MOOSE POPULATION RESEARCH
AND
MANAGEMENT STUDIES
IN YUKON

Moose Population Characteristics
in the Haines Junction
and Aishihik Lake area

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MOOSE POPULATION CHARACTERISTICS IN THE HAINES JUNCTION AND AISHIHIK LAKE AREA

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ABSTRACT

The mean number of moose declined (23%) significantly ($P<0.20$) in the Aishihik Lake area from 377±21% in 1981 to 291±18% in 1990 (both estimates uncorrected for sightability) for a finite rate of change of -2.8% per year. The 1990 population estimate after correcting for sightability 301±20%. With a current recruitment rate of 0.12 and a rate of change of between 0.90 and 1.02 (assumed natural mortality rate = 10% and 20%), this population would likely be stable or slowly declining at this time if there was no hunting. Any hunting would be in excess of sustainable limits. Ratios of calves to cows was significantly higher ($P<0.05$) in 1990 compared to 1981, however bull and yearling ratios were not significantly different. Distribution of moose was similar in the 1981 and 1990 surveys, except for the lack of concentration areas in 1990 between Long Lake and the Aishihik Road, and east of Canyon Lake (near the road). Indians accounted for the majority (57%) of the harvest, followed by resident non-Indians (39%), and non-residents (4%).

The mean number of moose has increased (50%) significantly ($P<0.05$) in the Haines Junction area from 329±20% in 1984 to 495±13% in 1990 (both estimates uncorrected for sightability) for a finite rate of change of 7.3% per year. The 1990 corrected estimate was 513±15%. With a current recruitment rate of 0.18 and a rate of change of between 0.97 and 1.10, this population is likely increasing without hunting at this time. If the finite rate of change since 1984 continues, the population target of 570 moose or 245 moose/1,000 km^2 (1981 levels) could be reached in 1992. Current harvest levels are below allowable limits, however harvest restrictions are recommended until the target population is achieved. Calf and yearling/cow ratios were significantly higher ($P<0.05$) in 1990 compared to 1984. Distribution remained the same between surveys. Indians accounted for most (75%) of the harvest, followed by non-Indian residents (15%), and non-residents (10%).

INTRODUCTION

Regional moose surveys have been conducted in priority moose management areas throughout the Yukon since 1980 (Appendix 1). The selection of priority areas was based on game management subzones (GMS) with high levels of moose harvest. The purpose of these surveys was to obtain a Yukon wide perspective of moose abundance, distribution, and sex/age composition. In addition, the information collected from the surveys has been used to set sustainable harvest levels, measure calf and yearling mortality, identify early winter moose habitats, and aid land use planning decisions.

In this paper, we present the results from November 1990 surveys in the Haines Junction and Aishihik Lake areas. The specific objectives are 1) to compare the 1990 survey results with the 1984 survey in the Haines Junction area (Markel and Larsen 1985) and the 1981 survey in the Aishihik Lake area (Larsen 1982) and 2) to determine the current status (stable, declining, or increasing) of the moose population and set allowable harvest levels.

A breakdown of the cost of the survey is presented in Appendix 2.

STUDY AREA

Aishihik

The Aishihik survey area (GMS's 5-42, and 5-45 to 5-47) encompasses 3,991km^2 of total area, 3,662km^2 of which is habitable moose range (Figure 1). Habitable range is defined by the area below 1,370m in elevation, excluding large water bodies. The vegetation and physiography have been previously described by Oswald and Senyk (1977) and Rowe (1972).

Sheep, caribou, wolves, black and grizzly bears occur in the survey area. There are approximately 430 Dalls sheep (108/1,000km^2 of total land area; internal files 1974-1984), an unknown number of woodland caribou (Farnell, pers. comm.), and approximately 20-30 wolves (5-8 wolves/1,000km^2; R. Hayes pers. comm.). Both grizzly bear and black bear are common but densities are unknown. A grizzly density of 10 bears/1,000km^2 was assigned to this area by Smith and Osmond-Jones (1991) through a habitat capability assessment.

The Aishihik area has a high potential for recreational opportunity, although consumptive use has declined recently (see Results and Discussion). We have no measure of non-consumptive use, however because of its location (i.e., near Whitehorse and next to the Alaska Highway) the potential is very high.

Haines Junction

The Haines Junction survey area (GMS's 7-01 to 7-06) is 2,918km^2 in total area and has 2,305km^2 of habitable moose range. Sheep, wolves, black and grizzly bears occur in this area. There are approximately 480 Dalls sheep or 164/1,000 km^2 of total land area (internal files). Wolf densities are currently at 12 wolves/1,000 km^2 (Hayes et al. 1991), however the wolf population was manipulated between 1983 and 1987 (see Results and Discussion). Grizzly bear

densities are unsubstantiated although 16 bears/1,000km^2 were documented in an adjacent area east of this survey block by Larsen and Markel (1989). Like the Aishihik area, there is a high potential for recreational opportunity, however, consumptive use has declined recently (see Results and Discussion).

METHODS

The stratified random sampling aerial survey technique developed by (Gasaway et al. 1986) was used to estimate moose abundance, composition, and distribution. This technique was modified by replacing fixed-wing aircraft with helicopters for the census portion (Larsen 1982). Briefly, the technique involves two phases; 1) the stratification survey in which sample units (SU's) are classified into high, medium, and low strata based on relative moose abundance observed from fixed wing reconnaissance flights; 2) the census survey in which all moose within selected SU's are counted. A sample of SU's was randomly selected and searched immediately after stratification. A sightability correction factor (SCF) for moose not observed on the census survey was estimated for both survey areas combined and applied to the separate density estimates in 1990. A SCF was estimated by re-surveying a portion of a SU 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 SU's censused. A SCF was not estimated during surveys conducted in previous years, therefore between year comparisons of population estimates were made using uncorrected data. Recording procedures for moose observations and age-sex determination have been previously described (Larsen 1982, Larsen et al. 1989b). Twinning rates were calculated as the number of cows with twins ÷ cows with calves in November. As such, twinning rates are a reflection of birth rates and calf survival to 6 months of age. Harvest estimation procedures have also been previously described (Kale 1982, Quock and Jingfors, 1989).

The 1990 Aishihik survey area was slightly larger (187km^2) then the same survey area in 1981. This difference was the result of changing survey boundaries to conform to GMS boundaries. The Haines Junction survey area remained the same between years. Density categories, used to describe moose distribution

(figures 2 and 4) are based on census rather than stratification data. Census data is more accurate than stratification data as some SU`s are misclassified during stratification, i.e., some SU's were stratified into one stratum but were later found during the census to have either a higher or lower density.

