MOOSE POPULATION RESEARCH AND MANAGEMENT STUDIES IN YUKON

SUMMARY OF YUKON MOOSE

POPULATION TREND SURVEY RESULTS

1988 and 1989

by

D.G. Larsen
and
R.M.P. Ward

PROGRESS REPORT 1990

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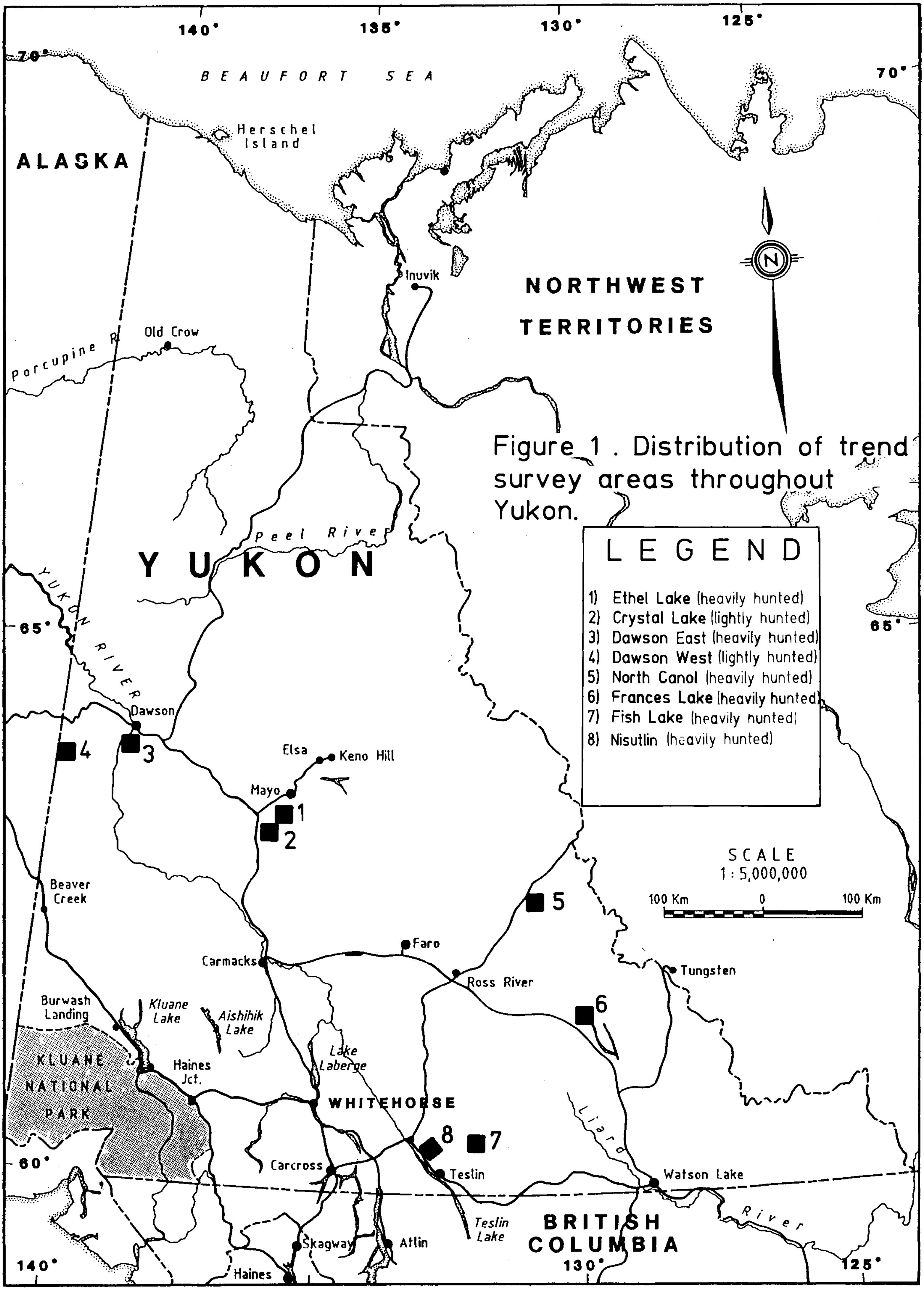
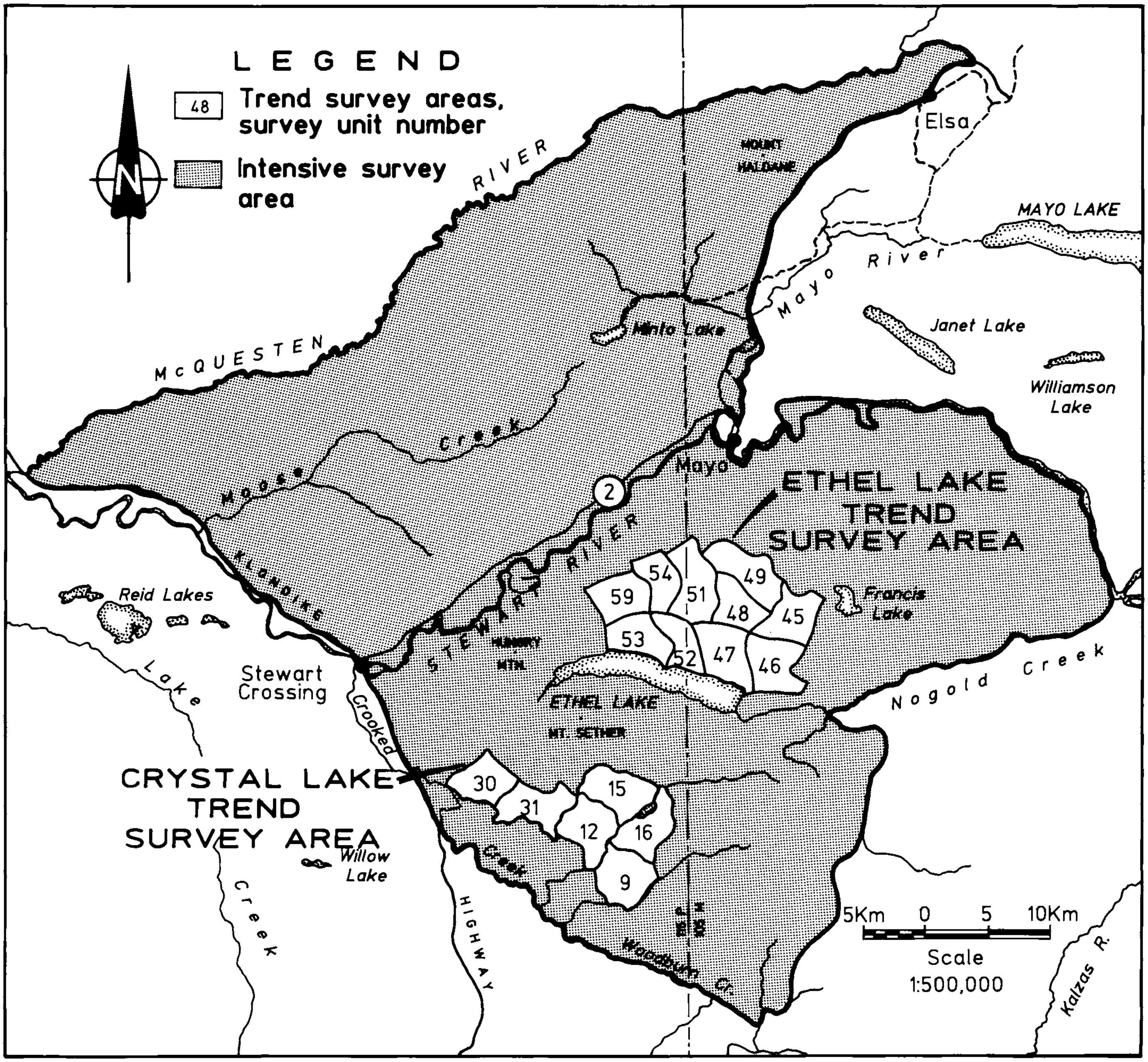
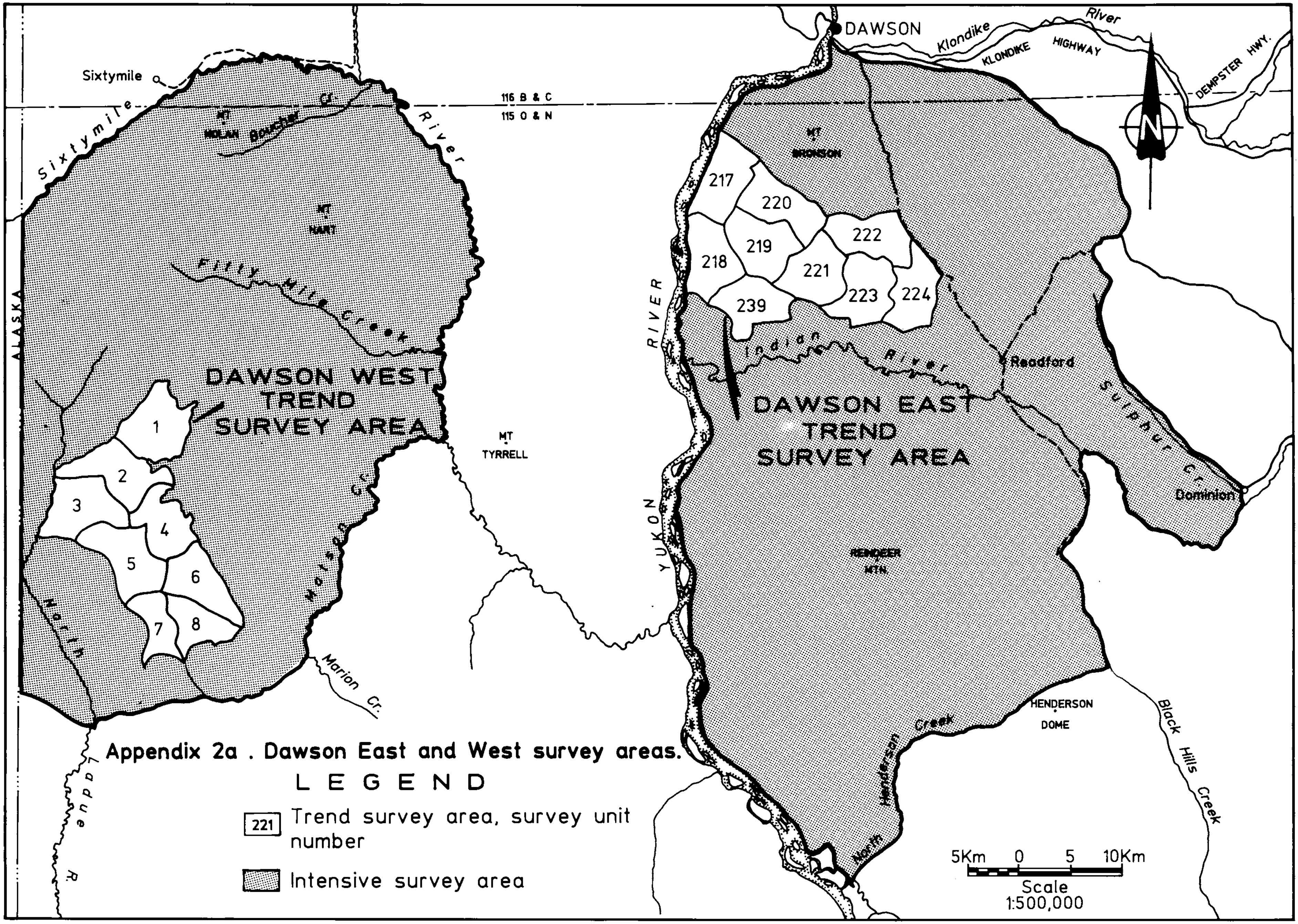


