MOOSE POPULATION RESEARCH AND MANAGEMENT STUDIES IN YUKON

MOOSE POPULATION CHARACTERISTICS IN THE DAWSON CITY AREA

by
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ABSTRACT

Moose density and sex and age composition were estimated, and moose distribution delineated in two survey areas in the Dawson area between October 22 and November 7, 1989. An increasing moose population with a density of 269 moose/1,000 km^2, and calf and yearling recruitment rates of 27% and 14% (of the total population) respectively, was documented in the gold fields south of Dawson City. This area is characterized by extensive mining and exploration activity, good access, and moderate to high hunting pressure. In comparison, a stable to slowly increasing moose population with a density of 168 moose/1,000 km^2, and calf and yearling recruitment rates of 16% and 9%, respectively, was documented in a remote area west of Dawson City, next to the Yukon-Alaska border. This area is characterized by limited mining and exploration activity, poor access, and limited hunting pressure. We speculate that the disparity in moose density and composition between the two areas is due to the influence of depressed bear populations in the gold fields and natural bear densities along the Yukon-Alaska border. Other potential limiting factors are discussed. Current harvest levels are within sustainable limits in both survey areas, however, harvest near the Yukon-Alaska border should not increase over the current low levels. The population south of Dawson could sustain higher harvest levels, then currently exist, over the short term.

Trend surveys near the Alaska-Yukon border indicate that this population has been stable to slowly increasing between 1982-1989.

A mean ($\pm$S.E.) annual minimum home range size of 89 km^2 ($\pm$24.3) was documented from 6 radio-collared moose between 1979-1980. Radio-collared moose moved to higher elevations in the early winter and returned to lower elevations in late winter and early spring. Uncollared moose were observed in higher-elevation habitat (mean=782 m) during the October-November 1989 aerial survey.

INTRODUCTION

A Yukon-wide moose inventory program was initiated in 1980, with the objective to determine moose abundance, distribution, and sex and age composition within priority areas throughout the Yukon. Study areas were selected based on the distribution of resident non-Indian hunting pressure. Information from the moose inventory program has been used to set harvest levels, identify habitat utilization, and potential impact of land use disturbances, and should be used to identify areas for potential non-consumptive use. In addition, survey results have helped managers to assess factors potentially limiting moose population growth.

To date, intensive moose surveys have been conducted in the southwest (Larsen 1982, Markel and Larsen 1983, Larsen et al 1989a), southeast (Johnston and McEwen 1984, Jingfors and Markel 1987, Jingfors 1988), and central Yukon (Johnston and McLeod 1983, Markel and Larsen 1988, Larsen et al 1989b). These areas represent approximately 20% of the territory land mass, in which 50% of the resident non-Indian harvest and hunting effort (1979-1988), 50% of the Indian harvest (1987-1988), and 20% of the outfitter harvest (1979-1988) occurs (Yukon hunting statistics).

The results of a regional moose survey conducted in the Dawson City area in 1989 are summarized in this paper. This was the first intensive survey flown in this area, and the final priority area to be surveyed in the territory. In addition to the above survey, trend surveys have been carried out within the Dawson City region since 1982 by the Alaska Department of Fish and Game (ADF&G). Their results are discussed along with our trend survey results collected in the same area in 1989. We discuss the potential affects of predation, mining, and hunting on moose in the Dawson City area. We also report on the annual home range size and seasonal elevation use of six radio-collared moose monitored between 1979-1980 in the Dawson City area.

STUDY AREA

Three areas (Dawson East, Dawson West, and Dawson North) were surveyed for moose in 1989 (Figure 1). The Dawson East (DE) survey area includes GMS's 3-07 and 3-10, covering about 2,611 km^2 of habitable moose range. Habitable moose range is described as the area below 1,370 m in elevation, excluding large water bodies. Areas above this elevation are generally devoid of moose browse or cover. The entire DE area was considered habitable to moose. Approximately 7% (180 km^2) of the DE area moose range has been burned since 1966 (our calculations from Department of Indian and Northern Affairs maps). The DE survey area has been mined since the turn of the century, with much of the area actively mined over the past 10 years (Figure 2)(Department of Indian and Northern Affairs). This area has also experienced moderate (GMS 3-10) to heavy (GMS 3-07) resident non-Indian harvest over the past 10 years (Yukon Fish and Wildlife hunter questionnaire).

The terrain in the DE area generally consists of low relief plateaus dissected by deep, narrow, V-shaped valleys (Oswald and Senyk 1977). Most of the area lies below 1000 m in elevation. Black spruce and paper birch are common on lower slopes. Aspen, balsam poplar, and birch occur on slopes lacking permafrost or in post-fire regeneration. Willow and shrub birch are common to abundant in the forest understory and extend beyond treeline (1,050 m).

The Dawson West (DW) survey area includes GMS 3-04 and covers about 1,870 km^2 of habitable moose range (Figure 1). One hundred thirty five km^2 (7%) of the area is above 1,370 m and considered unhabitable. A small proportion (2%) of this survey area has been burnt since 1966. Mining activity (Figure 2) and harvest pressure have been light in the DW survey area over the past 10 years.

Oswald and Senyk (1977) describe the DW 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 elevation. Black and white spruce stands occur in valleys and on lower slopes. Mixed stands of white spruce, aspen, balsam poplar, and paper birch are common along drainages. Shrub birch and willow are common in the understory, and extending beyond treeline (1,200 m).

The Dawson North (DN) survey area includes GMS's 3-02 and 3-03, and covers about 3,549 km^2 of habitable moose range (Figure 1). Three percent (95 km^2) are considered unhabitable. This area has been exposed to moderate mining pressure and moderate (gms 3-03) to heavy (gms 3-02) harvest pressure over the past 10 years. The physiography, climate, and vegetation is similar to that described for the DE survey area.

Weather data for the study area was based on information collected at the Dawson City airport (320 m elevation) from 1970-1988 (Environment Canada). The mean annual temperature was -4.9° C (range -2.9 to -7.5) and the the mean maximum snow accumulation was 60.9 cm (range 40.0 - 111.0 cm). Snow depths greater than 80 cm, occurred in the winters of 1974/1975 and 1978/1979. Snow depths generally peak at the end of February.

Caribou, bears, and wolves occur within the study area. Part of the Fortymile caribou herd winters in the western portion of the DW survey area although this herd ranges primarily in Alaska (Urquhart and Farnell 1986). Wolf densities have not been determined but 8 wolves/1,000 km^2 were recorded across the Yukon border near Tok, Alaska (Gasaway et al 1986a) and densities of 9-10, 5-6, and 3/1,000 km^2 were found in the Yukon, near Mayo, Beaver Creek, and Carmacks, respectively (Hayes YF&W unpubl. data). Grizzly bear densities are unknown in the study area. Smith and Osmond-Jones (in prep.) estimated 12 bears/1,000 km^2 based on an evaluation of habitat capability, while in a nearby area in Alaska estimates of 16 grizzly bears/1,000 km^2 has been made using radio collars (Boertje et al 1987). Black bears are abundant in the study area but densities are unknown.

Historically, moose in the Dawson City area have been an important source of food and recreation to residents since the turn of the century. Market hunters supplied Dawson with large amounts of moose meat during the gold rush. Currently, fewer moose are harvested from the Dawson City area with an average (1979-1988) of 86 moose taken per year or 15% of the total resident Indian and non-Indian harvest in the Yukon.

There is a potential market for non-consumptive use of moose and other wildlife in the Dawson City area. Dawson is the fourth most popular tourist destination in the Yukon, accounting for 30% (57,000 tourists) of all visitors to the Yukon in 1987 (Anonymous 1987). Seeing wildlife was among the most frequently mentioned reasons for visiting the Territory, however, most visitors felt that there was a lack of wildlife viewing opportunities throughout the Yukon, including the Dawson City area.

METHODS

Estimating moose abundance, composition, and distribution

Three types of aerial surveys were used to estimate moose abundance, distribution, and composition in the study area. All surveys were flown between late October and early December.

1) Stratified random sampling technique (intensive survey) - This technique has been extensively used for censusing moose in Alaska (Gasaway et al 1986b) and the Yukon (Larsen 1982). It is particularly suited for estimating moose abundance, composition, and distribution. Briefly, the technique involves three phases.

   First, an initial reconnaissance survey was flown over the entire survey area which was divided into blocks or sample units (su's). Su size averaged 30.3 km^2. This survey was done from a fixed-wing aircraft (Cessna 185 Maule or equivalent) with three observers plus the pilot and at a search intensity of approximately 0.5 min./km^2. Each su was rated as having a high, medium, or low density of moose. Ratings were based primarily on moose seen and fresh tracks and secondarily on habitat. This is called the stratification phase.

   Second, a portion of the su's within each of the high, medium, and low stratum were randomly selected and searched intensively by helicopter with the objective of counting all the moose in the s.u. These surveys were done with three observers plus the pilot at a search intensity of approximately 2.0 min./km^2. Su's were searched immediately after stratification to minimize movement of moose among su's.

Third, a small portion of the su's searched with the helicopter were reflown with the same helicopter and crew, but at a higher intensity (3.0 min./km^2). This procedure was used to determine how many moose were missed during the second phase. The difference in moose seen on the second and third phases is called a sightability correction factor (SCF). We assume all moose were seen during the third phase. The SCF was then applied to the population estimate to account for unobserved moose. A SCF was determined for each survey area.

A population estimate with associated variance was calculated for each stratum within the survey area using a ratio estimator (Gasaway et al 1986b). The overall population estimate, and composition were calculated by adding stratum estimates and variances together. The intensive survey technique was used to census moose in the DE and DW survey areas.