Changes in population size between surveys were tested using a two-tailed student's t-test. An alpha level of 0.20 was used to determine significance unless otherwise indicated. We accept a high probability of error (i.e. concluding that a change in numbers had occurred when in fact it may have not) so as to give the benefit of doubt to conservation of the moose population. We feel this is justified given the extremely low density of moose, especially in the Aishihik area. The finite rate of population change (net change after recruitment and mortality) was calculated both from the 1990 data and between the 1990 and the next most recent population estimate (1981 in Aishihik and the 1984 in Haines Junction). Finite rates involving more than one population estimate were calculated by $\hat{\lambda}=e^{r}$, were e=constant 2.7183 and r=exponential rate of increase, following Gasaway et al. (1986). Rates involving only one population estimate were calculated by $\hat{\lambda}=(1-M)\div(1-R)$ where M=the adult natural mortality rate and R=the proportion of recruits, following Gasaway et al. (1990).

Relative abundance of moose between surveys in both areas was measured by the number of moose seen/minute of search time on fixed-wing stratification and helicopter census flights. It was necessary to use a common denominator (min.) for between year comparisons as search intensity varied between surveys.

Recruitment rates were calculated as estimated number of yearlings ÷ estimated yearlings and adults. Allowable harvest rates were estimated by ([adult +

yearling] x adult and yearling natural survival) - adults. Natural survival rates were assumed to be either 80% or 90%. These values bracket the range of natural survival rates reported for moose in Alaska (Gasaway et al. 1990) and the Yukon (Larsen et al. 1989). Differences in age-sex proportions between surveys were tested using contingency table analysis. Changes in moose distribution was assessed by comparing the proportion of SU's containing the majority of the population between surveys, and the location of the SU's.

RESULTS AND DISCUSSION

Search and Sampling Intensity

Search intensity was similar on stratification (0.313 to .355 min./km^2), census (1.840 to 2.050 min./km^2) and sightability correction flights (2.617 to 3.257 min./km^2) between the two areas (Table 1). Similar areas and proportions of SU's were censused in both the Aishihik (1,385 km^2 or 37%) and the Haines Junction (1,032 km^2 or 43%) survey areas (Tables 1 and 2). Mean (±SE) SU size in the Aishihik area was 15.7km^2 (±0.265) and 13.6km^2 (±0.371) in the Haines Junction area.

Population Characteristics and Distribution

Aishihik Area

The estimated moose population using a SCF of 1.035 was 301±20% (90% CI) for a mean density of 82 moose/1,000km^2 (Table 3). This is the third lowest density documented in the Yukon to-date (Appendix 1). A decline (23%) in the uncorrected mean population estimates ($P<0.20$) has occurred between 1981 (377± 21%) and 1990 (291±18%, Appendix 3). The finite rate of change between surveys, assuming a constant rate of change, was -2.8% per year.

The relative number of moose seen on both the stratification and census flights between 1981 and 1990 also decreased (Appendix 3). Two hundred and forty two moose were seen on the stratification flight in 1981 compared to 133 in 1990. The number of moose seen/min. search time decreased from 0.336 to 0.116 between 1981 and 1990. Both the area stratified and the search intensity were greater in 1990, suggesting that the relative decline, between surveys, was greater than indicated. Gasaway (1986) found that the number of moose seen from supercubs increased up to a search intensity of approximately 2 min./km^2 then leveled off. Our search intensity in 1990 was just under this optimum level.

Two hundred and forty nine moose were seen on the census flight in 1981 compared to 172 in 1990 (Appendix 3). This decline occurred despite the fact that a larger number of sample units, and thus km^2, were searched in 1990 ($1,385km^2$) compared to 1981 ($760km^2$). Moose seen/min. search time declined from 0.256 to 0.067 between years. These results support our conclusion that moose have declined in this area. In fact, the decline may be greater than suggested by these values because search intensity is correlated with the number of moose seen on census flights (Gasaway et al., 1986) and search intensity was greater in 1990 (Appendix 3).

In addition to the declining trend in the number of moose seen on stratification and census flights (independent indices), further support of a decline is provided from circumstantial evidence given by all three consumptive resource user groups - resident non-Indian, Indians, and outfitter (personal communications).

The current status of the Aishihik population can only be inferred from estimates of rates of change and recruitment, as adult and yearling natural mortality rates are unknown. If we assume annual natural mortality rates (i.e. without hunting) of between 10% and 20% [11% was documented in the S.W. Yukon in the mid 1980s (Larsen et al. 1989a) and 9 to 22% in east-central Alaska during the same time period (Gasaway et al. 1990)] the current finite rate of change in this population would be between 0.904 and 1.017 (1.0 is stable). This analysis suggests that the population is near stable or slowly declining if there was no hunting. For comparison, Gasaway et al. (1990) documented rates of change of 0.97 in a near stable, 0.85 in a rapidly declining, and 1.18 in an erupting population in east-central Alaska. We suggest that the true finite rate of change is closer to 0.904 as this population has declined over

the past decade, and higher natural mortality rates are usually associated with declining populations (Gasaway et al. 1990).

The recruitment rate of the Aishihik population was 0.12. Gasaway et al. (1990) documented recruitment rates of 0.03-0.16 (mean=0.09) in rapidly declining, 0.06-0.16 (0.12) in near stable, 0.09-0.17 (0.13) in slowly increasing, and 0.18-0.28 (0.22) in rapidly increasing moose populations in east-central Alaska. The Aishihik recruitment rate is equivalent to the mean recruitment of a stable population, however, considering the measured decline, negative rate of change, and low recruitment, we suggest the Aishihik population is stable or slowly declining in the absence of hunting. Hunting will cause the population to decline or will speed up the existing decline.

Ratios of calves and yearlings/100 adult cows were 53 and 19, respectively (Table 3). The twinning rate was 8%. The proportion of calves to cows was significantly higher ($P<0.05$) in 1990 (53) compared to 1981 (29), however the yearling ratio were not significantly different between surveys (Appendix 3). We interpret this data to mean that although there is a potential for improved recruitment in 1991 (i.e. if over winter mortality was low on the high calf population in 1990), the yearling ratios suggest a declining population both in 1981 and 1990. The fact that the population did decline between 1981 and 1990 lends credence to the conclusion that the current yearling proportions will lead to a declining population. The bull/100 adult ratio of 57 in 1990 was not significantly different from the 63 in 1981. Both values are in excess of the 30/100 ratio used as a management target. We do not feel the current sex ratio is detrimental to herd productivity.