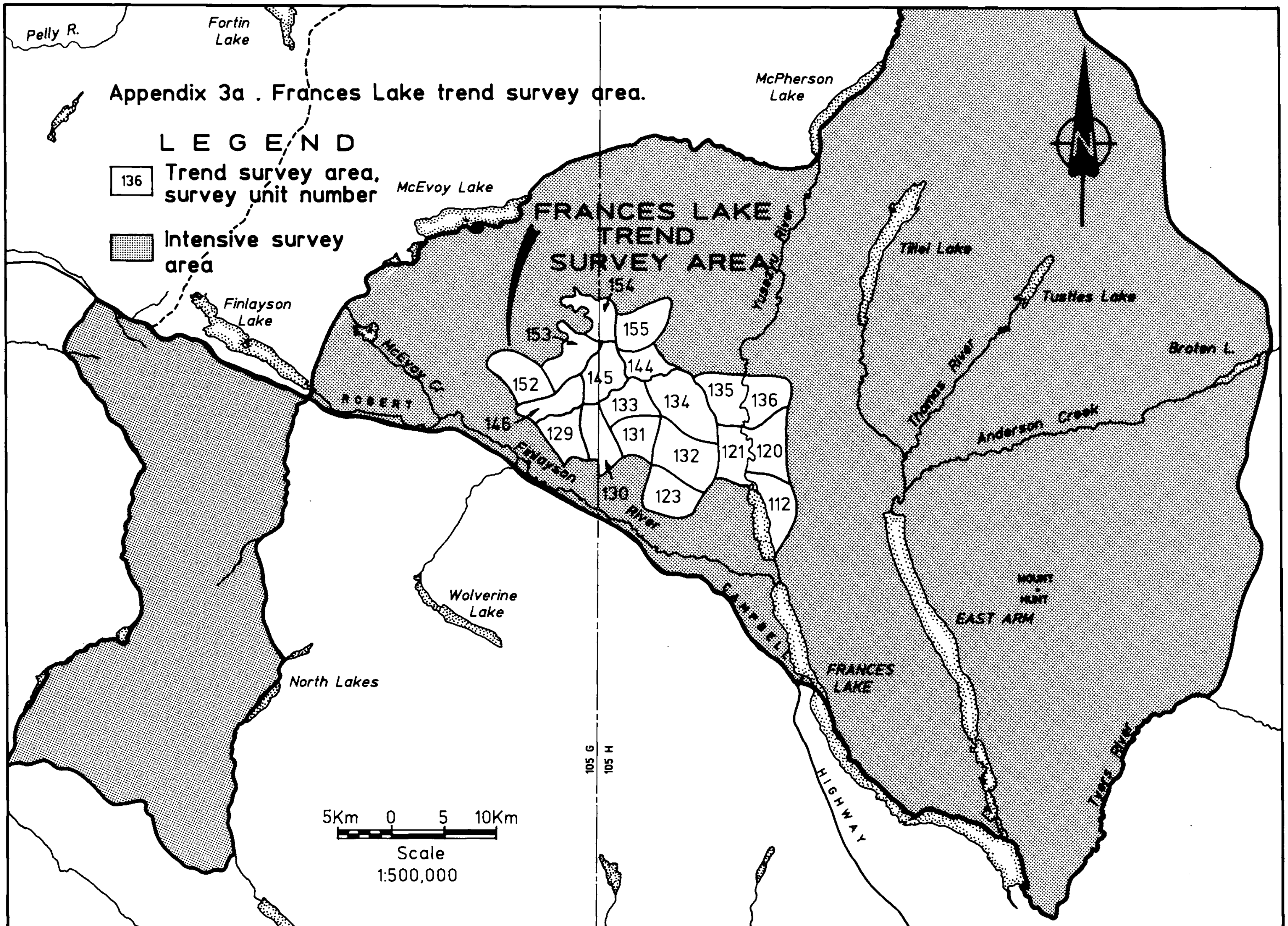
Figure 1 . Distribution of trend survey areas throughout Yukon.