2) Extended stratification - Phase one of the above technique was used for this survey. It was used to determine only the distribution and relative abundance of moose adjacent to the more intensive survey area. An extended stratification allows managers to obtain a regional perspective of the relative abundance and distribution of moose for little cost. Composition data was not collected as it was difficult in distinguishing between sexes, and density was not estimated due to the low sightability of moose as a result of the low search intensity. An extended stratification survey was flown in the DN survey area.

3) Trend surveys - Trend surveys were flown in a small portion of the larger intensive survey area. The objective was to obtain information on density,

composition, and changes in moose population size over time that were representative of the regional population. Because these areas are small, they are economical to fly and thus could be monitored annually, as opposed to the intensive surveys which have been flown approximately much less frequently.

Trend surveys were conducted with a Super Cub (or equivalent) using one observer plus the pilot. A contiguous area of approximately 300 km^2 was searched (2.0 min./km^2). Two trend survey areas were established, one each in the DE and DW survey areas (Figure 1). Only the DE trend area was surveyed in 1989. The DW trend area was not surveyed due to weather problems.

Moose population trends were determined from trend surveys conducted by the ADF&G in the DW survey area between 1982 and 1987 (Figure 3). We compared our helicopter census results in the same area to the ADF&G trend data.

Moose observations on all surveys were recorded on 1:50,000 topo maps. The age (calf, yearling, adult) and sex of each moose was recorded. Bulls were classified as yearlings or adults based on the size and shape of their antlers (Dubois et al 1981). Cows were differentiated from bulls by the presence of a white vulva patch (Mitchell 1970) and lack of antlers. Body shape and size were used to differentiate calves from adults. Yearling cows (18 months old) could not be reliably identified in the field, but were assumed to occur in the population in equal proportions to yearling bulls. Twinning rate is the number of cows with twins divided by the number of cows with calves. November twinning rates are a reflection of both initial calf production and mortality to 6 mo. of age. Elevation (meters) and aspect (degrees; e.g. N=360° S=180°)

of each observation site made during the intensive search with the helicopter were measured from a topographic map. Elevation and aspect reflect utilization rather than selection as we have no measure of availability. Differences in mean elevations between sexes and seasons, and differences in density between survey areas were tested using student t-test analyses. Differences in proportions of calves and yearlings per adult cows was tested using contingency table analyses. An alpha level of .05 was used for significance.

Survey costs and incidental sightings of caribou, wolves, and grizzly bears are reported in Appendices 1 and 2.

Estimating harvest

Moose are harvested by resident non-Indians, and Indians throughout the study area. Non-resident aliens do not hunt in this area. The resident non-Indian harvest and days hunted have been estimated throughout the Yukon since 1979 using a mailed questionnaire (Kale 1982). The Indian harvest was estimated through interviews with members of the Dawson Band in 1987 and 1988, but the results may under represent the true harvest and therefore should be used as a minimum values (Quock and Jingfors 1988, 1989).

Sustainable harvest levels were estimated as: (adults and yearlings) x (adult and yearling natural survival rate over one annual cycle) - (adults). Annual survival rates of .85 and .90 were arbitrarily used, as survival rates have not been determined for this area. Survival rates of .89 were documented in the S.W. Yukon (Larsen et al 1989a). Rates of .93 were estimated near Tok, Alaska (Gasaway et al, 1990), and .80 and .94 in the Tanana Flats (Gasaway et al 1983).

Estimating minimum home range

Six adult moose (3 bulls, 3 cows), within the DE survey area were immobilized and fitted with radio collars in November, 1979. They were monitored approximately every 1.5 months between November 1979 and November 1980 for an average of 8 relocations per moose. Relocations were plotted on 1:50,000 topographic maps, outside points were connected and the area within the polygon was measured with a compensating planimeter to determine home range size following the convex polygon technique (Mohr 1947). Due to the small number of relocations, home range values likely underestimate true home range size. Elevation was measured from topographical maps.

RESULTS

Search and sampling intensity

Fixed wing search intensity on all stratification flights averaged 0.45 min./km^2, however, search intensity varied between 0.27 and 0.66 min./km^2 among survey areas (Table 1). Helicopter search intensity was similar in the DE and DW intensive surveys, averaging 1.77 min./km^2. Helicopter search intensity on the S.C.F. plots was also similar in both areas, averaging 3.3 min/km^2. The trend survey search intensity in the DE area was identical (1.93 min./km^2) to the intensive search in the same area (Table 1).

The disparity in stratification search intensity among the survey areas is due to slightly differences in search patterns used by three navigators (Table 2). The navigator directs the pilot and thus determines search patterns and intensity. Navigators one and two had similar but higher search intensities (0.63 and 0.68 min/km^2) compared to the third navigator (0.31 min/km^2). The navigators with the higher stratification search intensity observed a higher proportion of the moose, as determined from subsequent helicopter census of the same area. Navigators one and two observed 97% and 87% of the moose, while navigator three observed only 42% of the moose. As a result of moose missed by navigator three, 37% of his su's were incorrectly assigned to a stratum, compared to navigators one and two who incorrectly assigned 16% and 17% of their su's.

Navigators one and two covered all, or most, of each su using overlapping parallel transects in flat and rolling terrain. The more precipitous terrain was searched using overlapping circles. The latter technique was used extensively at the head of drainages in subalpine cirques. These areas are preferred by moose during the post rut period. Navigator three used similar search patterns without overlapping transects and circles. Subalpine cirques were often covered with one pass, without circling.

The proportion of su's searched with helicopters (sampling intensity) varied between survey areas and strata. The DW survey area had a higher sampling intensity (52%) compared to DE (35%)(Table 3). The low, medium, and high stratum in the combined areas were sampled at an intensity of 30%, 58%, and 92%, respectively (Table 3).

Population abundance, composition, and distribution

Dawson East

An intensive survey was flown between October 22 - 30, 1989 resulting in an estimated 691 ± 23% (90% CI) moose (Table 4). This corresponds to a mean density of 269 moose/1,000 km^2 (207-331 moose/1,000 km^2, 90% CI), which is above the Yukon average (160 moose/1,000 km^2, Appendix 3). A SCF of 1.13 was estimated from 8 su's (5 high density su's, 3 low density su's).

Adult cows were the largest single age-sex group (making up 36% of the estimated population), followed by calves (27%), adult bulls (23%), and yearlings (14%)(Table 4). Calf production and survival were high with a twinning rate of 28%, and the calf/cow ratio and yearling/cow ratio of 76/100 and 35/100, respectively. All the above composition measurements exceed the Yukon averages (Appendix 3). The calf/cow ratio (76/100) was twice, the Yukon average (35/100), and the twinning rate was three and a half times the average (8%). Based on these parameters, and assuming a moderate natural annual mortality rate of 10-15% for yearlings and adults, this population is likely increasing.

Moose in the survey area were clumped in distribution (Figure 4), as the high density strata comprised only 12% of the habitable moose range (Table 3), but accounted for 44% of the moose (Table 4). Major concentrations of moose were found between Ruby and Reindeer Mountains, the area north of Henderson Dome, and between Mt. Bronson and the Indian River (Figure 4). Moose were observed at a mean elevation of 853 m. Moose were found on all aspects, however the majority were found on southerly (29%) and westerly (28%) slopes (Figure 5).

A trend survey was flown in the DE survey area between December 6-9, 1989 (Figure 1). The results of that survey are discussed in detail elsewhere (Larsen and Ward 1990). Generally the density in the trend area (251 moose/1,000 km^2) was representative of the regional survey area (238 moose/1,000 km^2) as was the proportion of mature bulls, cows, and yearlings. Calf proportions, however, were much lower in the trend area (16%) compared to the region (27%).

Dawson West

An intensive survey was flown between October 30 - November 7, 1989, resulting in an estimated 313 $\pm$ 19% (90% CI), moose (Table 5). This corresponds to a density of 168 moose/1,000 km^2 (136-200 moose/1,000 km^2, 90% C.I.), similar to the Yukon average (160 moose/1,000 km^2, Appendix 3) and significantly ($P<0.05$) lower than the D.E. survey area. A SCF of 1.0 was estimated from 4 su's (1 high density su, 3 medium density su's).

Adult bulls and cows occurred in approximately equal proportions (38% and 36% of the population) and represented the largest age-sex groups (Table 5). Calf/cow ratios were lower ($P<0.05$) in the D.W. area (35-55 calves/100 cows, 90% C.I., Table 5) compared to the D.E. area (62-90 calves/100 cows, 90% C.I. Table

4). Ratios in the D.W. area are similar to the Yukon averages of 35 calves/100 cows (Appendix 3). The twinning rate (18%) was higher than the Yukon average (8%). Based on these parameters, and the assumed adult and yearling natural mortality rate described previously, this population is likely stable to slowly increasing.

Moose were clumped in distribution (Figure 3) as the high and medium density strata comprising 38% of the habitable moose range (Table 3) but accounted for 74% of the moose population (Table 5). Concentrations were observed around Craig Mountain, Mt. Hart, and the unnamed mountain S.E. of Mt. Hart (Figure 3). Moose were observed at a mean elevation of 1,013 meters and found more or less equally on all aspects (Figure 5).

