branch, Whitehorse. 17 pp.

___________ and __________. 1984. Southwest Yukon moose survey results, Nov.-Dec. 1983. Internal Report, Yukon Fish and Wildlife Branch, Whitehorse. 22 pp .

___________ and __________. 1985. Southwest Yukon moose survey results, Nov.-Dec. 1984. Internal Report, Yukon Fish and Wildlife Branch, Whitehorse. 13 pp.

____________ and __________. 1988. Moose population characteristics in the Casino Trail area - 1987. Internal Report, Yukon Fish and Wildlife Branch, Whitehorse. 18 pp.

Mitchell, H. 1970. Rapid aerial sexing of antlerless moose in British Columbia J. Wildl. Manage. 34: 645-646.

Mytton, W.R. and L.B. Keith. 1981. Dynamics of moose populations near Rochester, Alberta, 1975-1987. Can. Field-Nat. 95(1): 39-49.

Nette, T. and P. Merchant. 1981. Distribution, abundance, and harvest of mountain sheep in outfitting area #8. Internal Report, Yukon Fish and Wildlife Branch, Whitehorse. 23 pp.

Novak, M. 1981. The value of aerial inventories in managing moose populations. Alces 17: 282-315.

Oswald, E.T. and J.P. Senyk. 1977. Ecoregions of Yukon Territory. Fisheries and Environ. Canada. 115 pp.

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

Quock, R. and K. Jingfors. 1988. Yukon Indian harvest survey progress report, 1987. Internal report, Yukon Fish and Wildlife Branch. Whitehorse. 35 pp.

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

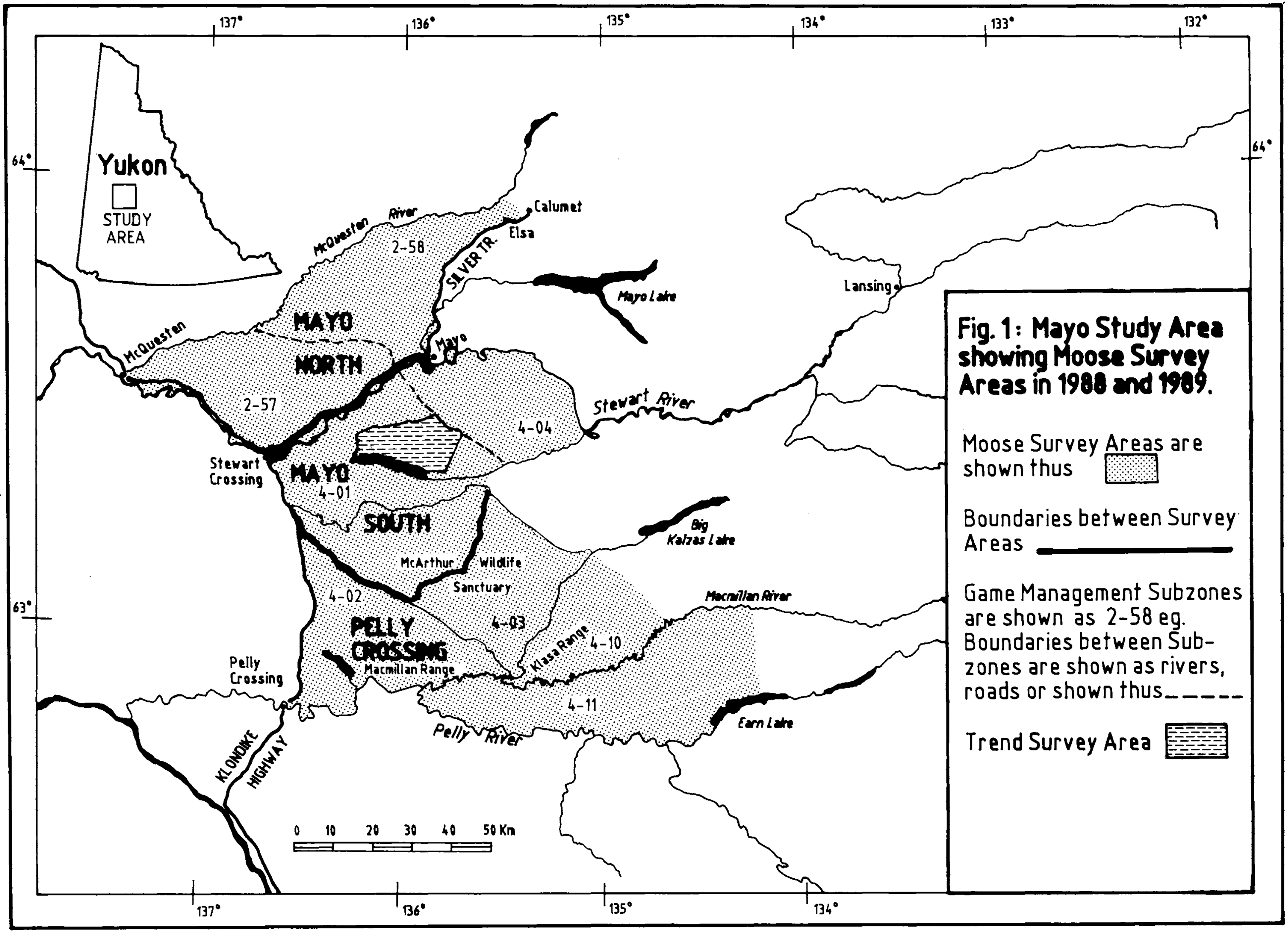


Fig. 1: Mayo Study Area showing Moose Survey Areas in 1988 and 1989.

