SUMMARY OF 1993 MOOSE SURVEYS in the BIG SALMON, MAYO, AISHIHIK-ONION CREEK and DAWSON AREAS

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Survey Report
September, 1994

SR-94-03

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ABSTRACT

This report summarizes the results of moose surveys conducted during the 1993/94 fiscal year. Survey blocks in the Big Salmon and Mayo areas were censused in November 1993 to determine moose abundance and composition. In addition, surveys were conducted in late February - March, 1994 to determine the proportion of calves in the late winter moose populations in the Aishihik - Onion Creek, Big Salmon, Mayo and Dawson areas.

Based on early winter survey data, an estimated 527±17% (90% C.I.) moose occupy the 2,706 Km^2 Big Salmon survey block for a density of 195 moose/1000 Km^2. This is somewhat higher than the mean density of 185 moose/1,000 Km^2 calculated using the most recent census data from other areas surveyed throughout the Yukon. Mature cows were the most abundant age/sex class in the population, comprising 42% of the total estimated population. Mature bulls and calves made up 30 and 21% of the total population respectively, for ratios of 71 bulls and 50 calves per 100 cows. The twinning rate was 25%. Yearlings comprised only 7% of the population. The yearling recruitment rate suggests that this population is likely stable or declining slowly. It must be emphasized, however, that it is not possible to accurately assess the status and trend of a population on the basis of a single year's recruitment data.

Moose were not uniformly distributed throughout the survey area. The majority of moose were concentrated in areas of preferred habitat on a few remote mountain blocks. Lower elevation areas dominated by various age stands of pine had very few moose. Cows with calves tended to be solitary.

It was not possible to accurately assess the harvest within the Big Salmon survey block because it encompasses only portions of several game management subzones and harvest data is collected by subzone. Assuming that all the harvest within these subzones occurred within the survey block, the mean annual harvest between 1989 and 1993 was 7.4 moose. Resident non-natives were responsible for the

majority of the reported harvest (73%) followed by First Nations members (16%) and non-residents (11%). Based on the observed recruitment rate in 1993 and assumed adult mortality rates, no harvest is sustainable within the survey area.

The early winter moose population in the 3,049 Km^2 Mayo survey block was estimated at 372$\pm$17% (90% C.I.) moose (122 moose/1,000 Km^2). This is not significantly different from the 1988 population estimate for the same area (315 moose). The population, therefore, appears to be stable or increasing slowly. Moose abundance in the Mayo area is lower than the mean density of 185 moose/1,000 Km^2 calculated using the most recent census data from other areas surveyed throughout the Yukon. It is, however, similar to the mean density estimated for the entire Yukon (132 moose/1,000 Km^2).

Mature cows were the most abundant age/sex class, making up 40% of the total estimated population. Mature bulls and calves comprised 33 and 20% of the total population respectively, for ratios of 82 bulls and 51 calves per 100 cows. The twinning rate was 24%. Yearlings comprised only 7% of the population. The calculated recruitment rate was 0.09%.

As in the Big Salmon area, moose in the Mayo survey block were not uniformly distributed. The majority of moose were concentrated in areas of prefered relatively high quality habitat above 1,070 m (3500 ft) in elevation. Cows with calves tended to be solitary.

The average reported annual harvest (1989 to 1993) in the Mayo survey block is 13.3 moose. Resident non-natives were responsible for the entire reported harvest. The Nacho Nyak Dun First Nation, however, did not participate in the native harvest monitoring program, so the actual total harvest is likely substantially higher.

The proportion of calves observed during the February - March, 1994 composition surveys in the Aishihik - Onion Creek, Big Salmon, Mayo and Dawson areas were

18%, 21%, 17%, and 6% respectively. In 1993 calves made up 10%, 10%, 12% and 7% respectively of moose populations in these same areas. The increase in the proportion of calves in the Aishihik - Onion Creek and Big Salmon areas was statistically significant ($P<0.05$).

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INTRODUCTION

This report summarizes the results of moose surveys conducted throughout the Yukon between November, 1993 and March, 1994. Early winter surveys (November 1993) were conducted in the Big Salmon and Mayo areas to determine moose population abundance and composition (Figure 1). The Mayo area had been previously surveyed in 1988.

The early winter surveys serve a dual purpose. First, they are part of the Department of Renewable Resources, Yukon Territorial Government (YTG), regular moose population monitoring program. These surveys provide data on population size, density and age/sex composition. This information is used, in turn, to assess population status and to estimate sustainable harvest. Resurveying the same areas every five to ten years helps to determine the effectiveness of past management regimes in achieving our population management objectives.

In addition, these areas will act as controls or comparison areas for the Aishihik moose and caribou recovery program, where wolf numbers are being reduced by 80% (Hayes 1992). The long term population trend of the comparison moose populations which have not experienced a reduction in wolf numbers can be compared with those in the Aishihik - Onion Creek recovery area (Figure 1). Using comparison areas will provide evidence to help determine whether any changes in moose numbers observed in the recovery area can be attributed to the reduction in wolf numbers.

Surveys were also conducted in February - March, 1994 in the Aishihik moose and caribou recovery area, and in the Big Salmon, Mayo and Dawson areas (Figure 1) to determine the proportion of calves in late winter moose populations as well as their relative moose abundance. The results of the late winter composition counts will be used to assess the effectiveness of wolf population reduction programs in increasing recruitment into moose populations.

The Aishihik-Onion Creek area was monitored to determine changes in the proportion of calves in the population after the wolf population reduction. The remaining three areas are being monitored as comparison areas for the Aishihik-Onion Creek experimental area. A breakdown of the cost of the surveys is presented in Appendix 1.

STUDY AREA

Moose surveys were conducted in 4 areas during the winter of 1993/94. Complete moose population abundance and composition surveys were conducted in the Big Salmon and Mayo areas (Figure 1) in November, 1993. Less intensive late winter surveys were conducted to determine the proportion of calves in the populations in the above 2 areas as well as in the Aishihik-Onion Creek and Dawson areas (Figure 1). A summary of survey area information is presented in Table 1. Detailed descriptions of each area are presented in the following sections.

Early Winter Survey Areas

Big Salmon

The Big Salmon survey block encompasses approximately 2,734 Km^2 within Game Management Subzone (GMS) 8-03 and 8-05 and 8-05 to 8-11, of which 2,706 Km^2 is habitable moose range. It is located within the Lake Laberge ecoregion (Oswald and Senyk 1977). The Lake Laberge ecoregion is made up of portions of the Lewes, Nisutlin and Teslin Plateaus. The topography is characterized by dissected plateaus and rolling hills and elevations are generally between 600 and 1500 m.

White spruce (Picea glauca) forest is the dominant climax cover type at lower elevations. Fire has been extensive in the region, however, and lodgepole pine stands (Pinus contorta) in post burn sites cover much of the area. Wetter sites are occupied by black spruce (Picea mariana) or mixed black and white spruce stands. Balsam poplar (Populus balsamifera) is common on flood plains. Aspen (P. tremuloides) and paper birch (Betula papyrifera) are present on warmer and cooler sites, respectively.

There are no weather observation stations within or immediately adjacent to the survey area, however, the area is located within the Pelly - Cassiar Mountains climatic region as described by Wahl et al. (1987). This region lies along an active Pacific storm track. Annual precipitation is relatively high for the south central Yukon, ranging between 500 and 700 mm. The comparatively high elevation results in less severe winter temperatures than adjacent lower elevation areas. Summers, however, are relatively cool. The mean annual daily temperature is -2.7° C.

Caribou are commonly observed in the area but population numbers are unknown. Sheep do not occur in the area. Wolf and grizzly bear densities are estimated at 10 wolves (Wildlife Branch, YTG unpublished data) and 17 bears (Smith and Osmond-Jones 1991) per 1,000 Km^2 respectively.

Mayo

The 1993 Mayo survey block (3,116 Km^2) consisted of portions of the Mayo north and south blocks surveyed in 1988 (Figure 2). The 1993 survey block encompassed 3,049 Km^2 of suitable moose habitat, within GMS 2-58, 4-01 and 4-04.

The survey block is contained within the Pelly River ecoregion (Oswald and Senyk 1977). The topography is dominated by rolling hills and plateaus. Vegetation at lower elevation is dominated by black spruce forest, which is replaced by white spruce on drier sites. Lodgepole pine frequently invades burned areas, but is often in competition with aspen and balsam poplar on wetter sites. Paper birch occurs on cooler sites. Treeline occurs around 1,350-1,500 m, and is characterized by a limited subalpine zone with willow (Salix spp), shrub birch (Betula. spp). and alpine fir (Abies lasiocarpa).

Weather data are available from two permanent stations within the survey area (Elsa at 504 m ASL, and Mayo at 814 m ASL; Environment Canada). Mean annual daily temperatures from both stations are similar (-4° C). Mean maximum annual snowfall is substantially higher in Elsa (203 cm) than Mayo (131 cm), with maximum snow depths occurring in March in Mayo and April in Elsa.

Other ungulates and large predators occur in the area. The Ethel Lake caribou herd is estimated at approximately 200 animals and seasonally occupies the southern portion of the survey block. Wolf densities were estimated at 10 wolves/1,000 Km^2 in late winter 1988 (Wildlife Branch, YTG unpublished data). Grizzly bear density has been estimated at 17/1,000 Km^2 (Smith and Osmond-Jones 1991). Black bears occur, but at unknown densities.

Late Winter Survey Areas

Aishihik - Onion Creek

The Aishihik - Onion Creek late winter survey area encompasses the entire 20,000 Km^2 of the Aishihik Recovery Program. Topography, climate and abundance of other large mammal populations have been described by Ward and Larsen (1994), and related survey information is summarized in Table 1.

Big Salmon

The late winter Big Salmon survey block includes the early winter survey block and adjacent areas. It encompasses approximately 4,000 Km^2 within GMS 8-03 to 8-11, Table 1). Topography, habitat, predators and other ungulate populations are as described for the early winter survey block.

