Characteristics Of Yukon Moose Populations Surveyed Between November 1994 And March 1995

Areas Surveyed

Nisutlin River
Mount Lorne
Whitehorse South
Aishihik/Onion Creek
Big Salmon River
Mayo
Dawson
Liard River
Finlayson Lake

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Abstract

In November and early December 1994, the Department of Renewable Resources conducted aerial moose surveys in the Nisutlin, Mount Lorne, and Whitehorse South areas. Estimates of moose abundance, distribution and sex/age composition from these surveys are compared to previous surveys in the same areas.

The department also conducted surveys in the Aishihik, Big Salmon, Mayo, Dawson, Liard, and Finlayson Lake areas in February and March 1995 to assess the number of moose calves surviving to become yearlings (recruitment). Recruitment surveys in the Aishihik, Big Salmon, Mayo, and Dawson areas will be used to assess the effect of the wolf population reduction in the Aishihik area on calf survival rates. Surveys in the Liard and Finlayson Lake areas were part of an ongoing program to monitor recruitment.

Nisutlin River area:

The moose density in the Nisutlin area increased from 131 moose per 1000 Km^2 in 1986 to 202 moose per 1000 Km^2 in 1994. This represents a 5.5 per cent annual rate of population growth increase. Calves comprised 21 per cent of the estimated population which should be enough to allow this population to remain stable or increase. Yearlings made up a smaller proportion of the population in 1994 (10 per cent of the population) than in 1986 (16 per cent of the population).

Mount Lorne area:

The moose density in the Mount Lorne area decreased from 184 moose per 1000 Km^2 in 1983 to

111 moose per 1000 Km^2 in 1994. The annual rate of decrease in population size was 4.5 per cent. Calves and yearlings made up 9.0 and 8.0 per cent of the total estimated population. These are below the proportions of calves and yearlings normally needed to maintain a stable moose population.

Whitehorse South area:

The Whitehorse South area was surveyed in 1994 using only stratification portion of the stratified random block technique. Numbers of moose seen and moose seen per minute of survey time are used as indices of total moose abundance. Based on these indices, moose abundance in this area has probably declined since the survey in 1986. We estimate that the current density in this area is approximately 200 moose per 1000 Km^2, down from the estimate of 287 moose per 1000 Km^2 in 1986.

Aishihik/Onion Creek area:

The proportion of calves in the Aishihik/Onion Creek late-winter moose population in 1995 (18.4 per cent calves) was higher than was observed in comparison areas, and should be adequate for population growth.

Big Salmon River, Mayo and Dawson areas:

The proportion of calves seen in the Big Salmon (9.0 per cent), Mayo (9.6 per cent) and Dawson (6.8 per cent) area moose populations is well below what was observed in the Aishihik/Onion Creek area. This is the third straight year of low calf numbers in the Dawson area.

Liard River area:

The proportion of calves observed in late winter in the Liard area since 1992 have varied from 5.7 per cent in 1993 to 18.0 per cent in 1996. On average, the proportion of calves surviving is probably sufficient to maintain a stable moose population.

Finlayson Lake area:

The proportion of calves in the late winter Finlayson Lake area moose population has been monitored annually since 1986. Calves consistently made up more than 20 per cent of the late winter moose population between 1986 and 1992. These high calf survival rates are probably a result of the wolf control program which was conducted in the area between 1983 and 1989. The proportion of calves has declined to between 12.0 and 17.8 per cent since 1993, concurrent with the recovery of the local wolf population.

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Introduction

The Department of Renewable Resources has conducted regional moose surveys in high priority moose management areas since 1980 (Appendix 1). The purpose of the surveys is to gather a Yukon-wide inventory of moose distribution, abundance, and sex/age composition. The survey information is used to assess the status of moose populations, set sustainable harvest levels, evaluate management strategies and provide input on land use and development applications.

In this report we summarize the results of moose surveys conducted throughout the Yukon between November 1994 and March 1995. We conducted early-winter surveys in the Nisutlin, Mount Lorne and Whitehorse South areas. The Nisutlin area had been surveyed in 1986, the Mount Lorne area (previously referred to as the Carcross area) had been surveyed in 1980, 1982 and 1983, and the Whitehorse South area had been surveyed in 1981 to 1983 and 1986.

We conducted late-winter moose surveys in the Aishihik moose and Caribou Recovery Area and in the Big Salmon, Mayo, Dawson, Liard and Finlayson Lake areas. These are known as composition (or recruitment) surveys, to determine the proportion of calves in late-winter moose populations.

Information gathered during composition surveys is used to assess whether calf recruitment (survival to late winter) is sufficient for population growth. Information from the Big Salmon, Mayo, Dawson areas will be used to determine if wolf population reduction is responsible for increasing moose calf survival in the Aishihik recovery area. Late winter composition surveys conducted annually in the Liard and Finlayson Lake areas are part of an ongoing program to monitor recruitment in these areas.

Survey Areas

The three early-winter and six late-winter survey areas are shown on Figure 1. A summary of information on each survey area is presented in Table 1.

Early-Winter Survey Areas

Nisutlin area:

The Nisutlin area includes all of Game Management Subzones (GMS) 10-21 to 10-23 that cover about 4847 Km^2? of which about 4337 Km^2 is moose habitat. Moose habitat includes all vegetated cover types except alpine tundra. The Nisutlin River valley and delta were surveyed for moose in the mid-70s (Hoefs 1974, 1976; Lortie 1974) and in 1986 (Jingfors and Markel 1987). Hayes and Baer (1987) estimated the wolf population of the area at 47 to 52 wolves, or nine to 11 wolves per 1000 Km^2.

The area is characterized by mountain ranges separated by wide valleys dominated by climax stands of open canopy black spruce (*Picea mariana*) or dense stands of white spruce (*P. glauca*), riparian willow (*Salix* spp.) and balsam poplar (*Populus balsamifera*) near drainages. Patchy burns have been re-vegetated with willows and lodgepole pine (*Pinus contorta*). The subalpine shrub zone is predominantly shrub birch (*Betula* spp.) and willows, but is not extensive (Oswald and Senyk, 1977).

Mount Lorne area:

The Mount Lorne area includes GMS 9-01, 9-02 and 9-04. Of its 1016 Km^2, about 927 Km^2 is moose habitat. The terrain consists of precipitous mountains rising to over 2200 m and separated by wide U-shaped valleys. Treeline occurs between 1070 m and 1220 m. Shrub birch and willows are the predominant shrubs in the extensive subalpine zone ranging from treeline to 1520 m. The dominant trees on lower slopes are white spruce and lodgepole pine with scattered stands of white birch (*Betula papyrifera*) and aspen (*Populus tremuloides*) (Oswald and Senyk, 1977).

Whitehorse South area:

The Whitehorse South area includes all or portions of GMS 7-13 to 7-27 that cover about 3505 Km^2. About 2606 Km^2 is moose habitat. This area was surveyed for moose annually between 1981 and 1983 (Larsen 1982, Johnston and McLoed 1983, Markel and Larsen 1984), and again in 1986 (Jingfors and Markel 1987). The bio-geographic features of the area are similar to those described for the Mount Lorne area (Oswald and Senyk, 1977).

Late-Winter Survey areas:

Aishihik/Onion Creek area:

The Aishihik/Onion Creek late winter survey area covers the entire 20000 Km^2 experimental area of the Aishihik moose and caribou recovery program (Carey et al. 1994). The experimental area includes the Ruby Range mountains, portions of the Kluane plateau, and the Nisling and Aishihik basins. It lies within the Ruby Range ecoregion (Oswald and Senyk 1977). The western boundary is formed by the Kluane Wildlife Sanctuary and Kluane National Park Preserve, which are in the northeastern flank of the massive St. Elias Mountains, the largest mountain range in North America. The terrain is rolling to undulating hills above 900 m in elevation.

Treeline is at 1200 m. White spruce is common on well-drained sites below treeline. Black spruce is common in moist lowland sites. Aspen and balsam poplar are found on warm, drained sites or in recently burned areas. Lodgepole pine is scarce except along the eastern edge of the region.

Common understory shrubs are willow, dwarf birch, soapberry *(Shepherdia canadensis)*, and alder *(Alnus* crispa). Shrub birch and willow communities are prevalent in the subalpine.

Big Salmon River area:

The Big Salmon area covers 4000 Km^2 within GMS 8-03 and 8-05 to 8-11. It lies within the Pelly Mountains and Lake Laberge ecoregions (Oswald and Senyk 1977). The Pelly Mountains ecoregion is made up of the Pelly and Cassiar mountains. Terrain is of moderately high relief, generally over 1500 m. 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. Elevations are generally between 600 and 1500 m.

Lodgepole pine stands occur in post burn sites that cover much of the area. White spruce forest is the dominant climax cover type at lower elevations. Black spruce or mixed black and white spruce stands occupy wetter sites. Balsam poplar is common on flood plains. Aspen and paper birch are present on warmer and cooler sites, respectively.

