THE DISTRIBUTION, MOVEMENTS, DEMOGRAPHY, AND HABITAT CHARACTERISTICS OF THE KLAZA CARIBOU HERD IN RELATION TO THE CASINO TRAIL DEVELOPMENT, YUKON TERRITORY

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Renewable Resources

FINAL REPORT

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Table of Contents

Table of Contents (Cont'd)

Table of Contents (Cont'd)

List of Tables

List of Figures

List of Figures (cont'd)

SUMMARY

To assess potential impact of the Casino Trail on caribou, a study of the Klaza caribou herd (KCH) was carried out between February 1987 and March 1990 to collect data on caribou distribution, movements, demography, and habitat characteristics.

Seventeen female caribou were radio-collared on the herd's winter range (12 in 1987, and 5 in 1988). Radio locations encompassed a home range of roughly 5300 km^2 in game management subzones 5-10 to 5-13 and 5-22 to 5-26.

The sex and age composition and size of the population was estimated from counts during the rut (Oct. 1987 and 1988) and by using a modification of the stratified random quadrat method (Farnell and Gauthier 1988) in March 1989. Calf recruitment for 2 years varied from 11% in 1987 to 24% in 1988 (23% by March 1989), the adult sex ratio was skewed and was 48 males/100 females in 1987, 46/100 in 1988 and 33/100 in March 1989. The herd was estimated at 486 caribou in March 1989 after correcting for male caribou missed during the survey. The adult natural mortality rate was derived from the death rate of collared female caribou and was 4.9%. Harvest was estimated from the Yukon hunter questionnaire analysis and Outfitter Trophy export returns which averaged 8.7 caribou from 1979 to 1988. A harvest rate of 3% or 15 caribou is recommended.

An assessment of possible alternate winter range was made by evaluating; late winter range condition (food habits), utilization of vegetation cover types (vegetation mapping in relation to caribou activity), and regional snow density and depths. Analysis of plant composition from fecal samples collected during winter indicated an adequate diet in terms of nutritional quality and suggests that winter range condition is good. Open and sparse spruce cover types were the most intensively used and most important cover types for caribou during late winter. All comparisons suggested that snow density was quite uniform throughout the study area and favorable for caribou to dig craters, while snow depths, although suitable regardless of cover type, were deeper on the late winter range, indicating that alternate winter range does exist for the KCH.

We proposed that because the KCH occupies the former wintering grounds of the Fortymile herd: this latter herd decline has a large bearing on the KCH's behavior and population dynamics.

Caribou will be most affected during winter when the majority of the herd occupies the traditional winter range in Selwyn R./Hayes Cr., an area bisected by the proposed road. The Mount Cockfield area was likewise inhabited by substantial numbers of caribou during spring, summer and fall.

Detailed recommendations are made concerning the herd's management in relation to the proposed Casino Trail.

INTRODUCTION

To make mineral exploration and extraction easier in the Dawson Range, the Regional Transportation Access Program (RTAP) provided funding for construction of an access road from Carmacks, west 150 km to the Casino mine site (Fig. 1). Concern over the effects of the Casino Trail on the local population of woodland caribou Rangifer tarandus caribou (the Klaza caribou herd, KCH) prompted a study to provide data on caribou movements, distribution, demography, and habitat characteristics; information necessary to recommend mitigative measures that would reduce impact of the Casino Trail, and other associated access roads, to a level that does not affect herd population dynamics. Conducted between February 1987 and March 1990 this study represents the first appraisal of the herd.

Road construction could negatively impact the KCH by: 1) increasing hunter access to the herd when they are most concentrated; 2) causing range abandonment resulting from mining development activities; and 3) causing direct loss of habitat through road construction, mining exploration and development.

Because road construction progressed concurrently with the study, it was necessary to provide immediate management recommendations as potential impacts became obvious. These recommendations were forwarded to the Local Resource Group (composed of representatives from the Selkirk and Carmacks/Little Salmon Bands, Yukon Community and Transportation Services, and a consultant). This group provided advice from regional perspectives on social, economic, and environmental impacts of the Casino Trail. Preliminary findings were incorporated into a big game management plan for the Casino Trail area (Jingfors 1989). Interim data also were presented at the Casino Trail Workshop held at Whitehorse on June 19-20, 1989. Earlier measures to reduce impact of the Casino Trail on the Klaza caribou herd (KCH) included:

1) a caribou hunting closure for all of the accessible regions of the herd's range (GMS 5-22 to 5-26).
2) a proposal for a special conservation area to be managed jointly by local residents of Carmacks and Pelly Crossing.
3) suspension of road construction to allow additional time for impact assessment of construction through the 'core winter range'.

Winter ranges are considered key habitat for woodland caribou (Klein 1982). Typically woodland caribou are found at their greatest annual concentration in late winter (March). For example the Finlayson caribou herd in east-central Yukon has a home range of approximately 26000 Km^2 with a late winter range of 2100 km^2 area (Farnell and Hayes in prep.). In addition, studies of other woodland caribou herds in the Yukon have shown that they return to a traditional late winter range each year (Farnell and Russell 1984, Farnell and McDonald 1988, 1989, 1990, Gauthier 1984). Herd fidelity to late winter ranges strongly suggest that these areas have biological significance essential to herd welfare.

Bergerud (1978) stated that in the winter caribou will always be located where snow cover and food presence provide the greatest relative availability of food ("law of least effort"). In British Columbia, lichens, an important food item, are most abundant on north and east slopes in the snow shadow of the prevailing moisture laden winds. The combination of abundant winter forage and shallow snow cover appears to determine that caribou winter on north and east slopes in British Columbia. According to Bergerud's theory we expect that the KCH winter range contains the greatest relative availability of lichen to caribou. Assuming that sufficient lichen, and shallow snow cover on the late winter range of the KCH, does not exist elsewhere within the herd's range, any impact to caribou or their habitat in this area could be detrimental. Disturbance and habitat loss, in theory, can result in "diminished growth and reproduction, avoidance or abandonment of critical areas, injury or death" (Bloomfield 1979). Roads and traffic, however, do not necessarily result in disturbance. The Alaska Highway, which bisects the late winter range of the Little Rancheria caribou herd, has not caused the herd to abandon their late winter range (Farnell and McDonald 1990).

Historically, the Dawson range was occupied by portions of a population of barrenground caribou, the Fortymile herd. Early in this century the Fortymile herd ranged across central Yukon/Alaska and was believed to number more than 500,000 caribou (Murie 1935). The herd made extensive use of the Dawson Range during winter, but was last recorded in that vicinity during 1942, at which time it was experiencing the most drastic decline of any caribou population in North America (Urquart and Farnell 1986). The herd was eventually reduced to 5000 by 1975 as a result of excessive hunting, made possible by roads bisecting seasonal ranges (Davis et al. 1978). The decline of the Fortymile herd provides the most dramatic example of the damage that uncontrolled hunting from roads can cause. The Fortymile herd has since, through intensive management, recovered to 22,000 caribou by 1989 (P. Valkenburg pers. comm.) and is reoccupying a fraction of its former Canadian range, well north of this study area (Data on file). As barrenground caribou of the Fortymile herd and woodland caribou of the KCH presently occupy ranges that do not overlap, the range use behaviour, and population dynamics of the KCH are not presently influenced by the Fortymile herd.

We compared the traditional late winter range of the KCH to surrounding habitat within and slightly beyond the total home range of the herd. We wanted to determine whether alternate late winter range existed in the event the KCH was totally displaced from their present late winter range. We speculated that alternate late winter range existed because the whole region had once served as winter range for the Fortymile caribou herd.

STUDY AREA

The study area is located in the central Yukon northwest of Carmacks (Fig. 1), and includes the entire home range of the KCH. It includes the eastern two-thirds of the Dawson Mountain Range. The study area is roughly 13,321 km^2 (5,144 mi^2) in size and is characterized by smooth, rolling topography, with moderate to deeply incised valleys. Most of the terrain lies between 1000m and 1500m elevation, the highest peaks (Prospector and Apex Mountains) are around 1800m above sea level.

Open stands of black spruce (Picea mariana) and white spruce (P. glauca) occur in valleys and on lower slopes, with black spruce on wetter sites and white spruce on better drained sites. Willow (Salix spp.), shrub birch (Betula spp.), Labrador tea (Ledum spp.), moss, and lichen (Cladina spp.) are principal understory species. Most terrain is above treeline however, at about 1200m where shrub birch and willow predominate.

The climate is continental and cold, with mean annual temperatures in the vicinity of $-7^{o}C$ and average annual precipitation about 330 mm. Precipitation may be somewhat higher in the southern portion than in the northern part because of the rainshadow effect of the mountains. Physiography, vegetation and climate are described in more detail by Oswald and Senyk (1977).

Other ungulates in the study area include 60-70 dall sheep (Ovis dalli) (Hoefs and Lortie 1975), and low densities (0.04/km^2) of moose (Alces alces) (Markel and Larsen 1988). Potential predators of caribou in the study area include wolves (Canis lupus), grizzly (Ursus arctos) and black bears (U. americanus), wolverine (Gulo gulo), lynx (Lynx canadensis), and golden eagle (Aquila chrysaetos).

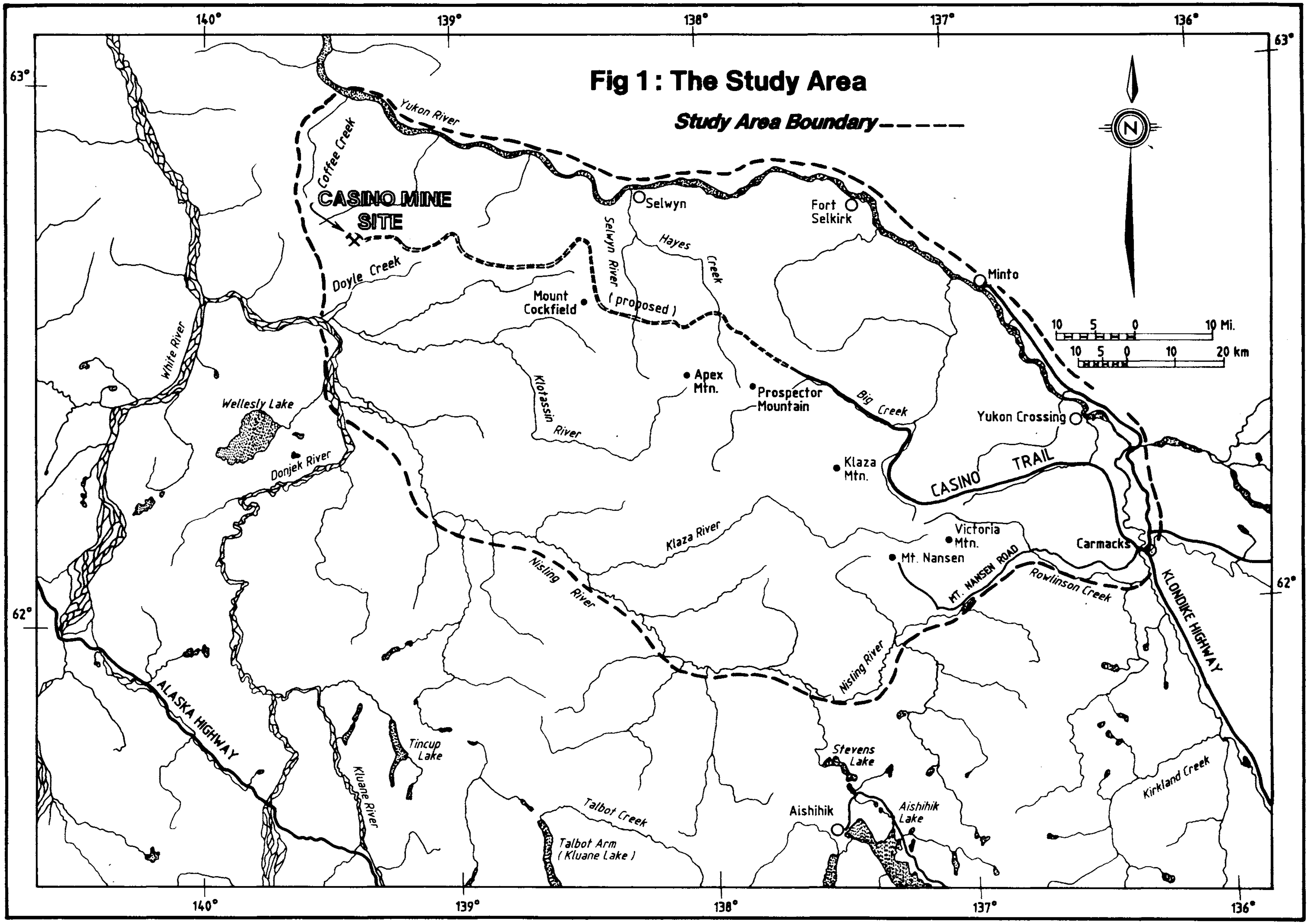


Fig 1 : The Study Area

SEASONAL MOVEMENTS AND DISTRIBUTION

OBJECTIVES AND METHODS

Objective: To determine patterns of range use for the KCH in relation to the proposed Casino Trail alignment.

Capture and Radio-collaring

Caribou were captured using the net-gun capture method (Barret et al. 1982). All caribou were captured on the winter range during mid-February. We selected adult female caribou for capture because females retain collars better than males. Neck expansion and contraction in males during the fall breeding season often leads to shed collars.

All radios contained movement sensitive mortality switches (Telonics Inc., Mesa, Arizona). To aid resightings, a highly visible vinyl covering with an identification number was sewn to each radio-collar.

Distribution and Movement Surveys

To determine the annual distribution of the KCH, 6 seasonal periods were selected for relocation of radio-collared caribou: winter, which included early (Dec.), mid (Feb.), and late (March) winter periods, calving (June), post-calving (July), and rut (Sept.-Oct.). There were 16 high level relocation surveys (84 hrs. fixed wing) flown between June 1987 and March 1990 (Appendix A). The relocation, the distances moved between seasonal periods, and the locations in relation to the proposed routing of the Casino Trail (Fig. 1) for radio-collared caribou, were plotted and/or measured on 1:250,000 topographic maps.

To determine the timing of caribou departure from winter range to calving sites 5 flights were flown during spring migration between 21 April and 10 June 1989 (21 hrs.).

Three fixed wing reconnaissance surveys were flown to determine the distribution of caribou tracks in the snow, which along with observations during relocation flights helped define the mid and late winter distribution of the herd. These track surveys were flown on; 1) 5-11 February 1987 (29 hrs.), 2) 15-17 March 1990 (24 hrs.), 3) 29-30 March 1990 (10 hrs.) (Appendix A).

The relocation of caribou during calving provides an opportunity to examine fidelity of females to calving areas. We considered caribou to be on the same calving range if they were relocated within 10 km of the previous year's calving location. We applied this distance because it is less than the mean, straight-line distances moved by radio-collared females between calving and post-calving periods (14 km) (Fig. 3) and therefore likely within the calving range of an individual at the time.

When a mortality signal was detected we returned to the site by helicopter to investigate the cause of death.

RESULTS AND DISCUSSION

Radio-collaring

All caribou captured for this study were adult females (Table 1). Twelve were captured during February 1987 in the Klaza River, Hayes and Selwyn Creek areas, and five during February 1988 in the Klaza River area (Fig. 2). Two collars were not fitted to caribou adequately and were found discarded after only a few relocations. Approximately 4% of the herd was radio-collared.

Table 1. Radio-collaring data for the Klaza caribou herd.

Date	Collar	Sex	Age	Capture Location	End Status	No. of Relocations
87/02/12	Z-44	F	Adult	Apex Mtn.	Cast	3
87/02/12	Z-54	F	Adult	Apex Mtn.	Alive	15
87/02/12	Z-45	F	Adult	Apex Mtn.	Alive	16
87/02/12	Z-01	F	Adult	Apex Mtn.	Dead	12
87/02/13	Z-90	F	Adult	False T. Cr.	Failure	12
87/02/13	Z-93	F	Adult	False T. Cr.	Alive	16
87/02/13	Z-91	F	Adult	False T. Cr.	Cast	3
87/02/14	Z-56	F	Adult	False T. Cr.	Alive	16
87/02/15	Z-51	F	Adult	Hayes Cr.	Dead	8
87/02/15	Z-14	F	Adult	Magpie Cr.	Alive	14
87/02/15	Z-88	F	Adult	Lonely Cr.	Alive	16
87/02/15	Z-96	F	Adult	Mt. Pitts	Alive	15
88/02/16	AA-91	F	Adult	Klaza R.	Alive	11
88/02/16	AA-25	F	Adult	Lonely Cr.	Alive	11
88/02/17	AA-05	F	Adult	Klaza R.	Alive	11
88/02/17	AA-93	F	Adult	Klaza R.	Alive	11
88/02/17	AA-06	F	Adult	Klaza R.	Alive	11

Distribution and Movement Surveys

There were 19 relocation surveys (84 hrs. fixed wing) flown between June 1987 March 1990, to obtain 236 contacts with radio-collared caribou during various seasonal periods (Table 2).

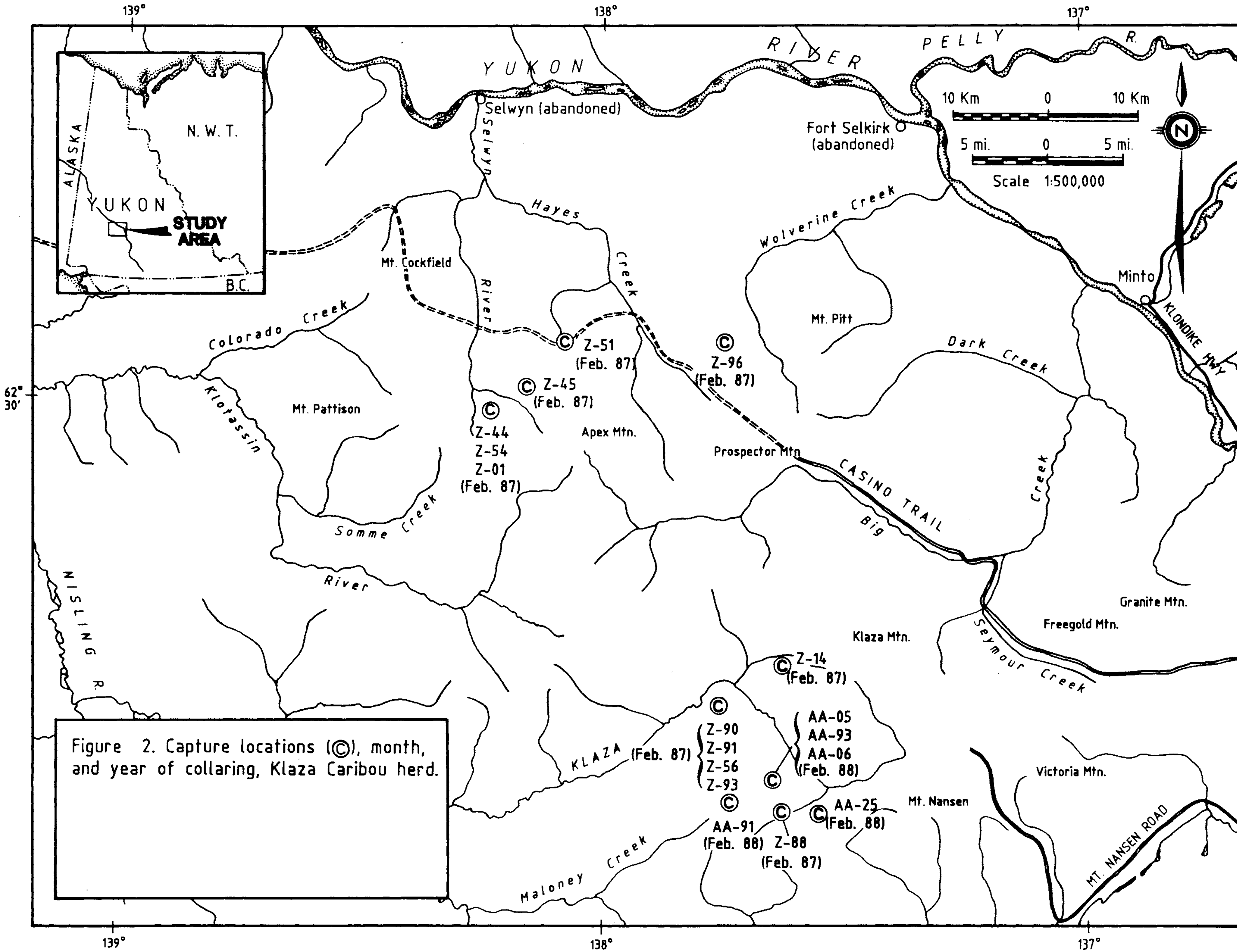


Figure 2. Capture locations (©), month, and year of collaring, Klaza Caribou herd.

Table 2. Summary of relocation flights during the study.

Period	1987	1988	1989	1990	No. of Relocations
Calving	3 June	9 June	10 June	----	39
Post-calving	16 July	9 July	20 July	----	41
Rut/Fall	3 Oct.	6 Oct.	25 Sept.	----	36
Early Winter	21 Dec.	20 Dec.	19 Dec.	----	35
Late Winter	----	----	15 March	29 March	25
Spring Migration	----	----	21 April 10 June	----	60

Calving Distribution

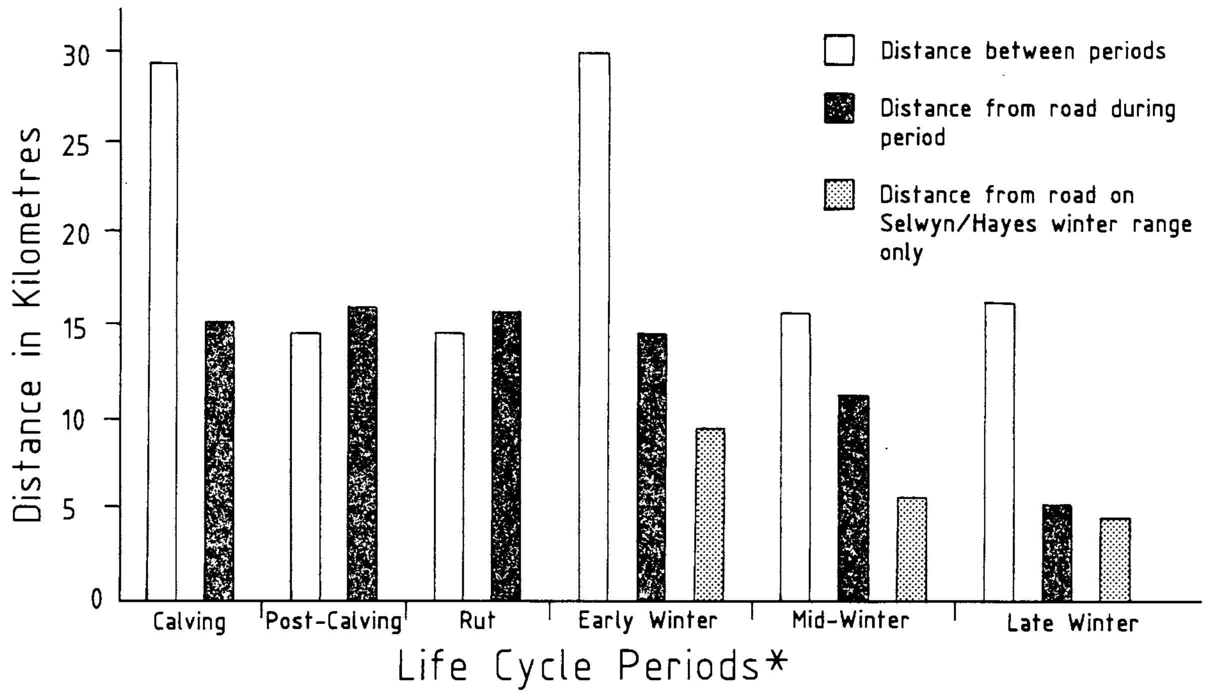
The straight line distances between late winter and calving locations averaged 28km (SD= 13.8, range= 8-68km) (Fig. 3). This was the second longest seasonal movement by KCH caribou during their annual cycle.

The KCH calving distribution and calving-areas were typical for woodland caribou. Caribou calved in a highly-dispersed pattern in alpine habitats associated with the higher terrain features of much of the herd's total range, with most being located in the Dawson Range from Victoria Mountain in the southeast to Mount Cockfield in the northwest (Fig.4).

Of radio-collared caribou located during the calving period, 3 were relocated for only one year, 6 for two consecutive years, and 8 for three years. Over the course of this study 43% (6/14) of radio-collared female caribou exhibited calving site fidelity and were relocated within 10 km of their previous calving-period location (Fig.4). Of these, 83% (5/6) were located within 3 Km of their previous calving-period location. Because the actual reproductive status of radio-collared females was not known, we cannot assess if birth rate and newborn calf mortality may have influenced calving-period location. The observed dispersal pattern and traditional use of specific areas by females is theorized to be an anti-predator tactic by woodland caribou to reduce the vulnerability of calves and make use of previously successful sites (Bergerud et al. 1984).