Mayo

The late winter Mayo survey area includes the early winter survey block and adjacent areas. Although all areas were not searched, the late winter survey block was approximately 5,000 Km^2 (Table 1). Topography, habitat, predators and other ungulate populations are as described for the early winter survey block.

Dawson

The Dawson survey area encompasses GMS 3-04 and covers 2,005 Km^2, of which approximately 1,870 Km^2 is habitable moose range. Approximately 2% of the area has been burned since 1966. Historically, mining activity has been limited and harvest pressure light. A new mining road, however, has recently been constructed from the Top of the World Highway to Matson Creek. This may result in increased activity in the area.

Oswald and Senyk (1977) describe the area as having smooth, rolling topography, with moderate to deep incised valleys. Most of the terrain lies between 1,000 m and 1,500 m ASL. Black and white spruce stands occur in valleys and on lower slopes. Mixed stands of white spruce, aspen, balsam, and paper birch are common along drainages. Shrub birch and willow are common in the understory, extending beyond treeline (1,200 m).

Caribou, bears and wolves occur in the area. Part of the Forty Mile caribou herd uses the area seasonally. Wolf densities have not been determined but 8 wolves/1,000 km^2 were recorded in adjacent parts of Alaska near Tok, Alaska in the mid 1980's (Gasaway et al. 1986b). Grizzly bear densities are unknown in the survey area. Smith and Osmond-Jones (1991) estimated 12 grizzly bears/1,000 km^2 based on an evaluation of habitat capability, whereas in a nearby area in Alaska, estimates of 16 grizzly bears/1,000 km^2 have been made using radio collars (Boertje et al. 1987). Black bears are abundant in the study area but densities are unknown.

METHODS

Early Winter Population Census

As in past surveys, the stratified random block aerial survey technique described by Gasaway et al. (1986a) was used to estimate moose abundance, composition, and distribution during the early winter surveys of the Big Salmon River and Mayo areas. This technique was modified by substituting helicopters for fixed-wing aircraft during the census portion of the survey (Larsen 1982). The technique involves three phases; 1) the stratification portion of the survey, in which sample units (SU's) are classified into high, medium, and low strata based on relative moose abundance observed during fixed-wing reconnaissance flights; 2) the census portion, in which all moose within a randomly selected sample of SU's are counted; and 3) development of a sightability correction factor (SCF) for moose not observed during the census of sample units. SCF's were developed by re-surveying a portion of selected SU's at a higher search intensity. The difference between the number of moose observed on the census and the SCF surveys is used to correct for moose missed in the remaining SU's censused.

To facilitate between-year comparisons of moose population abundance and composition in the Mayo area, estimates were recalculated for the portions of the 1988 Mayo North and South survey blocks that were included in the 1993 survey block. Between-year comparisons were based on uncorrected population estimates because a different technique was used to develop the SCF during the 1988 survey of the Mayo area.

Recording procedures for moose observations and age-sex determination have been previously described (Larsen 1982, Larsen et al. 1989b). Twinning rates were calculated as the number of cows with twins divided by the total number of cows with calves in November. As such, twinning rates reflect both birth rates and calf survival to 6 months of age. Harvest estimation procedures have also been calf survival to 6 months of age. Harvest estimation procedures have also been previously described (Kale 1982, Quock and Jingfors 1988).

Density categories describing moose distribution (Figures 3, 5 and 6) are based on census rather than stratification data. Census data are more accurate than stratification data because some SU's are misclassified during the stratification process, (i.e. some SU's were stratified into one stratum but were later found, during the census, to have either more or less moose than expected).

Our approach to statistical analysis of changes in population size within an area between surveys follows that described by Gasaway et al. (1986). We have arbitrarily set a 20% change in population size as the minimum that will normally be considered to be significant for moose management purposes. Gasaway et al. (1986) termed this the "Consequential Difference" (CD). Changes is abundance of less than the Consequential Difference (20%) will not normally lead to changes in our management strategy for the population.

In testing for a statistical difference between population estimates, we have increased the alpha level (the probability of concluding that a change had occurred when in fact it had not changed, due to chance alone) from the generally accepted 0.05 level to 0.10. Increasing the alpha level results in a decrease in beta, the probability of concluding that no change occurred when in fact it did. Estimating beta and the value 1-beta is called Power Analysis. Power is an estimate of how confident we are in detecting a change with that test. Ensuring our ability to detect changes in population size is especially important if the population is declining because management actions must often be undertaken promptly in order to avert an even more severe decline. We accordingly attempt to design and conduct our surveys to be 75% sure (the power of the test) of detecting a 20% change in population size.

Briefly, our approach is to first use a two-tailed Student's T-test to determine

0.10 alpha level. If the observed difference between population estimates is statistically significant and exceeds 20% , the appropriate management options to respond to the change are considered. If the population has increased this wold likely mean liberalizing the harvest. If the population has decreased harvest would be limited or other management options to stop the decline would be considered. If the observed change in numbers exceeds 20% but the difference is not statistically significant, power analysis is used to determine the probability of detecting a change of 20. If there is less than a 75% chance of detecting a 20% change in population estimates then additional sampling is required to improve the power of the test.

The finite rate of population change (net change after recruitment and mortality) was calculated using the 1993 data for the Big Salmon area and both the 1988 and 1993 population estimates for the Mayo area. Finite rates involving more than one population estimate were calculated using $\lambda = e^r$, where e=constant 2.7183 and r=exponential rate of increase, following Gasaway et al. (1986a). Rates involving only one population estimate were calculated using $\lambda = (1-M) \div (1-R)$ where M=adult natural mortality rate and R=proportion of recruits in the population, following Gasaway et al. (1990).

Recruitment rates were calculated as the estimated number of yearlings divided by the sum of the estimated number of yearlings and adults. Sustainable harvest rates were estimated as ([adult + yearling] x adult and yearling natural survival) - adults. The natural survival rate for yearlings and adults was assumed to be between 80% and 90%. These values bracket the range of natural survival rates reported for moose in Alaska (Gasaway et al. 1990) and the Yukon (Larsen et al. 1989a). Differences in age-sex proportions between surveys in the Mayo area were tested using contingency table analysis (Zar 1984). Change in moose distribution in the Mayo area was assessed by comparing the proportion of SU's containing the majority of the population between surveys, and the location of the SU's.

Late Winter Population Composition Surveys

Late winter composition counts were conducted using a Piper Super-cub or equivalent aircraft flown at an altitude of 60-90 meters agl, and at an airspeed of approximately 130 km/h. No attempt was made to cover the entire area, but habitats such as burns with regrowth and subalpine willow, expected to contain concentrations of moose were thoroughly searched. Once sighted, each moose or group of moose was plotted on a 1:50,000 scale map and each individual was classified as either a calf or an adult. No attempt was made to distinguish between yearlings and older age classes or between bulls and cows. The proportion of calves was calculated as a percentage of the total population observed. A minimum sample of 100 moose was recorded in each area. Search times were recorded and moose seen per minute of survey time was calculated. Moose seen per minute of survey time was used to assess relative moose abundance in each of the four areas surveyed.

Statistical comparisons of between-year changes in proportion of calves in moose populations were conducted using X^2 2x2 contingency tables with Cochran's correction for continuity (Zar 1984).

RESULTS AND DISCUSSION

Search and Sampling Intensity - Early Winter Surveys

Search intensity during the stratification phase of the surveys was similar for the Big Salmon and Mayo survey areas (0.54 to 0.66 min./km^2; Table 2). These values are similar to or slightly higher than those normally used for the stratification portion of surveys in the Yukon (0.40 - 0.50 min./Km^2) and are substantially higher than the 0.17 min./km^2 suggested by Gasaway et al. 1986a.

The intent of using a higher search intensity during stratification is to reduce the chances of assigning sample units to the wrong stratum (i.e. density class). This should reduce the number of sample units that must be searched during the census phase of the survey to obtain a final population estimate with acceptable confidence intervals (90% C.I. $\pm$ 20%) (McNay 1993). This should, in turn, reduce the overall cost of the survey.

The benefits of a higher search intensity during the stratification are offset to some extent by the increase in the length of time required to complete the stratification. The increased time between the stratification and the census of sample units provides more opportunity for moose to move between sample units. This can result in sample units that are correctly assigned to one density class during the stratification to have more or less moose than expected to occur during the census. In general, however, increased search intensity during the stratification phase of the survey should reduce the overall survey costs (McNay 1993).

Search intensity during the census phase of the Big Salmon and Mayo surveys were the same (2.0 min./km^2; Table 2). This is the search intensity recommended by Gasaway et al. 1986a. We have found that this search intensity, combined with our substitution of helicopters with three observers for fixed wing aircraft with one observer as recommended by Gasaway et al. 1986a, generally results in relatively high sightability rates. SCF's from the helicopter surveys average 1.06 (range 1.00 to 1.13) while SCF's for surveys conducted in Alaska using Piper Super-Cubs are generally somewhat higher, averaging 1.15 (McNay 1993).

Search intensity during the calculation of the sightability correction factor (SCF) was 4.6 and 3.8 min./km^2 in the Big Salmon and Mayo survey areas respectively (Table 2). This is approximately twice the time used for the initial census. The resulting SCF's were 1.07 and 1.03 for Big Salmon and Mayo, respectively.

Mean sample unit size was similar in the Big Salmon (22.2 km^2) and Mayo (25.4 km^2) survey areas. Similar proportions of the Big Salmon (39% of sample units and habitable moose range) and Mayo (43% of sample units and habitable moose range) survey areas were censused (Table 3).

Population Characteristics and Distribution - Early Winter Surveys

Big Salmon Area

The Big Salmon survey area had an estimated 527$\pm$17% (90% C.I.) moose (Table 4). An SCF of 1.07 was incorporated into this estimate. This population estimate corresponds to a mean density of 195 moose/1,000 km^2 (161-229, 90%C.I.). This is higher than the mean density of approximately 186 moose/1,000 km^2 calculated using the most recent survey data from other areas surveyed to date in the Yukon (Appendix 2).