Trend surveys have been flown in the North Ladue River area by the ADF&G between 1982 - 1987 using a Super Cub (Gasaway, unpubl. data, Figure 3). The same area was flown by the YF&WB in 1989 using a helicopter (Table 6). Although different types of aircraft were used, we believe the survey results are comparable because of the extremely open habitat in this area and similar search intensities between aircraft types (Table 6). The results from the trend surveys indicate that the population was likely stable or increasing slowly during the 1980s. Calf/cow ratios increased from 17 during the early 1980's to the 30's and 50's during the late 1980's. The total lack of yearlings in all years is inconsistent with a stable to increasing population (Table 6), and was likely a bias of the small area surveyed (118 km^2).

The 1989 YF&WB survey results from the Alaskan trend area were representative of the regional DW survey area in density (153 vs 168 moose/1,000 km^2), calf proportions (13% vs 16%) and adult cow proportions (38% vs 36%)(Tables 5 and

6). They were not representative in adult bull (50% vs 38%) or yearling proportions (0% vs 9%). We speculate that the proportionately higher number of large bulls in the trend area may have discouraged the presence of yearling bulls in this area. This would explain the apparent stable to increasing population trend in the Alaskan trend survey area with no apparent recruitment of yearlings. If the ADF&G trend area data represents the regional population, the DW moose population was likely stable to increasing since 1982.

Dawson North

An extended stratification survey was flown in the DN survey area between November 5-7, 1989 (Figure 3). Moose distribution and density in this area are confounded as we suspect that a high proportion of the su's in the D.N. survey area were incorrectly rated (navigator three stratified this area; see search and sampling results).

Harvest

Moose harvest rates for the study area have averaged 16 moose/year for resident non-Indians between 1979 and 1988, and 4 moose/year for Indians between 1987 and 1988 (Figure 6). The combined harvest of 20 moose/year represents a harvest intensity of 2.4 moose/1,000 km^2 of total land area. Harvest levels differed among survey areas (Table 7). The average combined (Indians and non-Indians) harvest was 3.4 moose/1,000 km^2 (9 per year) for DE, 2.7 moose/1,000 km^2 (10 per year) for DN and 0.5 moose/1,000 km^2 (1 per year) for DW. The differences in harvest rates are likely a reflection of accessibility.

Harvest levels in the DE and DW survey areas have likely been within sustainable levels in recent years. Based on the 1989 survey, the allowable harvest in the DE survey area was between 24-50 moose (Appendix 4). The harvest for this same area in 1988 was 11 moose, well within the allowable limits. If we assume the population was stable over the past 10 years, the mean annual harvest rate of 9 moose between 1979-1988 was also within allowable levels. Based on the 1989 survey, the allowable harvest in the DW survey area was between -11 and 2 moose (Appendix 4). Both the 1988 harvest and the 1979-1988 mean harvest was 1 moose. This level is also likely within sustainable limits. We were unable to determine the allowable harvest for the DN survey area because the density and composition data were not reliable for that area.

Home range size and elevation use

Radio-collared moose in the DE survey area were sedentary between November 1979 and November 1980 (Figure 7), resulting in an average home range size (±SE) of 89.3 km^2 (±24.3) (range 49-209). These results should be used with caution as they were based on a small sample (49).

The mean elevation that radio-collared moose were observed at was not significantly different (P=0.40) between bulls (669 m) and cows (720 m) over the one year period, therefore, the data were combined (Figure 8). The average elevation, regardless of sex or season, was 695 m. Both bulls and cows were observed at significantly (P=0.003) higher elevations (mean = 777 m) in winter (November-March) compared to the rest of the year (mean = 602 m). A movement to higher elevations occurred between the end of September and mid-November. The mean elevation of radio-collared moose in November 1979 and 1980 was 782 m, which is similar to the mean elevation of 853 m for moose seen on the 1989 October-November census. From April to September, radio-collared moose were observed at lower elevations (approximately 600 meters, Figure 7) typical of much of the DE survey area.

DISCUSSION

Potential Limiting Factors to Moose Population Growth

We have documented a clear disparity in moose density and composition between the DE and DW populations, and between the DE population and the mean for the Yukon. The DE area has a significantly ($P<0.05$) higher density of moose compared to the DW area (269 vs 168 moose/1,000 km^2), a higher proportion of calves (27% vs 16%), higher calf/cow ratios (76 vs 45 calves/100 cows), and a higher yearling/cow ratio (41 vs 25/100 cows). Compared to sixteen other surveyed areas in the Yukon, the DE population ranks third in density, the first in percent calves, twinning rate, and calf/cow ratios, and the fourth in yearling/cow ratio (Appendix 3). These results suggest that the moose population in the DE area has not been limited in size to the same extent as the DW population, or many other moose populations in the Yukon.

The primary cause of calf mortality and the most significant limiting factor on moose population growth in the northern boreal region has been documented to be high levels of predation by grizzly bears, black bears, and wolves. (Franzmann et al 1980; Stewart et al 1985; Fuller and Keith 1980; Bergerud et al 1983; Messier and Crete 1985; Ballard et al 1981; Ballard and Miller 1989; Gasaway et al 1983, 1986a, 1990; Ballard and Larsen 1988; and Larsen et al 1989a, 1989c). In addition to predation, excessive hunting, deep snow, and forage could potentially limit moose populations. Our assessment of these limiting factors in the Dawson City area is severely hampered by a lack of information on predator numbers, causes of moose mortality, and forage conditions. As a result, any conclusion about limiting factors are speculative at this time.

Predation by grizzly and black bears may be the most significant limiting factor on moose population growth in the Dawson area. The disparity in density and calf-yearling ratios between the DE and DW area may be the result of lower bear densities in the former area. We suggest that bear densities have been suppressed in the DE area for decades, primarily as a result of miners killing bears in defense of life and property.

Unfortunately, there isn't a good estimate of the number of bears killed by miners, however, it is commonly known that bears are attracted to mining and exploration camps and that these bears are often disposed of without documentation. The DE survey area is believed to have the highest overharvest of grizzly bears compared to any other area in the Yukon (B. Smith in prep.). Within the Dawson area, there is substantially more mining activity, and presumably more bears killed, in the DE area compared to the DW area (Figure 2).

Wolves may also be an important liming factor on moose population growth in the Dawson area with densities around 8-10 wolves/1,000 km^2. At these densities, the moose to wolf ratios would be between 24-30 moose/wolf in the DE area and between 17-21 moose/wolf in the DW area. Based on studies in Alaska (Gasaway et al. 1983), when there are greater than 30 moose/wolf the effects of wolf predation are likely not significant enough by itself to cause a decline in the moose population. Ratios between 20-30 moose/wolf is cause for concern, while a ratio of less than 20 moose/wolf suggests that wolf predation may be sufficient to cause a decline in moose numbers. These figures suggest that wolves may be a more significant factor in the DW compared to the DE survey area. We emphasize again that wolf densities have not been established for the Dawson area.

Excessive harvest is another potentially limiting factor. Our assessment of hunting in the Dawson survey areas indicated that harvest was within sustainable levels in recent years and probably within the past decade. Hunting intensity is largely controlled by access. The DW survey area has limited access and, therefore, receives very little harvest pressure. Conversely, the DE survey area has very good access and consequently receives a moderate to high level of harvest pressure. Because of the relatively dense moose population and the high recruitment rates in this area, the high harvest levels are currently within sustainable limits. We conclude that the reported harvest is not a significant source of moose mortality in either Dawson survey areas and, therefore, is likely not a major limiting factor.

Both excessive snow depths and forage are potential limiting factors to moose population growth. Snow is not normally a limiting factor in the Dawson area as snow accumulation rarely exceed 80 cm. Coady (1974) suggested that depths greater than 80 cm will lead in decreased moose calf survival. The average (1970-1988) snow depths in the Dawson area is 60.9 cm. Accumulations greater than 80 cm have occurred twice over the past two decades (1974 and 1978). In those years, snow may have affected calf survival.

We are unable to directly assess habitat at this time. Both the DW and DE survey areas have had limited burns over the past two decades, suggesting that fires have not been an important factor influencing moose habitat, and in turn, moose densities in recent years. A gross visual assessment of browse during the moose survey indicated abundant browse in both survey areas.

In summary, we feel that the unsubstantiated reduction of bear numbers, primarily by miners, may be responsible for the higher moose densities in the

DE survey area compared to the DW area. This conclusion is speculative at this time and further studies to determine bear numbers and causes of moose mortality are warranted.

Moose distribution

During the 1989 intensive surveys (post rut period), moose were clumped in distribution with 69% of the combined DW and DE population in 34% of the survey areas (high and medium strata). Moose were observed at the higher elevations (853 m) on the intensive survey. Radio-collared moose were also found at higher elevations (782 m) in November. In late winter/early spring radio-collared moose moved down into the valleys. Movement back up into the subalpine occurred during or following the rut (September).

Movement to higher elevations in early winter may be in response to warmer temperatures at higher elevations during the winter (thermal inversion), or it may be an anti-predator strategy to utilize more open areas over most of the winter. Movement to lower elevations in the late winter/early spring may be in response to a combination of deeper snow at higher elevations, earlier green up of vegetation at lower elevations, availability of open water for escape terrain during calving or availability of sodium rich aquatic vegetation.

Klondike Valley Land Use Plan Implications

The results of the 1989 moose survey are of limited direct value to the Klondike Valley District Land Use Plan (1988). Firstly, the moose survey area overlapped with only a small portion of the planning area (Hunker Creek to Dawson, south of the Klondike Highway). Extrapolation of moose density and composition from the DE survey area to the remainder of the planning area may be unwarranted given the differences in topography, human settlements, and highway activity. Secondly, the 1989 survey was flown in early winter when moose are not typically found along valley bottoms, which is the primary area covered by the land use plan.