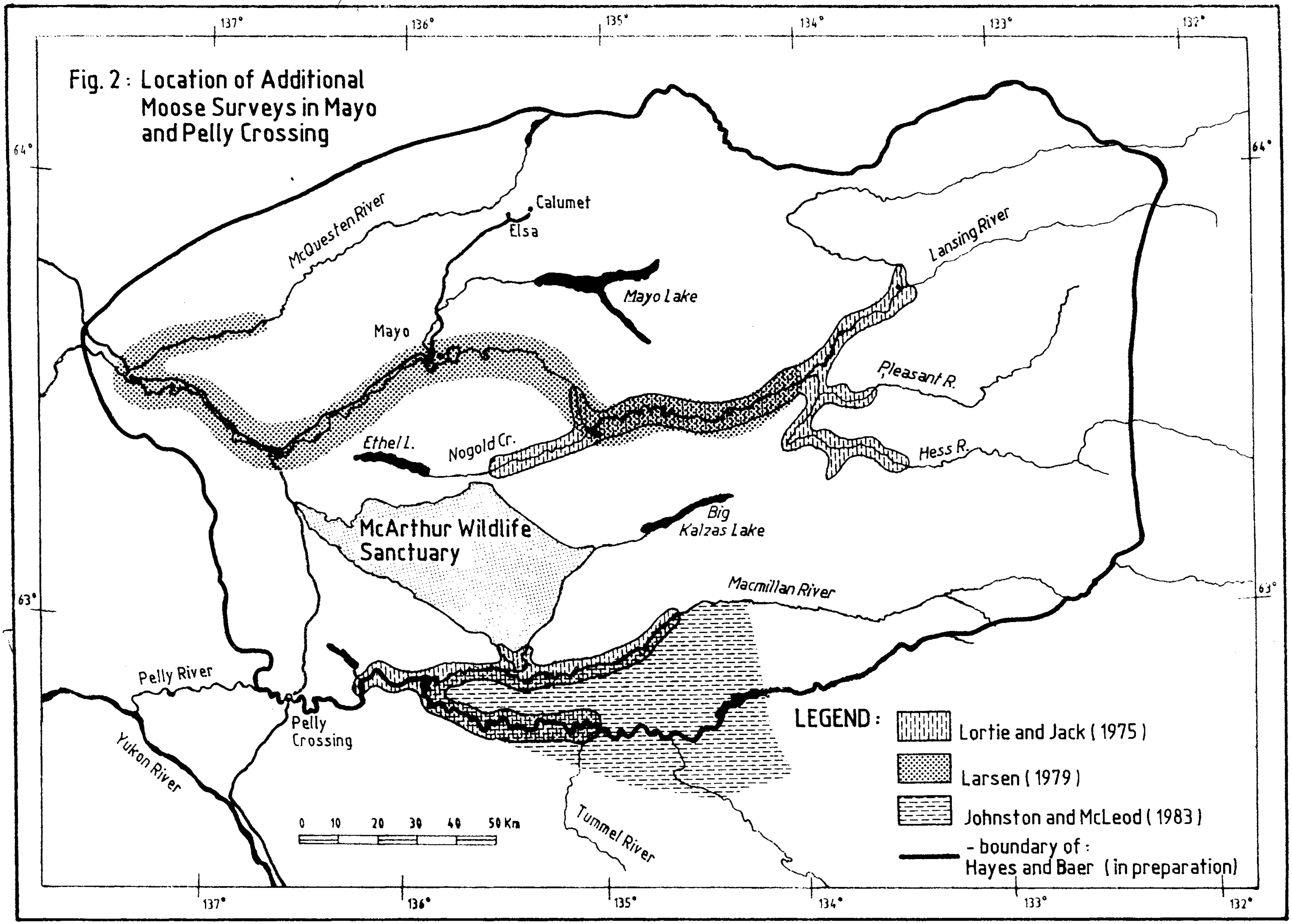


Fig. 2 : Location of Additional Moose Surveys in Mayo and Pelly Crossing
137°
136°
135°
134°
133°
132°
64°
63°
McQuesten River
Calumet
Elsa
Mayo Lake
Mayo
Lansing River
Pleasant R.
Hess R.
Ethel L.
Nogold Cr.
McArthur Wildlife Sanctuary
Big Kalzas Lake
Macmillan River
Pelly River
Pelly Crossing
Yukon River
Tummel River
0 10 20 30 40 50 Km
LEGEND :
Lortie and Jack (1975)
Larsen (1979)
Johnston and McLeod (1983)
- boundary of : Hayes and Baer (in preparation)

