Inventory of Yukon's Wolf Lake Caribou Herd

Yukon
Renewable Resources

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Final Report

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ABSTRACT

Studies of the Wolf Lake caribou herd were carried out between September 1984 and March 1987 when observations were made of caribou movement and distribution patterns, demography, and range condition. A total of 13 caribou (12 female and 1 male) were radio-collared on various seasonal ranges and subsequent aerial surveys found a home range boundary that comprises game management subzones 10-10, 10-13, 10-14, 10-16, 10-21, 10-23 to 10-26, and the western one-half of 10-27 and 10-28. The population size and composition of the herd was estimated using the stratified random quadrat method in March 1987. The herd numbered 664 $\pm$ 159 caribou at the 90% confidence level. Recruitment of 10 month old calves was 17% of herd numbers (28 calves/100 females) and the sex ratio was heavily skewed against males who represented only 22% of adult proportions. Comparison with neighboring herds indicate that very unbalanced sex ratios are common for southern Yukon and northwestern British Columbia populations and likely the product of natural predation rates. The adult natural mortality rate was derived from the death rate of collared caribou and was 9.8%. The harvest from the herd as estimated from the Yukon hunter questionnaire analysis and guide returns has averaged 7.1 caribou over the last 9 years. Analysis of plant composition from fecal samples during late winter indicate a diet typical of caribou inhabiting a forested environment and appears adequate in terms of nutritional quality. But snow conditions on the winter range, as assessed by snowdepth measurements during late winter, may be preventing caribou from ingesting maximum amounts of forage during that period. The condition of the winter range is not thought to be limiting the herd at its present density and the herd is increasing slowly. The implications of this study are that the herd be allow to proceed on its natural course by restricting hunting to 2% of the population size, and closing areas of herd range that become accessed by newly constructed mining roads. To evaluate the effectiveness of this management scheme, a population estimate is recommended for 1993 or 1994.

INTRODUCTION

Without data on population demography, woodland caribou herds cannot be adequately managed and thus should not be hunted. In those cases where inventory information is lacking, harvest should be restricted until an allowable yield can be validated. For the present in is the other way around in much of Yukon, and harvests are often permitted in the absence of justifying data. Hence, the Department of Renewable Resources is conducting a systematic inventory of Yukon's woodland caribou herds. Of perhaps 23 herds, 11 have been studied to date. As part of this program, we present the findings from the inventory study of the Wolf Lake caribou herd, conducted between September 1984 and March 1987.

The Wolf Lake herd (WLH) was first identified through anecdotal accounts and other wildlife surveys. Pilots flying in the area reported numerous caribou observations in the Wolf Lake lowlands during winter, where caribou have historically wintered. A resident of Wolf Lake between 1890 and 1966, Tommy Peters of Teslin, recalled that caribou were always plentiful during winter and their numbers were greatest in 1930 (letter on file). More recently, while conducting field investigations for a proposed ecological reserve, Geist et al. (1974) reported that caribou was the second most abundant ungulate in the Wolf Lake area after moose. They suggested that caribou probably numbered less than 500 animals. A sheep and goat inventory survey east of the Wolf Lake lowlands, and within the northern Cassiar Mountains, found substantial numbers of caribou inhabiting that area during summer (Lortie et al. 1978). It was speculated that these caribou were from the Wolf Lake winter range. In general, trappers, hunters and prospectors, who had made extensive travels over the Wolf Lake-northern Cassiar region, report that caribou numbers have declined within the last 10 years (E. Leach, D. Smarch, D.Taylor, D. McIntosh, and G.Toole, pers. comm.).

Recent mineral exploration and extraction developments in the northern Cassiar Mountains have improved access to WLH caribou. As a result, the information provided by this study is necessary for preventing a potential overharvest of caribou, or conversely, avoiding unnecessarily restrictive management options.

Our inventory approach is designed to measure three key parameters essential for management:

1.Seasonal Movements and Distribution- an understanding of the WLH range use pattern is essential to delineating the area where management actions and later inventory will apply solely to this herd. Identification of important caribou environments (i.e. movement corridors, calving sites, core wintering areas) is also necessary for providing input to land management practices designed to conserve these key habitats.

2.Herd Demography- assessment of WLH population characteristics (herd size, composition, natural mortality rates, and harvest) is necessary for setting harvest limits, and maintaining caribou numbers at prescribed levels.

3.Range Condition- winter range quality and winter severity are important factors influencing caribou productivity and

mortality. A crude evaluation of winter range condition can be made by comparing the late winter diet to food availability (snow depth) to evaluate herd potential, as dictated by its environment.

Because winter range is the most confined locality where all individuals from a particular herd can be found, it is the focal point for woodland caribou. It should be noted here that for management purposes we define a woodland caribou herd as: 'those caribou occupying a common winter range'. While woodland caribou occupy a continuous distribution across Yukon, past studies have shown that herds are largely discrete and should be managed individually (Farnell and Russell 1984, Farnell and McDonald in prep.a.). We therefore use the terms 'herd' and 'population' interchangeably recognizing that some genetic exchange is possible. It is our belief that movements between herds is a rare event at present densities.

STUDY AREA

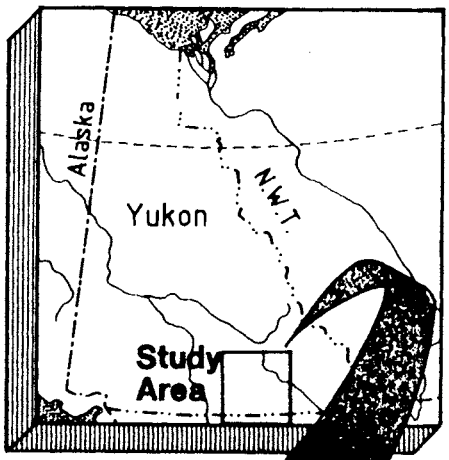
As investigations progressed, the study area was expanded until it encompassed the range of the WLH. The study area is located north of the Yukon/British Columbia border in the southeastern Yukon (Fig. 1). It includes the Cassiar Mountains in the east, the Englishman Range to the west, and a small portion of the Pelly Mountains to the north. The study area is approximately 11,200 km^2 (4,320 mi^2) in size.

Elevation ranges from 990 meters a.s.l. (3,250 feet a.s.l.) at lake levels to a maximum elevation of 2,133 meters a.s.l. (6,998 feet a.s.l.) in the Cassiar Mountains. The eastern half of the study area is drained by the Liard River and its tributaries (Meister, Upper Rancheria) and the western half is drained by the Yukon and its tributaries (Smart, Morley, Wolf). Treeline occurs at 1350 meters a.s.l. (4429 feet a.s.l.) to 1500 meters a.s.l. (4,922 feet a.s.l.).

The study area lies in the Pelly Mountains ecoregion (Oswald and Senyk 1977), where treeless tundra is common. According to Oswald and Senyk (1977) the lower elevations have white and black spruce/moss communities, warmer sites have white spruce/lodgepole pine, the subalpine have alpine fir, shrub/willow and alpine wetlands have sedge/tussock communities.

Moose (Alces alces) occur in low densities throughout the study area. A recent fall census found a density of 13 moose/100 km^2 occurring in the southwestern one-third of the study area (Jingfors and Markell 1987). Sparse numbers of Fannin sheep (Ovis dalli) occur in scattered groups across the Cassiar Mountains (Lortie et al. 1978). The density of wolves in the study area is similar to that found for undisturbed wolf populations elsewhere in central and southern Yukon (Hayes and Bowers 1987). A wolf population survey in the northern one-half of the study area found a density of 9.3-10.5 wolves/1000 km^2 (57-64 wolves) in winter 1985 (Hayes and Bowers 1987), and wolf abundance is likely uniform across the study area.

Fig 1: The Wolf Lake Study Area



Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres

METHODS

SEASONAL MOVEMENTS AND DISTRIBUTION

Capture and Radio-collaring

The net-gun capture method (Barret et al. 1981) was used to capture and radio-collar caribou. Caribou were captured at various locations during fall, winter and summer to reduce the possibility of individual seasonal movement and distribution biases. There is increasing evidence that individual woodland caribou remain loyal to particular seasonal ranges, (Farnell and Russell 1984, Hatler 1986, Brown and Theberge 1985, Edmonds and Bloomfield 1984, Farnell and McDonald in prep. a) we therefore assumed that caribou collared on summer ranges would subsequently reveal the location of the herd's winter range. These individuals will likely return to the same summer range each year. To view the herd's entire seasonal range use pattern, requires that caribou also be collared on the winter range. Subsequent relocations over time should demonstrate all or most annual movements and distributions of the herd.

Finances limited capture and radio-collaring to 13 caribou (1 male and 12 females). More females were selected than males since females yield an understanding of calving areas. Females also retain collars better than males because neck expansion and contraction in males during the breeding season often leads to shed collars.

Radio-collars were constructed of heavy machine belting to which hermetically sealed transmitters were attached. All radios contained movement sensitive mortality switches (Telonics Inc., Mesa, Arizona). To aid resightings, a highly visible vinyl covering was sewn to each radio-collar.

Distribution Surveys

Four life cycle periods were selected for relocation surveys: late winter (February-March), calving (June), post-calving (July), and rut (October). In all there were 9 relocation surveys flown between June 1985 and March 1987 (Appendix A). These surveys were flown at high altitude (3000 to 4500 meters a.s.l.) as transects over the entire study area for all periods except late winter. During late winter, surveys were confined to the Wolf Lake lowlands. When relocated, a signal was circled at high altitude and pinpointed within 7 km^2 on 1:250,000 maps. It was not economically feasible to attempt a visual sighting at every relocation. When a mortality signal was detected, the site was later accessed by helicopter and the cause of death was investigated. Caribou snow-tracking sign was recorded during fall, winter and spring surveys to assist in recording distribution and movements. Distribution information was also available from composition count surveys conducted during post-calving and rut, and these included a visual sighting of each collared caribou.

Gauthier and Theberge (1985) demonstrated that seasonal range sizes as estimated from radio-collared caribou consistently underestimate the actual area occupied by a herd, particularly

during calving. We did not attempt to determine exact seasonal range sizes in our analysis but did, however, make a subjective estimate of the entire home range boundary of the WLH based on radio-collars and other survey data.

HERD DEMOGRAPHY

Population Size

Initially, we attempted to census the WLH using the total count method during the breeding season in October 1985 and 1986. The reliability of this method is questionable since there is no accounting for animals not observed during the survey. As additional funds became available at the close of this study (March 1987), we elected to census the herd using the stratified random quadrat sampling method (Gasaway et al. 1986). An evaluation of the reliability of both methods for censusing the WLH and the Finlayson caribou herd was presented in the proceedings of the Third North American Caribou Workshop, held at Chena Hotsprings, Alaska, November 1987 (Farnell and Gauthier 1988). Because the accuracy and precision of the March 1987 population estimate far exceeded that of the fall total counts, the March 1987 results are used exclusively in our demographic analysis.

The stratified random quadrat technique entails three phases: delineation, stratification, and census. The delineation phase involves a fixed-wing survey to establish a survey area that includes the herd's entire late winter distribution. This survey is also supported by a radio-tracking flight to confirm the presence of all radio-collared caribou within the survey area. The stratification phase is an extensive fixed-wing survey over the entire survey area to classify survey units (SU) of 20 km^2 average size, into primary (numerous caribou present) and secondary (few caribou present) strata. The classification of SU's was based on the abundance of fresh snow-tracking sign and the direct observation of caribou. The census phase involves an intensive and thorough (2 min./km^2) helicopter survey of caribou from all the primary SU's and a sample of randomly selected SU's in the secondary stratum. Survey units were systematically surveyed from east to west across the primary portion of the herds distribution to reduce the possibility of double counting caribou that could have moved across SU boundaries between survey flights. Two aircraft were used simultaneously for both the stratification and census surveys. A subsample of SU's was intensively searched at 4.5 min./ km^2 for the purpose of determining a sightability correction factor for caribou missed during the 2 min./km^2 survey. All data were plotted on 1:250,000 maps. The formula and HP-97 program developed by Gasaway et al. (1986) was used to calculate the population size of the WLH.

Population Composition

We attempted to estimate the composition of the WLH using two methods during three life cycle periods. The first method entailed a comprehensive helicopter survey of the WLH range, as depicted by radio-collars, during post-calving (on 23 and 18 July,

1985 and 1986, respectively), and rut (on 5 and 11 October 1985 and 1986, respectively). These surveys served multiple purposes in that they provided additional and more specific information on herd distribution, and population size. The fall composition data was also used to compare WLH recruitment levels, as a control, to the levels found in the neighboring Finlayson herd (Farnell and McDonald 1987).

The second method consisted of calculations made from the composition data collected during the March 1987 population estimate, using the formula developed by Gasaway et al. (1986). Adult female, calf and adult male proportions were weighted to population size, to provide an unbiased estimate of herd structure. In all cases, caribou were sexed and aged using the criteria set out by Farnell and Russell (1984). The data provided by the March 1987 count are more reliable than post-calving and rut counts because the areas searched during the survey were randomly selected, and a large portion (80%) of the herd was observed. The March 1987 count provides our best estimate of actual recruitment and adult composition because 10 months of mortality have taken place, and the count is representative of the herd's pre-calving population structure. We will therefore use this data exclusively in our demographic analysis.

Bergerud (1971, 1974, 1978, and 1979) and Bergerud and Elliot (1986) have made the most exhaustive study of caribou sex ratios in North America. Since the sex ratio of the WLH fell out as an important consideration in our composition analysis, we have followed Bergerud (1978 and 1979) and Bergerud and Elliot (1986) by calculating the proportion of males as the percent males to total adults.

Adult Natural Mortality

Because it is difficult to measure, the natural mortality of adults is the least understood aspect of caribou population dynamics. The adult natural mortality rate of WLH caribou was calculated from the death rate of radio-collared females using the formula derived by Gasaway et al. (1983).

Harvest

The harvest of caribou from the game management subzones within the range of the WLH was taken from the hunter questionnaire analysis and trophy export declarations. Hunters are classified into three categories by which they are regulated;

1) non-resident hunters- must be accompanied by licensed guide and may hunt only within that guide's concession area during the regular hunting season.

2) resident non-native hunters- may hunt anywhere in Yukon within the regular hunting season.

3) native hunters- have full aboriginal rights and may hunt anywhere, for an unlimited amount of caribou, during any time of the year, for subsistence purposes. Native hunting is essentially unregulated by government.

RANGE CONDITION

Food Habits

The late winter food habits of the WLH were examined by composite fecal sample collections made between 1986 and 1987. These collections were made at various locations on the herd's winter range. Each composite sample contained 20 fecal pellets, one from each of 20 different fecal pellet groups. Fecal samples were analyzed at the Composition Analysis Laboratory at Colorado State University in Ft. Collins, Colorado. The relative density of plant fragments was based on 100 fields per sample. The microhistological analysis of caribou samples was tabulated, indicating the percentage of each plant group. The accuracy of fecal analysis is influenced by differential digestion among the major food groups (Holechek et al. 1982), and is an estimate of the composition of the late winter diet, rather than actual proportions ingested. The rumen turnover rate for caribou during winter is about two days (White and Trudell 1980). Therefore, fecal collections should be representative of the food intake for 20 caribou over a much broader area than the actual collection sites. A crude assessment of WLH winter range condition was made from plant composition of fecal samples during late winter.

Winter severity

Snow conditions become increasingly severe for caribou as winter progresses (Martell and Russell 1984), and March levels probably represent the maximum average snow depth affecting caribou activity (Farnell and McDonald 1987). In March 1987, snow depth was measured using the mean of 10 samples taken at 14 stations along east-west and north-south transects over the WLH winter range. This data was then compared to the long-term average snow depths measured by Environment Canada at six stations within and peripheral to the WLH winter range to assess normal snow depth levels.

It should be noted that our evaluation of woodland caribou range condition is limited by the lack of other comparative data from northern woodland caribou herds. This information should include data on late winter food habits, snow conditions and known demographic trend. The main utility of the data presented here is to augment previous collections from other woodland caribou herds for an in depth analysis of typical range use patterns and the variability of range quality. Such information will be useful for evaluating management options in consideration of a herds potential as dictated by range condition.

RESULTS AND DISCUSSION

SEASONAL MOVEMENTS AND DISTRIBUTION

Radio-collaring

With the exception of one immature male, all 13 caribou collared during this study were female (Table 1). Initially 7 caribou were captured and radio-collared in the Cassiar Mountains on 24 and 25 September, 1984 (Fig. 2) to test our assumption that caribou from this summer range were those inhabiting the Wolf Lake lowlands during winter. On 24 July 1985, we captured and radio-collared a single caribou in the extreme southeast corner of the study area to assess herd fidelity for sparse numbers of caribou known to inhabit this area (Fig. 2). We expected this caribou to move onto the Wolf Lake lowlands during winter and confirm our assumption that the greater range of the WLH also included that portion of the Cassiar Mountains. On 7 February 1986, we captured and radio-collared 5 caribou at the north end of Wolf Lake. We expected caribou marked on the winter range to move onto summer ranges not yet determined, and therefore reveal the overall seasonal movement and distribution pattern of the herd.

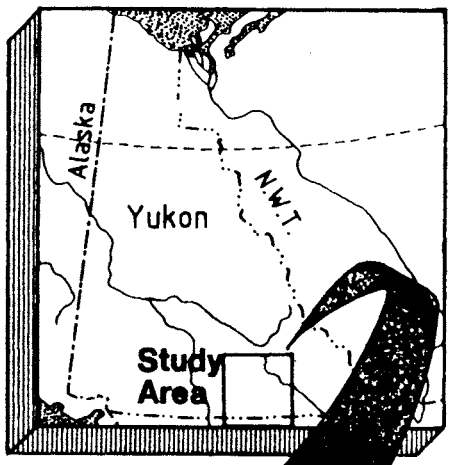
Table 1. Radio-collaring data for the Wolf Lake caribou herd.

DATE	COLLAR	SEX	AGE	LOCATION	STATUS (3/87)	NO. OF RELOCATIONS
09-24-84	T64	M	Immature	Ram Creek	Dead	6
09-24-84	T98	F	Adult	Ram Creek	Alive	7
09-25-84	T65	F	Adult	Irvine Cr.	Dead	7
09-25-84	T88	F	Adult	Irvine Cr.	Failure	2
09-25-84	T85	F	Adult	Irvine Cr.	Alive	9
09-25-84	T96	F	Adult	Irvine Cr.	Alive	8
09-25-84	T97	F	Adult	Irvine Cr.	Alive	6
07-24-85	T43	F	Adult	Goat Lk.	Alive	6
02-07-86	X04	F	Adult	Wolf Lk.	Alive	4
02-07-86	X41	F	Adult	Wolf Lk.	Alive	3
02-07-86	X42	F	Adult	Wolf Lk.	Alive	4
02-07-86	X35	F	Adult	Wolf Lk.	Failure	1
02-07-86	X40	F	Adult	Wolf Lk.	Alive	4

Distribution Surveys

A total of 33.2 hours of fixed-wing aircraft time were flown on 9 occasions (Appendix A) to obtain 66 contacts with radio-collared caribou. The data for all relocations are presented in Appendix B. Data from composition and census surveys provided additional information on the distribution of the WLH.