Mayo area:

The Mayo area is made up of portions of the Mayo North and South blocks surveyed in 1988 (Larsen et al. 1989a). Although not all areas were searched, the survey area included about 6000 Km^2 of GMS 2-58, 4-01, and 4-04. The area is part of the Pelly River ecoregion (Oswald and Senyk 1977). The topography is dominated by rolling hills and plateaus.

Lower elevations are dominated by black spruce, which is replaced by white spruce on drier sites. Lodgepole pine frequently invades the burns, but is often in competition with aspen and balsam poplar on wetter sites. Paper birch occurs on cooler sites. Treeline starts at 1350 to 1500 m. There is a limited subalpine zone of willows, shrub birch and alpine fir (*Abies lasiocarpa*).

Dawson area:

The Dawson area lies within GMS 3-04 and covers 2005 Km^2. About 1870 Km^2 is moose habitat. Oswald and Senyk (1977) described the area as smooth, rolling topography, with moderate to deep incised valleys. Most of the terrain lies between 1000 m and 1500 m elevation. Lakes are uncommon. About two per cent of the area has burned since 1966. Black and white spruce stands occur in valleys and on lower slopes. Mixed stands of white spruce, aspen, balsam popular, and paper birch are common along drainages. Shrub birch and willow are common in the under-story and extend beyond treeline at 1200 m.

Liard River area:

The Liard composition survey area includes about 420 Km^2 of winter moose habitat within the Liard River valley. It is within the Liard River ecoregion described by Oswald and Senyk (1977). This ecoregion is described as having closed and nearly closed stands of black and white spruce. These stands frequently lie adjacent to dense growths of riparian willow which occur on the river flood plains.

It is the combination of the closed stands of spruce, which provides relief from deep snow accumulations, and an ample supply of browse on the adjacent flood plain that makes this area critical to the regional moose population.

Finlayson Lake area:

The Finlayson Lake composition survey area includes all of the Finlayson Caribou Herd Recovery area (approximately 23000 Km^2). It lies north of the Robert Campbell Highway between Frances Lake and the North Canol Road (Figure 1).

Because of the large geographic extent of the area, it is difficult to summarize the physiographic features of the area concisely. It encompasses portions of the Liard River, Logan Mountains, Pelly River, Mayo Lake - Ross River, and Itsi Range ecoregions described by Oswald and Senyk (1977). Mountains rise precipitously to approximately 2300 m along the Yukon/Northwest Territories border and this area receives the highest annual precipitation in the Yukon (approximately 750 mm). Treeline occurs at 1350 to 1500 m. Open black and white spruce forests dominate on lower slopes and River valleys.

As one moves south and west the topography generally becomes less severe and annual precipitation decreases. Open black and white spruce forests still dominate although extensive lodgepole pine forests occur on dryer sites.

Caribou, mountain sheep and mountain goats also occupy various portions of the area. Wolves, grizzly bears and black bears range throughout the area.

Methods

Early-Winter Surveys

We used aerial survey techniques based on those described by Gasaway et al. (1986) to estimate moose abundance, composition, and distribution in the Nisutlin and Mount Lorne areas. The only significant modification to their technique was the substitution of helicopters with three observers for fixed-wing aircraft with one observer during the census portion of the survey (Larsen 1982).

This aerial survey technique has three phases:

1) the stratification – surveyors in fixed-wing aircraft classify sample units (SUs) into high, medium, and low density strata based on relative moose abundance;
2) the census – surveyors in helicopters attempt to count all moose in selected SUs. A sample of SUs is randomly selected and searched within several days of stratification; and,
3) the sightability correction factor (SCF) – used to correct for moose missed during the initial the census survey. An SCF was calculated by re-surveying portions of some SUs 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 on the remaining SUs.

We calculated and applied an independent SCF to each stratum following Becker and Reed (1990).

An SCF was not developed for previous surveys of the Nisutlin and Mount Lorne areas. We therefore make between year comparisons of population estimates based on 1994 survey data with no correction made for sightability. While reviewing the 1986 Nisutlin area survey data (Jingfors and Markel 1987) we found errors in the original measurement of SU areas (Km^2). We therefore recalculated and present moose population estimates and sex/age composition for this area using the corrected SU areas.

Larsen and Ward (1995) described methods for recording moose observations, aging, and sexing adults and yearlings. We sexed calves based on the presence or absence of antler buds and, secondarily, on the presence or absence of a vulva patch.

We calculated twinning rates as the proportion of cows with calves in November that had twins. Both birth rates and calf survival between birth and November influence twinning rates.

Harvest estimates are based on questionnaire responses from resident hunters (Kale 1982), compulsory submissions from outfitters of non-resident hunters (Yukon Department of Renewable Resources internal files) and personal interviews with First Nation hunters (Quock and Jingfors 1988).

We use census data to describe moose distribution in the Nisutlin and Mount Lorne areas. Census data is more accurate than stratification data because some SUs are incorrectly classified during stratification due to lower sightability. We used stratification data to describe moose distribution in the Whitehorse South survey area because census data are not available.

Our approach to statistical analysis to test for changes in population size within an area between surveys follows Gasaway et al. (1986). We have arbitrarily set a 25 per cent change in population size as the minimum that will normally be considered significant for moose management purposes. Gasaway et al. (1986) call this the Consequential Difference (CD). Changes in abundance of less than 25 per cent will not normally lead to changes in our management strategy.

In testing for statistical differences between population estimates, we have increased the alpha level (i.e. the probability of concluding that a change had occurred when, in fact it had not) from the generally accepted 0.05 level to 0.10. Increasing the alpha level results in a decrease in beta (i.e. the probability of concluding that no change had occurred when, in fact, it had). Estimating beta and the value 1-beta is called “power analysis”. Power is an estimate of how confident we are that we would detect a change if it had occurred. Ensuring our ability to detect changes in population size is especially important if the population is declining because management actions must be taken promptly in order to avert an even more severe decline. We accordingly attempt to design and conduct our surveys to be 75 per cent sure (the power of the test) of detecting a 25 per cent change in population size.

Our approach is to begin with a two-tailed Student’s T-test, setting alpha at 0.10 to determine if a statistically significant change in population size has occurred. If our moose population estimates are statistically different and indicate a change of more than 25 per cent we consider appropriate management options. If the population has increased, this could mean liberalizing harvest restrictions. If the population has declined, we would consider ways to reduce the harvest and other appropriate management options to stop the decline. If the observed change in population size exceeds 25 per cent but the difference is not statistically significant, we use power analysis to determine the probability of detecting a 25 per cent change. If there is less than a 75 per cent chance of detecting a 25 per cent change in population size, and if time and funding allow, we use additional sampling to improve the power of the test.

We calculated the finite rate of population change (net change after recruitment and mortality) between the previous population estimates and the 1994 estimate (after Gasaway et al. 1986) and using only 1994 data (after Gasaway et al. 1992).   Larsen and Ward (1995) give examples of the methods.

We calculate yearling recruitment rates as: (the estimated number of yearlings) / (the estimated number of yearlings + the estimated number of adults). We can not distinguish between yearling and older cows during the census so we assume they are equal in number to male yearlings. This is in all likelihood a conservative estimate, since yearling males are harvested before our counts are conducted in November.

We use Chi-square statistics to test for differences in age and sex composition between surveys and survey areas.

We estimate the sustainable harvest rates as: ([estimated number of adults + estimated number of yearlings] x the adult and yearling survival rate) - estimated number of adults. We assume average annual adult and yearling survival rates are between 80 and 90 per cent, the range reported for moose in Alaska (Gasaway et al. 1990) and the Yukon (Larsen et al. 1989b).

We surveyed Whitehorse South area using only the stratification portion of the survey technique. Although this technique does not provide a precise estimate of moose abundance, it does provide information on distribution and the total number of moose seen and the number of moose seen per minute of survey time on the stratification flights provide crude estimates of the relative abundance of moose (Gasaway et al. 1986). This assessment is complicated, however, if survey intensity varies between areas and years.

Late-Winter Composition Surveys

We conducted late-winter composition counts in the Aishihik, Big Salmon, Liard, Mayo, and Dawson areas using Piper Super-cub or similar aircraft flown at an altitude of 60 to 90 m above ground and an airspeed of approximately 130 Km per hour. We did not attempt to cover the entire area. Instead, we thoroughly search habitats expected to contain concentrations of moose.

We plot the location of each moose or group of moose that was seen on a 1:250000-scale map to avoid re-counting. Each individual seen is classified as either a calf or adult. We do not sex the moose or distinguish between yearlings and adults. We calculate the proportion of calves as a percentage of the total number of moose observed. We attempt to classify a minimum of 100 moose in each area. We record search times and calculate moose seen per minute of survey time as a crude index of abundance.

Prior to 1995 information on moose population composition in the Finlayson Lake area was gathered during surveys intended primarily to census area wolf populations. Aircraft type, airspeed, and flight level used during these surveys was similar to those described above. Since 1995 we have used surveys like those described above to assess late winter moose population composition in the Finlayson area. Because of the delay in producing this report, we will also present information on moose population composition for 1995 and 1996.