Moose were unevenly distributed throughout the survey area with 115 moose (38% of the population) estimated in the high stratum which made up only 6% of the survey area (Tables 2 and 3). SU's with the highest moose densities (0.26-1.7 moose/km^2) were located in the Long Lake and Mt. Shaneinbaw areas (Figure 2). The low numbers of moose in the northern half of the Aishihik survey area is speculated to be due, at least in part, to habitat differences. Although there is no quantitative information available, the availability of browse appears lower north of Long Lake compared to the southern half of the survey area.

The distribution of moose in 1990 was similar to that found in 1981. The proportion of moose in high and medium SU's was not different ($P>0.05$) between the two surveys. The location of concentration areas were also similar between surveys. The most conspicuous difference in the distribution between the two surveys was the loss of higher density SU's on the west side of the mountain complex to the east of Canyon Lake, and in the area west of Long Lake (Figure 2).

Moose have been harvested at a minimum mean rate of 16 kills/year since the initial population estimate in 1981 (Figure 3). This is a minimum rate for two reasons; 1) the Indian harvest data is thought to underestimate the true harvest (Quock and Jingfors 1988) and 2) Indian harvest was only available for 1988 and 1989, when moose populations were lower, and therefore harvest lower than the early 1980's. The mean annual Indian harvest for 1988 and 1989 was used for all years since 1981. Most of the kills in recent years (1988 and 1989) were made by Indians (57%) followed by non-Indian residents (39%), and non-residents (4%). Nearly all of the moose harvested were males. Quock and Jingfors (1988) reported that the Yukon wide Indian harvest comprised 80%

males, and resident non-Indian and non-resident harvest is restricted to males only.

Consumptive use in the Aishihik area has declined over the past decade (Figure 3). Approximately 500 hunter days and 10 moose kills/year occurred in the early to mid 1980's. Since 1986, these values have declined to approximately 250 days and 8 moose/year. The hunting season has remained liberal at 3 months with an unlimited number of hunters.

Given that this population has declined at 2.8% per year since 1981 suggests that the population was overharvested in the past. The fact that it is currently stable without hunting indicates that there is no allowable harvest. The overharvest of males has not jeopardized calf production as there are sufficient males (57/100 cows) to breed all reproductive cows in the population (Table 3). A mean ratio of 47 bulls/100 cows in a study carried out in the S.W. Yukon resulted in 89% of all cows ($\geq$3 years old) being pregnant (Larsen et al. 1989a).

The effects of hunting bulls from this population may have ramifications beyond the obvious affects of harvesting in excess of sustainable limits. The harvesting of bulls will decrease the prey available to wolves, which in turn will likely increase predation proportionately on the remaining moose population. As a result, predation pressure may be increased indirectly through hunting. Also, the effects of harvesting at a constant number of moose becomes increasingly more significant as the population declines. An annual harvest of 16 moose/year represented 4% of the population in 1981 and 6% in 1990. If these losses continue, and if there is no interventions to enhance moose densities, the population may decline to even lower densities.

Haines Junction

The estimated moose population using a SCF of 1.035 was 513±15% (90%CI) for a mean density of 223 moose/1,000km^2 (Table 4). This is slightly above the Yukon average of 210 moose/1,000km^2, based on 30 surveys conducted since 1980 (Appendix 1). The uncorrected mean population estimate has increased ($P<0.05$) by 50% between 1984 (329±20%) and 1990 (495±13%, Appendix 4). The finite rate of change was +7.3% per year between these surveys.

The relative number of moose seen on the stratification and census flights between 1984 and 1990 also increased (Appendix 4). Two hundred and ten moose were seen on the stratification flight in 1984 compared to 250 in 1990. The number of moose seen/minute search time increased from 0.189 to .306 between surveys. The area stratified was the same in both surveys, however search intensity was lower in 1990 (0.355 minute/km^2) compared to 1984 (0.475 minute/km^2), indicating that the number of moose seen in 1990 may have been underrepresented. If so, the increase may have been larger than indicated by these values. The number of moose seen on the census increased from 0.25 moose/km^2 in 1984 to 0.35 moose/km^2 in 1990 or from 0.13 moose/minute search time in 1984 to 0.17 in 1990. Search intensities were similar in both years.

As with the Aishihik population, the current status of this population can only be inferred. Assuming natural adult mortality rates of 10% to 20%, the current finite rate of change would be between 0.974 and 1.096. These data suggest that the population could be either near stable or increasing, without hunting, however a recruitment rate of 0.18 suggests that this population is increasing based on data from Alaska (Gasaway et al. 1990).

Considering the measured increase in the Haines Junction population since 1984, a positive rate of change, and high recruitment rate, we suggest that this population is currently increasing. If the rate of increase documented between 1984 and 1990 (7.3% per year) continues, the population could recover to the 1981 level by the year 1992.

Ratios of calves and yearlings/100 adult cows were 45 and 34, respectively. The twinning rate was 13%. Both the proportions of calves/cows and yearlings/cows were significantly ($P<0.05$) higher in 1990 compared to 1984 (Appendix 4). As discussed above, the high proportion of yearlings suggests that the population should be increasing. A bull/cow ratio of 57/100 is not detrimental to herd productivity.

Moose continue to be clumped in distribution in 1990 with 61% of the population occurring in 13% of the area (Tables 2 and 4). These proportions were similar ($P<0.05$) to that documented in 1984, as were the location of moose (Markel and Larsen 1985). Major concentration of moose were found near Mt. Bratnober, Granite Lake, and north of Frederick Lake (Figure 4).

Moose harvest since the last survey (1984) has been 12 kills/year (Figure 3). The above harvest rate assumes that the Indian harvest between 1984-1987 and 1990 was equal to the 1988-1989 mean (8 moose/year). As discussed earlier, Indian harvest rates are minimum values. Most of the kills in recent years, 1988-1989, were made by Indians (75%), followed by non-residents (15%), and non-Indian residents (10%). A mean harvest of 12 moose represented 4% of the estimated post-hunt population in 1984 and 2% in 1990.

Consumptive use of moose by resident non-Indians in the Haines Junction survey area was high (approximately 700 hunter days/year and 30 moose harvested/year) in the early 1980's, but has declined substantially since 1984 (approximately 100 hunter days and 4 moose harvested/ year). Season lengths were reduced in 1985 and a limited permit system was implemented in 1989.