Movement patterns shown by our radio collared-moose support the Klondike Valley Plan position that the valley habitat such as the Klondike Valley is potentially important to moose in late winter. Valley habitats, such as that found east of Rock Creek, may be used by moose in both late winter and in spring during calving.

Survey Technique Considerations

Our results demonstrate that search intensity during stratification should be maintained at a high level to ensure that su's are assigned to the correct strata. Low search intensity during stratification would result in a high proportion of the su's being incorrectly assigned and would result in wide confidence levels around population estimates.

Another reason for maintaining high search intensity during stratification is to develop a potentially accurate, yet inexpensive technique for monitoring changes in population density. A high search intensity will result in a high proportion of the population being observed, which in turn will result in a more accurate and precise population index. If the technique is applied consistently among years and survey areas, a valuable technique for monitoring moose density may be developed. Such a technique may replace the current trend surveys which are very localized and, therefore, may not reflect regional differences.

RECOMMENDATIONS

1. Maintain the current hunting level in the DW survey area and increase the harvest in the DE area. Harvest in the former is at sustainable levels while the latter is below sustainable levels. If new access roads are developed into the DW survey area, hunting restrictions should be imposed.

2. Continue monitoring the moose population annually through the trend surveys established in 1989. Without frequent monitoring, population densities could decline without being detected for years. Rebuilding low density populations is time consuming, expensive, and the techniques used are often controversial.

3. Evaluate the quantity of browse in the DW and DE areas to determine the potential limiting affects of browse on moose densities. This information would help to evaluate the importance of browse availability relative to other limiting factors.

4. Determine wolf densities in the DW and DE survey areas to evaluate our preliminary assessment of wolf predation on moose in this region.

5. Determine grizzly bear densities and unreported harvest levels in the DW and DE survey areas in order to address our speculation that grizzly bear densities, and thus moose densities, differ between these two areas.

6. Promote moose viewing opportunities in the DE survey area. Recent visitor surveys have shown that Dawson City is an important tourist destination, and that many tourists are currently dissatisfied with wildlife viewing opportunities. Our moose survey has shown that adequate densities occur in this area.

7. Maintain consistently high search intensity (0.6 min./km^2) during stratification flights to obtain cost effective, and precise population estimates.

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LITERATURE CITED

Anonymous. 1987. Yukon Visitor Exit Survey 1987. Part 1: Visitors to the Yukon Basic Information. Yukon Bureau of Statistics. 161 pp.

Ballard, W.B., and S.D. Miller. 1989. Effects of reducing brown bear density on moose calf survival in southcentral Alaska. Trans. Int. Congr. Game Biol. XVIII. In press.

____________, and D.G. Larsen. 1988. implications of predator-prey relationships to moose management. Viltrevy: (Stockholm) In press.

____________, T.H. Spraker, and K.P. Taylor. 1981. Causes of neonatal moose calf mortality in southcentral Alaska. Wildl. Manage. 98, 1-54.

Boertje, R.D., W.C. Gasaway, D.V. Grangaard, D.G. Kellyhouse, and R.O. Stephenson 1987. Factors limiting moose population growth in Game Management Unit 20E. Federal Aid in Wildlife Restoration progress report, projects W-22-4 and W-22-5. Alaska Department of Fish and Game. Juneau.

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

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

Franzmann, A.W., C.C. Schwartz, and R.O. Peterson. 1980. Moose calf mortality in summer on the Kenai Peninsula, Alaska. J. Wildl. Manage. 44:764-768.

Fuller, T.K., and L.B. Keith. 1980. Wolf population dynamics and prey relationships in northwestern Alberta. J. Wildl. manage. 44:683-602.

Gasaway, W.C., R.D. Boertje, D.V. Grangaard, D.G. Kellyhouse, R.O. Stephenson, and D.G. Larsen. 1990. Predation limiting moose at low densities in Alaska and Yukon, and implications for conservation. Alaska Dept. Fish and Game. Prog. Report, 106 pp.

____________, ____________, ____________, ____________, ____________. 1986a. Factors limiting moose population growth in Game Management Unit 20E. Alaska Dept. Fish and Game Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-22-4 and W-22-5, 52 pp.

____________, S.D. DuBois, D.J. Reed, and S.J. Harbo. 1986b. Estimating moose population parameters from aerial surveys. Biological Papers of the University of Alaska; No. 22.

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

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

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

Johnston, W.G. and H.A. McLeod. 1983. Moose population dynamics in the Dromedary Mountain area, central Yukon Territory. Internal report, Yukon Fish and Wildlife Branch, Whitehorse. Prepared by Northern Biomes Ltd. Whitehorse, 31 pp.

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

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

Larsen, D.G. 1982. Moose inventory in southwest Yukon. Alces 18142-167.

__________, D.A. Gauthier, R.L. Markel, and R.D. Hayes. 1989a. Limiting factors on moose population growth in the southwest Yukon. Internal report, Yukon Fish and Wildlife Branch, Whitehorse. 96 pp.

__________, R.L. Markel, and R.M.P. Ward. 1989b. Moose population characteristics in the Mayo and Pelly Crossing areas, 1988-1989. Internal report, Yukon Fish and Wildlife Branch, Whitehorse. 30 pp.

__________, D.A. Gauthier, and R.L. Markel. 1989c. Causes and rates of moose mortality in the southwest Yukon. J. Wildl. Manage. 53:548-557.

__________ and R.M.P. Ward. 1990. Summary of Yukon moose population trend survey results 1988 and 1989. Progress report, Yukon Fish and Wildlife Branch, Whitehorse.

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

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

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

Messier, F. and M. Crete. 1985. Moose-wolf dynamics and the natural regulation of moose populations. Oceologia 65:503-512.

Mohr, C.O. 1947. Table of equivalent populations of North American small mammals an. Midl. Nat. 37(1):223-249.

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

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

_________ and _________. 1989. Yukon Indian harvest survey progress report. 1988. Internal report. Yukon Fish and Wildlife Branch. Whitehorse. 37 pp.

Stewart, R.R., E.H. Kowal, R. Beaulieu, and T.W. Rock. 1985. The impact of black bear removal on moose calf survival in eastcentral Saskatchewan. Alces 21:403-418.

Urquhart, D. and R. Farnell. 1986. The Forty-mile herd. - on the comeback trail to the Yukon. Internal report. Yukon Fish and Wildlife Branch. Whitehorse. 16 pp.

Figure 1. Dawson Study Area with three areas surveyed for moose in Oct.-Nov., 1989.