Fig.2 : Locations, month and year of collaring, Wolf Lake Caribou Herd



Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres

a) Winter Distribution

A core winter range for the WLH was apparent from surveys (Fig. 3). Large numbers of caribou were found occupying a distribution consistent with anecdotal accounts during all winters of the study (1985,1986,and 1987). The apparent fidelity to this winter range suggests that it may be traditional and probably the result of an obligatory response to environmental parameters (eg. habitat preference, snow depth selection, etc.). The winter range of the WLH lies entirely within the Wolf Lake lowlands. This area extends from the western flank of the Cassiar Mountains westward to the Nisutlin River, and along the north flank of the Englishman and Thirtymile Ranges northward to the extreme headwaters of the Liard and Red Rivers. The winter range used by the WLH is characterized by boreal forest habitat and is similar to the winter habitats used by most Yukon caribou herds.

Previous studies of Yukon woodland caribou have shown that winter range distributions tend to become more confined as winter progresses (Farnell and Russell 1984, Farnell and McDonald in prep. a). Since the winter range boundaries presented here are the result of late winter surveys, they are more representative of the herd's core winter range and not the entire winter range of the herd. The broader area occupied through winter is probably larger, and more variable than the area depicted in Figure 3.

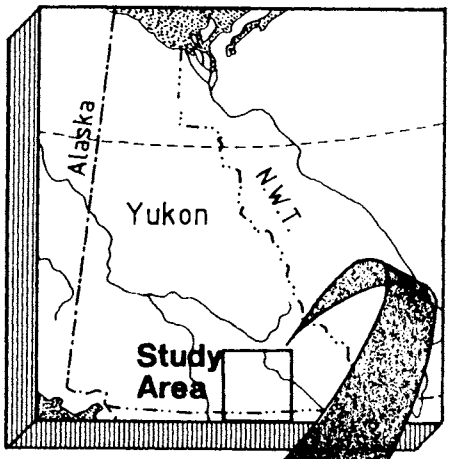
Some exceptions to this winter range distribution are known to exist. Small groups of caribou have been observed within the range of the WLH during winter, north of Downey Lake and on the east flank of the Cassiar Mountains (B. Hayes and J. Kuhn pers. comm.). Our surveys did not find caribou at these localities in late winter indicating that these areas are not often occupied by the WLH.

All radio-collared caribou were relocated on the observed winter range. We therefore conclude that caribou collared during the summer and fall periods were part of the WLH. The movement and distribution behavior of these caribou, and those collared on the Wolf Lake winter range in 1986, should then be representative of the herd's greater range use pattern during subsequent periods.

Because of its remoteness, there is little human activity on the WLH winter range. A few trappers were the only people observed during winter field operations, and we have no knowledge of other human uses for this area. It was our impression, however, that this situation could change dramatically if the Conwest winter access trail would be upgraded to a road. This particular trail extends from the town of Teslin north to the Tintina mining exploration site near Junkers Lake (Fig. 3). The trail is routed through the center of the WLH winter range and could, if upgraded, facilitate large scale hunting of the herd during winter. The case histories of Yukon's Finlayson herd (Farnell and McDonald 1987) and Alaska's Fortymile caribou herd (Davis et al. 1978) have demonstrated the need for intensive management when caribou winter ranges have been bisected by roads.

Respecting key habitats, we noted a spring upwelling at the north end of Wolf Lake adjacent to the Conwest trail (Fig. 3). This site was heavily used as a lick by caribou during all winters of the study. Because of the vulnerability of caribou to hunting,

Fig. 3 : Locations of collared caribou during late winter (Feb.–March) with a generalized delineation of the Wolf Lake herd winter range



Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres

and to other disturbances at licks, this area should be designated as critical habitat and protected by wildlife and land use regulation.

b) Calving Distribution

Calving surveys were flown on 3 June 1985 and 1986. By this time most collared caribou had moved in an easterly direction away from the Wolf Lake winter range to dispersed calving sites in the northern Cassiar Mountains (Fig. 4). The broader distribution as depicted by radio-collars also included alpine habitats in the northern Dorsey Range, and a small portion of the central Pelly Mountains. The calving distribution revealed by our radio-collar sample is no doubt a minimum calving range boundary, but provides a partial representation of the WLH dispersion pattern at calving. We suspect that some WLH calving may also take place in the Englishman and Thirty Mile Ranges because of their immediate juxtaposition to the winter range and suitability as both calving and summer habitat for caribou, With the exception of the single male in our sample (T64), all collared caribou were relocated in alpine or subalpine habitats during calving surveys. The single male caribou was located in forested habitat on the Wolf Lake winter range during both calving surveys.

Other woodland caribou range use studies have documented strong fidelity to specific calving sites for females (Farnell and Russell 1984, Brown and Theberge 1985, Hatler 1986). Fidelity to specific calving sites was apparent in three cases during this study. Collared females T85, T65, and T98 were relocated at or near previous calving sites on subsequent calving surveys (Fig.4). Since our survey timing was slightly ahead of the 6 June calving peak for woodland caribou (Bergerud 1978, Hatler 1986) and high level relocations are not always precise, the accuracy of our relocation surveys was inadequate to assess the degree to which all collared caribou exhibited fidelity to calving sites. We believe that strong calving site fidelity would have been apparent had repeated visual relocation surveys been flown over the entire calving period.

c) Post-calving Distribution

Post-calving relocation surveys were flown on 20 July (1985) and 17 July (1986). Composition count surveys on 23-24 July (1985) and 18 July (1986) also provided information on post-calving distribution. In general, the post-calving distribution of the WLH was similar to the calving distribution, and most collared caribou were found in the northern Cassiar Mountains (Fig. 5). Little movement apparently took place between surveys. A helicopter reconnaissance of the Thirty Mile Range found sparse numbers of caribou, while reconnaissance of the northern Englishman Range found no caribou. Despite this finding, we still suspect that some WLH caribou could inhabit the Englishman Range during summer. We therefore consider the Englishman Range as part of the summer range boundary of the WLH.

Collared caribou X-41 used a different area than other collared caribou during calving in 1986, but was not relocated during the subsequent post-calving survey (Appendix B; Fig. A-10).

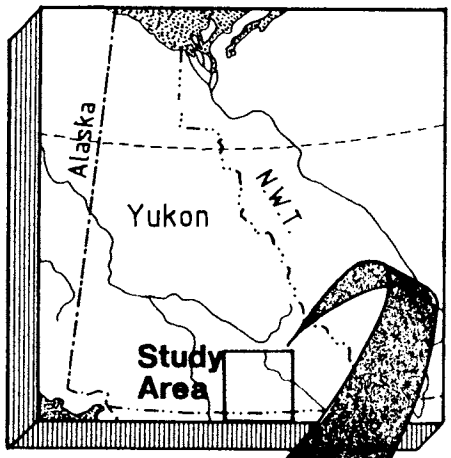
Fig. 4 : Locations of collared caribou during the calving period, Wolf Lake herd

= Two Years Data

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres



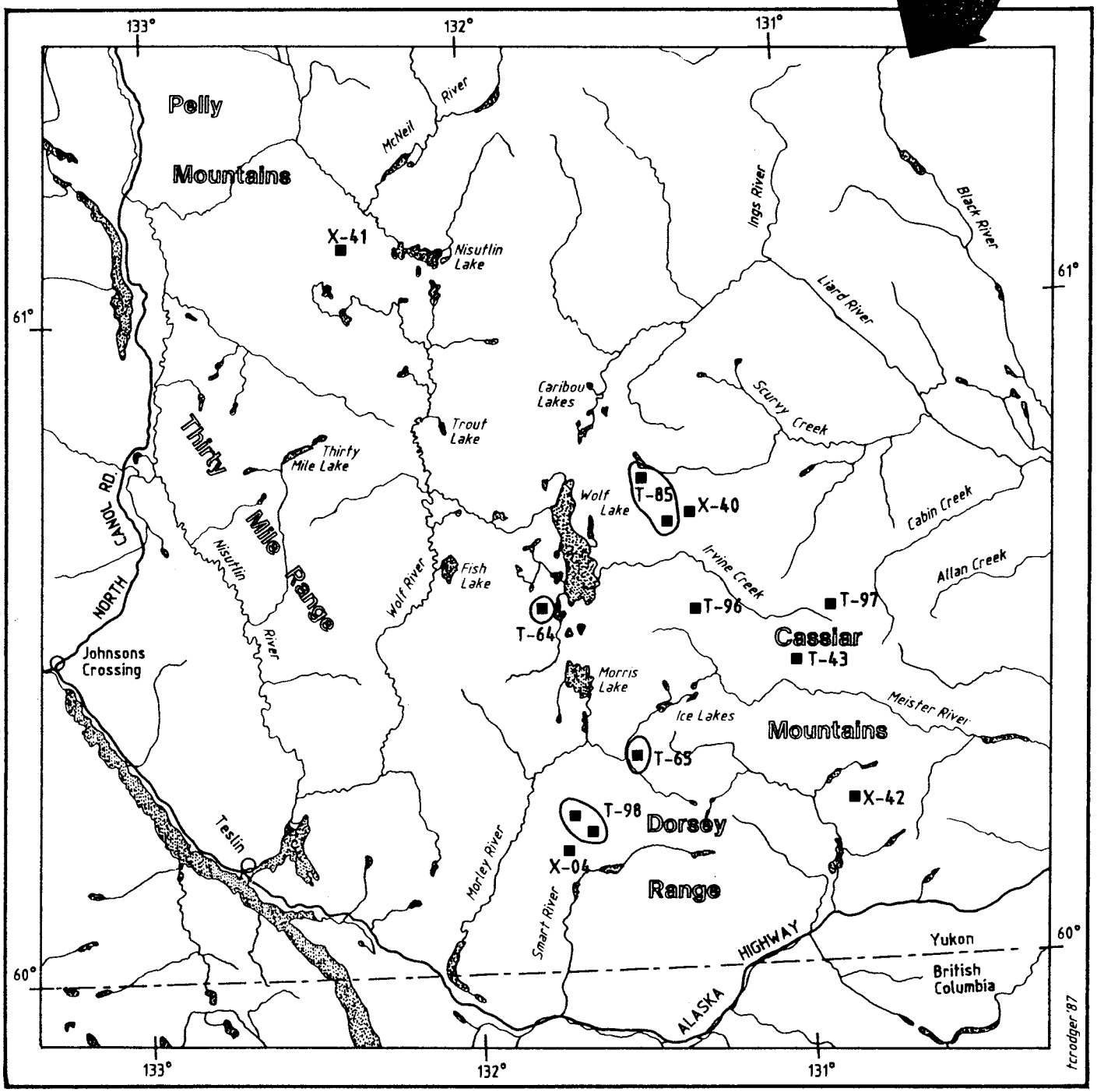
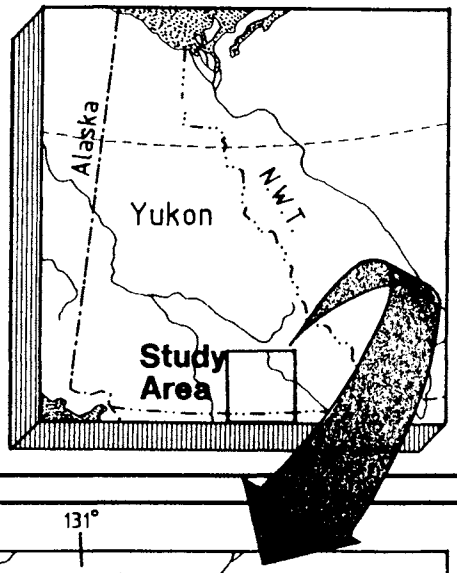


Fig. 5 : Locations of collared caribou during the post-calving period (July 1985, 1986) of the Wolf Lake herd



Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres

133° 132° 131°

61°

60°

McNeil River
Nisutlin Lake
Ings River
Black River
Liard River
Caribou Lakes
Scurvy Creek
Trout Lake
Thirty Mile Lake
Thirty Mile Range
Wolf Lake
X-40
Cabin Creek
CANOL RD.
NORTH
Nisutlin River
Wolf River
Fish Lake
Irvine Creek
T-96
T-97
Allan Creek
T-85
X-04
T-43
Johnsons Crossing
Morris Lake
Ice Lakes
Meister River
Englishman Range
T-64
T-65
T-98
X-42
Teslin
Morley River
Smart River
HIGHWAY
ALASKA
Yukon
British Columbia

tcrodger'87

We unfortunately have no way of telling whether this individual had moved deeper into the Pelly Mountains after calving or was simply missed. Expanded survey effort did not find this caribou (Appendix A).

Caribou were less widespread at post-calving than at calving. Helicopter composition counts found aggregations on snowfields and windswept alpine ridges. This behavior is typical of caribou escaping fly harassment during summer (Downes 1985).

d) Fall Distribution

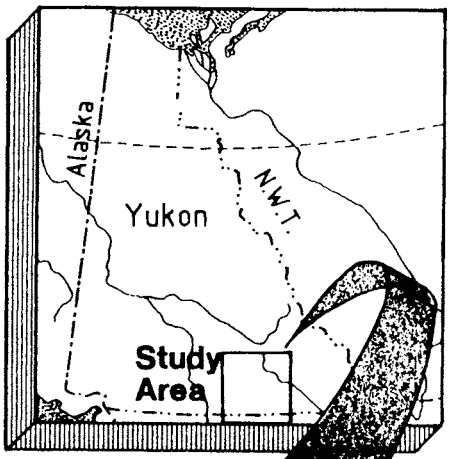
Surveys were flown during days of favorable weather on 3 October (1986) and 9 October (1987). Fall distribution information was also supported by observations made from composition surveys during 5 October (1985) and 11-12 October (1986). With one exception, all collared caribou were found in the northern Cassiar Mountains (Fig. 6). The exception (X-41), was relocated within a band of 7 caribou on the Wolf Lake winter range in 1986, and these caribou were travelling in a southeasterly direction towards the northern Cassiar Mountains. Composition surveys during fall found caribou aggregations near Ice Lakes and on the ridges between Irvine Creek and Stoneaxe Lake. The latter area has been reported as a traditional rutting ground for the WLH (Doug Smarch pers. comm.). A group of 25 caribou was found associated with collared individual X-42 immediately north of Goat Lake in fall 1987. Caribou were mostly found in alpine or subalpine habitats during fall.

The fall breeding season is a time when large numbers of mixed sex and age groups of woodland caribou can be observed for census or composition surveys (Bergerud 1978 and 1986, Farnell and McDonald 1987). It is therefore important to document rutting areas during initial inventory. The largest number of caribou observed on fall composition surveys was 234 (Appendix D), and 142 of these were found in one aggregation north of Irvine Creek. This observation was consistent with those made over many years by outfitter Doug Smarch (pers. comm.) and indicate that the Irvine Creek-Stoneaxe Lake area is likely a traditional rutting area. We failed to find other large aggregations of caribou during the fall breeding season and noted that, for the most part caribou were sparsely distributed in small bands. We suspect that large sample sizes of caribou for demographic analysis may be difficult to find for the WLH during fall.

e) Home Range Boundaries

Using what we now know about the seasonal movements and distributions of the WLH, we delineated a home range boundary that is roughly bounded by the Alaska Highway to the south, the length of the Nisutlin River to Nisutlin Lake to west and northwest, and the upper reaches of the Liard River and eastern flank of the northern Cassiar Mountains to the northeast and east (Fig. 7). The game management subzones that correspond to this home range are; 10-10, 10-13, 10-14, 10-16, 10-21, 10-23 to 10-26, and the western one-half of 10-27 and 10-28 (Fig. 8). Management actions directed at the WLH should be applied to this area alone, to avoid compounding those actions over caribou populations with other

Fig. 6 : Locations of collared caribou during the fall breeding season (Oct. 1985, 1986) Wolf Lake herd

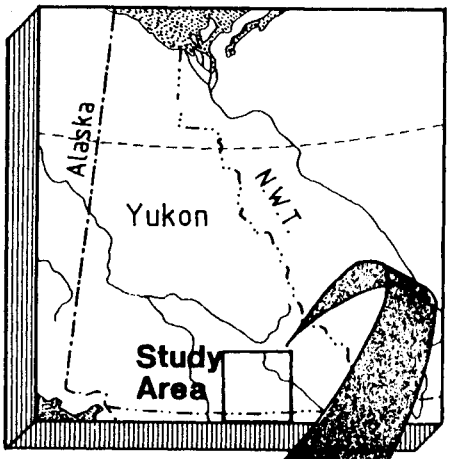


Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres

Fig.7 : Relocations of all collared caribou with a delineation of the home range boundary for the Wolf Lake caribou herd



Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres

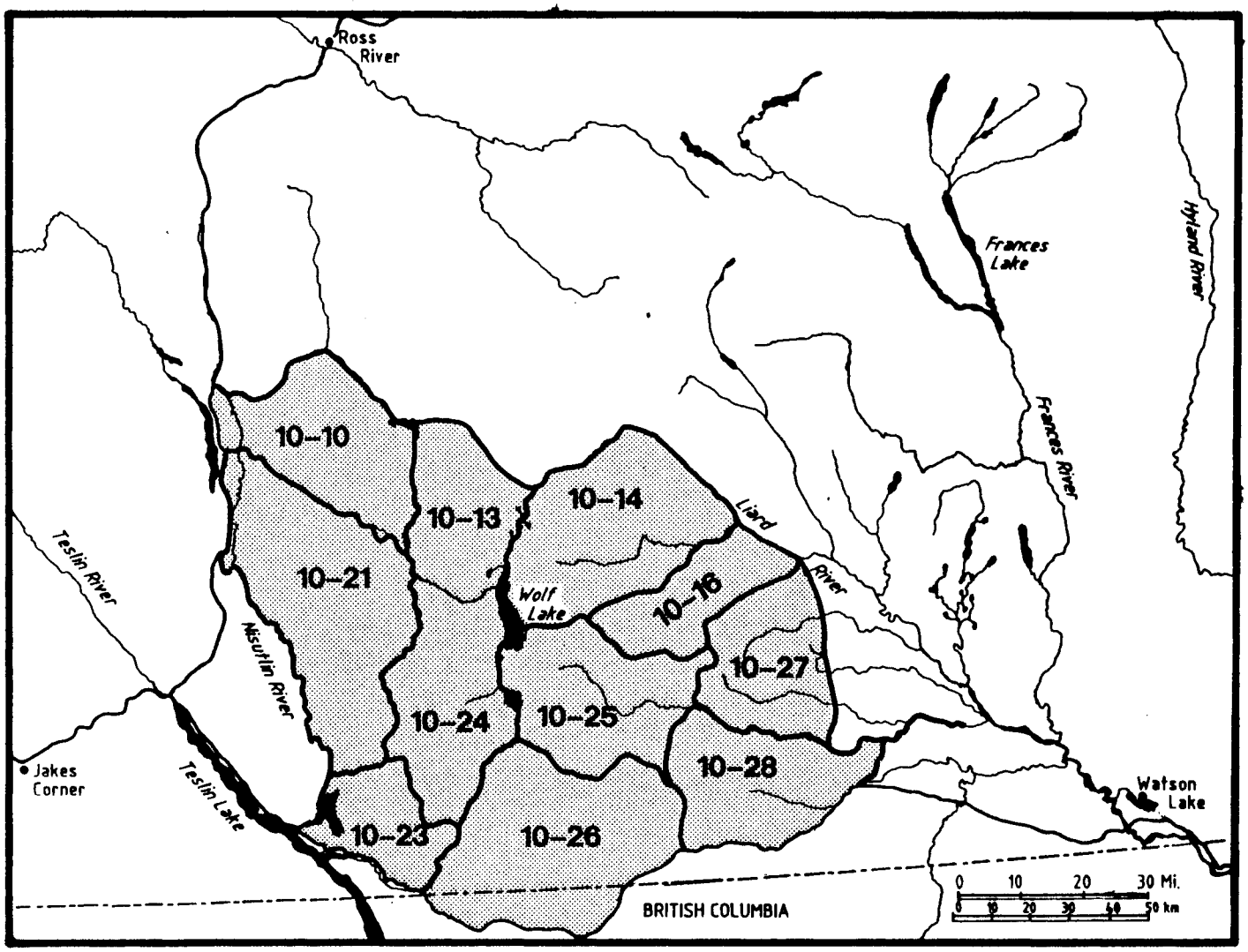


Fig. 8 : Game Management Subzones that correspond to the home range boundary of the WLH.

demographic and human use characteristics. Known caribou populations bordering the range of the WLH are: the Finlayson herd to the north (Farnell and McDonald 1987), the Little Rancheria herd to the southeast (Farnell and McDonald in prep. b), and the Teslin and Squanga Lake herds to the southwest (Larsen 1980). Bergerud (1978) speculated that a distinct herd of caribou, the Swan Lake herd, may exist in an area that lies immediately south of the WLH range. But a distinct range tradition was not observed during the Little Rancheria herd inventory (Farnell and McDonald in prep.b.), or during this study. We have speculated that caribou in that area are part of the Little Rancheria herd. Caribou known to inhabit the Big Salmon Range, west of the WLH, (Lortie et al. 1978) have yet to be inventoried, and it is likely that a discrete herd will be found there.