The current allowable harvest is between 0 and 29 moose, depending on the natural mortality rates for adults. We suggest the actual allowable harvest is closer to 29 than 0 as we would expect the lower natural adult mortality rate (10%) to occur in an increasing population (Gasaway et al. 1990).

The reason(s) for the observed 50% increase in moose numbers between 1984 and 1990 is problematic, however, a reduction in both wolf numbers and harvest occurred during this time period. Wolf densities were manipulated between the winter of 1983 and 1987. Prior to wolf reduction (1982) wolf densities were 12/1,000km^2, at the peak of reduction (1985) they were approximately 5/1,000km^2, and by 1988 they had recovered to their pre-reduction density (Hayes et al. 1991). Between 1984 and 1988 (approximate moose survey period) the mean wolf reduction ($\pm$SE) was 40% ($\pm$9.5%). Between 1984 and 1990 resident non-Indian and non-resident harvest declined from 13 to 4 (69%), however, the largest drop occurred between 1984 and 1985 (62%). Between 1985 and 1990 (moose survey period), the mean harvest ($\pm$SE) remained relatively low and constant at 4.5 ($\pm$0.84) per year. We consider both hunting and wolf predation to be additive sources of moose mortality and therefore both likely contributed to the increased numbers of moose.

RECOMMENDATIONS

1. Harvesting of moose in the Aishihik survey area should be eliminated as the population has declined over the past decade, and is currently at best, stable without hunting. Any harvest would be in excess of sustainable limits. We recognized that a complete closure on short notice may be politically unacceptable, therefore we recommend that severe restrictions on hunting (2% of November population) be implemented immediately with the intent of closing the area in the next two years if the population does not show signs of increasing in the interim. The status of this population should be monitored annually by trend surveys. A two-year grace period would allow time to collect additional information on population trend and would alert user groups of a potential closure.

2. Develop, along with the Fish and Wildlife Management Board, a management strategy to increase moose densities in the Aishihik Lake area. Elevated moose densities would result in an increase in recreational (consumptive and non-consumptive) opportunities, increase wildlife values to counter habitat alienating development, and create a more favorable management situation, such that annual fluctuations in moose numbers will not jeopardize the population.

3. Maintain the current limited number of permits for resident and non-resident hunters in the Haines Junction area. This population should be monitored closely with the trend surveys over the next two years for signs of continued increase. The population should be reassessed using intensive surveys in 1992 or 1993 to determine with certainty whether or not the population has continued to increase. Once the desired population objective is reached more liberal hunting regulations could be adopted.

4. Assess moose habitat in the Aishihik Lake survey area to determine if it is currently limiting moose density, especially in the northern portion of this area.

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LITERATURE CITED

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

_____, 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 report, Job no. 1.37R. 106pp.

Hayes, R.D., A. Baer, and D.G. Larsen (1991). Population dynamics and prey relationships of an exploited and recovering wolf population in the southern Yukon. Yukon Fish and Wildl. Br. Final Rep. TR-91-1. 67pp.

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 18:142-167.

Larsen, D.G. and R. Markel. 1989. A preliminary estimate of grizzly bear abundance in the southwest Yukon. Yukon Fish and Wildl. Br. Report.

Larsen, D.G., D.A. Gauthier, R.L. Markel, and R.D. Hayes. 1989a. Limiting factors on moose population growth in the southwest Yukon. Yukon Fish and Wildl. Branch Report. 105pp.

Larsen, D.G., _____, and _____. 1989b. Causes and rates of moose mortality in the southwest Yukon. J. Wildl. Manage. 53:548-557.

Markel, R.L. and D.G. Larsen. 1985. Southwest Yukon moose survey results, Nov.-Dec. 1984. Internal Report, Yukon Fish and Wildl. Br. Report. 13pp.

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

Quock, R and K. Jingfors. 1988. Yukon Indian harvest survey progress report 1987. Internal report, Yukon Fish and Wildl. Br. Report. 35pp.

Rowe, J. 1972. Forest regions of Canada. Can. For. Serv. Publ. No. 1300. 172pp.

Smith, B. and T. Osmond-Jones. 1991. Grizzly bear abundance and harvest in Yukon ecoregions. Yukon Fish and Wildl. Br. Report.