During calving collared caribou were located on average 15km (SD= 10.2, range 1-47 km) (Fig. 3) from the Casino Trail and proposed alignment. In our opinion the only area in which the Casino Trail, as it is presently aligned, would likely pose disturbance

Figure 3 . Mean distances of radio-collar relocations between life cycle periods, and in relation to the Casino Trial, Klaza Caribou herd 1987-1990.



* Spring migration period not included in this analysis.

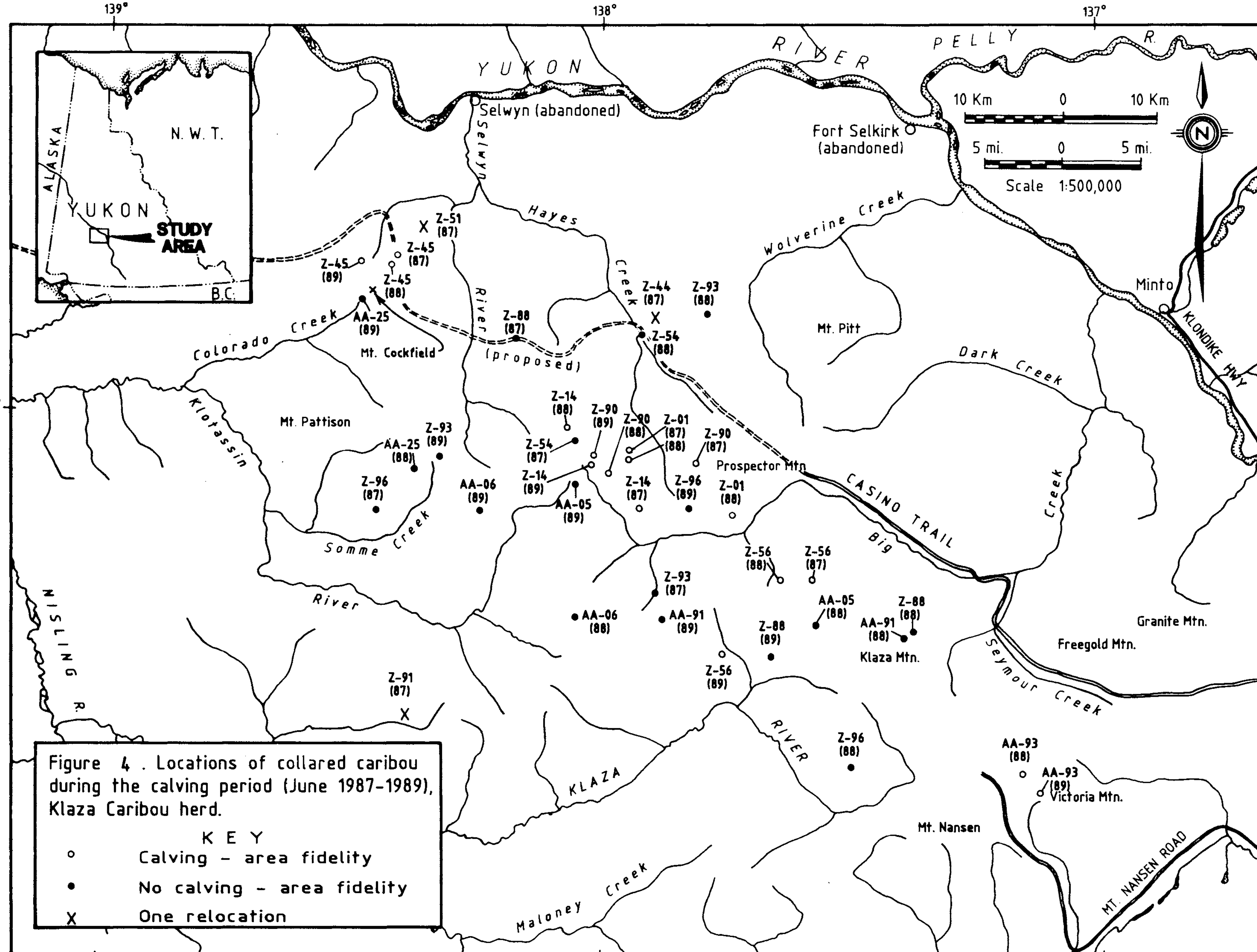


Figure 4. Locations of collared caribou during the calving period (June 1987-1989), Klaza Caribou herd.

KEY
○ Calving - area fidelity
● No calving - area fidelity
X One relocation

to caribou at calving, is in the vicinity of Mount Cockfield (Fig.4). The proposed road alignment is routed through the alpine close to a small but nevertheless significant calving region. Road alignment could be changed to prevent possible caribou disturbance by routing it away from specific alpine calving habitats in the Mount Cockfield area, or by taking an alternate route altogether. Disturbance could best be avoided by continuing down Hayes Creek to cross the Selwyn River north of Mount Cockfield before proceeding to the Casino mine destination.

Post-calving Distribution

Following calving, radio-collared females moved an average of 14 km straight line distance (SD= 10.9, range= 0-40 km) (Fig.3).

These movements dispersed the herd throughout most of the total range (Fig. 5). Most radio-collared caribou were located in alpine or subalpine habitats and showed some tendency to aggregate. Woodland caribou are often observed to aggregate while in alpine areas, particularly on permanent snowpatches, which act as 'relief habitat' from heat stress and/or insect harassment (Farnell and Russell 1984, Farnell and McDonald 1989, 1990, Ion and Kershaw 1989). Our relocation surveys were flown at high altitude and did not allow a reliable estimate of group sizes. Some relatively large aggregations of caribou probably occurred during this period, based on clusters of radio relocations. We suggest that large groups could have been associated with collared caribou at the south side of Big Creek in 1987 (Z-90, Z-96, Z-88, Z-14), on the north flank of Prospector Mountain in 1988 (Z-01, Z-54), between the upper Klotassin-Klaza Rivers (AA-05, AA-06, Z-90) in 1988, between the upper Selwyn-Klotassin Rivers in 1989 (AA-93, Z-93), and on the south flank of Apex Mountain in 1989 (AA-06, Z-14, Z-96). The annual variability of group size may be due to differing weather conditions during our post-calving surveys, with warm windless days providing the most pronounced heat stress and/or insect harassment. We noted that few permanent snowpatches occur in the Dawson Range compared to other Yukon mountain ranges. Summer 'relief habitat' for the KCH may be limited solely to windswept alpine ridges.

Collared caribou were located furthest, average 17 km (SD= 11.7, range 2-39 km), from the Casino Trail and proposed alignment during the post-calving period. The proposed Casino Trail alignment could conceivably conflict with post-calving caribou activity in the Mount Cockfield area. The variability of group size and location, make predictions of impact from spur road development on post-calving caribou imprecise.

Fall Distribution

Following post-calving radio-collared caribou moved an average 14 km straight line distance (SD= 10.8, range= 2-42 km) (Fig.3).
The distribution during rut was slightly more confined than during either the calving or post-calving periods. Relocations during this period concentrated into three areas (Fig. 6); north aspect

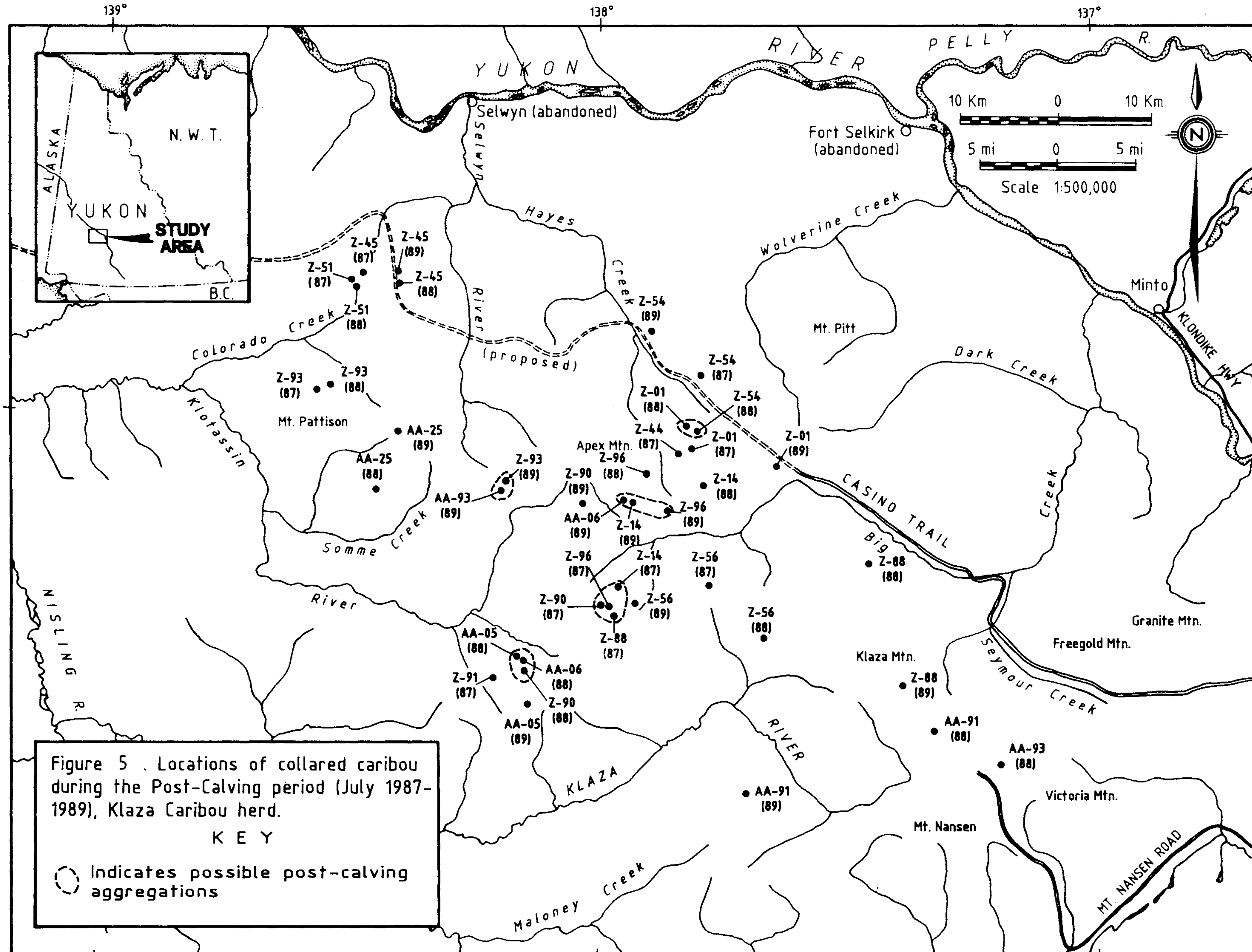


Figure 5 . Locations of collared caribou during the Post-Calving period (July 1987-1989), Klaza Caribou herd.

KEY

( ) Indicates possible post-calving aggregations

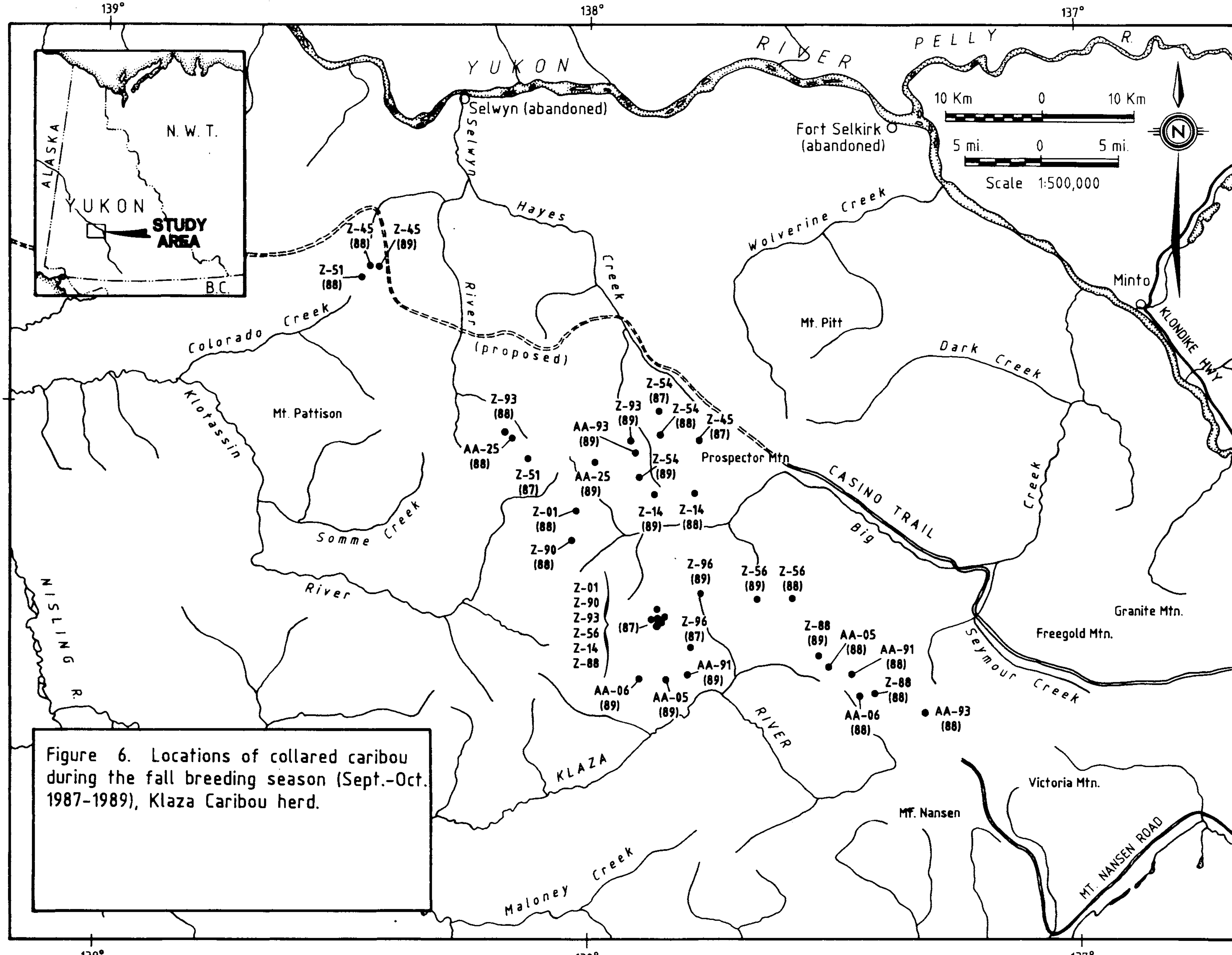


Figure 6. Locations of collared caribou during the fall breeding season (Sept.-Oct. 1987-1989), Klaza Caribou herd.

alpine areas in upper Klaza River (53%), Prospector and Apex Mountains (39%), and Mount Cockfield (8%). Caribou tended to be faithful to these areas for this period over the duration of the study.

Both radio-collar location data and observations made during fall 1987 and 1988 composition counts indicate that caribou tended to form large aggregations during the rut. The most dramatic example of aggregating was found during October 1987 when 6 radio-collared caribou were located in one aggregation of 148 animals on the north side of the Klaza River (Fig. 6). This group represented approximately 34% of the KCH.

The mean distance of radio-collared caribou from the Casino Trail during the rut was similar to that found for calving and post-calving and was 16 km (SD= 7.7, range= 3-35 km). This indicates that the proposed Casino Trail routing will not expose a large segment of the KCH to hunting during the rut. The single exception once again is the proposed alignment through the Mount Cockfield area. This area should be avoided to minimize impact of the road on caribou. Because there is a significant amount of caribou activity in the Prospector and Apex Mountain areas during rut, spur road developments should only proceed after detailed consideration of long-term access needs and the welfare of caribou.

Winter Distribution

As the study progressed it became evident that the winter period was the time when most caribou encounter the Casino Trail. We therefore intensified survey effort for this period by surveying herd distribution during early (Dec.), mid (Feb.) and late (March) winter. Our surveys include 3 relocation flights for early winter (87-89), 2 relocation flights for mid-winter (88&90) with 1 low level reconnaissance (87), and 2 relocation flights (89&90) with 2 low level reconnaissance (89&90) for late winter.

Early Winter

Caribou were Located in two relatively distinct regions; on the north and south flanks of the Dawson Range (Fig. 7). Of radio-collars located during early winter, 80% (28/35) were in the Selwyn River/Hayes Creek area to the north, while 20% (7/35) were found in the upper Klaza River area to the south. During our study the Selwyn/Hayes early winter range was used by caribou far more extensively than the upper Klaza, and of these most relocations (69%, 24/35) were centered in the Hayes Creek drainage, suggesting that this area is the principal winter range.

The average distance of radio-collared caribou from the Casino Trail during the early winter period was 14 km (SD= 19.3 range= 2-39 km) (Fig. 3). This distance was similar to that found during summer and fall when averaged using all data. However, the average distance of caribou inhabiting the Selwyn/Hayes winter range, or 80% of the herd, is only 8 km (SD= 7.6, range= 2-34),

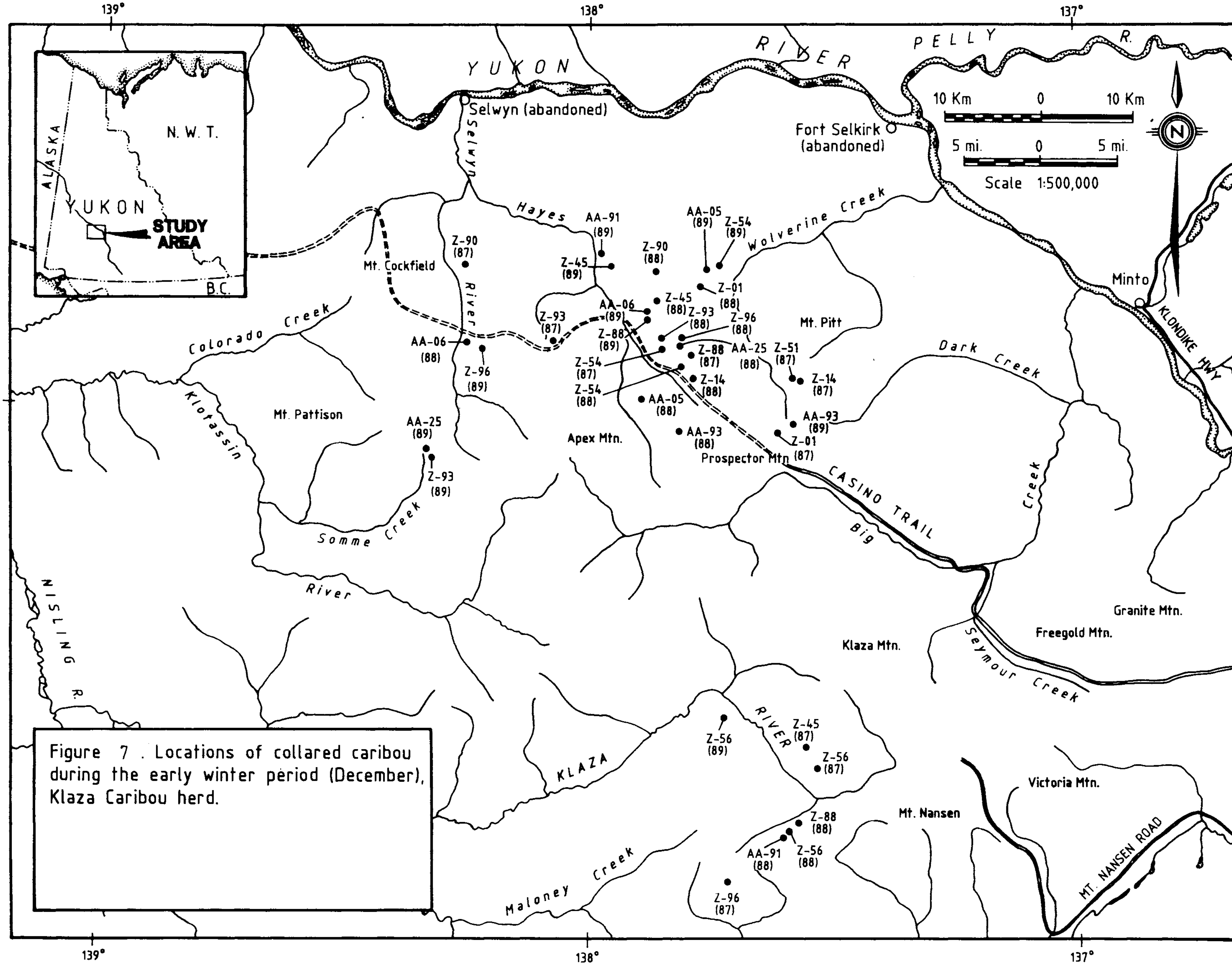


Figure 7 . Locations of collared caribou during the early winter period (December), Klaza Caribou herd.

indicating that most caribou are rather close to the Casino Trail during early winter.

Mid-winter

Our initial survey (5-11 February 1987) found a pattern similar to that observed for early winter, with distinct groups being located in an area to the north and south (Fig. 8). The northern region included the upper Klotassin River, along with Selwyn River, and Hayes Creek, while the southern distribution was located in or along the upper Klaza River valley.

Pronounced over-winter movement was observed for the northern group. Snow-tracks were noted in the Klotassin River/Somme Creek area at the time of the survey and heavily used snow-trails indicated that those caribou likely moved northeast over the Somme Creek summit into the Selwyn River/Hayes Creek area prior to the survey.

The distance between early winter and mid-winter relocations suggest that caribou are mobile during winter. Early winter to mid-winter movements averaged 16 km (SD= 10.6, range= 2-44) (Fig. 9).

Collared caribou were located on the upper Klaza winter range only once during mid-winter 1988 (Fig. 9). From early winter 1987 to mid-winter 1988 collared caribou (Z-56,Z-45,Z-96) remained on the upper Klaza winter range. Over this same period for 1989-1990 only a single collared caribou (Z-56) was observed on the Klaza winter range and moved 44km to the principal winter range in Hayes Creek by mid-winter. Z-56 is the only marked individual that had stayed on the upper Klaza winter range during early winter and then moved to another range during one of two winters for which there are mid-winter data.

The average distance of radio-collared caribou from the Casino Trail was less in mid-winter than for any other previous seasonal period (mean 12 km; SD= 13; range= 2-44). However, since 76% of radio-collars were relocated on the Selwyn/Hayes winter range, most caribou were closer to the Casino Trail than this data indicate. The average distance of collared caribou from the road excluding those relocations in upper Klaza and Klotassin River areas was 6 km (SD= 2.5, range= 2-12). Indicating that most caribou in the KCH are close to the road during mid-winter.

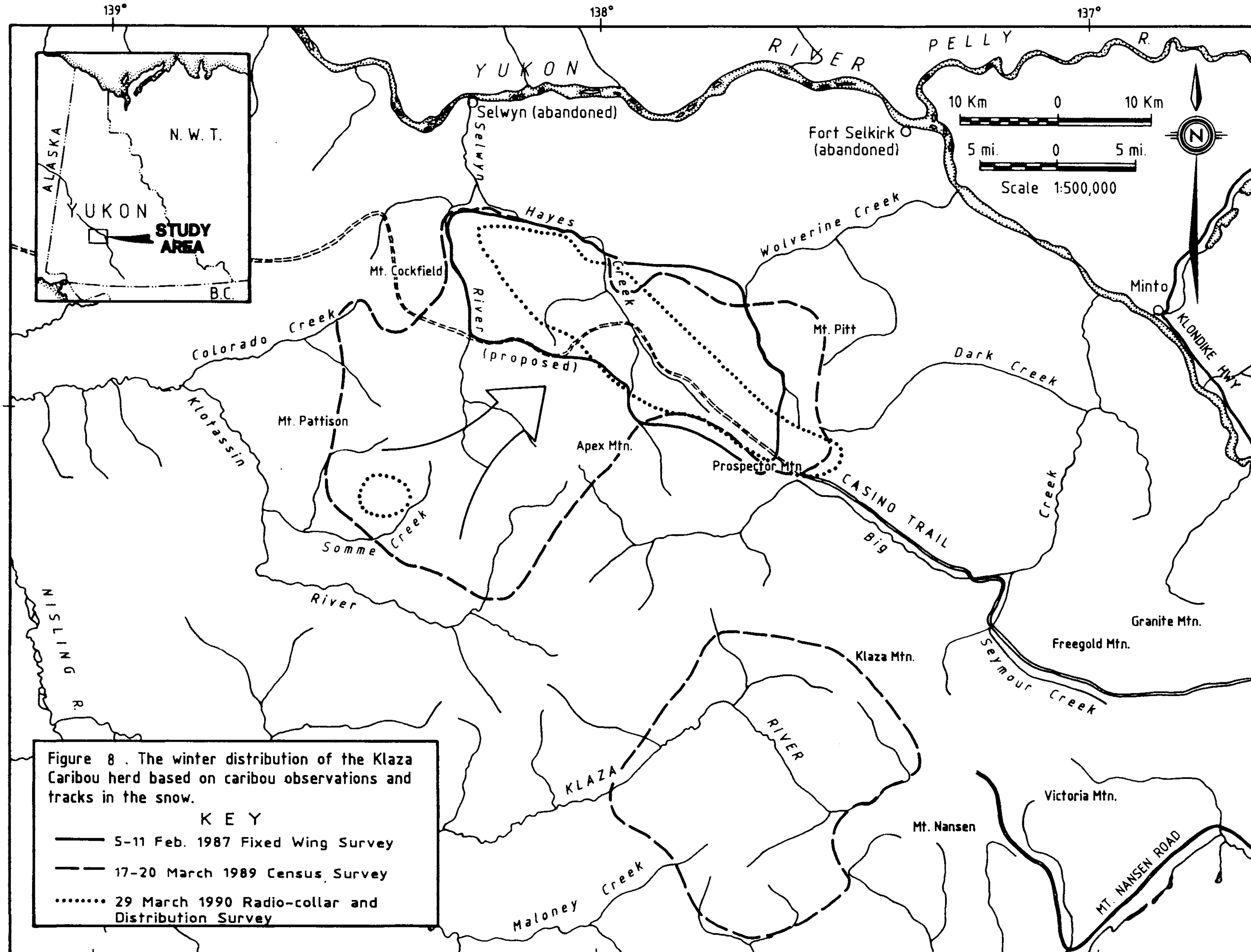


Figure 8 . The winter distribution of the Klaza Caribou herd based on caribou observations and tracks in the snow.