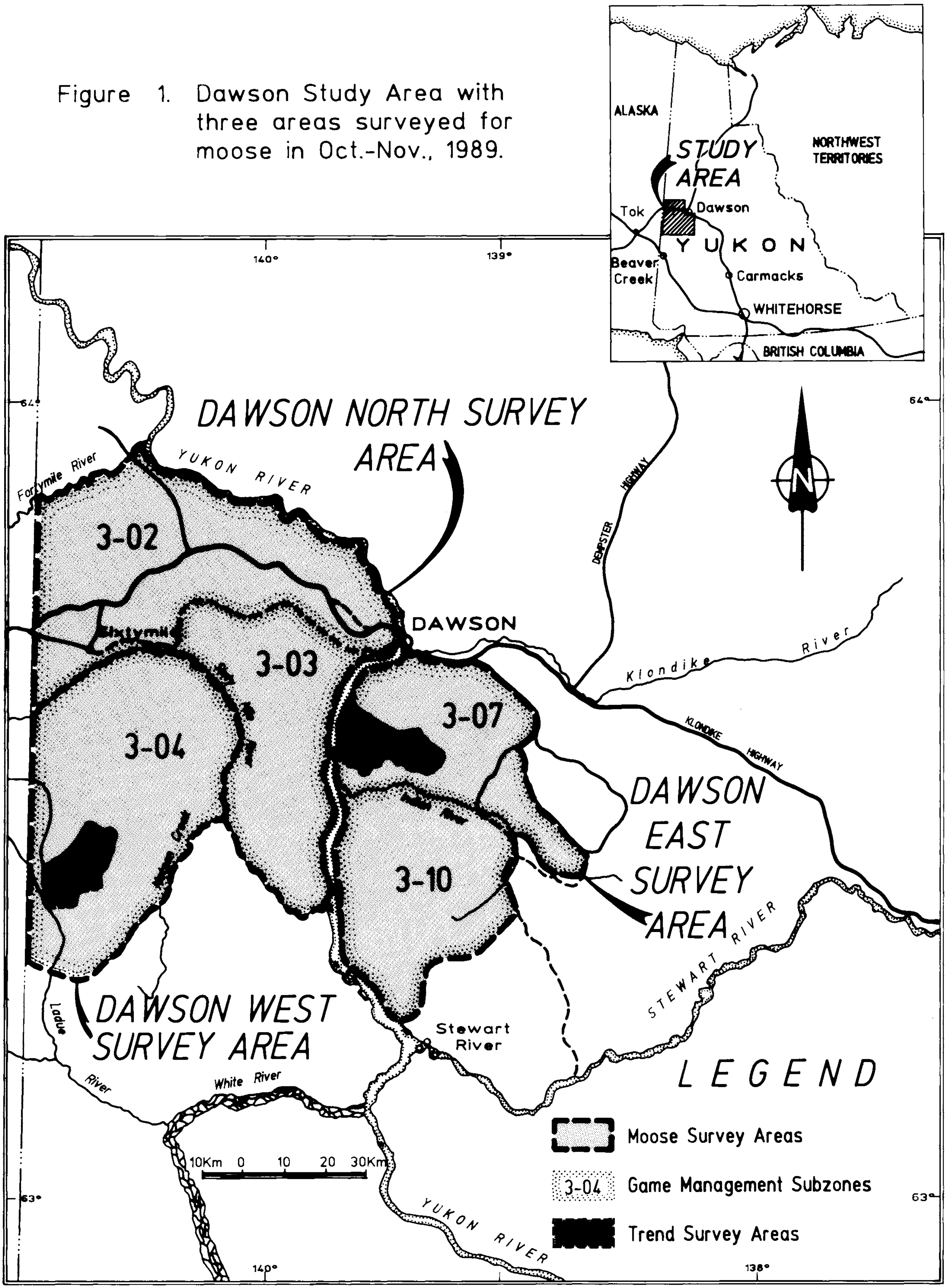
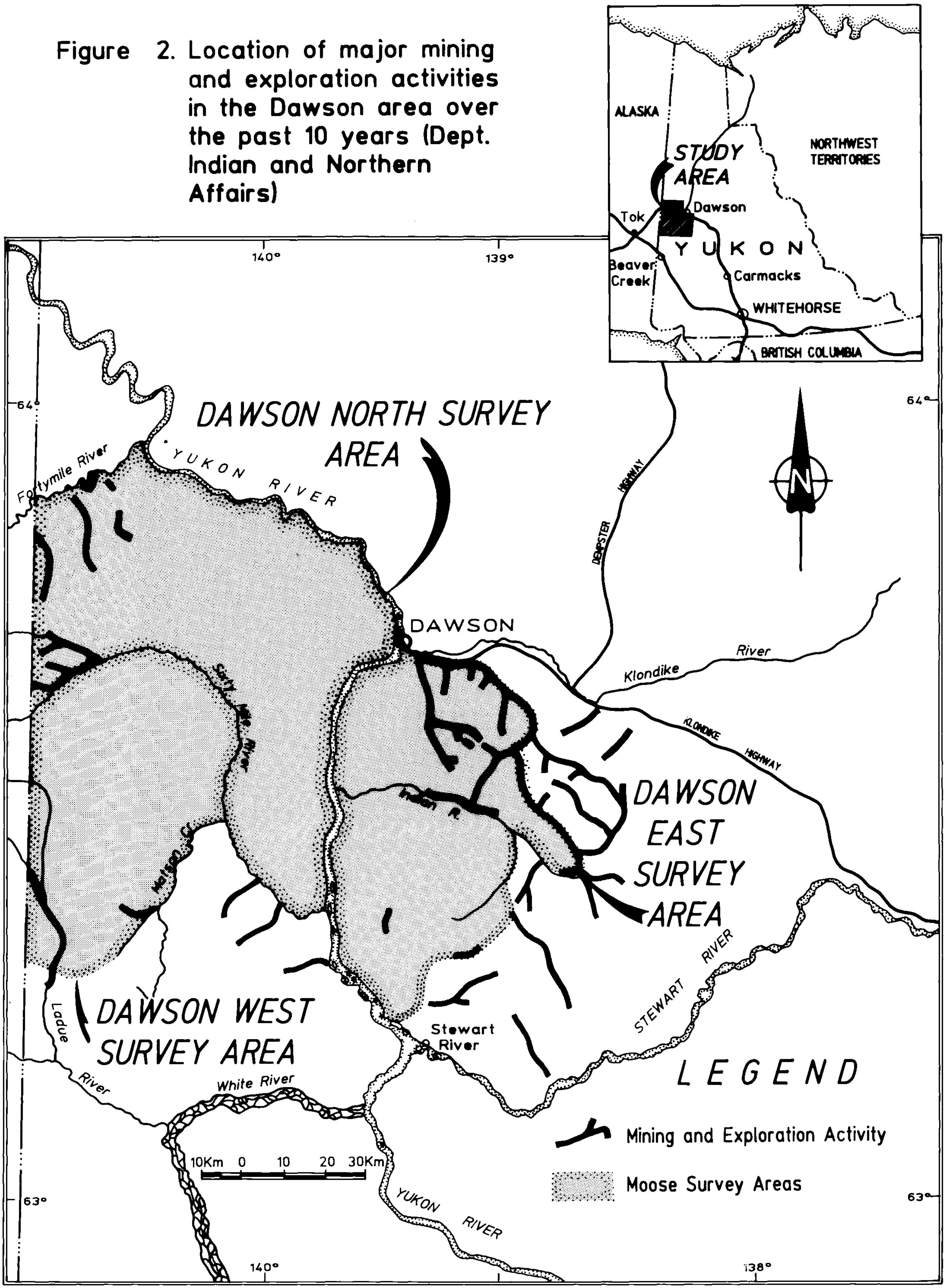


Figure 2. Location of major mining and exploration activities in the Dawson area over the past 10 years (Dept. Indian and Northern Affairs)



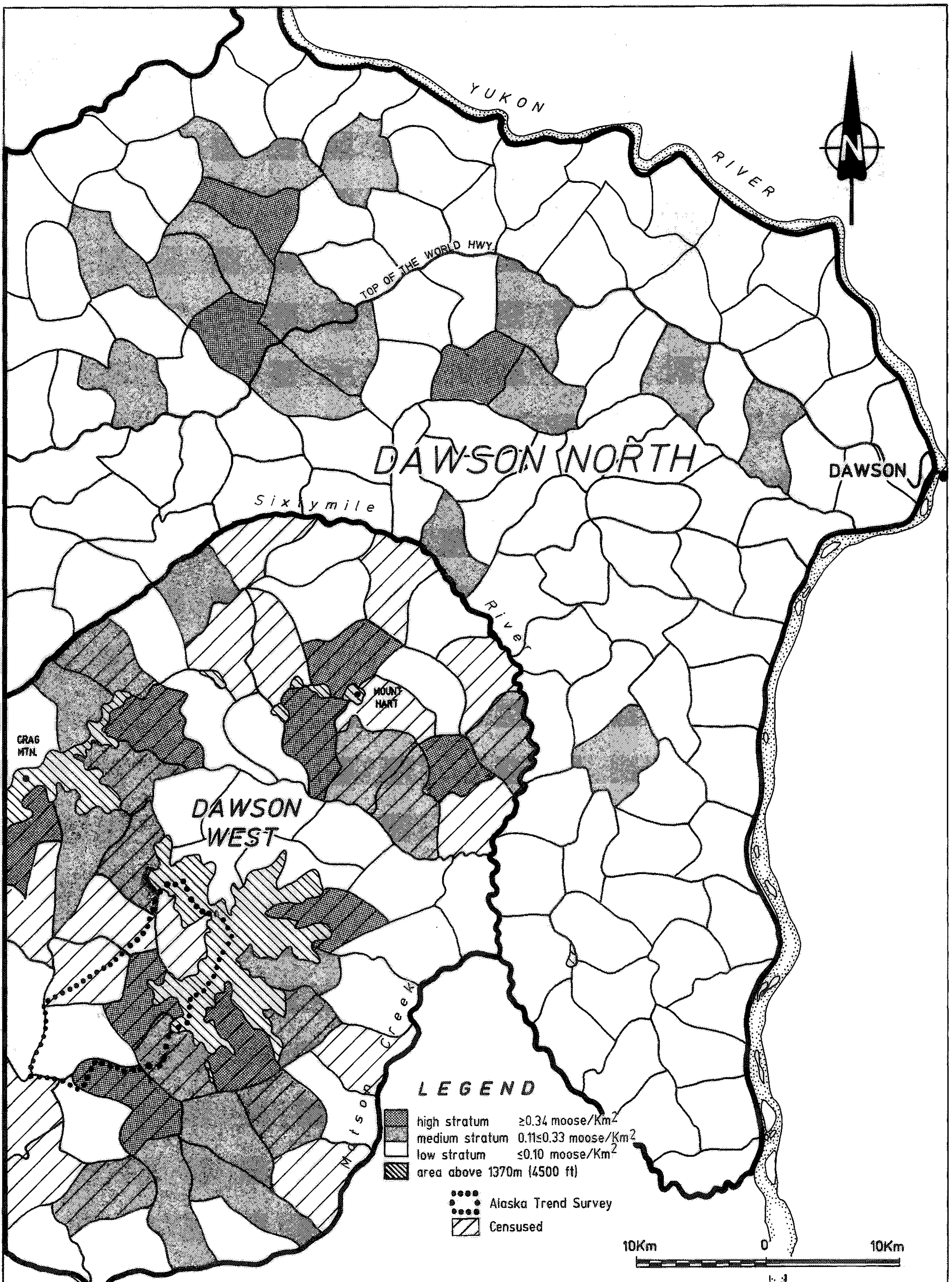


Figure 3. Location of sample units and distribution of moose in the Dawson North and West Survey Areas Oct. 30-Nov. 7, 1989