Mature cows were the most abundant age-sex group in the population, comprising 42% of the total estimated population, followed by mature bulls at 30% of the total (Table 4). The resulting estimated ratio of 71 mature bulls/100 mature cows is well in excess of the 30 mature bulls/100 mature cows we consider to be the minimum ratio sufficient to ensure complete breeding during the first oestrous cycle.

Yearlings were not well represented in the population (7% of the total estimated population; Table 4). This is consistent with the low proportion of 10 month old calves (10% of the observed population) recorded in the Big Salmon area in March, 1993. This suggests relatively poor survival of calves born in the spring of 1992 (see Discussion of late winter population composition surveys, pg 20). Assuming an average natural mortality rate of between 10% and 20% (Larsen et al. 1989b, Gasaway et al. 1986b), the resulting recruitment rate (proportion of yearlings entering the breeding population) of 0.09 would not be sufficient to maintain a stable population.

In contrast to yearlings, however, calf abundance in the population was well above average. Calves comprised 21% of the total estimated population during the early winter survey, for a calf:cow ratio of 50/100 (Table 4). The average calf:cow ratio from previous moose surveys conducted throughout the Yukon is approximately 38:100 (Appendix 2). Good survival of the 1993 calf crop was documented during the March, 1994 composition surveys when calves made up 21% of the observed population (Table 6). The 1993 twinning rate was also unusually high at 24% (Table 4).

The Big Salmon area had not been censused previously so the actual population status and trend can only be inferred. The finite rate of increase for the survey area, assuming adult natural mortality rates of between 10% and 20%, was calculated to be between 0.989 and 0.879. These values suggest that the population is likely stable or declining slowly. The finite rate of increase, however, this is based on only a single year's recruitment data and assumes average mortality rates. Calf survival, and therefore recruitment, can also vary widely from year to year due to a wide range of environmental factors.

Moose were not evenly distributed throughout the Big Salmon survey block. This uneven distribution was exhibited in 3 ways:

1) Excluding solitary cow-calf groups, roughly 60% of moose observed were in groups ranging in size from 2 to 8 animals (mean = 2.8). Many of these groups were in close proximity, making it difficult to determine what actually constituted a group. In contrast to the general trend for moose to aggregate, 94% of cows with calves were solitary.

2) Moose tended to be concentrated geographically within a limited number of sample units. Approximately 75% of moose observed during the census portion of the survey were located in only 29% of the sample units censused. These relatively high density sample units were concentrated in recently burned areas (within the past 20 years) in the Semenof Hills and mountains in the north-eastern and southeastern corners of the survey block (Figure 3).

3) Finally, a disproportionate number of moose were located at higher elevations. About 66% of moose observed were located between 3,500 and 5,000 feet elevation. This elevation range made up only 28% of available habitat in the Big Salmon survey area.

While not all similar habitats had similarly high moose densities, a subjective assessment suggests that moose were selecting areas of relatively high willow browse abundance. Sample units with high moose densities were almost invariably within areas which had been burned within the past 20 years and were in early-mid successional stages with dense willow cover. In addition, the subalpine zone where willows are the climax community, generally ranges between 3,500 and 5,000 feet elevation in this area.

Moose may select areas of high browse abundance at this time of year in order to rebuild energy reserves depleted during the rut. The rut is especially costly for bull moose which can lose as much as 5-10% of their body weight and virtually all of their fat reserves during this time (Schwartz et al. 1987).

It was not possible to accurately calculate hunter effort and the annual moose harvest within the Big Salmon survey area. Effort and harvest data are collected by game management subzone and the survey area included portions of a number of game management subzones. It was, therefore, impossible to tell which harvest occurred within the survey area. For the purposes of this report, we assume that all of the harvest in GMS 8-03, 8-05 to 8-07 and 8-09 to 8-11 occurred within the Big Salmon survey block.

The reported mean annual harvest within the Big Salmon area has declined since the early 1980's (Figure 4). The 5 year mean annual harvest for the area declined from 11.8 moose/year (1979-1983) to 7.4 moose/year (1989-1993). Reported hunter effort (days hunted) declined similarly over the same period (Figure 4). Most of the reported harvest occurred in the subzones adjacent to the main branch of the Big Salmon River, Little Salmon Lake and Lake Laberge.

Non-First Nations residents were responsible for about 73% of the reported harvest between 1989 and 1993. First Nations members and non-residents were responsible for 16% and 11% of the reported harvest respectively. The Big Salmon survey block lies within the Traditional Territories of the Little Salmon/Carmacks, Ta'an Kwach'an and Kwanlin Dun First Nations. Participation by these First Nations in the native harvest survey over the past five years has been intermittent. As a result, the First Nations harvest presented here undoubtedly under-estimates the actual harvest (Quock and Jingfors 1988).

Given the low estimated proportion of yearlings entering the population and the assumed natural mortality rates any harvest would not be sustainable within the Big Salmon survey block. This information, however, is based on a single year's recruitment. Yearling recruitment into the 1993 population appears to have been low as a result of poor survival of the 1992 calf crop. If the average annual recruitment rate is higher over a number of years then a certain level of harvest may be sustainable.

Mayo Area

The estimated total moose population in the 1993 Mayo survey block (Figure 2) was 372±17% (90% C.I.) for a density of 122 moose/1,000 km^2 (Table 5). A sightability correction factor (SCF) of 1.03 is incorporated into this estimate. The population estimate with no SCF incorporated was 361±14% moose, which is not significantly different (t=0.92, P>0.2) from the 315±22% moose estimated in the area from the 1988 survey data (Appendix 3).

Having accepted the null hypothesis that there no statistical difference in the estimates we tested the power of the test. The power, i.e. the probability of detecting a 20% difference (consequential difference) in population estimates was 0.75. Therefore we accept there was no change with a .25 (*beta*) probability of error. Moose abundance in the Mayo survey area is somewhat below the average density of 185 moose/1,000 km^2 calculated using the most recent census from other areas surveyed to date throughout the Yukon (Appendix 2).

Based on estimated composition data, mature cows were the most abundant age/sex class in the Mayo population, making up 40% of the total (Table 5). Mature bulls were the second most abundant class at 33% of the total, for a mature bull:mature cow ratio of 82:100. Calves comprised 20% of the population, for a calf:cow ratio of 51:100. As in the Big Salmon survey area, yearlings were poorly represented in the Mayo moose population comprising only 7% of the total population (18 yearlings per 100 mature cows).

The proportion of mature cows and calves in the 1993 population estimate were not significantly different from the 1988 estimate (Contingency table analysis, X^2=2.102, df=1, P>0.10) (Appendix 3). Mature bulls made up a significantly (X^2 =9.3, P<0.005) greater proportion of the population in 1993 than in 1988. The ratio of mature bulls to mature cows, however, was not significantly different between surveys (X^2=1.526, P>0.10). The bull:cow ratios recorded during both the

1988 and 1993 surveys were both well above the minimum ratio of 30 adult bulls/100 adult cows normally assumed to be the lower limit that will ensure effective breeding. Yearlings made up a significantly smaller proportion of the population in 1993 than in 1988 ($X^2=20.6$, $P<0.001$).

The 1993 recruitment rate was 0.09. This is within the range of values normally associated with declining moose populations. Gasaway et al. (1990) documented recruitment rates of 0.03-0.16 (mean=0.09) in rapidly declining, 0.06-0.16 (0.12) in near stable, 0.09-0.17 (0.13) in slowly increasing, and 0.10-0.28 (0.22) in rapidly increasing moose populations in east-central Alaska and the Yukon. Despite the low recruitment rate estimated in 1993, the Mayo population has remained stable since the 1988 survey. This suggests that either the average recruitment rate between the 1988 and 1993 surveys in the Mayo area has been higher than that observed in 1993, or the adult mortality rate was lower than that in the populations reported by Gasaway et al. (1990).

Recruitment rates and observed population trends for areas previously surveyed throughout the Yukon support the finding of Gasaway et al (1990). Moose populations with recruitment rates in the neighbourhood of 0.09 are generally stable or declining (Appendix 2). A recruitment rate of around 0.15 is generally necessary to ensure population growth. As in the discussion of the Big Salmon survey results, it must be emphasized that assessment of population trends on the basis of a single year's recruitment is difficult at best. Recruitment can fluctuate markedly from year to year as a result of a number of environmental factors regardless of the longer term population trend. In 1992, there appears to have been poor survival of the moose calf crop throughout a large portion of the Yukon. This may have been due to record cold temperatures and wet conditions during the spring summer and fall of that year (Environment Canada records) resulting in the low yearling recruitment rate observed in 1993.

Based on past surveys and population trends (Larsen et al. 1989a, unpubl. data), a ratio of at least 30 calves per 100 cows is normally necessary to maintain stable moose populations. Assuming average survival rates, the 51 calves/100 mature cows observed during the 1993 survey of the Mayo area should be sufficient to maintain a stable population.

As in the Big Salmon survey block, moose were unevenly distributed throughout the Mayo survey area during the 1993 survey. Approximately 56% of moose observed during the census were concentrated in 17% of the sample units censused. The majority of these sample units were clustered along the ridge between the Stewart River and Nogold Creek in the southern portion of the survey block (Figure 6).

In addition, moose also tended to aggregate at higher elevations. About 34% of moose observed were located between 1,070 and 1525 metres (3,500 and 5,000 feet) elevation (i.e. 25% of available habitat in the Mayo survey block). Aggregations of moose in this elevation zone were invariably located in the subalpine areas where the density of willows was relatively high. In contrast to the overall pattern of moose aggregating in these areas, approximately 80% of cows with calves were solitary.