KEY

- 5-11 Feb. 1987 Fixed Wing Survey
- 17-20 March 1989 Census Survey
- 29 March 1990 Radio-collar and Distribution Survey

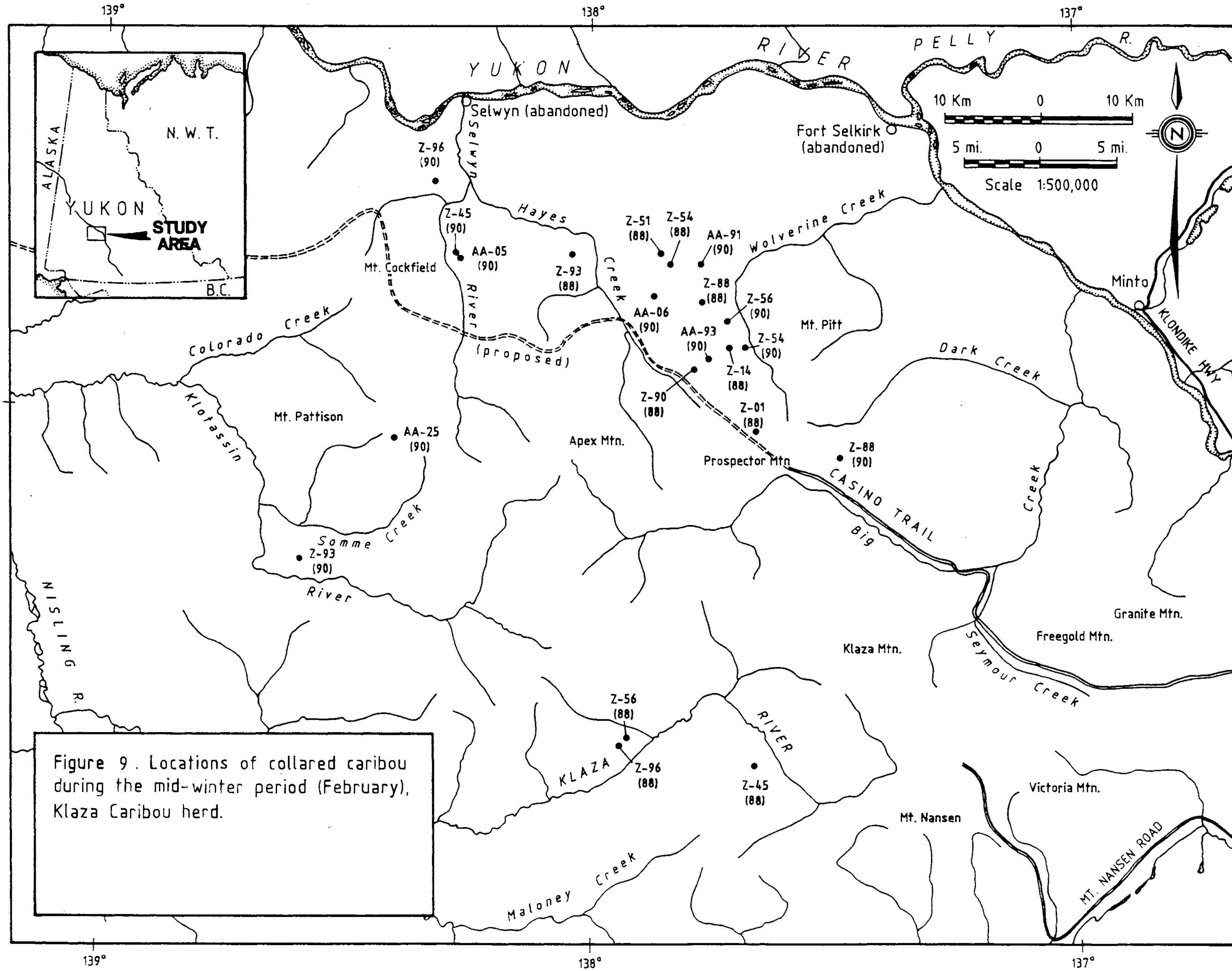


Figure 9. Locations of collared caribou during the mid-winter period (February), Klaza Caribou herd.

Late Winter

From mid to late winter, radio-collared caribou moved an average 17 km (SD= 6.3, range= 0-26) (Fig. 3), indicating that caribou were still making major range shifts between winter periods.

Most of the KCH was found in late winter on the Selwyn/Hayes winter range in the most confined concentrations of all annual distributions (Fig. 10). The single exception was a group of caribou (Z-93 and AA-25) inhabiting a small area within the Somme Creek drainage in March 1990. Assuming that radio-collared caribou proportions are representative of total herd abundance, then over all years 92% of the KCH were found on the Selwyn/Hayes winter range during late winter. This is consistent with the tendency of Yukon's woodland caribou herds to occupy a traditional 'core winter range' during late winter (Farnell and Russell 1984, Farnell and McDonald 1988, 1989, 1990, Gauthier 1984). The distribution of caribou is the most confined on the 'core winter range' (i.e. the KCH inhabited an area 482 Km^2 in March 1989, within a total range of 5354 km^2). The use of a 'core winter range' is thought to be influenced by snow cover patterns in relation to lichen abundance provided by the habitat (Bergerud 1978). The KCH 'core winter range' will be bisected by the proposed routing of the Casino Trail (Fig. 10).

The average distance of radio-collared caribou from the Casino Trail was less in late winter than for any other period and was 5 km (SD= 6.3, range= 0-26) (Fig. 3). However, if we exclude the 2 outlying radio-collared caribou (Z-93 & AA-25) from this analysis the data indicates an average distance of 3.5 km (SD= 2.8, range= 0-12 km) for 92% of the herd located on the Selwyn/Hayes winter range. These findings indicate caribou in late winter could be critically impacted upon from the Casino Trail development by; 1) improving hunter access, 2) direct loss of habitat through mining development, 3) displacing caribou from all or portions of the 'core winter range' through disturbance from mining operations.

Spring Migration

Surveys to locate caribou during spring migration provided 42 relocations of collared caribou between 21 April and 10 June 1989 and provided an assessment of timing of female caribou departure from lowland winter range to alpine calving sites (Appendix A, Fig. 11). The proportion of females departed from winter range were; 50% (5/10) from 15 March to 21 April, roughly 66% (9/12 & 10/13) by 26 April and 2 May, 80% (10/12) by 18 May, and 100% (13/13) by 10 June (end of the calving period). We conclude from these observations that some female caribou (20-33%) linger on the winter range until roughly late May-early June before moving to calving sites. Hence, activities that may disturb female caribou should be restricted to a period after 1 June.

We were unable to determine the timing of male caribou departure from winter range because only females had collars. Evidence from other Yukon woodland caribou studies indicate that spring

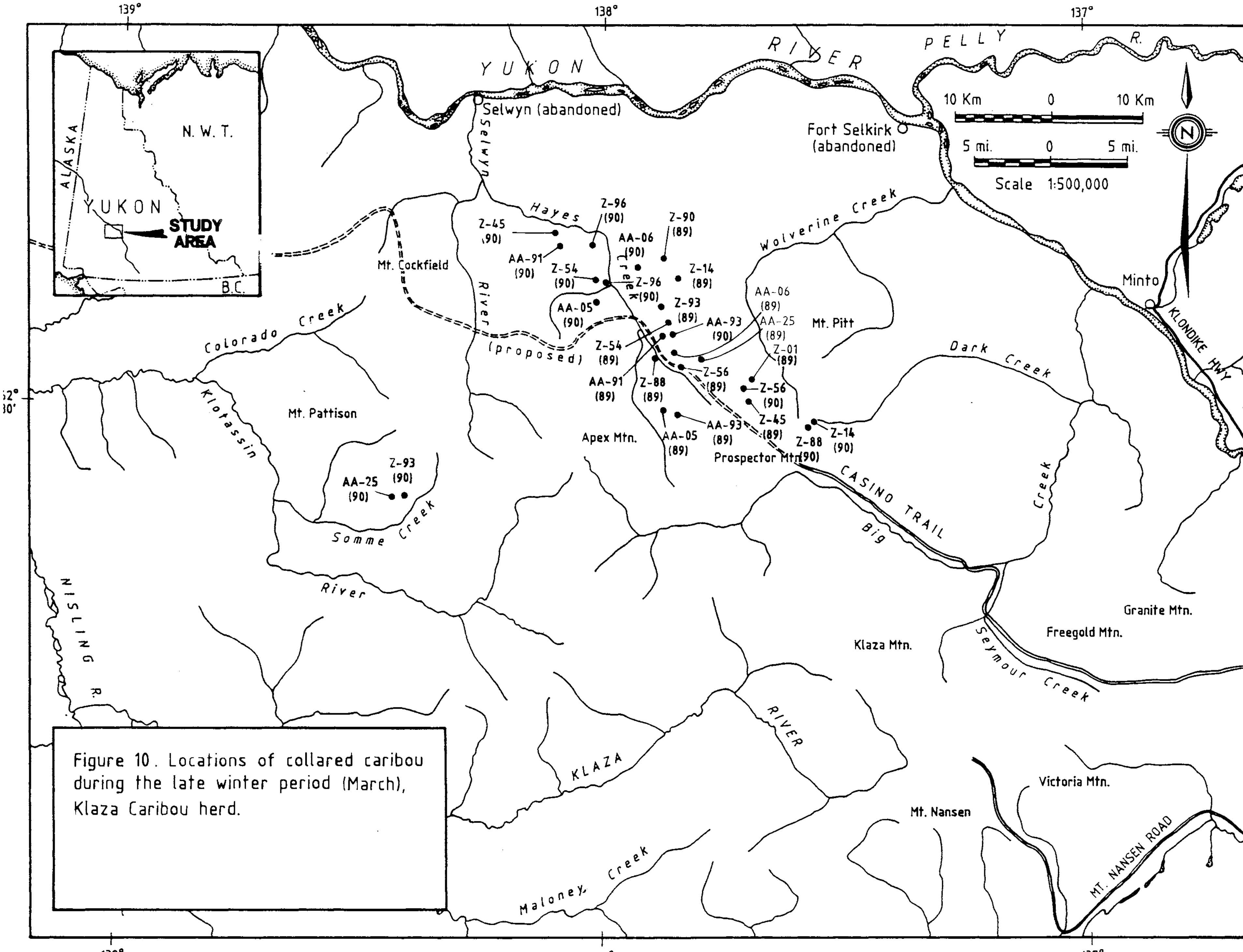


Figure 10. Locations of collared caribou during the late winter period (March), Klaza Caribou herd.

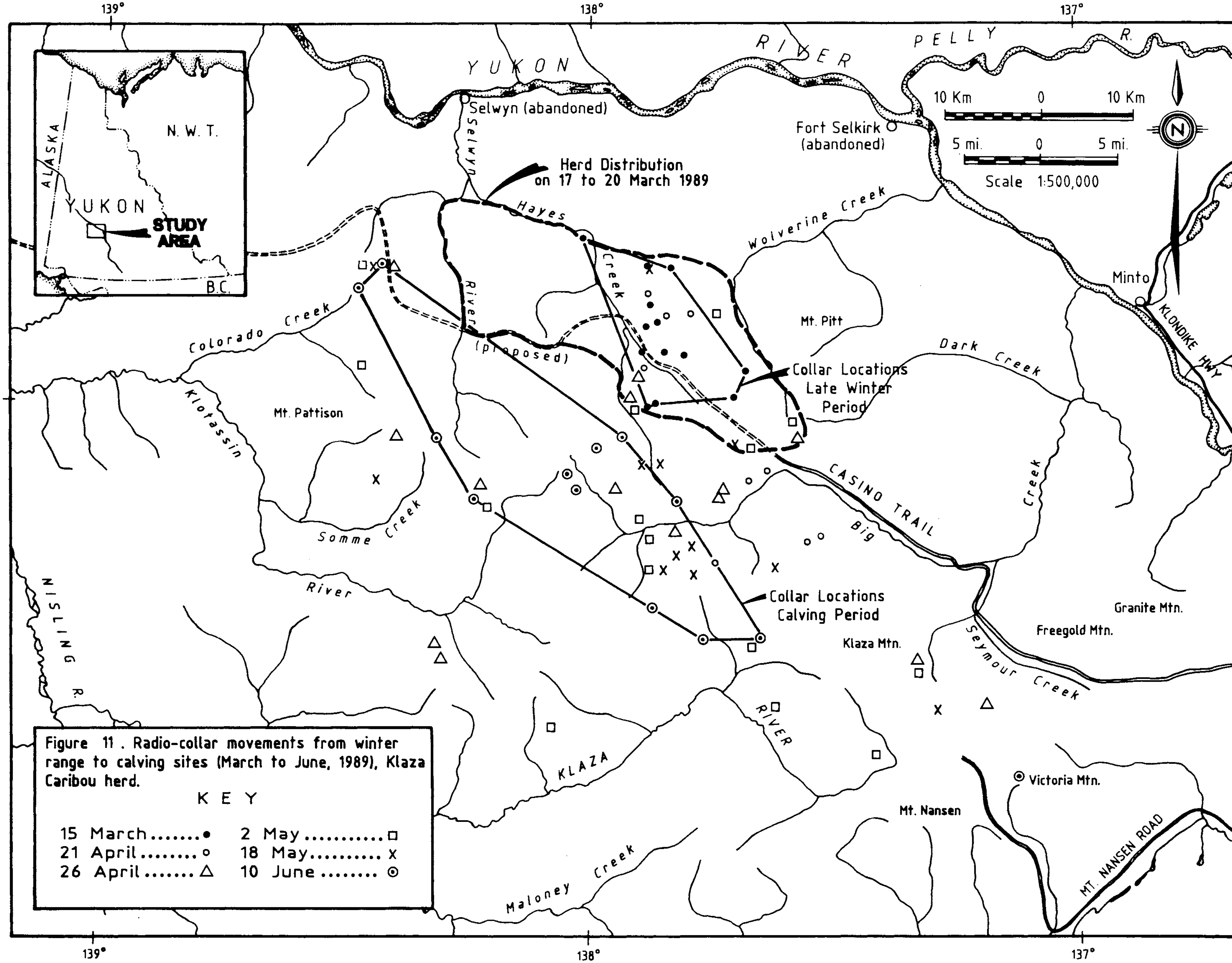


Figure 11. Radio-collar movements from winter range to calving sites (March to June, 1989), Klaza Caribou herd.

KEY

15 March .... ●	2 May .... □
21 April .... ○	18 May x
26 April .... △	10 June .... ⊙

migration may be a full month later for males and yearlings than for females.

Home Range Boundaries

The estimated home range of the herd is roughly 5300 km^2 (2067 mi^2) (Fig. 12). The game management subzones that fall within this home range are 5-10 to 5-13 and 5-22 to 5-26 (Fig. 13).

HERD DEMOGRAPHY

OBJECTIVES AND METHODS

Objective: To determine population size and evaluate recruitment and mortality rates for establishing a safe harvest level.

Population Size

We censused the herd in March 1989 using the stratified random quadrat sampling method (Gasaway et al. 1986, Farnell and Gauthier 1988). This method 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 supported by a radio-tracking flight to confirm the presence of all radio-collared caribou within the survey area. The delineation survey is extended well beyond the known distribution to ensure that no outlying caribou are missed during the census phase. The stratification phase is an intensive fixed wing survey over the entire survey area to classify sample units (SUs), of 20 km^2 average size, into primary (numerous caribou present) and secondary (few caribou present) strata. The classification of SUs was based on the abundance of fresh tracks in the snow and the direct observation of caribou.

The census phase involves an intensive and thorough (2 min./km^2) helicopter survey of caribou in all the primary SUs and usually a sample of randomly selected SUs in the secondary stratum. However, since the KCH inhabited an exceptionally confined distribution during late winter it was practical to survey all the secondary SUs and thus improve the precision of the estimate. Sample units were systematically surveyed from east to west across the herd's distribution and two aircraft were used simultaneously to reduce the possibility of double counting caribou that could have moved across SU boundaries between survey flights.

For the purpose of generating a sightability correction factor (SCF) for caribou that are inevitably missed during the survey, a portion or subsample within an SU is normally searched again at a higher intensity (6 min./km^2). However, in this case opportunities to derive a significant sample of SCF's using that method were too few to be of practical use. These attempts failed because caribou groups were sparsely distributed over a broad area

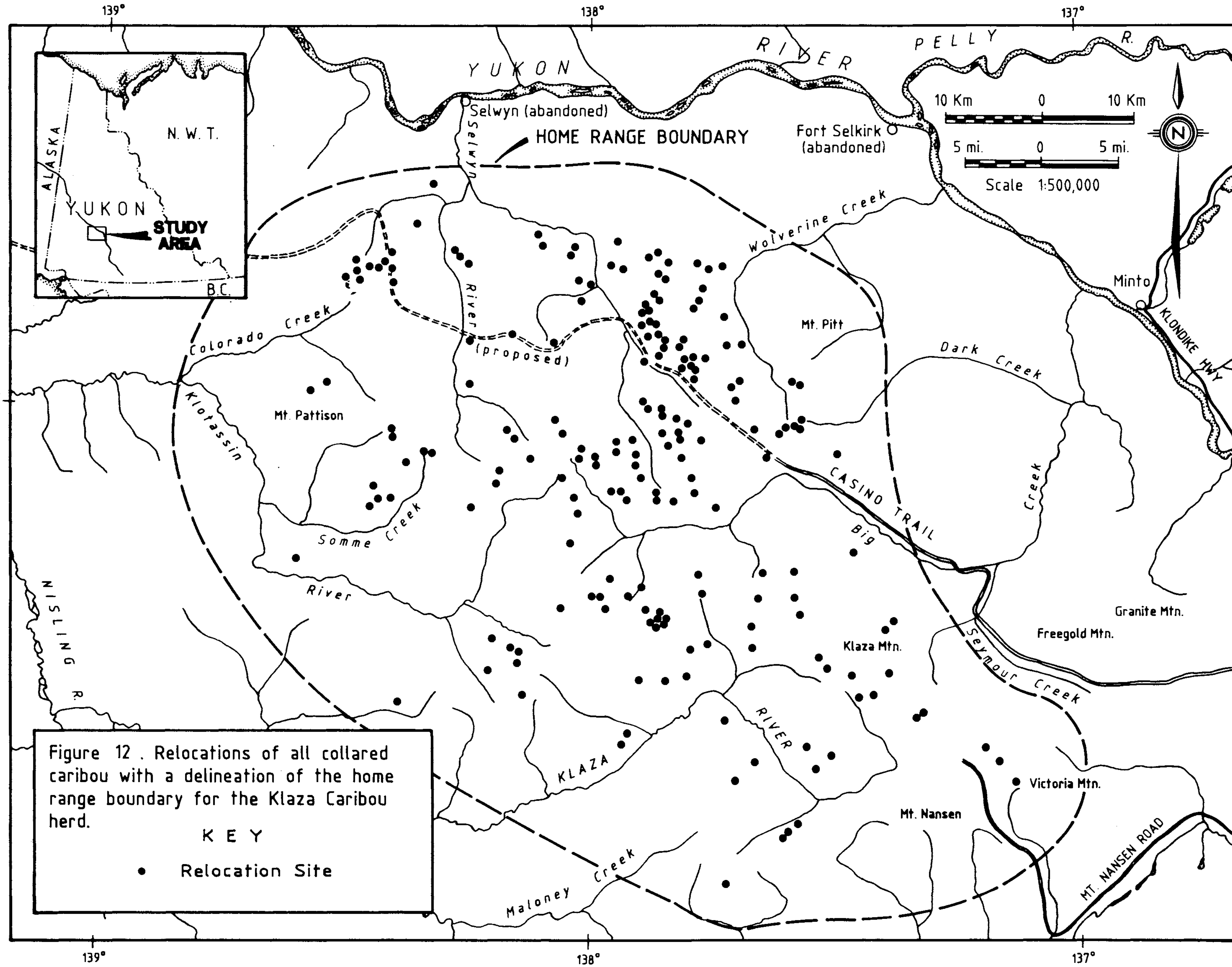


Figure 12 . Relocations of all collared caribou with a delineation of the home range boundary for the Klaza Caribou herd.

KEY

● Relocation Site

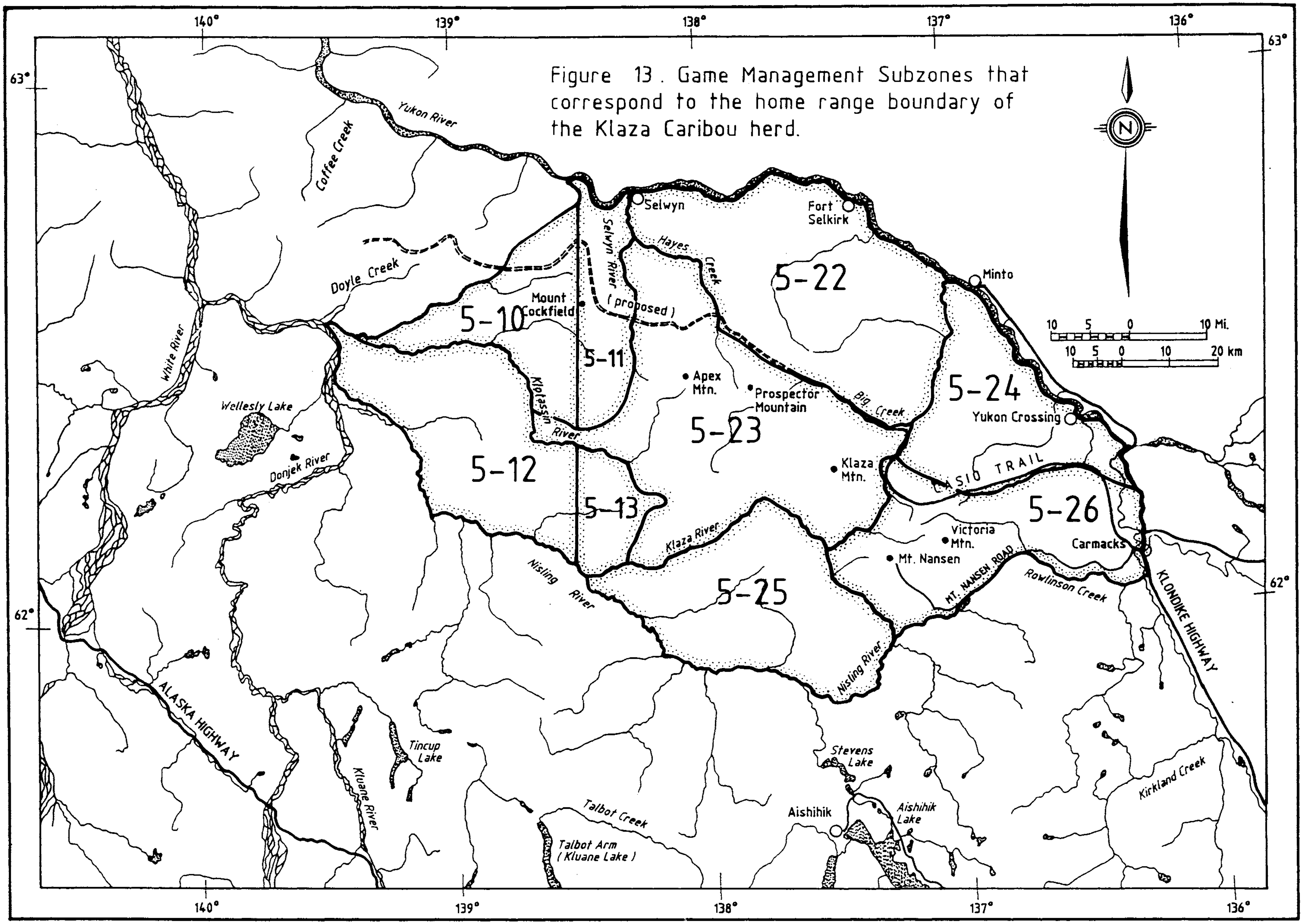


Figure 13. Game Management Subzones that correspond to the home range boundary of the Klaza Caribou herd.

and tended to move out of the designated area by the time we returned at 6 min./km^2 search intensity. As an alternative; we divided the number of radio-collared caribou known to be present within the survey area from relocation flights, by the number of radio-collared caribou observed within the survey area on the 2 min./km^2 census survey flight, to generate an SCF. All data were plotted on 1:50,000 topographical maps. The formulae and HP-97 program developed by Gasaway et al. (1986) are normally used to calculate the population size of the KCH.