Results and Discussion

Early Winter Surveys

Search and Sampling Intensity

Our search intensity during the stratification phase of the surveys ranged between 0.32 minutes per Km^2 in the Mount Lorne area and 0.56 minutes per Km^2 in the Whitehorse South area (Table 2). Logistic problems (the lack of suitable aircraft) contributed to the lower stratification search intensity in the

Mount Lorne area. Search intensities in all areas were within the range normally used for stratification in the Yukon. They were also substantially higher than the 0.17 minutes per Km^2 suggested by Gasaway et al. (1986).

We use higher search intensity in the Yukon to reduce the chance of assigning sample units (SUs) to the wrong stratum (i.e., moose density class). This should reduce the number of SUs that must be searched during the census phase of the survey to obtain a population estimate with acceptable precision (90 per cent confidence interval (C.I.) within (±) 20 per cent of the population estimate). The need to survey fewer SUs should, in turn, reduce overall survey costs (McNay 1993). Surveys costs are summarized in Appendix 2.

The benefits of higher search intensity are offset to some extent, however, by the greater time required to complete the stratification. The longer time between the stratification and the census of SUs provides more opportunity for moose to move between SUs. As a result, SUs that are correctly assigned to one density class during the stratification may have more or fewer moose than expected when surveyed.

Search intensity during the census phase of the Nisutlin and Mount Lorne surveys were similar at 1.93 and 1.95 minutes per Km^2 respectively (Table 2). These values are within the range normally used for the census portion of moose surveys in the Yukon and are similar to the 2.0 minutes per Km^2 recommended by Gasaway et al. (1986).

Our search intensity during the calculation of the sightability correction factor (SCF) was 4.1 and 3.6 minutes per Km^2 in the Nisutlin and Mount Lorne survey areas respectively (Table 2). This is roughly double that used for the initial census. The resulting SCFs were 1.20 for low and medium strata and

1.04 for the high stratum in the Nisutlin area (Table 2). Pooling the data across strata results in an SCF of 1.17. We calculated SCFs of 1.15 and 1.12 for low and medium strata respectively in the Mount Lorne survey area. The SCF with the data pooled across strata is 1.13.

These SCFs are somewhat higher than normally required for the Yukon surveys but are still relatively low. The average pooled SCF (a single SCF calculated pooling data across strata) for surveys conducted to date throughout the Yukon is 1.07 (range 1.00 to 1.17). In contrast, the average SCF for surveys conducted in Alaska using Piper Super-cubs is 1.14 (range 1.00 to 1.33; McNay 1993). Substitution of helicopters with three observers for fixed-wing aircraft with one observer is likely the primary reason for the lower SCFs calculated for Yukon surveys.

It has been our experience that it often necessary to census a relatively high proportion of SUs in low density moose populations in order to achieve an acceptable level of precision (90 per cent C.I. ± 20 per cent). This is born out in the Mount Lorne area (density = 127 moose per 1000 Km^2) where it was necessary to census 75 per cent of SUs in order to achieve an acceptable level of precision. In contrast, it was only necessary to census 31 per cent of SUs in the Nisutlin area (density = 235 moose per 1000 Km^2) in obtain a similar level of precision (Table 3).

Population Characteristics and Distribution

Nisutlin

We estimated the moose population in the Nisutlin area to be 1017 (90 per cent C.I. 825 to 1210) moose (Table 4). SCFs of 1.04 for high stratum sample units and 1.20 for medium and low strata sample units were incorporated into this estimate. The density was 235 moose per 1000 Km^2, somewhat higher than the average density of 180 moose per 1000 Km^2 for other areas surveyed in the Yukon (Appendix 1).

The Nisutlin area was previously surveyed in 1986 when the moose population was estimated to be 558 (90 per cent C.I. 452 to 664 moose; Appendix 3). This estimate is not directly comparable with the 1994 estimate, however, because a SCF was not developed in 1986. The comparable 1994 population estimate with no SCF is 878 (90 per cent C.I. 746 to 1010 moose; Appendix 3). This is significantly higher than the 1986 estimate ($P<0.01$) and indicated an average annual population growth rate of 5.5 per cent.

This relatively rapid increase in moose abundance in the area is unexpected as no intensive moose management programs were conducted in this area between the 1986 and 1994 surveys. Although cow moose hunting was phased out Yukon-wide between 1982 and 1985 and there has been a trend towards declining resident non-native hunting effort and harvest in the area, (Figure 2) it seems unlikely that these factors alone are sufficient to explain the increase. It seems probable that a combination of a relatively low natural mortality rate and high recruitment must be responsible for the observed increase.

Calf survival was good in 1994. Based on estimated abundance data (Table 4), there were 52 calves per 100 adult cows in the population. This is well above the ratio of 30 calves per 100 adult cows that we assume is normally sufficient to maintain stable moose populations (Yukon Government Moose Management Guidelines).

In contrast, the yearling recruitment also was only fair in 1994. There were an estimated 18 yearlings per 100 adult cows in the area. This is below the 25 to 30 yearlings per 100 adults normally considered necessary to maintain a stable moose population.

The yearling recruitment rate calculated for the Nisutlin area in 1994 was 0.10, similar to the average of 0.11 calculated for all recent surveys conducted throughout the Yukon. It is also within the range of values associated with rapidly declining, near stable or slowly increasing moose populations. Gasaway et al. (1990) documented recruitment rates of 0.03 to 0.16 (average of 0.09) in rapidly declining, 0.06 to 0.16 (average of 0.12) in near stable, 0.09 to 0.17 (average of 0.13) in slowly increasing, and 0.10 to 0.28 (average of 0.22) in rapidly increasing moose populations in east central Alaska (Figure 3).

The true yearling recruitment rate in the Nisutlin area may, however, have been somewhat higher than suggested by our indices. As previously mentioned, we assume that the number of yearling females in the population is equal to the number of yearling males estimated from the survey results. This assumption undoubtedly under-estimates the number of female yearlings in the population because some yearling males are shot prior to the survey.

Given the relatively high calf:cow ratio and fair yearling recruitment rate in the Nisutlin area in 1994 the moose population will probably continue to increase, at least into 1995.

We observed a ratio of 74 adult bulls per 100 adult cows during the 1994 survey, similar to 88 bulls per 100 cows observed during the 1986 survey (Appendix 3). Both values are well above the ratio of 30 adult bulls per 100 adult cows that we use as the lower acceptable limit for management purposes. Based on studies in Alaska, we feel that 30 bulls per 100 cows should be sufficient to ensure effective breeding. About 90 per cent of cow moose in Alaska were pregnant in populations with only four to 20 bulls per 100 cows (Bishop and Rausch 1974).

Twenty (38.5 per cent) of 52 calves classified during the Nisutlin area survey were males, and 32 (61.5 per cent) were females. This not significantly different from a 1:1 sex ratio (X^2 P>0.05). Most studies of other moose populations have reported 1:1 moose calf sex ratios (Schwartz 1993; Boer 1992; among others). However, a few studies have reported skewed sex ratios. Sex ratios favoring females have been reported by Larsen et al. (1989) and Eason (1986). Sex ratios favoring males have been reported by Franzmann (cited in Verme and Ozoga, 1981).

As in most surveys, moose distribution throughout the 1994 Nisutlin survey area was clumped. Approximately 24 per cent of the estimated moose population was in the high stratum which comprised only six per cent of the total survey area, 23 per cent were in the medium stratum (15 per cent of the total survey area), and 53 per cent were located in the low stratum (Tables 3 and 4).

The distribution of moose and strata was similar to that found in 1986. As in the previous survey (Jingfors and Markel 1987), most moose were located in the subalpine zones along the Thirty Mile, Big Salmon and, to a lesser extent, Englishman Mountain Ranges (Figure 4). Similar patterns of concentration of moose in subalpine and other areas of high browse abundance in late fall have been well documented (Gasaway et al. 1978, Bangs et al. 1984) and is probably related to a need to regain body condition after the energetically costly rut (LeResche et al. 1973).

In contrast, Hayes and Baer (1987) found moose in all habitats in January, and Hoefs (1974 and 1976), found late winter (February) concentrations along the major river drainages. These finding probably reflect the moose’s response to changing snow conditions as winter progresses. Moose tend to move out of rutting and post rut concentration areas when snow depths exceed 60 to 80 centimeters (Edwards and Ritcey, 1956; Coady, 1974).

The annual moose harvest in the Nisutlin area (GMS 10-21 to 10-23) has shown a decline since the early 1980s (Figure 2). The average annual reported harvest (excluding the harvest by First Nation's people) declined from 24.2 moose per year between 1979 and 1983 to 12.9 between 1990 and 1994 (five year averages). The harvest by First Nation's members is excluded from this comparison because harvest data are available for the Teslin Tlingit First Nation only for the years 1987 through 1991. In that five year period, the First Nation accounted for 62 per cent of the moose harvest. Nearly all of the moose harvested are bulls. Non-First Nation residents and non-residents are required by law to harvest bulls only. Quock and Jingfors (1988) reported that bulls made up 80 per cent of the harvest by First Nations members Yukon-wide.