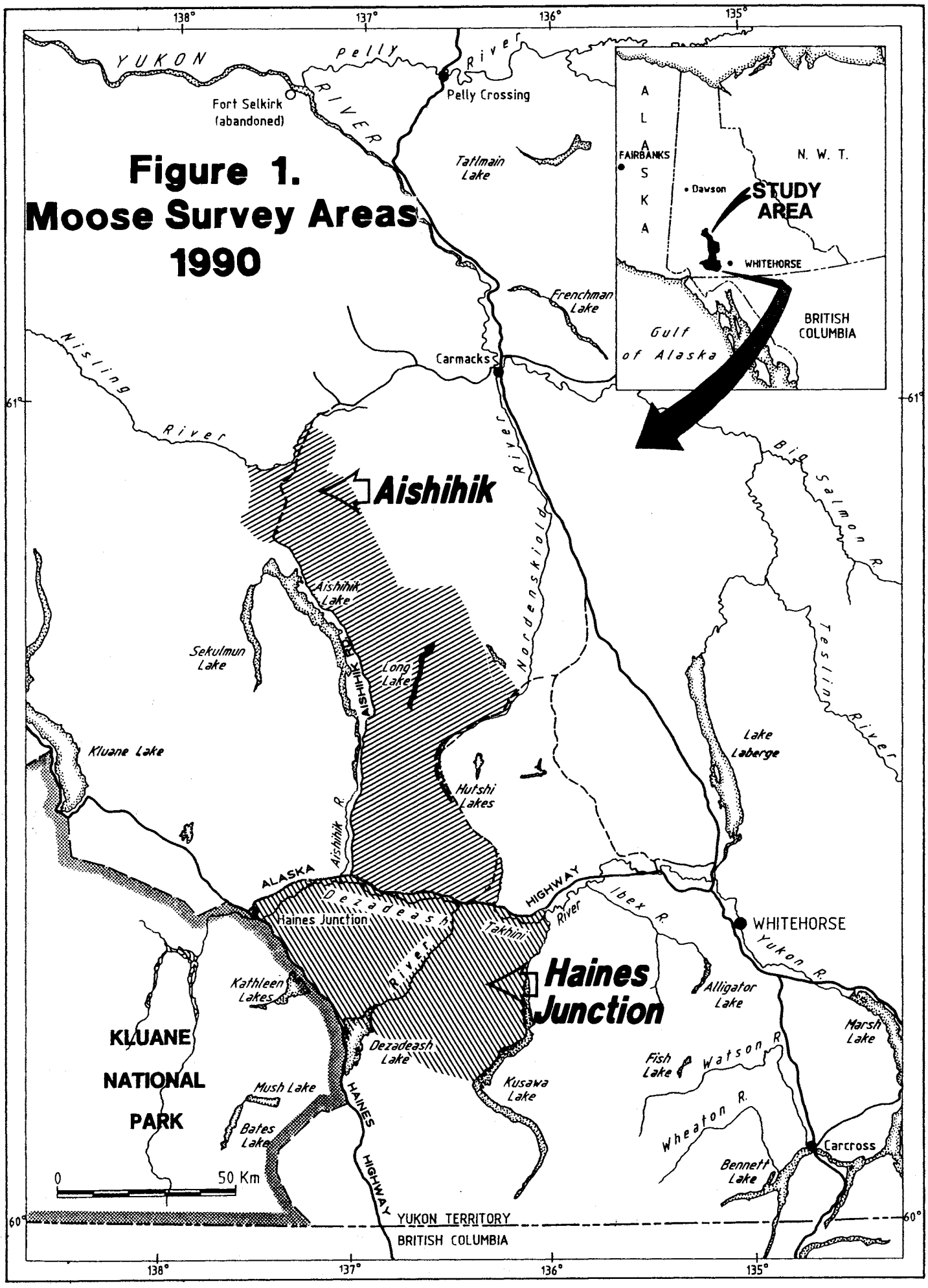


Figure 1.
Moose Survey Areas
1990
138°
137°
136°
135°
61°
60°
YUKON
Pelly River
Fort Selkirk
(abandoned)
Pelly Crossing
Tatlmain Lake
ALASKA
FAIRBANKS
N. W. T.
Dawson
STUDY AREA
WHITEHORSE
BRITISH COLUMBIA
Gulf of Alaska
Frenchman Lake
Carmacks
Nisling River
Aishihik
Aishihik Lake
Sekulmun Lake
Long Lake
Nordenskiold River
Big Salmon R.
Teslin River
Kluane Lake
Hutshi Lakes
Lake Laberge
Aishihik R.
ALASKA HIGHWAY
Dezadeash River
Haines Junction
Takhini River
Ibex R.
WHITEHORSE
Yukon R.
Kathleen Lakes
Alligator Lake
Marsh Lake
KLUANE NATIONAL PARK
Dezadeash Lake
Fish Lake
Watson R.
Kusawa Lake
Mush Lake
Bates Lake
HAINES HIGHWAY
Wheaton R.
Carcross
Bennett Lake
0
50 Km
YUKON TERRITORY
BRITISH COLUMBIA