Population Composition

We estimated population composition using two methods during two life cycle periods. The first entailed a helicopter survey of the KCH range, as depicted by radio-collars, during the rut (on 6-7 Oct., 1987 and 6 Oct., 1988). The second consisted of calculations made from composition data collected during the March 1989 population census. Samples of the population were classified into adult female, adult male and calf age and sex classes using the criteria set out by Skoog (1968).

Adult Natural Mortality

The adult natural mortality rate of adult caribou excludes human caused mortality and was estimated using the procedure developed by Gasaway et al. (1983). Observations of radio-collared animals were used to establish a death rate based on animal-periods rather than the actual number of individuals because all caribou are not observed for complete periods (e.g. a transmitter may fail within a 12 month observation period). The use of animal-periods also eliminates the problem of incomplete records for caribou that were collared within an observation period. Cause of death was determined by evidence obtained at the carcass.

Harvest

Since 1979 the Yukon big game harvest has been estimated by the hunter questionnaire survey, which annually samples 70% of licensed resident hunters (Smith and Hare 1988). Guided non-resident hunters must report their harvest of big game by outfitter trophy export declarations. Indians are not required to buy a hunting licence, and are therefore not sampled by the hunter questionnaire survey. To document this harvest the Yukon Indian Harvest Survey was begun in 1987. Unfortunately the survey did not include the harvest from Indian bands that traditionally hunt the KCH (Carmacks-Little Salmon and Selkirk) during this study. Thus, there are no data for native harvest on the KCH.

Most of the accessible parts of the KCH range were closed to caribou hunting for non-natives in 1989. More remote regions of KCH range are open to hunting for one male caribou from 1 August to 31 October.

RESULTS AND DISCUSSION

Population Size

The KCH census was carried out over a 4 day period from 17 to 20 March 1989. A survey area of 481.5 km^2 was established around a concentrated caribou distribution centered in the Hayes Creek area (Fig. 14), the entire late winter distribution of the herd. Flights over the remainder of the KCH home range failed to find any recent sign of caribou, and all active radio-collar transmitters were found within the survey area. The KCH survey area was small, and less than one-half the average size of areas found for 3 neighboring herds censused within the last 3 years (Farnell and McDonald 1988, 1989, and 1990).

The survey area was subdivided into 22 sample units (SUs) averaging 22 km^2 in size (Table 2). When stratified, there were 10 primary (240.8 km^2) and 12 secondary (240.7 km^2) SUs. Because the KCH survey area was small, a 100% survey intensity was conducted. The search intensity averaged 2 min/km^2 during the census flights.

A total of 378 caribou were counted on the census survey (Table 2). With a SCF of 1.166, (12 collars observed/14 collars present) the estimated population size was 441 caribou.

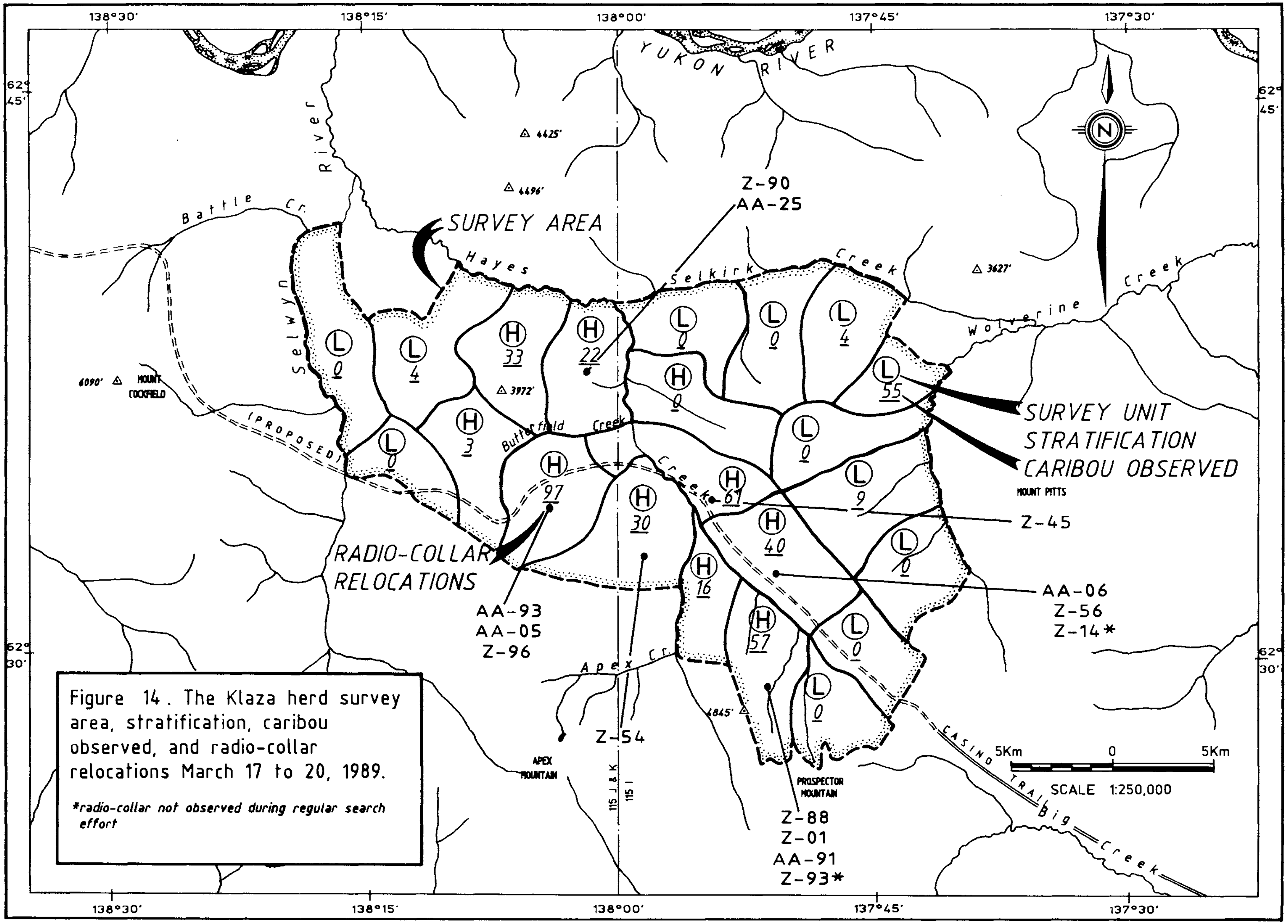


Figure 14. The Klaza herd survey area, stratification, caribou observed, and radio-collar relocations March 17 to 20, 1989.

*radio-collar not observed during regular search effort

Table 3. Caribou survey data for the Klaza herd population estimate, 19-20 March 1989.

Number	Date	Sample Unit	Adult Cow	Calf	Immature Male	Mature Male	Unclass.	Total Caribou	Area (km^2)	Time (min)	Collars
Primary Stratum											
1	3/19	21	35	8	7	4	-	54	24.3	44	Z-88,Z-01,AA-91
2	3/19	19	11	6	2	16	5	40	25.0	50	AA-06,Z-56
3	3/19	20	6	5	-	5	-	16	13.2	39	
4	3/19	9	41	12	-	8	-	61	25.4	81	Z-45
5	3/19	8	14	7	6	3	-	30	29.2	62	Z-54
6	3/19	10	-	-	-	-	-	0	22.5	43	
7	3/19	7	58	30	6	1	2	97	29.5	60	AA-93,AA-05,Z-96
8	3/19	6	13	5	-	4	-	22	23.4	47	Z-90,AA-25
9	3/19	4	-	-	-	3	-	3	24.1	37	
10	3/20	5	24	8	1	-	-	33	24.2	66	
	Total		202	81	22	44	7	356	240.8	529	
Secondary Stratum											
11	3/19	22	-	-	-	-	-	0	15.2	22	
12	3/19	18	-	-	-	-	-	0	15.3	21	
13	3/20	17	-	-	-	-	-	0	20.5	55	
14	3/20	16	5	3	-	1	-	9	27.8	66	
15	3/20	3	-	-	-	-	-	0	10.0	8	
16	3/20	15	-	-	-	-	-	0	20.0	43	
17	3/20	1	-	-	-	-	-	0	24.1	19	
18	3/20	13	1	-	-	3	-	4	21.4	33	
19	3/20	2	3	1	-	-	-	4	28.6	41	
20	3/20	11	-	-	-	-	-	0	20.1	46	
21	3/20	14	2	-	-	3	-	5	13.6	21	
22	3/20	12	-	-	-	-	-	0	24.1	51	
	Total		11	4	-	7	-	22	240.7	426	
Grand Total			213	85	22	51	7	378	481.5	955	

Sightability Correction Factor

Collars observed but not present:

AA-91 in S.U. # 21
Z-14 in S.U. # 19

12 observed during survey/ 14 present during survey = 1.166 SCF

Population Composition

Both fall and late winter composition data are presented in Table 3. Relatively few calves in the herd in 1987 (11%, 17 calves/100 females) suggest that there was poor calf survival and/or production. The calf counts were considerably higher during the following years with 24% in fall 1988 (46 calves/100 females) and 23% in late winter 1989 (40 calves/100 females); these were favorable years for population growth. If good calf survival and/or production years are the norm rather than the exception then they should overcompensate for the bad years, and provide overall population growth.

Adult sex ratios during the rut were similar in 1987 and 1988 (48 and 46 males/100 females respectively) (Table 3), and higher than observed during March 1989 (33 males/100 females). This indicates that some males were likely missed during the census survey. There is therefore a possibility that some male caribou were located outside the survey area during the March 1989 census, causing an underestimate of herd size. By multiplying the average male proportion observed during rut (47/100) times the estimated number of females in the herd (248); we determine that 117 males should be present in the census. Thus the survey may have underestimated population size by 44 (117-73) caribou. The size of the KCH corrected for missing male caribou is therefore 485.

Table 4. The composition of the Klaza caribou herd during October 1987, 1988 and March 1989 surveys.

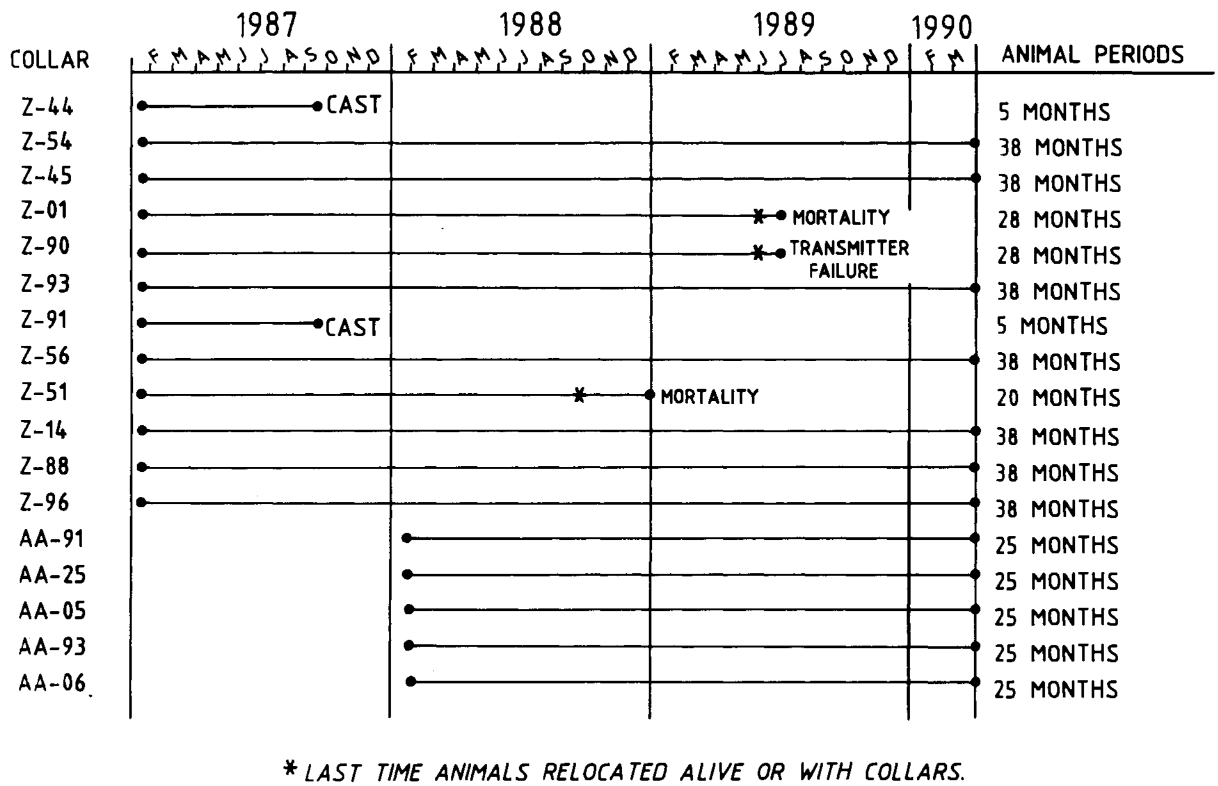
Date	Females		Calves			Males			
	Count	%	Count	%	Ratio/100 Females	Count	%	Ratio/100 Females	Total Count
87/10/06	190	61	33	11	17	91	28	48	314
88/10/06	113	52	52	24	46	52	24	46	217
89/03/20	213	57	85	23	40	73	19	33	376

Adult Natural Mortality

Collared females Z-44 and Z-91 were counted as 5 caribou/months each because their collars were cast shortly after capture (Fig. 15). A third caribou (Z-90) provided 28 caribou/months before the transmitter failed (confirmed in July 1989).

During the course of this study 2 collared caribou died. Collared caribou Z-01 died between June and July of 1989 (28 caribou/months), while collared caribou Z-51 died between October 1988 and March 1989 (20 caribou/months) (Appendix B-4 & B-9) (Fig. 15).

Figure 15 . Status of individual radio-collared caribou over the duration of the study (February 1987-March 1990) with animal periods used to calculate the mortality rate, Klaza Caribou herd.



When these mortalities are calculated against the estimated number of collared animal/periods (477 caribou/months = 39.8 caribou years) they provide an annual estimated adult natural mortality rate of 4.9%. This rate likely underestimates male mortality because males are known to suffer greater mortality as evidenced by their lower proportion in the adult population (Table 3).

To calculate male mortality and weight male and female mortality against the importance of herd age structure and potential longevity of individuals would require assumptions for which we presently have no baseline data. We are therefore unable to provide a complete estimate of adult mortality. However, compared with measurements of adult natural mortality for numerous other caribou herds in North America (Appendix C) the KCH rate of adult female mortality falls out in the lower end of observations and suggest to us that survival of adult caribou may be relatively high in this herd.

Harvest

The estimated non-native harvest from the KCH has averaged 9 caribou/year between 1980 and 1988 (range: 3-27) (Table 4). The harvest peaked in 1984 when 27 caribou were believed harvested (11 were reported). The KCH non-native harvest was mostly by resident hunters and averaged 8 caribou/year, while guided non-residents averaged 1 caribou/year between 1980-84. The outfitter rotated caribou hunts between the KCH and another herd in his concession (R. Hardie pers. comm.), which explains the lack of harvesting between 1985 and 1988. Most of the resident harvest was in GMZ 5-26 (94%), which includes the Mount Nansen and Casino Trail access roads (Fig. 12). A few caribou (6%) were also taken in 5-23 by resident hunters. The guided non-resident harvest was in 5-25 (73%), 5-23 (18%) and 5-26 (9%). GMZ 5-22 to 5-26 were closed to caribou hunting in 1989 and reopened again on a permit basis in 1991 for a total of 6 resident and 2 non-resident hunter permits.

With the inclusion of the Carmacks/Little Salmon Band into the Yukon Indian Harvest Survey in 1989, attempts are underway to document the native harvest of caribou from the KCH.

Table 5. The estimated non-native harvest of caribou from the Klaza herd, 1979 to 1988.

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	$\bar{X}$ & SD
Estimated Resident (reported)	0 (0)	6 (5)	8 (4)	10 (6)	8 (6)	26 (11)	6 (3)	5 (5)	3 (3)	4 (4)	7.6 ± 7.1 (4.7 ± 2.8)
Reported Non-resident	0	3	3	1	3	1	0	0	0	0	1.1 ± 1.4
Total Estimated Harvest (reported)	0 (0)	9 (8)	11 (7)	11 (7)	11 (9)	27 (12)	6 (3)	5 (5)	3 (3)	4 (4)	8.7 ± 7.5 (5.8 ± 3.5)

Other Management Implications

Two elements of regional big game ecology should be taken into account when considering long-term management possibilities for the KCH;

1. Big game numbers in the study area are extremely low by comparison to the remainder of the Yukon. Only sparse numbers of Dall Sheep (30-35) occur in the Dawson Range (Hoefs and Lortie 1975). Moose occur at the lowest density ever recorded in Yukon ($0.04/km^2$) (Markel and Larsen 1987). The KCH is a small population by Yukon standards as most herds range from 650 to 5000 caribou (file data). Low prey abundance is no doubt the reason why wolves occur at very low densities ($3/1000km^2$), compared to the rest of central and southern Yukon ($6-18/1000km^2$) (pers. comm. R. Hayes). Predator-prey studies in southern and central Yukon (Larsen et al. 1987; Farnell and McDonald 1988), and east central Alaska (Bortje et al. 1987) indicate that predation is the main factor limiting big game population growth. In fact, the KCH range is a small portion of what is thought to be a broad area experiencing a low-density predator-prey equilibrium (Gasaway et al. in press.). Factors limiting the KCH may also limit all other large mammal populations in the entire region.

2. Decline of the Fortymile herd has had a profound influence on present day big game abundance as evidenced by the fact that the area of low big game numbers coincides exactly with the Fortymile herd's former range (Urquhart and Farnell 1986). We speculate that the drastic decline experienced by this herd during the late 1960's-early 1970's, produced an ecological calamity by subsequently causing excessive mortality on resident prey populations (alternate prey) from a large predator population (primarily wolves) that was previously sustained by the once abundant Fortymile herd. Depletion of alternate prey (moose, sheep, woodland caribou) eventually led to an ensuing decline in

predator numbers, leaving this area largely devoid of any significant large mammal population.

For an analogy consider what would happen to a stream ecosystem if salmon were prevented from returning to their spawning grounds. An interlocking web of energy flow from prey to predator would be severely damaged. Organisms reliant on salmon in both the aquatic environment (resident trout, aquatic insects, plankton, etc.), and in the adjacent terrestrial environment (bears, eagles, seagulls, etc.) would suffer the consequences of diminished food because they are part of an 'open' system in which the main food supply is 'imported' from outside the stream. In the end the food chain would become shorter, less complex, less productive, and hence the system would also be less stable.

In our opinion, the Fortymile herd is a vital link to wildlife systems over the entire west-central Yukon. Recovery of this herd will reestablish a more abundant natural community with higher densities of big game. Wildlife management in this region must recognize the importance of the Fortymile herd and begin rebuilding that herd. We therefore contend that long-term KCH management will require initiatives along the Yukon/Alaska border to rebuild the Fortymile herd. In the interim, harvesting and conflicting land use developments should proceed conservatively in regard to the KCH.

RANGE ANALYSIS

OBJECTIVES AND METHODS

Objective: To assess food habits and habitat selection of the KCH in relation to available range.

The following assumptions were made;

1. To determine the condition of the observed winter range used by the KCH we assumed that the quality of plant composition in fecal samples collected during late winter reflect what is available, hence range condition.

2. To determine which vegetation cover types are important for caribou we assumed that;
a. sightings within a cover type represent the amount of use of that cover type, and;
b. the amount of use of a cover type is proportional to the degree of importance of that cover type.

3. To determine available range, we located all vegetation cover types of a kind used by caribou in late winter. We assumed that if caribou fed in certain cover types on their traditional late winter range then any similar cover type outside their traditional range would also contain caribou foods. We did not map the distribution of foods used by caribou during winter.

4. Vegetation types were assumed to be available to caribou in late winter if snow depths were less than 60 cm and snow density was less than 0.35 g/cc, snow depth and density values favorable for caribou to dig craters (Russell and Martell 1984).

We define alternate late winter range as any area outside the observed late winter range of the KCH that has similar vegetation cover and has average snow depths and snow densities below those considered critical to caribou.

Food Habits

The winter food habits of the KCH were determined from composite collections of fecal samples made during February and March 1987 to 1989. Fecal analysis provides a crude assessment of KCH winter range condition and composition by indicating the overall quality of food in the diet. Each year, sampling sites were chosen at various locations on the herd's winter range. Each sample contained 20 fecal pellets, one from each of 20 different fecal pellet groups. Samples were analyzed at the Composition Analysis Laboratory at Colorado State University in Ft. Collins, Colorado. The relative frequency of plant fragments was based on 100 fields per sample. The microhistological analysis of caribou samples was tabled, indicating the percentage of each plant group. The accuracy of fecal analysis is influenced by differing digestion rates among the major food groups (Holechek et al. 1982), and is an estimate of the composition of the winter diet, rather than actual proportions ingested. The rumen turnover rate for caribou is about two days (White and Trudell 1980). Therefore, fecal collections were representative of food intake over a much broader area than the actual collection sites.

Vegetation Cover Mapping

A basemap of the Casino Trail area was produced from 1:250,000 topographic maps with 500 foot (165 meter) contour intervals.

Satellite remote sensing data (Landsat 5~TM) was obtained in the form of a transparent image with color enhancement appropriate for vegetation interpretation. The image of August 27, 1989 was of scene 61-16/124, at a 1:1,000,000 scale, using color composites of bands 3, 4, 5.

The image was mounted on a 'PROCOM II' Image Transfer System projected at an enlarged scale of 1:250,000 and superimposed directly onto the basemap.

Topographic maps and air photographs (1989) assisted to cross check when cover typing was uncertain.

Field checking of the preliminary cover map included noting the vegetation cover type at each of 85 snow measurement stations throughout the study area. Additional checking was conducted using a Cessna 172 aircraft on March 29th, 1990. The ground cover of snow did not allow us to identify the understory or low shrub cover but aided in determining tree canopy and density of both hardwoods and softwoods. Therefore, vegetation communities were based on tree type, % cover and elevation rather than on understory species composition.

Snow Parameters

To estimate regional snow depths, and compare current year with the long term mean snow depths we obtained data collected at six permanent snow course stations within and surrounding the study area.

Further, to gain a detailed local understanding of snow conditions in the study area, snow measurements were conducted at stations located throughout and slightly beyond the total range of the KCH. The final vegetation cover map was not completed when we conducted the snow measurements, therefore we could not determine how many samples would be required to sample each cover type in proportion to its availability. We conducted a Chi-square test after the map and sampling was completed to determine whether we had sampled cover types in proportion to their availability.

Snow measurements were taken at ten kilometer intervals along transects which ran east to west (Fig. 16). An additional five stations were sampled at sites where caribou or fresh caribou cratering was observed.

At each snow station we used a Mt. Rose snow tube, to measure snow depth and density. Ten depth measurements were obtained at 5 m intervals along a 50 m transect within the representative cover type.

In addition, at each snow station we recorded the cover type, presence or absence of caribou sign, and, where sign was present, the type of sign i.e. tracks, craters, fresh or old.

RESULTS AND DISCUSSION

Food Habits

The percent of discerned plant fragments found in all fecal samples collected on the winter range of the KCH are summarized in Table 6. For reference purposes the percentages found in each sample collected are presented in Appendix D.