If we assume that First Nations were responsible for 62 per cent of the total moose harvest in all years, the average total annual harvest between 1990 and 1994 was 33.9 moose. This represents 6.0 and 3.3 per cent of the 1986 and 1994 moose population estimates respectively (4.3 per cent of the average of the two population estimates.

Assuming a natural mortality rate of between 10 per cent and 20 per cent (as found in studies in the Yukon and Alaska) and that the yearling recruitment rates calculated for 1986 and 1994 (0.16 and 0.10 respectively) are accurate, this harvest would appear to be unsustainable. However, the fact that the population as grown by approximately 5.5 per cent per year indicates that the harvest has been well within sustainable limits. Again, either our estimated recruitment rate is too low or our estimates of adult natural mortality and/or harvest are too high.

Mount Lorne area:

We estimated the moose population in the Mount Lorne area to be 118 (90 per cent C.I. 96-140) moose (Table 5). This estimate incorporates SCFs of 1.12 and 1.15 for low and medium density sample units respectively. The moose density was 127 moose per 1000 Km^2, lower than the average density of 180 moose per 1000 Km^2 for other areas surveyed in the Yukon (Appendix 1).

The Mount Lorne area was previously surveyed in 1980, 1982 and 1983. There were an estimated 406 (no confidence interval available) moose in the area in 1980, 320(±214) in 1982 and 171(±62)in 1983 (Appendix 4). No sightability correction factors are incorporated in these estimates. The 1994 estimate without a SCF was 103(±14 moose). This is significantly ($P<0.05$) lower than the 1983 population estimate and indicated an average annual population growth rate of negative 4.5 per cent.

A number of factors may be responsible for the observed decline in moose abundance in the area. Although hunting restrictions have been imposed on resident and non-resident in the area over the past decade the total annual harvest may be at or above sustainable levels. The current annual reported moose harvest by residents and non-residents averages about two moose per year, less than two per cent of the estimated moose population. Moose populations can normally sustain a three to four per cent harvest rate. This reported harvest does not, however, include harvest by First Nations which may increase the total annual harvest for the area significantly.

Recruitment into this moose population has been low in during each year surveyed since 1982. Based on estimated abundance data (Table 5), there about 19 calves and 18 yearlings for every 100 adult cows in the area in 1994. These ratios are well below the 30 calves and 25 to 30 yearlings per 100 cows we normally consider necessary to maintain a stable population.

We calculated a yearling recruitment rate of 0.09 from the 1994 the Mount Lorne area survey data. Based on this recruitment rate and an adult natural mortality rate of between 10 and 20 per cent, the Mount Lorne moose population is not capable of sustaining any harvest. Although our estimate of yearling recruitment may be too low (see page 20), it is obvious that sustainable harvest for this area is very low.

The calf and yearling:cow ratios were also well below those needed to maintain a stable population in 1983 (four calves and seven yearlings per 100 adult cows (Appendix 4). The 1982 data are inconsistent as there were 84 calves per 100 cows but only 2 yearlings (Appendix 4). These low recruitment rates would tend to reduce the sustainable harvest level below the normal three to four per cent rates.

Finally, incidental observations we recorded during the 1994 survey suggest that the quality of browse southern part of the area which burned in 1958 may be declining as the willows grow out of the reach of moose.

We estimated a ratio of 70 adult bull per 100 cows from the 1994 survey results, well above the ratio of 30 adult bulls per 100 adult cows considered sufficient to ensure that all cows are bred (Yukon

Government Moose Management Guidelines).

Four of eight moose calves we classified during the Mount Lorne survey were males and four were female. This sample size is too small to draw conclusions about the overall calf sex ratio for the population.

Moose were relatively evenly distributed throughout the survey area. Eighty per cent of the estimated moose population located in the low stratum, which comprises 90 per cent of the area. Twenty percent of the moose population was located in the medium stratum, which comprised 10 per cent of the area (Tables 3 and 5). There were no SUs considered to have high moose density in the Mount Lorne survey area.

The relatively uniform distribution of moose in the Mount Lorne area is in contrast to most other surveys. Moose are generally clumped in a relatively few SUs in areas of high browse abundance. As in other survey areas, most of the medium density SUs were located in the shrub dominated subalpine zones, primarily around Caribou and Lansdowne mountains and parts of the 1958 burn in the southern portion of the survey area Figure 5). Other medium density SUs were spread throughout the survey area.

As discussed for the Nisutlin survey area, the pattern of concentration of moose in subalpine and other areas of high browse abundance during the post rut period is common and has been well documented (Gasaway et al. 1978, Bangs et al. 1984) and is probably due to a need to regain body condition after the energetically costly rut (LeResche et al. 1973).

The annual moose harvest in the Mount Lorne area has declined dramatically over the past 16 years (Figure 6). A combination of increased hunting restrictions and a lower moose population has contributed to this decline. Excluding the harvest by First Nation's people, the average reported harvest has declined from 17.3 moose per year between 1979 and 1983 to 1.7 between 1990 and 1994. First Nations harvest data are only available for the period 1988 to 1991, when the average harvest was reported to be three moose per year. During that period, the First Nations accounted for at least 82 per cent of the harvest.

Whitehorse South area:

We counted a total of 294 moose in the Whitehorse South area during the 1994 stratification survey (Table 2). This is a continuation of the trend towards declining numbers of moose seen in the area during stratification flights since 1982. Totals of 328, 334 and 315 moose seen during stratification surveys of the area conducted in 1982, 1983, and 1986 respectively (Appendix 5). The number of moose observed per minute of survey time shows a similar pattern, remaining stable at 0.29 moose per minute during 1983 and 1986 surveys and declining to 0.20 moose per minute during the 1994 survey (Appendix 5). Data on moose seen per minute of survey time are not available for the 1982 survey of the Whitehorse South area.

Based on these numbers it seems likely that moose abundance in the Whitehorse South area has declined since 1982. However, it is difficult to assess the magnitude of the decline because of inconstancies in search intensity (number of minutes used to survey each Km^2). Search intensity increased from 0.31 minutes per Km^2 in 1983 to 0.41 minutes per Km^2 in 1986 and to 0.56 minutes per Km^2 in 1994. This complicates analysis because the proportion of moose actually in an area that are seen during a survey generally increases with increasing search intensity while, at higher search intensities, the number of moose seen per minute tends to decline.

A relatively crude estimate of moose density can be derived from stratification data. Regression analysis of stratification and census data from past surveys conducted throughout the Yukon indicates that there is a strong relationship between moose seen per minute of survey during stratification and moose density (Figure 7). Using the derived relationship for moose seen per minute and moose density, and the equation for prediction of the dependent variable: Estimated moose density = ((Moose seen per minute during stratification) - (the Y intercept of the regression line)) / (the slope of the regression line) as described in Zar (1984) we can estimate moose density.

Based on the above relationship, we estimated a current density of 201 moose per 1000 Km^2 in the Whitehorse South area. If this estimate is correct moose abundance in the Whitehorse South area has declined by approximately 30 per cent since 1986.

The apparent decline in moose abundance has not been uniform throughout the survey area (Figure 8). Areas such as Fish Lake, Rose Creek and Alligator Lake which have become more accessible with the advent of high powered all terrain vehicles and snow machines have experienced dramatic declines in moose abundance. In contrast, moose numbers in remote areas have remained at historic levels.

Calves represented 10.5 per cent of moose we classified during the 1994 survey. This is near or below the minimum proportion of calves normally required to maintain a stable moose population, assuming a 10 to 20 per cent adult mortality rate.

The annual moose harvest in the Whitehorse South area has declined significantly over the past 16 years (Figure 9). A combination of a lower moose numbers and reduced hunting opportunities has likely contributed to this decline. Excluding the harvest by First Nation's people, the average reported harvest has declined from 55.0 moose per year between 1979 and 1983 to 3.1 between 1990 and 1994. First Nations harvest data are only available for the period 1987 to 1991, when the average harvest was reported to be 15.8 moose per year. During that period, the First Nations accounted for at least 67 per cent of the harvest.

Late-Winter Population Composition Surveys

We conducted late winter population composition surveys to monitor calf recruitment (proportion of calves surviving to become adults) in the Aishihik/Onion Creek, Big Salmon, Mayo and Dawson areas (Figure 1) in February-March, 1995 as part of the Aishihik moose and caribou recovery program. We conducted additional late winter composition surveys in the Liard and Finlayson Lake areas (Figure 1) as part of an ongoing program to monitor recruitment into moose populations in these areas.

We will present the data from these two programs separately in the following sections. Due to the delay in producing this report, we also present data from surveys of these areas in 1995 and 1996 are in Tables 6 and 7. Late winter survey costs are summarized in Appendix 2.

Aishihik Recovery Program Late Winter Surveys

We observed and classified least 110 moose in each of the Aishihik Recovery Program survey areas in

1995. The calf recruitment rate (percent calves in the population) varied from 6.8 per cent in the Dawson area to 17.6 per cent in the Aishihik area (Table 6). The values in the three comparison areas (6.8 per cent to 11.6 per cent) are within the range normally associated with stable or declining moose populations based on early winter survey composition information. The average proportion of calves in 16 moose populations assessed as stable or declining during November surveys was 11.2 per cent (Appendix 1).