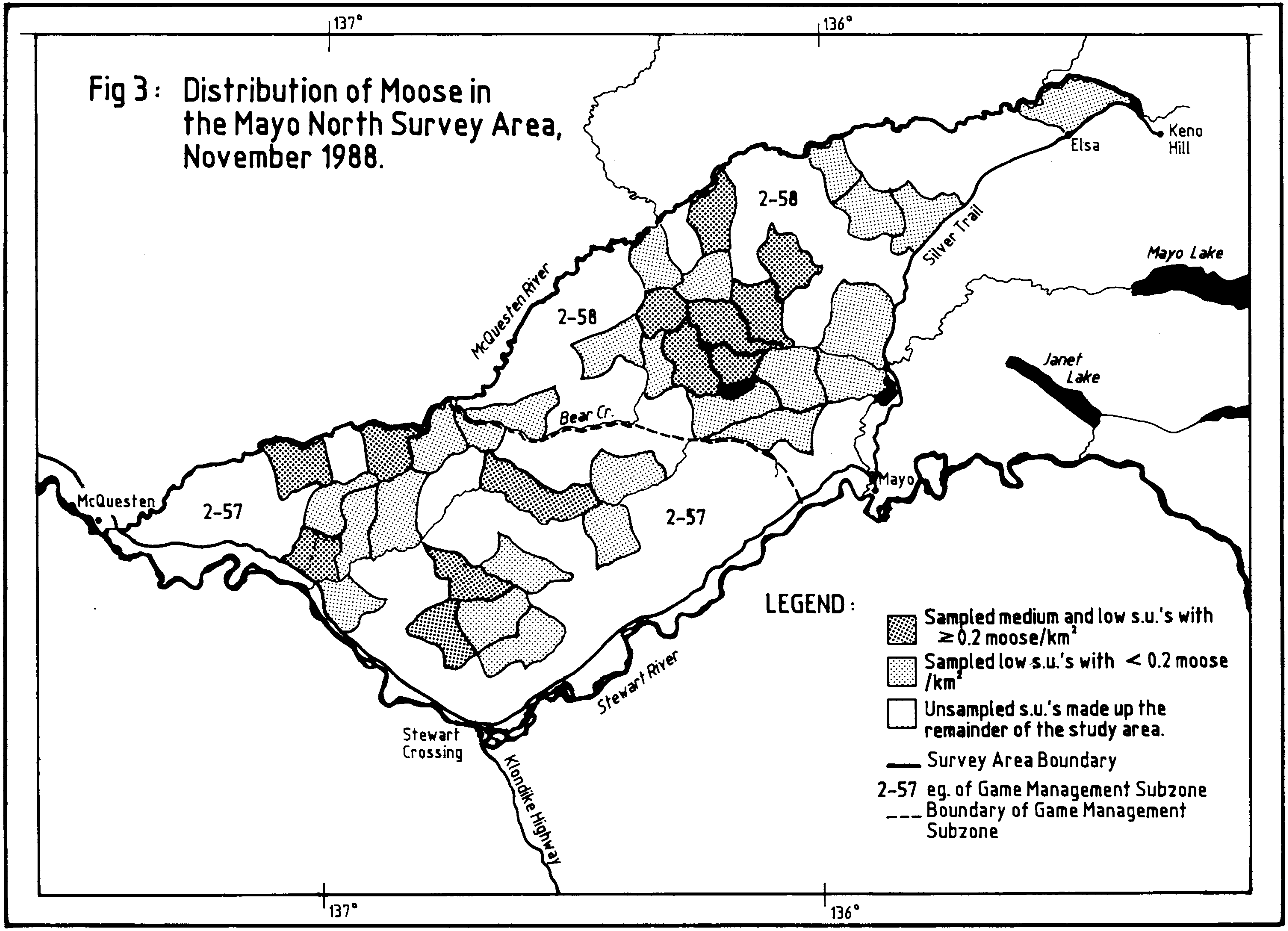


Fig 3: Distribution of Moose in the Mayo North Survey Area, November 1988.

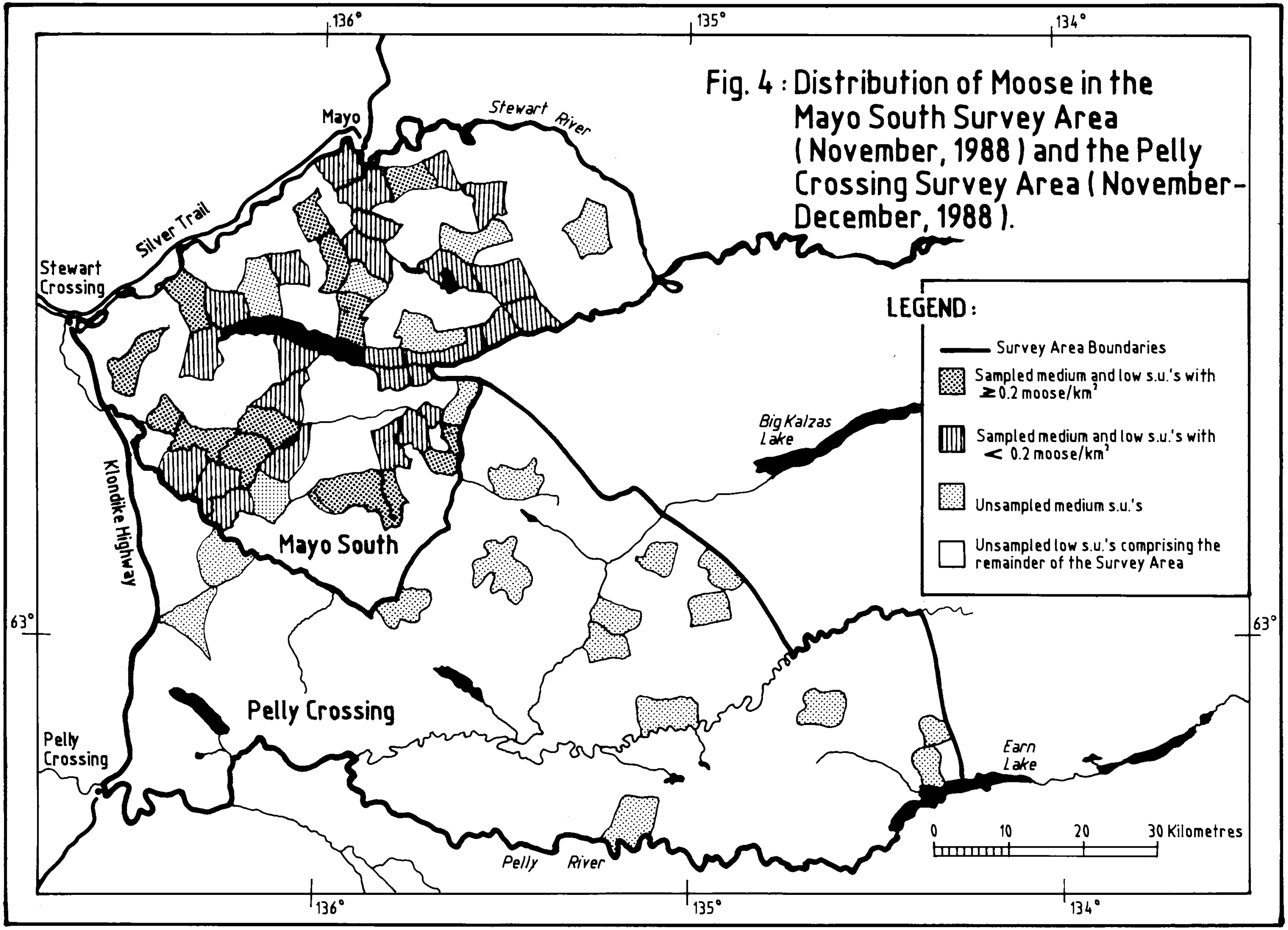


Fig. 4 : Distribution of Moose in the Mayo South Survey Area (November, 1988) and the Pelly Crossing Survey Area (November-December, 1988).