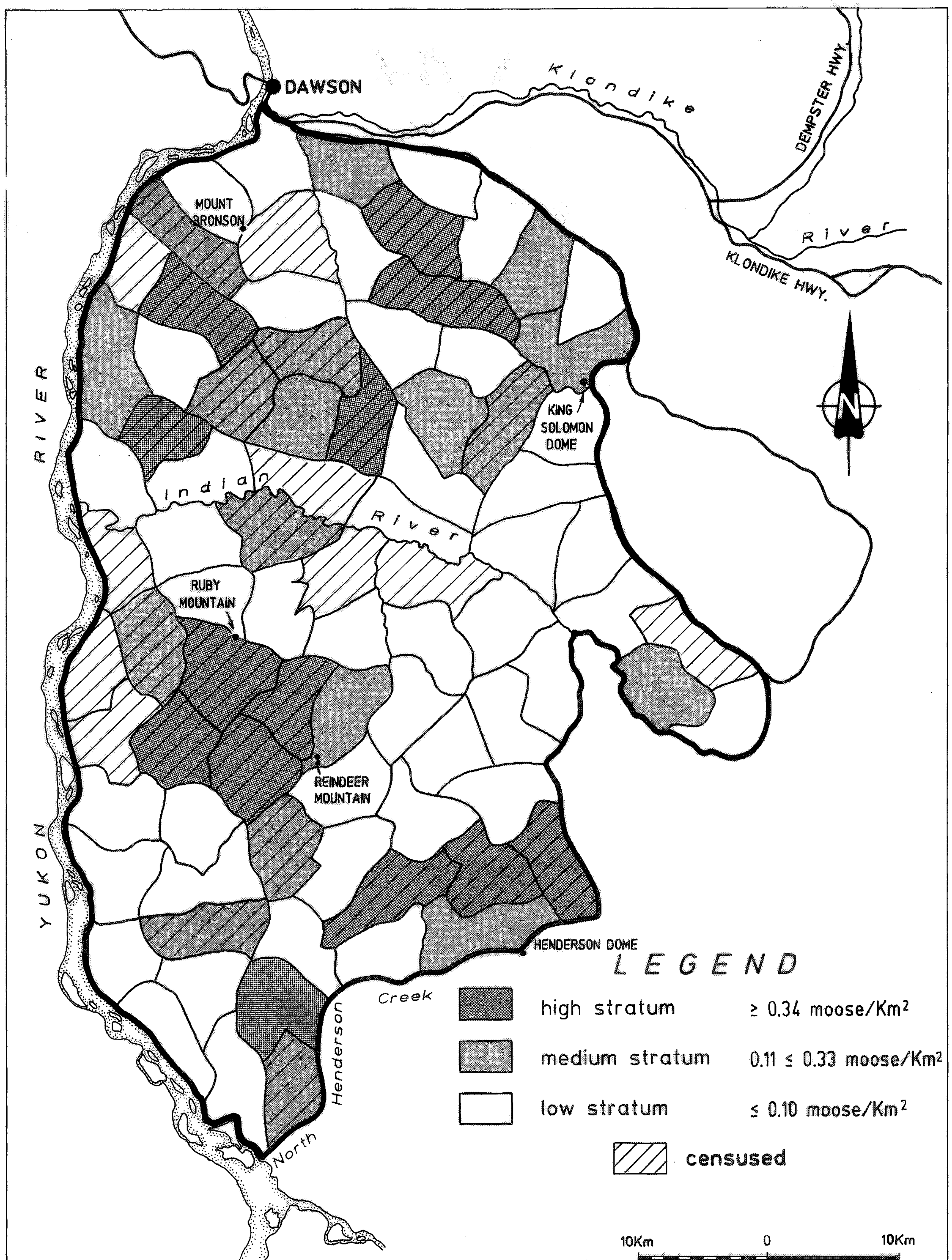


Figure 4. Location of sample units and distribution of moose in the Dawson East Survey Area, Oct. 22-30, 1989.

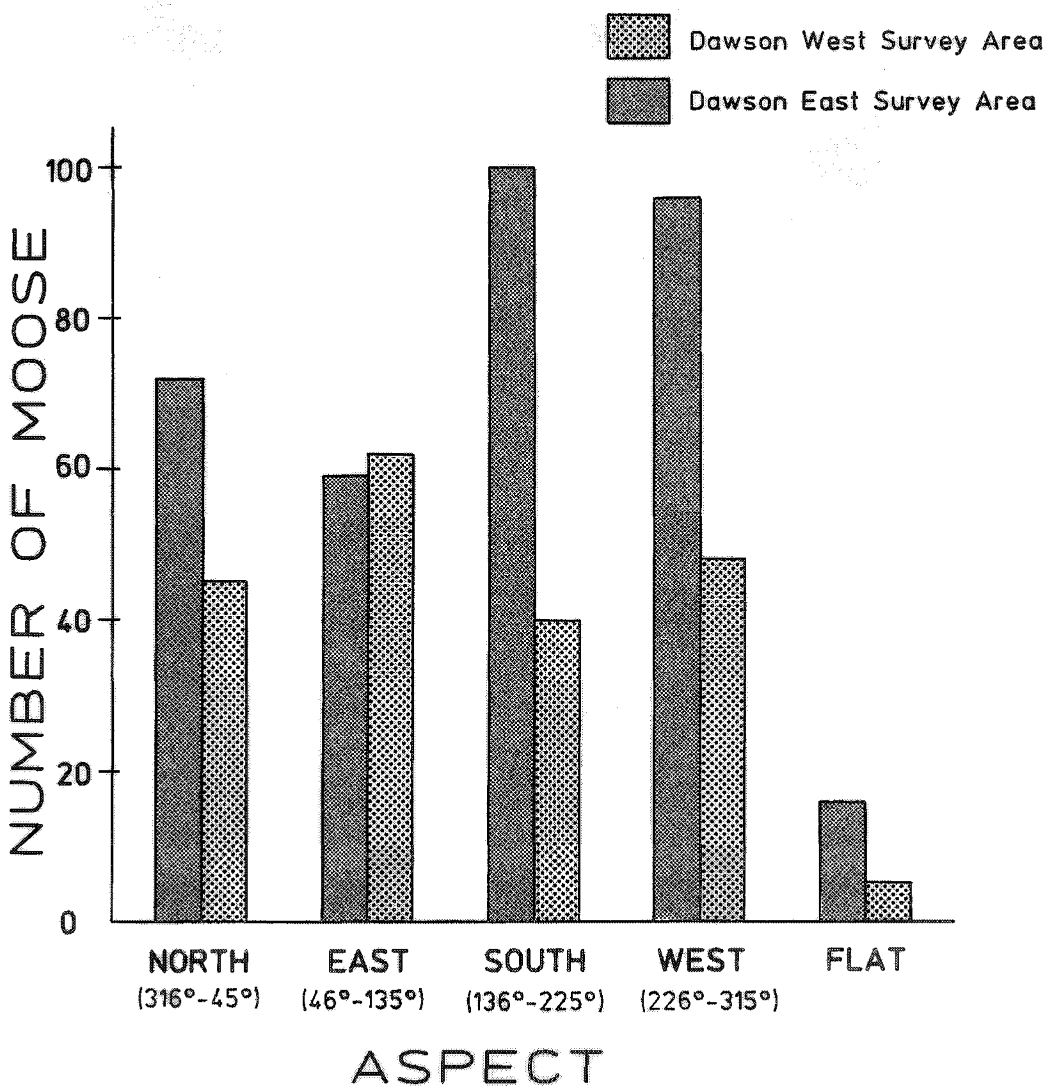


Figure 5. Aspect used by moose seen on helicopter searches in the Dawson Study Area Oct. 22 - Nov. 7, 1989.

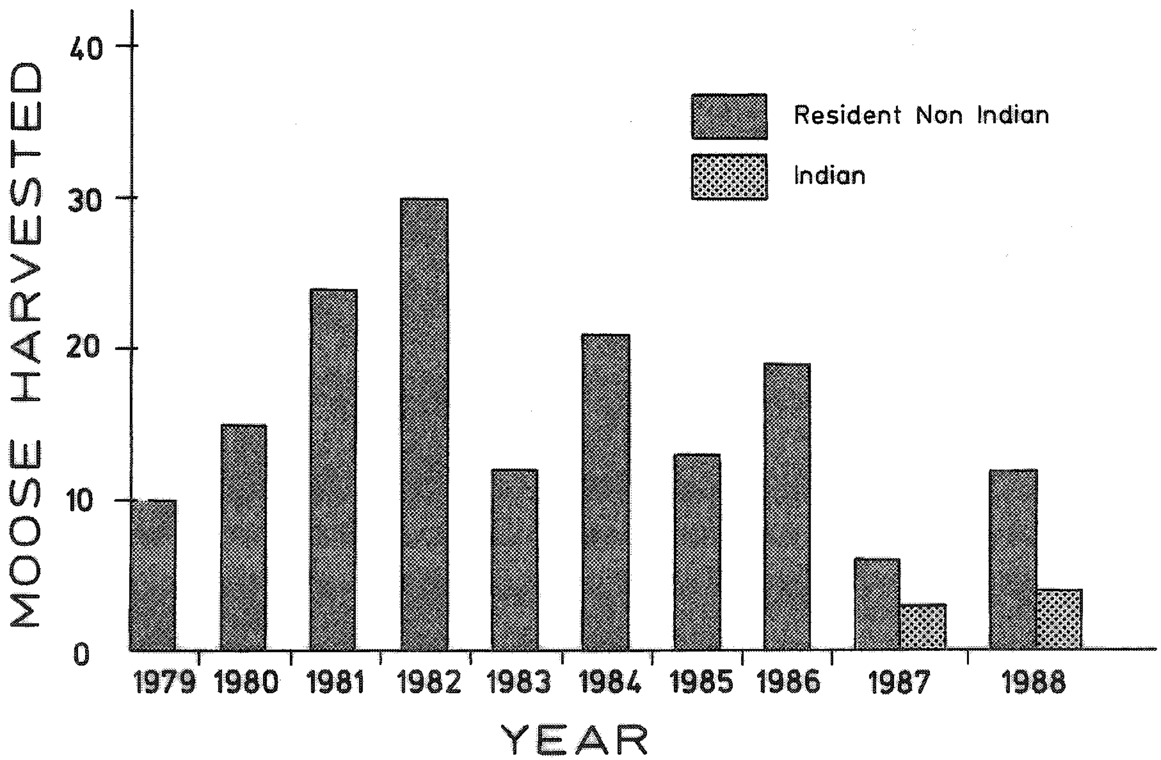


Figure 6. Resident Non-Indian and Indian moose harvest in the Dawson Study Area 1979 - 1988 (Indian harvest information was not collected before 1987).