The calf recruitment rate in the Aishihik/Onion Creek area in 1995 was 18.4 per cent, indicative of a stable or increasing moose population. Fifteen stable or increasing moose populations had an average of 18.7 per cent calves during fall surveys (Appendix 1). We also observed a high calf recruitment rate was in the Aishihik/Onion Creek area in 1994. These recruitment rates, combined with an anticipated increase in adult survival rates as a result the wolf control program should be sufficient to create population growth. In contrast, the 1993 recruitment rate, prior to wolf control, was 10.0 per cent.

Recruitment rates in the Big Salmon and Mayo areas in 1995 (9.0 per cent and 9.6 per cent respectively) were substantially lower than that recorded in the Aishihik area (Table 6). They are also lower than we observed in the Big Salmon and Mayo areas in 1994 (22.0 and 16.8 per cent respectively). The average recruitment rates observed in the Big Salmon and Mayo area since 1993 should be sufficient to maintain stable populations or provide slow growth.

The 1995 calf recruitment in the Dawson area was also very low for the third straight year, suggesting that the population should be declining. Local knowledge suggests that cows with calves in a portion of the Dawson survey area move to lower elevations, outside the survey area in winter. This would tend to bias our results towards bulls and cows without calves and lead to an estimate of recruitment that is too low. If this is the case, the moose population in this area may, in fact, be stable or increasing.

Moose distribution within each survey area has remained similar among years.

Numbers of moose we saw per minute of survey time were similar in the Aishihik, Big Salmon and Dawson areas at about 0.14-0.17 moose per minute (Table 6). Our moose-sighting rate in the Mayo area was lower at about 0.08 moose per minute of survey time. The most recent early-winter survey results for these areas indicated that all the comparison areas had higher moose densities than the Aishihik area (Appendix 1).

Liard and Finlayson area Late Winter Composition Surveys

We have conducted late winter population composition surveys to monitor moose calf recruitment in the Liard area annually since 1992. The number of moose we classified each year has ranged from 70 in 1993 to 297 in 1992 (Table 7). The per cent calves in the population (recruitment) has also varied considerably between years, from 5.7 per cent in 1993 to 18.0 per cent in 1996 (Table 7). With the exception of 1992, recruitment rates have been between 12.9 per cent and 18.0 per cent, indicative of a stable to slowly increasing population. Low calf recruitment was observed in several areas of the Yukon in 1993 (Table 6; Appendix 1) and was likely a result of a cold, wet spring and an early fall with snow and cold temperatures in 1992 (Environment Canada records).

Data on calf recruitment in the Finlayson Lake area moose population has been collected annually since 1986. With the exception of 1995, this information was gathered coincidentally during surveys designed primarily to monitor the area’s wolf population. In 1995 the survey was intended specifically to assess moose recruitment.

Calf recruitment was consistently high (18.5 to 30.8 per cent calves) between 1986 and 1989 (Table 7), the years during which wolf numbers were reduced by 70 to 85 per cent as part of the Finlayson caribou recovery program. Moose recruitment remained high (26.9 per cent in 1990 and 27.2 per cent in 1991) for two years after the end of the wolf control program. Since 1992, however moose recruitment has shown a generally declining trend, dropping from 20.9 per cent calves in 1992, to 12.0 per cent in 1994 and 12.6 per cent in 1995. In 1996 calf recruitment was somewhat higher at 16.5 per cent.

Concurrent with the high recruitment rates of the late 1980's moose abundance in the Finlayson Lake area increased from about 190 moose per 1000 Km^2 (no correction is made for moose missed during the survey) to about 380 moose per 1000 Km^2 (includes correction for moose missed during survey) in 1991 (Larsen and Ward, 1995). Between 1991 and 1996 estimated moose abundance declined to about 335 moose per 1000 Km^2 (Yukon Government file report), following the pattern of declining calf recruitment.

Although late-winter population composition surveys can our provide valuable information on recruitment into local moose populations, we must interpret the results with caution. Sample sizes are often small and subject to error. There is also an assumption made that adult cows and bulls are sampled at equal rates (i.e., no clumping or sexual segregation). There is some evidence that seasonal movements and habitat selection may sex-biased; for example cows with calves may select dense cover where their sightability is reduced, and cows with calves may be less tolerant of deep snow. This may be the case in the Dawson area. Variable survey technique and weather may also effect the number of moose observed per minute.

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Table 1. Moose survey area information 1994-95

Survey Area	Total Area (Km²)	Moose Habitat (Km²)	Eco-regions [1]	Game Management Subzones	Survey Type	Caribou[2]	Sheep[3]	Wolves[4] per 1000Km²	Grizzly Bears[4]
November - December 1994									
Nisutlin	4538	4270	4&5	10-21 to 10-23	Census[5]	1200	0	11.0	15
Mount Lorne	964	927	5	9-01, 9-02 9-04	Census	450	40	28	15
Whitehorse South	3505	2606	6	7-13 to 7-27	Strat.[6]	340	1450	15.7	22
February - March 1995									
Aishihik	20000	not calculated	8&10	5-12 to 5-14 5-19, 5-25, 5-27 to 5-42 5-45 to 5-47	Comp. Count[7]	640	1800	5-14	10-20
Big Salmon	4000	not calculated	4&5	8-03 8-05 to 8-11	Comp. Count	unknown	0	10	15
Mayo	5000	not calculated	12	2-58, 4-01, 4-04	Comp. Count	200[8]	0	10	17
Dawson	2005	1870	10&11	3-04	Comp. Count	few	0	8	12
Liard	420	420	2	10-17,18,20, 27,28,30,31,32 11-28,29	Comp. Count	300-400[7]	15-20	7.8 - 12.3	9
Finlayson	23000	NA	2-4, 12-14	10-01 to 10-09 11-01 to 11-26	Comp. Count	4000	350-400	10.4 -11.7	9 - 17

[1] after Oswald and Senyk (1977)
[2] estimated number (R. Farnell, pers. comm. 1997; Farnell and McDonald 1990)
[3] estimated number (J. Carey, pers. comm. 1997)
[4] estimated density per 1000 Km²(A. Baer, pers. comm.; Hayes 1995)
[5] estimated density per 1000 Km² (Smith and Osmond-Jones 1990)
[6] seasonal Use
[7] seasonal use by part of Rancheria Herd (Farnell and McDonald 1990)

Table 2. Search intensity on early-winter moose surveys 1994.

Survey	Survey Area		
	Nisutlin	**Mount Lorne**	**Whitehorse South**
Stratification			
survey dates	Nov. 6-11	Dec. 2	Nov. 27-29
area searched (Km^2)	4337.5	926.9	2605.8
survey time (minutes)	1995	300	1458
search intensity (minutes per Km^2)	0.46	0.32	0.56
moose seen	503	62	294
moose seen per minute of search	0.25	0.21	0.20
Census			
survey dates	Nov. 10-20	Dec. 5-10	NOT CENSUSED
area searched (Km^2)	1361.1	701.3	-
% of total area searched	31%	76%	-
survey time (minutes)	2626	1368	-
search intensity (minutes per Km^2)	1.93	1.95	-
moose seen	417	81	-
moose seen per minute of search	0.16	0.06	-
Sightability Correction Factor (SCF) (helicopter)			
area searched (Km^2)	105.6	51.3	-
survey time (minutes)	433	184	-
search intensity (minutes per Km^2)	4.1	3.6	-
calculated SCF – High Stratum	1.04	N/A	-
calculated SCF – Medium Stratum	1.20	1.12	-
calculated SCF – Low Stratum	1.20	1.15	-
calculated SCF – Pooled Strata	1.17	1.13	-

Table 3. Estimated moose abundance, and observed and estimated composition of moose in the Nisutlin survey area, November 1994.

