DISTRIBUTION AND ABUNDANCE OF DALL'S SHEEP IN THE SOUTHERN MACKENZIE MOUNTAINS, NWT

RAY CASE

DEPARTMENT OF RENEWABLE RESOURCES

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ABSTRACT

Dall's sheep surveys conducted in the southern Mackenzie Mountains, NWT between 1984 and 1988 indicated moderate densities of sheep and good lamb production. A total of 860 1+ year old sheep were located in five mountain blocks. Lamb production, as indicated by lamb:nursery sheep ratios, varied between years with the highest being recorded in 1984. Lamb production was low in 1988. Problems with the survey method were identified including the preference for very rugged terrain by ewes with newborn lambs and the use of caves by nursery sheep in the Nahanni Range. Based on a management regime to maintain high trophy quality the recommended harvest for the entire study area is calculated to be 17-26 adult rams per year. The harvest since 1965 has been within or below this range. A review of past and present non-renewable resource developments in the area shows little reason for concern.

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INTRODUCTION

Since 1984 the Department of Renewable Resources has conducted surveys for Dall's sheep (Ovis dalli) on the mountain ranges in the southern Mackenzie Mountains. These surveys were in response to concerns about the development of mineral and petroleum resources in the area and with increased levels of harvest by non-resident, resident and native hunters.

Three resource-related developments have occurred in the southern Mackenzie Mountains: a gas field at Pointed Mountain, a Mine on Prairie Creek and a gas well on the Jackfish River. These developments have the potential to affect Dall's sheep through increased access, disruption of movements and disruption of licks.

The sheep in the study area are also harvested. Most of the harvesting is by non-resident hunters hunting through an outfitter, however, residents and natives (GHLs) also hunt in the area. This has resulted in some conflicts between the three hunter groups and has raised the concern of over-harvesting.

STUDY AREA

The study area is located in the southeast portion of the Mackenzie Mountains. The ranges included in the study are the Liard Range, the Kotaneelee Range, the Tlogotsho Range (also referred to as the Tlogotsho Plateau), the Nahanni Range and the section of the Canyon Ranges south of Ram Creek (Figure 1). The area contains a wide variety of habitat types resulting from a complexity of geographical formations and wide variations in altitude, attitude and soil conditions.

Of prime concern in this study are the characteristics of the alpine areas. These vary widely between the mountain ranges. The Liard Range is essentially a single jagged mountain ridge, which falls away rapidly into deep river valleys on both sides. The east side is generally steeper and contains numerous cliffs with talus slopes on the lower parts of the cliffs. The west side slopes into the Kotaneelee River valley with deep ravines spaced regularly along the length of the range. There is only one major cirque on the range located in the north portion of the range at the headwaters of Matson Creek.

The mountains of the Kotaneelee Range are generally much rounder with gentle slopes intermixed with the occasional cliff. The top of the range is quite flat and heavily vegetated. The slopes consist of broken rock and are not as heavily vegetated as the top.