While moose distribution throughout the survey area showed some similarities between the 1988 and 1993 surveys (Figures 5 and 6), fidelity to specific sample units was limited. In general, moose were more abundant along the ridge to the north of Ethel Lake and south of the Stewart River than elsewhere in the survey area. Virtually all areas of relatively high moose abundance were at higher elevations (1,070 to 1,525 metres, 3,500 and 5,000 feet) and had been burned within the past 20 years.

The annual reported moose harvest in the Mayo survey block has fluctuated markedly since record keeping was initiated in 1979, although there has been no consistent trend in the data (Figure 7). The 5 year average annual reported moose harvest in the survey block between 1989 and 1993 averaged 13.3 moose. Records indicate that resident non-natives are responsible for the entire reported harvest. The Nacho Nyak Dun First Nation, however, has not taken part in the Native harvest survey program so the actual total harvest is likely substantially higher. Local outfitters do not generally hunt within the survey block.

In recent years, Mayo area residents have expressed concern about the influx of hunters from other parts of the Yukon, primarily Whitehorse residents. They are concerned that the perceived increase in hunting pressure may result in a decline in the local moose population and reduce hunting opportunities for local residents. The results of our surveys and hunter questionnaire returns, however, do not support this concern. Not only has the population remained stable or possibly increased slightly between 1988 and 1993, no trend towards an increase in hunting effort or reported harvest is indicated from hunter questionnaire returns (Figure 7). Between 1979 and 1983, non-Indian residents hunted an average of 609 days per year in the Mayo survey area and harvested an average of 13.1 moose per year. Between 1989 and 1993 resident non-Indian hunters averaged only 425 days per year in the area and harvested 13.3 moose annually.

Given these data, the reason for the local perception that there has been an influx of outside hunters is unclear. One possible explanation is that a decline in hunting pressure by local hunters, as a result of the closure of the Elsa and Keno mines, has been compensated for by an increase in the number of non-local hunters. Mayo residents may have recognized and accepted Elsa and Keno residents whereas others, from outside the Mayo area are viewed as potential competitors. The fact that the overall population size and the proportion of mature bulls in the population have remained stable since the 1988 survey indicates that the 1989-1993 harvest in the area has been within sustainable limits.

Late Winter Population Composition Surveys

The proportion of calves in late winter moose populations was estimated in the Aishihik - Onion Creek area and 3 other comparison areas. This data is being used to help determine the effectiveness of the wolf population reduction program in increasing recruitment, and subsequently, moose abundance. There has now been one year of pre-wolf population reduction, and one year of post reduction moose composition data for the Aishihik - Onion Creek area, and 2 concurrent years of moose composition data for the 3 other comparison areas.

The proportion of 10 month old calves in the Aishihik - Onion Creek moose population increased, but not significantly (Contingency table analysis, Cochran's Corrected, X^2=2.58, df=1, P>0.10) from 10% in 1993 (pre-wolf reduction) to 18% in 1994 (post reduction) (Table 6). The proportion of 10 month old calves increased by a similar amount in 2 of the 3 comparison areas in the absence of wolf control. The proportion of calves in the Big Salmon area increased from 10% to 21% between the 1993 and 1994 surveys (X^2=3.82, $0.05<p<0.10$,statistically significant). Calves in the Mayo area increased from 12% to 17% of the population (X^2=.92, P>0.25, not significant) over the same period (Table 6). The proportion of calves in the Dawson area was low both years 7% and 6% respectively (X^2= ,P>.50, not significant).

The proportion of calves observed in the Aishihik - Onion Creek area in the late winter 1994 moose population, in combination with the anticipated decline in adult moose mortality rate as a result of wolf reduction, should be sufficient to produce healthy population growth. It is unclear at this point, however, whether the increase in recruitment rate can be attributed to the wolf reduction program. The similar increase in recruitment in 2 of the 3 comparison areas suggests that some other widespread environmental factor may have been responsible for the increase in recruitment. Climate may have been at least partially responsible for the increase in proportion of calves observed in these widely separated moose populations throughout the Yukon. The spring, summer, and fall of 1993 were unusually warm and dry (Environment Canada records, ideal weather for calf rearing. The reasons for the low proportion of calves in the Dawson area are unknown but may be related to predator densities in the area. Additional years of monitoring the calf compositionin the Aishihik - Onion Creek and the 3 comparison areas will be required to determine the relative significance of wolf predation on 10 month old calf recruitment rates.

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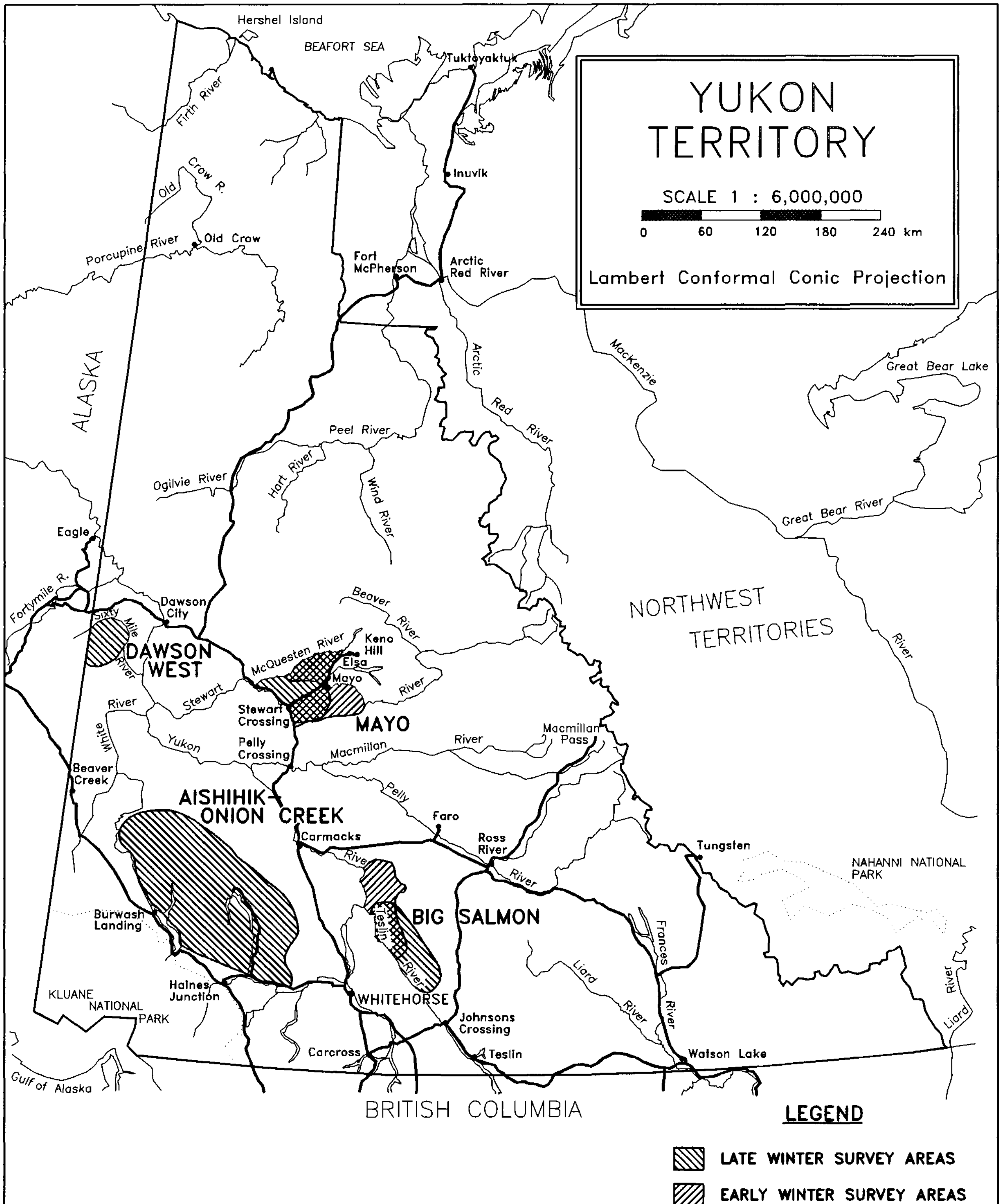