	Stratum			
	Low	**Medium**	**High**	**Total (90% C.I.)**
Estimated Abundance[a]				
Total Moose	536	235	246	1017 (825-1210)
Density (moose per 1000 Km^2)	156	368	927	235
Estimated Composition[a]				
Adult Bulls (≥ 30 months)	127	88	94	309 (233-384)
Adult Cows (≥ 30 months)	240	84	91	415 (326-503)
Yearlings (≥ 18 months)	28	28	21	77 (43-111)
Calves (≤ 7 months)	141	35	39	216 (164-267)
Unidentified	0	0	1	1 (1-1)
Estimated Population Ratios[a]				
Adult Bulls per 100 Adult Cows	53	105	103	74 (57-92)
Yearlings per 100 Adult Cows	12	33	23	18 (10-27)
Calves per 100 Adult Cows	59	42	43	52 (44-60)
Unid. Moose per 100 Adult Cows	0	0	1	<1 (0-1)
% Adult Bulls in Total Population	24	37	38	30 (25-35)
% Adult Cows in Total Population	45	36	37	41 (37-45)
% Yearlings in Total Population	5	12	8	8 (5-11)
% Calves in Total Population	26	15	16	21 (18-24)
% Unid. Moose in Total Population	0	0	<1	<1 (0-1)
Observed Composition[b]				
Adult Bulls (≥ 30 months)	27	25	90	142
Adult Cows (≥ 30 months)	51	24	87	162
Yearlings (≥ 18 months)	6	8	20	34
Calves (≤ 7 months)	30	10	38	78
Unidentified	0	0	1	1
TOTAL	114	67	236	417
Observed Ratios[b]				
Adult Bulls per 100 Adult Cows	53	104	103	88
Yearlings per 100 Adult Cows	12	33	23	21
Calves per 100 Adult Cows	59	42	44	48
Unid. Moose per 100 Adult Cows	0	0	1	1
% Adult Bulls in Total Population	24	37	38	34
% Adult Cows in Total Population	45	36	37	39
%Yearlings in Total Population	5	12	8	8
% Calves in Total Population	26	15	16	19
% Unid. Moose in Total Population	0	0	<1	<1
Twinning rate[c]				12%

[a] adjusted for sightability bias: Low and Medium Strata = 1.20; High Stratum = 1.04
[b] actual number of moose seen during census. Total cows were calculated by subtracting the observed number of yearling males and total yearlings were calculated by doubling the observed number of yearling males
[c] twinning rate is the proportion of cow with calves that had twins

Table 4. Sampling intensity of moose habitat by stratum and survey area during early-winter surveys 1994.

Survey Area	Stratum			
	Low	**Medium**	**High**	**Total**
Nisutlin				
Number of SUs[a] in area (% of strata)	192(80)	35(14)	14(6)	241(100)
Number of SUs censused (% of strata)	49(26)	12(34)	14(100)	75(31)
Area in stratum (Km^2) (% of total area)	3432(79)	640(15)	265(6)	4337(100)
Mount Lorne				
Number of SUs in area (% of total)	61(90)	7(10)	--	68(100)
Number of SUs censused (% of strata)	44(72)	7(100)	--	51(75)
Area in stratum (Km^2) (% of total area)	835(90)	92(10)	--	927(100)
Whitehorse South				
Number of SUs in area (% of total)	146(82)	26(15)	5(3)	177(100)
Number of SUs censused (% of strata)	N/A	N/A	N/A	N/A
Area in stratum (Km^2) (% of total area)	2113(81)	413(16)	80(3)	2606(100)

[a] Sample Units

Table 5. Estimated moose abundance, and observed and estimated composition of moose in the Mount Lorne survey area, December 1994.

	Stratum		
	Low	**Medium**	**Total (90% C.I.)**
Estimated Abundance[a]			
Total Moose	92	26	118 (96-140)
Density (moose per 1000 Km^2)	110	281	127
Estimated Composition[a]			
Adult Bulls (≥ 30 months)	30	10	40 (30-50)
Adult Cows (≥ 30 months)	43	14	57 (43-71)
Yearlings (≥ 18 months)	10	0	10 (4-16)
Calves (≤ 7 months)	9	2	11 (7-15)
Estimated Population Ratios[a]			
Adult Bulls per 100 Adult Cows	70	77	70 (50-90)
Yearlings per 100 Adult Cows	23	0	18 (7-29)
Calves per 100 Adult Cows	21	15	19 (14-24)
% Adult Bulls in Total Population	33	38	34 (29-39)
% Adult Cows in Total Population	47	54	48 (41-55)
% Yearlings in Total Population	11	0	8 (4-12)
% Calves in Total Population	10	8	9 (7-11)
Observed Composition[b]			
Adult Bulls (≥ 30 months)	19	9	28
Adult Cows (≥ 30 months)	27	12	39
Yearlings (≥ 18 months)	6	0	6
Calves (≤ 7 months)	6	2	8
TOTAL	58	23	81
Observed Ratios[b]			
Adult Bulls per 100 Adult Cows	70	75	72
Yearlings per 100 Adult Cows	22	0	15
Calves per 100 Adult Cows	22	17	21
% Adult Bulls in Total Population	33	39	35
% Adult Cows in Total Population	47	52	48
% Yearlings in Total Population	10	0	7
% Calves in Total Population	10	9	10
Twinning Rate[c]			0%

[a] adjusted for sightability bias: Low Stratum = 1.15; Medium Stratum = 1.12

[b] actual number of moose seen during census. Total Cows were calculated by subtracting the observed number of yearling males and Total Yearlings were calculated by doubling the observed number of yearling males

[c] twinning rate is the proportion of cows with calves that had twins

TABLE 6. Summary of 1993 - 1996 Aishihik study area late winter moose population composition data.

AREA	YEAR	ADULTS SEEN	CALVES SEEN	TOTAL MOOSE SEEN	PERCENT CALVES	SURVEY TIME (minutes)	MOOSE SEEN PER MINUTE
Aishihik - Onion Creek	1993	95	11	106	10.4%	1510	0.07
	1994	125	27	152	17.8%	989	0.15
	1995	151	34	185	18.4%	1158	0.16
	1996	149	28	177	15.8%	1577	0.11
Big Salmon	1993	90	10	100	10.0%	1192	0.08
	1994	78	22	100	22.0%	1272	0.08
	1995	121	12	133	9.0%	1047	0.13
	1996	148	39	187	20.9%	940	0.20
Mayo	1993	109	15	124	12.0%	997	0.12
	1994	84	17	101	16.8%	1317	0.08
	1995	103	11	114	9.6%	1373	0.08
	1996	126	38	164	23.2%	1094	0.15
Dawson	1993	100	8	108	7.4%	910	0.12
	1994	105	7	112	6.3%	610	0.18
	1995	124	9	133	6.8%	804	0.17
	1996	101	7	108	6.5%	800	0.14

TABLE 7. Summary of the Liard and Finlayson late winter moose population composition data.

AREA	YEAR	ADULTS SEEN	CALVES SEEN	TOTAL MOOSE SEEN	PERCENT CALVES	MOOSE SEEN PER MINUTE
Liard	1992	258	39	297	13.1	1.35
	1993	66	4	70	5.7	0.26
	1994	182	27	209	12.9	0.46
	1995	142	22	164	13.4	0.36
	1996	219	48	267	18.0	0.42
Finlayson	1986	99	44	143	30.8	NA
	1987	133	45	178	25.3	NA
	1988	162	44	206	21.4	NA
	1989	189	43	232	18.5	NA
	1990	114	42	156	26.9	NA
	1991	193	72	265	27.2	NA
	1992	170	45	215	20.9	NA
	1993	83	18	101	17.8	NA
	1994	331	45	376	12.0	NA
	1995	104	15	119	12.6	0.19
	1996	177	35	212	16.5	NA

Appendix 1. Summary of Yukon early-winter Moose Survey Results

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	2349	589[2]	251	34	21	38	.14		
	1982	2349	351[2]	150	37	3	11	.02		
	1983	2349	346[2]	147	32	1	7	.01		
	1984	2349	330[2]	141	47	1	18	.01	-18	rapid decline 1981-1984 (O)
	1990	2335	509[2,3]	218	49	30	42	.17	+7	increase 1984-1990 (O)
6. Whitehorse South	1981	2671	608[2]	218	31	25	21	.16		
	1982	2671	674[2]	252	34	6	25	.05		
	1983	2671	654[2]	245	41	4	30	.03		
	1986	2671	715[2]	283	27	18	31	.13	+3	slow increase 1981-1986 (O)
	1995	2883	447[2]	155	58	28	42	.15		

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
		1995	2883	457[3]	159	58	28	42	.15	-5	slow decline 1986-1995 (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]	111	72	17	21	.09	-5	decline 1983-1994(O)
		1994	927	118[3]	127	70	18	19	.09		
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	4337	878[2]	202	75	19	52	.10	+6	increase 1986-1994 (O)
		1994	4337	1017[3]	235	74	18	52	.10		
10.	Liard West	1983	7217	829[2]	115	71	18	18	0.10		decline (P)
		1983	4380	372[2]	88	61	8	11	.05		
		1995	4380	712[2]	166	46	32	46	.18	+6	increase 1983-1995(O)
		1995	4380	827[3]	189	43	34	47	.19		
11.	Liard East	1986	2210	305[2]	138	79	37	51	.17		stable to slow increase (P)
12.	North Canol	1987	2744	512[2]	187	66	50	64	.23		
		1991	2954	938[2]	317	90	38	52	.17	+16	rapid increase 1987-1991 (O)
		1991	2954	988[3]	335	90	38	52	.17		
		1996	2954	728[2]	246	102	41	28	.17		
		1996	2954	820[3]	277	102	41	28	.17	-4	Slow decline 1991-1996 (O)

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 RECRUITMEN T (YEARLINGS/Y EARLINGS AND ADULTS)	ANNUAL FINITE RATE OF CHANGE BETWEEN SURVEYS (%)	POPULATION STATUS (P)=predicted (O)=observed
13. Frances Lake	1987	3894	741[2]	190	55	65	69	.29		
	1991	3870	1409[2]	370	57	42	44	.21	+18	rapid increase 1987-1991 (O)
	1991	3870	1454[3]	376	57	42	44	.21		
	1996	3918	1220[2]	311	46	18	30	.11		
	1996	3918	1323[3]	338	46	18	30	.11	-2	stable to slow decline 1991-1996 (O)
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[2]	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	2565	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 (P)
21. Onion Creek	1992	3397	416[3]	122	49	12	12	.08		stable to slow decline (P)
22. Big Salmon	1993	2700	527[3]	195	71	17	50	.09		stable to slow decline (P)
23. Pelly Crossing	1995	3581	748[3]	209	62	31	85	.16		
Yukon Wide Average		67,745[5]	60,000 to 65,000[6]	180[7] 135 - 137[8]	68[9]	23[9]	40[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. 14% of Yukon.
6 moose population estimate for entire Yukon
7 average density from most recent census of areas surveyed
8 estimated mean density for entire Yukon based on density estimates for each Game Management Subzone
9 average from most recent census of areas surveyed

10 average from all areas censused

Appendix 2 Cost (x 1000) associated with aerial moose surveys in 1994/95.