The plant composition of fecal samples from the KCH winter range was predominantly fruiticose lichens (78%), mostly terrestrial lichen (74% Cladina spp.). These are typical proportions of lichen when compared to those found for other woodland caribou herds in Yukon (Farnell and Russell 1984, Farnell and McDonald 1988, 1989, and 1990).

Horsetails (Equisetum) was the second most common component (12%) of the diet. Horsetails, along with grasses and sedges are an

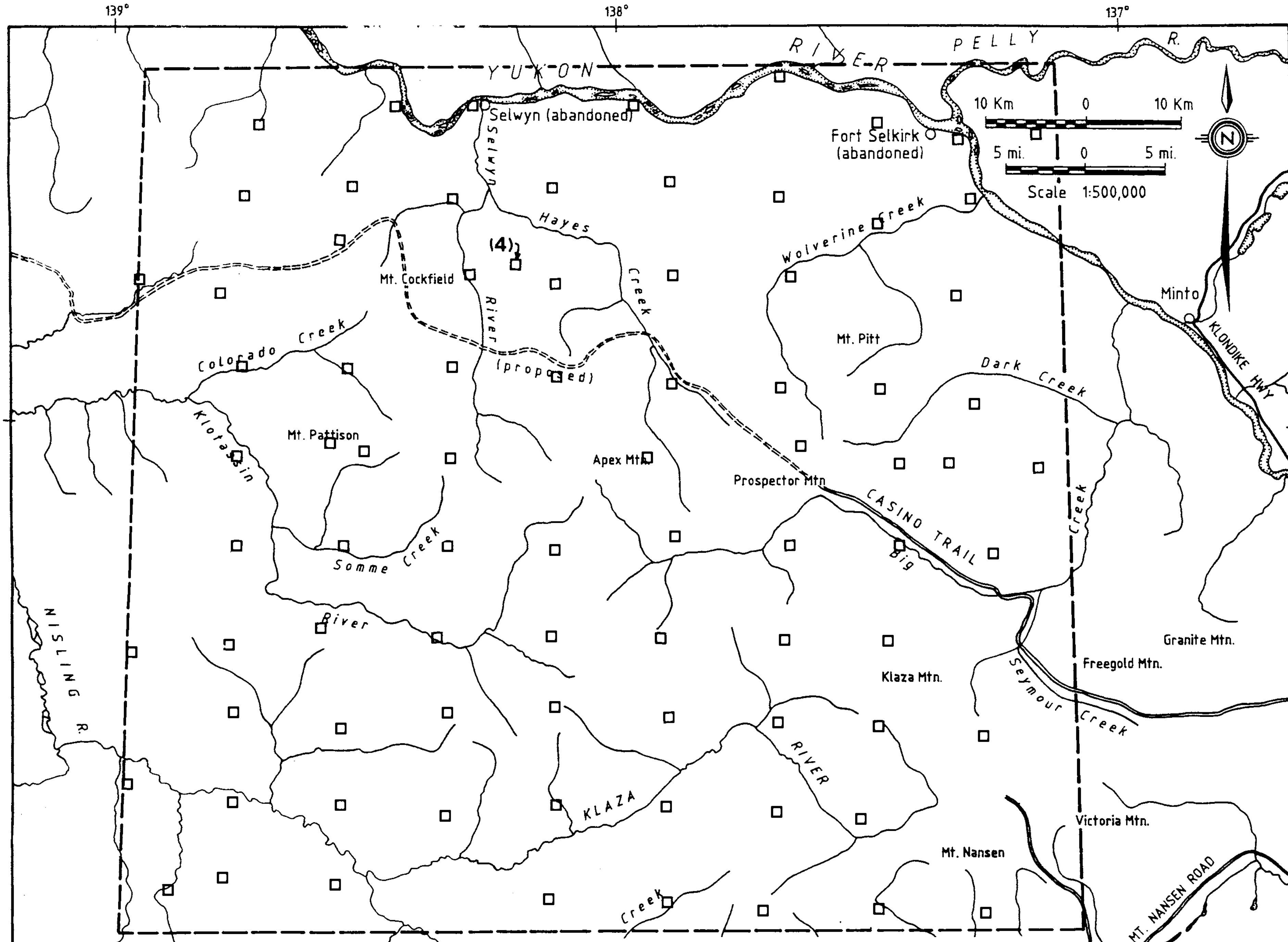


Figure 16 . Location of snow stations in the Klaza Study Area.

important component in the winter diet of caribou because they provide relatively high levels of nitrogen and protein for winter. But this component is usually represented by higher levels of sedges (Graminoids), primarily *Carex* spp., in the diets of other Yukon woodland caribou herds (Farnell and McDonald 1988, 1989, and 1990). The winter habitat of the KCH may provide an explanation for this disparity. Sedges used by caribou are mostly found along lake and wet meadow shorelines, uncommon habitats on the KCH range. Horsetails are not restricted to marshes and some species are located in treed areas, of which there is ample habitat on the KCH winter range. Horsetails may be a nutritional substitute for graminoids which are relatively unavailable to the KCH. The low incidence of poorer quality forage, evergreen shrubs (4%) and moss (3%)), indicate that this herd occupies range that provides a high energy winter diet.

Table 6. Average percent relative frequency of plant fragments from fecal samples collected during winter on the range of the Klaza caribou herd from 1987 to 1989.

Plant Genus or Group (sample frequency)	Average Percentages (± SE)	
Moss(6/6)		3.215 (0.38)
Fruiticose Lichens(6/6)		76.213 (4.14)
(Terrestrial)		
Cetraria-type(6/6)	1.982 (0.57)	
Cladonia-type(6/6)	74.156 (4.47)	
Alectoria(1/6)	0.075 (0.18)	
Foliose Lichens(5/6) (Peltigera)		2.138 (1.06)
Total Lichens		78.351
Horsetails(6/6) (Equisetum)		11.680 (2.26)
Graminoids(6/6)		2.973 (0.71)
Carex(6/6)	2.208 (0.66)	
Festuca(3/6)	0.208 (0.13)	
Eriophorum(1/6)	0.095 (0.23)	
Poa(2/6)	0.292 (0.38)	
Luzula(1/6)	0.170 (0.42)	
Deciduous Shrubs(1/6) (Shepherdia)		0.060 (0.15)
Evergreen Shrubs(6/6)		3.720 (0.70)
Ledum(6/6)	3.128 (0.81)	
Picea(4/6)	0.450 (0.19)	
Pinus(1/6)	0.142 (0.35)	

Vegetation Cover Mapping

Cover types recorded at the 85 snow stations verified the nine vegetation cover types that had been defined during the cover mapping project. Cover types are defined below and shown in Figure 17.

MAP SHEETS 115K AND 115I

TREED	DENSITY	ELEVATION
SPRUCE	OPEN (25-60%)	LOW-MID
SPRUCE	SPARSE (>10-25%)	LOW-MID
SPRUCE	VERY SPARSE (>5-10%)	MID-HIGH
ASPEN	SPARSE (>10-25%)	LOW-MID
SPRUCE/ASPEN	OPEN (25-65%)	LOW-MID
SPRUCE/PAPER BIRCH	OPEN (25-65%)	LOW-MID
SHRUB LAND		
SHRUB BIRCH/WILLOW	(<5% SPRUCE COVER)	MID-HIGH
DRYAS/LICHEN/GROUNDSHRUBS		MID-HIGH
BURN IN EARLY SERAL STAGE		________

OTHER
Geologic trenches
Bluffs

Snow Parameters

At snow depths greater than 74 cm and snow densities greater than 0.40 g/cc, snow conditions are considered adverse for sedentary forest caribou to dig craters (Russell and Martell 1984). More favorable cratering conditions are considered to be less than 60 cm and 0.35 g/cc for snow depth and density respectively

At only one of our 85 snow stations (Fig. 16) did snow depth or snow density exceed the threshold that is unfavorable to caribou. The mean snow depth was 48.35 cm (SD=19.28) and the mean density was 0.14 g/cc (SD=0.06) for the Klaza study area. Isolines showing snow depths in 10 cm increments are shown in (Fig. 18). Lower snow depths occurred at higher elevations which correspond closely to the Very Sparse Spruce and Dryas/Lichen/Groundshrubs cover types (Table 7). If the two high elevation cover types are excluded from the analysis, the mean snow depth was 53.88 (SD= 13.82), still favorable for cratering.

Snow was deeper in 1990 for all permanent stations with the exception of Carmacks and Casino Creek during late March (Table 8). Snow depths obtained at the six snow courses during 1990 were within the range of those measured at our 85 snow stations. Suggesting that our snow stations reflect the annual trend and are representative of the snow depths in the region. Even in 1990, a year when snow depths were above average, snow conditions were favorable for caribou to dig craters in 98% of the study area.

LEGEND

	DENSITY	ELEVATION
TREED		
Spruce	Open (25-60%)	low-mid
Spruce	Sparse (>10-25%)	low-mid
Spruce	Very Sparse (>5-10%)	mid-high
Aspen	Sparse (>10-25%)	low-mid
Spruce/Aspen	Open (25-65%)	low-mid
Spruce/Paper Birch	Open (25-65%)	low-mid
SHRUB LAND		
Shrub Birch/Willow	(>5% Spruce cover)	mid-high
Dryas/Lichen/Groundshrubs		mid-high

geologic trenches

bluffs

winter range

Figure 17. Vegetation cover types in the Klaza Study Area.

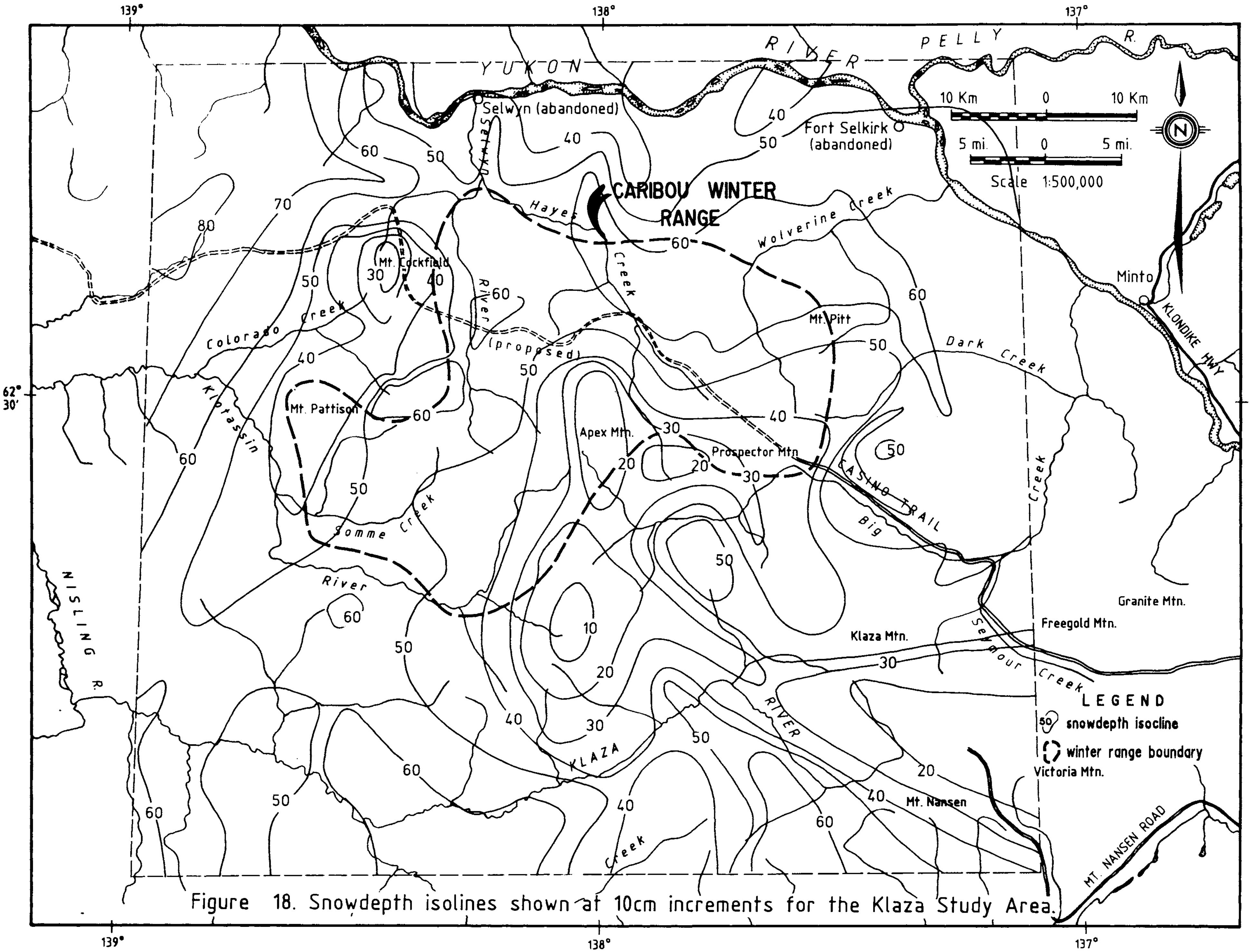


Figure 18. Snowdepth isolines shown at 10cm increments for the Klaza Study Area.

Snow within cover types was sampled in proportion to their availability (X^2=15.43, P=0.05).

Table 7. Number of snow stations, mean snow depth and snow density within each vegetation cover type.

COVER TYPE	# SNOW STATIONS (%)	$\bar{x}$ SNOW DEPTH (S. Dev.)	$\bar{x}$ SNOW DENSITY (S. Dev.)
Open Spruce	13 (15)	52.21 (14.3)	0.14 (0.02)
Sparse Spruce	23 (27)	57.71 (12.6)	0.15 (0.08)
Very Sparse Spruce	2 (2)	26.55 (21.6)	0.09 (0.03)
Sparse Aspen	0 (0)	____ ____	____ ____
Open Spruce/Aspen	10 (12)	50.30 (13.0)	0.15 (0.04)
Open Spruce/Paper Birch	3 (4)	49.97 (24.1)	0.13 (0.02)
Shrub Birch/Willow	16 (19)	52.56 (16.5)	0.16 (0.05)
Dryas/Lichen/Groundshrubs	17 (20)	29.43 (24.1)	0.12 (0.07)
Burn	1 (1)	56.00 ____	0.13 ____

Table 8. Comparison of late winter 1990 snow depths to mean snow depths at 6 snow courses within and proximal to the Klaza study area (INAC unpubl. rep. 1990, Atmos. Env. Serv. Unpubl. data).

Snow Course	Snow Depth Feb., 1990	Snow Depth Mar., 1990	$\bar{x}$ Snow Depth February	$\bar{x}$ Snow Depth March
Carmacks	45.0	23.0	36.4(n=15)	33.9(n=15)
Casino Creek	73.0	60.0	57.0(n=13)	61.0(n=13)
Fort Selkirk	46.6	40.0	36.6(n=15)	26.9(n=15)
Macintosh	63.0	57.0	42.0(n=15)	49.0(n=15)
Mt. Nansen	41.0	44.0	39.0(n=15)	42.0(n=15)
Pelly Farm	53.0	42.0	42.0(n= 5)	40.0(n= 5)

Based on late winter locations of the radio-collared caribou and observations of caribou during the 1989 late winter population census, caribou were observed in only 4 of the 8 cover types (Table 9). However, sixty (86%) of the 70 observations of caribou occurred in the sparse (59%) and open (27%) spruce types.

Table 9. Cover types that caribou were located in during the late winter 1989 population census (i.e. includes both radio-collared and uncollared caribou).

COVER TYPE	# LOCNS/OBS(%)	AREA (km^2) COVER TYPE IN STUDY AREA (%)
Open Spruce	19 (27%)	1214 (16)
Sparse Spruce	41 (59%)	1717 (23)
Very Sparse Spruce	1 (1%)	611 (8)
Sparse Aspen	0 (0%)	176 (2)
Open Spruce/Aspen	0 (0%)	801 (11)
Open Spruce/Paper Birch	0 (0%)	110 (1)
Shrub Birch/Willow	9 (13%)	2016 (26)
Dryas/Lichen/Groundshrubs	0 (0%)	992 (13)
Burn	0 (0%)	30 (<1)
TOTAL	70 (100)	7667 (100)

Mean snow depth ($\bar{x}$=51.2cm), although deeper was not significantly deeper ($p>0.05$) on the late winter range ($\bar{x}$=47.5cm) than outside the late winter range of the Klaza herd. Mean snow depth ($\bar{x}$=60.3cm) was significantly deeper ($p<0.001$) in open and sparse spruce, the two preffered cover types, on their winter range than outside their late-winter range ($\bar{x}$=53.5cm). Mean snow depth ($\bar{x}$=67.6cm) was also significantly deeper ($p<0.001$) where caribou had recently cratered than where no caribou sign was observed in open and sparse spruce

Based on distribution surveys the late winter range of the KCH is 1222 km^2. Open and sparse spruce cover comprises 543 km^2 of the late winter range. Outside the late winter range there is an additional 2388 km^2 of open and sparse spruce cover suggesting there are adequate amounts of late winter cover for caribou.

There may be other reasons e.g. social as to why caribou concentrate during late-winter. The fact that the Hayes Creek watershed has been the most consistently and most heavily used portion of the traditional winter range (Figures 8 & 10) should not be overlooked. It is very likely that important biological parameters draw caribou to that watershed each winter. We may have failed to measure the correct combination of biological factors.

In review then, we find that the winter range presently used by the KCH appears to provide high quality forage for caribou as evidenced by fecal sample analysis. Open and sparse spruce cover are the most intensively used and most important cover types for caribou during late winter and snow conditions throughout the home range were favorable for caribou to dig craters. Snow density was quite uniform throughout the study area, and below values considered unsuitable for cratering. Although snow depths were suitable for cratering, snow depth was less favorable for digging craters within the traditional late winter range, and within the cover types where caribou were most frequently observed. We also found that adequate amounts of cover used by Klaza caribou during late winter exist outside their traditional winter range but within the home range of the KCH.

For two reasons these results should not be generalized and applied to other woodland caribou winter ranges in the Yukon. First, the KCH winter range lies within the larger, former winter range of the Fortymile barrenground caribou herd and this is not the case for most other woodland caribou herds in the Yukon. Secondly, this study represents a crude assessment of the winter habitat. In addition, there are many other habitat parameters such as the distribution and abundance of winter foods for caribou that should be examined in a more detailed search for alternate winter range.

This crude assessment of late winter caribou range indicated that alternate late winter range does exist. If we assume that similar amounts of lichen exist within similar cover types no matter where they are located in the traditional home range, then the law of least effort (Bergerud 1978) would not appear to apply to the Klaza caribou herd.

HERD HEALTH

OBJECTIVES AND METHODS

Objective: To assess disease frequency in the herd.

Coincident with capture and collaring activities we assessed disease frequency in the herd by collecting blood samples from 3 caribou during the February 1988 capture operations. These were sent to the Alaska Department of Fish and Game, Wildlife Disease Coordinator, Fairbanks, Alaska.

RESULTS AND DISCUSSION

Blood sample analysis by the Alaska Department of Fish and Game, Wildlife Disease Coordinator, Fairbanks, Alaska, found no evidence of exposure to the following disease agents;

Infectious bovine rhinotracheitis	Bluetongue virus
Bovine viral diarrhea virus	Contagious ecthyma virus
Parainfluenza III virus	Q fever rickettsium
Respiratory syncytial virus	Brucellosis bacterium
Epizootic hemorrhagic disease virus	Leptospirosis bacterium

These diseases have been documented in certain Alaska caribou herds. Therefore, the absence of such evidence in these animals is a favorable commentary on the health of the KCH (R. Zarnke pers. comm.).

CONCLUSIONS AND RECOMMENDATIONS

1. The late winter range of the KCH, specifically Hayes Creek, has special values which causes caribou to concentrate there. Such clumping makes them vulnerable to over-harvesting, and/or absolute range abandonment in response to associated disturbance, as demonstrated by declines in other woodland caribou herds whose ranges were intersected by roads (Bergerud 1978, Bloomfield 1979, Farnell and McDonald 1988). Further construction of the Casino Trail will provide permanent access to the herd during winter. Thus, a high level of protection is warranted to maintain or increase the present population. The highest level of protection would be to protect this herd's late winter range from access by road. However, recognizing that there could be sufficient socio-economic justification for continuing the Casino Trail project, the following mitigation procedures are recommended;

A. The Mount Cockfield area is inhabited by substantial numbers of caribou during the calving, post-calving, and rut periods. Disturbance to caribou associated with activities from the Casino Trail will be inevitable at this location, and that specific alignment proposal is acknowledged to be a technically difficult route to negotiate (P. Percival pers. comm.). We therefore suggest an alternative to bypass this area and the late winter range of the herd by routing the road north down the Wolverine Creek drainage, then drop back to Hayes Creek and follow it downstream to the south bank of the Yukon River. This option would provide little or no contact with caribou.

B. It is understood that right-of-way clearing and other construction-related activities will remove approximately 30 ha of habitat. This is not a significant amount; however, experience has shown that an initial road results in the construction of spur roads, such that a network of roads and trails develops over time. For example, by 1989 an RTAP funded spur road was built from the Casino Trail terminus 30 km across the Prospector/Apex Mountain uplands to access mining claims and build an airstrip in an area frequented by caribou during post-calving and rut periods (Fig.'s 5 & 6). This exacerbates the negative impacts by progressively opening up more and more of the range to hunting, as well as adding to the loss of prime habitat. Despite our finding that alternate late winter range exists, the KCH has shown fidelity to a winter range and specifically to the Hayes Creek watershed. Therefore we recommend that, if construction of the Casino Trail continues, we monitor habitat loss in the traditional late winter range and we be permitted to close the Casino Trail and prohibit various land use activities if 30% of the habitat is destroyed naturally i.e. fire, or unnaturally i.e. by construction, development, and exploration. Trail closure and prohibition of activities would continue until such time as Dept. of Renewable Resources has deemed that herd ecology was not threatened.

C. Since the further construction of the Casino Trail will bisect the KCH winter range it will be necessary to regulate access on the road to reduce impact on caribou during the winter months. This can be accomplished by constricting the period of large vehicle access to the periods when caribou are not on the Hayes Creek winter range. The road should therefore not be maintained by snow-plowing from 15 November until 1 June annually. This will require enforcing s.7(1) of the Highways Regulations which makes it an offense to maintain a public road without authorization. We also suggest that a directive to Highway Maintenance personnel be issued annually stating that no maintenance activity may occur prior to 1 June in any year.

D. If the Casino Trail development is to proceed, the demography of the KCH should be monitored periodically to evaluate the ultimate impact of the road. We recommend that another herd census be scheduled for late winter 1994 (5-year interval). We also recommend that before further construction proceeds, a written agreement between the Dept. of Renewable Resources and Community and Transportation Services (C&TS) be completed. This agreement would commit C&TS to funding a 1994 herd census and purchase of satellite images to monitor habitat loss. We estimate that $35,000 in 1990 dollars would be required to conduct this monitoring.

E. Once a final route has been established, the Environmental Protection Plan should be updated to include site-specific wildlife protection measures.

F. It is imperative that adequate lead time and sufficient details on proposed route alignment are provided to management agencies and the Casino Trail Local Resource Group for their input into further road developments in the Dawson Range.

G. If the Casino mine site goes into production a new mainline road should be built that does not cross the winter range. Perhaps north to along the Yukon River and then south again into the mine site.

2. Management actions directed at the KCH should be applied GMS 5-10 to 5-13 and 5-22 to 5-26 (Fig. 13) to avoid affecting other caribou populations that may have different demographic and human use characteristics. We are aware of only one other caribou

population that may border the range of the KCH, the Aishihik herd to the south. It was apparent from this study that the KCH does not interact in any way with the Aishihik herd, hence, the behavior of that population is of little consequence to the KCH for the present at least.

3. Our recommended harvest strategy for the KCH is to limit harvest to 3% of the herd (15 caribou) annually. Because the herd is a comparatively small population its growth could be prevented by the removal of females. We therefore recommend that harvest be limited to males only. Non-native harvesting opportunities have consequently been restricted to roughly one-half (permits for 8 male caribou) the allowable yield in consultation with the Carmacks/Little Salmon Band.

4. We suspect that the low big game densities and wolf numbers observed in the Dawson Range are the result of a predator-prey 'low-density equilibrium' that could have occurred after the drastic decline of the Fortymile herd. We contend that the ultimate measure needed to elevate big game numbers in this region is the recovery of the Fortymile caribou herd and subsequent reoccupation of its former range. By providing large amounts of alternate prey from this herd the KCH and local moose population may have a chance to grow. We therefore recommend that joint Yukon/Alaska management efforts be directed toward building the Fortymile herd.