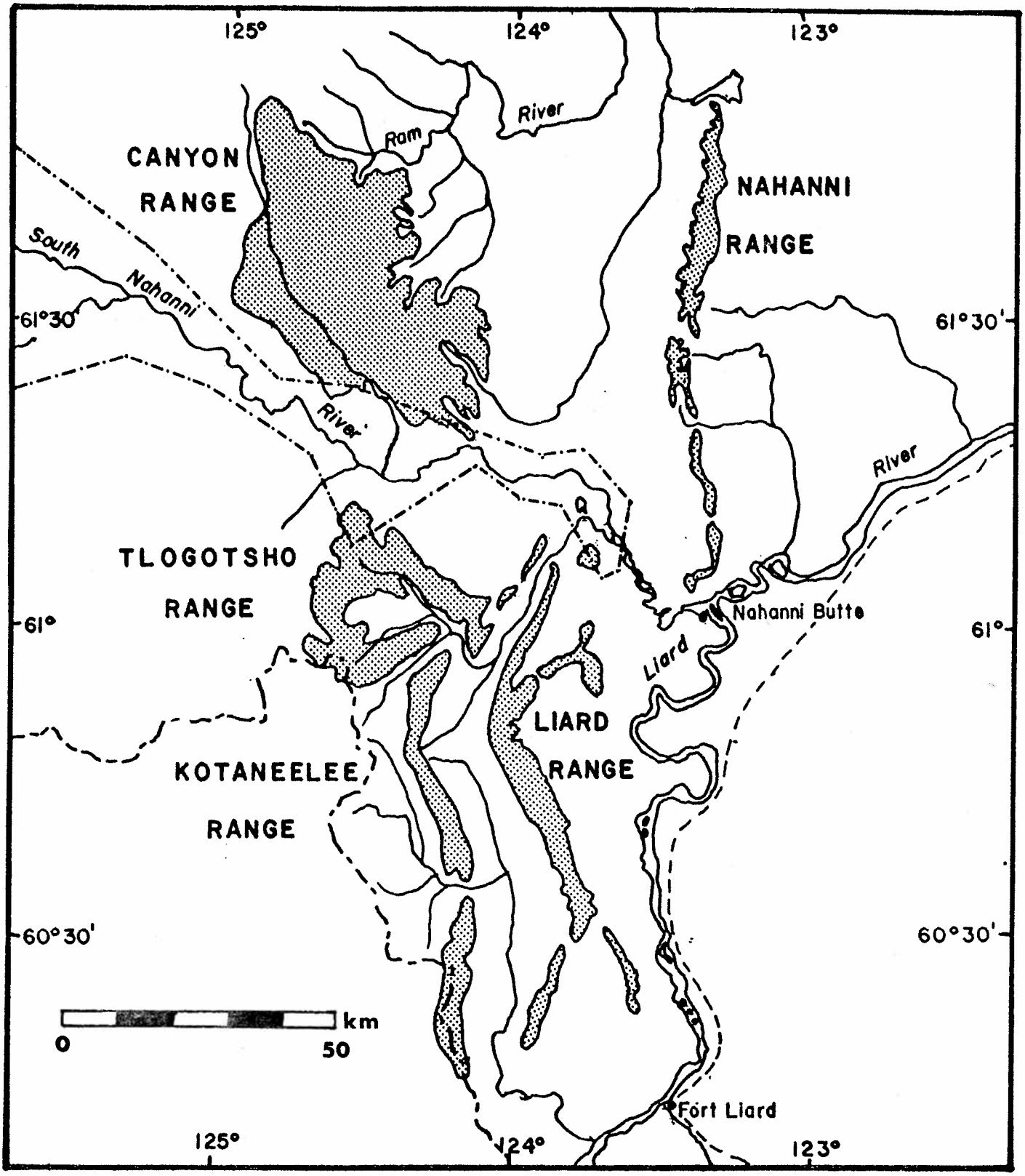

Figure 1. Dall's sheep survey areas in the south Mackenzie Mountains, NWT, 1984-1988.

The Nahanni Range is very similar to the Liard Range in topography with the west side consisting mainly of steep cliff faces ending in talus slopes. The west side is more convoluted than the Liard Range with numerous, irregularly spaced ravines.

The southeastern portion of the Tlogotsho range is, like the Kotaneelee Range, made up of rounded gently sloping hills and valleys. The northern and western edges of the range are, however, characterized by steep cliffs and heavily vegetated cirques and creek valleys.

The southern portion of the canyon range around Prairie creek also tends to be rounded and gently sloping. There are, however, extensive cliffs and canyons on the southern edge, along the South Nahanni River and the creeks which flow into the South Nahanni. These cliffs are very steep and, for the most part, are sparsely vegetated.

METHODS

All of the surveys discussed in this report were conducted in June (Table 1). A Bell 206B or Long Ranger helicopter equipped with rear bubble windows was used to conduct the surveys. The crew consisted of the pilot, an observer/recorder in the left front seat and two observers in the rear seats except for a two day period when there was only one observer in the rear seat. Location, age and sex of all sheep observed were recorded on a 1:50,000 scale map sheet and then later transposed into a field note book.

Table 1. Dall's Sheep Surveys conducted in the Southern Mackenzie Mountains, 1984-1988.