EARLY WINTER	NISUTLIN	MT. LORNE	WHITEHORSE SOUTH
ITEM	**COST ($ x 1000)**	**COST ($ x 1000)**	**COST ($ x 1000)**
Aircraft[a]			
fixed wing	11.5 (including fuel)	2.5 (including fuel)	6.3 (including fuel)
helicopter	39.7 (including fuel)	19.0 (including fuel)	NA
Personnel[b] (casual and contract)	13.0	4.0	4.3
Food and Lodging	2.2	0	0
Miscellaneous (including fuel haul costs)	0.9	0.5	0.5
TOTAL	67.3	26.0	11.1
COST PER 1000 Km^2	15.8	28.0	4.3

LATE WINTER[a]	AISHIHIK	BIG SALMON	MAYO	DAWSON	LIARD	FINLAYSON[d]
Aircraft[a]	3.5	3.6	4.1	3.5	2.1	NA
Fuel	0.5	0.5	0.5	0.5	0.2	NA
Personnel[C] (casual)	1.0	1.0	1.3	1.2	1.0	NA
Food and Lodging	0	0	0.5	0.5	0	NA
Miscellaneous	0	0	0	0	0	NA
TOTAL	5.0	5.1	6.4	5.7	3.3	NA

a. Aircraft costs (dry) were: Early Winter Surveys: fixed wing: $190-215 per hr., helicopter: $455 per hr.
Late Winter Surveys: Piper Super Cub $133-145 per hr.
b. A total of 167 person days (permanent, casual and contract) between 12 people (excluding preparation and write-up) were needed to conduct the early winter surveys.
c. Surveys were flown using casual and permanent staff and required 23 days to complete.
d. Finlayson survey was flown in conjunction with a wolf survey. Species specific survey costs are not available.

Appendix 3. Summary of 1986 and 1994 Nisutlin early-winter moose population survey results and characteristics.

Population Characteristics	1986	1994
Estimated Abundance (90% C.I.)		
Total Moose[1]	558 (452-664)	878 (746-1010)
Density (moose per 1000 Km^2)	131	202
Estimated Composition (90% C.I.)		
Adult Bulls (> 30 months)	180 (124-236)	269 (213-325)
Adult Cows (> 30 months)	205 (154-256)	357 (296-418)
Yearlings (> 18 months)	73 (42-104)	67 (35-79)
Calves (< 7 months)	99 (66-132)	185 (150-220)
Unidentified	1 (1-1)	1 (1-1)
Estimated Population Ratios (90% C.I.)		
Adult Bulls per 100 Adult Cows	88 (57-119)	75 (59-91)
Yearlings per 100 Adult Cows	36 (16-56)	19 (11-27)
Calves per 100 Adult Cows	48 (35-61)	52 (45-59)
Unid. Moose per 100 Adult Cows	<1 (0-1)	<1 (0-1)
% Adult Bulls in Total Population	32 (27-38)	31 (26-36)
% Adult Cows in Total Population	37 (30-44)	41 (38-44)
% Yearlings in Total Population	13 (8-18)	8 (5-11)
% Calves in Total Population	18 (13-23)	21 (18-24)
% Unidentified moose in Total Population	<1 (0-1)	<1 (0-1)
Observed Composition[2]		
Adult Bulls (≥ 30 months)	98	142
Adult Cows (≥ 30 months)	105	162
Yearlings (≥ 18 months)	36	34
Calves (≤ 7 months)	46	78
Unidentified	1	1
TOTAL	286	417
Observed Ratios[2]		
Adult Bulls per 100 Adult Cows	93	88
Yearlings per 100 Adult Cows	34	21
Calves per 100 Adult Cows	44	48
Unid. Moose per 100 Adult Cows	1	1
% Adult Bulls in Total Population	34	34
% Adult Cows in Total Population	37	39
% Yearlings in Total Population	13	8
% Calves in Total Population	16	19
% Unid. Moose in Total Population	<1	<1
Twinning Rate[3]	12%	12%

Appendix 3 cont.

Survey Characteristics	1986	1994
Stratification		
Area Searched (Km^2)	4270	4337
Survey Time (minutes)	1296	1995
Search Intensity (minutes per Km^2)	0.30	0.46
Moose Seen	321	503
Moose Seen per minute of search	0.25	0.25
Survey Dates	Nov. 15-17	Nov. 6-11
Census		
Area Searched (Km^2)	1063	1361
% of Total Area Searched	25%	31%
Survey Time (minutes)	1860	2626
Search Intensity (minutes per Km^2)	1.75	1.93
Moose Seen	286	417
Moose Seen per minute of search	0.15	0.16
Survey Dates	Nov. 18-21	Nov. 10-20
Sightability Correction Factor[4]		
Area Searched (Km^2	-	105.6
Survey Time (minutes)	-	433
Search Intensity (minutes per Km^2)	-	4.1
SCF - High Stratum	-	1.04
SCF - Medium Stratum	-	1.20
SCF - Low Stratum	-	1.20
SCF - Strata Pooled	-	1.17

[1] sightability correction factor not applied. 1986 and 1994 estimates significantly different (P<0.01)
[2] actual number of moose seen during the census
[3] twinning rate is the proportion of cows with calves that have twins
[4] sightability correction factor not determined for 1986 survey.

Appendix 4. Summary of 1982, 1983 and 1994 Mount Lorne early-winter moose population survey results and characteristics.

Population Characteristics	1982	1983	1994
Estimated Abundance (90% C.I.)			
Total Moose[1]	320 (105-534)	171 (110-231)	103 (88-117)
Density (moose per 1000 Km^2)	345	184	111
Estimated Composition (90% C.I.)			
Adult Bulls ($\geq$ 30 months)	127 (0-257)	54 (34-74)	35 (28-42)
Adult Cows ($\geq$ 30 months)	175 (78-272)	105 (68-143)	49 (40-58)
Yearlings ($\geq$ 18 months)	3 (0-5)	8 (0-15)	8 (4-12)
Calves ($\leq$ 7 months)	15 (0-32)	4 (0-7)	10 (7-13)
Estimated Population Ratios (90% C.I.)			
Adult Bulls per 100 Adult Cows	73 (13-132)	51 (41-62)	72 (53-90)
Yearlings per 100 Adult Cows	2 (0-3)	7 (1-13)	17 (7-26)
Calves per 100 Adult Cows	84 (0-188)	4 (0-7)	21 (16-26)
% Adult Bulls in Total Population	40 (20-60)	32 (27-37)	34 (29-39)
% Adult Cows in Total Population	55 (37-73)	62 (59-65)	48 (42-54)
% Yearlings in Total Population	1 (0-2)	4 (1-8)	8 (4-12)
% Calves in Total Population	5 (0-10)	2 (0-4)	10 (8-12)
Observed Composition[2]			
Adult Bulls ($\geq$ 30 months)	42	33	28
Adult Cows ($\geq$ 30 months)	88	65	39
Yearlings ($\geq$ 18 months)	2	4	6
Calves ($\leq$ 7 months)	6	2	8
TOTAL	138	104	81
Observed Ratios[2]			
Adult Bulls per 100 Adult Cows	48	51	72
Yearlings per 100 Adult Cows	2	6	15
Calves per 100 Adult Cows	7	3	21
% Adult Bulls in Total Population	30	32	35
% Adult Cows in Total Population	64	63	48
% Yearlings in Total Population	1	4	7
% Calves in Total Population	4	2	10
Twinning Rate[3]	0%	0%	0%

Appendix 4 cont.