HERD DEMOGRAPHY

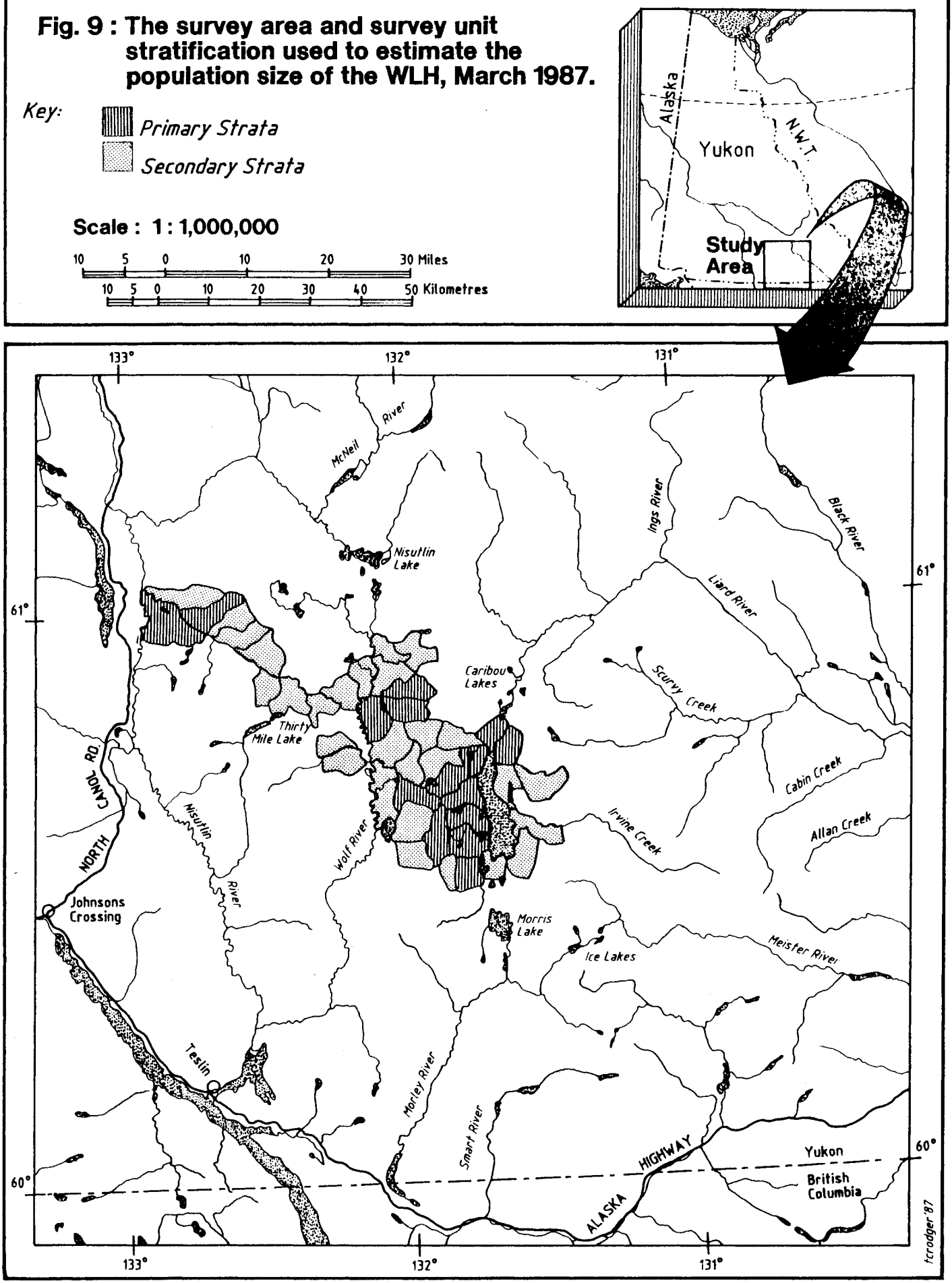
Population Size

A census of the WLH was carried out over a 7 day period between 20 and 26 March, 1987. The data collected to calculate the population size of the WLH is presented in Appendix C. A survey area of 1009 Km^2 was established within the Wolf Lake lowlands (Fig. 9). The survey area encompassed the entire WLH winter distribution, and this assumption was supported by the presence of all active radio-collar transmitters within the survey area as confirmed by visual relocations (Fig. 10).

The survey area was subdivided into 44 sample units (SU's) averaging 23 Km^2 in size. When stratified, there were 15 primary and 29 secondary SU's, comprising 46% and 54% of the total survey area (Table 2). The survey intensity was 59% (26/44) overall with 100% in the primary and 38% (11/29) in the secondary being sampled.

The search intensity averaged 2 min/km^2 during the census flights. There was no appreciable difference in search intensity between strata during the census. A total of eight intensive survey areas (ave. size 4.4 km^2) within SU's with relatively large numbers of caribou were selected and flown again at 4 min/km^2 intensity to estimate a sightability correction factor (SCF) (Appendix C).

Fig. 9 : The survey area and survey unit stratification used to estimate the population size of the WLH, March 1987.



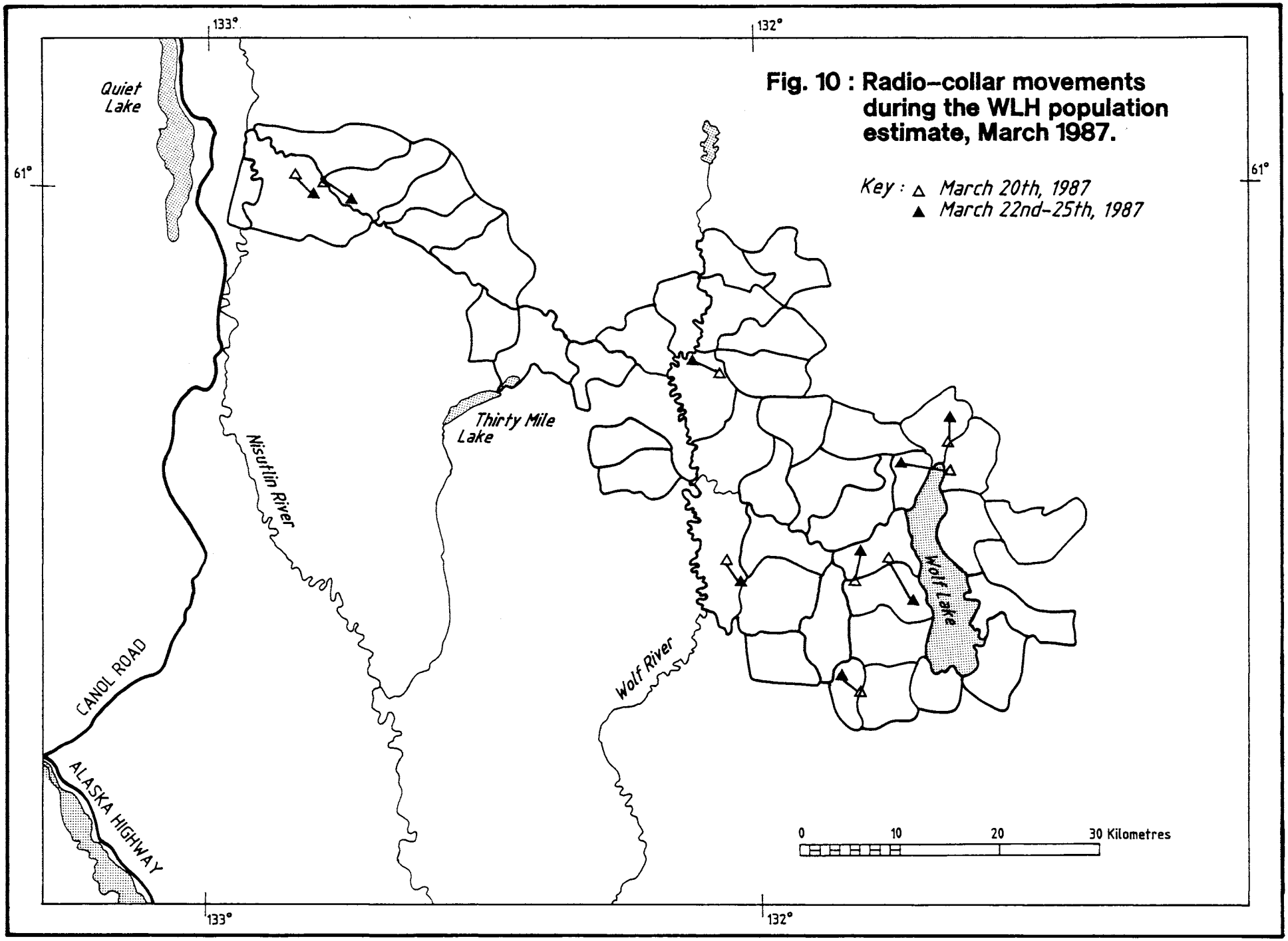


Fig. 10 : Radio-collar movements during the WLH population estimate, March 1987.

Table 2. Summary of caribou survey data, and population estimate for the WLH at the 90% confidence level, March 1987.

STRATA	SAMPLE UNITS		AREA (KM^2)		CARIBOU OBSERVED	EXPANDED POPULATION ESTIMATE	*POPULATION ESTIMATE WITH SCF
	SAMPLED	TOTAL	SAMPLED	TOTAL			
PRIMARY	15	15	468.6	468.6	453	453	520
SECONDARY	11	29	324.3	540.5	75	125	143
TOTALS	26	44	792.9	1009.1	528	578	664

*Population estimate from Gasaway et. al. (1986) with a sightability correction factor of 1.15.

A total of 453 caribou were counted in the primary stratum, and 75 in the secondary stratum (Table 2). Including a SCF of 1.15, the estimated population size for the WLH was 664 ±20% (797-531) at 90% confidence limits.

The actual count of caribou using the stratified random quadrat census method during winter far exceeded our best previous count of caribou during fall 1987 (N=234), and the projected estimate of caribou during winter, greatly exceeded this fall count. This result indicates that we were missing significant numbers of caribou during the fall surveys. The problem being that the WLH is distributed at low density over a broad area during this period. Hence our small sample of radio-collars did not facilitate finding all caribou and sightability was poor. We likewise may not have located all of the major rutting areas used by the herd.

The low numbers found on WLH surveys prior to this population estimate caused concern for herd viability and emphasized the need for setting restrictive harvest levels. The improved count of caribou now demonstrates that the herd is significantly larger than previously thought and, given adequate recruitment and survival, may support a moderate level of harvest.

Population Composition

Because of its greater reliability we have restricted our composition analysis to the March 1987 data set. The smaller samples of post-calving and fall composition statistics are presented in Appendix D for reference purposes.

Calves represented a substantial proportion and made up 17% of the herd (Table 3). However the ratio of calves to adult females was 28:100 which indicates only a modest level of 10-month old recruitment. Calves appear as a substantial proportion of the total because the sex ratio is heavily skewed against males. Males comprised 18% of the herd, and the adult sex ratio was 29 males/100 females, or 22% of total adults. We are confident all WLH caribou were located within the delineated survey area and therefore rule out the possibility that significant numbers of males may have been missed on the census.

Table 3. The unbiased composition of the Wolf Lake caribou herd calculated from the population estimate at the 90% confidence level, March 1987.

	Adult Female (22Mo.)	Calves (10Mo.)	Adult Males (22Mo.)
Corrected no. of caribou	409 ± 19%	110 ± 23.2%	112 ± 16.4%
Percentage of Population*	61.6 ± 1.8%	17.0 ± 5.5%	17.7 ± 6.0%
Ratio per 100 females	----	27.6 ± 5.9%	28.7 ± 5.9%

*3.7% were unclassified.

The WLH sex ratio of about 1 male to 4 females is the lowest to be documented for Yukon, and the second lowest for North America. The mean sex ratio for adults among North American caribou herds is 36%, (Bergerud 1979). Since the WLH sex ratio falls well below this value, an explanation is warranted.

Composition data from neighboring caribou herds indicate that very unbalanced sex ratios may be a regional phenomenon. Data collected in March 1988 (Farnell and McDonald in prep.b.), using the same methodology and from an immediately adjacent population, the Little Rancheria herd (Fig.11), indicate a population composition that is almost exactly the same as that of the WLH (Appendix E). The proportion of males to total adults in this herd was 23%. Bergerud (1979) reported on three similar caribou

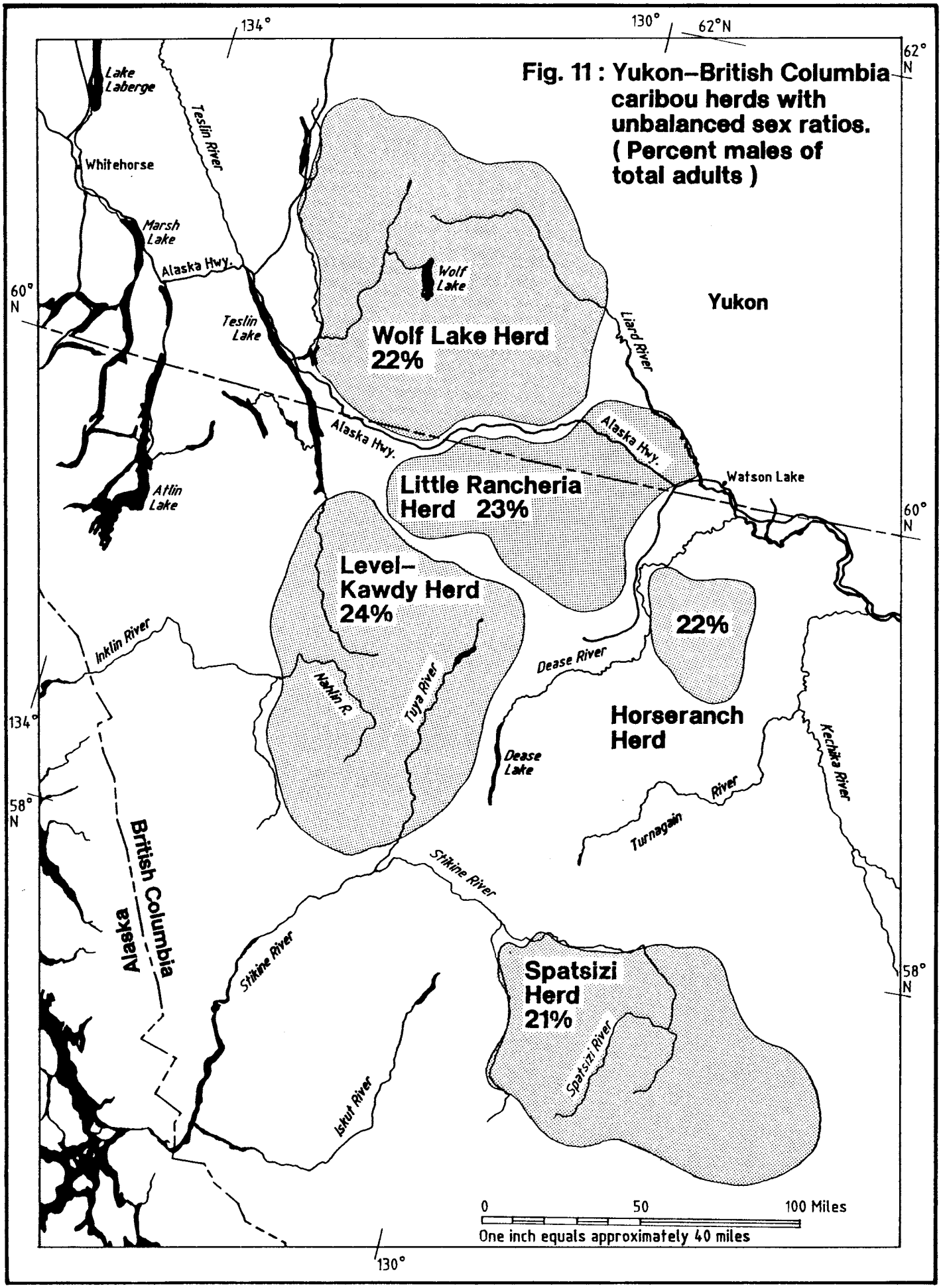


Fig. 11 : Yukon–British Columbia caribou herds with unbalanced sex ratios. (Percent males of total adults)
134°
130°
62°N
62° N
Lake Laberge
Teslin River
Whitehorse
Marsh Lake
Alaska Hwy.
60° N
Teslin Lake
Atlin Lake
Wolf Lake
Wolf Lake Herd 22%
Yukon
Liard River
Alaska Hwy.
Alaska Hwy.
Watson Lake
Little Rancheria Herd 23%
60° N
Level–Kawdy Herd 24%
22%
Inklin River
Dease River
Nahlin R.
Tuya River
Horseranch Herd
Dease Lake
Kechika River
River
Turnagain
134°
58° N
British Columbia
Alaska
Stikine River
Stikine River
Spatsizi Herd 21%
Spatsizi River
58° N
Iskut River
130°
0
50
100 Miles
One inch equals approximately 40 miles

populations in northern British Columbia; the Horseranch, Level-Kawdy, and Spatsizi herds, that occupy ranges immediately south of the WLH, and have male proportions ranging from 21 to 24% of total adults (Fig.11). The mean proportion of males to total adult caribou for this entire region of southern Yukon and northern British Columbia (22.1 $\pm$ 1.1) is well below the North American mean (36%).