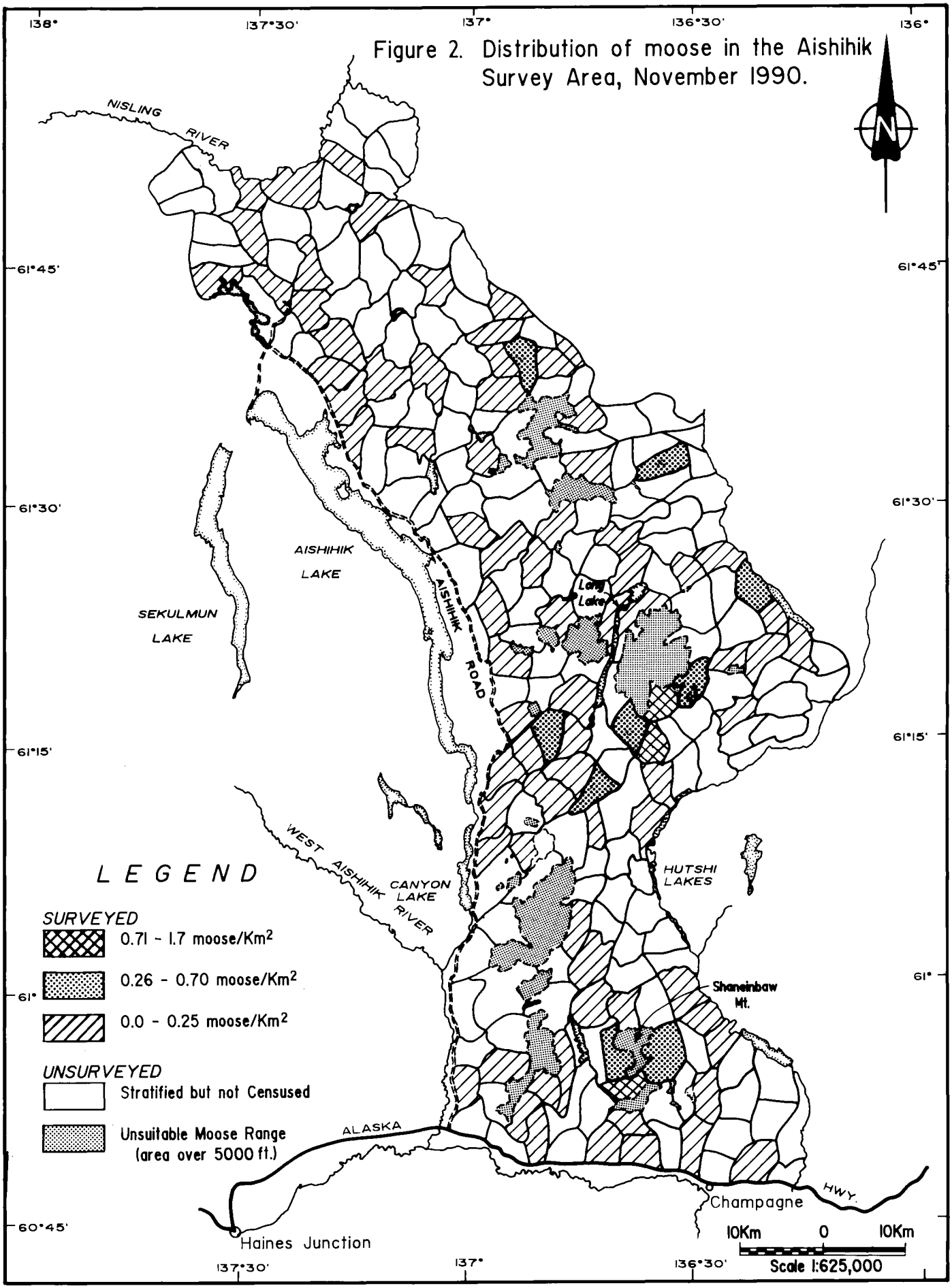
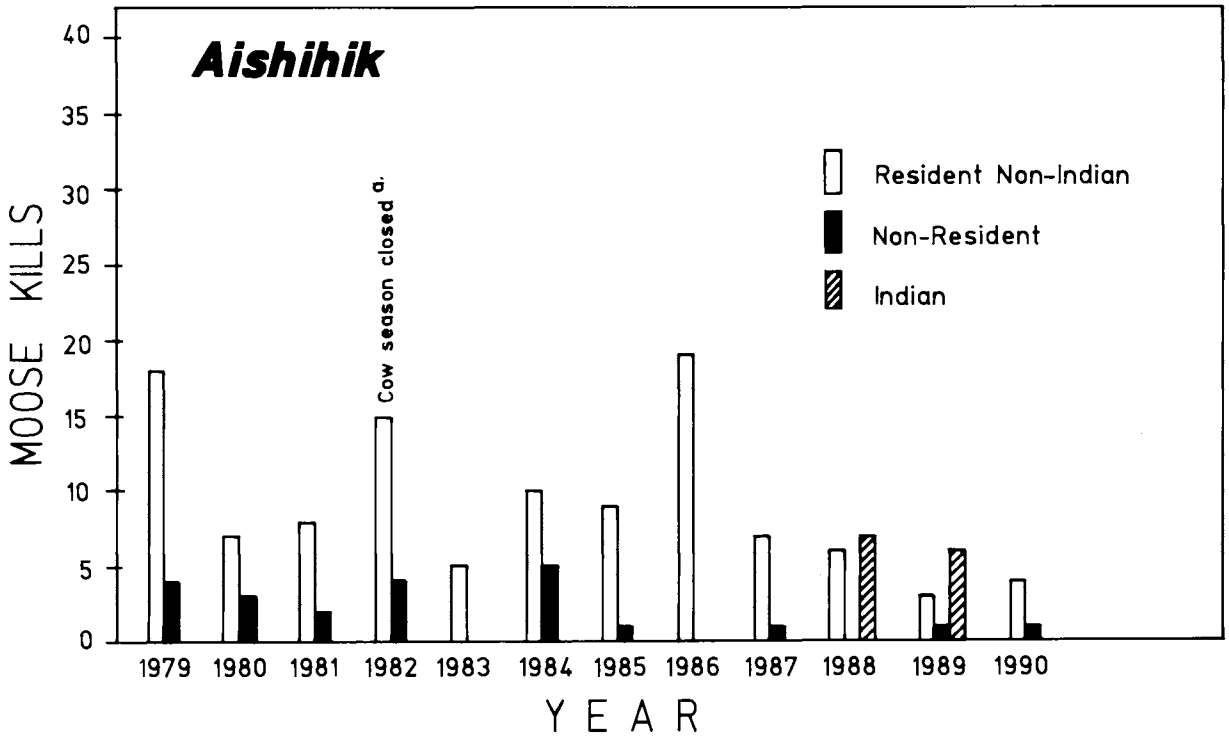
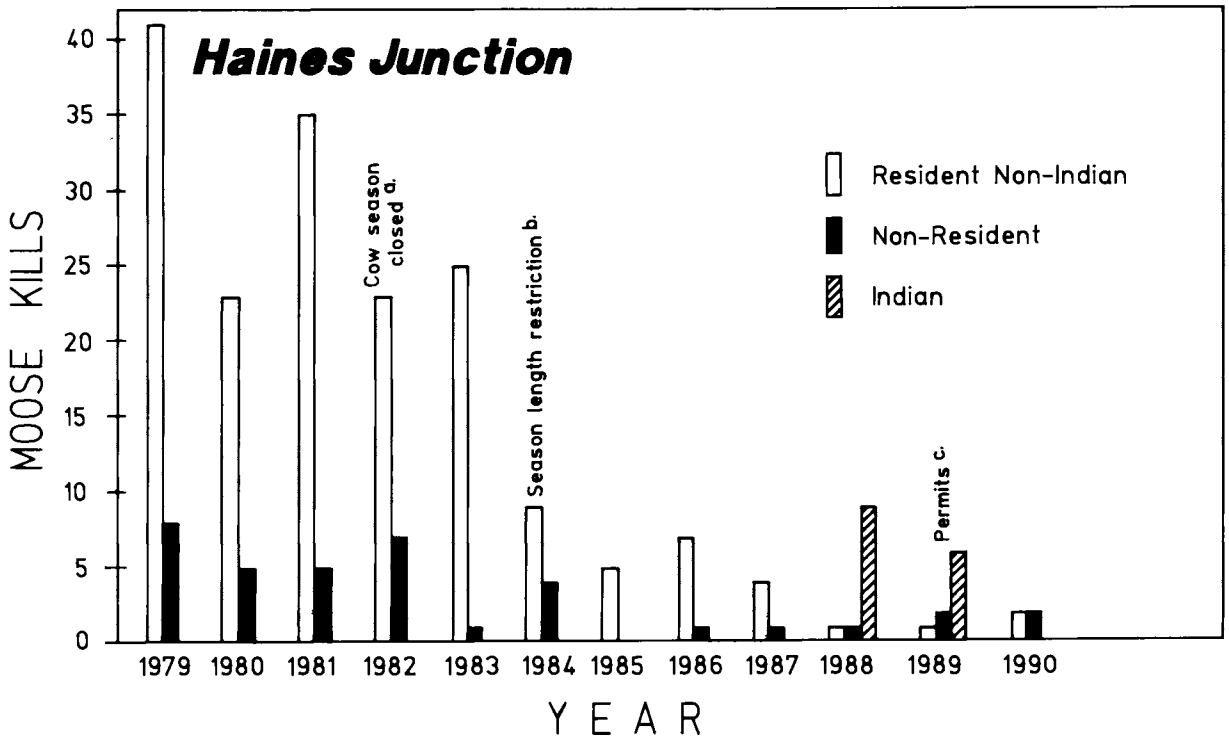


Figure 2. Distribution of moose in the Aishihik Survey Area, November 1990.

Figure 3. Estimated moose harvest in the Aishihik and Haines Junction survey areas between 1979 and 1990.





a. Cow season closed to Resident Non- Indian
b. Bull season restricted to 15 days for Resident Non-Indian
c. Limited permits for Resident Non-Indian and Non-Residents

NOTE: Indian harvest was not available prior to 1988 or in 1990.