Survey Characteristics	1982	1983	1994
Stratification			
Area Searched (Km^2)	927	927	927
Survey Time (minutes)	204	260	300
Search Intensity (minutes per Km^2)	0.22	0.28	0.32
Moose Seen	116	42	62
Moose Seen per minute of search	0.57	0.16	0.21
Survey Dates	Nov. 3-5	Dec. 5&6	Dec. 2
Census			
Area Searched (Km^2)	191	387	701
% of Total Area Searched	21%	42%	76%
Survey Time (minutes)	613	698	1368
Search Intensity (minute per Km^2)	3.1	1.80	1.95
Moose Seen	138	104	81
Moose Seen per minutes of search	0.23	0.15	0.06
Survey Dates	Nov. 5-11	Dec. 7&8	Dec. 5-10
Sightability Correction Factor[4]			
Area Searched (Km^2	-	-	51.3
Survey Time (minutes)	-	-	184
Search Intensity ((minutes per Km^2)	-	-	3.6
SCF - High Stratum	-	-	N/A
SCF - Medium Stratum	-	-	1.12
SCF - Low Stratum	-	-	1.15
SCF - Strata Pooled	-	-	1.13

[1] sightability correction factor not incorporated. 1983 and 1994 estimates significantly different ($P<0.05$)
[2] actual number of moose seen during the census
[3] twinning rate is the proportion of cows with calves that have twins
[4] sightability correction factors not determined for 1982 and 1983 surveys

Appendix 5. Summary of Whitehorse South early-winter survey characteristics 1981 to 1983, 1986 and 1994

Survey Characteristics	1981	1982	1983	1986	1994
Stratification					
Area Searched (Km^2)	2613	2613	2613	2613	2606
Survey Time (minutes)	N/A	N/A	810	1077	1458
Search Intensity (minutes per Km^2)	N/A	N/A	0.31	0.41	0.56
Moose Seen	354	328	334	315	294
Moose Seen per minutes of search	N/A	N/A	0.29	0.29	0.20
Survey Dates	Late Nov.	Nov. 11-17	Nov. 15-17	Nov. 7-8	Nov. 27-29
Census					
Area Searched (Km^2)	518	505	745	925	No
% of Total Area Searched	17	18	29	35	census
Survey Time (minutes)	691	659	1278	1687	
Search Intensity (minutes per Km^2)	1.3	1.3	1.7	1.8	
Moose Seen	329	285	393	452	
Moose Seen per minutes of search	0.48	0.43	0.31	0.27	
Survey Dates	Dec. 1-3	Nov. 18-22	Nov. 18-22	Nov. 9-12	

Summary

This report presents the results of moose surveys done in the Nisutlin, Mount Lorne, Whitehorse, Aishihik/Onion Creek, Big Salmon River, Mayo, Dawson, Liard River and Finlayson Lake areas between November, 1994 and March, 1995.

We did precise moose counts in the Nisutlin and Mount Lorne areas in November and early December 1994. These counts tell us how many calf, yearling and adult moose there are in each of the areas. This information tells us if moose numbers in these areas are going up or down or if they are staying the same.

We did a similar, but less exact type of moose count in the area south of Whitehorse in late November 1994. This type of survey gives us a rough idea of how many moose are in an area and where they are, but it is difficult to say for sure if moose numbers are increasing or decreasing.

Finally, we did surveys in the Aishihik/Onion Creek, Big Salmon River, Mayo, Dawson, Liard River, and Finlayson Lake areas in February and March 1995, to find out how many moose calves survived their first winter. We use the information gathered in the Aishihik/Onion Creek, Big Salmon, Mayo, and Dawson areas to determine the effect of the wolf control program in the Aishihik area on moose calf survival. Surveys in the Liard River and Finlayson Lake areas are part of our ongoing program to monitor calf survival in these areas.

Nisutlin River area:

The number of moose in the Nisutlin area increased between 1986 and 1994. We estimated that

there were 558 moose in the Nisutlin area in 1986. In 1994, we estimated that there were 1017 moose in the same area. These estimates are not fully comparable because we did the counts slightly differently, but they are close enough to show that moose numbers in the area had increased substantially. We do not know why moose numbers increased so quickly in this area.

Twenty-one of every 100 moose in the Nisutlin area in 1994 were calves. This should be enough to allow the population to remain stable or continue to increase. However, only 10 of every 100 moose were yearlings. Usually between 10 and 20 of every 100 moose in a population must be yearlings for the population to remain stable. Wolves and bears usually take 10 to 20 of every 100 adult moose in a population each year and without enough yearlings the population cannot make up for these losses.

Mount Lorne area:

Moose numbers in the Mount Lorne area have declined substantially since we did our first moose count in 1982. We estimated that there were about 345 moose in the area in 1982. By 1994 there were about 118 moose in the same area. We think this decline is due to a combination of predation, heavy hunting pressure and a decline in habitat quality as the area returns to mature forest after the 1958 fire.

Of every 100 moose in the Mount Lorne area only nine were calves and eight were yearlings - likely too few to keep the population from declining still further. Predation is the most common cause of low numbers of calves and yearlings in Yukon moose populations.

Whitehorse South area:

We counted 294 in the area Whitehorse South in 1994 - fewer than we counted during similar surveys of the area since 1981, even though we spent more time searching the area for moose in 1994. Based on this, we think that moose abundance in the area south of Whitehorse area has declined since the 1986 survey. Based on our count of 294 moose, we estimate that there was a total of about 524 moose in the area in 1994, down the estimate of 717 moose in the area in 1986. Most of the decline in moose numbers has occurred in more accessible parts of the area. This suggests that over-hunting may be the cause.

Aishihik/Onion Creek, Big Salmon River, Mayo, and Dawson areas:

Twenty-seven of 157 moose seen in the Aishihik/Onion Creek area were nine month old calves - enough to support growth in the moose population.

Calf numbers seen in the Big Salmon and Mayo areas were lower than those observed in the Aishihik/Onion Creek area but they should be high enough to sustain stable to increasing moose populations.

Few calves were seen in the Dawson area in 1994. This is the third straight year of low calf numbers in this area which suggests that the local moose population may be declining. Local knowledge suggests, however, that cows with calves in a portion of the Dawson survey area move to lower elevations, outside the survey area in winter. If this is the case, our estimate of the number of calves in the population is too low.

Liard River area:

The number of calves seen in the Liard area since 1992 has varied considerably. Overall, however, there are probably enough calves surviving to maintain a stable moose population.

Finlayson Lake area:

We have monitored the number of calves surviving in the Finlayson Lake area every year since 1986. There were consistently more than 20 calves for every 100 moose seen in the area during late winter between 1986 and 1992. These high calf numbers are a result of the wolf control program which was conducted in the area between 1983 and 1989. Calf numbers have declined since the end of the wolf control program. In 1994 there were only 12 calves for every 100 moose seen during late winter. This may not be enough to maintain a stable moose population.

Explanation of Terms

alpha level a statistical term used with tests (such as Student's T) to state the likelihood that, based on our survey results, we will conclude that there has been a change in moose abundance when, in fact, there has been no change. For example, if we say that moose abundance has increased ($P<0.05$), there is less than a five per cent chance that moose abundance has not increased. In other words we are 95 per cent sure that the moose population has increased. *see Student's T-test*

beta level a rarely used statistical term to state the likelihood that, based on our survey results, we will conclude that there has not been a change in moose abundance when, in fact, there has been a change. For example, we might say, based on our survey results, that moose abundance in an area has not increased when, in fact it has. The beta level is linked to the alpha level - as you decrease the chance of making one type of error the chance of making the other type of error increases. *see alpha level and Student's T-test*

CD see consequential difference

composition the number of bull, cow, yearling and calf moose in a population. This information is often presented as a ratio or percentage. For example, the calves in a population may be presented as the number calves for every 100 adult cows (calves/100 cows) **or** as the per cent of the total moose population that are calves (% calves).

consequential difference the increase or decrease in moose numbers in an area that will cause us to consider changing our management strategy. Changing our management strategy will usually mean increasing or easing hunting restrictions. The consequential difference is usually set at 25% of our previous moose population estimate for the area. The consequential difference is also used in our statistical analysis to determine how reliable our surveys are.

density the average number of moose we would expect to find in an area of a given size. For example, with moose we normally talk about the number of moose in every 1000 square kilometers. This makes it easier to compare moose abundance between different areas.

game management subzone (GMS) the geographic units that are used for wildlife management in the Yukon. Harvest is reported, wildlife populations are monitored and hunting regulations are usually developed on the basis of one or more of these units. See the Yukon Hunting Synopsis for map of game management subzones.

GMS see game management subzone

Km an abbreviation for kilometer; one kilometer equals about 0.62 miles.

Km^2 an abbreviation for square kilometers; one square kilometer equals about 0.39 square miles.

m an abbreviation for meters; one meter equals about 3.3 feet.

recruitment the number of calves or yearling moose that survive to become adults; see composition.

SCF see sightability correction factor

sightability correction factor (SCF) a correction made for the number of moose that may have been missed during the survey. For example, if we think we may have missed 10 per cent of the moose in areas we searched (censused) we multiply our initial population estimate by 1.1. See the methods section for a description of how we develop the SCF.

Student's T-test a statistical procedure used determine if, based on our survey results, there appears to have been a change in moose abundance in an area. If we are concerned that moose abundance may have increased or decreased we apply the procedure as a two-tailed test. In contrast, if we are only concerned that moose abundance may have decreased it is applied as a one-tailed test. A detailed description of the test can be found in any statistical textbook such as the one written by Zar (see the Literature Cited section).

SUs an abbreviation for Sample Units; Sample Units are the small (approximately 15 to 20 Km^2) areas searched during the survey