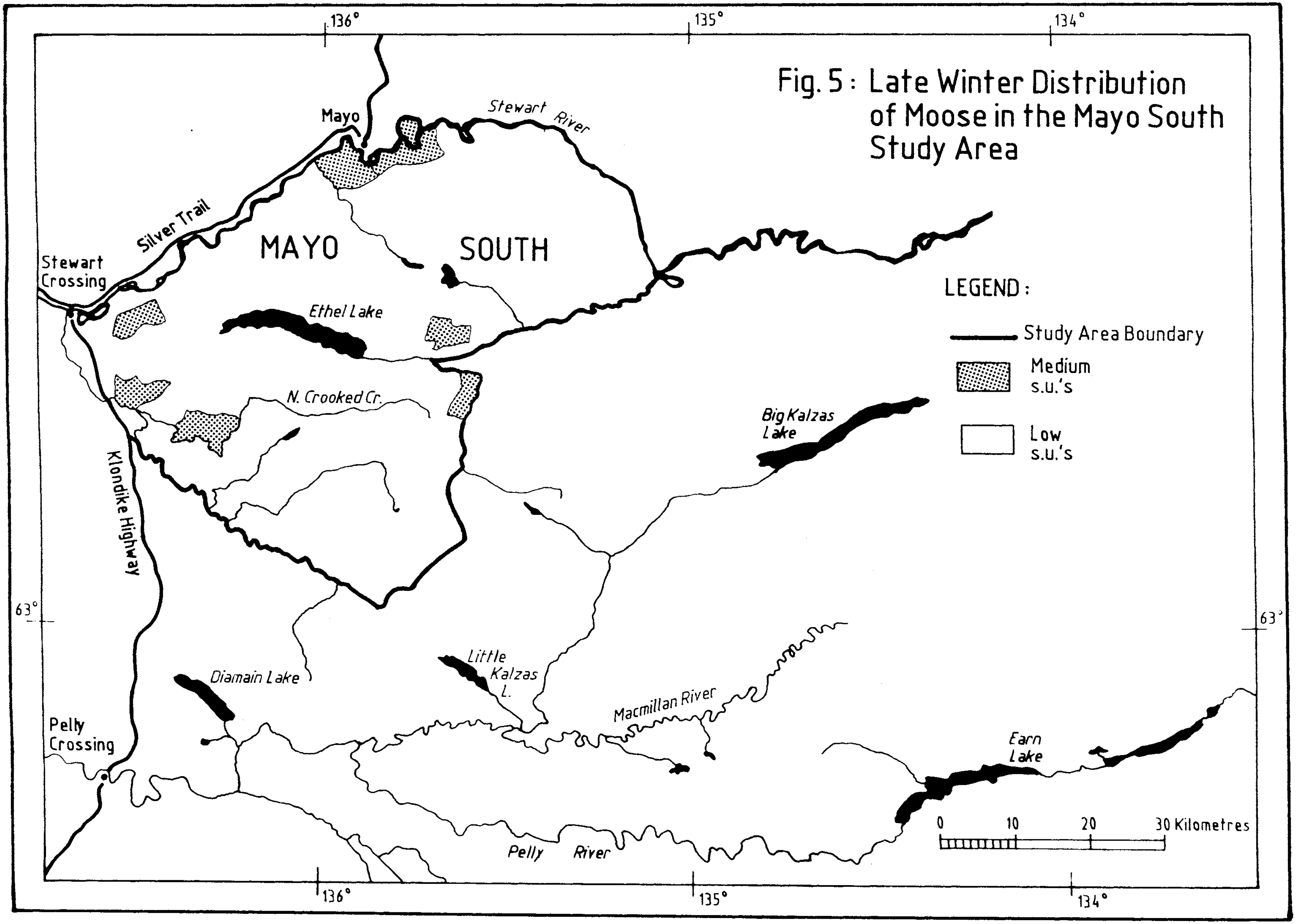


Fig. 5 : Late Winter Distribution of Moose in the Mayo South Study Area
136°
135°
134°
63°
63°
Mayo
Stewart River
Silver Trail
Stewart Crossing
MAYO
SOUTH
Ethel Lake
N. Crooked Cr.
Klondike Highway
LEGEND :
Study Area Boundary
Medium s.u.'s
Low s.u.'s
Big Kalzas Lake
Little Kalzas L.
Diamain Lake
Macmillan River
Pelly Crossing
Earn Lake
Pelly River
0
10
20
30 Kilometres
136°
135°
134°