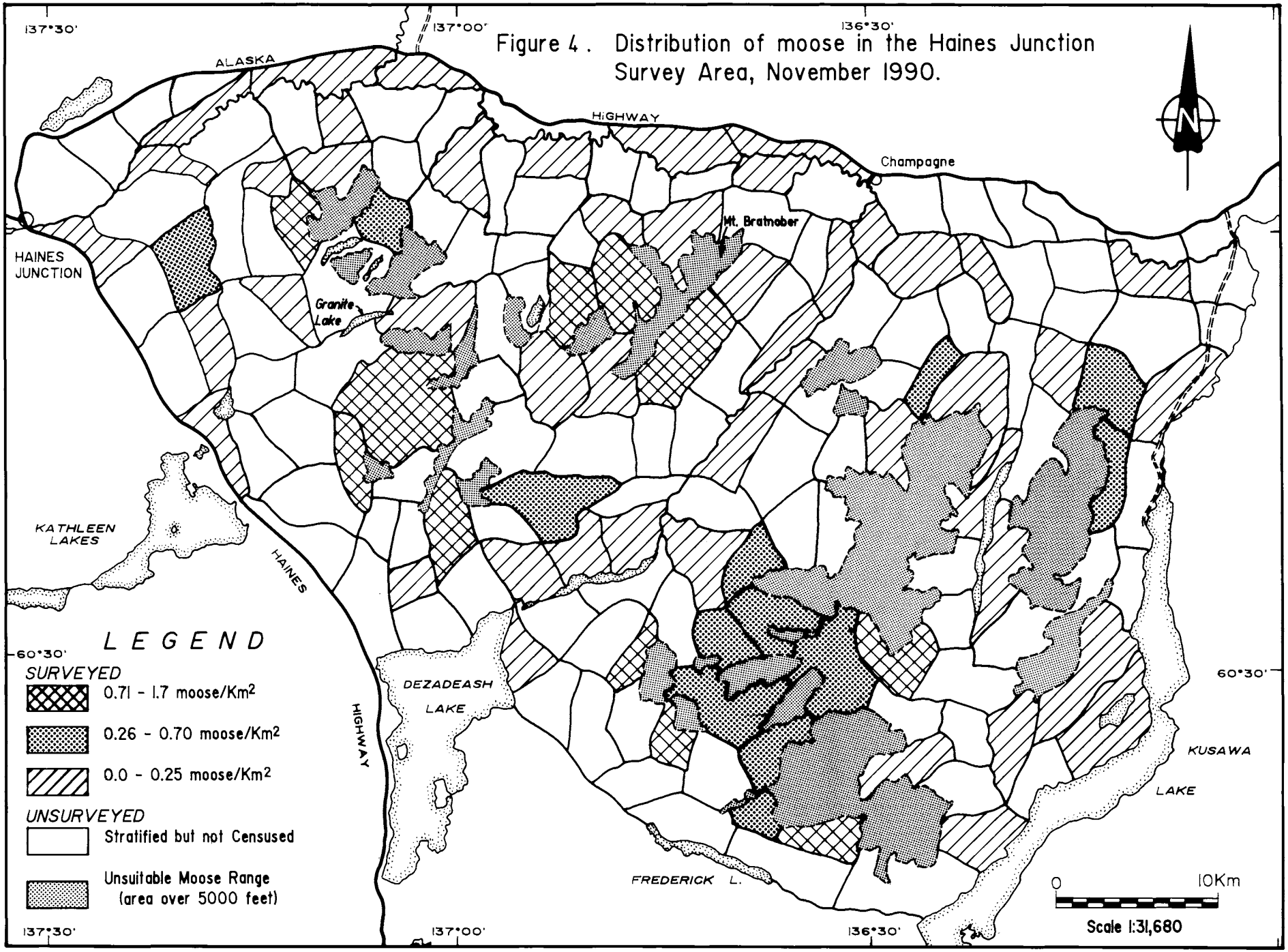


Figure 4. Distribution of moose in the Haines Junction Survey Area, November 1990.

Table 1. Search intensity (min./km^2) on early winter moose surveys in S.W. Yukon, 1990.

	SURVEY AREA		
SURVEY/AIRCRAFT	AISHIHIK	HAINES JUNCTION	COMBINED
Stratification (fixed wing)			
area (km^2)	3,662	2,305	5,967
time (min.)	1,148	818	1,966
search intensity (min./km^2)	0.313	0.355	0.329
Survey (helicopter)			
area (km^2)	1,385	1,032	2,417
time (min.)	2,549	2,116	4,665
search intensity (min./km^2)	1.840	2.050	1.930
Sightability Correction Factor (helicopter)			
area (km^2)	47	35	82
time (min.)	123	114	237
search intensity (min./km^2)	2.617	3.257	2.890

Table 2. Sampling intensity of habitable moose range by stratum and survey area during the early winter census in S.W. Yukon, 1990.

	STRATUM			
SURVEY AREA	LOW	MEDIUM	HIGH	TOTAL
Aishihik				
Number of SU* in area (% of total)	220(94)	N/A	13(6)	233(100)
Number of SU surveyed (% of strata)	74(34)	N/A	13(100)	87(37)
Haines Junction				
Number of SU in area (% of total)	147(87)	9(5)	13(8)	169(100)
Number of SU surveyed (% of strata)	51(35)	8(89)	13(100)	72(43)

* Sample Unit

Table 3. Estimated moose abundance, observed and estimated composition of moose in the Aishihik survey area, November, 1990.

	STRATUM		
	HIGH	LOW	TOTAL
Estimated Abundance (90% CI)			
Total moose[a]	115	186	301±20%
Density (moose/1,000 km^2)	529	54	82
Estimated Composition[a] (90% CI)			
Adult bulls (≥30 mo.)	27	52	79±40%
Adult cows (≥30 mo.)	52	76	128±20%
Yearlings (≥18 mo.)	8	18	27±74%
Calves	28	40	68±29%
Observed Composition			
Adult bulls (≥30 mo.)	26	17	43
Adult cows (≥30 mo.)	50	25	75
Yearlings[b] (≥18 mo.)	8	6	14
Calves	27	13	40
TOTAL	111	61	172
Observed Ratios			
Adult bulls/100 adult cows	52	68	57
Yearlings/100 adult cows	16	24	19
Calves/100 adult cows	54	52	53
Adult bulls/total population			25%
Adult cows/total population			44%
Yearlings/total population			8%
Calves/total population			23%
Twinning Rate[c]			8%

a. Adjusted for sightability bias (1.035).

b. Total yearlings were calculated by doubling the observed number of yearling males.