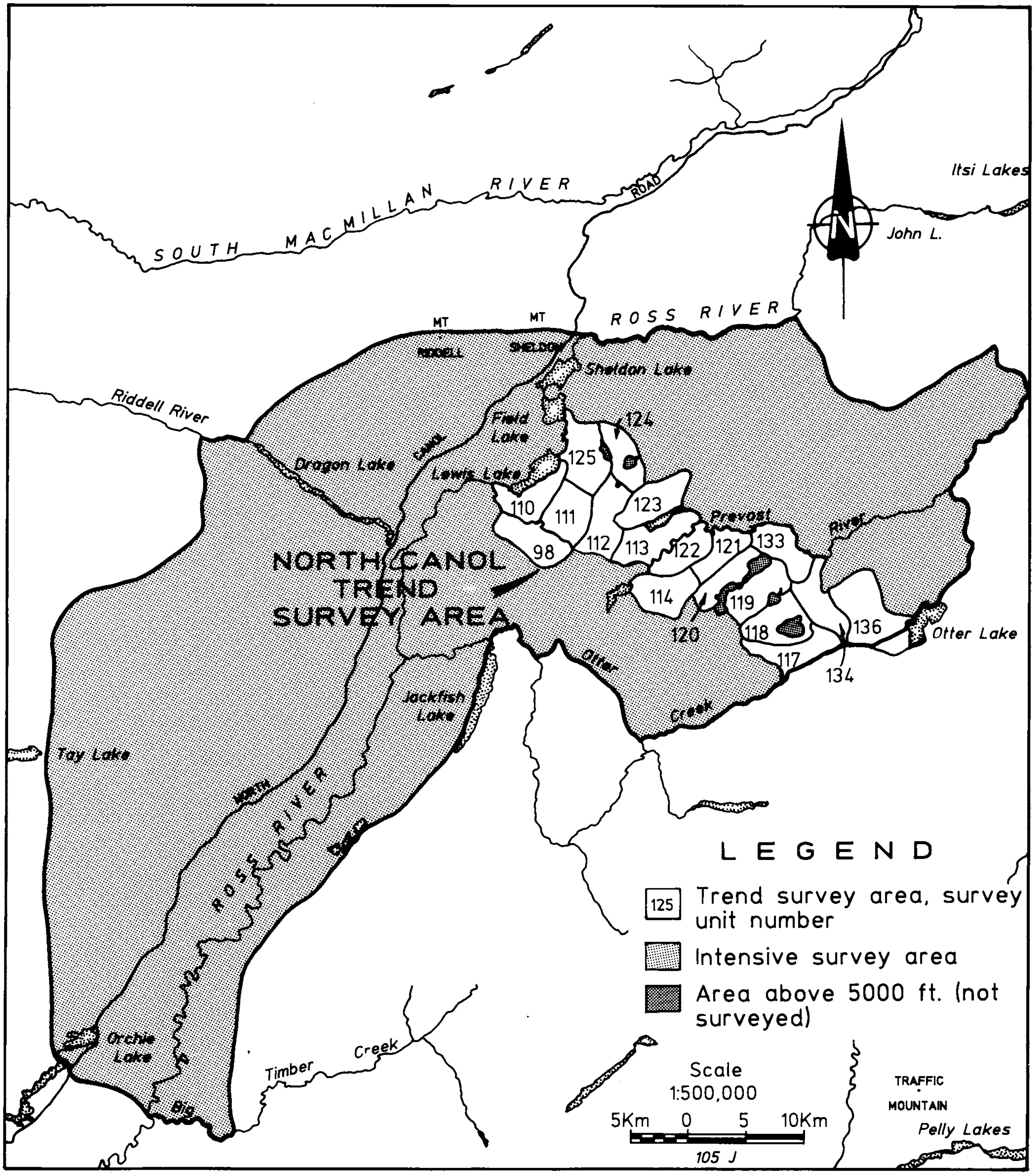
Appendix 1a . Mayo trend survey areas.



Appendix 2a . Dawson East and West survey areas.



Appendix 3a . Frances Lake trend survey area.



Appendix 4a . North Canol trend survey area.