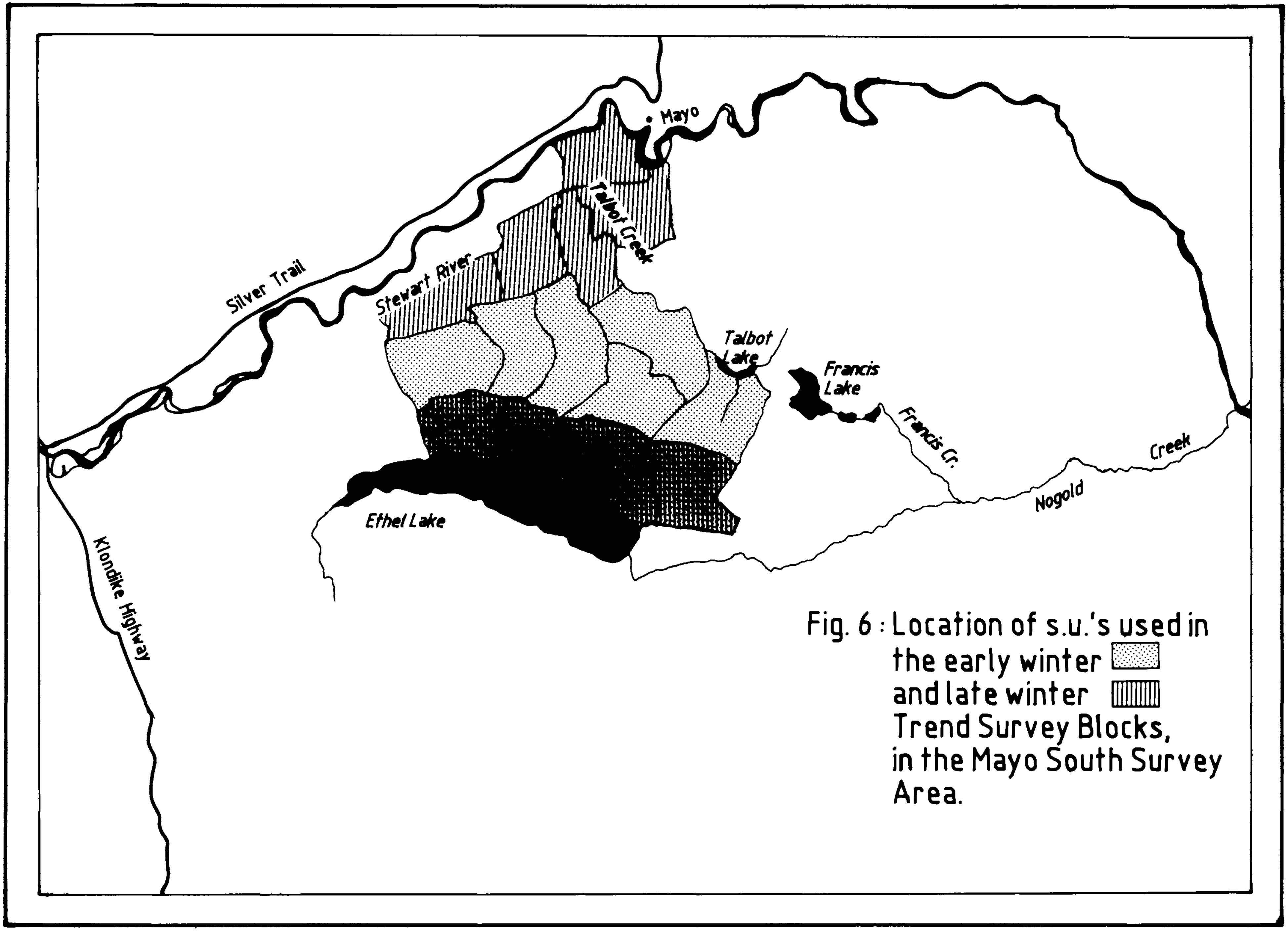


Fig. 6 : Location of s.u.'s used in the early winter and late winter Trend Survey Blocks, in the Mayo South Survey Area.

Table 1. Search intensity (minutes/km^2) for each survey conducted in the Mayo and Pelly Crossing survey areas, 1988-1989.

Survey Period	Survey Area	Search Intensity (minutes/km^2)	
		Fixed wing	Helicopter
A. Early winter surveys Intensive surveys			
	Mayo north	0.4	1.9
	Mayo south	0.4	1.8
Extended stratification			
	Pelly Crossing	0.3	n/a
Trend areas			
	Mayo south	2.0	n/a
Aircraft comparisons areas			
	Mayo south	2.0	2.2
B. Late winter surveys			
	Stratification Mayo south	0.3	n/a
	Composition counts Mayo south	2.0	n/a

Table 2. Sampling intensity by stratum and survey area during the helicopter census of the Mayo area, November - December, 1988.

Survey Area	Sample Units (SU)	Stratum		
		Medium	Low	Total
Mayo north ($2235\ km^2$)	No. of SU (%)	7(8)	82(92)	89(100)
	SU surveyed (% sampled)	7(100)	31(38)	38(43)
Mayo south ($2618\ km^2$)	No. of SU (%)	16(16)	86(84)	102(100)
	SU surveyed (% sampled)	9(56)	26(30)	35(34)

Table 3. Estimated moose population abundance and composition in the Mayo south and Mayo north survey areas, November - December, 1988.

Survey Area	Parameter	Strata Med.	Strata Low	Total (90% CI)	% of Total
Mayo north	Estimated total moose population (uncorrected for observability)	60	175	233±25%	-
	Density (moose/km^2)	0.317	0.085	0.104	-
	Estimated total population (corrected for observability, SCF=1.23)	74	213	286±25%	-
	Density (moose/km^2)	0.392	0.104	0.128	-
	Composition (corrected for observability)				
	Adult bulls (≥ 30 mo.)[a]			55±33%	19
	Adult cows (≥ 30 mo.)[a]			111	39
	Yearlings (18 mo)[a]			47	16
	Calves			75±36%	26
	Ratios				
	Bulls (≥18 mo)/100 cows (≥18 mo.)			59±45%	
	Yearlings/100 cows (≥30 mo.)[a]			42	
	Calves/100 cows (≥18 mo.)			55±22%	
	Calves/100 cows (≥30 mo.)[a]			68	
Mayo south	Estimated total moose population (uncorrected for observability)	145	170	315±20%	-
	Density (moose/km^2)	0.316	0.079	0.120	-
	Estimated total moose population (corrected for observability, SCF=1.23)	178	209	387±20%	-
	Density (Moose/km^2)	0.388	0.097	0.148	-
	Composition (corrected for observability)				
	Adult bulls (≥ 30 mo.)[a]			119±28%	31
	Adult cows (≥ 30 mo.)[a]			159	41
	Yearlings (18 mo)[a]			17	4
	Calves			89±29%	23
	Ratios				
	Bulls (≥18 mo)/100 cows (≥18 mo.)			76±30%	
	Yearlings/100 cows (≥30 mo.)[a]			11	
	Calves/100 cows (≥18 mo.)			53±24%	
	Calves/100 cows (≥30 mo.)[a]			56	

Table 3 continued ...