Location	Dates	Source
Liard Range	25-26 June 1984	Ferguson et al. (1985)
Kotaneelee Range	26 June 1984	Ferguson et al. (1985)
Prairie Creek Area	16-18 June 1986	This study
Nahanni Range	18-19 June 1986	This study
Liard Range	23-26 June 1987	This study
Tlogotsho Plateau	15-17 June 1988	This study

Sheep were usually classified from the air, however, the movement of animals in large groups made this difficult so larger groups were classified from the ground using a 20X spotting scope. Animals were classified as nursery sheep, lambs and rams. Nursery sheep included ewes and yearlings as well as young rams still grouped with the ewes, yearlings and lambs. It was not possible to determine reliably the difference between the members

of nursery groups from a helicopter.

The degree of horn curl was recorded for all rams in ram groups during surveys of the Liard Range (1987) and the Tlogotsho Range (1988). Rams were classified as less than 1/2 curl, 1/2 curl, 3/4 curl or Full curl (Figure 2). Degree of horn curl was not recorded during surveys of the Liard Range (1984), the Kotaneelee Range, the Nahanni Range or the Canyon Range. Except for a small portion of the Tlogotsho Range, all the alpine areas of the ranges were intensively searched in an attempt to locate all the sheep in the area. Cliff faces were generally searched with two passes along the face of the cliff, one just below the ridge line and one just above the top of the talus slope. The helicopter remained about two hundred feet from the face in order to provide visual coverage of a larger area and to reduce the disturbance to the sheep. Rolling, flat-topped ridges were generally surveyed with a flight about midway up the slope and then a pass along the top or crest of the ridge.