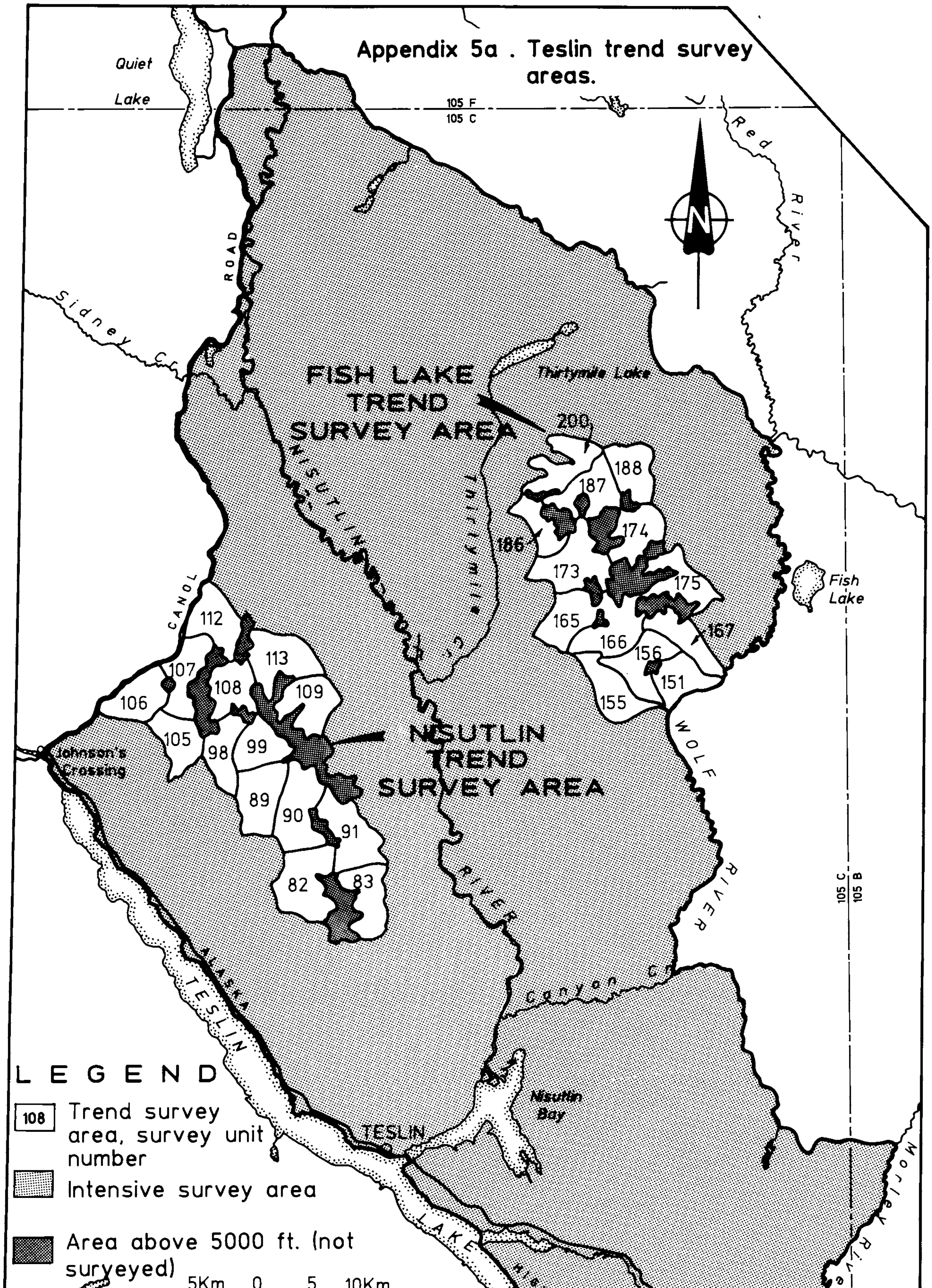

Appendix 5a . Teslin trend survey areas.
Quiet Lake
105 F
105 C
Red River
ROAD
Sidney Cr.
FISH LAKE TREND SURVEY AREA
Thirtymile Lake
200
188
187
174
186
173
175
Fish Lake
165
167
166
156
151
155
CANOL
112
113
107
108
109
106
105
98
99
NISUTLIN TREND SURVEY AREA
Johnson's Crossing
89
90
91
82
83
NISUTLIN
Thirtymile Cr.
RIVER
WOLF RIVER
105 C
105 B
Canyon Cr.
ALASKA
TESLIN
Nisutlin Bay
TESLIN
LAKE
HIGHWAY
Morley River
Morley Lake
LEGEND
108 Trend survey area, survey unit number
Intensive survey area
Area above 5000 ft. (not surveyed)
5Km 0 5 10Km
Scale
1:500,000

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TABLE of CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF APPENDICES CONTINUED

ABSTRACT

The results of the 1988 and 1989 moose population trend surveys are summarized. Two trend areas in the Mayo area (Ethel Lake and Crystal Lake) were established in 1988, with six additional areas established in the Dawson area (Dawson West and East), Ross River area (North Canol and Fances Lake) and Teslin area (Fish Lake and Nisutlin) in 1989. Poor weather conditions prevented flying in the Crystal Lake trend area in both 1988 and 1989, and in the Dawson West area in 1989.

Moose density and composition are compared between years (1988 and 1989) in the Ethel Lake area, however, there is insufficient data to draw any conclusions about trends at this time. All the areas had recruitment rates (percentage of 6 month and 18 month old moose in the population) indicative of stable or increasing moose populations. Some anomalies in composition data from Nisutlin, Fish Lake, and Ethel Lake were noted.

Insufficient data were available to evaluate if trends in density and composition within the trend areas reflect trends throughout the region. Recommendations have been made to test this potential bias. Other potential biases in survey technique have been noted. Some variables should be tested (i.e. time of year and time of day of the survey, and variability between standardized surveys) while other potential biases should be dealt with by standardizing the survey technique between years and within survey areas (i.e. type of aircraft, observer and pilot experience, search intensity, search patterns, air speed, and altitude).

INTRODUCTION

Prior to the establishment of moose population trend surveys in 1988, moose population size was determined in priority moose areas throughout the Yukon approximately once every five to ten years using intensive stratified random block techniques (Larsen 1982, Gasaway et al. 1986). At this survey frequency it was unlikely that a population decline would be detected in the early stages. As a result, populations could decline to very low numbers before being detected, and would require drastic management actions to rebuild. To this extent, moose management in Yukon was by necessity reactive rather than adaptive.

The need for more immediate information on moose populations was especially apparent in areas where moose were subject to high levels of predation, hunting, and land-use activities. Trend surveys were implemented in order to gather this more immediate data. In addition to monitoring moose population fluctuations over time, trend surveys have the potential to examine the influence of hunting and industrial development on local moose population size and composition, and are therefore designed partially to accommodate regional differences between hunting and land-use activities.

In this paper, we table the results of moose density and composition in trend areas in 1988 and 1989. We also compare trend survey results between years (1988 and 1989) in the Ethel Lake area.

STUDY AREAS

Eight moose population trend areas have been established in the Yukon (Figure 1). The first two were created in the Mayo area (Ethel and Crystal Lakes) during the fall of 1988. (Appendices 1a and 1b) (Larsen et al. 1989). Six more trend areas were established during the fall of 1989, two each in Dawson (Dawson East and West), Ross River (Frances Lake and North Canol) and Teslin (Fish Lake and Nisutlin)(Appendices 2 through 5). Ethel Lake and Dawson east trend surveys were flown concurrently with regional survey in those areas. Each trend area is composed of 9 to 19 sample units prescribed for the regional moose census, and encompass approximately 250 to 350 Km^2. Descriptions of the climate, topograghy and habitat can be found in Oswald and Senyk (1977) as well as the census reports for each area (Jingfors and Markel 1987, Jingfors 1988, Larsen et al 1989, and Larsen and Ward in prep.).

METHODS

Trend surveys were flown in areas of 250 to 350 km^2 using a Piper supercub (PA 18), Maule or similar aircraft with a single observer. The entire area was searched at an intensity of about 2 minutes per km^2. Trend surveys were flown in fall (late October and November) when snow was on the ground and while moose were still in their post-rut aggregations typically in open habitat. Flights were made at an altitude of 60-90 m AGL and an airspeed of approximately 95 km/h. Search patterns consisted of overlapping circles in areas where concentrations of moose normally occur such as alpine cirques, subalpine shrub zone, and along creeks. On flatter terrain parallel and overlapping transects are flown. When moose were observed, regardless of terrain, they were circled to determine if there were other moose in the area.

The sample units (s.u.) within the trend area were plotted on 1:50,000 topographic maps; these maps were used to navigate during the survey. Once the boundaries for the unit were identified, flight lines were flown to provide complete coverage within each unit. The pilot acted as navigator while the observer counted and recorded observations.

The location, age, and sex of individuals in the group were recorded on topographic maps. Age was recorded as calf (6 months), yearling bulls (18 months) or adult (=> 30 months) based on size, facial dimensions and antler characteristics. It was not possible to distinguish yearling cows from adult cows. We assumed that the sex ratio of yearlings is equal. Therefore, the estimated number of yearling males is (a) doubled to estimate the total number of yearlings, and (b) subtracted from the total number of cows to calculate the number of mature cows (=> 30 months) in the sample. Sex was determined on the basis of the presence or absence of antlers, antler scars or a vulva patch.