Survey Area	Parameter	Strata Med.	Strata Low	Total (90% CI)	% of Total
Combined	Estimated total moose population (uncorrected for observability)	205	343	548±16%	-
	Density (moose/km^2)	0.316	0.082	0.113	-
	Estimated total moose population (corrected for observability, SCF=1.23)	252	422	674±16%	-
	Density (moose/km^2)	0.389	0.100	0.139	-
	Composition (corrected for observability)				
	Adult bulls (≥ 30 mo.)			175±21%	26
	Adult cows (≥ 30 mo.)[a]			271	40
	Yearlings (18 mo)[a]			64	10
	Calves			164±22%	25
	Ratios				
	Bulls (≥18 mo)/100 cows (≥18 mo.)[a]			68±25%	
	Yearlings/100 cows (≥30 mo.)[a]			24	
	Calves/100 cows (≥18 mo.)[a]			54±16%	
	Calves/100 cows (≥30 mo.)[a]			61	

a. Yearling females were assumed to be equal to yearling males in numbers. However, we could not assume yearling females were distributed in the same SU's as yearling males; therefore, CI could not be calculated for parameters in which yearling and adult cows were combined or in which yearling males and females were combined.

Table 4. Comparison of moose indices (moose seen/minute flight time) from survey conducted in the Pelly Crossing area.

Survey	Reference	Moose Seen	Search Time (min.)	Moose Seen/min. search time
Pelly R. to Granite Canyon, Feb. '76 (River Reconn.)	Lortie and Jack 1975	61	85	0.72
Macmillan River Feb.'76 (River Reconn.)	Lortie and Jack 1975	28	72	0.39
Pelly River Feb.'76 (Transects)	Lortie and Jack 1976	29	82	0.35
Dromedary Area Nov. '83 (Stratification)	Johnston and McLeod 1983	123	1170	0.10
Pelly Area Nov.-Dec. '88[a] (Stratification)	This study	40	428	0.09

a Only the portion of the Pelly Crossing area enclosed by the Pelly and Macmillan rivers was surveyed.

Table 5. Numbers and density of moose in aggregation areas in the Mayo survey areas. Nov.-Dec. 1988 (aggregation areas are SU's which were surveyed with a helicopter and found to have $\geq$0.2 moose/km^2).

Survey Area	SU Number	SU Size (km^2)	Total Moose	Density (moose/km^2)
Mayo north	77	29.5	9	0.3
	91	41.2	11	0.3
	95	26.0	19	0.7
	104	28.4	5	0.2
	106	22.9	9	0.4
	110	24.3	4	0.2
	133	23.2	8	0.4
	137	22.6	10	0.4
	138	20.1	4	0.2
	139	22.6	4	0.2
	147	25.3	9	0.4
	155	21.8	6	0.3
Mayo south	12	26.6	12	0.5
	15	29.7	8	0.3
	18	31.0	6	0.2
	23	24.0	8	0.3
	30	26.1	6	0.2
	31	33.6	10	0.3
	47	29.5	19	0.6
	51	29.7	16	0.5
	55	21.4	6	0.3
	65	30.5	10	0.3
	69	22.3	5	0.2
	235	28.8	5	0.2
Total		641.1	209	7.9
Mean		26.7	8.7	0.3

Table 6. Observed moose population abundance and composition on various types of surveys in the Mayo study area, 1988-1989.

Period/ Location	Survey Type	Aircraft	Unidentified adult and yearling (%)	Calves (%)	Total
Early Winter					
Mayo north	stratification	Cessna 207,185	80 (88)	11 (12)	91
Mayo south	stratification	Cessna 207,185	151 (88)	20 (12)	171
Pelly Crossing	stratification	Cessna 207,185	145 (88)	19 (12)	164
Late Winter					
Mayo south	stratification	Cessna 207,185	76 (77)	23 (23)	99
Mayo south	composition counts	Supercub	15 (75)	5 (25)	20

Table 7. Moose harvest information from the Mayo and Pelly survey areas, 1979-1987.

Survey Area	Harvest Parameter	Year 1979	1980	1981	1982	1983	1984	1985	1986	1987	Mean	Harvest Intensity[b] (Mean Kills/ 1000km^2)	Harvest Rate[c] (% of Popul. Killed)
A. Mayo north (GMS 2-57, 2-58; 2288 km^2)													
	Resident non-Indian harvest	5	7	7	10	6	9	8	4	1	6.3		
	Non-resident harvest	0	0	0	0	0	0	0	0	0	0		
	Total Harvest	5	7	7	10	6	9	8	4	1	6.3	2.8	2.1
	Resident non-Indian effort (days)	198	138	214	354	192	397	297	151	179	236		
	Resident non-Indian success (days effort/moose killed)	40	20	31	35	32	44	37	38	179	51		
B. Mayo south[a] (GMZ 4-01, 4-04, 3421 km^2)													
	Resident non-Indian harvest	3	4	8	16	10	6	14	12	3	8.6		
	Non-resident harvest	0	0	0	0	0	0	0	0	0	0		
	Total Harvest	3	4	8	16	10	6	14	12	3	8.6	2.5	n/a
	Resident non-Indian effort (days)	264	266	200	857	466	674	409	309	289	415		
	Resident non-Indian success (days effort/moose killed)	88	67	25	54	47	112	29	26	96	49		

Table 7. continued ...