Figure 1: 1993/94 MOOSE SURVEY AREAS

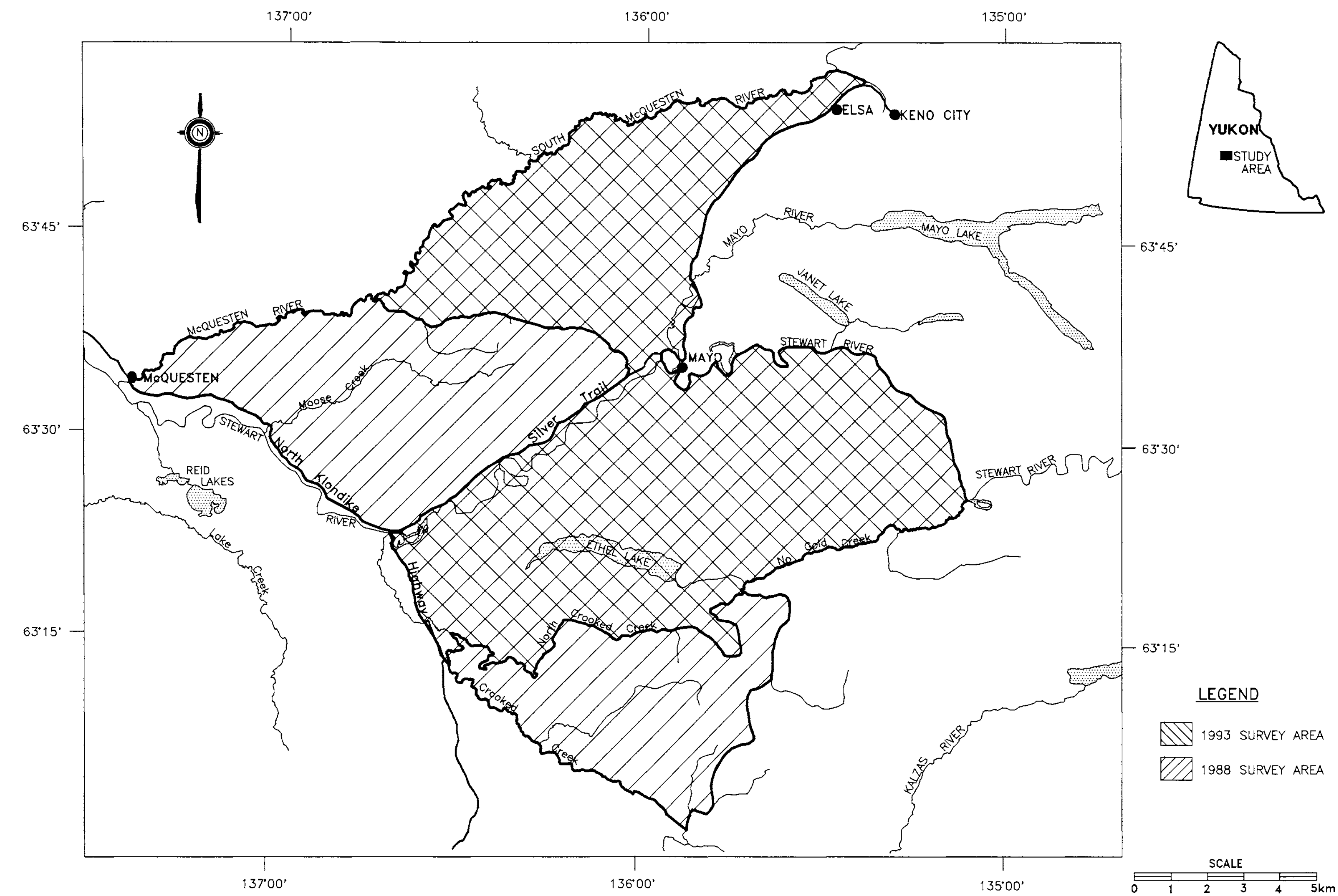

FIGURE 2: 1988 & 1993 MAYO MOOSE SURVEY AREAS

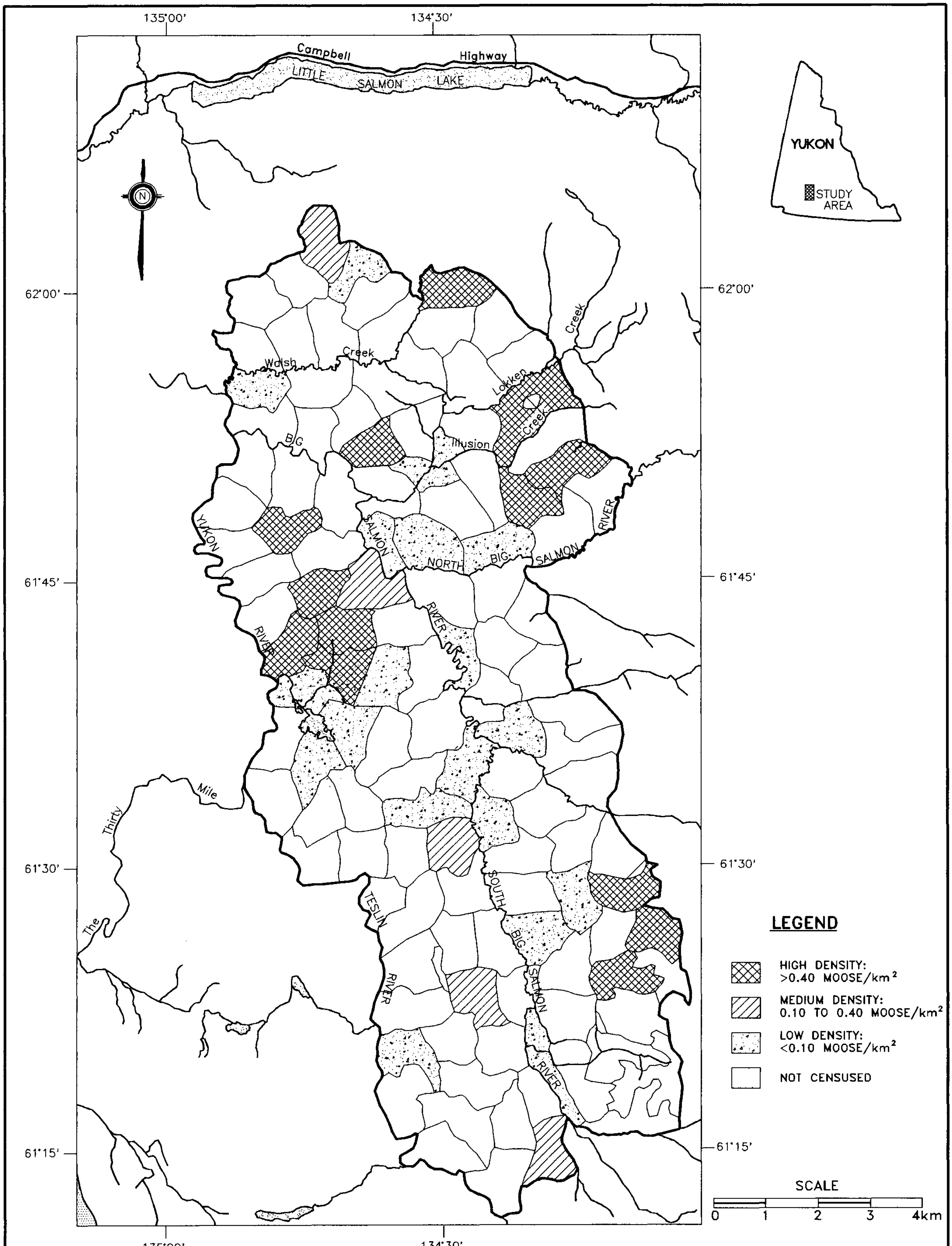

FIGURE 3: DISTRIBUTION OF MOOSE AMONG CENSUSED SAMPLE UNITS IN THE BIG SALMON SURVEY AREA

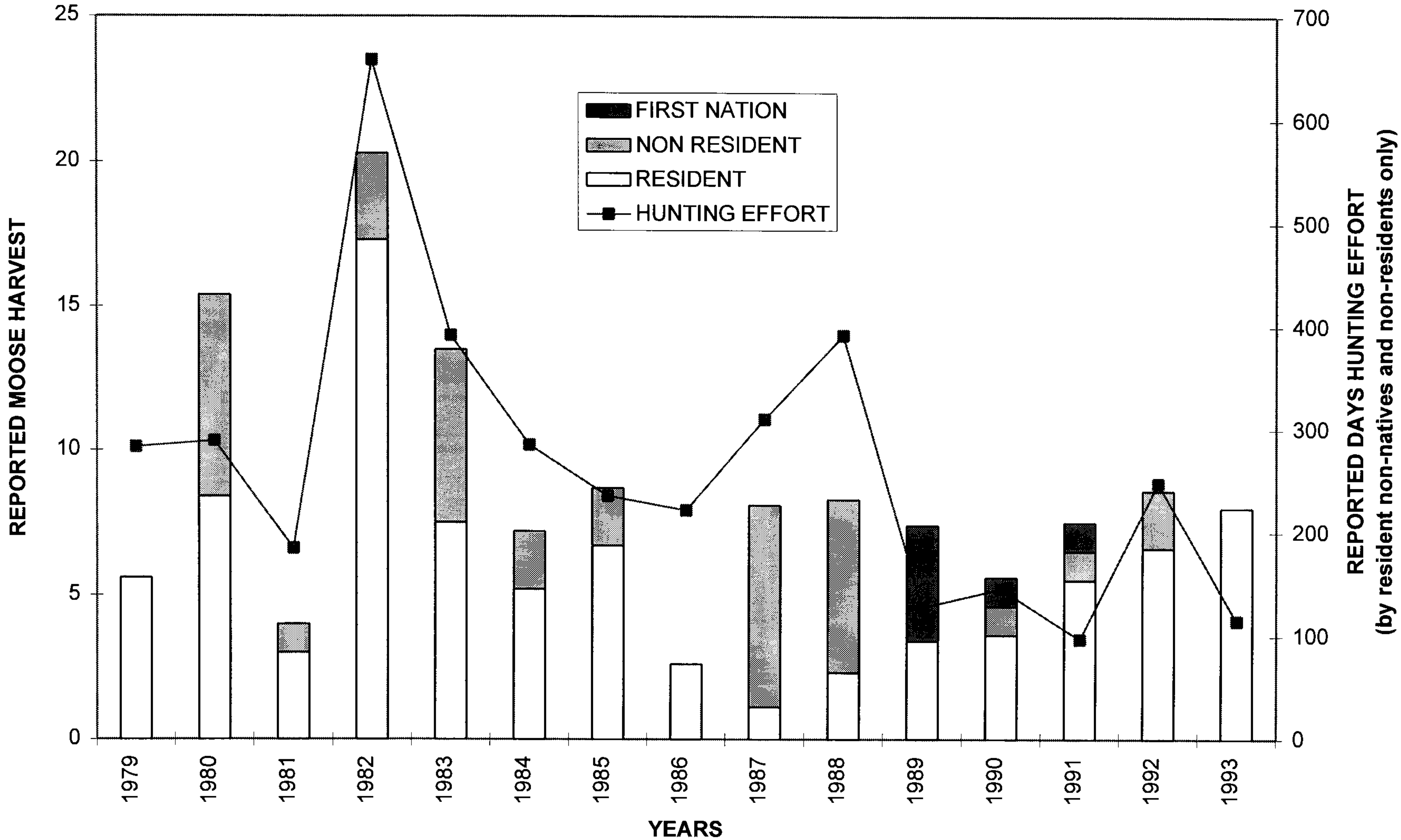

Figure 4. Reported annual moose harvest and days hunting effort in the Big Salmon Area. (GMS 8-03, 8-05 to 8-07 and 8-09 to 8-11) 1979 to 1993.