RESULTS

The results of each trend survey are discussed in the following sections. A summary of the 1988 and 1989 results are presented in Table 1 with details by sample unit in Appendices 1 through 5. Appendix 6 has a breakdown of the 1989 survey cost.

MAYO

Ethel Lake: The Ethel Lake trend area was surveyed in late November 1988 and 1989 (Appendices 1a and 1b). Search intensity was similar in 1988 and 1989, averaging 1.99 (S.E.= 0.10) and 1.82 (S.E.= 0.09) minutes/km^2, respectively (Table 1). Total moose seen on the trend surveys declined from 83 to 70, from 1988 to 1989, a decline in density from 0.30 to 0.25 moose/km^2. Moose were seen at a rate of 1 moose every 6.5 min. survey time/in 1988, and every 7.2 min. in 1989 (Table 1).

Moose distribution within the trend area was similar between 1988 and 1989. Of the 10 s.u.'s in the trend area in 1988, 4 were rated as having a high number of moose (16-22 moose/s.u.) and 6 were rated low (0-3 moose/s.u.). In 1989, the same 4 s.u. were rated high (12-20 moose/s.u.) and the same 6 s.u. were rated low (0-2 moose/s.u.)(Appendix 1b).

The proportion of calves in the population remained constant at 20% in both years (Table 2). The ratio of calves/100 mature cows changed from 59 in 1988 to 70 in 1989. The percentage of yearlings increased from 10% (N=8) in 1988 to 31% (N=22) in 1989. Note that the number of yearlings in 1989 exceeds what would have been expected even with 100% survival of the previous years calf crop (Table 1). The number of large bulls/100 mature cows declined from 100 to 70 from 1988 to 1989.

The Ethel Lake trend area was surveyed twice in 1988. Thirty-one (31) moose were seen in the trend area during the regional survey and 38 were seen one week later in the trend area. Search intensity was similar during the regional (1.8 minutes/km^2) and trend (2.0 minutes/km^2) surveys.

Crystal Lake: Poor flying weather prevented the surveying of the Crystal Lake trend area in both 1988 and 1989.

DAWSON

Dawson East: A trend survey was flown in this area in December 1989 (Appendices 2a and 2b) at a search intensity of 1.9 minutes/km^2 (Table 1). Seventy moose (0.25 moose/km^2) were seen. Moose were seen at a rate of 1 moose every 7.7 min. survey time (Table 1). Mature cows were the most abundant group (44% of the population) followed by mature bulls (29%), calves (16%), and yearlings (11%)(Table 2).

This trend area was also surveyed twice in 1989. Once during the regional survey in late October and again six weeks later. Fewer moose were seen during the December survey compared to the October survey (70 vs 87). Search intensity was identical (1.9 minutes/km^2) during both surveys.

Dawson West: Weather prevented the completion of the Dawson west area trend survey during the fall of 1989.

ROSS RIVER

Frances Lake: A trend survey was flown in this area in early December 1989 (Appendices 3a and 3b). Ninety-five moose were observed for a density of 0.28 moose/km^2 (Table 1). Search intensity was 1.0 minutes/km^2, roughly half the recommended intensity. Moose were seen at a rate of 1 moose every 3.7 min survey time (Table 1). Mature cows represented the most abundant group (44%), followed by calves (31%), mature bulls (15%), and yearlings (11%)(Table 2)

North Canol: A trend survey was flown in this area in early December, 1989 (Appendices 4a and 4b). Forty moose (0.13 moose/km^2) were observed (Table 1). Search intensity for the trend survey was 1.1 minutes/km^2, again roughly half the recommended intensity. Moose were seen at a rate of 1 moose every 8.9 min survey time (Table 1). Mature bulls and cows represented the most abundant groups (38% and 35%, respectively), followed by calves (18%) and yearlings (10%)(Table 2).

TESLIN

Fish Lake: A trend survey was flown in the Fish Lake area in late November, 1989 (Appendices 5a and 5b). A total of 45 moose (0.19 moose/km^2) were observed (Table 1). The average search intensity was 1.1 minutes/km^2, again roughly half the intended intensity. Moose were seen at a rate of 1 every 6.1 min survey time/moose (Table 1). Mature bulls represented the largest group (49%), followed by mature cows (20%), yearlings (18%), and calves (13%) (Table 2).

Nisutlin: A trend survey was flown in this area in late November, 1989 (Appendices 5a and 5b). A total of 24 moose (0.08 moose/km^2) were observed (Table 1). The search intensity was 1.0 minutes/km^2, once again only half the intended intensity. Moose were seen at a rate of 1 moose every 11.0 min survey (Table 1).

As with the Fish Lake area, mature bulls represented the largest group (50%), followed by yearlings (33%), mature cows (13%), and calves (4%) (Table 2).

DISCUSSION

Trend Survey Procedure

The 1988 and 1989 trend surveys were the first to be flown in the Yukon. Trend surveys are designed to meet the following criteria:

1. They must be conducted frequently; every year or every other year.
2. They must be economical. The 1988 and 1989 surveys were economical at an average cost of about three thousand dollars per area. This is approximately 3% of the cost of a regional survey.
3. They must reflect the temporal trends in population density and composition which occur within the region which they occur. Currently, there is insufficient data for this to be determined. This cannot be assessed until subsequent regional surveys are flown and trends in the region are compared to trends in the trend area.
4. They should be large enough to accommodate annual and periodic variations in moose distribution. The annual variation in moose distribution, relative to the trend area has not been determined. We have attempted to minimize this potential bias by using large continuous survey blocks (250-350 km^2) and survey the entire area within 2-4 days. The variation in distribution over longer periods of time are difficult to predict.

On a more localized scale, distribution within the Ethel Lake trend area did not change between 1988 and 1989. In fact, individual s.u.'s had approximately the same number of moose in both years. If distribution was similar relative to the small s.u.'s within this trend area, we could expect distribution to be similar relative to the trend area within the region.

5. They must provide an adequate sample of moose as small sample sizes could lead to erroneous conclusions. We believe the number of moose observed in the Ethel Lake (70), Dawson east (70), and Frances Lake (95) trend areas constituted a sufficiently large sample size. The remaining trend areas, however, have insufficient sample sizes ($\leq$45). In areas of low moose densities (<200 moose/1,000 $km,^2$) trend areas will need to be proportionately larger (up to 500 km^2). Small sample sizes were suspected to be a confounding factor in the Ethel Lake, North Canol, Fish Lake, and Nisutlin trend areas.

6. Sampling errors should be minimized to allow accurate comparisons between years. Trend survey results and thus comparisons between years, can be profoundly affected by the technique used to obtain them. Variations in survey area, search intensity, search patterns, altitude and air speed, pilot and observer experience, type of aircraft, time of day, and time of year could all affect the results. These potential biases can be dealt with either by measuring the variability associated with differences in the technique and adjusting the results accordingly, or by standardizing the

technique between surveys. We assume that standardized procedures, especially high search intensities between areas and years, will result in high observability and thus low variability in the number of moose seen. However, if other aspects of the technique are consistent between surveys, the biases should also be consistent. As a result, trends should be unaffected by these potential biases.