Survey Area	Harvest Parameter	Year 1979	1980	1981	1982	1983	1984	1985	1986	1987	Mean	Harvest Intensity[b] (Mean Kills/ $1000km^2$)	Harvest Rate[c] (% of Popul. Killed)
C. Pelly Crossing[a] (GMZ 4-02, 4-10, 4-11; 4432 km^2)													
	Resident non-Indian harvest	0	3	5	2	2	5	4	8	6	3.9		
	Non-resident harvest	0	0	0	2	0	1	4	3	7	1.9		
	<u>Total Harvest</u>	0	3	5	4	2	6	8	11	13	5.8	1.3	n/a
	Resident non-Indian effort (days)	43	25	36	62	69	85	71	96	95	65		
	Resident non-Indian success (days effort/moose killed)	n/a	8	7	31	35	17	14	12	16	17		

a. Harvest and moose population data were not collected on a common land base, therefore harvest rates could not be calculated for these area.

b. Harvest intensity was based on total land area rather then habitable moose range.

c. Harvest rates are mean annual harvest expressed as a % of the prehunt population. In Mayo North, the prehunt population = 293.4 (287 posthunt 1988 population + 6.4 mean harvest).

Appendix 1. Early winter moose population characteristics in surveyed areas throughout the Yukon, 1981-1988.

	Survey Areas[a]													
	Kluane	Aishihik	Whse. North	Haines Junction	Rose Lake[b]	Carcross	Teslin	Nisutlin	Liard West	Liard East	Carmacks	North[c] Canol/ Francis Lake	Dromedary	Mayo
Year of most recent survey	1981	1981	1982	1984	1986	1983	1984	1986	1983	1986	1987	1987	1982	1988
Established total moose/ 1000 km^2	120	110	170	140	274	187	417	130	116	140	40	190	64	139
Estimated bulls (≥30 mo.)/ 100 cows (≥30 mo.)	59	70	45	43	27	51	65	89	75	79	n/a	55-66	37	65
Estimated yearlings/ 100 cows (≥30 mo.)	n/a	n/a	1	1	18	7	13	36	18	37	n/a	54-65	1	24
Estimated calves/ 100 cows (≥30 mo.)	17	23	23	20	31	4	39	49	18	51	n/a	64-69	15	61
twinning rate (%)[d]	n/a	n/a	n/a	n/a	4(28[e])	n/a	n/a	12	n/a	13	n/a	5-10	0	14

a. References: Larsen (1982), Johnston and McLeod (1983b), Johnston and McEwen (1984), Markel and Larsen (1983, 1988), Jingfors and Markel. (1987), Jingfors (1988), and Larsen et al. 1989b.
b. This population was likely influenced by localized moderate wolf control.
c. This population was influenced by extensive wolf control.
d. Cows with twins/cows with calves in November.
e. Twinning rate at birth.

Appendix 2. Additional moose survey results from the Mayo/Pelly Crossing region.

Location (# refers to map location on Fig.2)	Date	Area (km^2)	Survey type[a]	Moose Observed (%) Ad (≥30mo) ♂	Ad (≥18mo) ♀	Yrl (18mo) ♂	Calves	Unident. Ad(≥18 mo)	Total	Density (moose/ $1000km^2$)	Ratios Calves/ 100♀ (≥18mo)	♂(≥18mo)/ 100♀(≥18mo)	Yrl♂ 100♀ (≥18mo)	Reference
1 Pelly/Macmillan Rivers	Feb '76	unk.	reconnaissance	unk.	unk.	unk.	14(16)	-	89	unk.	unk.	unk.	unk.	Lortie & Jack 1975
2 Pelly River	Feb '76	36	line transects	unk.	unk.	unk.	1(3)	28	29	805	unk.	unk.	unk.	Lortie & Jack 1975
3 Stewart River	Feb '76	unk.	reconnaissance	unk.	unk.	unk.	6(12)	50	56	unk.	unk.	unk.	unk.	Lortie & Jack 1975
4 Stewart River	Feb '76	76	line transects	unk.	unk.	unk.	2(5)	37	39	460	unk.	unk.	unk.	Lortie & Jack 1975
5 Stewart River downstream from Mayo/McQuesten River	Feb/Mar '79	793	line transects and block counts	20(31)	31(48)	1(1)	11(17)	2(3)	65	82	35	68	3	Larsen 1979
6 Stewart River upstream from Mayo	Feb '79	338	line transects and block counts	24(36)	24(36)	1(1)	14(21)	4(6)	67	198	58	104	4	Larsen 1979
7 Dromedary Mountain	Dec '82	3548	stratified random block counts	55(24)	150(66)	1(1)	22(10)	-	228	60 ± 20	15	37	1	Johnston and McLeod 1983
8 Mayo Area	Feb '88	unk.	incidental observ. on wolf surveys	unk.	unk.	unk.	17(16)	92(84)	109	unk.	unk.	unk.	unk.	Hayes 1989 survey files

Appendix 2. continued ...

Location (# refers to map location on Fig.2)	Date	Area (km^2)	Survey[a] type	Moose Observed (%) Ad (≥30mo) ♂	Ad (≥18mo) ♀	Yrl (18mo) ♂	Calves	Unident. Ad(≥18 mo)	Total	Density (moose/ 1000km^2)	Ratios Calves/ 100♀ (≥18mo)	♂(≥18mo)/ 100♀(≥18mo)	Yrl♂/ 100♀ (≥18mo)	Reference
9 Mayo/Hess River/ Macmillan River Areas	Feb '89	unk.	Incidental obser. on wolf surveys	unk.	unk.	unk.	34(10)	304	338	unk.	unk.	unk.	unk.	Hayes 1989 survey files

Survey types: Five types of search patterns were used:

1) Reconnaissance - helicopter flights along valley bottoms, usually with 3 observers.
2) Line Transects - helicopter flights along transects spaced 2 minutes apart, observation width of 1/4 mile, usually with 3 observers.
3) Block Counts - intensive helicopter survey of an entire area within prescribed boundaries, with 3 observers.
4) Stratified Random Block Counts - see (Gasaway et al. 1986, Larsen 1982).
5) Incidental Observations on Wolf Surveys - wolf surveys are done from a supercub, following drainages and ridges looking for wolf tracks (Hayes et al 19__).