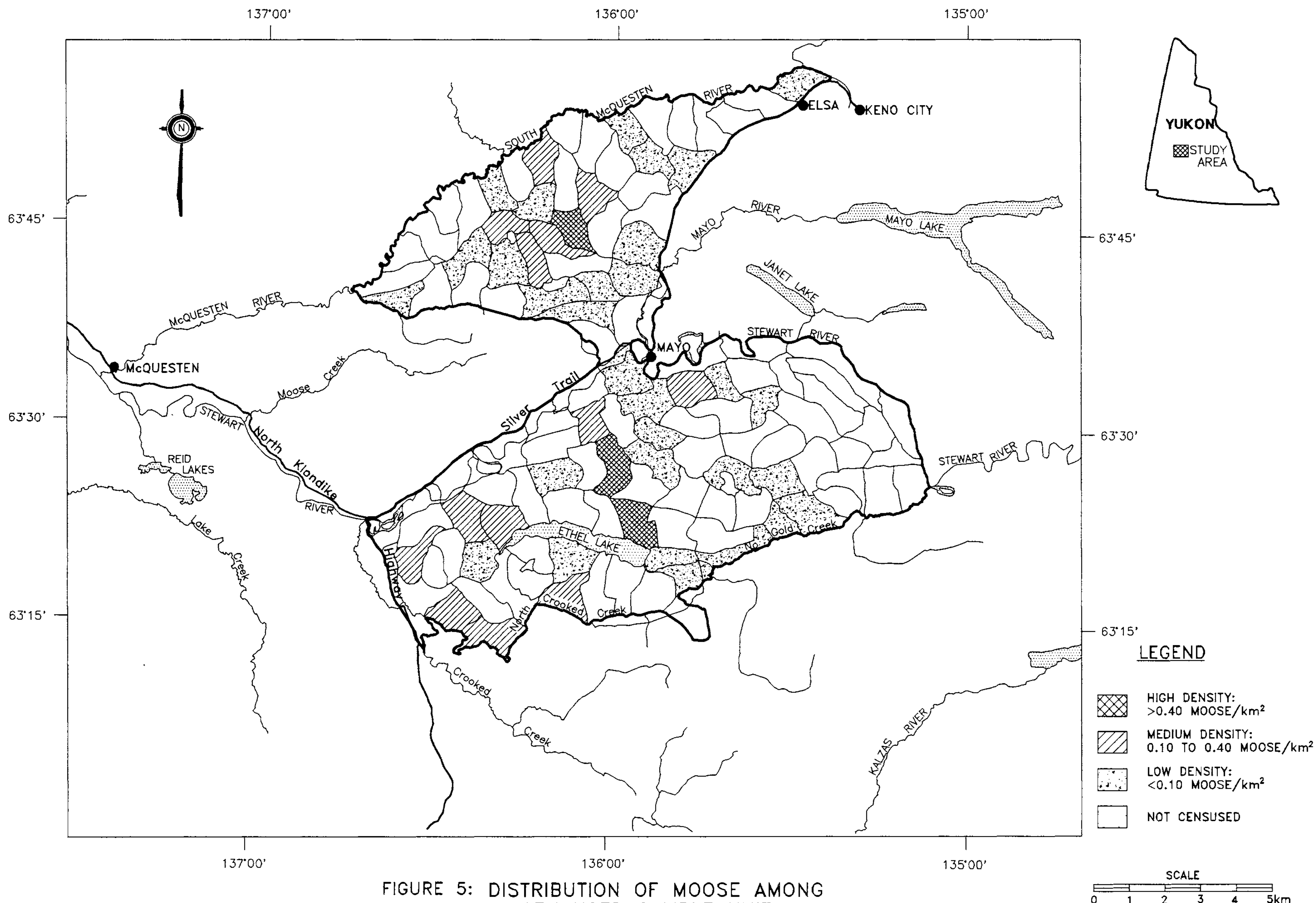

FIGURE 5: DISTRIBUTION OF MOOSE AMONG CENSUSED SAMPLE UNITS IN THE 1988 MAYO SURVEY AREA

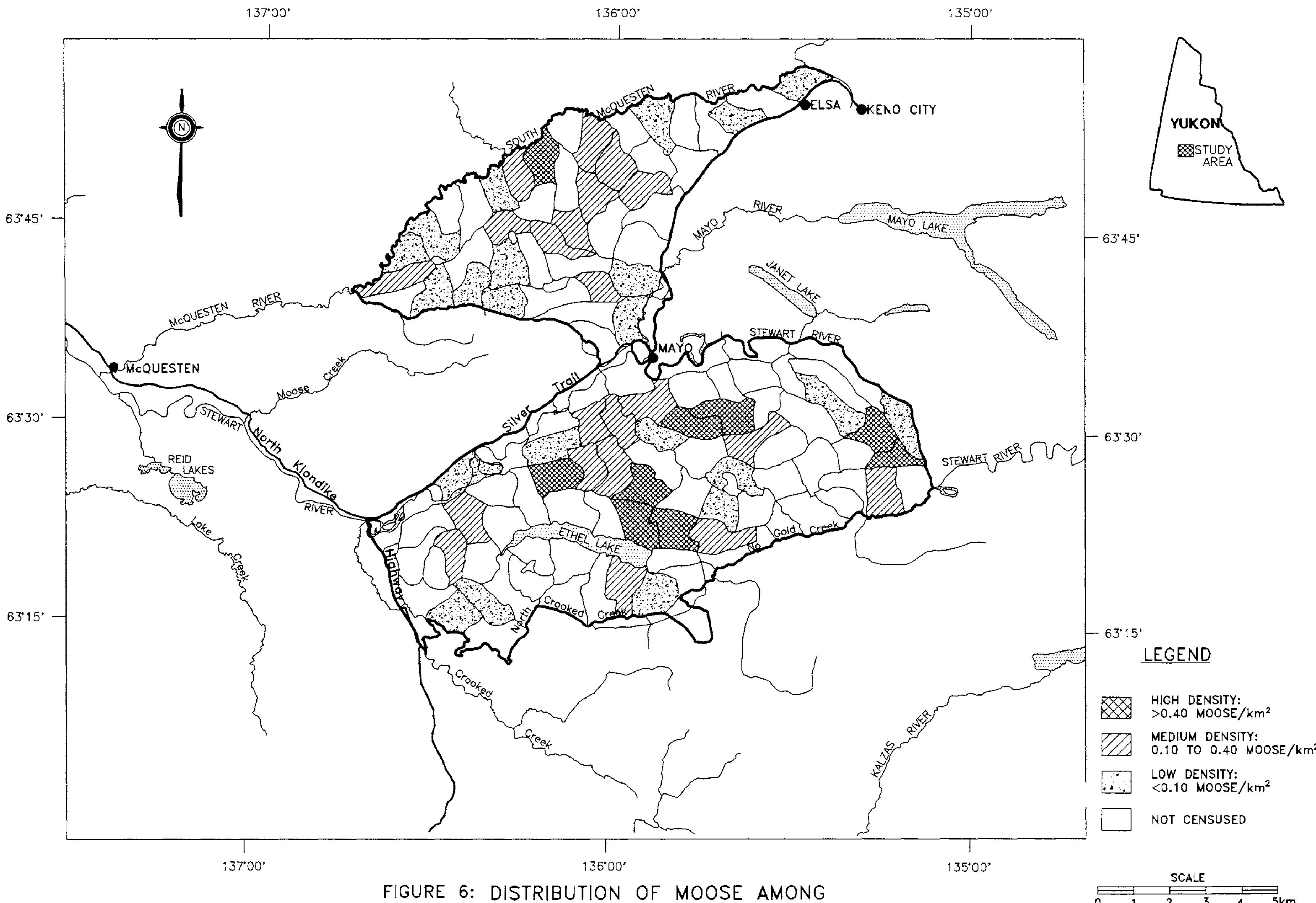

FIGURE 6: DISTRIBUTION OF MOOSE AMONG CENSUSED SAMPLE UNITS IN THE 1993 MAYO SURVEY AREA

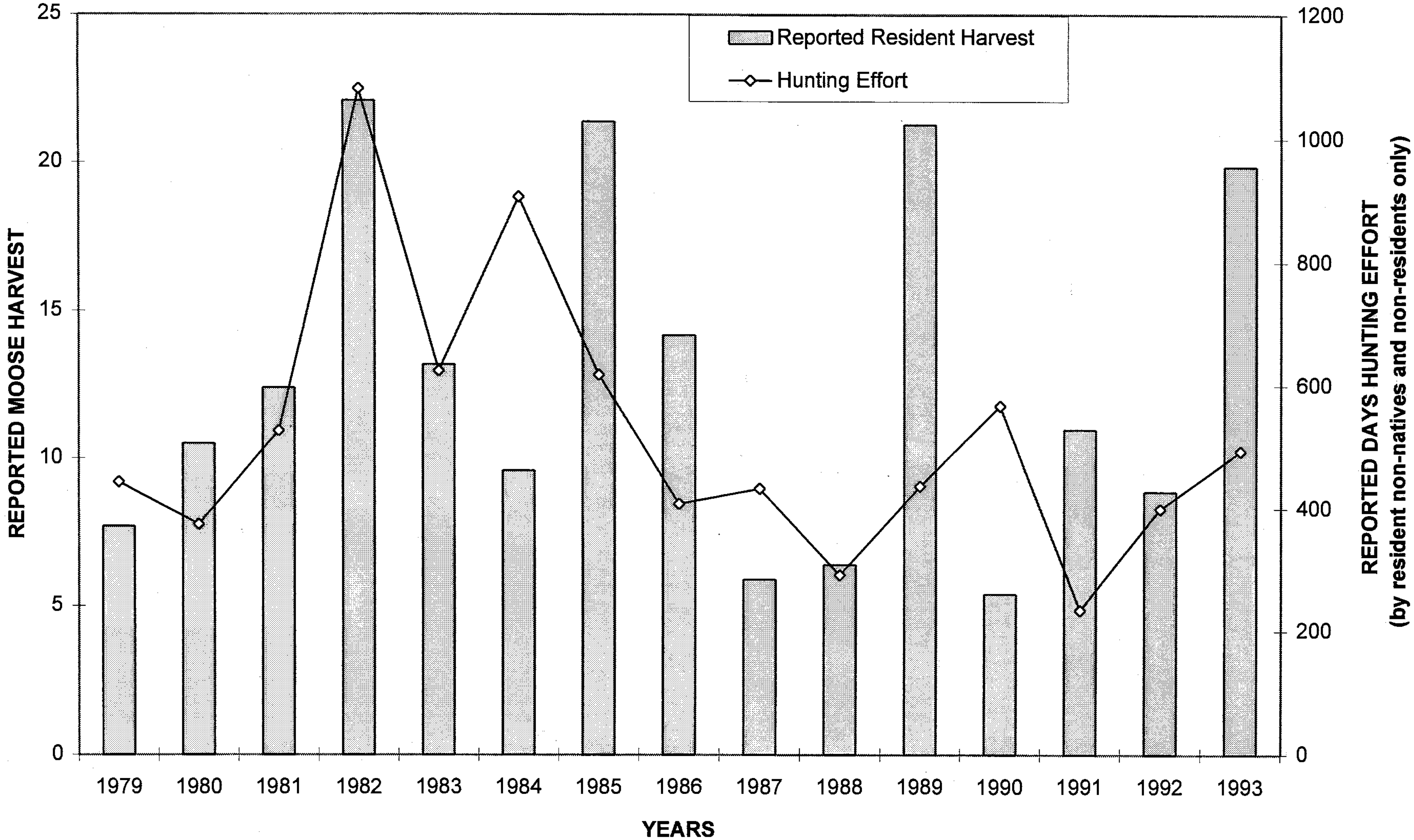

Figure 7. Reported annual moose harvest and days hunting effort in the 1993 Mayo Survey area (GMS 2-58, 4-01 & 4-04) 1979 to 1993.

Table 1. Summary of 1993-94 moose survey area information

Survey Area	Total Area (Km^2)	Moose Habitat (Km^2)	Eco-regions[1]	Game Management Subzones	Survey Type	Caribou[2]	Sheep[2]	Wolves[3]	Grizzly Bears[3]
			Early	Winter	1993				
Big Salmon	2,734	2,706	5	8-03, 8-05 to 8-07, 8-09 to 8-11	Strat. Random Block	present but # unknown	0	10	15
Mayo	3,116	3,049	10	2-58, 4-01, 4-04	Strat. Random Block	200[4]	0	10	17
			Late	Winter	1993				
Aishihik - Onion Creek	20,000	not calc.	8&10	5-12 to 5-14, 5-19,5-25, 5-27 to 5-42, 5-45 to 5-47	Winter Comp. Count	640	1,800	5 - 14	10 -20
Big Salmon	4,000	not calc.	4&5	8-03, 8-05 to 8-11	Winter Comp. Count	present but # unknown	0	10	15
Mayo	5,000	not calc.	10	2-58, 4-01, 4-04	Winter Comp. Count	200[4]	0	10	17
Dawson	2,005	1,870	10&11	3-04	Winter Comp. Count	few	0	8	12

1. After Oswald and Senyk 1977
2. Estimated number
3. Estimated density per 1,000 Km^2
4. Seasonal Use

Table 2. Search intensity (min./km^2) during 1993 early winter moose surveys.

SURVEY/AIRCRAFT	SURVEY AREA	
	BIG SALMON	MAYO
Stratification (fixed wing)		
survey dates (November)	7-10	20-24
area (km^2)	2706.3	3049.4
time (min.)	1455	2000
search intensity (min./km^2)	0.54	0.66
moose seen	276	253
Census (helicopter)		
survey dates (November)	11-17	24-Dec. 1
area searched (km^2)	1054.4	1334.2
% of total area searched	39%	44%
time (min.)	2151	2603
search intensity (min./km^2)	2.0	2.0
moose seen/min. of search	0.15	0.10
Sightability Correction Factor (helicopter)		
area (km^2)	30.5	35.2
time (min.)	139	133
search intensity (min./km^2)	4.6	3.8
calculated SCF	1.07	1.03

Table 3. Sampling intensity of habitable moose range by stratum and survey area during the early winter census in November 1993.

SURVEY AREA	STRATUM LOW	MEDIUM	HIGH	TOTAL
Big Salmon				
Number of SU* in area (% of total)	99(81)	13(11)	10(8)	122(100)
Number of SU censused (% of strata)	28(28)	10(77)	10(100)	48(39)
Area in km² in stratum (% of total)	2197(81)	293(11)	216(8)	2706(100)
Mayo				
Number of SU in area (% of total)	94(78)	20(17)	6(5)	120(100)
Number of SU censused (% of strata)	28(30)	18(90)	6(100)	52(43)
Area in km² in stratum (% of total)	2346(77)	546(18)	158(5)	3049(100)

* Sample Unit

Table 4. Estimated moose abundance, and observed and estimated population composition of in the Big Salmon survey area, November, 1993.

	STRATUM			
	HIGH	MEDIUM	LOW	TOTAL
Estimated Abundance (90% CI)				
Total moose[a]	209	110	210	527±17%
Density (moose/1,000 km^2)	970	366	95	195
Estimated Composition[a] (90% CI)				
Adult bulls (≥30 mo.)	74	42	42	158±19%
Adult cows (≥30 mo.)	90	39	91	221±18%
Yearlings (≥18 mo.)	7	8	23	38±58%
Calves	39	18	53	111±26%
Estimated Population Ratios				
Adult bulls/100 adult cows	82	107	46	71
Yearlings/100 adult cows	7	21	25	17