Bergerud (1979) has offered four possible explanations that alone or in concert could suppress male proportions. These include; heavy predation, selective hunting of males, winter starvation, and chronic poor recruitment. Two other characteristics shared by the herds are; that they are lightly exploited by hunters, and not likely exposed to high levels of winter starvation. Selective hunting for males, and winter starvation cannot therefore explain the large disparity in adult proportions. Male proportions for the WLH and adjacent herd's are likely the product of a natural process that reflects past mortality and recruitment. We have opted to agree with Bergerud and Elliot (1986) that chronic poor recruitment of male calves coupled with extremely high natural mortality of adult males act to skew adult sex ratios in favor of females. Bergerud and Elliot (1986) have implicated heavy predation as the cause. The Yukon experience has shown that predation, principally by wolves, has a profound influence on caribou calf recruitment levels (Farnell and McDonald 1987), and we have noted that adult male rut and post-rut behavior and physiology predispose them to heavy predation by wolves and grizzly bears. In our view, further study of the population dynamics of these very similar herds will reveal to managers that the sex ratio can be an indicator of a predation levels.

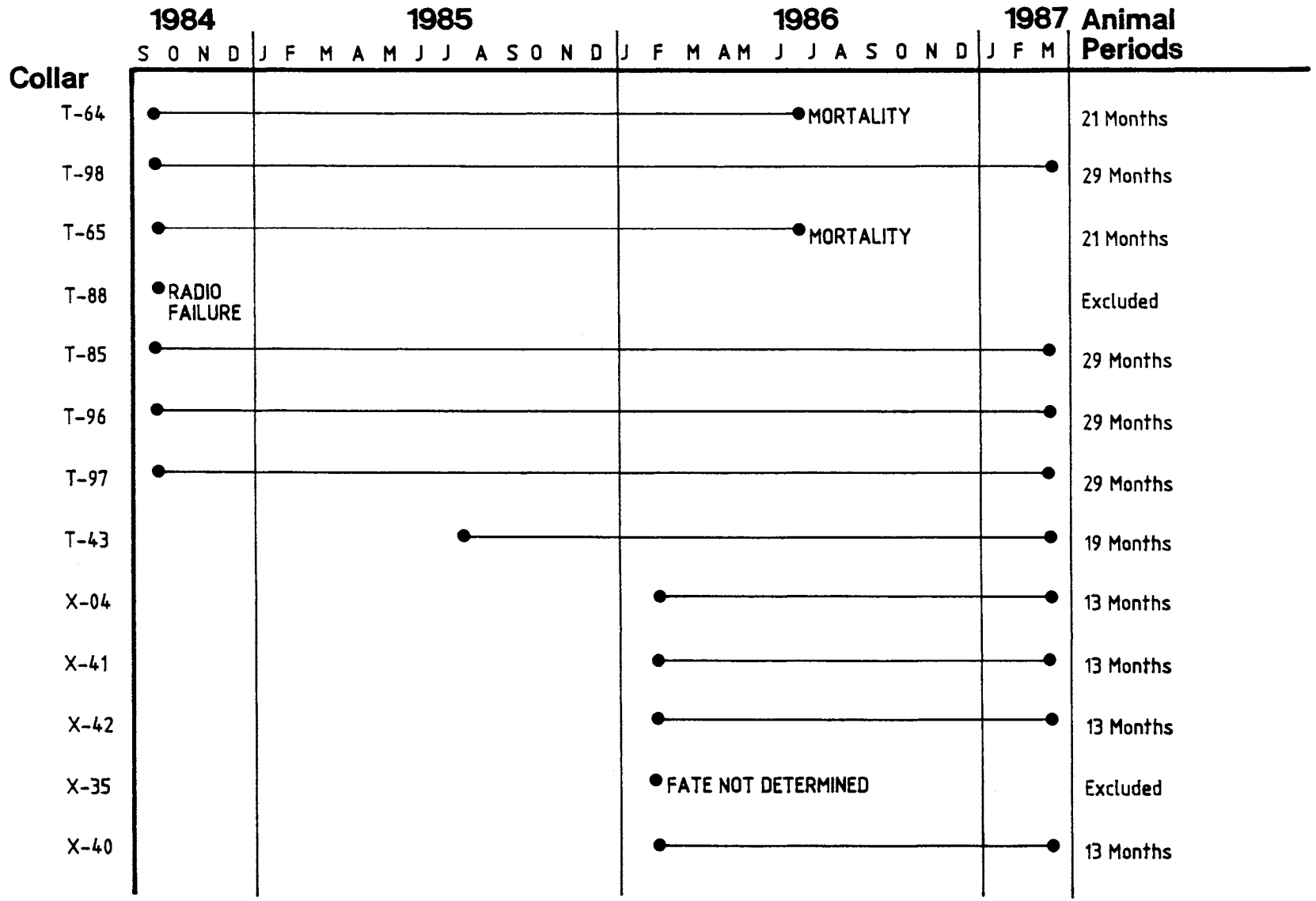
The sex ratio of the WLH is a matter for concern as too few males may not be able to breed all females during their first estrous cycle. Calves conceived from females that breed in a second estrous are at a disadvantage and may experience poor survivorship. Returning the sex ratio to a more optimum level should be a primary consideration for WLH management. This will be a difficult task since the sex ratio is being dictated by a natural process and not a human caused event.

Adult Natural Mortality

The natural mortality rate of adult caribou excludes human caused mortality and was estimated by tracking the death rate of radio-collared caribou. The estimate is biased towards female mortality rates because 10 females as opposed to 1 male were used in our radio-collar sample. Radio-collared females T-88 and X-35 were rejected from our sample because their transmitters failed immediately following capture. Their eventual fate during this study was therefore not clearly determined.

Two collared caribou died from predation over the duration of this study (Fig.12). The immature male T-65 was found dead by wolf predation in June of 1986, and adult female T-64 was likewise found dead by wolf predation in October of 1986 (Appendix B). The adult natural mortality rate of collared caribou, averaged out over the duration of the study was, 9.4%. This is likely an

Fig. 12 : Status of individual radio–collared caribou over the duration of the study (September 1984 – March 1987) with animal periods used to calculate the mortality rate.



underestimate of true mortality as it is representative of adult females, not males, and males are known to suffer greater mortality rates than females (Bergerud 1979). Since we have no better method to measure this parameter, we will use a natural mortality rate of 10% for setting harvest levels and projecting population trend. Refinement of WLH mortality rates will be possible by census extrapolation following a second population estimate survey at some future time.

Harvest

The harvest of caribou from the WLH as estimated by the hunter questionnaire analysis is presented in Table 4. The accuracy of this estimate can be considered absolute for non-resident harvest as it is based on a compulsory report. The resident non-native harvest estimate is considered good because it is based on a 70% return of hunter questionnaires issued to licensed hunters. The native harvest estimate is crude because not all native hunters acquire licenses in Yukon and only licensed native hunters are sampled by this method. Therefore some native harvest is missed by the hunter questionnaire analysis.

Table 4. The Wolf Lake caribou herd harvest estimated from the Yukon hunter questionnaire analysis, 1979-1986.

CATEGORY	YEAR 1979	1980	1981	1982	1983	1984	1985	1986	1987	MEAN ± SD
NON-RESIDENT	13	0	0	8	9	0	0	0	0	3.3±5.2
NON-NATIVE RESIDENT	3	3	0	3	3	2	4	5	1	2.6±1.5
NATIVE RESIDENT	1	0	2	0	0	0	7	0	0	1.1±2.3
TOTAL	17	3	2	11	12	2	11	5	1	7.1±5.7

According to this data, non-natives take a greater number of caribou from the WLH, and proportions are slightly higher for non-residents (mean 3.3 vs 2.6). The total kill of caribou from the WLH has ranged between 2 and 17 since 1979 and averaged 7.1 animals annually. Compared to the March 1987 population size of the WLH, the harvest of caribou is low and represents 1% of the herd. Typically, the distribution of the resident hunter kill has been restricted to areas accessible by road, and has for the most part been absent from remote areas habituated by WLH caribou (Fig.13). Non-residents have harvested caribou in remote areas, and on a crop rotation scheme between the WLH and the Finlayson herd (D. Smartch pers. com.).

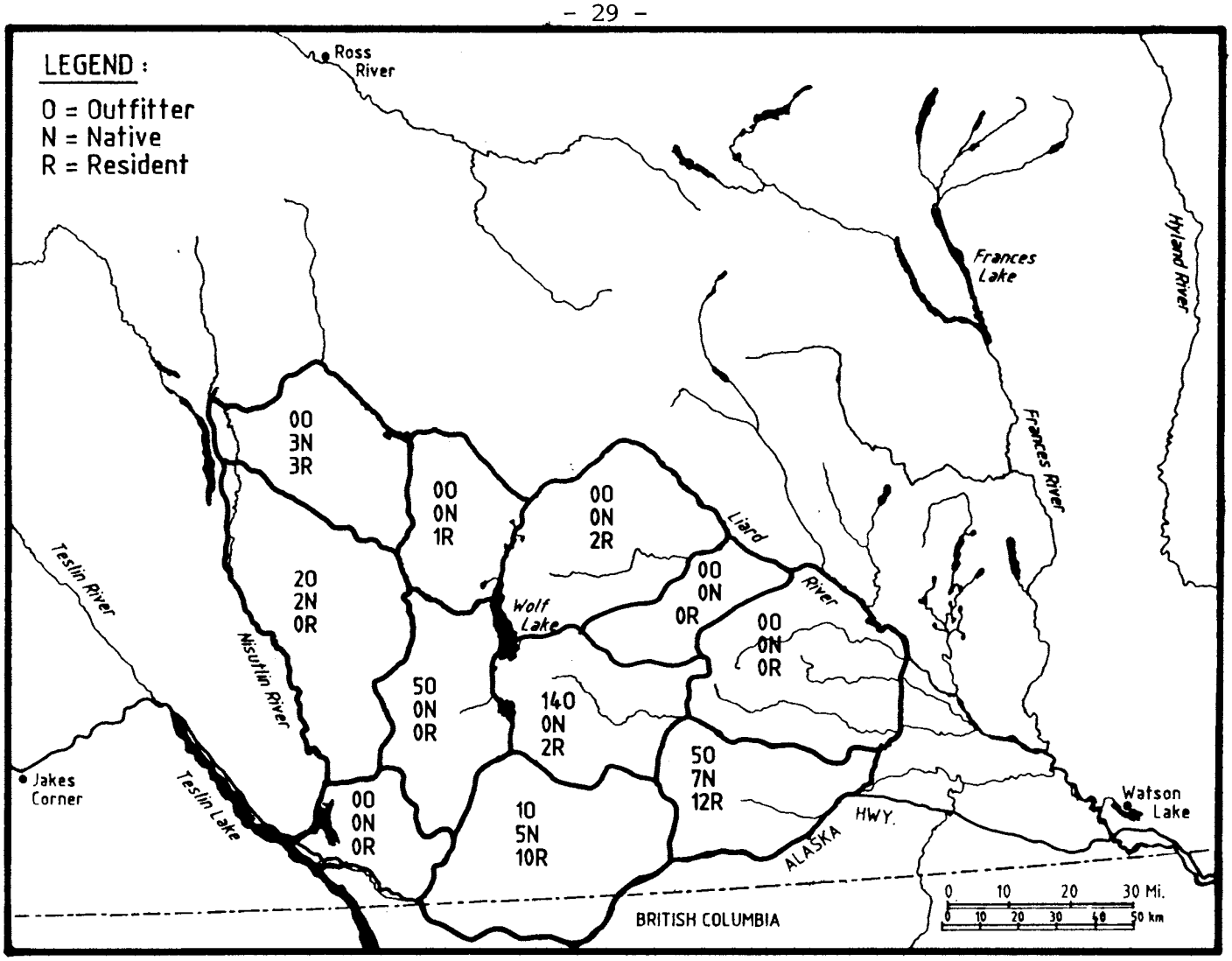


Fig.13: Distribution of the WLH Caribou Harvest, 1979 –1986.

Attempts are underway to better document the native harvest from the WLH (Quock and Jingfors 1988). During 1987, the first year of the Teslin native harvest study, reported harvest exceeded the harvest estimated by the hunter questionnaire analysis. In that year 3 caribou were reported taken from the WLH, and consumption for that band was reported to be 16 caribou/year. While we are presently getting better information, the actual native harvest is still thought to be underestimated (Quock and Jinfors 1988).

Population Projection

Projecting population growth will have utility for assessing herd status and setting harvest quotas if recruitment and mortality levels observed during this study are representative of the long term average experienced by the WLH. If we assume that adult male caribou in the WLH are dying at twice the rate as that observed for females (20% vs 10%), then the adjusted natural mortality rate for all adults is 12% (41 females + 22 males = 63 deaths annually / 521 total adults) (Table 3). Then the recruitment of calves into the WLH provides for a +4% annual growth rate (17% calf recruitment - (12% adult natural mortality + 1% harvest)). We emphasize that this is a hypothetical growth rate that could only be verified by another population estimate, but for lack of more refined data, management of the WLH will have to be based on these calculations.

RANGE CONDITION

Food Habits

The plant composition of fecal samples from the WLH during late winter was predominantly lichens (84%; Table 5) and is typical of that found for most caribou populations inhabiting forested environments (Russell and Martell 1984). This was followed by evergreen shrubs as the second most common component of the diet (9%), and grasses and sedge as the third (6%).

Of interest are the presence of *Picea* and *Pinus* (-1% and 7% respectively) components, which suggest that these species are ingested incidental to foraging on arborial lichens (*Cetraria* type 3%). This result runs contrary to the food habits of most Northern woodland caribou herds in western Canada which are presently thought to forage almost exclusively on terrestrial lichens (Bergerud 1978, Stevenson and Hatler 1985).

While the late winter diet of the WLH is high in carbohydrates (lichen) it still remains adequate in terms of nutritional quality for caribou. With respect to range condition the negligible incidence of mosses (-1%) indicate that adequate forage is available. A high incidence of moss is considered indicative of poor range condition (D. Russell pers. com.).

Table 5. Percent relative frequency of discerned plant fragments from fecal samples collected during late winter 1986 and 1987 on the range of the Wolf Lake caribou herd.

Plant genus or group (sample frequency)	Average Percentages (± SE)			
Moss (2/3)			0.4	(0.25)
Fruticose Lichens (3/3)			80.5	(4.26)
Cetraria-type (3/3)	3.0	(0.15)		
Cladonia-type (3/3)	77.5	(4.33)		
Foliose Lichens (2/3) (Peltigera)			3.8	(2.61)
Mushrooms (1/3)				
Horsetails (1/3) (Equisetum)			0.1	(0.12)
Graminoids (3/3)			5.7	(3.48)
Carex (2/3)	5.1	(3.44)		
Poa (1/3)	0.2	(0.20)		
Festuca (2/3)	0.4	(0.20)		
Evergreen Shrubs (3/3)			8.7	(1.92)
Ledum (2/3)	1.0	(0.52)		
Picea (1/3)	0.3	(0.31)		
Vaccinium (1/3)	0.3	(0.25)		
Pinus (3/3)	7.2	(1.12)		
Forbs (3/3) (Lupinus)			0.6	(0.08)
Total Lichens			84.3	(2.12)

Snow Distribution

While food habits analysis may indicate forage quality for the WLH it does not indicate food availability, hence the amount ingested. The amount of food available to caribou is of equal importance (Russell and Martell 1986), and can be assessed by examining snow depth on the winter range. The snow distribution on the WLH winter range was determined by snow depth transects (Fig. 14a and 14b). The snow depth depicted by an east to west transect was variable and averaged 59.7 cm. (SD=13.2). The snow depth along the north to south transect was less variable, but deeper, and averaged 78.1 cm. (SD=4.7). The snow depth averaged

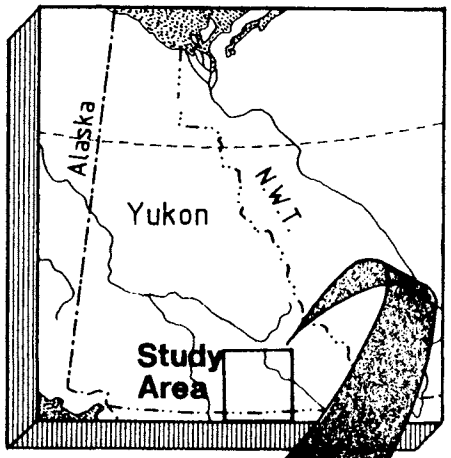
Fig. 14a The Snow Distribution on the WLH Winter Range, March '87