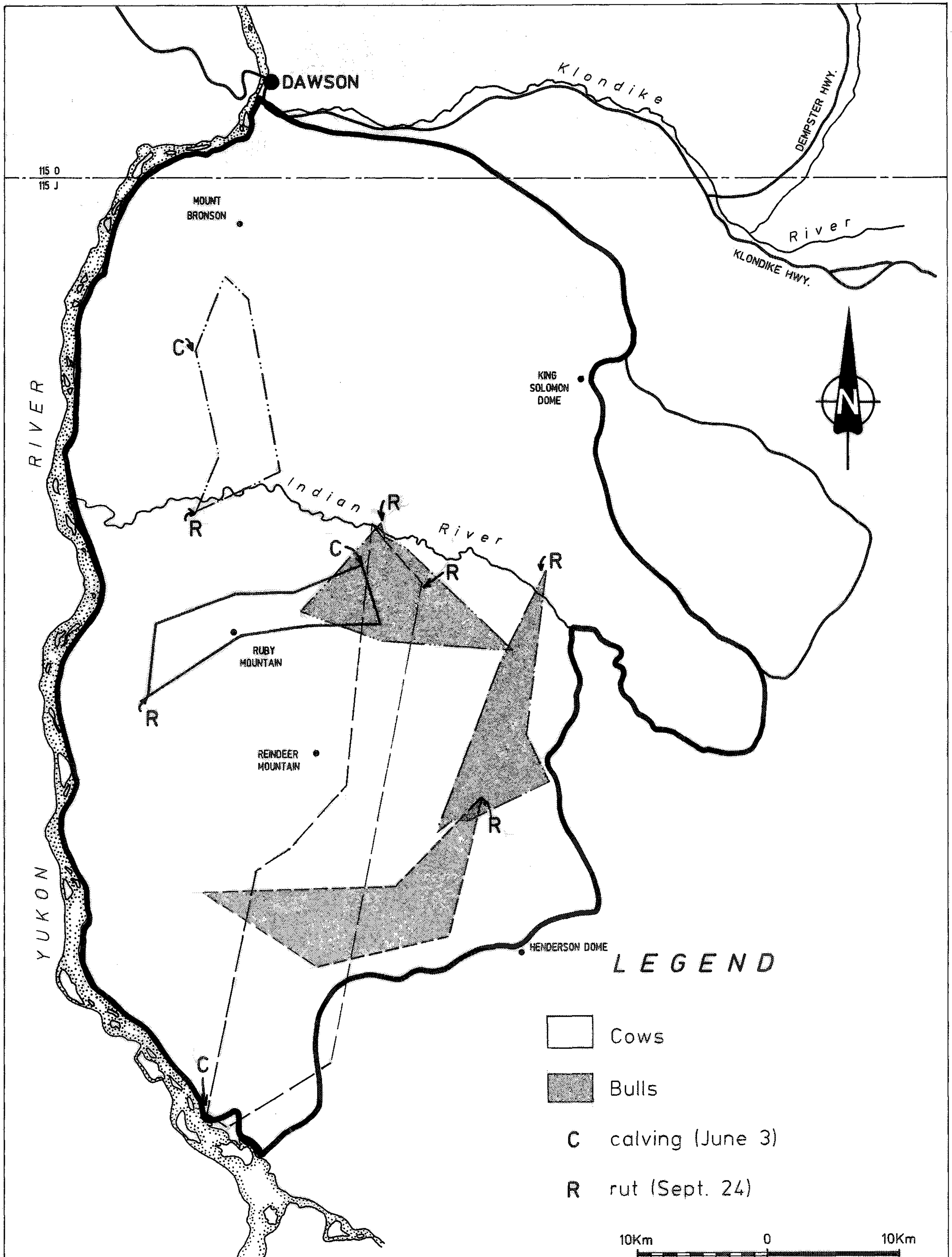


Figure 7. Home ranges of six radio-collared moose in the Dawson East Survey Area between Nov. 1979 - Nov. 1980.

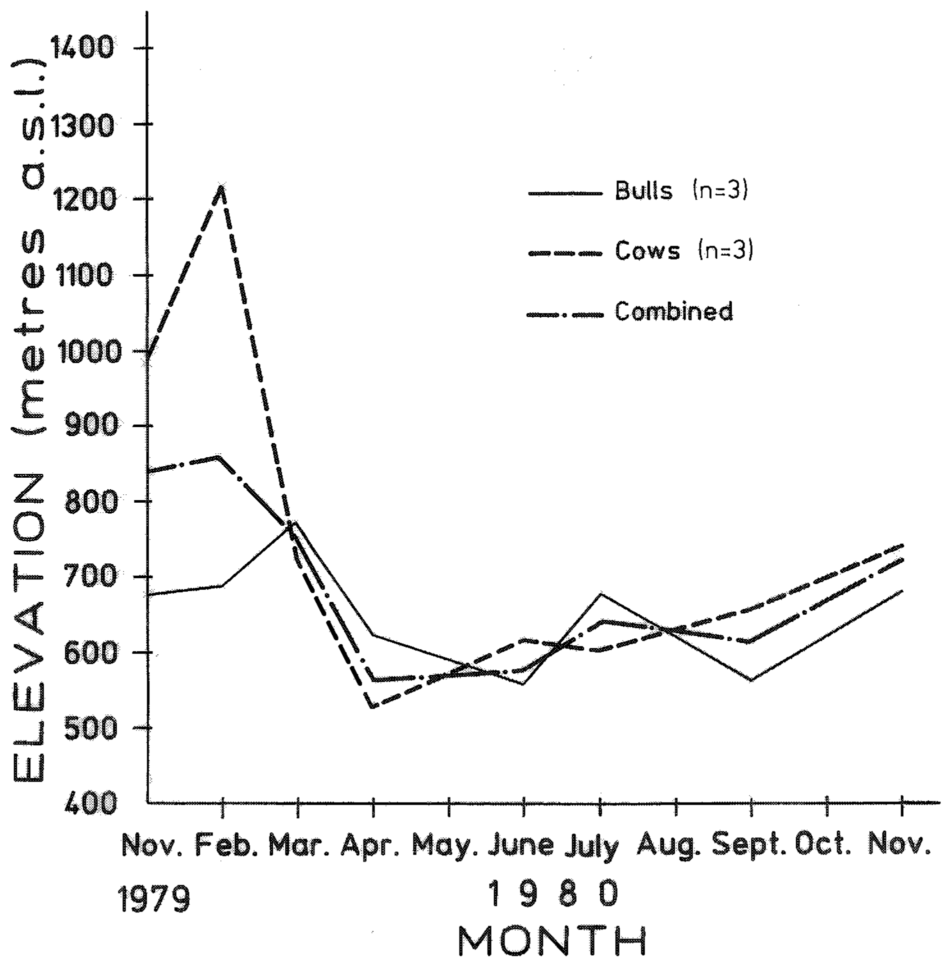


Figure 8. Monthly elevation use by six radio-collared adult moose in the Dawson East Study Area, Nov. 1979 - Nov. 1980.

Table 1. Search Intensity (min./km^2) of aerial surveys in the Dawson area, 1989.

TYPE OF SURVEY	SURVEY AREA			
	DAWSON EAST	DAWSON WEST	DAWSON NORTH	COMBINED
Stratification (fixed wing)	0.66	0.43	0.27	0.45
Intensive Search (helicopter)	1.93	1.62	n/a	1.77
S.C.F.* Search (helicopter)	3.36	3.23	n/a	3.30
Trend (fixed wing)	1.93	n/a	n/a	n/a

Table 2. Moose seen on stratification vs census flights by different observers in the Dawson West and East survey areas, 1989.

	NAVIGATOR			
	1	2	3	COMBINED
Stratification Intensity (min./km^2)	0.63	0.68	0.31	0.56
Moose seen on stratification	265	134	49	448
Moose seen on census	272	154	118	544
Percentage of censused moose seen on stratification	97	87	42	82
Incorrect stratification (percentage)	7/43 (16)	8/48 (17)	7/19 (37)	22/110 (20)

* sightability correction factor

Table 3. Sampling intensity of habitable moose range by stratum and survey area during the intensive census in the Dawson area, 1989.

SURVEY AREA		STRATUM			
		LOW	MEDIUM	HIGH	TOTAL
Dawson East:	Number of su* (% of total su)	59(69)	16(19)	10(12)	85(100)
	Number of su surveyed (% of total su surveyed)	14(47)	7(23)	9(30)	30(100)
	Number of su surveyed (% of su within the strata)	14(24)	7(44)	9(90)	30(35)
Dawson West:	Number of su (% of total su)	40(62)	22(34)	3(4)	65(100)
	Number of su surveyed (% of total su surveyed)	16(47)	15(44)	3(9)	34(100)
	Number of su surveyed (% of su within the strata)	16(40)	15(68)	3(100)	34(52)
Combined:	Number of su (% of total su)	99(66)	38(25)	13(9)	150(100)
	Number of su surveyed (% of total su surveyed)	30(47)	22(34)	12(19)	64(100)
	Number of su surveyed (% of su within the strata)	30(30)	22(58)	12(92)	64(43)

* sampling units

Table 4. Estimated moose abundance and composition in the Dawson East survey area October 22-30, 1989.