We attempted to be consistent in our survey techniques between years and areas, however, we were unsuccessful in meeting all the standards. First, search intensity in the Frances Lake, North Canol, Fish Lake, and Nisutlin trend areas were approximately half (1.0 min/km^2) the recommended level. Secondly, an additional aircraft (Maule) was brought in towards the end of the survey period in 1989 as weather prevented completion of all trend areas with the super cub within the preferred November time period. And lastly, surveys in the Dawson East, Frances Lake, and North Canol trend areas were flown later than the preferred time period.

The reduced search intensity in the above areas may have effected the number of moose seen. Gasaway et al (1986) determined that a optimum search intensity in similar habitats in Alaska, and using the same technique was between 1.5 and 2.0 minutes/km^2, with proportional fewer moose seen at lower intensities. Therefore, moose densities where likely underestimated in the above trend areas. An under-estimation of moose numbers could in turn lead to small sample sizes which may have been biased.

The differences in observability between observers in a supercub and Maule have not been tested, however we would expect the effects to be minor if search intensity was consistently high. In our opinion, the supercub is the preferred aircraft for this type of survey, however, the availability of supercubs and experienced pilots in the Yukon is currently limited.

The potential effects of conducting trend surveys in December are three fold. First, post-rutting groups are more dispersed than in November (Larsen 1982), making it difficult to obtain an adequate sample size. Secondly, large bulls start dropping their antlers towards the end of November, making it difficult to determine sex. Thirdly, light conditions deteriorate rapidly in December, thus limiting the number of flying hours in a day, and prolonging the survey. A prolonged survey could result in double counting or missing moose due to movement between surveyed and unsurveyed areas.

Our results suggest that trend surveys must be flown at the same time of year in order to obtain comparable information. Replicate surveys in the Ethel Lake trend area yielded similar counts when surveys were repeated within 1 week, however, replicate surveys in the Dawson East trend area were dissimilar when surveys were repeated 6 weeks apart. Considerable movement likely occurs at this time of year as post-rut aggregations start breaking up in November (Larsen 1982). Differences of more than a few weeks between annual trend surveys may invalidate comparisons between years.

We suspect yearling bulls may have been misidentified in some trend areas in 1989. Yearlings are difficult to identify as considerable overlap in antler characteristics occurs between yearlings and 2 and 3 year olds (Gauthier and Larsen 1985, Gasaway et al 1987). Incorrect classification can have drastic effects on composition results, especially when dealing with small sample sizes.

Most of the potential biases associated with our survey technique will be dealt with in the future by standardizing survey procedures. However, it will be impossible to adhere to all procedures due to one uncontrollable factor, weather. Both the time of year (i.e. month) and the time of day will likely vary between surveys. In addition, variability in the number of moose seen may occur between surveys even though procedures are standardized. These potential biases should be tested.

We reported on an anomaly in calf and yearling numbers from the Ethel Lake area between 1988 and 1989. The number of yearlings in 1989 could not be accounted for by the number of calves the previous year, even if there was a 100% survival of calves over that time period. This discrepancy could have been caused by several factors. Yearlings may have moved into the trend area from adjacent habitats, mature bulls (2 and 3 year olds) could have been misidentified as yearlings, or it may have simply been the result of incomplete sampling. Whatever the cause, this example points out some of the difficulties in interpreting trend data and emphasizes the need for standardized techniques and a measure of variance.

7. To compare changes between the two areas in order to correlate hunting intensity and industrial development to changes in moose population size and composition, surveys should occur in pairs. We assume that all other factors are equal between the control and experimental areas. We were unable to assess the effects of hunting or development in any of the trend areas, as not all trend areas were surveyed in 1989, surveys were not conducted in pairs due to financial constraints and weather and only one years information was collected in others.

Application of trend surveys to moose management

Trend surveys are designed to monitor relative changes in moose density and composition in a localized area. The trends in these areas will hopefully represent trends over a much larger area. If they do, the question remains as to when and how do we use the trend information to manage moose populations. The following points should be considered.

Trend results should initially be used only as indices to changes in the regional population. They should not replace regional surveys. Once we are confident that trend results represent regional trends, the regional surveys may be eliminated or flown less frequently.

In most cases, management recommendations should not be made until three years of trend results have been collected from an area. This, in turn dictates a three-year schedule for regulation changes. Exceptions to this schedule would occur in areas which show drastic changes in recruitment and density, if those changes could be collaborated by changes in hunting levels (e.g. new road access), or enhancement programs (e.g. predator control).

Trend results could be used to set sustainable harvest levels, by adjusting the harvest until population indices stabilize at a desired level. However, it may be difficult to calibrate harvest to population dynamics. A more proactive approach would be to periodically determine sustainable harvest through intensive regional surveys and use trend surveys to monitor annual changes which occur between regional surveys.

Both recruitment and density indices should be used to make management decisions. Recruitment (6 mo. and 18 mo. old moose) expressed either as a ratio per 100 mature cows or as a proportion of the total population is the first indication of subsequent changes in density. Recruitment data, especially dramatic changes in recruitment rates, should be used initially to recommend harvest restrictions or proposed enhancement programs. Recruitment rates are, however, only an indices to changes in moose population size. Density estimates are required to verify these changes as well as to calculate sustainable yield.

Moose composition and density within the trend areas currently may not represent the regional population. In order to obtain a sufficient sample size during the trend survey, medium and high density areas have been selected. Medium and high density strata, in areas surveyed throughout the Yukon in early winter, constitute approximately 10-20% of the habitable moose range and support an estimated 2/3 to 3/4 of the moose population. Because our trend areas are a sample of the medium and high strata, they are by design not representative of the regional population density. Also, composition within the trend areas is likely biased. Cows with calves are commonly under-represented and mature bulls over-represented in high density areas (Larsen 1982). Because of these known biases, trend survey results should only be used to monitor relative changes in density and recruitment rather than to represent regional density and recruitment.

Keeping this limitation in mind, the 1988 and 1989 composition data suggests that survival of calves to 6 months and 18 months of age was relatively good in all trend areas. As discussed above, calf recruitment is likely under-represented in our results, therefore, recruitment throughout the region could be even higher than we have recorded for the trend areas. Some anomalies exist (i.e. yearlings in Ethel Lake, Fish Lake, and Nisutlin in 1989). The number of calves and yearlings in all areas is indicative of a stable or increasing moose population.

RECOMMENDATIONS

1. The precision of trend surveys to estimate changes in density and composition within the region must be evaluated. This should be done by comparing trends in the trend area to trends in the region. Trend surveys should be scheduled in areas in which regional surveys are planned. In this way, trend surveys could be tested without jeopardizing the regional survey program. Regional surveys are tentatively scheduled for the southeast Yukon in 1990, Finlayson area (Francis Lake and North Canol) 1991, Nisutlin River area in 1992, and possibly Mayo in 1993.

   The southwest Yukon and Finlayson areas are best suited for a regional comparison as changes in both trend and regional moose densities and composition are anticipated as a result of predator control programs (s.w. Yukon program is tentative).

   We recommend that only one trend area be flown in each region. Currently, trend areas occur in pairs, however, due to anticipated budget restraints over the foreseeable future, and the need for trend areas in other regions, trend areas should be limited to one per region. Additional trend surveys could be added to other regions once the technique has been tested and depending on budgets and program prioritizations.