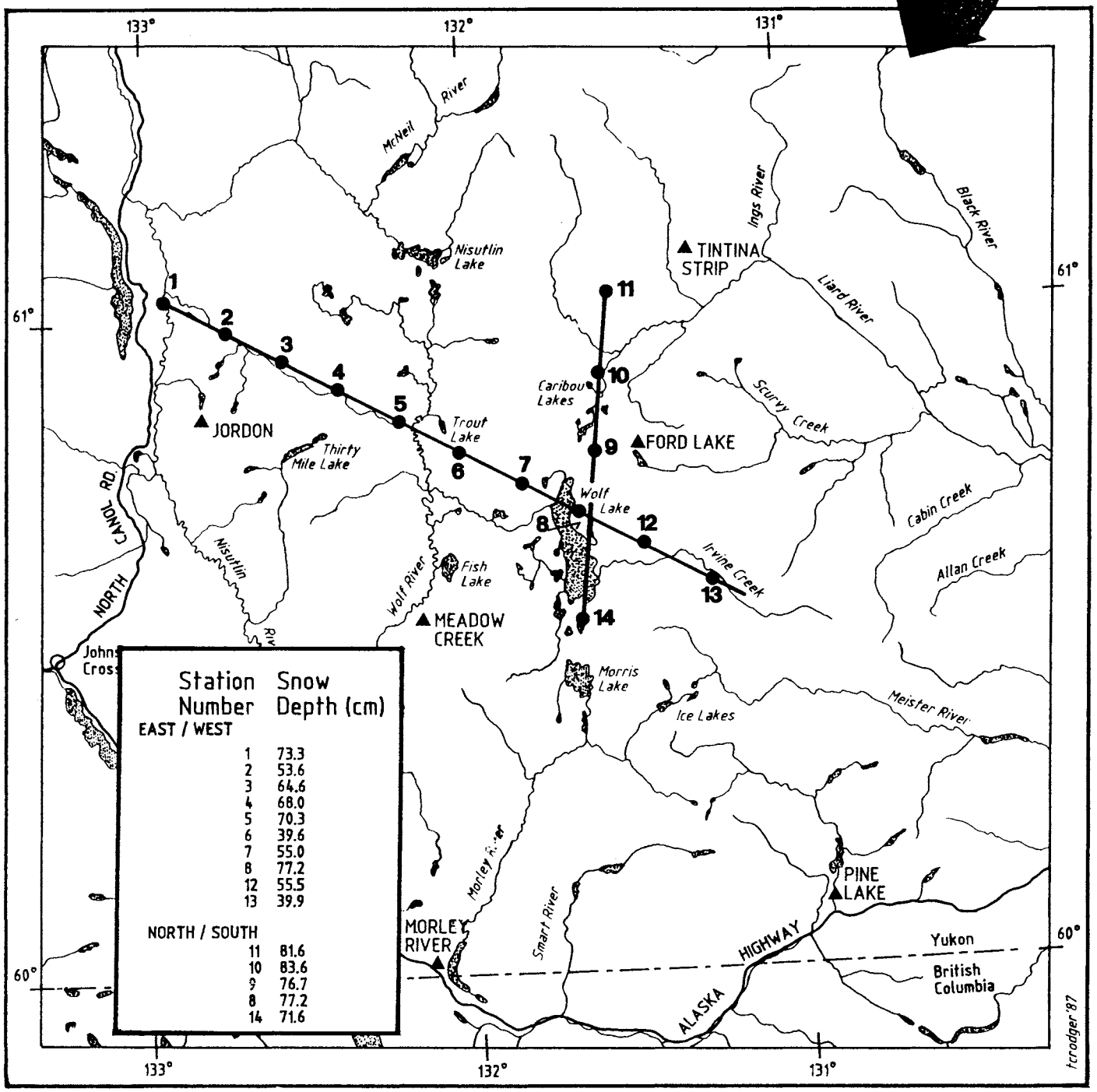
▲ **Environment Canada Snow Stations**

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

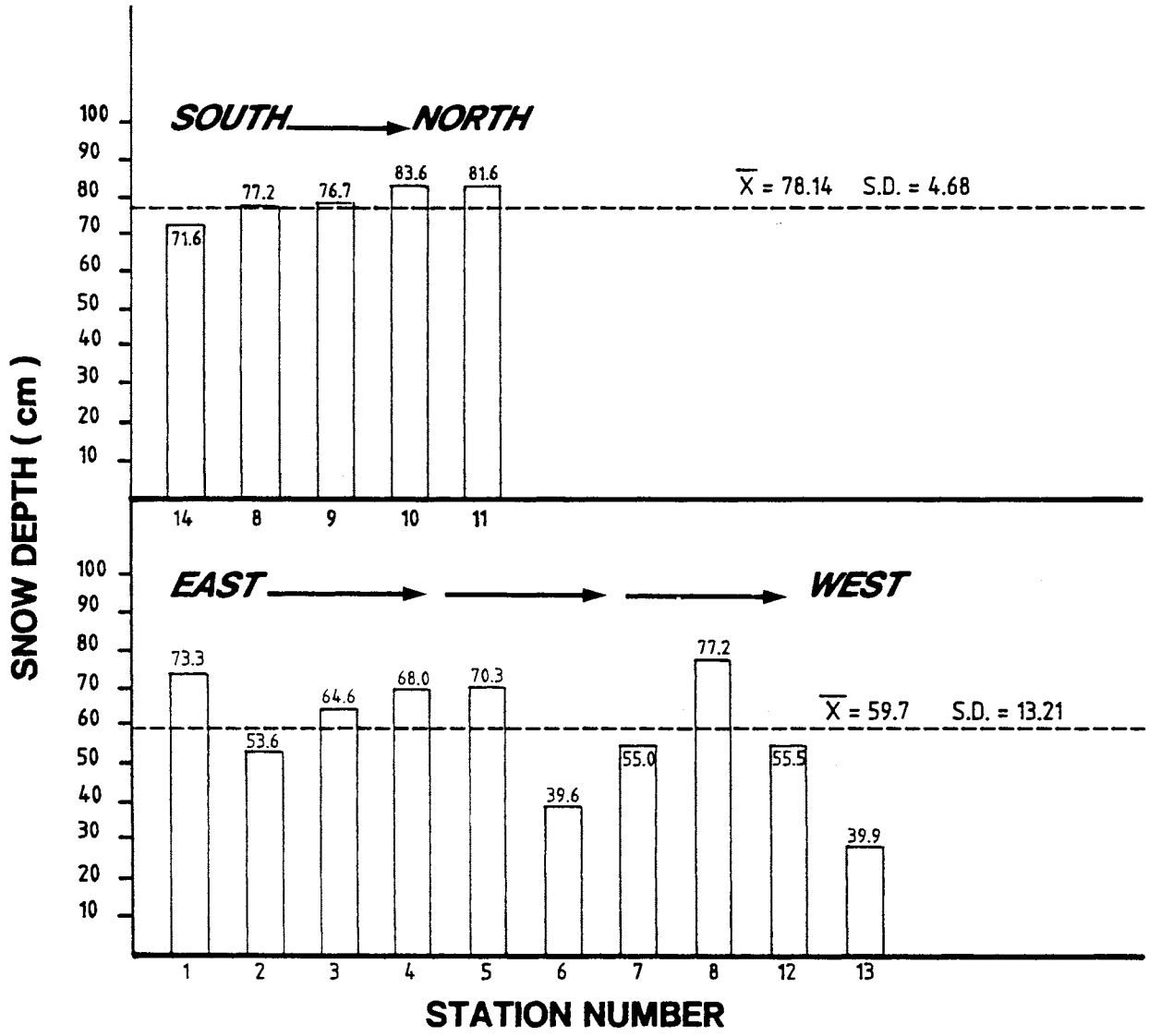
10 5 0 10 20 30 40 50 Kilometres





Station Number	Snow Depth (cm)
EAST / WEST	
1	73.3
2	53.6
3	64.6
4	68.0
5	70.3
6	39.6
7	55.0
8	77.2
12	55.5
13	39.9
NORTH / SOUTH	
11	81.6
10	83.6
9	76.7
8	77.2
14	71.6

Fig.14b: The snow distribution pattern on the WLH winter range, March 1987.



over the entire area was 65.9 cm. (SD=14.1). When compared to snow data collected by Environment Canada at six stations within and peripheral to the WLH winter range (Fig.14a, Table 6), their was less snow along our transects, and 1987 falls out as a year of slightly below average snow depths in the area. If we relate snow depth more precisely to caribou distribution and include only those stations that correspond to primary strata classified during the March, 1987 census survey (Fig.9), or stations 1,2, and 6-9, the mean snowdepth goes down further to 62.6 (SD=15.5).

Comparing the snow data indicates a pattern whereby minimal snow depths correspond to winter range distribution, as observed for other Yukon (data on file) and British Columbia herds (Bergerud 1978). This comparison does not indicate that a decreasing snow depth gradient, or 'snowshadow' condition, exist over the winter range of the WLH. But does indicate that most caribou are in fact seeking out available areas of less snow and are thus following the 'law of least effort' as predicted by Bergerud (1978). We content that the traditional use of winter ranges by woodland caribou is the product of a response to snow depth conditions coupled with availability of preferred forage. As it is demonstrated here, this obligatory response by caribou to those environmental forces, indicate that the winter range is a critical habitat and should be managed carefully.

Table 6. Snow depth data collected by Environment Canada at six stations within and peripheral to the WLH winter range.

			Past Record		
Station	Date of Survey (1987)	Snow Depth (1987)	Average Snow Depth	Years of Previous Record	Difference
Tintina Strip	31/3	73cm.	82cm.	11	-9cm.
Pine Lake	2/4	79cm.	88cm.	13	-9cm.
Meadow Creek	26/3	89cm.	103cm.	13	-14cm.
Morley River	2/4	63cm.	62cm.	2	+1cm.
Jordan	1/4	67cm.	62cm.	2	+5cm.
Ford Lake	31/3	80cm.	82cm.	2	-2cm.

The depth of snow on the WLH winter range was not altogether favorable for caribou in March 1987, and exceeded the depths critical for solitary animals to dig craters (50-60 cm.), (Russell and Martell 1984). However, this snow depth was not critical for cratering by groups of caribou (80-90 cm.). Since 1987 was

overall a low snow year, the WLH probably confronts fairly adverse snow conditions most winters.

In summary then, the winter range of the WLH appears to provide forage typical of caribou diets, but snow conditions on this range may prevent caribou from ingesting maximum amounts during the late winter period. This conclusion does not necessarily suggest that population growth in the WLH is presently limited by the winter range. But does indicate that that force should be considered within any option to manage the herd to higher numbers.

CONCLUSIONS and RECOMMENDATIONS

The inventory of the WLH provides us with some initial conclusions concerning herd management:

1. The WLH is a small woodland caribou population that is lightly hunted. Mortality does not appear to exceed recruitment, and the herd is probably increasing slightly. The feasibility of increasing the WLH is limited by the fact that the base population is small and considerable time and effort is required to substantially increase the WLH. The winter range capability of the herd may also moderate growth rates under intensive management. The WLH should therefore be managed by allowing it to proceed on its own course and be left relatively undisturbed.

2. Hunting of the WLH should be closely monitored. Most caribou populations in North America that coexist with wolves have experienced declines when harvested at 5% or greater (Bergerud 1979). The density of wolves in the range of the WLH is 9.3-10.5 wolves/1000 km^2, and is similar to levels found throughout the south and central Yukon (Hayes and Bowers 1987). Wolves are known to have a profound influence on woodland caribou population growth (Farnell and McDonald 1987), and the margin of harvestable surplus is slim. We believe that the WLH cannot support a substantial hunter kill and should not be harvested in excess of 2% of its population size. The annual kill should therefore not exceed 15 caribou. The harvest of caribou from the WLH under the present regulatory scheme is below this upper harvest limit, but if it were to increase, then a quota system should be implemented.

3. The sex ratio of the WLH is a matter of concern for management. Sex ratios have been suppressed to as low as 31 males/ 100 females elsewhere in North America by selective hunting, without loss of productivity (Bergerud 1971). The sex ratio of the WLH is 29/100 and likely the result of a natural process, not selective hunting. We could be on the verge of losing too many males from this herd, and there is little we can do about it without initiating an intensive management scheme (i.e. predator control). Harvest manipulation by selecting for females would likely have little effect and would be contrary to our general guideline of harvesting surpluses of males when only small yields of caribou are possible. Hence, the harvest level should also be kept low for the sake of preserving males.

4. Land use management is the principal tool at our disposal for maintaining the WLH at its present level. We have repeatedly seen caribou herds decrease because of increased access by roads and subsequent overharvest. There is a great deal of mineral extraction and exploration development taking place in the summer range of the herd. The potential therefore exists to see increased localized harvests of WLH caribou adjacent to mining roads. To prevent this from happening, and in the interest of maintaining the viability of the WLH, caribou hunting within WLH subzones that are bisected by new roads, should be disallowed.

5. The WLH inhabits a fairly large range (11,200 km^2) at low density (6 caribou/100 km^2), and sufficient sample sizes of caribou cannot be found efficiently during post-calving or rut to procure estimates of population composition for management purposes. Monitoring of WLH demography should therefore be confined to repeating the stratified random quadrat sampling technique during late winter, when it is deemed necessary to provide such data. We need to test the accuracy of our population projection, and management strategy. We should also monitor the status of the WLH sex ratio. We therefore recommend that a second population estimate of the WLH be conducted during late winter of 1993 or 1994. For the interim we hope that harvest monitoring and manipulation will be sufficient tools to maintain this herd at its present level.

ACKNOWLEDGEMENTS

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PERSONAL COMMUNICATIONS

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APPENDIX A
Summary of surveys flown to inventory the Wolf Lake caribou herd

Appendix A. Summary of surveys flown to inventory the Wolf Lake caribou herd.

	DATE	SURVEY TYPE	CARIBOU SEASON	OBJECTIVE
1.	09-24-84 09-25-84	Helicopter (10 hrs.)	Fall	a. Capture and radio-collar seven caribou.
2.	03-20-85	Fixed wing (5 hrs.)	Late Winter	a. Relocate radio-collars. b. Determine winter distribution.
3.	06-03-85	Fixed wing (5 hrs.)	Calving	a. Relocate radio-collars. b. Determine calving distribution.
4.	07-20-85 07-21-85	Fixed wing (5.5 hrs.)	Post-calving	a. Relocate radio-collars. b. Determine post-calving distribution.
5.	07-23-85 07-24-85	Helicopter (8 hrs.)	Post-calving	a. Composition count. b. Distribution details c. Capture and radio-collar T-43.
6.	10-03-85	Fixed wing (2 hrs.)	Rut	a. Relocate radio-collars. b. Determine fall distribution.
	10-05-85	Helicopter (3 hrs.)		c. Composition count. d. Distribution details.
7.	02-02-86	Fixed wing (3.5 hrs.)	Late Winter	a. Relocate radio-collars b. Determine winter distribution.
	02-07-86	Helicopter (3.5 hrs.)		c. Capture and radio-collar five caribou. d. Collect fecal samples.
8.	06-03-86	Fixed wing (3.4 hrs.)	Calving	a. Relocate radio-collars. b. Determine calving distribution.

Appendix A. (continued).

9.	07-17-86	Fixed wing (2.8 hrs.)	Post-calving	a. Relocate radio-collars. b. Determine post-calving distribution.
	07-18-86	Helicopter (7 hrs.)		c. Composition count. d. Distribution details.
	07-30-86	Fixed wing (2.5 hrs.)		e. Search for missing collar X-41.
10.	10-09-86	Fixed wing (2.5 hrs.)	Rut	a. Relocate radio-collars. b. Determine fall distribution.
	10-11-86	Helicopter (7.4 hrs.)		c. Composition count.
	10-12-86			d. Distribution details e. Investigate mortality.
11.	02-10-87	Fixed wing (3.5 hrs.)	Late Winter	a. Relocate radio-collars. b. Determine winter distribution.
	03-20-87	Fixed wing (3.5 hrs.)		a. Relocate radio-collars. b. Delineate survey area for census.
	03-21-87	Fixed wing (20 hrs.)		c. Stratification survey.
	03-22-87 to 03-26-87	Helicopter (30.8 hrs.)		d. Census survey. e. Fecal sample collection. f. Snow distribution survey.

APPENDIX B
The data for all relocations by radio-collar

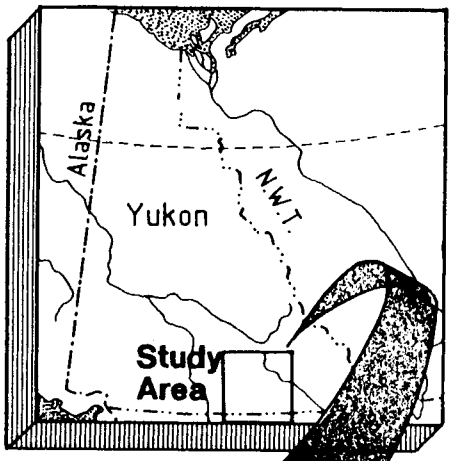
Figure A-1 : Relocations of Immature Male Caribou T-64

Notes :
- **6 relocations**
- **dead between June-July 1986**
- **captured on summer range**

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



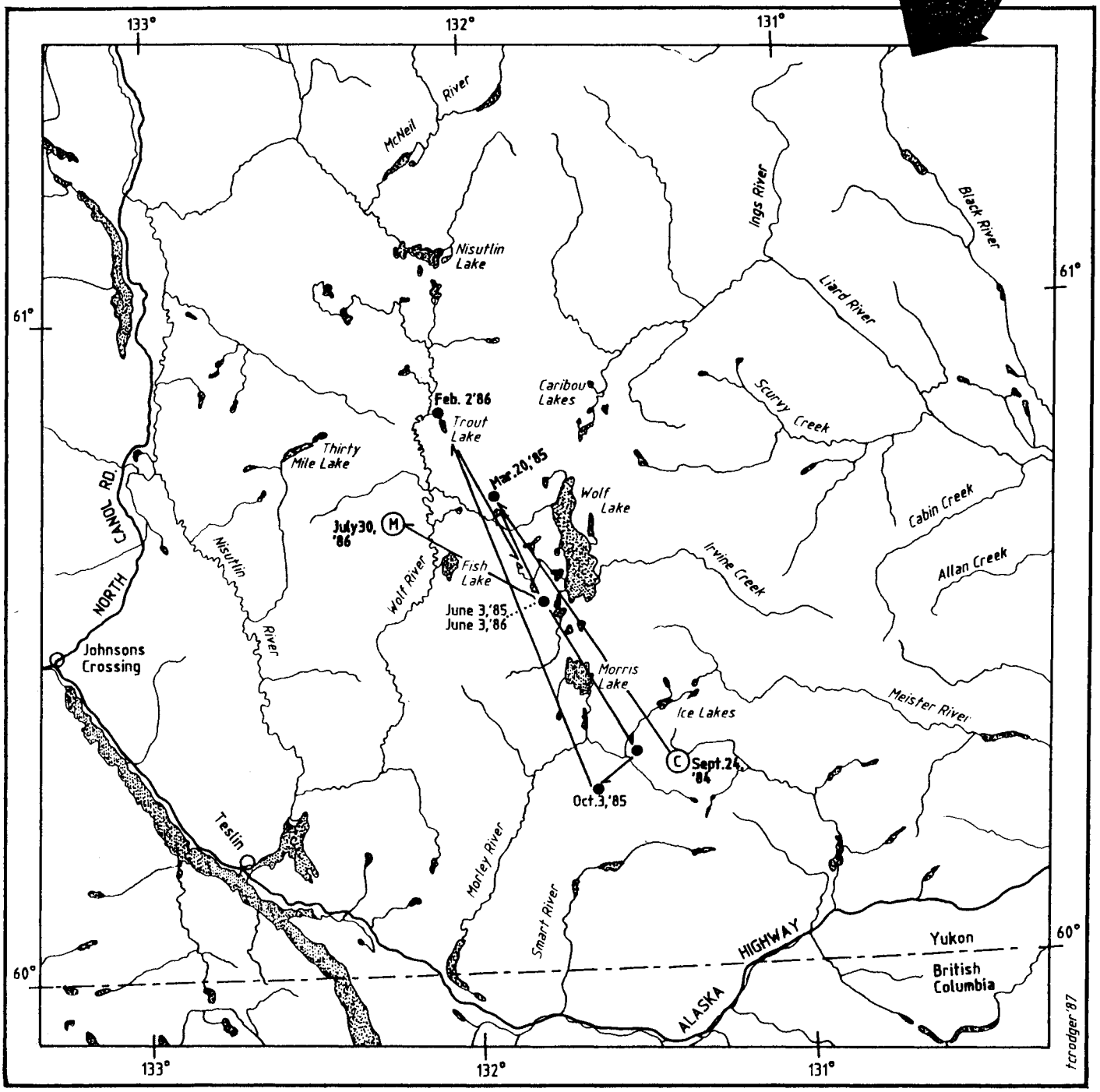


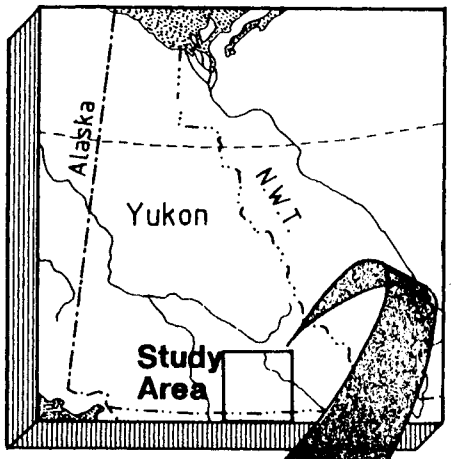
Figure A-2 : Relocations of Adult Female Caribou T-98