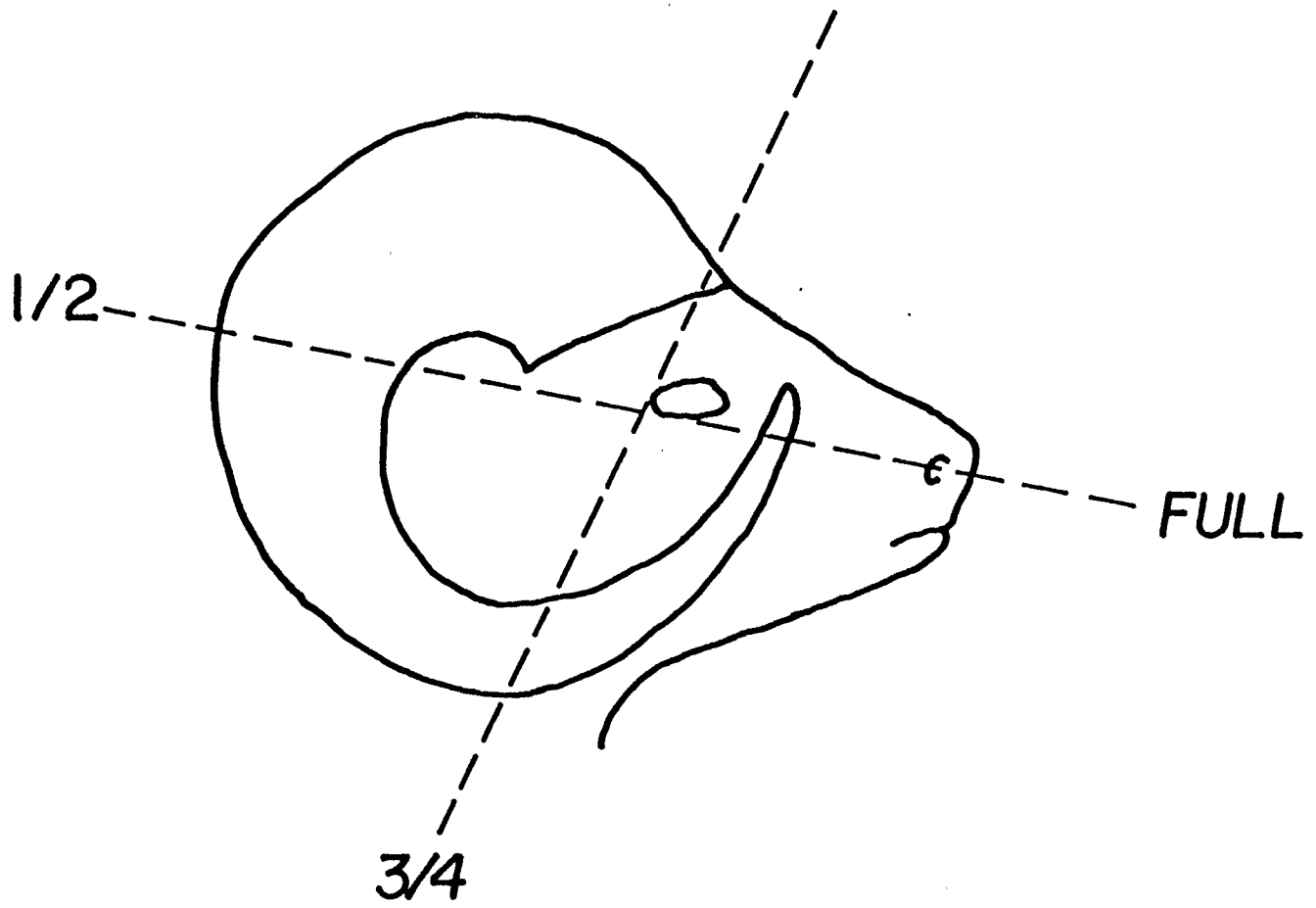

Figure 2. Classification of Dall's sheep ram's horn curl.

RESULTS

This report covers six surveys of five mountain ranges (the Liard Range was surveyed twice) conducted since 1984. A report on two of these surveys (Kotaneelee and Liard ranges in 1984) has already been prepared by Ferguson et al. (1985) but are also included in this report to enable the reader to aquire a complete overview of the status of Dall's sheep in the study area.

Abundance and Distribution

The numbers and age and sex of the sheep observed in the various mountain ranges are listed in Table 2. Based on these figures, and assuming a stable population over the four years of the study, there are in excess of 860 1+ year old sheep in the study area.

Table 2. Numbers, age and sex of sheep observed during sheep surveys in the southern Mackenzie Mountains, 1984-1988.

	Number of sheep observed				
Mountain Range	Nursery	Lambs	Rams	Unknown	Total
Kotaneelee[a]	32	21	24	5	82
Liard (84)[a]	175	105	77	1	358
Canyon	53	13	41	-	107
Nahanni	69	5	29	-	103
Liard (87)	218	81	86	-	385
Tlogotsho	163	35	136	-	336

[a] Results from Ferguson et al. (1985)

In the Kotaneelee Range all but four of the sheep located by Ferguson et al. (1985) were located north of the gap where the Kotaneelee River bisects the range (Figure 3). The rolling topography of the range holds little escape terrain for ewes and lambs and as such they appeared to be concentrated into two main groups. The ram groups were more widely dispersed.

Dall's sheep were widely scattered across the Canyon Range survey area. The only area of concentration located was on the headwaters of Sundog Creek (Figure 4). The remainder of the sheep were located east of Prairie Creek along the perimeter of the plateau where occasional cliffs and talus slopes offered escape terrain. The top of the plateau offers little escape terrain and no sheep were observed there.

The area to the west of Prairie Creek, which actually is part of the Headless and Funeral ranges, consisted mainly of low rolling topography. No sheep were located in this area.

Most of the sheep observed on the Nahanni Range were located north of the Grainger River (Figure 5). Only four rams were observed south of the river and these were just north of Nahanni Butte. The southern area appears to be suitable for sheep. There is abundant escape terrain and well-vegetated slopes in the area and sheep are occasionally spotted on the cliffs above Nahanni National Park Headquarters at Nahanni Butte (K. Colosimo, pers. comm.).