PARAMETER	STRATUM			
	HIGH	MEDIUM	LOW	TOTAL (90% C.I.)
A. Abundance[1]				
Estimated total moose	304	154	233	691±23%
Density (moose/1,000km^2)	903	320	133	269
S.C.F. - Number of moose observed on standard search	57	--	5	
- Numbers of moose observed on intensive search	64	--	7	
B. Composition				
Adult bulls (≥30 mo.)	85	28	46	160±34%
Adult cows (≥30 mo.)	102	60	84	245±25%
Yearlings (18 mo.)[2]	57	16	28	100±34%
Calves	61	50	75	186±30%
C. Ratios				
Adult bulls/100 adult cows				65±30%
Yearlings/100 adult cows				41±33%
Calves/100 adult cows				76±18%
Adult bulls/Total moose (%)				23%
Adult cows/Total moose (%)				36%
Yearlings/Total moose (%)				14%
Calves/Total moose (%)				27%
Twinning rate[3]				28%

1. Moose abundance has been corrected for sightability (S.C.F. = 1.13). Densities are based on habitable moose range.

2. Yearling males are assumed to equal yearling females in numbers.

3. Cows with twins divided by cows with calves.

Table 5. Estimated moose abundance and composition in the Dawson West survey area October 30 - November 7, 1989.

PARAMETER	STRATUM			
	HIGH	MEDIUM	LOW	TOTAL (90% C.I.)
A. Abundance[1]				
Estimated total moose	51	180	82	313±19%
Density (moose/1,000km^2)	608	288	71	168
S.C.F. - Number of moose observed on standard search	4	20	--	
- Numbers of moose observed on intensive search	4	20	--	
B. Composition				
Adult bulls (≥30 mo.)	20	69	31	120±24%
Adult cows (≥30 mo.)	14	64	36	114±29%
Yearlings (18 mo.)[2]	10	18	0	28±40%
Calves	7	29	15	51±35%
C. Ratios				
Adult bulls/100 adult cows				105±21%
Yearlings/100 adult cows				25±42%
Calves/100 adult cows				45±21%
Adult bulls/Total moose (%)				38%
Adult cows/Total moose (%)				36%
Yearlings/Total moose (%)				9%
Calves/Total moose (%)				16%
Twinning rate[3]				18%

1. All moose were seen on initial survey, therefore, no sightability correction factor was applied (S.C.F. = 1.00). Densities are based on habitable moose range.

2. Yearling males are assumed to equal yearling females in numbers.

3. Cows with twins divided by cows with calves.

Table 6. Moose trend survey results from the North Ladue River area, 1982-1989[1].

DATE	COMPOSITION				TOTAL	DENSITY (moose/ 1,000 km^2)	RATIOS/100 ADULT COWS			PERCENTAGE OF TOTAL POPULATION		SEARCH INTENSITY (min/km^2)
	ad bull (≥30 mo.)	yrl bull	ad cow (≥30 mo.)	calves			ad bulls	yearlings	calves	yearlings	calves	
2.11.82	5	0	6	1	12	102	83	0	17	0	8	2.0
13.11.84	7	0	6	1	14	119	117	0	17	0	7	1.6
11.11.85	5	0	6	0	11	93	83	0	0	0	0	1.6
23.11.86	11	0	11	3	25	213	100	0	27	0	12	1.3
19.11.87	10	0	7	4	21	178	143	0	57	0	19	1.6
7.11.89	8	0	6	2	16	153[2]	133	0	33	0	13	1.3

1. Surveys between 1982-1987 were conducted by the Alaska Department of Fish and Wildlife (ADF&G) (Gasaway unpubl. data) using a Super Cub. In 1989, the Yukon Fish and Wildlife Branch resurveyed much of the same area using a helicopter. The ADF&G survey area was 118 km^2.

2. This density was based on a total of 18 moose rather than the 16 indicated above. The additional 2 moose were estimated from an unsurveyed low density sample unit (34.3 km^2) in the trend area. The sample unit area was multiplied by the average density of the low stratum in the survey area.

Table 7. Moose harvest by resident non-Indians and Indians[1] in the Dawson survey areas between 1979 and 1988.

YEAR	DAWSON SURVEY AREAS							
	EAST		WEST		NORTH		COMBINED	
	RESIDENT	INDIAN	RESIDENT	INDIAN	RESIDENT	INDIAN	RESIDENT	INDIAN
1979	4	--	2	--	4	--	10	--
1980	8	--	2	--	6	--	16	--
1981	11	--	1	--	12	--	24	--
1982	15	--	1	--	14	--	30	--
1983	10	--	0	--	2	--	12	--
1984	7	--	0	--	14	--	21	--
1985	6	--	0	--	7	--	13	--
1986	9	--	0	--	10	--	19	--
1987	1	0	0	0	5	3	6	3
1988	8	3	1	0	3	1	12	4
TOTAL	79	3	7	0	77	4	163	7

1. Indian harvest was not estimated until 1987.

Appendix 1. Cost (excluding personnel) of the 1989 Dawson survey (cost in thousands).

Aircraft - fixed wing - stratification of DN, DW, and DE	28.1
- trend survey in DE	3.7
- helicopter - census in DE and DW	55.1
Food and Accommodations	9.4
Miscellaneous	3.4
TOTAL	97.7

Appendix 2. Incidental wildlife observation during the Dawson survey in October and November 1989.

SAMPLE UNIT	CARIBOU	WOLVES	GRIZZLY BEAR
117	9		
120	6		
121	4		
122	Tr		
123	6		
128	2		
137	2		
138	31		
139	20		
145	22		
146	37		
148	unknown		
149	14		
150	5		
151	11		
216			1
293	unknown		
295	Tr		
296	Tr		
298	8		
500		1	

APPENDIX 3. SUMMARY OF NOVEMBER YUKON MOOSE SURVEY RESULTS (revised 1991)

SURVEY BLOCK	SURVEY AREA (KM^2)	YEAR	ESTIMATED TOTAL 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	ESTIMATED POPULATION STATUS	
									OBSERVED	PREDICTED
1 Kluane	3755	1981	120	54	27	17	.15			stable to decline
2 Aishihik	3626	1981	107	66	31	23	.16			
		1990	82	62	21	53	.12	-3% (between 1981-1990)	decline	
3 Whitehorse North	3108	1982	170	45	1	6	.04			decline
4 Haines Jct.	2332	1981	244	34	19	40	.13			
		1982	151	37	3	11	.02	-17% (between 1981-1984)	decline	
		1983	145	32	1	7	.01			
		1984	141	42	1	20	.01			
		1990	223	50	31	41	.17	+7% (between 1984-1990)	increase	
5 Whitehorse South	2613	1981	232	33	27	20	.17			
		1982	223	31	2	26	.02			
		1983	249	42	4	30	.03	+3% (between 1981-1986)		
		1986	274	27	18	31	.13			

continued/...

Continued

SURVEY BLOCK	SURVEY AREA (KM^2)	YEAR	ESTIMATED TOTAL 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	ESTIMATED POPULATION STATUS	
									OBSERVED	PREDICTED
6 Carcross	916	1980	443	51	41	37	.21			
		1982	328	76	1	9	.01	-25% (between 1980-1983)	decline	
		1983	187	51	7	4	.03			
7 Teslin Burn	2515	1982	550	39	12	19	.08			
		1983	431	30	1	30	.01	-13% (between 1982-1984)	decline	
		1984	417	66	13	39	.07			
8 Nisutlin	4248	1986	130	89	36	49	.16			stable to slow increase
9 Liard West	7236	1983	116	75	18	18	.09			stable to decline
10 Liard East	2227	1986	140	79	37	51	.17			stable to slow increase
11 North Canol	2744	1987	190	66	54	64	.24			rapid increase
12 Frances Lake	3894	1987	190	55	65	69	.29			rapid increase

continued/...

Continued

SURVEY BLOCK	SURVEY AREA (KM^2)	YEAR	ESTIMATED TOTAL 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	ESTIMATED POPULATION STATUS	
									OBSERVED	PREDICTED
13 Dromedary	3700	1982	65	37	1	15	.01			decline
14 Casino Trail	3055	1987	40	--[1]	--[1]	--[1]	unknown			stable to decline
15 Mayo North	2235	1988	128	49	42	68	.22			rapid increase
16 Mayo South	2616	1988	148	76	11	56	.06			stable to decline
17 Dawson East	2611	1989	269	65	41	76	.20			rapid increase
18 Dawson West	1870	1989	168	105	25	45	.11			stable to increase
Yukon Wide Average	51,601[2]	--	210	54	20	34	.11			

[1]Sample size too small to accurately determine sex and age ratios.
[2]Total area surveyed = approx. 20% of Yukon.

fw2/DL10/policy

Appendix 4. Allowable harvest calculations for moose in the Dawson east and west survey areas, 1989.

SURVEY AREA	ADULT AND YEARLING ANNUAL NATURAL SURVIVAL RATE[1]	ALLOWABLE HARVEST[2]	TOTAL LAND AREA (km^2)	ALLOWABLE HARVEST/ 1,000 km^2 TOTAL LAND AREA
Dawson East	90%	(505 x .90)-408=50	2611	19
	85%	(505 X .85)-405=24		9
Dawson West	90%	(262 x .90)-234=2	2005	1
	85%	(262 x .85)-234=-11		0

1. Natural survival rates were assumed to be between 85%-90%. Survival rates in the S.W. Yukon were estimated at 89% (Larsen et al. 1989).

2. Allowable harvest is calculated as [{(adult + yearling) x adult and yearling annual natural survival rate} - adults].

Yukon
Renewable Resources