Notes :
- **7 relocations**
- **not found March 1985 and March 1986**
- **captured on summer range**

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



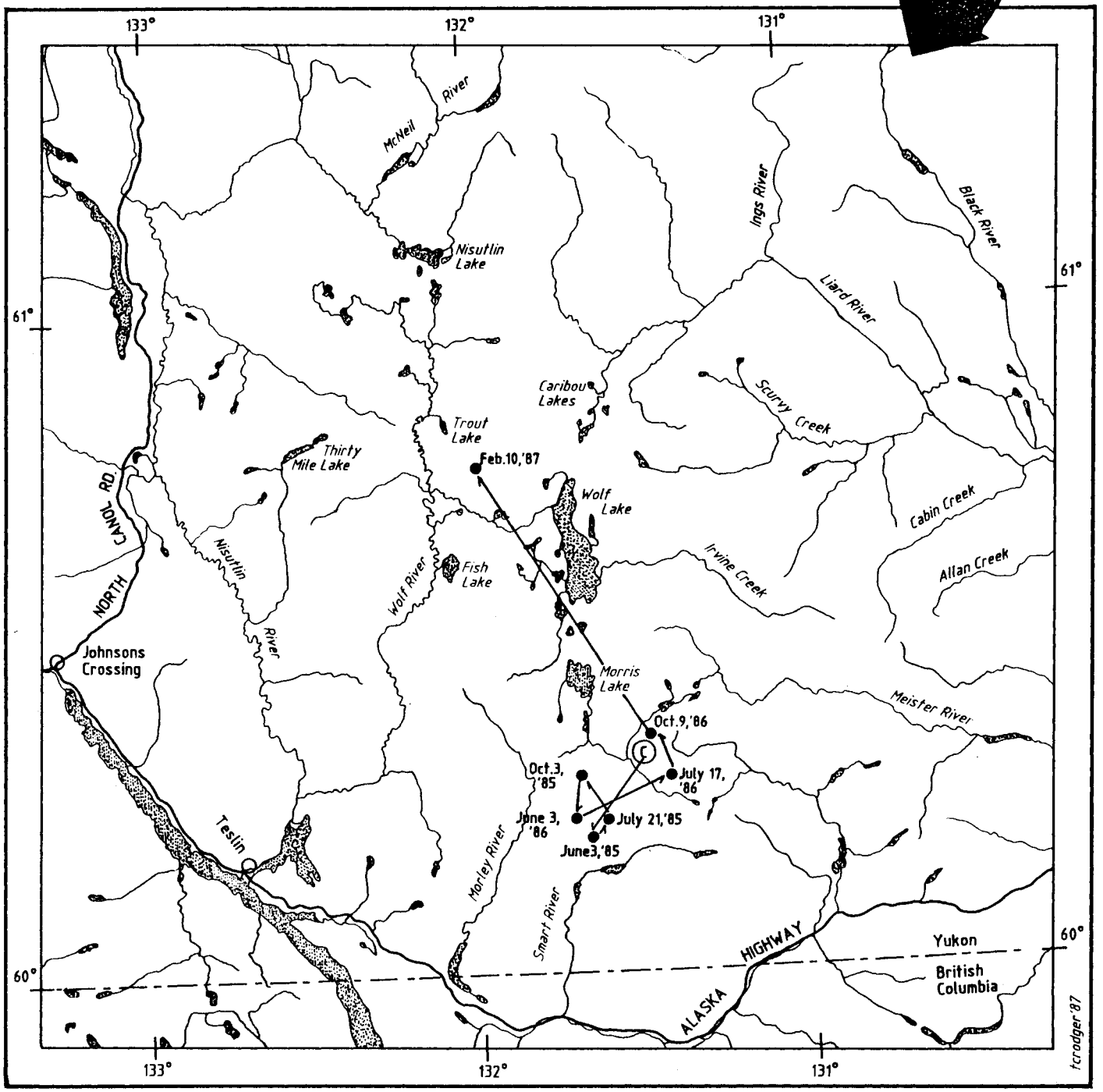


Figure A-3 : Relocations of Adult Female Caribou T-65

Notes :
- 7 relocations
- dead between June-July 1986
- captured on summer range

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres

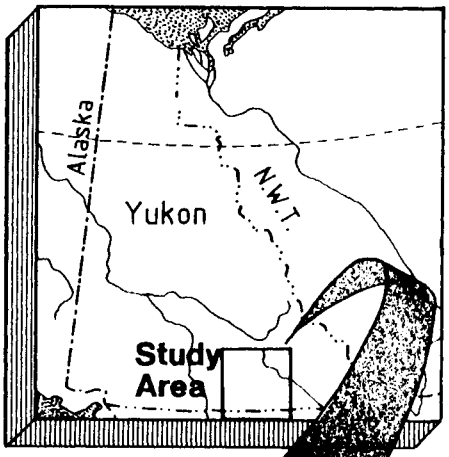


Figure A-4 : Relocations of Adult Female Caribou T-88

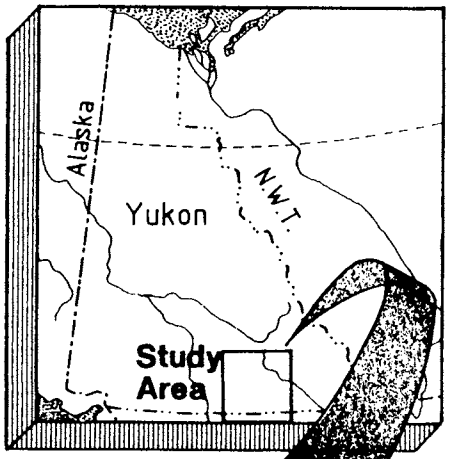
Notes :
- **transmitter failed after capture**
- **observed visually on two occaisions**
- **captured on summer range**

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres



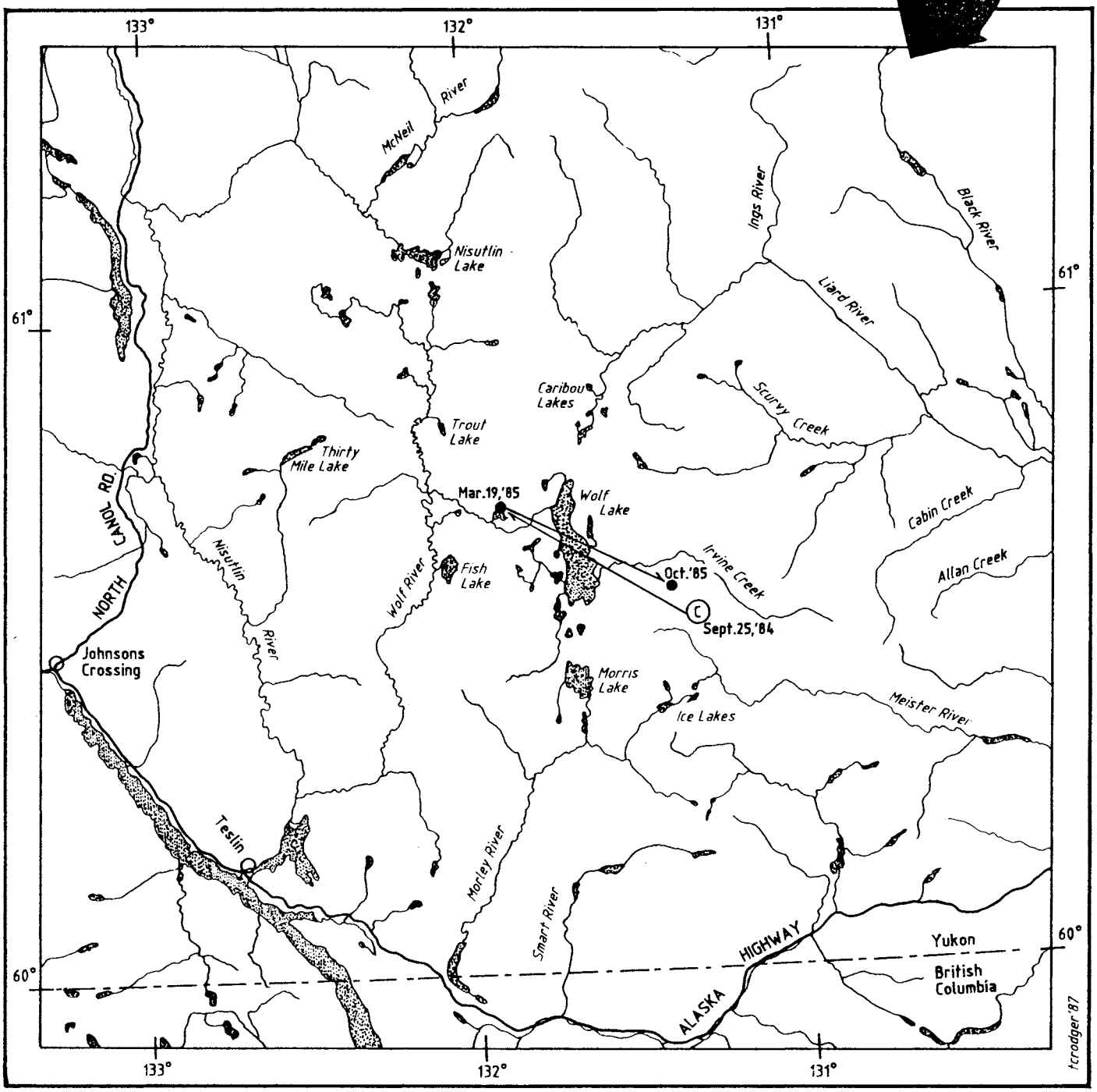


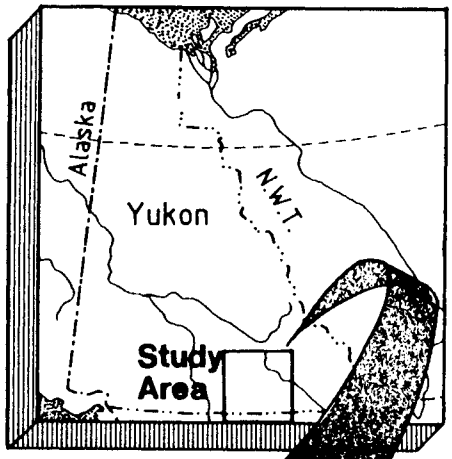
Figure A-5 : Relocations of Adult Female Caribou T-85

Notes :
- **9 relocations**
- **captured on summer range**

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



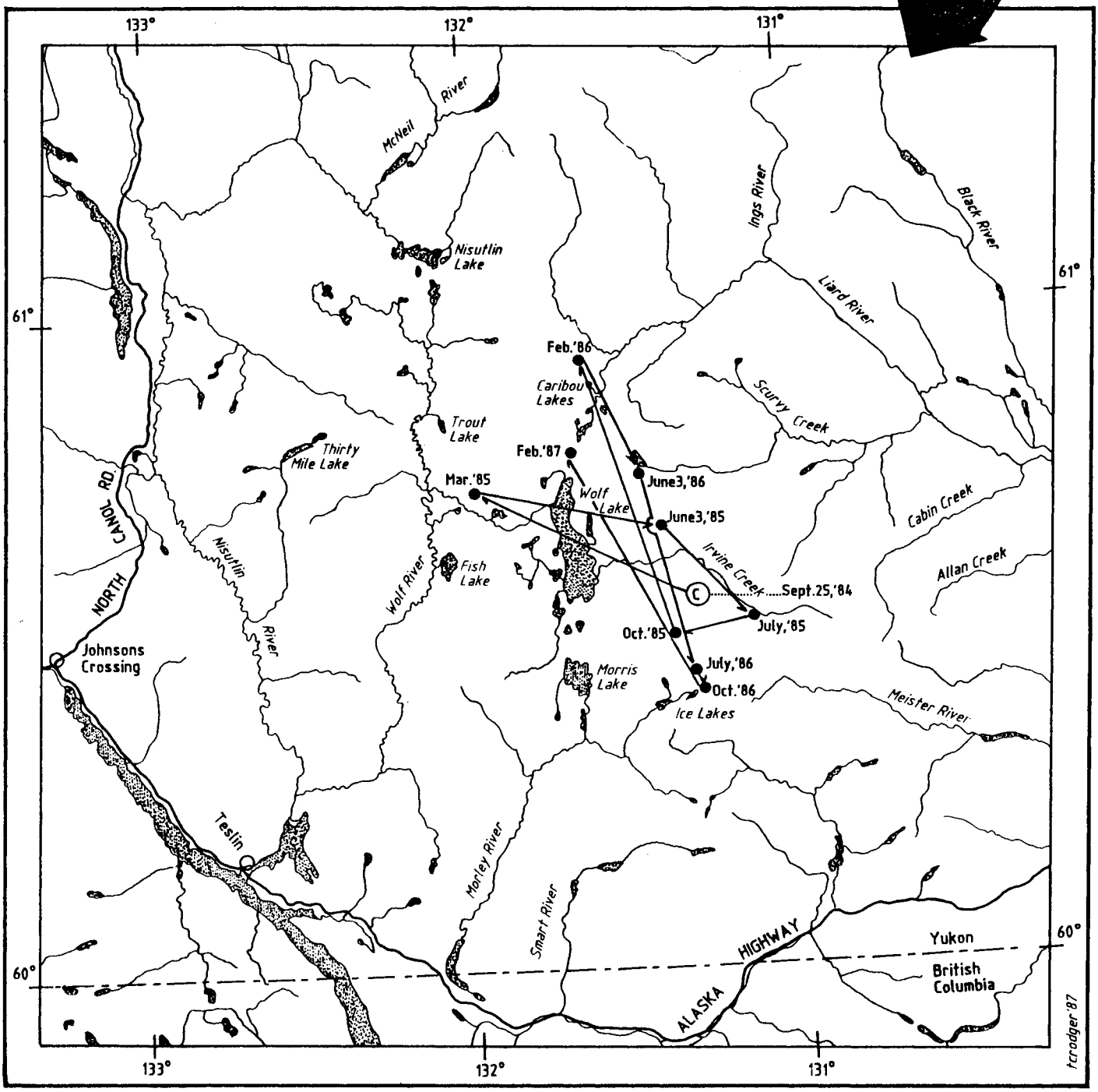


Figure A-6 : Relocations of Adult Female Caribou T-96

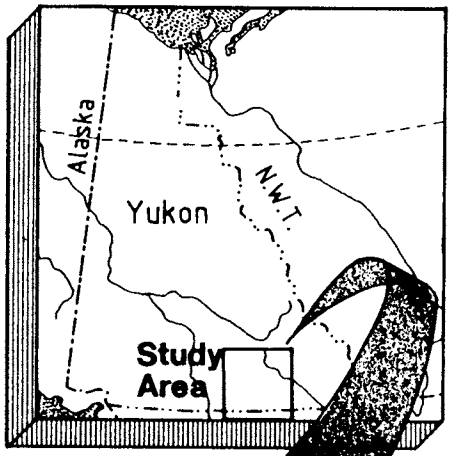
Notes :
- **8 relocations**
- **captured on summer range**

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres



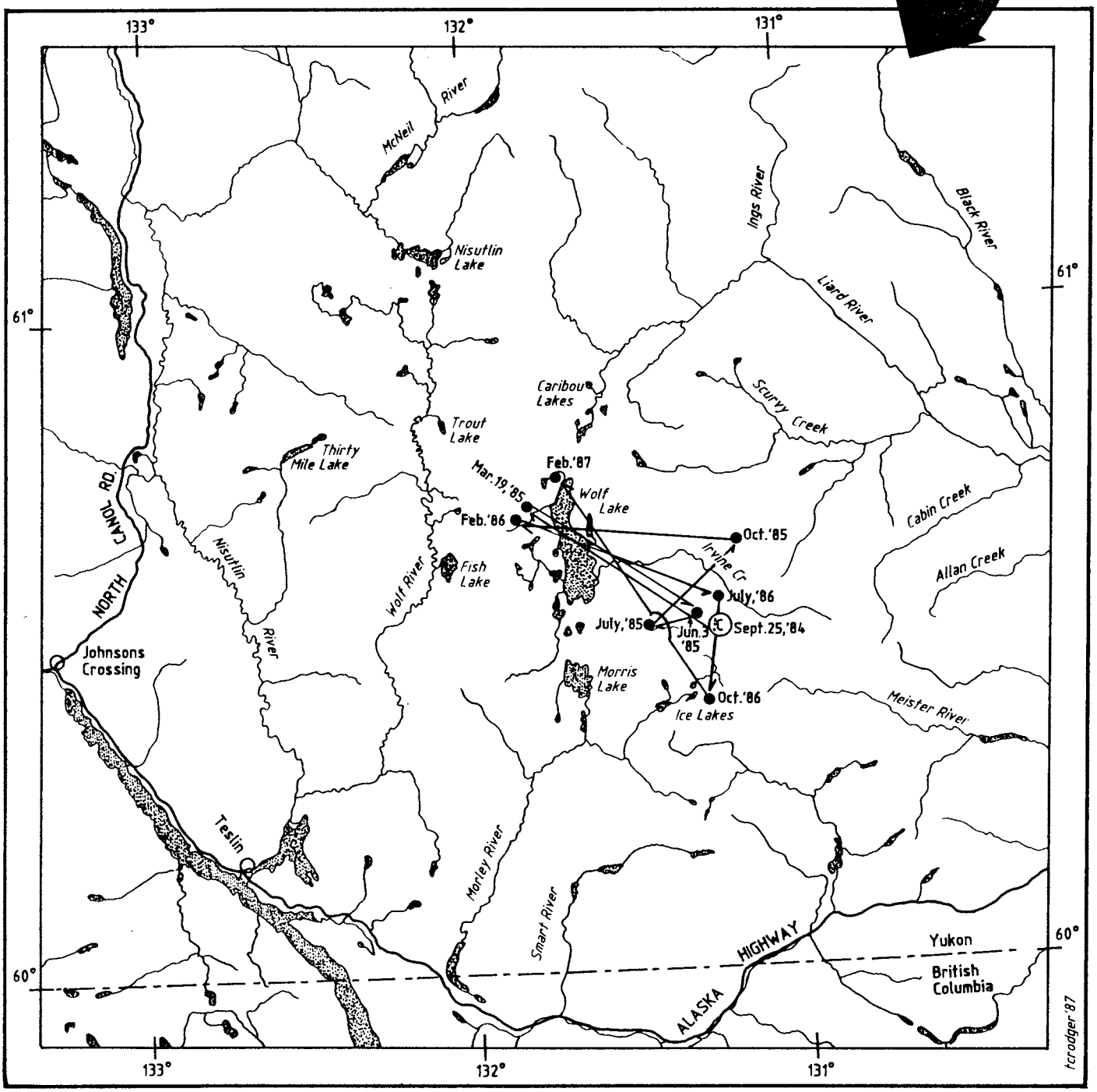


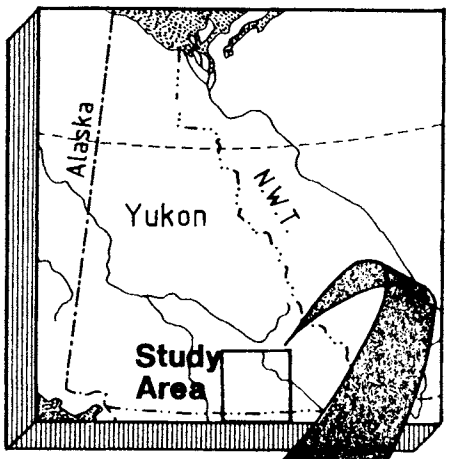
Figure A-7 : Relocations of Adult Female Caribou T-97