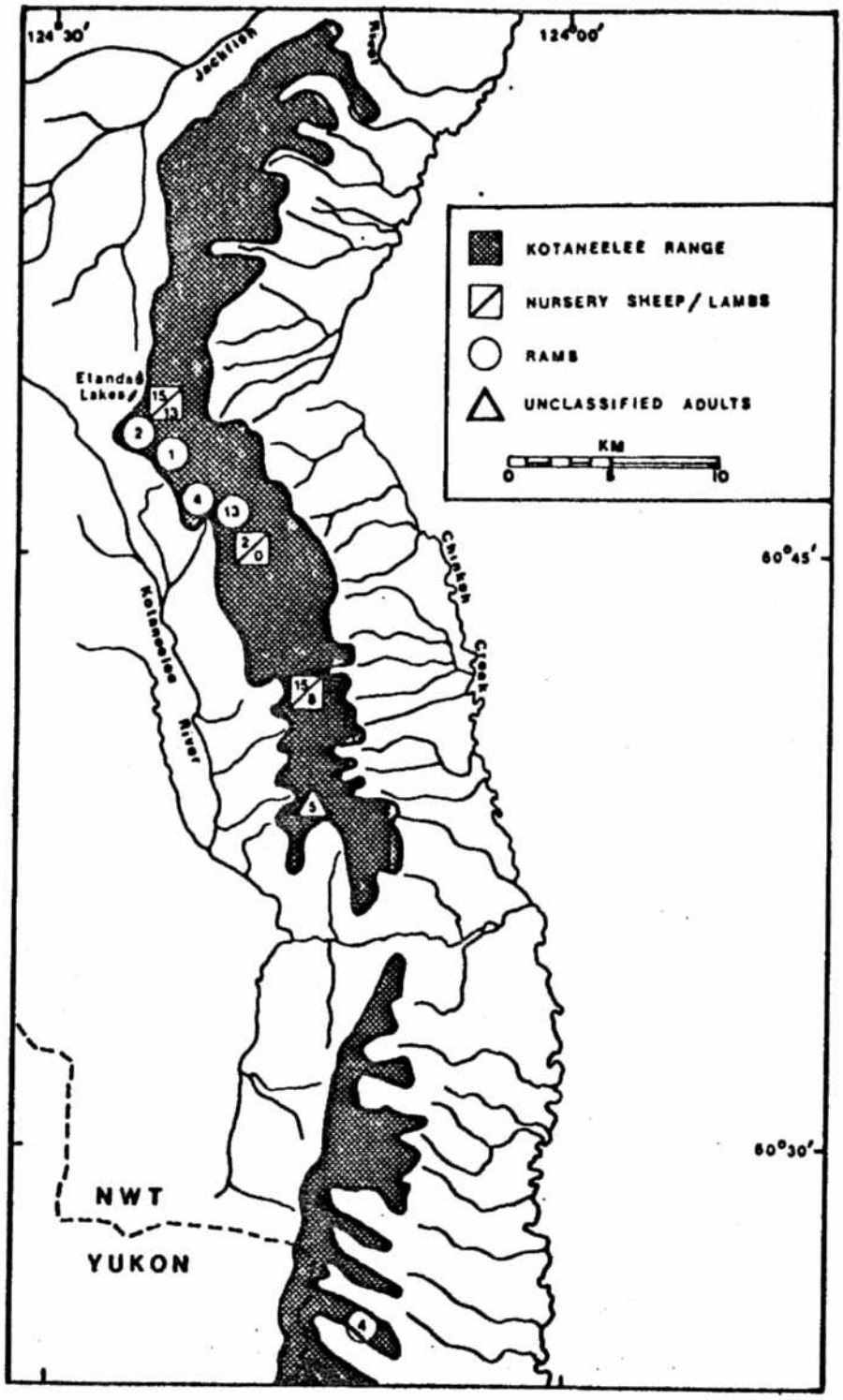

Figure 3. Distribution and abundance of Dall's sheep in the Kotaneelee Range, NWT in June 1984 (from Ferguson et al. 1985).