Calves/100 adult cows	43	46	58	50
Adult bulls/total population	35%	39%	20%	30%
Adult cows/total population	43%	36%	44%	42%
Yearlings/total population	3%	8%	11%	7%
Calves/total population	19%	17%	25%	21%
Observed Composition[b]				
Adult bulls (≥30 mo.)	68	30	11	109
Adult cows (≥30 mo.)	83	28	24	135
Yearlings[c] (≥18 mo.)	6	6	6	18
Calves	36	13	14	63
TOTAL	193	77	55	325
Observed ratios				
Adult bulls/100 adult cows	82	107	46	81
Yearlings/100 adult cows	7	21	25	13
Calves/100 adult cows	43	46	58	47
Adult bulls/total population	35%	39%	20%	34%
Adult cows/total population	43%	36%	44%	42%
Yearlings/total population	3%	8%	11%	6%
Calves/total population	19%	17%	25%	25%
Twinning Rate[d]				24%

a Adjusted for sightability bias (1.07)
b Actual number of moose seen during census
c Total yearlings were calculated by doubling the observed number of yearling males.
d Twinning rate = the number of cows with twins divided by the total number of cows with calves in November.

Table 5. Estimated moose abundance, and observed and estimated population composition in the Mayo survey area, November, 1993.

	STRATUM			
	HIGH	MEDIUM	LOW	TOTAL
Estimated Abundance (90% CI)				
Total moose[a]	80	164	127	372±17%
Density (moose/1,000 km^2)	509	301	54	122
Estimated Composition[a] (90% CI)				
Adult bulls (≥30 mo.)	28	62	32	121±26%
Adult cows (≥30 mo.)	28	57	64	149±23%
Yearlings (≥18 mo.)	10	16	0	26±16%
Calves	14	30	32	76±31%
Estimated Population Ratios				
Adult bulls/100 adult cows	100	108	50	82
Yearlings/100 adult cows	37	28	0	18
Calves/100 adult cows	52	52	50	51
Adult bulls/total population	35%	37%	25%	33%
Adult cows/total population	35%	35%	50%	40%
Yearlings/total population	13%	10%	0%	7%
Calves/total population	18%	18%	25%	20%
Observed Composition[b]				
Adult bulls (≥30 mo.)	27	54	9	90
Adult cows (≥30 mo.)	27	50	18	95
Yearlings[c] (≥18 mo.)	10	14	0	24
Calves	14	26	9	49
TOTAL	78	144	36	258
Observed ratios				
Adult bulls/100 adult cows	100	108	50	96
Yearlings/100 adult cows	37	28	0	25
Calves/100 adult cows	52	52	50	52
Adult bulls/total population	35%	38%	25%	35%
Adult cows/total population	35%	35%	50%	37%
Yearlings/total population	13%	10%	0%	9%
Calves/total population	18%	18%	25%	19%
Twinning Rate[d]				22%

[a] Adjusted for sightability bias (1.03)

[b] Actual number of moose seen during census

[c] Total yearlings were calculated by doubling the observed number of yearling males.

[d] Twinning rate = the number of cows with twins divided by the total number of cows with calves in November.

Table 6. Summary of 1993 and 1994 late winter moose population composition data for the Aishihik-Onion Lake and comparison areas.

AREA	YEAR	ADULTS SEEN	CALVES SEEN	TOTAL MOOSE SEEN	PERCENT CALVES	MOOSE SEEN PER MINUTE
Aishihik - Onion Creek	1993	95	11	106	10%	0.07
	1994	125	27	152	18%	0.15
	CHANGE				+8%	+0.08
Big Salmon	1993	90	10	100	10%	0.08
	1994	79	21	100	21%	0.08
	CHANGE				+11%	0
Mayo	1993	109	15	124	12%	0.12
	1994	84	17	101	17%	0.08
	CHANGE				+5%	-0.04
Dawson	1993	105	8	113	7%	0.12
	1994	105	7	112	6%	0.18
	CHANGE				-1%	+0.06

Appendix 1. Costs (x 1,000) associated with aerial moose surveys conducted during the 1993-94 fiscal year.