Notes :
- 6 relocations
- not found March '86, June '85, July '85
- captured on summer range

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



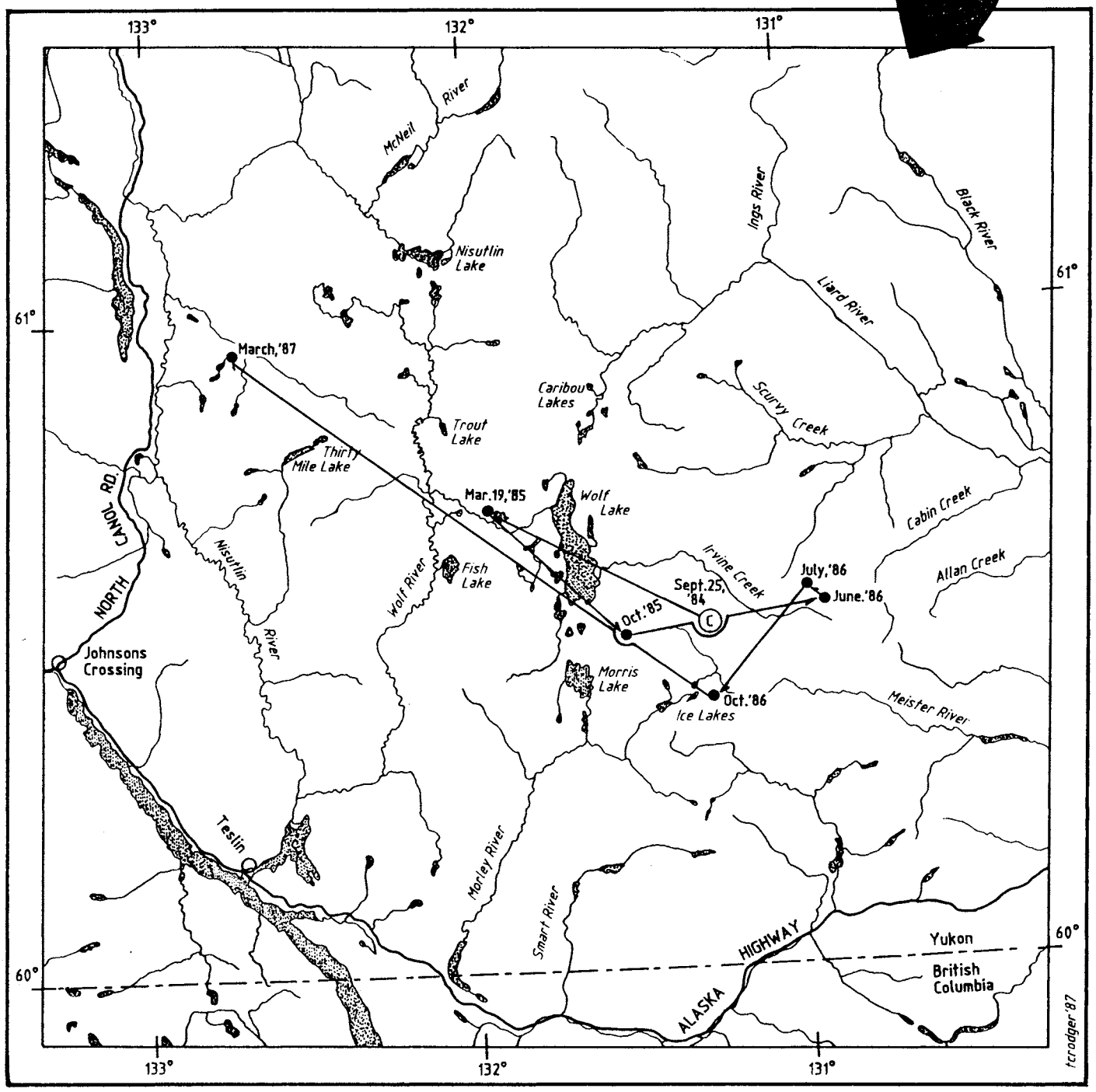


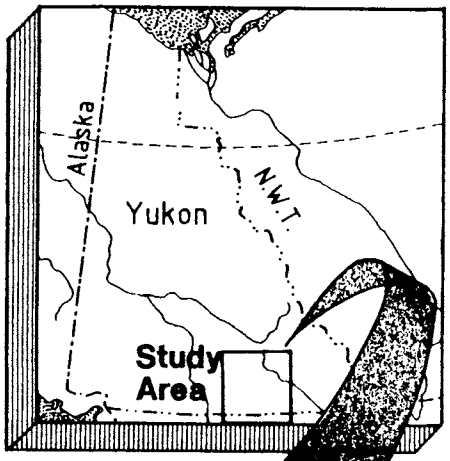
Figure A-8 : Relocations of Adult Female Caribou T-43

Notes :
- 6 relocations
- captured in July (Goat Lake area)
- captured on summer range

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



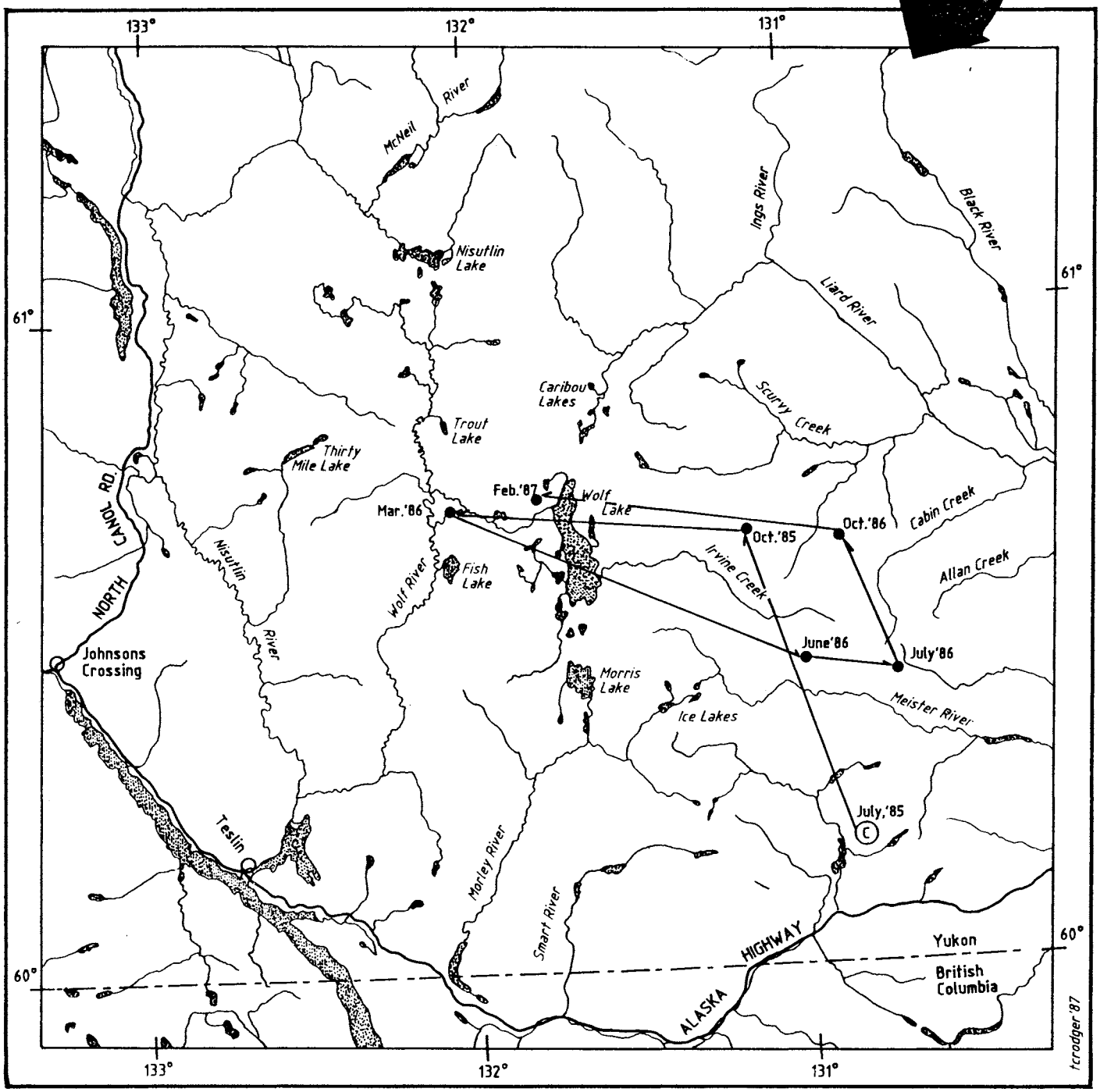


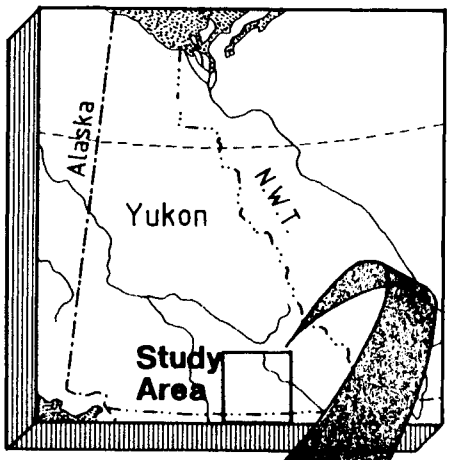
Figure A-9 : Relocations of Adult Female Caribou X-04

Notes :
- **4 relocatios**
- **captured on winter range**

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



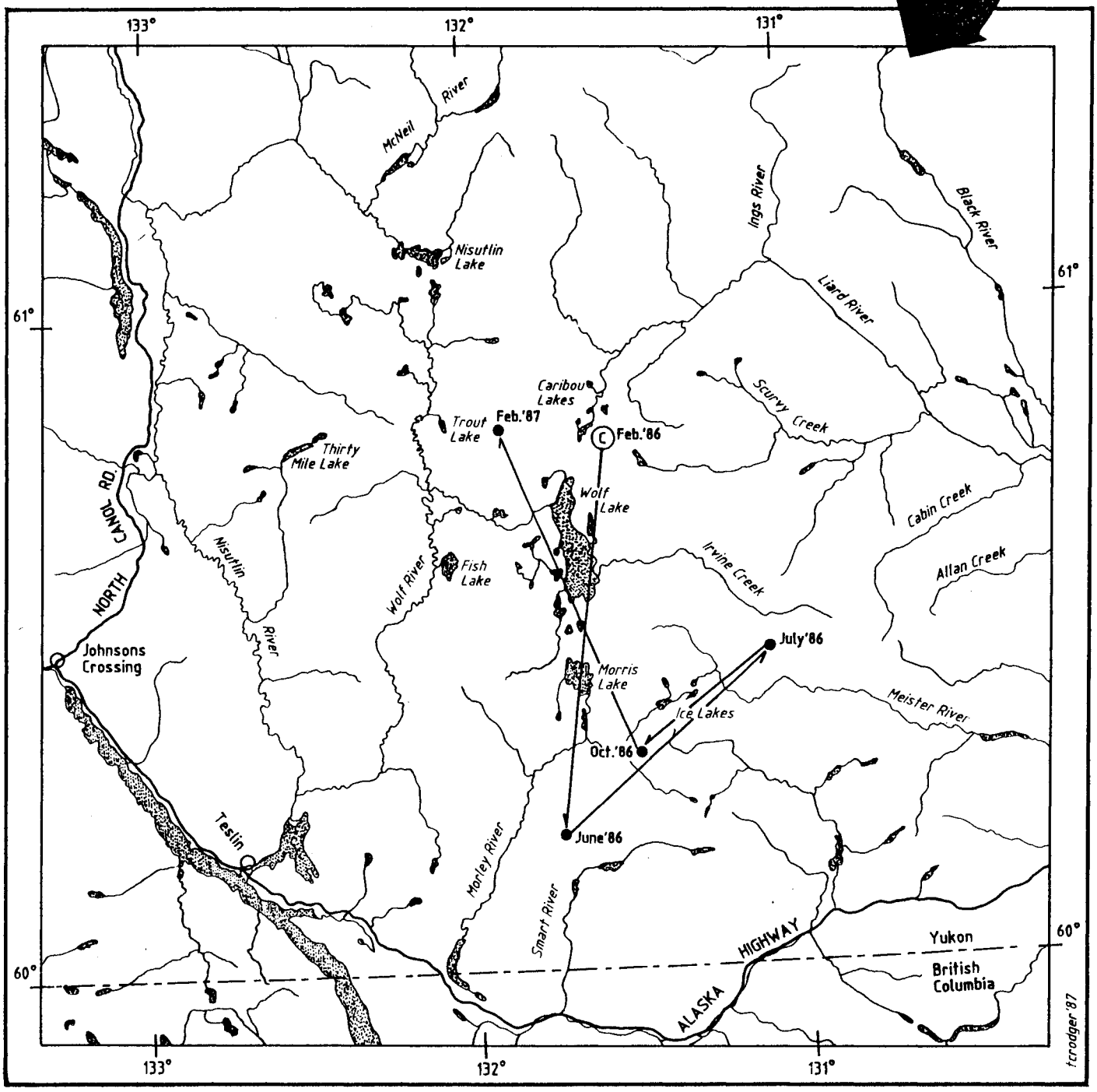


Figure A-10 : Relocations of Adult Female Caribou X-41

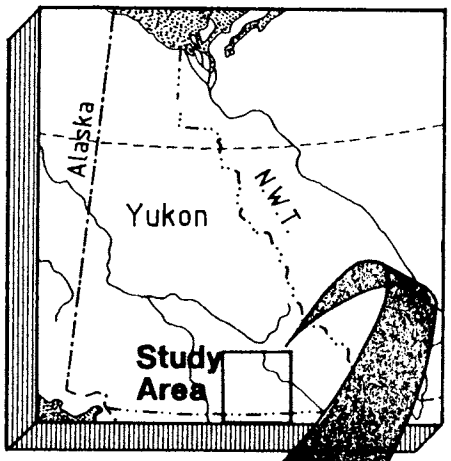
Notes :
- 3 relocations
- not found July 1986
- captured on winter range

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles

10 5 0 10 20 30 40 50 Kilometres



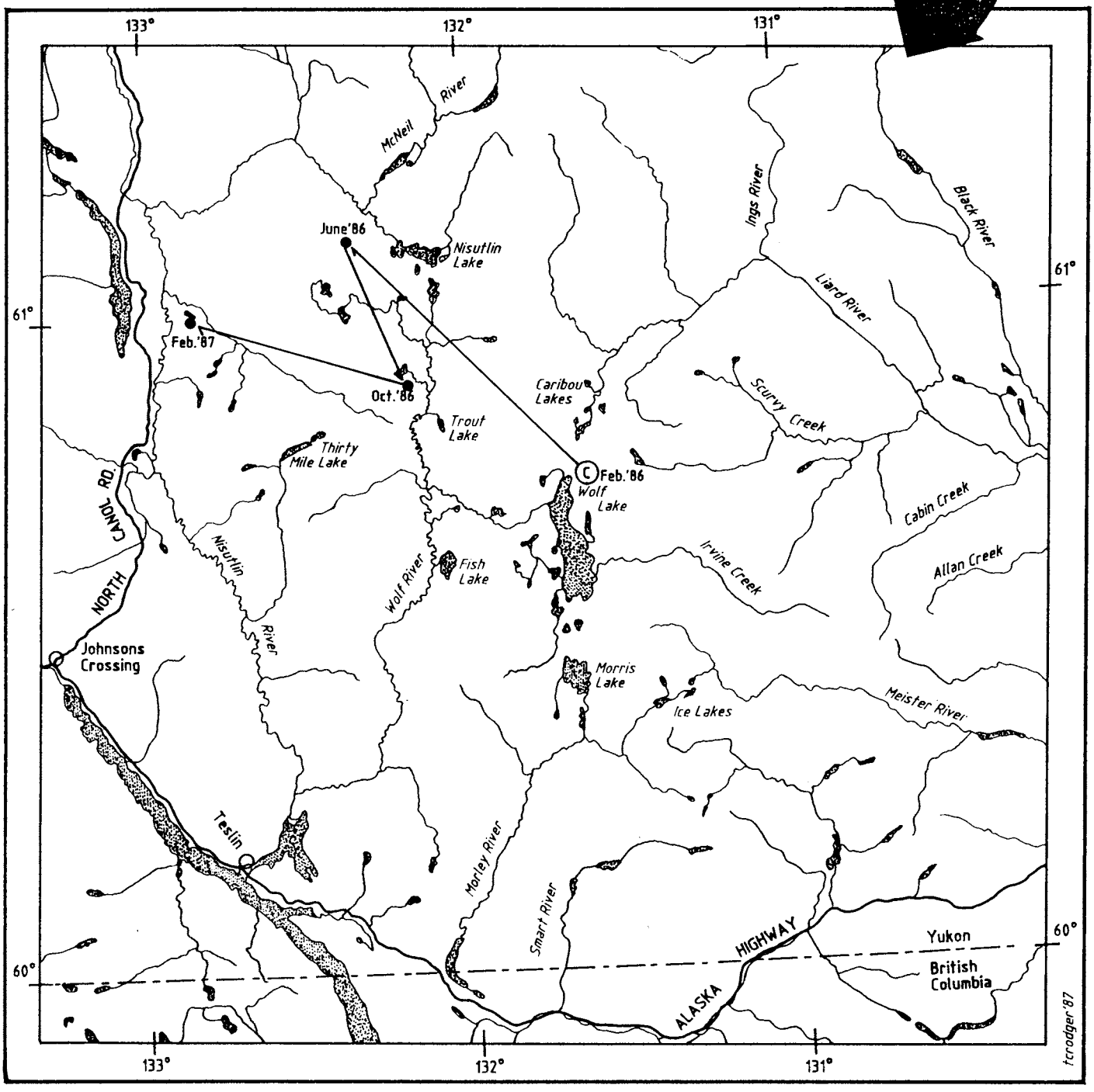


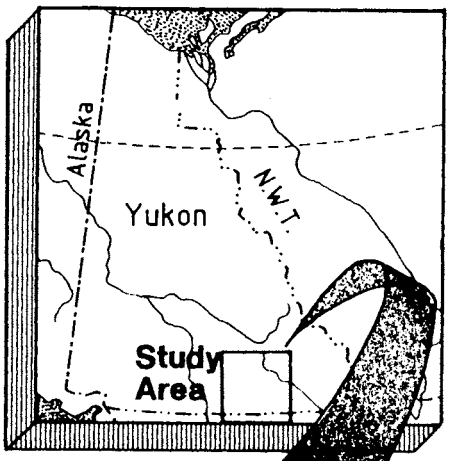
Figure A-11 : Relocations of Adult Female Caribou X-42