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APPENDICES

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

	Date	Survey Type	Caribou Season	Objective
1.	87-02-05 87-02-11	Fixed Wing (28.7 hrs.)	Late Winter	a. Determine winter distribution.
2.	87-02-12 87-02-15	Helicopter (16.1 hrs.)	Mid-winter	a. Capture and radio-collar twelve caribou. b. Collect fecal samples.
3.	87-06-03	Fixed Wing (7.0 hrs.)	Calving	a. Relocate radio-collars. b. Determine calving distribution.
4.	87-07-16	Fixed Wing (4.8 hrs.)	Post-calving	a. Relocate radio-collars. b. Determine post-calving distribution.
5.	87-10-03	Fixed wing (3.8 hrs.)	Rut	a. Relocate radio-collars. b. Determine rut distribution.
	87-10-06 87-10-07	Helicopter (10.9 hrs.)		a. Composition count b. Distribution details. c. Investigate mortality.
6.	87-12-21	Fixed wing (6.0 hrs.)	Early Winter	a. Relocate radio-collars. b. Determine early winter distribution.
7.	88-02-07	Fixed wing (7.1 hrs.)	Mid-winter	a. Relocate radio-collars. b. Determine mid-winter distribution.
	88-02-16 88-02-17	Helicopter (4.3 hrs.)		c. Capture and radio-collar four caribou. d. Fecal sample collection.

Appendix A. (continued)

8.	88-06-09	Fixed Wing (4.9 hrs.)	Calving	a. Relocate radio-collars. b. Determine calving distribution.
9.	88-07-19	Fixed Wing (4.6 hrs.)	Post-calving	a. Relocate radio-collars. b. Determine post-calving distribution.
10.	88-10-06	Fixed Wing (4.5 hrs.)	Rut	a. Relocate radio-collars. b. Determine rut distribution.
		Helicopter (7.2 hrs.)		c. Composition count. d. Distribution details.
11.	88-12-20	Fixed Wing (4.5 hrs.)	Early Winter	a. Relocate radio-collars. b. Determine early winter distribution.
12.	89-03-15	Fixed Wing (6.2 hrs.)	Late Winter	a. Relocate radio-collars. b. Delineate survey area for census.
	89-03 17	Fixed Wing (24.0 hrs.)		c. Stratification survey.
	89-03-19 89-03-20	Helicopter (32.7 hrs.)		e. Census survey.
	89-03-21	Helicopter (4.8 hrs.)		f. Snow distribution survey. g. Fecal sample collection. h. Investigate mortality.
13.	89-04-21 89-04-26 89-05-02 89-05-18	Fixed Wing (21.1 hrs.)	Spring Migration	a. Relocate radio-collars. b. Determine spring migration pattern.
14.	89-06-10	Fixed Wing (5.4 hrs.)	Calving	a. Relocate radio-collars. b. Determine calving distribution.

Appendix A. (continued)

15.	89-07-20	Fixed Wing (5.1 hrs.)	Post-calving	a. Relocate radio-collars. b. Determine post-calving distribution.
16.	89-10-25	Fixed Wing (5.0 hrs.)	Rut	a. Relocate radio-collars. b. Determine rut distribution.
17.	89-12-19	Fixed Wing (5.0 hrs.)	Early Winter	a. Relocate radio-collars. b. Determine early winter distribution.
18.	90-02-15	Fixed Wing (4.5 hrs.)	Mid-Winter	a. Relocate radio-collars. b. Determine mid-winter distribution.
19.	90-03-29 90-03-30	Fixed Wing (13.2 hrs.)	Late Winter	a. Relocate radio-collars. b. Determine late winter distribution.
	90-03-31	Fixed Wing (9.7 hrs.)		c. Locate juxtaposed distribution of the Aishihik herd.

APPENDIX B

The data for all relocations by radio-collar

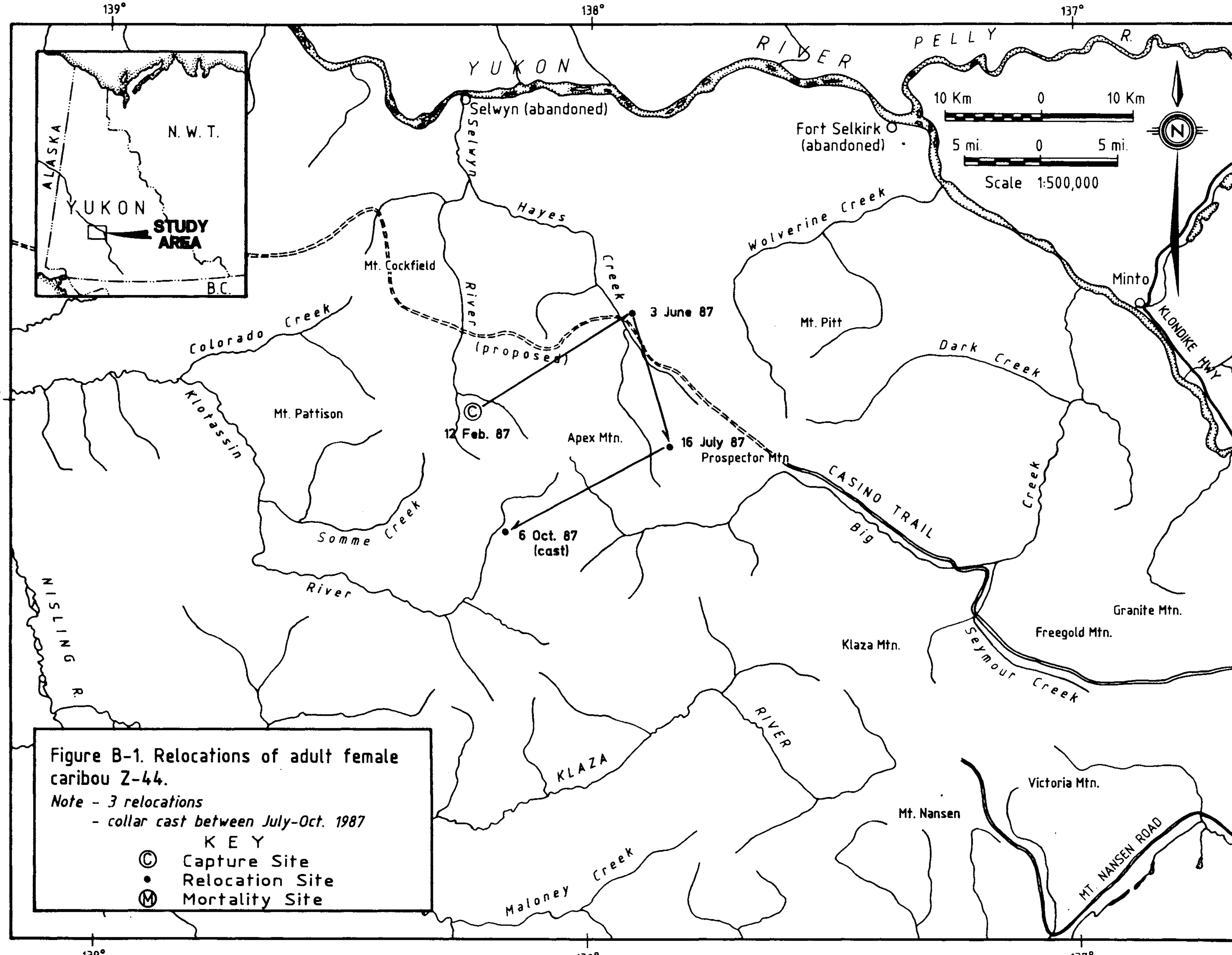

Figure B-1. Relocations of adult female caribou Z-44.
Note - 3 relocations
- collar cast between July-Oct. 1987

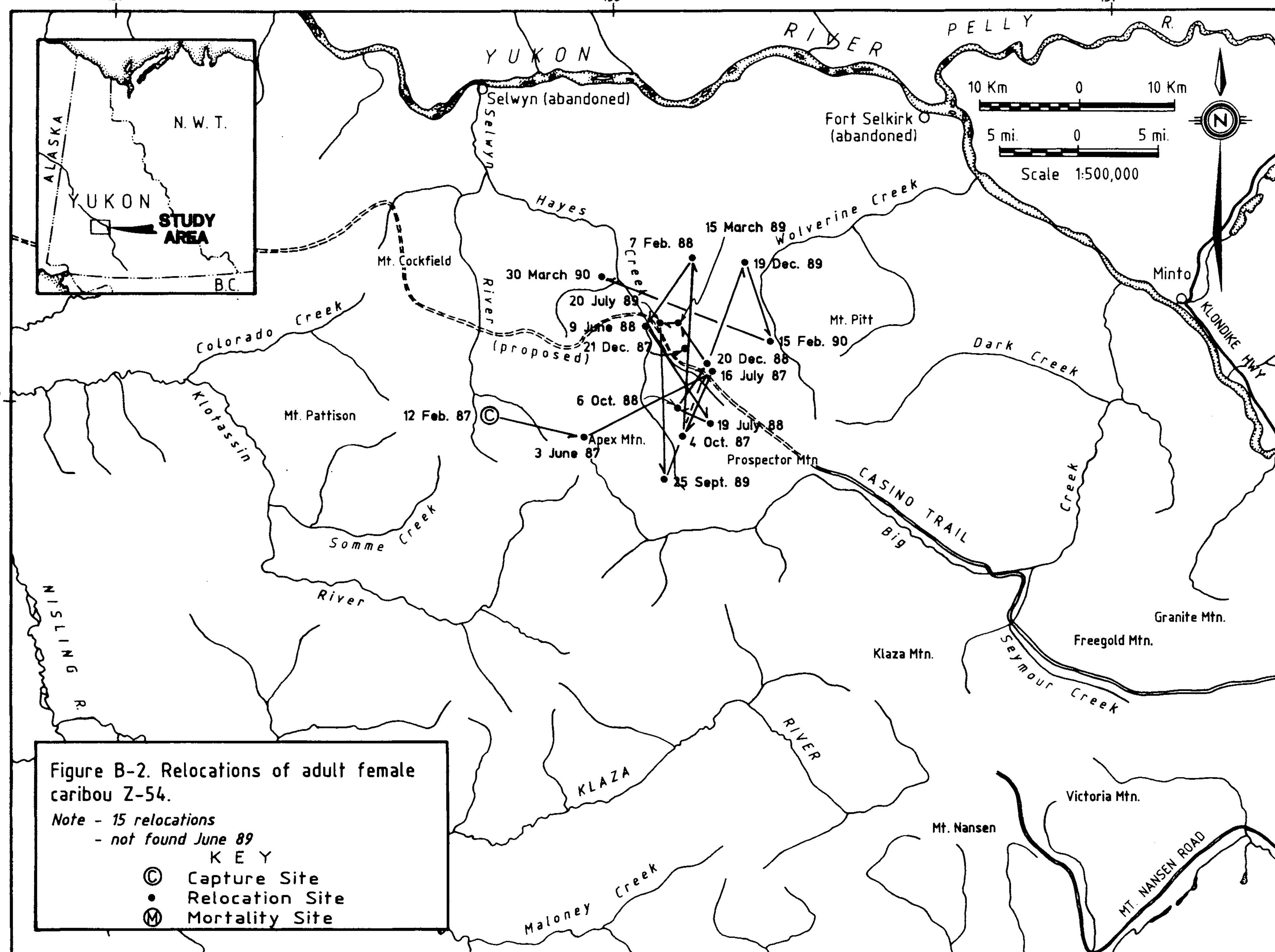

Figure B-2. Relocations of adult female caribou Z-54.

Note - 15 relocations
- not found June 89

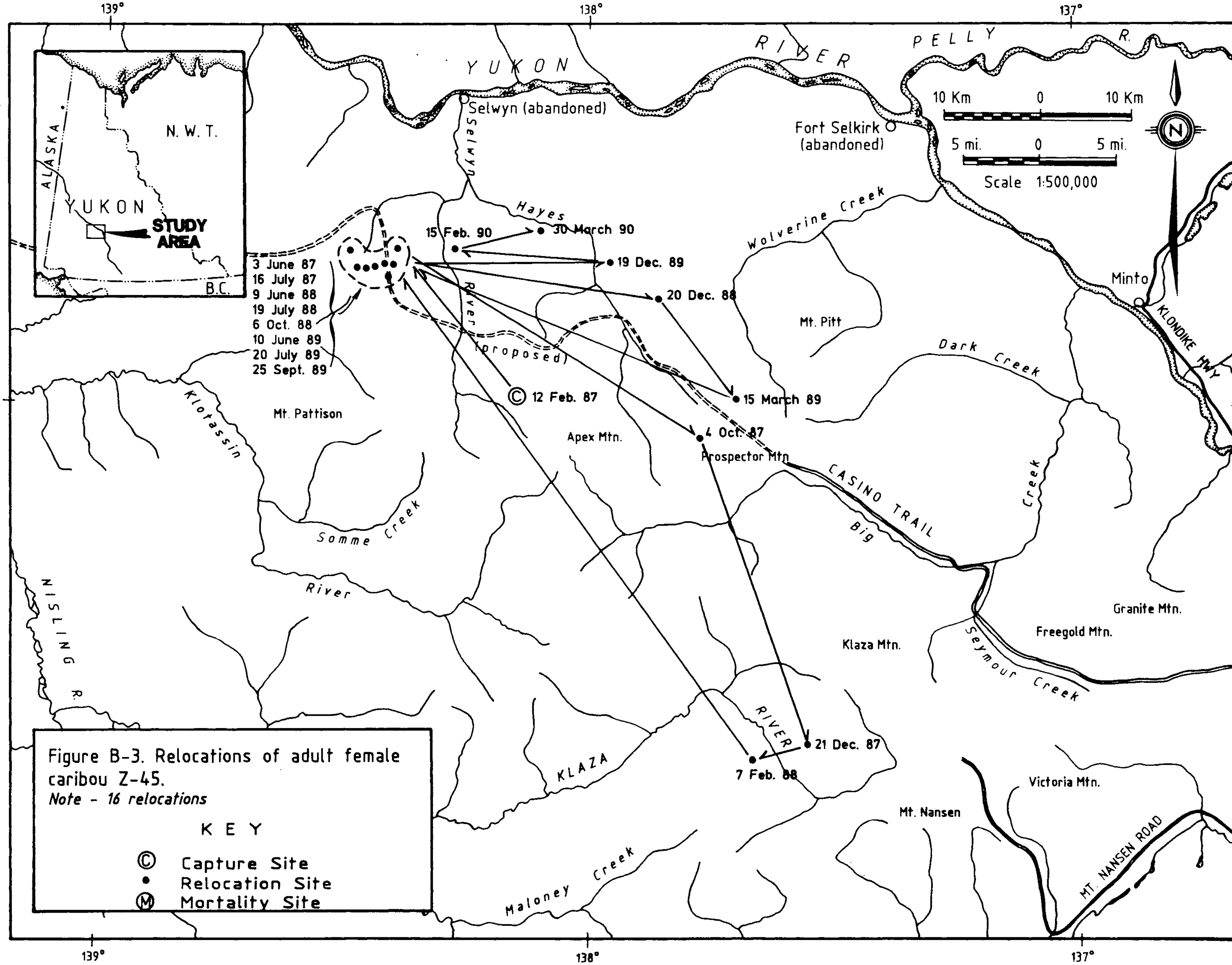

Figure B-3. Relocations of adult female caribou Z-45.
Note - 16 relocations

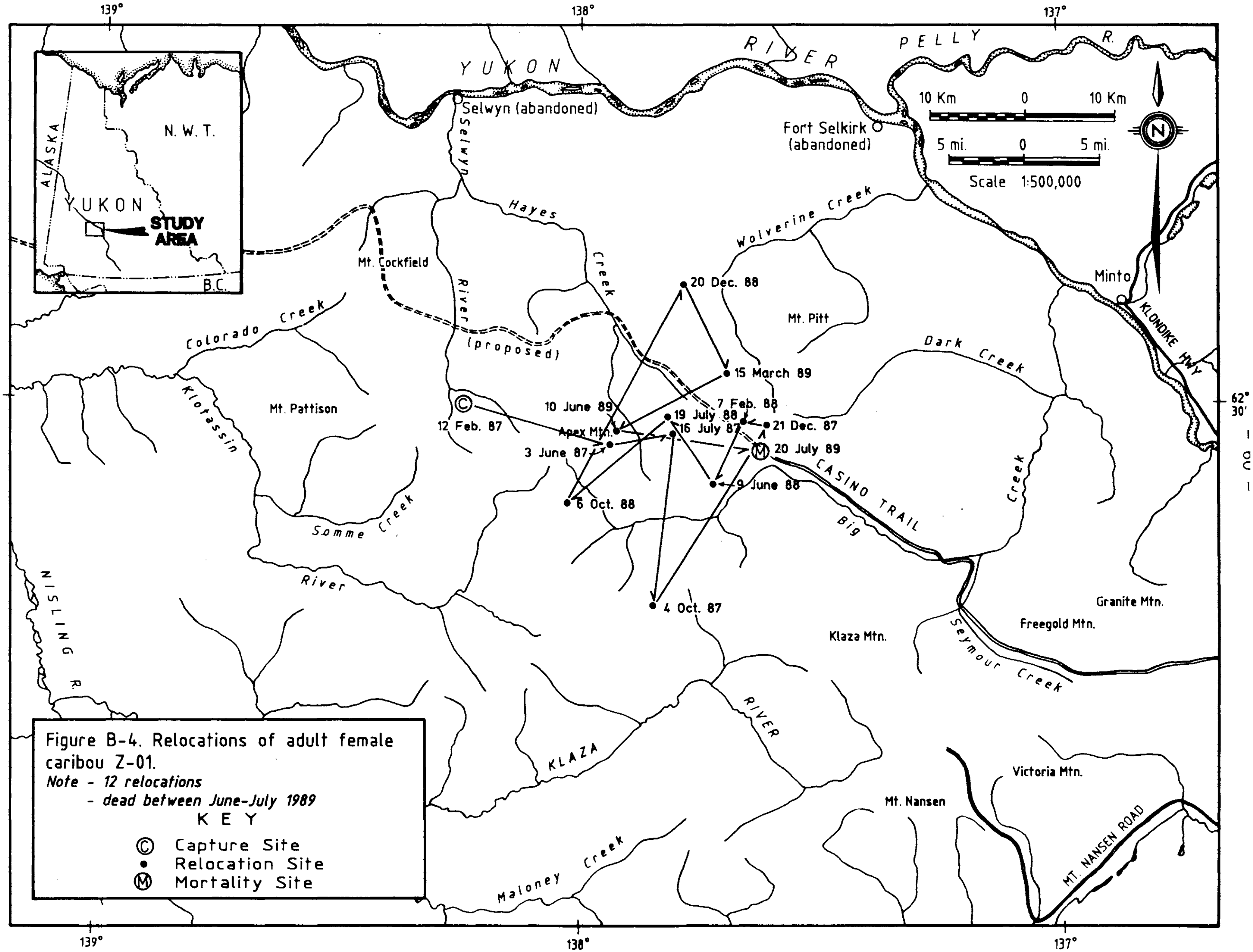

Figure B-4. Relocations of adult female caribou Z-01.

Note - 12 relocations

- dead between June-July 1989

KEY

Ⓒ Capture Site

• Relocation Site

Ⓜ Mortality Site

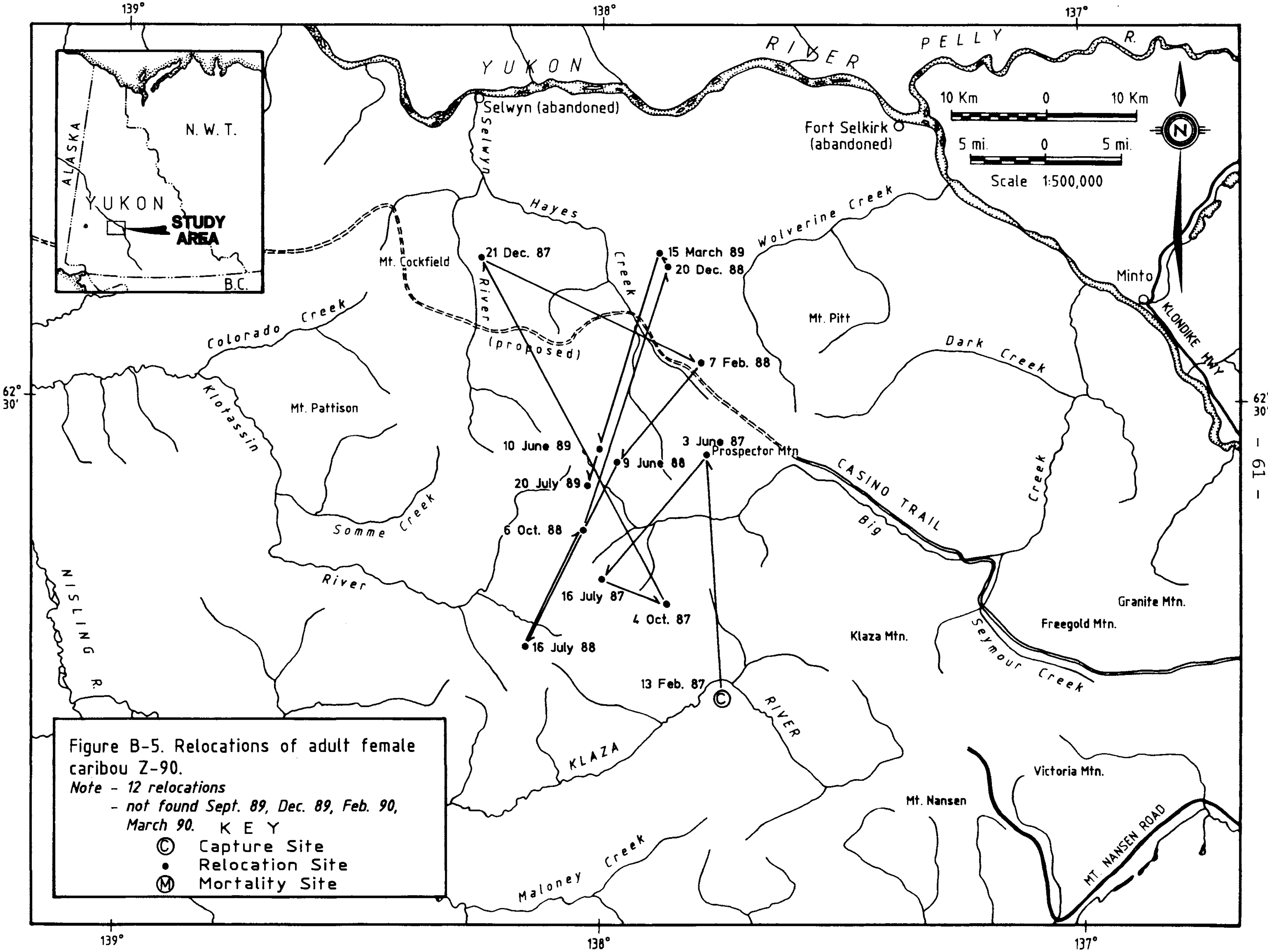

Figure B-5. Relocations of adult female caribou Z-90.
Note - 12 relocations
- not found Sept. 89, Dec. 89, Feb. 90, March 90.