2. We recommend maintaining a minimum trend area size of 250 km^2 in order to minimize potential biases due to annual and periodic variation in moose distribution. The extent of this potential bias can be assessed in the future by comparing changes in distribution within trend areas (through replicated trend surveys) and within the region (through regional survey), in relation to the trend area.

3. Maintain a minimum sample size of 70 moose (between 200-250 moose/1,000 km^2) within a trend area. The North Canol, Fish Lake, and Nisutlin trend areas had less than 45 moose. If these areas are flown in the future, we recommend increasing the sample size in the former two areas by increasing the search intensity to 2.0 min./km^2. Surveys in both areas were conducted at 1.1 min./km^2 in 1989. The Nisutlin sample size should be increased by increasing search intensity, as well as, the area surveyed.

4. We recommend testing for variability in the time of year (end of October to the 1st week in December), and time of day of the survey. Also, we recommend that the variability between standardized surveys be evaluated. All three potential biases could be tested through replicate surveys. Variation due to the time of year would be determined by flying the same trend area at various time periods within the same year e.g. late-October, mid-November, early December. Variation due to the time of day would be determined by

repeated flights over selected s.u.'s at various times of the day. Variability between standardized surveys will be tested through replicate surveys of the same trend area. Three surveys should be flown back to back with the same survey crew. These tests should be carried out by experienced pilots and observers within the southwest Yukon in 1990.

We recommend that other potential biases in survey technique, i.e. search intensity, search patterns, altitude and airspeed, pilot and observer experience, and type of aircraft, be kept consistent between years to eliminate potential variation due to these factors.

Whenever possible, supercubs should be used to fly trend surveys. If there is an insufficient number of supercubs available, a Maule or similar aircraft would be acceptable. Because of problems experienced in completing the 1989 trend surveys, we recommend that there be at least one aircraft for every three trend areas.

We recommend that the local conservation officers continue to be used as observers. Optimum survey periods should be identified to the conservation officers well in advance so they may commit their time.

We also recommend that in the future, observers receive a more thorough briefing on how to distinguish between 1, 2, and 3-year old bulls.

This could be accomplished by viewing antlers of known aged moose currently being collected, as well, videos of bull moose could be taken during regional surveys.

ACKNOWLEDGEMENTS

We would like thank conservation officers Kevin Bowers, Tony Grabowski, Torrie Hunter, and Jack McClintock for acting as observers on the trend surveys. Their patience in repeatedly modifying their already overloaded work schedules in order to complete the surveys as weather permitted is greatly appreciated. Denny Dennison (Coyote Air) and Tom Hudgins (Aerokon Aviation) provided first rate flying support. Norman Barichello's review comments greatly improved the paper.

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TABLE 1. Moose seen on trend surveys in 1988 and 1989.

SURVEY AREA	AREA (KM^2)	DATE	SEARCH INTENSITY (MIN./KM^2)	SURVEY TIME/MOOSE SEEN (MIN.)	COWS (≥18 mo)	CALVES	YEARLING BULLS[a]	MATURE BULLS (≥30mo)	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY (MOOSE/KM^2)
Ethel Lake	274.7	Nov 26 - Dec 2, 1988	2.0	6.5	33	17	4	29	83	0.29
		Nov 21-29, 1989	1.8	7.2	31	14	11	14	70	0.25
Dawson East	278.9	Dec 6-9, 1989	1.9	7.7	35	11	4	20	70	0.25
Francis Lake	346.5	Dec 3-5, 1989	1.0	3.7	47	29	5	14	95	0.28
North Canol	317.6	Dec 2-3, 1989	1.1	8.9	16	7	2	15	40	0.13
Fish Lake	249.1	Nov 21-22, 1989	1.1	6.1	13	6	4	22	45	0.19
Nisutlin	257.3	Nov 28-29, 1989	1.0	11.0	7	1	4	12	24	0.08

a. The number of yearling cows were assumed to equal yearling bulls, therefore, total yearlings = 2 x yearling bulls.

TABLE 2. Moose ratios from trend surveys.

SURVEY AREA	YEAR	PERCENTAGE MATURE COW	PERCENTAGE MATURE BULLS	PERCENTAGE YEARLINGS	PERCENTAGE CALVES	MOOSE/100 MATURE COWS ($\geq$ 30 mo.)		
						CALVES	YEARLINGS	MATURE BULLS
Ethel Lake	1988	35	35	10	20	59	28	100
	1989	29	20	31	20	70	110	70
Dawson East	1989	44	29	11	16	35	26	65
Francis Lake	1989	44	15	11	31	69	24	33
North Canol	1989	35	38	10	18	50	29	107
Fish Lake	1989	20	49	18	13	67	89	244
Nisutlin	1989	13	50	33	4	33	267	400

APPENDIX 1b. Ethel Lake Trend Area Results, November 26 to December 2, 1988 and November 21 to 29, 1989.

SAMPLE UNIT	AREA (KM^2)	YEAR	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEAR-LING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
45	26.2	1988	2.4	62	0	1	0	0	1	3	0.11
		1989	1.5	40	0	0	0	0	0	0	0.00
46	32.9	1988	2.1	68	6	3	0	2	8	22	0.67
		1989	1.7	57	1	2	2	3	5	19	0.58
47	29.5	1988	2.2	64	2	6	0	0	7	21	0.71
		1989	2.4	71	4	2	0	3	5	16	0.54
48	23.4	1988	1.8	42	3	4	0	1	4	16	0.68
		1989	1.7	40	8	3	0	3	3	20	0.85
49	31.5	1988	1.6	49	0	0	0	0	0	0	0.00
		1989	1.4	44	0	0	0	0	0	0	0.00
51	29.7	1988	2.0	60	5	3	0	1	5	17	0.57
		1989	2.0	59	5	1	1	2	0	12	0.40
52	25.1	1988	2.5	62	0	0	0	0	2	2	0.08
		1989	1.7	43	0	0	0	0	1	1	0.04
53	28.7	1988	1.7	49	0	0	0	0	0	0	0.00
		1989	1.9	55	0	0	0	0	0	0	0.00

APPENDIX 1b. Continued

SAMPLE UNIT	AREA (KM^2)	YEAR	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEAR-LING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
54	21.2	1988	1.5	31	0	0	0	0	0	0	0.00
		1989	1.9	41	2	0	0	0	0	2	0.09
59	26.5	1988	2.1	55	0	0	0	0	2	2	0.08
		1989	2.0	53	0	0	0	0	0	0	0.00
ALL SAMPLE UNITS	274.7	1988	2.0	542	16	17	0	4	29	83	0.29
		1989	1.8	503	20	8	3	11	14	70	0.25

APPENDIX 2b. Dawson east Trend Area Results, December 6 to 9, 1989.

SAMPLE UNIT	AREA (KM^2)	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEARLING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
217	32.6	2.0	65	2	2	0	0	0	6	0.18
218	31.1	1.8	55	1	0	0	0	0	1	0.03
219	30.5	1.7	52	1	1	0	0	1	4	0.13
220	33.2	2.0	65	3	2	0	0	1	8	0.24
221	29.8	2.1	64	4	1	0	0	6	12	0.40
222	30.1	2.0	61	3	0	0	0	3	6	0.20
223	31.3	1.9	60	1	3	0	2	0	9	0.29
224	29.2	2.0	59	0	2	0	1	3	8	0.27
239	31.1	1.9	60	9	0	0	1	6	16	0.51
ALL SAMPLE UNITS	278.9	1.9	541	24	11	0	4	20	70	0.25

APPENDIX 3b. Frances Lake Trend Area Results, December 3 to 5, 1989.