Appendix 3. Moose Density Estimate for the Pelly survey area, November - December, 1988

Parameter	Stratum		
	Medium	Low	Total
Number of SU's	15	135	150
Area (km^2)	460.8	3781.5	4242.3
Estimated density (moose/km^2)a	0.389	0.100	0.131
Estimated number of moose	179	378	557[a]

[a] assumes that the medium and low strata in the Pelly survey area were similar to the medium and low strata in the Mayo area (Table 2).

Appendix 4. Moose observed on trend counts in the Mayo south survey area between 26 November - 2 December, 1988.

Date	SU	Survey Time (min.)	Area (km^2)	Adult Bulls (≥30mo.)	Adult Cows (≥30mo.)	Yearling Bulls	Calves	Total
26 November	45	62	26.2	1	1	0	1	3
	46	68	32.9	8	9	2	3	22
	47	64	29.5	7	8	0	6	21
	48	42	23.4	4	7	1	4	16
28 November	51	60	29.7	5	8	3	1	17
	52	62	25.1	2	0	0	0	2
	53	49	28.7	0	0	0	0	0
	54	31	21.2	0	0	0	0	0
29 November	49	49	31.5	0	0	0	0	0
2 December	59	55	26.5	2	0	0	0	2
Total(%)		542	274.7	29(35)	33(40)	4(5)	17(20)	83(100)

Appendix 5. Comparison of moose observed from a helicopter (Bell 206B) a supercub (PA-18) in the same SU's, Mayo south area November 1988.

SU	Aircraft	Search Intensity (min/km^2)	Composition(%) Adult Bulls	Adult Cows	Yearling Bulls	Calves	Total
15	Cub	2.0	0	2	0	1	3
	Hel.	3.3	1	4	0	3	8
31	Cub	1.6	5	0	2	0	7
	Hel.	1.7	4	3	2	1	10
51	Cub	2.4	1	6	0	2	9
	Hel.	2.4	1	10	2	3	16
65	Cub	2.0	1	4	0	1	6
	Hel.	2.0	1	6	0	3	10
47	Cub	2.0	7	7	0	3	17
	Hel.	2.1	6	8	0	5	19
12	Cub	1.8	1	4	0	2	7
	Hel.	2.5	4	4	0	2	10
236	Cub	1.9	0	0	0	0	0
	Hel.	1.9	0	0	0	0	0
49	Cub	2.3	0	0	0	0	0
	Hel.	2.2	0	0	0	0	0
	Cub Means	2.0 Totals	15(31%)	23(47%)	2(4%)	9(18%)	49(100%)
	Hel	2.2	17(23%)	35(48%)	4(5%)	17(23%)	73(100%)

Appendix 6. Costs (excluding personnel) of the Mayo and Pelly Crossing aerial moose surveys, 1988-1989

Survey		Cost (x $1,000)			
		Aircraft	Food and Accommodations	Misc.	Total
Early Winter	Mayo north and south	50.1	4.2	0.5	54.8
	Pelly Crossing	4.0		0.2	4.2
	Trend Surveys	1.7			1.7
	Aircraft Comparison (supercub)	2.0			2.0
Late Winter	Stratification of Mayo south (supercub)	7.5	1.0	0.1	8.6
	Composition Counts	2.0	0.3		2.3
	Total	67.3	5.5	0.8	73.6

Appendix 7. Allowable harvest calculations for moose in the Mayo and Pelly survey areas, 1988

Survey Area (Total land area)	Ad. and Yrl. Survival Rate	Allowable Harvest ([{ad. + yrl.}x ad. and yrl. natural survival rate]-ad.)	Allowable Harvest/ 1000 km^2 total land area
Mayo north ($2288km^2$)	90%	([{166 + 47}x .90]-166) = 26	11/1000
	85%	([{166 + 47}x .85]-166) = 15	7/1000
Mayo south[a] ($2033km^2$)	90%	([{200 + 12}x .90]-200) = -9	0
	85%	([{200 + 12}x .85]-200) = -20	0
Combined ($4321km^2$)	90%	([{366 + 59}x .90]-366) = 17	4/1000
	85%	([{366 + 59}x .85]-366) = -5	0

[a] The allowable harvest in the Mayo south area was calculated for only the huntable portion of the area (i.e. excluding the McArthur Sanctuary). A ratio estimator was used to recalculate the number of adults and yearlings in the adjusted Mayo south area. For example, adults in Mayo south = 278 - (.28 x 278) = 200 adults. The McArthur Sanctuary made up 28% of the Mayo south survey area.

Appendix 8. Incidental wildlife observations in the Mayo and Pelly Crossing areas, November - December, 1988.

Survey Area	Sample Unit	Caribou	Wolves	Sheep
Mayo north and south	7	Tr		
	10	13		
	11	18		
	12	4		
	15	Tr	2	
	16	1		
	17	6		
	20			25
	23	1		
	25	Tr		
	26	4		
	31	6		
	35	10		
	36	Tr		
	37	12		
	38	6		
	39	4		
	40	Tr		
	43		2	
	44		1	
	55		Tr	
	56		1	
	72	15		
	73	25		
	109	Tr		
	164		2	
Pelly Crossing	66			1
	64	Tr		
	71		1	
	102			15

Yukon
Renewable Resources