Notes :
- **4 relocations**
- **captured on winter range**

Key : Capture Site Ⓒ
Relocation Site ●
Mortality Site Ⓜ

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



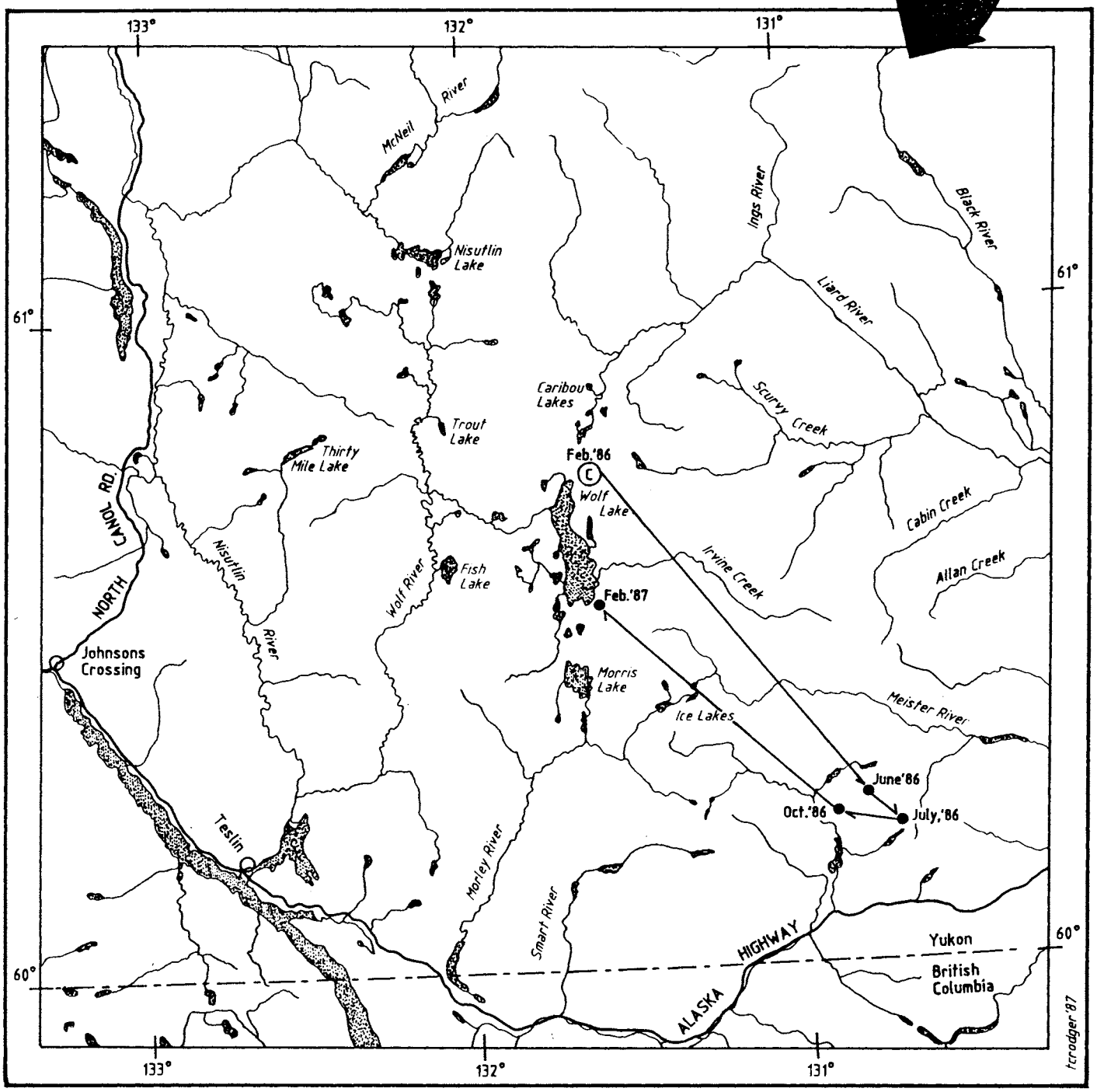
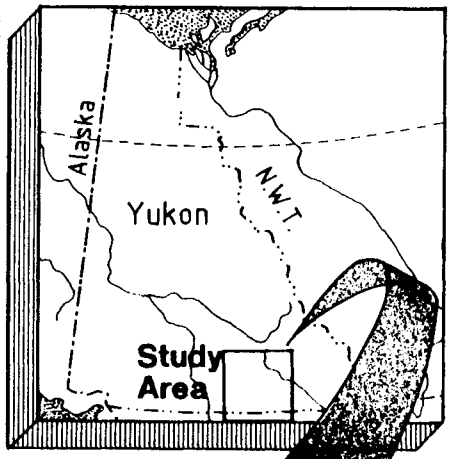


Figure A-12 : Relocations of Adult Female Caribou X-35
- 1 relocation
- transmitter malfunction
- fate not determined
- collared on winter range

Key : Capture Site Ⓒ
Relocation Site ●

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres



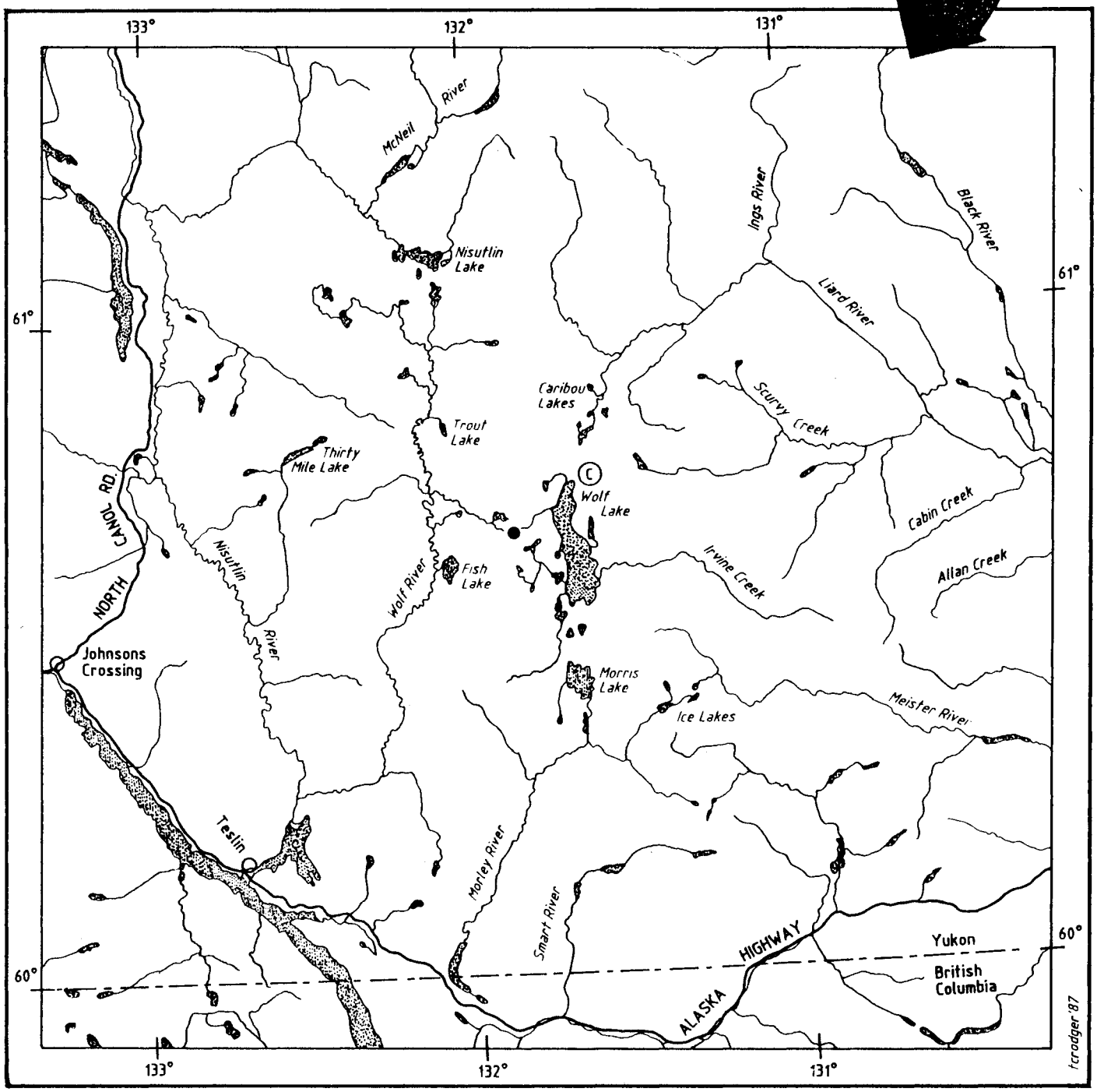


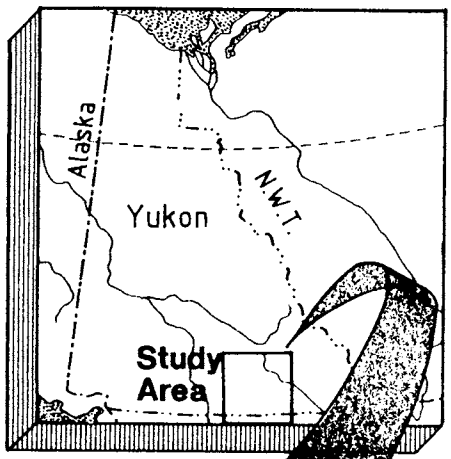
Figure A-13 : Relocations of Adult Female Caribou X-40

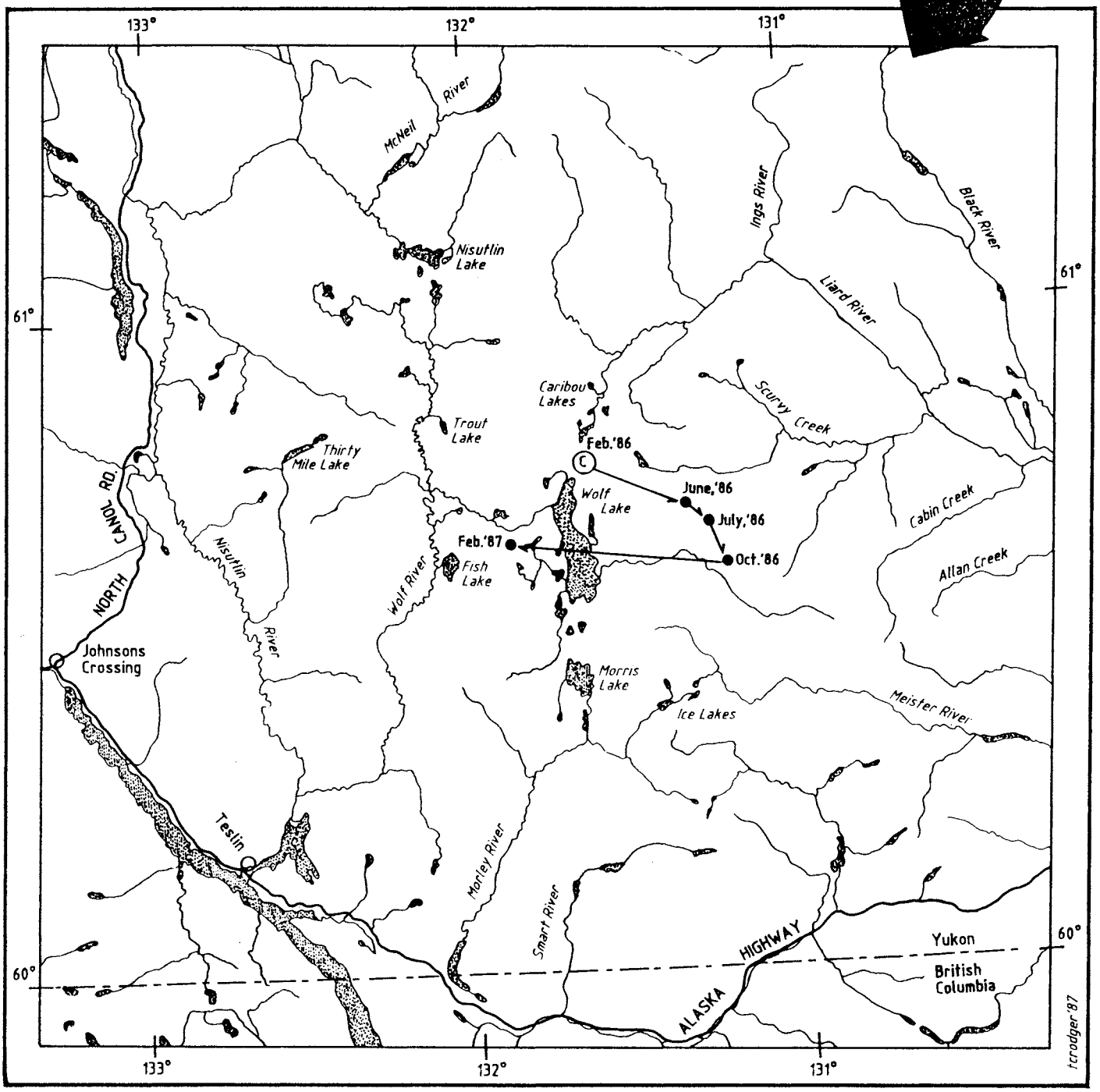
Notes :
- **4 relocations**
- **collared on winter range**

Key : Capture Site (C)
Relocation Site ●
Mortality Site (M)

Scale : 1 : 1,000,000

10 5 0 10 20 30 Miles
10 5 0 10 20 30 40 50 Kilometres





APPENDIX C
Caribou survey data for the Wolf Lake herd population estimate, 22 to 25 March 1987

Appendix C. Caribou survey data for the Wolf Lake herd population estimate, 22 to 25 March 1987.

Low Intensity Search (2.0 min./km.^{2})

Number	Date	Survey Unit	Adult Cow	Calf	Immature Male	Mature Male	Unclass.	Total Caribou	Area (km^2)
Primary Stratum									
1	3/22	16	14	7	1	-	-	22	22.55
2	3/22	17	12	4	3	3	-	22	18.35
3	3/22	18	16	8	3	1	-	28	15.35
4	3/22	19	8	-	5	6	-	19	35.35
5	3/22	32	33	11	5	1	5	55	47.62
6	3/22	34	26	6	-	1	3	36	37.20
7	3/23	10	34	4	1	2	-	41	31.95
8	3/23	2	8	1	-	8	-	17	32.70
9	3/23	9	37	5	5	7	-	54	37.50
10	3/23	8	13	4	1	4	-	22	32.45
11	3/23	7	5	3	-	-	-	8	25.95
12	3/23	25	46	12	6	3	5	72	37.65
13	3/23	26	20	4	3	-	-	27	33.50
14	3/23	27	6	-	3	-	-	9	6.85
15	3/24	5	3	1	3	14	-	21	33.60
	TOTAL		281	70	39	50	13	453	468.57
Secondary Stratum									
16	3/24	1	-	-	-	-	-	0	50.50
17	3/24	14	4	2	1	-	-	7	29.86
18	3/24	4	-	-	-	-	-	0	23.08
19	3/24	22	25	8	5	1	5	44	28.97
20	3/24	31	-	-	-	-	-	0	11.75
21	3/24	39	-	-	-	-	-	0	29.45
22	3/24	28	10	3	1	-	-	14	25.40
23	3/24	30	-	-	-	-	-	0	33.83
24	3/24	13	6	4	-	-	-	10	37.63
25	3/24	21	-	-	-	-	-	0	34.30
26	3/25	11	-	-	-	-	-	0	19.55
	TOTAL		45	17	7	1	5	75	324.32
GRAND TOTAL			326	87	46	51	18	528	792.89

.../2

Appendix C. (Cont'd)

High Intensity Search (4.1 min./km^2)

Survey Unit	Area (km^2)	Time (min.)	Intensity Over Survey Count	S.C.F.[a]
17	2.40	17	36/29	1.24
18	4.28	27	25/21	1.19
34	7.16	25	28/26	1.07
10	2.36	10	15/13	1.15
25	6.32	9	27/23	1.17
26	5.62	21	23/23	1.00
27	3.65	12	7/6	1.16
5	3.00	23	16/13	1.23
	34.79	144		MEAN=1.15

[a] sightability correction factor

APPENDIX D
Composition of the WLH from post-calving and fall survey samples 1985 and 1986.

Appendix D. Composition of the WLH from post-calving and fall survey samples 1985 and 1986.

YEAR	SEASON	FEMALES	CALVES	YEARLINGS	MALES	TOTAL
			COUNT			
1985	July	46	13	9	15	83
1985	October	139	21	8	66	234
1986	July	22	6	3	16	47
1986	October	70	14	-	29	113
			PERCENTAGES			
1985	July	55	16	11	18	-
1985	October	60	9	3	28	-
1986	July	47	13	6	34	-
1986	October	62	12	0	26	-
			RATIOS (per 100 females)			
1985	July	-	28	20	33	-
1985	October	-	15	6	47	-
1986	July	-	27	14	72	-
1986	October	-	20	0	41	-

APPENDIX E

The composition of the Little Rancheria caribou herd calculated from the stratified random quadrat census in March 1988

Appendix E. The composition of the Little Rancheria caribou herd calculated from the stratified random quadrat census in March 1988. (from Farnell in prep.b)

	Adult Females (22 mo.)	Calves (10 mo.)	Adult Males (22 mo.)
Corrected no. of caribou	410 ± 24%	122 ± 30.4%	122 ± 38.2%
Percentage of population[a]	62.7	18.6	18.7
Ratio per 100 females	------	29.8 ± 18.6%	29.7 ± 26.7%

* 2% were unclassified.

APPENDIX F

Average percentage (± SD) of discerned fragments in fecal samples collected during winter on the range of the Wolf Lake caribou herd

Appendix F. Average percent (± SD) of discerned fragments in fecal samples collected during winter on the range of the Wolf Lake caribou herd.

Plant genus or group	1985 Sample		1987 Sample 1		1987 Sample 2	
Moss	---		0.86		0.41	
			0.86	(1.21)	0.41	(0.92)
Fruticose Lichens	88.47		73.94		78.98	
Cetraria-type	2.94	(2.72)	3.27	(1.82)	2.75	(2.54)
Cladonia-type	85.53	(3.95)	70.67	(13.81)	76.23	
Foliose Lichens	---		8.81		2.63	
(Peltigera)			8.81	(12.85)	2.63	(1.81)
Mushrooms	0.44		---		---	
	0.44	(0.98)				
Horsetails	---		0.37		---	
(Equisetum)			0.37	(0.83)		
Graminoids	0.55		4.33		12.34	
Carex			3.74	(0.83)	11.68	(6.57)
Poa			0.59	(1.32)		
Festuca	0.55	(1.23)			0.66	(0.91)
Evergreen Shrubs	9.93		11.29		4.98	
Ledum	1.18	(1.12)	1.76	(2.12)		
Picea			0.94	(1.36)		
Vaccinium	0.74	(1.05)				
Pinus	8.01	(1.80)	8.59	(2.85)	4.98	(1.97)
Forbs	0.61		0.40		0.66	
(lupinus)	0.61	(0.84)	0.40	(0.90)	0.66	(0.91)
Total Lichens	88.47		82.75		81.61	