EARLY WINTER CENSUS	**BIG SALMON**	**MAYO**
Aircraft[a]		
fixed wing	6.9 (excluding fuel)	11.4 (including fuel)
helicopter	26.0 (excluding fuel)	27.2 (including fuel)
Fuel	6.9	0
Personnel[b] (casual and contract)	7.4	7.2
Food and Lodging	0	4.1
Miscellaneous	0.4	0
TOTAL	47.6	49.9
COST PER 1000 Km^2	17.6	16.4

LATE WINTER COMPOSITION COUNTS	**AISHIHIK**	**BIG SALMON**	**MAYO**	**DAWSON**
Aircraft[a]	3.8	5.3	3.9	3.7
Fuel	1.2	1.3	1.5	2.1
Personnel (casual)	2.2	0[c]	2.6	2.1
Food and Lodging	0.4	0[c]	0.5	0.4
TOTAL	7.6	6.6	8.5	8.3

[a] Aircraft costs (dry) were: Piper Super Cub - $138/Hr; Maule M-7 - $210/Hr; Cessna 185 - $195/Hr; Cessna 206 - $225/Hr; Bell 206 - $359/hour.

[b] A total of 173 person days (permanent, casual and contract) between 18 people (excluding preparation and write-up) were needed to conduct the surveys.

[c] Survey based out of Whitehorse using permanent staff and required 9 days to complete.

APPENDIX 2. **SUMMARY OF NOVEMBER MOOSE SURVEY RESULTS IN THE YUKON (revised March, 1995).**

SURVEY BLOCK	YEAR	SURVEY AREA (KM^2)	POPULATION ESTIMATE	ESTIMATED TOTAL[1] MOOSE/1,000 KM^2	ESTIMATED BULLS/100 COWS	ESTIMATED YEARLINGS/100 COWS	ESTIMATED CALVES/100 COWS	ESTIMATED RECRUITMENT (YEARLINGS/ YEARLINGS AND ADULTS)	ANNUAL FINITE RATE OF CHANGE BETWEEN SURVEYS (%)	POPULATION STATUS (P)=predicted (O)=observed
1. Kluane	1981	3755	434[2]	120	54	27	17	.15		slow decline 1981-1992 (P)
2. Aishihik	1981	3626	377[2]	107	66	31	23	.16		
	1990	3626	291[2]	79	61	21	52	.12	-3	slow decline 1981-1990 (O)
	1990	3626	301[3]	82	62	21	53	.12		
3. Aishihik South	1981	1965	322[2]	166	67	45	24	.21		
	1990	1965	253[3]	129	42	26	56	.16	-5	slow decline 1981-1990 (O)
	1992	1965	126[3]	64	61	15	11	.08	-24	rapid decline 1990-1992 (O)
4. Whitehorse North	1982	3108	533[2]	170	45	1	6	.04		
	1993	3275	295[2]	90	117	20	53	.09	-5	slow decline (O)
	1993	3275	403[3]	123	117	20	53	.09		
5. Haines Junction	1981	2332	570[2]	244	34	19	40	.13		
	1982	2332	351[2]	151	37	3	11	.02		
	1983	2332	337[2]	145	32	1	7	.01		
	1984	2332	329[2]	141	42	1	20	.01	-17	rapid decline 1981-1984 (O)
	1990	2332	513[3]	223	50	31	42	.17	+7	increase 1984-1990 (O)
6. Whitehorse South	1981	2613	607[2]	232	33	27	20	.17		
	1982	2613	582[2]	223	31	2	26	.02		
	1983	2613	651[2]	249	42	4	30	.03		
	1986	2613	717[2]	274	27	18	31	.13	+3	slow increase 1981-1986 (O)
7. Carcross	1980	916	406[2]	443	51	41	37	.21		
	1982	916	300[2]	328	76	1	9	.01		
	1983	916	171[2]	187	51	7	4	.03	-25	rapid decline 1980-1983 (O)
	1994	927	103[2]	110	70	16	22	.09	-5	decline (O)
	1994	927	117[3]	125	72	16	22	.09		

See page 41 for footnoes

SURVEY BLOCK	YEAR	SURVEY AREA (KM²)	POPULATION ESTIMATE	ESTIMATED TOTAL[1] MOOSE/1,000 KM²	ESTIMATED BULLS/100 COWS	ESTIMATED YEARLINGS/100 COWS	ESTIMATED CALVES/100 COWS	ESTIMATED RECRUITMENT (YEARLINGS/ YEARLINGS AND ADULTS)	ANNUAL FINITE RATE OF CHANGE BETWEEN SURVEYS (%)	POPULATION STATUS (P)=predicted (O)=observed
8. Teslin Burn	1982	2512	1383[2]	550	39	12	19	.08		
	1983	1095	472[2]	431	30	1	30	.01		
	1984	2512	1051[2]	417	66	13	39	.07	-13	rapid decline 1982-1984 (O)
9. Nisutlin	1986	4210	563[2]	134	98	36	49	.16		
	1994	4423	875[2]	198	76	19	52	.10	+6	increase 1986-1994 (O)
	1994	4423	1013[3]	229	75	19	52	.10		
10. Liard West	1983	7236	838[2]	116	75	18	18	.09		decline (P)
11. Liard East	1986	2210	305[2]	138	79	37	51	.17		stable to slow increase (P)
12. North Canol	1987	2744	516[2]	188	66	54	64	.24		
	1991	2954	950[2]	321	90	38	52	.17	+16	rapid increase 1987-1991 (O)
	1991	2954	1001[3]	339	90	38	52	.17		
13. Frances Lake	1987	3894	741[2]	190	55	65	69	.29		
	1991	3870	1428[2]	370	57	42	44	.21	+18	rapid increase 1987-1991 (O)
	1991	3870	1475[3]	381	57	41	44	.21		
14. Dromedary	1982	3548	228[2]	64	37	1	15	.01		rapid decline (P)
15. Casino Trail	1987	3055	137[2]	45	--[4]	--[4]	--[4]	unknown		stable to decline (P)
16. Mayo North	1988	2235	286[2]	128	49	42	68	.22		rapid increase (P)
17. Mayo South	1988	2616	387[2]	148	76	11	56	.06		
18. Mayo	1988	3029	315	104	65	54	72	.25		
	1993	3049	361[2]	118	82	18	51	.09	+3	stable to slow increase (O)
	1993	3049	372[3]	122	82	18	51	.09		
19. Dawson East	1989	2611	691[3]	269	65	41	76	.20		rapid increase (P)
20. Dawson West	1989	1870	313[3]	168	105	25	45	.11		stable to slow decline
21. Onion Creek	1992	3397	416[3]	122	49	12	21	.08		" "
22. Big Salmon	1993	2700	527[3]	195	71	17	50	.09		" "

See page 41 for footnoes

SURVEY BLOCK	YEAR	SURVEY AREA (KM²)	POPULATION ESTIMATE	ESTIMATED TOTAL[1] MOOSE/1,000 KM²	ESTIMATED BULLS/100 COWS	ESTIMATED YEARLINGS/100 COWS	ESTIMATED CALVES/100 COWS	ESTIMATED RECRUITMENT (YEARLINGS/ YEARLINGS AND ADULTS)	ANNUAL FINITE RATE OF CHANGE BETWEEN SURVEYS (%)	POPULATION STATUS (P)=predicted (O)=observed
Yukon Wide Averages		61,765[5]	62,456[6]	186[7] 134[8]	68[9]	23[9]	38[9]	.12[10]		stable (P)

1 Small differences between estimated population size, area surveyed and density are due to rounding error
2 Sightability correction factor not applied
3 Sightability correction factor applied
4 Sample size too small to accurately determine sex and age ratios.
5 Total area surveyed = approx. 13% of Yukon.
6 Moose population estimate for entire Yukon. Survey and anecdotal information used to extrapolate densities across Game Management Zones. This was then used to generate a Yukon wide estimate (no confidence limits)
7 Average density calculated from the most recent census data only from areas surveyed to date.
8 Estimated mean density for entire Yukon based on density estimates for each Game Management Subzone, from #6
9 Average from most recent census of areas surveyed only
10 Average from all areas censused

Appendix 3. Comparison of moose survey results from the 1993 Mayo survey area, November 1988 and 1993[1].

POPULATION CHARACTERISTICS	1988	1993
Estimated Abundance (90% CI)		
Total moose[2]	315(±22%)	361(±14%)
Density (moose/1,000 km^2)	104	118
Estimated Composition (90% CI)		
Adult bulls (≥30 mo.)	70(±31%)	118(±21%)
Adult cows (≥30 mo.)	108(±36%)	144(±19%)
Yearlings (approx. 18 mo	59(±71%)	26(±12%)
Calves	78(±32%)	74(±26%)
Observed Composition		
Adult bulls	30	90
Adult cows	52	95
Yearlings	24	24
Calves	35	49
TOTAL	141	258
Observed Ratios		
Adult bulls/100 adult cows	58	95
Yearlings/100 adult cows	46	25
Calves/100 adult cows	67	52
Adult bulls/total population	21%	35%
Adult cows/total population	37%	37%
Yearlings/total population	17%	9%
Calves/total population	25%	19%
Twinning Rate	3%	22%
Survey Characteristics		
Stratification		
Area (km^2)	3029	3049
Time (min.)	n/a	2000
Search Intensity (min./km^2)	0.40	0.66
Moose Seen	127	253
Moose Seen/min.	n/a	0.13
Dates	Nov. 5-6 Nov.18-22	Nov. 20-24
Census		
Area (km^2)	1154	1334
Percentage of Survey Area Searched	38%	44%
Time (minutes)	n/a	2726
Search Intensity (min./km^2)	n/a	2.0
Moose Seen	141	259
Moose Seen/min.	0.09	0.10
Dates	Nov. 6-10 Nov.22-26	Nov. 24-Dec.1

[1] NOTE: sightability correction factor has not been incorporated.

[2] Significantly different between 1981 and 1990; 1990 and 1992 (P<0.20), 1 Tailed Student's t-Test.