SAMPLE UNIT	AREA (KM^2)	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEARLING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
112	19.0	1.5	28	6	4	1	2	3	22	1.16
120	18.6	1.0	18	2	1	1	0	0	7	0.83
121	19.0	0.8	16	0	4	0	0	0	8	0.42
123	17.7	0.8	14	0	1	0	0	0	2	0.11
129	14.2	1.5	21	3	1	0	0	0	5	0.35
130	26.0	0.9	23	0	1	0	1	0	3	0.12
131	13.5	1.0	14	3	1	0	1	2	8	0.59
132	17.8	0.8	15	1	0	0	0	2	3	0.17
133	20.0	0.8	15	2	0	0	0	0	2	0.10
134	18.7	0.7	14	1	1	1	0	1	7	0.37
135	18.7	1.1	20	0	3	0	0	0	6	0.32
136	16.6	1.3	22	0	0	0	0	0	0	0.00
144	17.6	1.1	19	0	1	0	0	0	2	0.11
145	19.5	0.9	18	0	0	0	1	0	1	0.05
146	16.1	1.4	23	1	0	0	0	2	3	0.19
152	23.2	0.9	20	0	2	1	0	0	7	0.30

APPENDIX 3b. Continued

SAMPLE UNIT	AREA (KM^2)	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEARLING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
153	16.1	1.4	23	0	0	0	0	2	2	0.12
154	17.7	0.8	14	0	0	0	0	0	0	0.00
155	16.5	0.9	15	3	1	0	0	2	7	0.42
ALL SAMPLE UNITS	346.5	1.0	352	22	21	4	5	14	95	0.27

APPENDIX 4b. North Canol Trend Area Results, December 2 and 3, 1989.

SAMPLE UNIT	AREA (KM^2)	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEARLING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
98	18.7	0.7	14	1	0	0	0	0	1	0.05
110	16.2	1.2	20	0	0	0	0	0	0	0.00
111	18.6	0.8	15	0	0	0	0	0	0	0.00
112	17.3	1.4	25	0	0	0	0	0	0	0.00
113	15.5	1.4	22	2	0	0	0	2	5	0.32
114	16.3	0.9	14	1	2	0	0	2	7	0.43
117	16.9	1.0	17	2	0	0	1	4	7	0.41
118	16.9	1.2	20	0	0	0	0	0	0	0.00
119	18.7	1.1	20	0	1	0	0	0	2	0.11
120	15.8	0.8	13	0	0	0	0	0	0	0.00
121	16.8	1.1	18	0	0	0	1	1	2	0.12
122	15.8	1.3	20	0	0	0	0	0	0	0.00
123	17.3	0.9	15	0	0	0	0	0	0	0.00
124	16.8	1.5	26	0	0	0	0	0	0	0.00
125	19.3	1.2	24	0	3	0	0	0	6	0.31
133	18.1	1.0	19	1	1	0	0	4	7	0.39

APPENDIX 4b. Continued

SAMPLE UNIT	AREA (KM^2)	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEARLING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
134	18.1	1.3	23	1	0	0	0	1	2	0.11
136	24.5	1.7	41	1	0	0	0	1	2	0.08
ALL SAMPLE UNITS	317.6	1.1	366	9	7	0	2	15	40	0.13

APPENDIX 5b. Fish Lake Trend Area Results, November 21 and 22, 1989.

SAMPLE UNIT	AREA (KM^2)	SEARCH INTENSITY ($MIN./KM^2$)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEARLING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY ($MOOSE/KM^2$)
151	16.6	1.8	30	3	2	1	0	0	6	0.36
155	28.2	1.4	40	2	0	0	1	1	4	0.14
156	26.4	0.9	25	0	0	0	0	1	1	0.04
165	19.9	1.3	25	0	0	0	1	3	4	0.20
166	17.9	1.1	20	0	0	0	0	0	0	0.00
167	17.9	1.4	25	0	4	0	0	1	9	0.50
173	19.2	0.8	15	2	0	0	0	4	6	0.31
174	18.1	0.9	16	0	0	0	1	0	1	0.06
175	19.7	0.8	15	0	0	0	0	0	0	0.00
186	14.0	1.1	15	0	0	0	0	4	4	0.29
187	15.5	0.6	10	0	0	0	0	0	0	0.00
188	17.6	1.4	24	1	0	0	1	5	7	0.40
200	18.1	0.8	15	0	0	0	0	3	3	0.17
ALL SAMPLE UNITS	249.1	1.1	275	8	4	1	4	22	45	0.18

Appendix 5c. Nisutlin Trend Area Results, November 28 and 29, 1989.

SAMPLE UNIT	AREA (KM^2)	SEARCH INTENSITY (MIN./KM^2)	SEARCH TIME (MIN.)	LONE COWS	COWS WITH 1 CALF	COWS WITH 2 CALVES	YEARLING BULLS	MATURE BULLS	TOTAL MOOSE SEEN	TOTAL MOOSE DENSITY (MOOSE/KM^2)
82	21.2	1.3	27	2	1	0	0	9	13	0.61
83	19.4	0.8	15	0	0	0	0	0	0	0.00
89	20.2	1.2	25	1	0	0	3	1	5	0.25
90	18.9	1.6	30	1	0	0	0	0	1	0.05
91	18.6	0.8	15	0	0	0	0	0	0	0.00
98	14.8	1.4	20	0	0	0	0	0	0	0.00
99	15.0	1.0	15	0	0	0	0	0	0	0.00
105	19.2	1.3	25	0	0	0	0	1	1	0.05
106	21.2	1.2	25	0	0	0	0	0	0	0.00
107	19.4	0.9	18	1	0	0	1	1	3	0.15
108	15.8	0.9	14	0	0	0	0	0	0	0.00
109	18.6	0.5	10	0	0	0	0	0	0	0.00
112	17.4	0.6	10	0	0	0	0	0	0	0.00
113	17.6	0.9	15	1	0	0	0	0	1	0.06
ALL SAMPLE UNITS	257.3	1.0	264	6	1	0	4	12	24	0.09

APPENDIX 6. Summary of 1989 Trend Survey Costs.

SURVEY AREA	AIRCRAFT TYPE	CHARTER RATE	HOURS FLOWN	CHARTER COST	FOOD AND ACCOMMODATIONS	MISCELLANEOUS	TOTAL
Dawson East	Piper Supercub	128.00[1]	17.4	2,227.20	604.55	450.66[2] 460.80[3]	3,743.21
Ethel Lake	Piper Supercub	128.00[1]	15.1	1,932.80	825.00	385.81[2] 2,291.20[3]	5,434.81
Fish Lake	Maule M-7	200.00	8.2	1,640.00	--	--	1,640.00
Frances Lake	Maule M-7	200.00[1]	10.3	2,060.00	139.00	93.00[2]	2,292.00
North Canol	Maule M-7	200.00[1]	13.1	2,620.00	139.55	102.00[2]	2,861.55
Nisutlin	Maule M-7	200.00	7.3	1,460.00	--	--	1,460.00
TOTAL			71.4	11,940.00	1708.10	3783.47	17,431.57

1. plus fuel costs
2. fuel costs
3. tariff charges for daily minimums not flown

Yukon

Renewable Resources