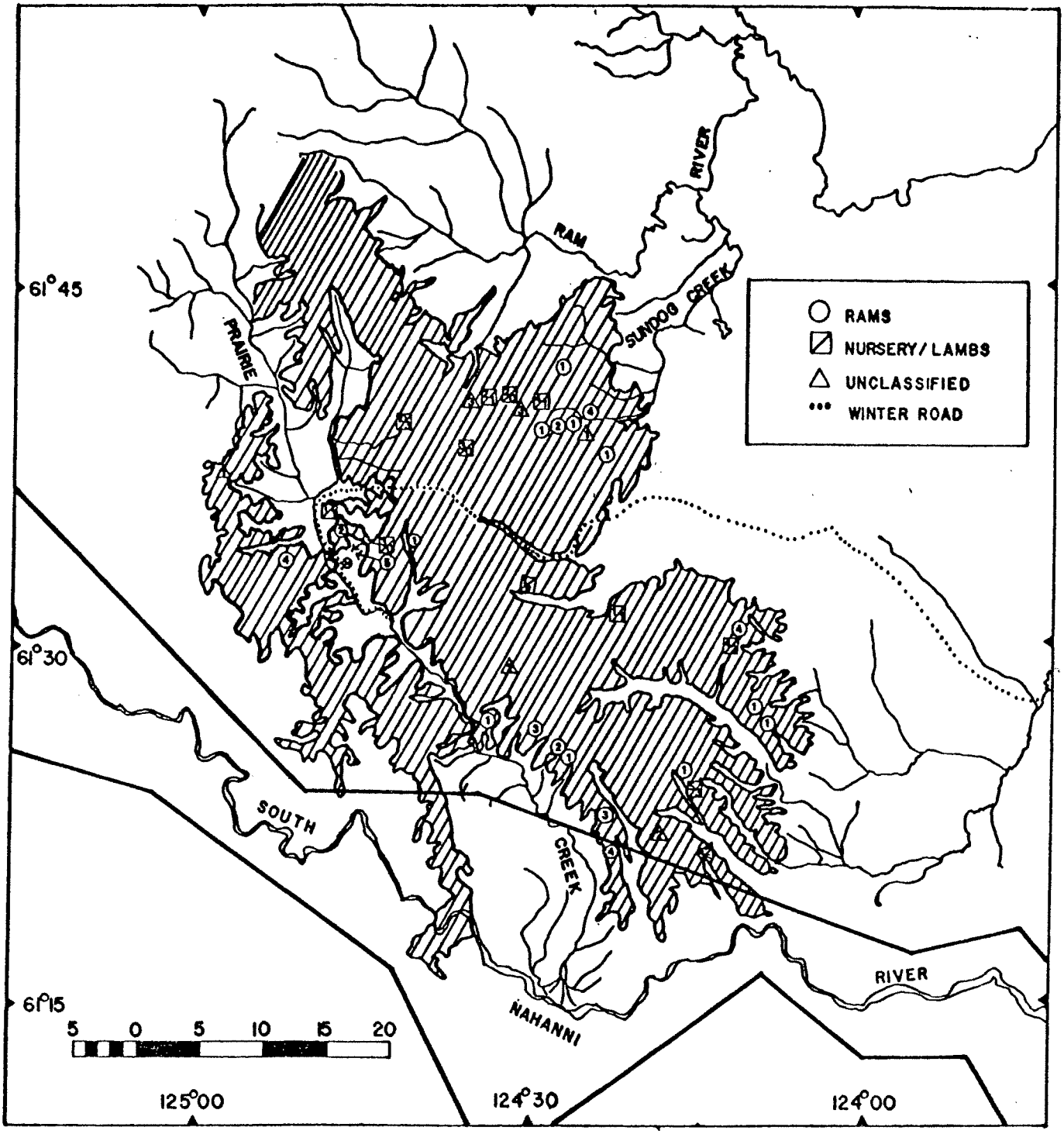

Figure 4. Distribution and abundance of Dall's sheep in the southern Canyon Range, NWT in June 1985.