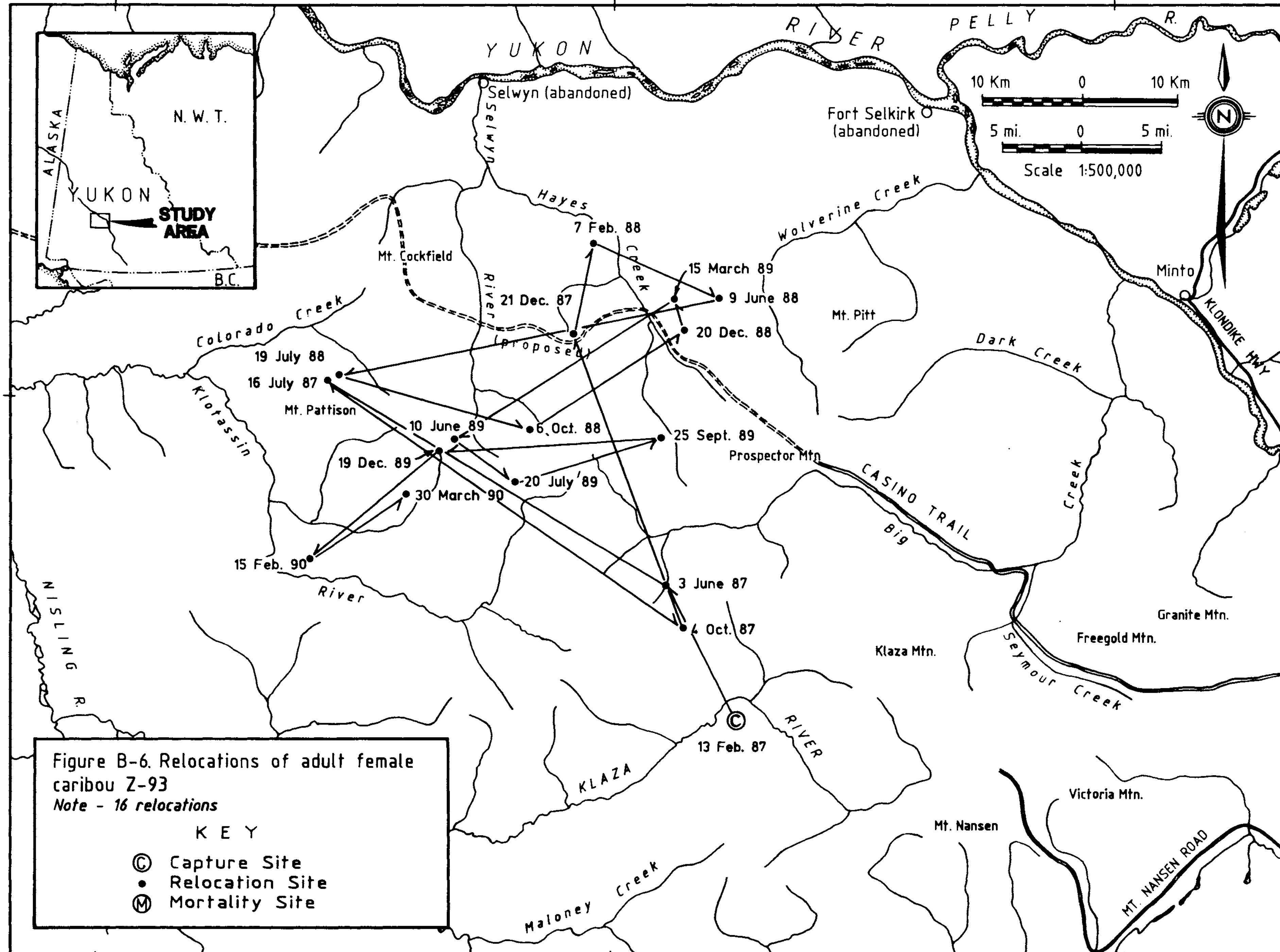

Figure B-6. Relocations of adult female caribou Z-93
Note - 16 relocations

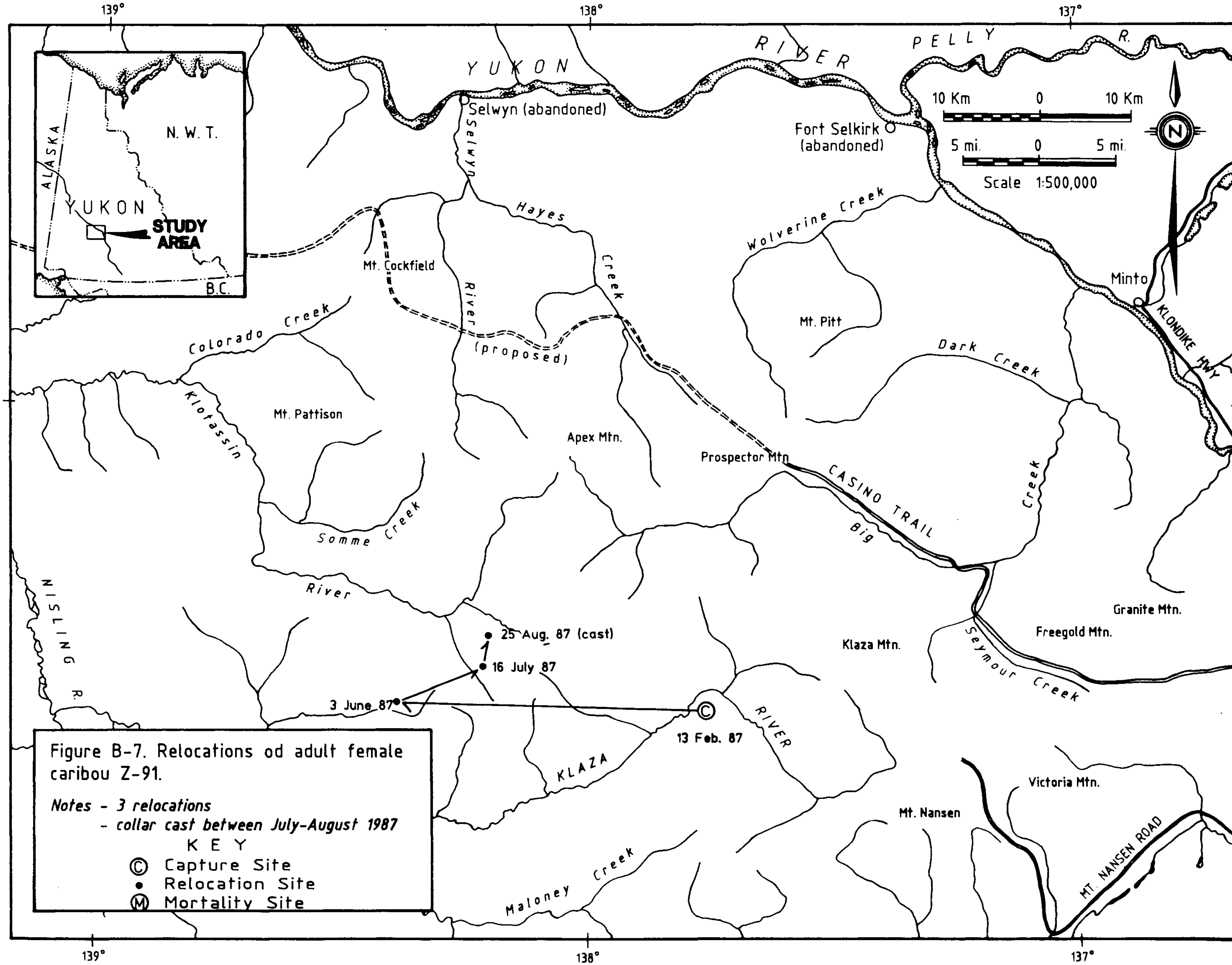

Figure B-7. Relocations od adult female caribou Z-91.

Notes - 3 relocations
- collar cast between July-August 1987

KEY
Ⓒ Capture Site
• Relocation Site
Ⓜ Mortality Site

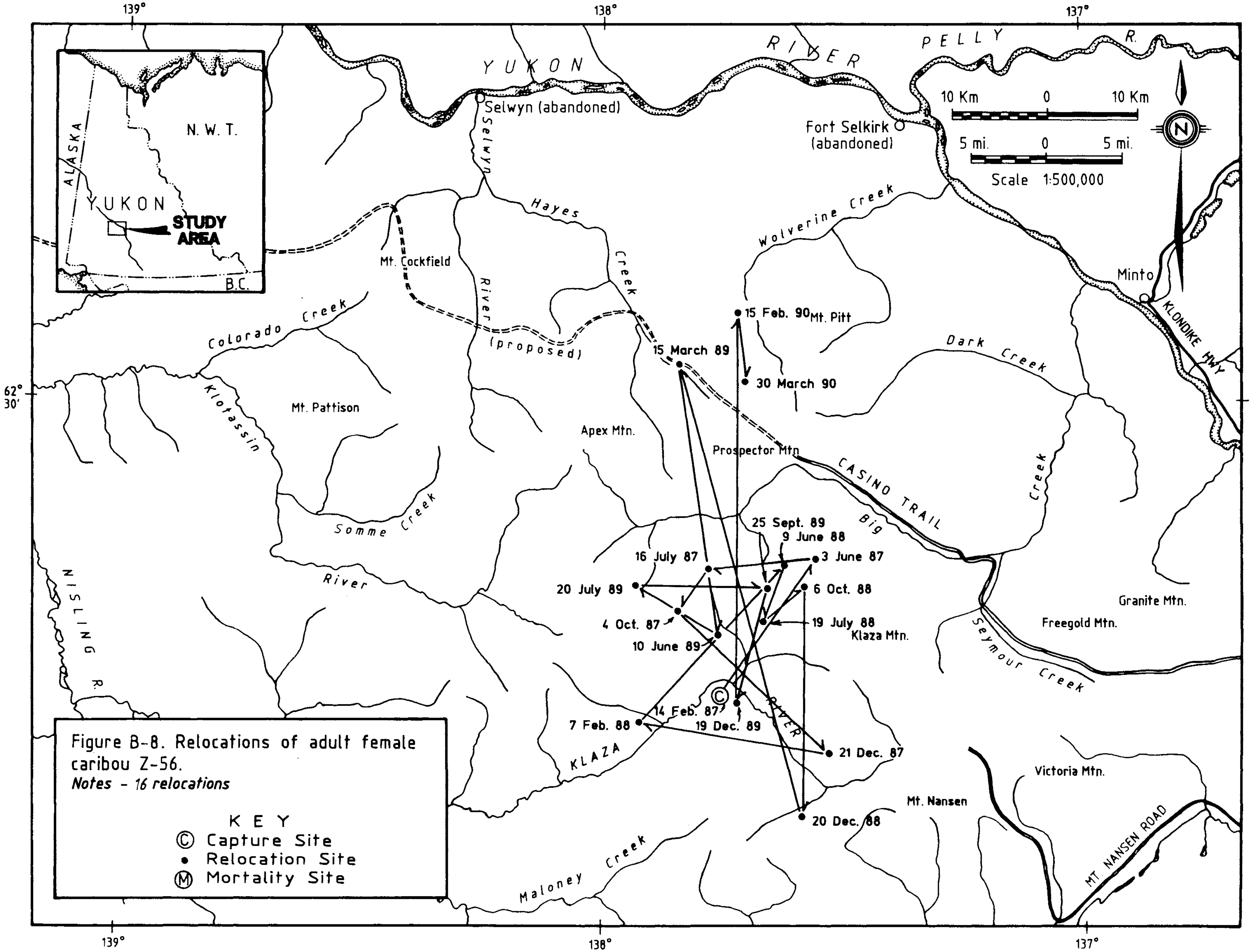

Figure B-8. Relocations of adult female caribou Z-56.
Notes - 16 relocations

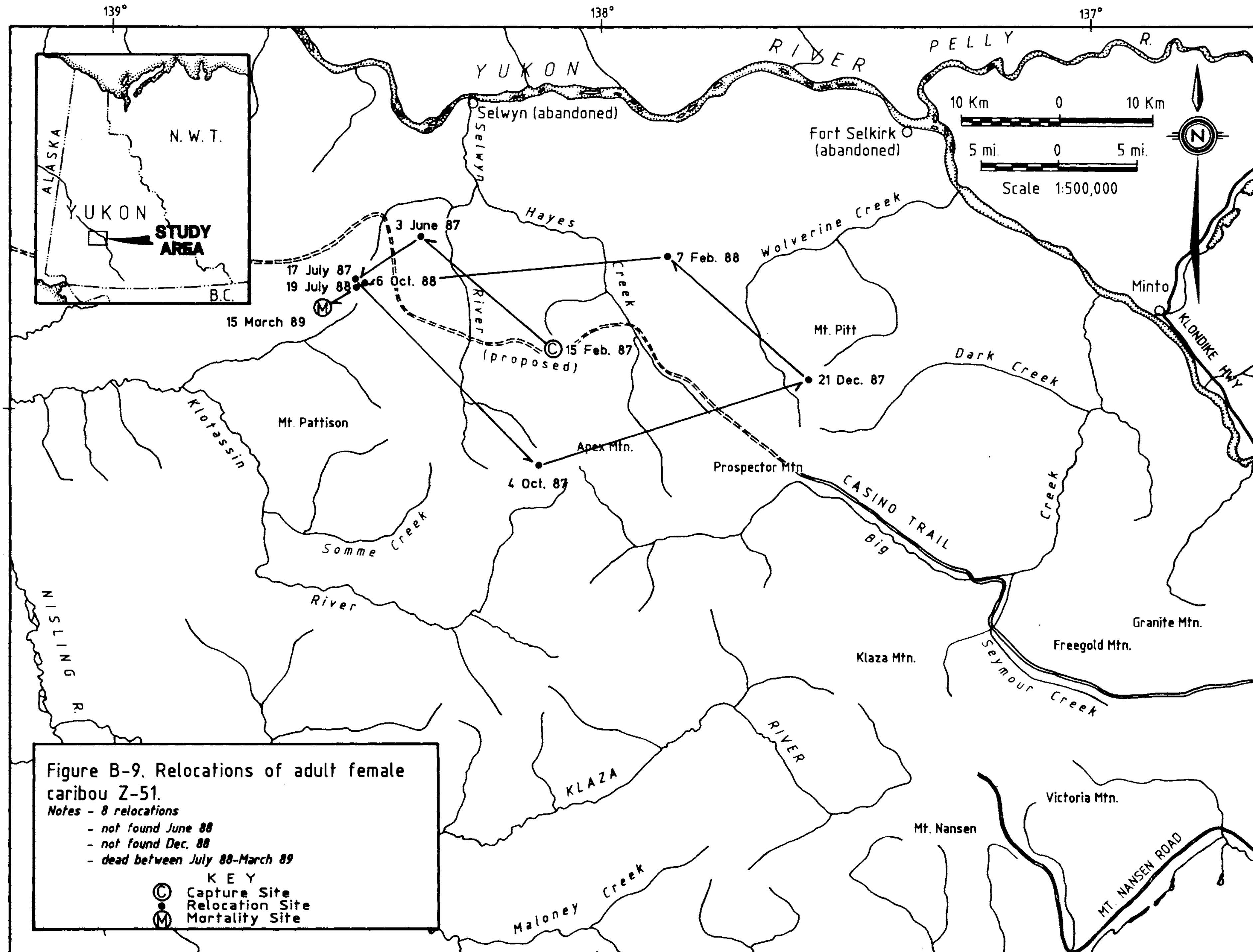

Figure B-9. Relocations of adult female caribou Z-51.

Notes - 8 relocations
- *not found June 88*
- *not found Dec. 88*
- *dead between July 88-March 89*

KEY
- (C) Capture Site
- ● Relocation Site
- (M) Mortality Site

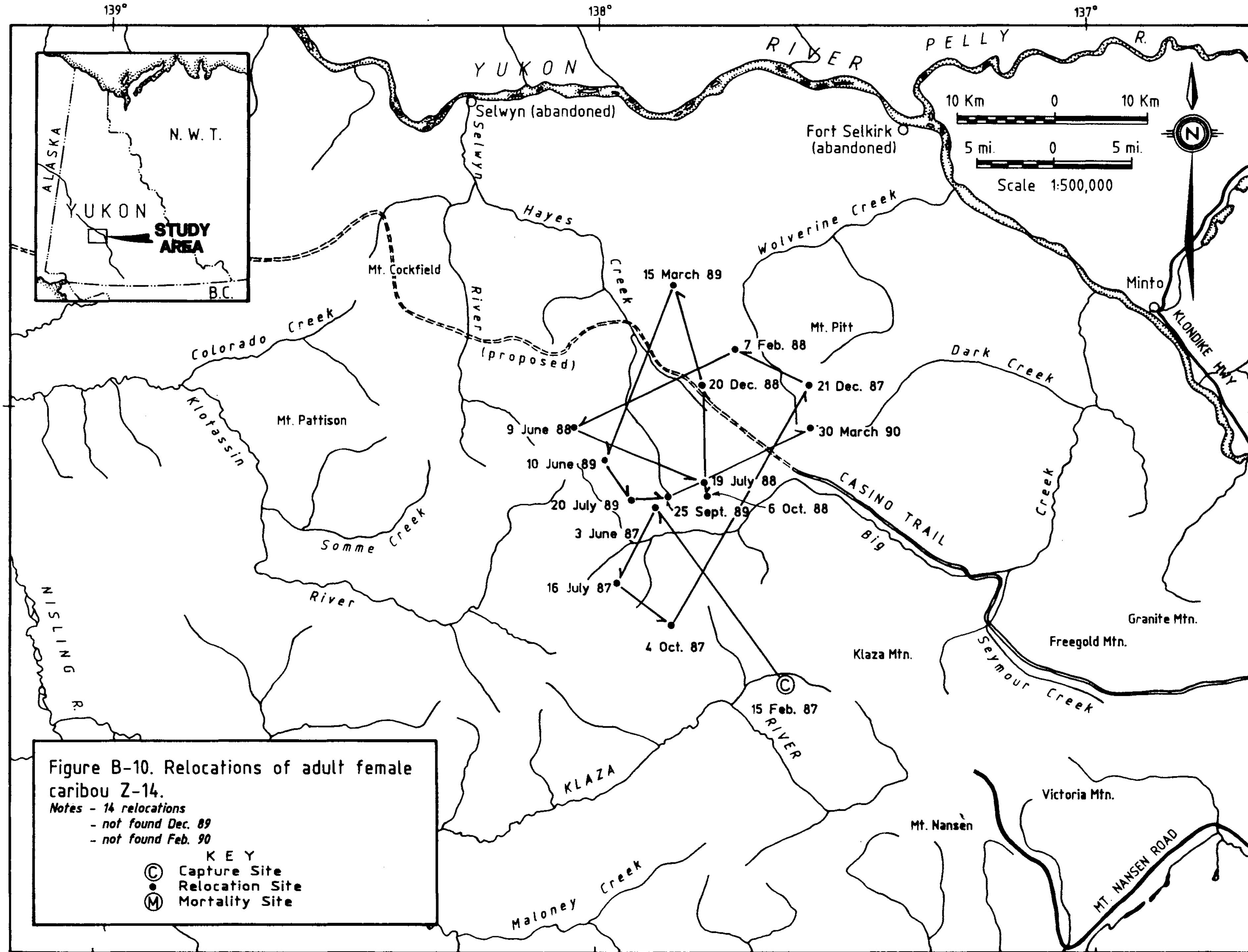

Figure B-10. Relocations of adult female caribou Z-14.

Notes - 14 relocations
- not found Dec. 89
- not found Feb. 90

KEY
Ⓒ Capture Site
• Relocation Site
Ⓜ Mortality Site

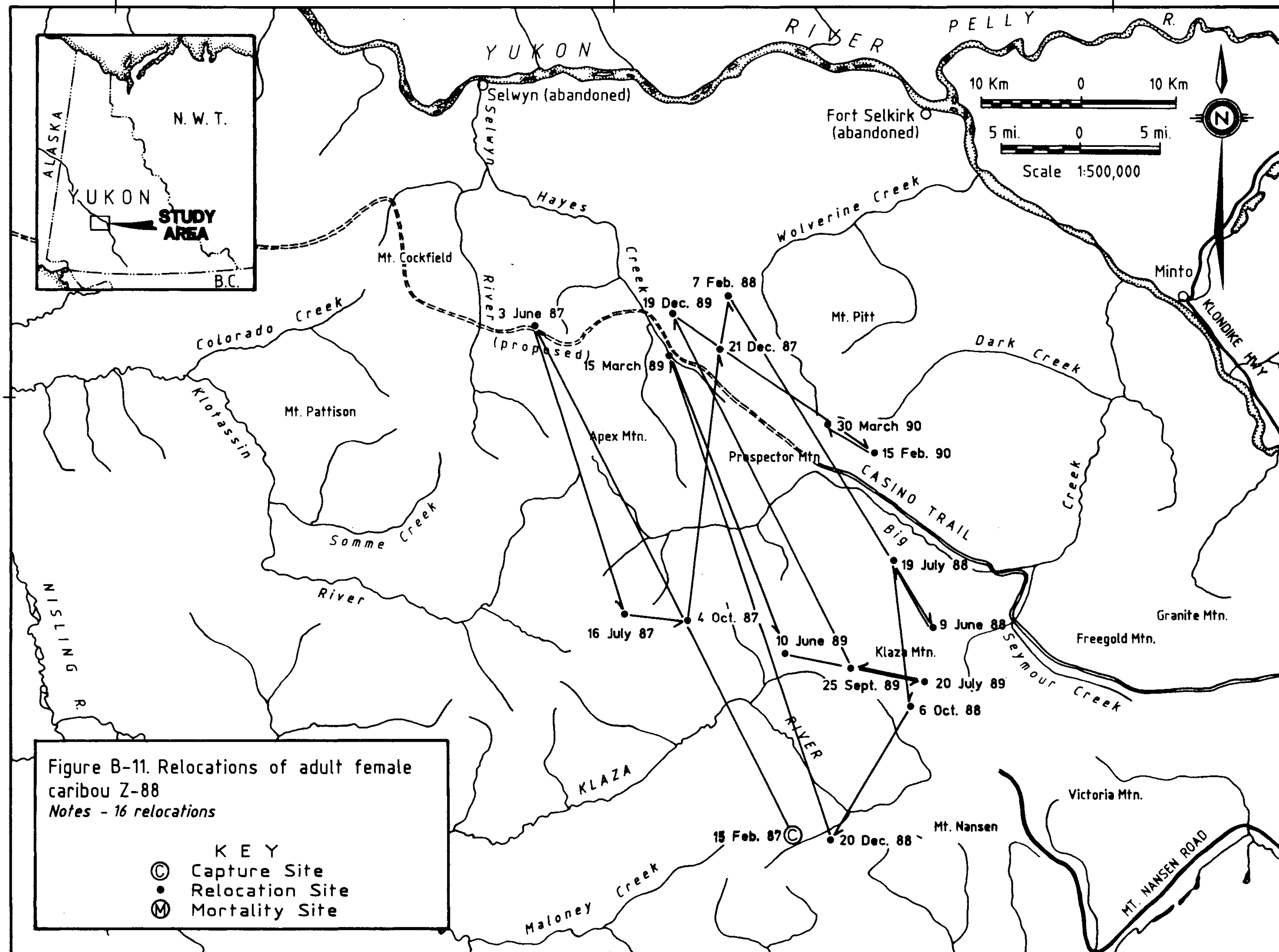

Figure B-11. Relocations of adult female caribou Z-88
Notes - 16 relocations

KEY
Ⓒ Capture Site
• Relocation Site
Ⓜ Mortality Site

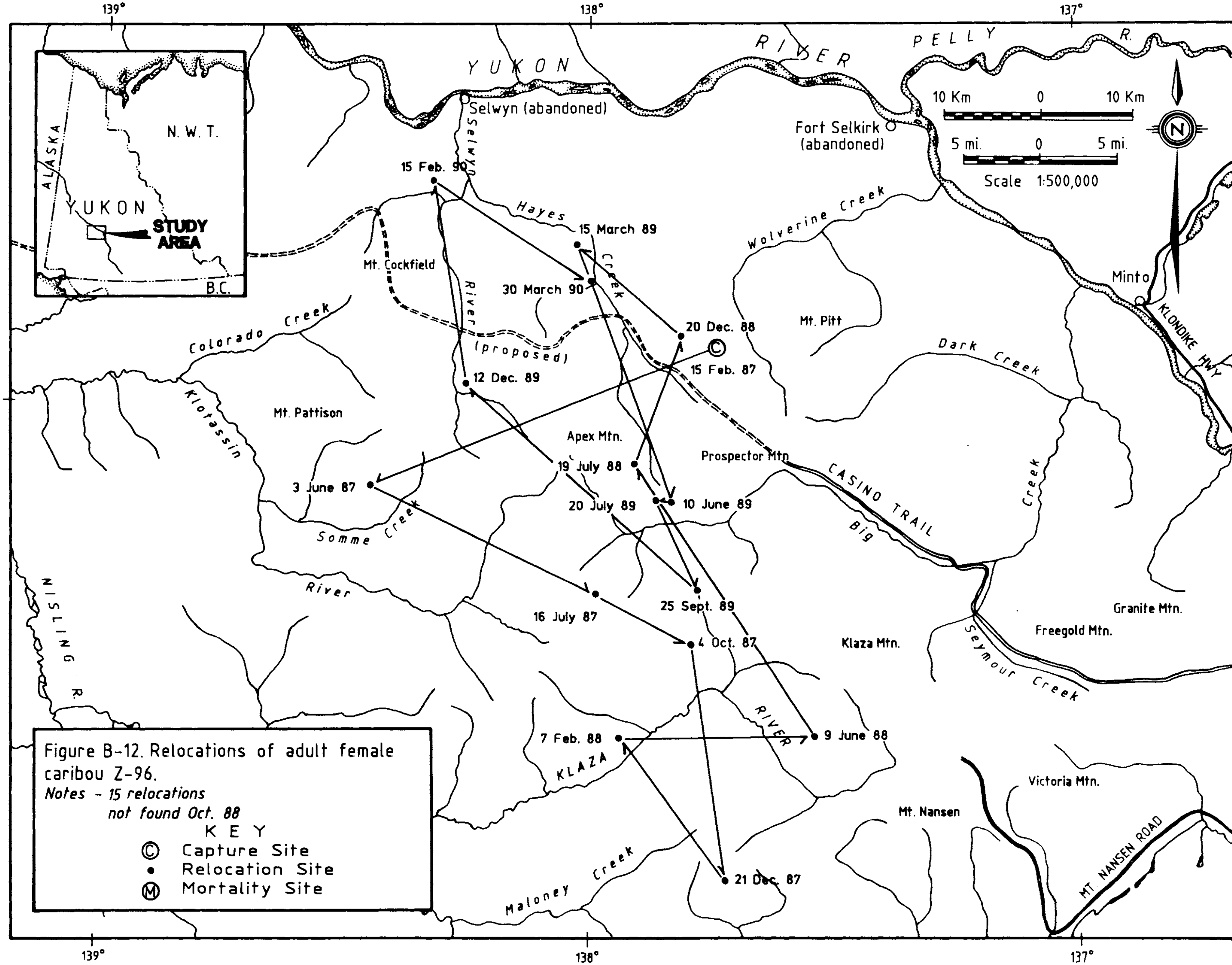

Figure B-12. Relocations of adult female caribou Z-96.
Notes - 15 relocations not found Oct. 88