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

Table 4. Estimated moose abundance and observed and estimated composition in the Haines Junction survey area, November, 1990.

	STRATUM			
	HIGH	MEDIUM	LOW	TOTAL
Estimated Abundance (90% CI)				
Total moose[a]	246	69	198	513±15%
Density (moose/1,000 km^2)	913	512	104	223
Estimated Composition[a] (90% CI)				
Adult bulls (≥30 mo.)	66	13	37	116±19%
Adult cows (≥30 mo.)	93	34	103	230±18%
Yearlings (≥18 mo.)	41	5	24	71±30%
Calves	46	17	33	96±18%
Observed Composition				
Adult bulls (≥30 mo.)	64	11	12	87
Adult cows (≥30 mo.)	90	28	34	152
Yearlings[b] (≥18 mo.)	40	4	8	52
Calves	44	14	11	69
TOTAL	238	57	65	360
Observed Ratios				
Adult bulls/100 adult cows	71	39	35	57
Yearlings/100 adult cows	44	14	24	34
Calves/100 adult cows	49	50	32	45
Adult bulls/total population				24%
Adult cows/total population				42%
Yearlings/total population				14%
Calves/total population				19%
Twinning Rate[c]				13%

a. Adjusted for a sightability correction factor or 1.035.

b. Total yearlings were calculated by doubling the observed number of yearling males.

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

APPENDIX 1. Yukon wide moose densities

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.

Appendix 2. Cost (x 1,000) associated with aerial moose surveys in 1990.

Aircraft[a]	fixed wing	17.0	(including fuel)
	helicopter	75.0	(including fuel)
Food and Lodging		2.5	
Generator		2.1	
Miscellaneous		1.5	
TOTAL		98.1[b]	

a. Aircraft costs (dry) were $200/hour f.w., $500/hour helicopter

b. Personnel costs are not included - total of 141 man days between 7 people (excluding preparation and write-up) were needed to conduct the survey.

Appendix 3. Summary of moose survey results from the Aishihik survey area, November 1981 and November 1990. NOTE: sightability correction factor has not been incorporated.

Population Characteristics	1981	1990
Estimated Abundance (90% CI)		
TOTAL moose[1]	377±21%	291±18%
Density (moose/1,000 km^2)	107	79
Estimated Composition (90% CI)		
Adult bulls (≥30 mo.)	113±37%	76±38%
Adult cows (≥30 mo.)	172±28%	124±18%
Yearlings (≥18 mo.)	53±44%	26±70%
Calves	39±45%	65±27%
Observed Composition		
Adult bulls	73	43
Adult cows	116	75
Yearlings	37	14
Calves	23	40
TOTAL	249	172
Observed Ratios		
Adult bulls/100 adult cows	63	57
Yearlings/100 adult cows	32	19
Calves/100 adult cows	29	53
Adult bulls/total population	29%	25%
Adult cows/total population	47%	44%
Yearlings/total population	15%	8%
Calves/total population	9%	23%
Twinning Rate	17%	8%
Survey Characteristics		
Stratification		
Area (km^2)	3,475	3,662
Time (min.)	720	1,148
Search Intensity (min./km^2)	0.207	0.313
Moose Seen	242	133
Moose Seen/min.	0.336	0.116
Dates	Nov. 19-21	Nov. 5-10

Continued ...

Appendix 3 continued

Census	1981	1990
Area (km^2)	760	1,385
Percentage of Survey Area Searched	22%	38%
Time	974	2549
Search Intensity	1.282	1.840
Moose Seen	249	172
Moose Seen/min.	0.256	0.067
Dates	Nov. 23-26	Nov. 9-16

1. Significantly different between 1981 and 1990 ($P<0.20$), 2 Tailed Student t-Test.

Appendix 4. Summary of moose survey results from the Haines Junction survey area, 1981 through 1990. NOTE: sightability correction factor has not been incorporated.

Population Characteristics	1981	1982	1983	1984	1990
Estimated Abundance (90% CI)			*[1]		
		**		**	
TOTAL moose	570±21%	351±26%	337±27%	329±20%	495±13%
Density (moose/1,000 km^2)	244	151	145	141	215
Estimated Composition (90% CI)					
Adult bulls (≥30 mo.)	100±29%	86±47%	78±41%	85±33%	112±17%
Adult cows (≥30 mo.)	294±20%	233±29%	240±30%	201±24%	223±16%
Yearlings (≥18 mo.)	57±41%	6	2	2	68±28%
Calves	119±37%	26±71%	17±55%	41±24%	93±17%
Observed Composition (numbers seen)					
Adult bulls	70	51	54	47	87
Adult cows	166	129	145	110	152
Yearlings	39	6	2	2	52
Calves	49	9	12	24	69
TOTAL	324	195	213	183	360
Observed Ratios					
Adult bulls/100 adult cows	42	40	37	43	57
Yearlings/100 adult cows	23	5	1	2	34
Calves/100 adult cows	30	7	8	23	45
Adult bulls/total population	22%	26%	26%	26%	24%
Adult cows/total population	51%	66%	60%	60%	42%
Yearlings/total population	12%	3%	1%	1%	14%
Calves/total population	15%	5%	6%	13%	19%
Twinning Rate	5-15%	0%	0%	0%	13%
Survey Characteristics					
Stratification					
Area (km^2)	2,305	2,305	2,305	2,305	2,305
Time (min.)	570	N/A	696	1,110	818
Search Intensity (min./km^2)	0.246	N/A	0.298	0.475	0.355
Moose Seen	382	192	N/A	210	250
Moose Seen/min.	0.670	N/A	N/A	0.189	0.306
Dates	Oct. 28-31	Nov. 1-5	Nov. 22-24	Nov. 19-27	Nov. 17-19

Continued ...

Appendix 4 continued

Census	1981	1982	1983	1984	1990
Area (km^2)	392	443	587	734	1,032
Percentage of Survey Area Searched	17%	19%	25%	31%	45%
Time	610	566	1,025	1,374	2,116
Search Intensity	1.556	1.278	1.727	1.872	2.050
Moose Seen	324	195	213	183	360
Moose Seen/min.	0.531	0.345	0.201	0.133	0.170
Dates	Oct. 30-Nov. 2	Nov. 6-9	Nov. 26-28	Nov. 28-Dec. 3	Nov. 21-26

1. * Not significantly ($P>0.05$) different, 2 Tailed Student t-Test.
   ** Significantly ($P<0.05$) different.


Yukon
Renewable Resources