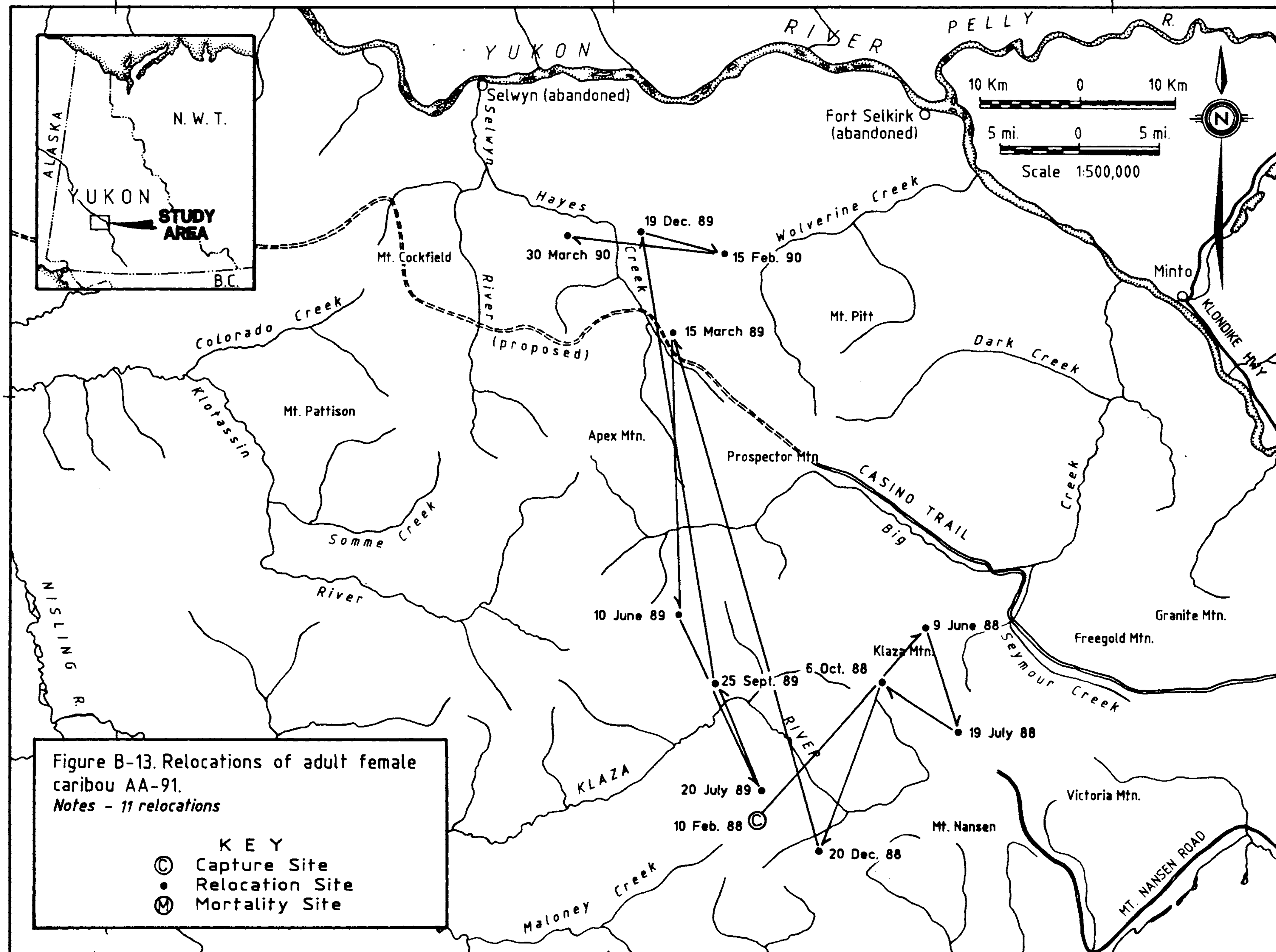

Figure B-13. Relocations of adult female caribou AA-91.
Notes - 11 relocations

KEY
Ⓒ Capture Site
• Relocation Site
Ⓜ Mortality Site

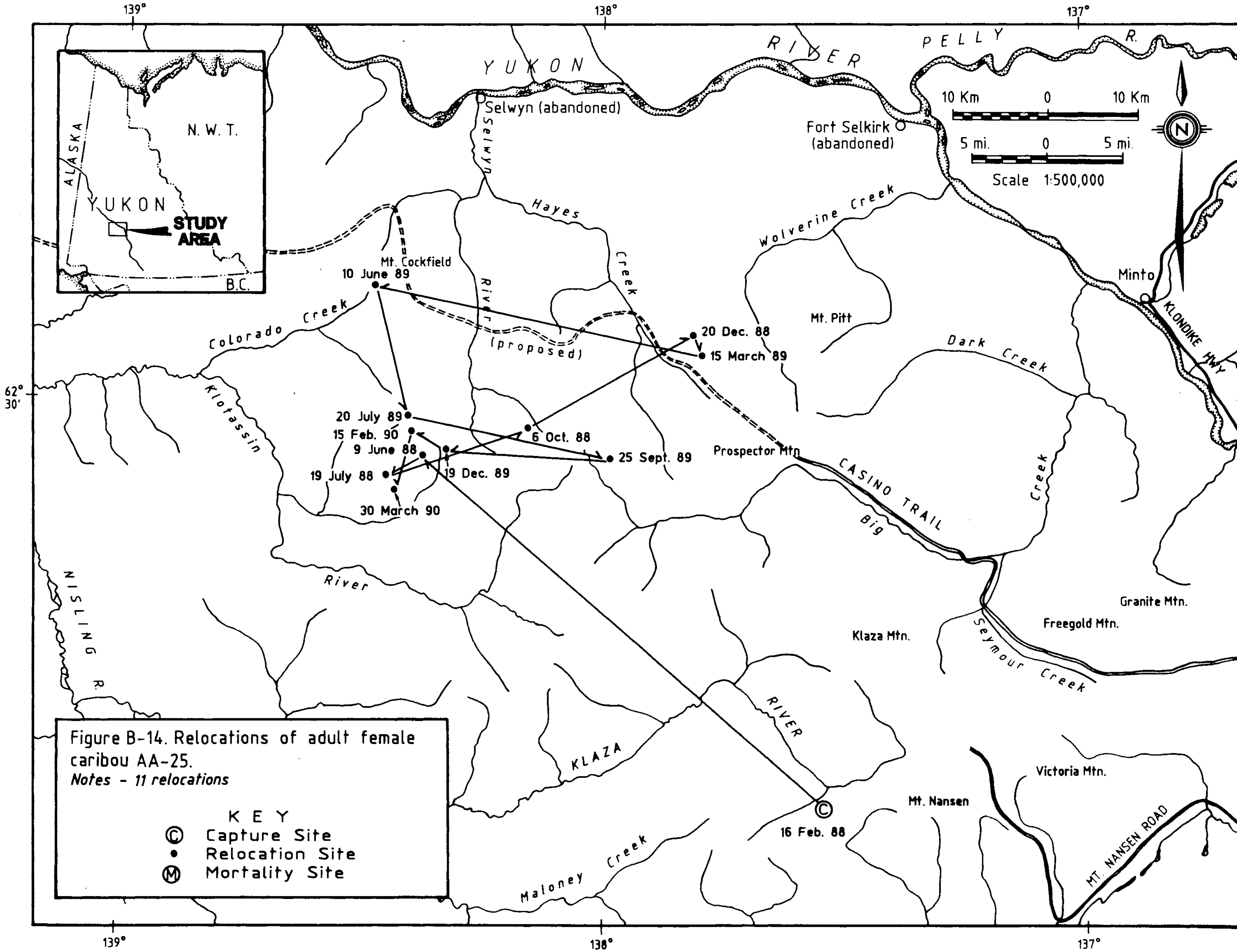

Figure B-14. Relocations of adult female caribou AA-25.
Notes - 11 relocations

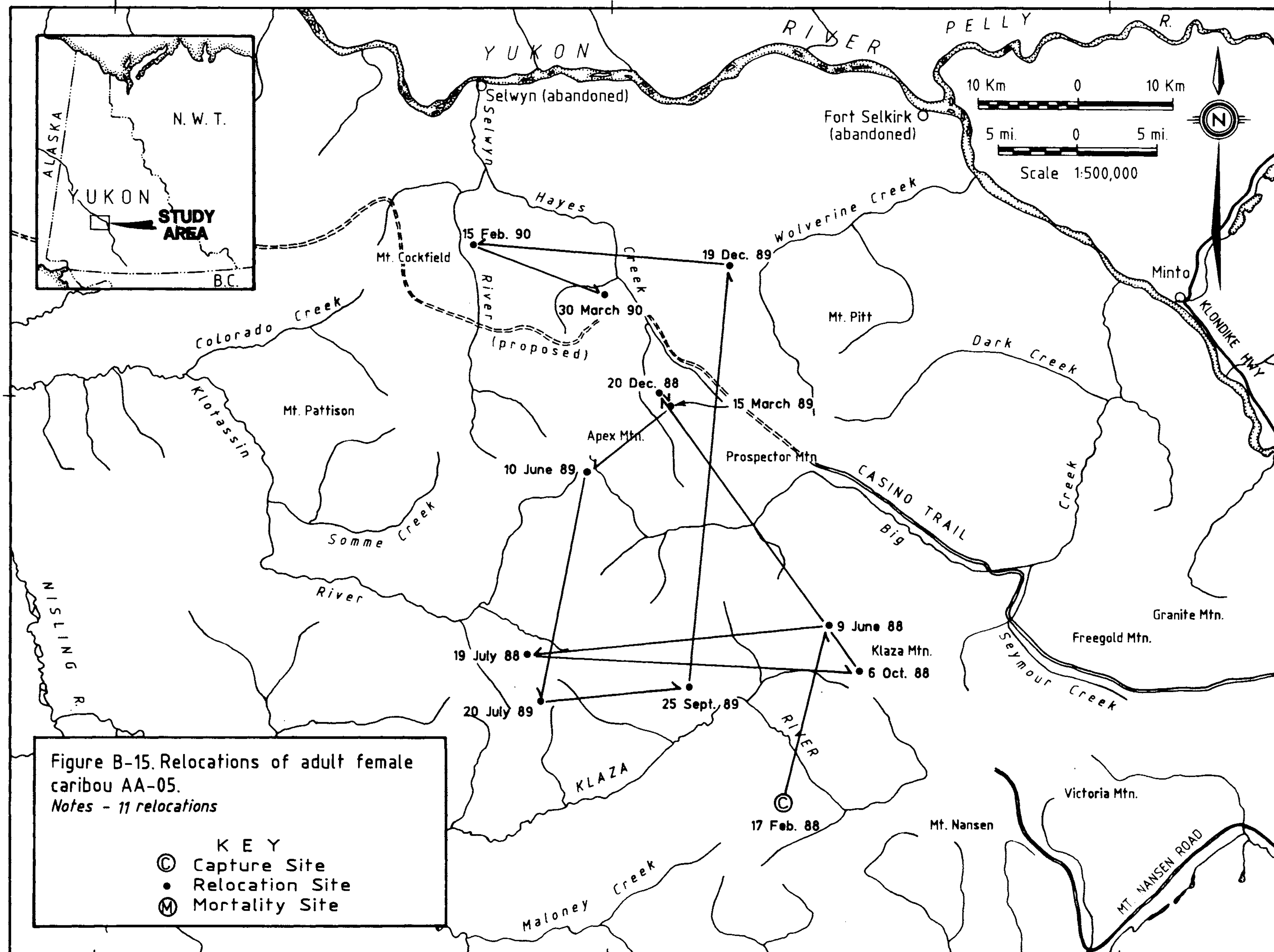

Figure B-15. Relocations of adult female caribou AA-05.
Notes - 11 relocations

KEY
Ⓒ Capture Site
• Relocation Site
Ⓜ Mortality Site

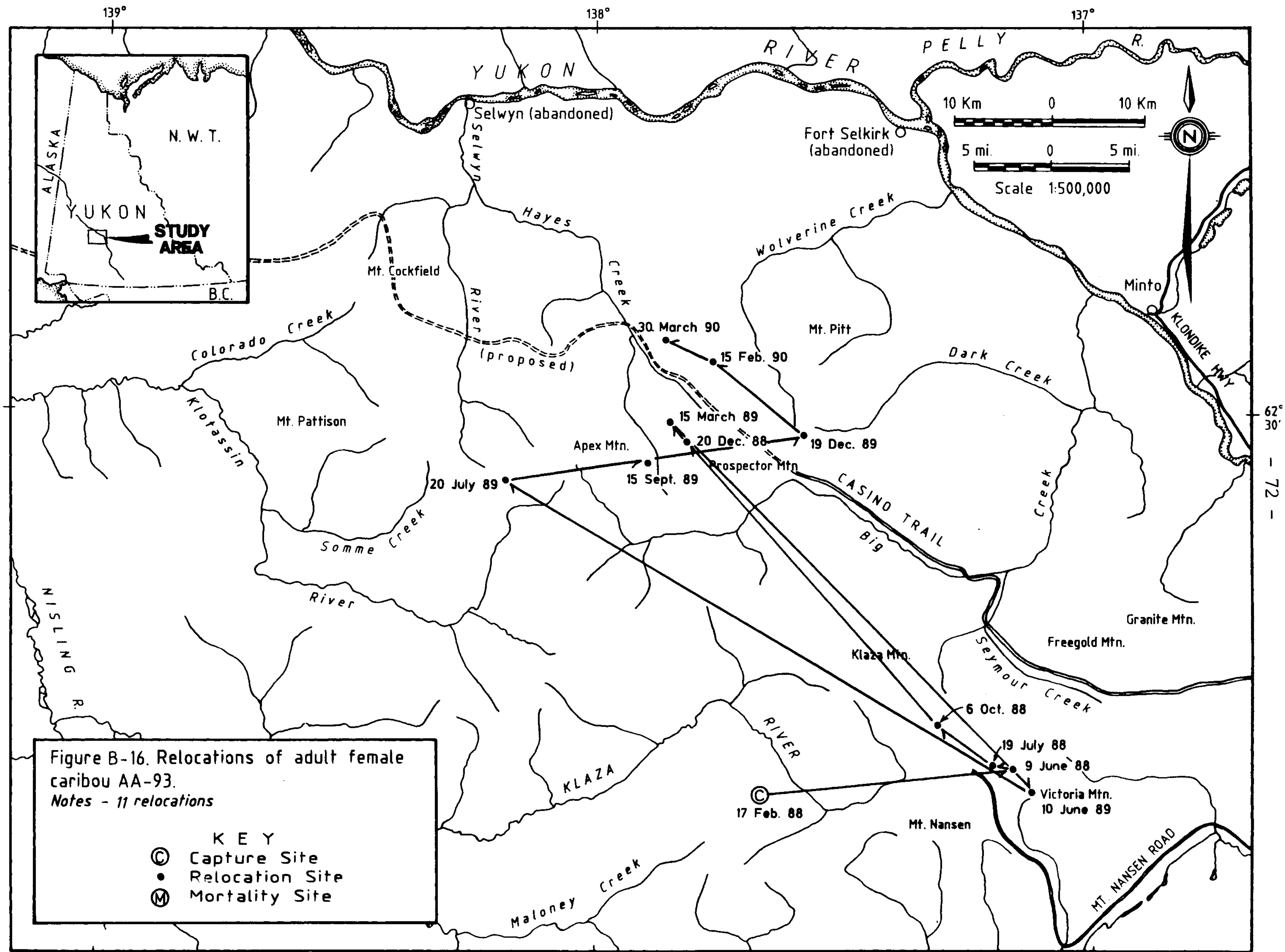

Figure B-16. Relocations of adult female caribou AA-93.
Notes - 11 relocations

KEY
Ⓒ Capture Site
• Relocation Site
Ⓜ Mortality Site

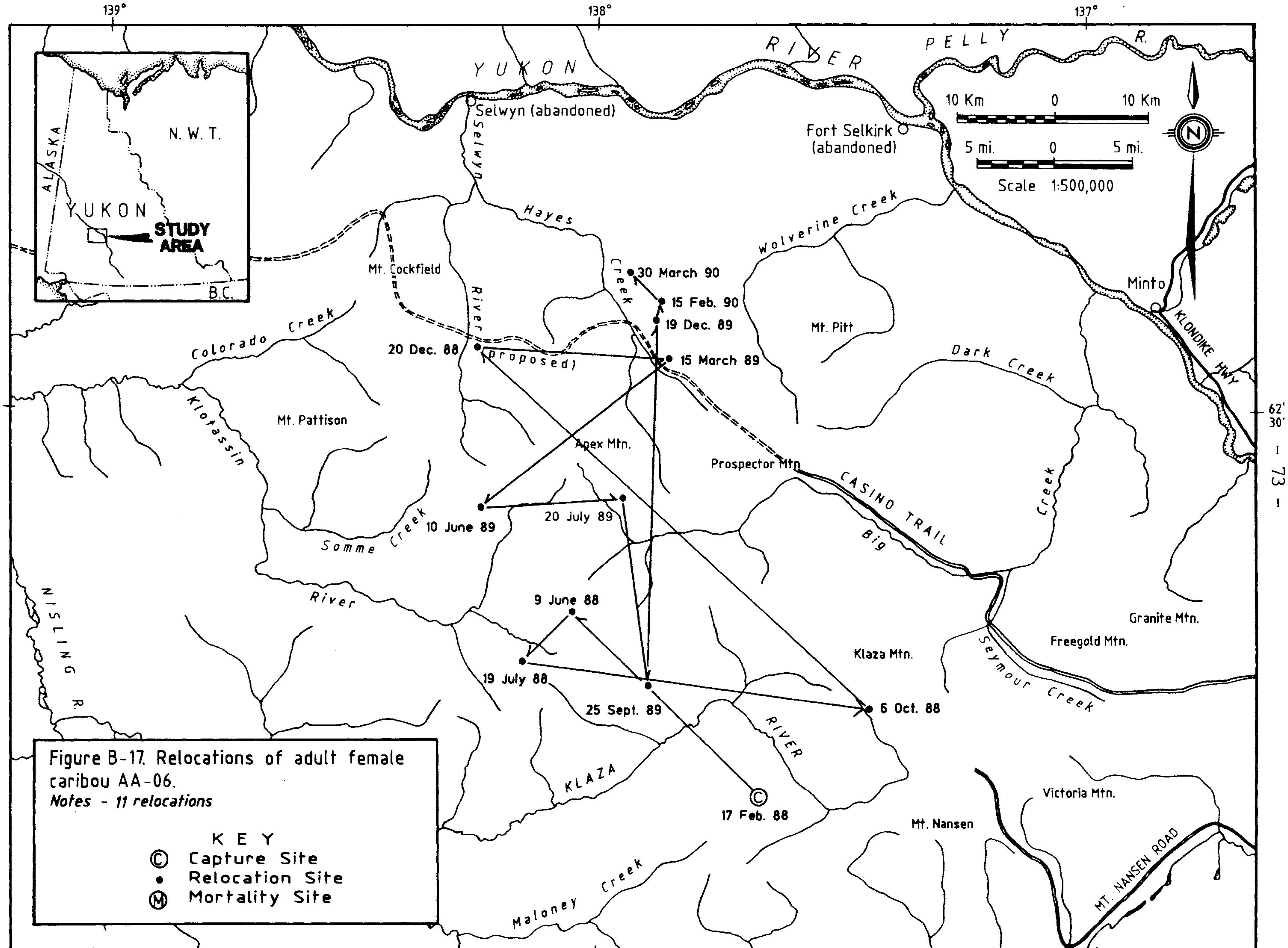

Figure B-17. Relocations of adult female caribou AA-06.
Notes - 11 relocations

Appendix C. Annual rates of adult natural mortality estimated for various caribou herds in North America.

Herd	Mortality Rate	Procedure	Source
Kaminuriak	24.0%	Life Table	Miller 1974
8 herds[a]	7-13%	Census[b]	Bergerud 1978b, 1980
N.E. Alberta	15.0%	Telemetry[c]	Fuller and Keith 1981
Porcupine	20.0%	Life Table	Martell and Russell 1982
	12.0%	Telemetry	Fancy et al. in prep.
W. Arctic	7.1%	Telemetry	Davis and Valkenburg 1983
	8.0%F	Telemetry	Davis and Valkenburg 1985
	16.0%M		
Bluenose	8.0%	Census	Carruthers and Jakimchuk 1983
Burwash	7.3%	Telemetry	Gauthier 1984
	7.0%	Regression[d]	
	17.7%	Census	
Spatsizi	12.8%	Telemetry	Hatler 1986
Spatsizi& Kawdy	18-20%	Census	Bergerud and Elliot 1986
Fortymile	9.3%	Telemetry	Valkenburg and Davis 1987
	7-9%F	Telemetry	Valkenburg and Davis 1989
	19-35%M		
Mentasta	17.0%	Telemetry	Leib et al. 1989
Wells Grey	8.0%	Telemtry	Seip 1990
Alaska Peninsula	39.0%	Telemetry	Pitcher et al. 1990

[a] McKinley, Edziza, Kaminuriak, Nelchina 1962-68, Itcha Mts., Mentasta, Nelchina 1975-77, Alaska Pen. herds.

[b] Census interpolation method (Bergerud 1980).

[c] Based on observed radiocollar death rates.

[d] Regression equation demonstrated by Bergerud (1978b, 1980, 1978a).

Appendix D. Percent ($\pm$ SD) of discerned plant fragments in fecal samples collected during winter on the range of the Klaza caribou herd.

Appendix D. Percent (± SD) of discerned plant fragments in fecal samples collected during winter on the range of the Klaza caribou herd.

Plant genus or group	87/02/15 Sample 1		Sample 2		88/02/18 Sample 1		Sample 2		89/03/20 Sample 1		Sample 2	
Moss	2.92		5.05		2.58		3.18		2.69		2.87	
	2.92	(0.92)	5.05	(3.52)	2.58	(2.80)	3.18	(3.34)	2.69	(1.26)	2.87	(1.73)
Fruiticose Lichens	82.79		77.39		61.75		65.72		84.00		85.63	
(Terrestrial)												
Cetraria-type	1.74	(1.84)	0.68	(0.94)	2.10	(2.57)	4.64	(2.24)	1.07	(1.77)	1.66	(1.74)
Cladonia-type	81.05	(2.54)	76.71	(7.22)	59.65	(3.24)	61.08	(7.87)	82.93	(6.14)	83.52	(5.44)
(Arboreal)												
Alectoria											0.45	(1.04)
Foliose Lichens	---		0.61		6.28		3.56		0.78		1.60	
(Peltigera)			0.61	(1.36)	6.28	(2.44)	3.56	(2.84)	0.78	(1.07)	1.60	(1.72)
Horsetails	10.84		8.84		19.28		17.18		9.49		4.45	
(Equisetum)	10.84	(2.63)	8.84	(4.44)	19.28	(7.02)	17.18	(6.00)	9.49	(4.25)	4.45	(2.85)
Graminoids	1.86		4.50		4.29		4.76		0.74		1.69	
Carex	1.43	(0.87)	4.13	(3.52)	3.89	(3.74)	2.69	(2.71)	0.74	(1.66)	0.37	(0.83)
Festuca			0.37	(0.83)	0.40	(0.90)	0.48	(1.07)				
Eriophorum							0.57	(1.28)				
Poa	0.43	(0.97)									1.32	(1.21)
Luzula							1.02	(1.41)				
Deciduous Shrubs	---		0.36		---		---		---		---	
Shepherdia			0.36	(0.81)								
Evergreen Shrubs	1.59		3.25		5.82		5.60		2.30		3.76	
Ledum	0.87	(1.30)	2.53	(1.15)	5.82	(3.79)	5.16	(0.52)	1.45	(1.53)	2.94	(1.10)
Picea	0.72	(1.02)	0.72	(0.99)			0.44	(0.99)			0.82	(1.14)
Pinus									0.85	(1.17)		