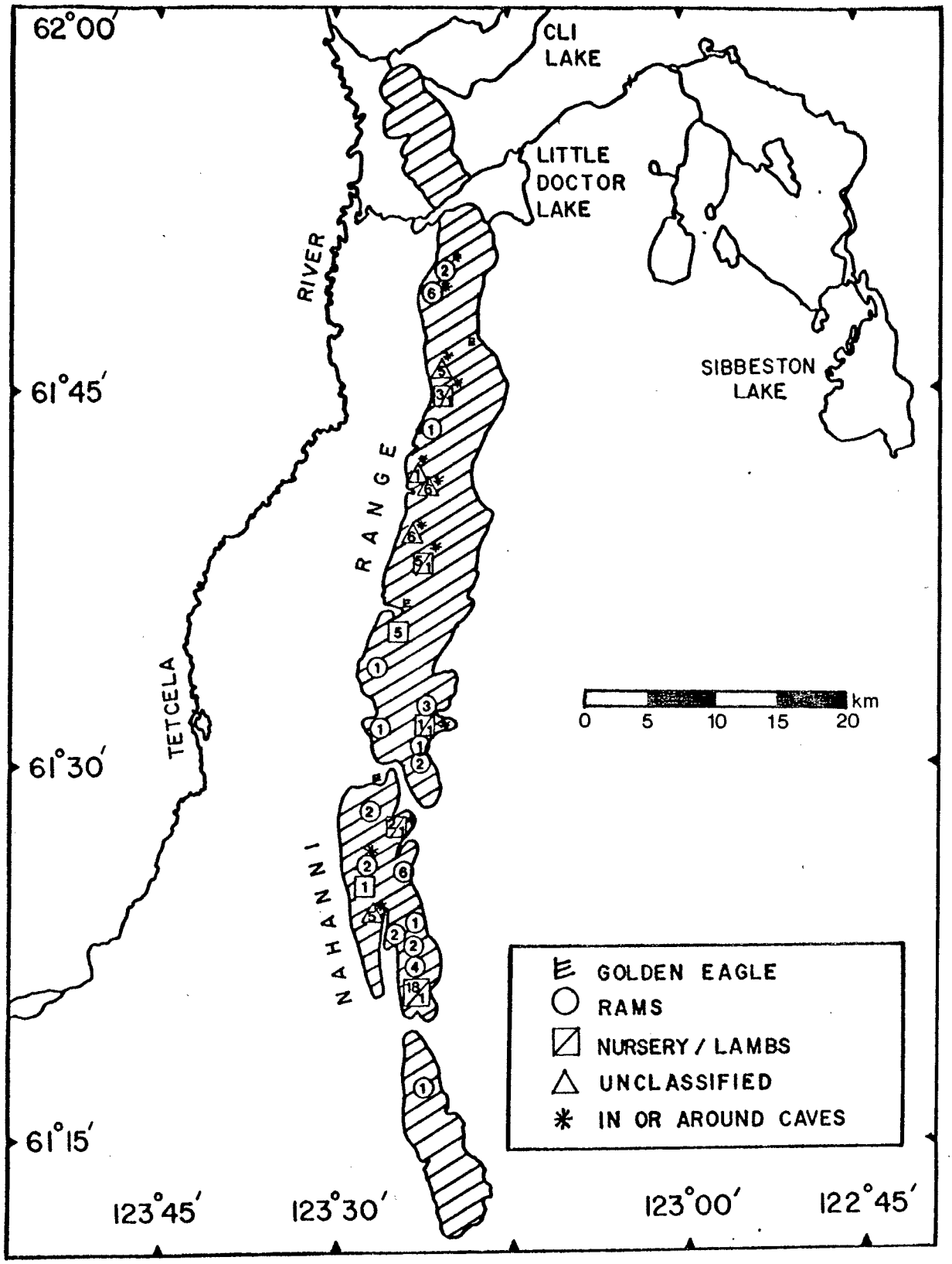

Figure 5. Distribution and abundance of Dall's sheep in the Nahanni Range, NWT in June 1985.

The majority of the sheep were located on the west side of the range. The east side is essentially one long cliff face and offers little vegetation. The convoluted east side offers much more diverse topography with heavily vegetated creek valleys surrounded by talus slopes and steep cliffs.

An unusual aspect of the distribution of sheep in the Nahanni Range was the association of the sheep with caves. All of the sheep observed, with the exception of one ewe-lamb pair and approximately 10 rams were in, or in close association with, caves. The limestone geology of the Nahanni Range has resulted in an abundance of caves in the range. The caves which were being used were generally at the top of talus slopes or at the top of cliffs with easy access from above.

Two caves were examined on foot. The first cave was on a south-facing slope about 1060m above sea level (asl) with ledges leading to the cave on both sides. The entrance had a scree platform in front. The entrance was rectangular, about 1.5m high and 1m wide. There was approximately a 3m overhang above the entrance. A person could walk approximately 10m into the cave, but the hole was a continuous slope upwards (Figure 6). The upper reaches were coated in an 8cm layer of fine mud. The cave was very cool and the sheep used the lower part of the cave for bedding as clumps of hair were seen hanging off the rocks. There was no evidence of licking anywhere within the cave. There were two ewes inside the cave when it was located.

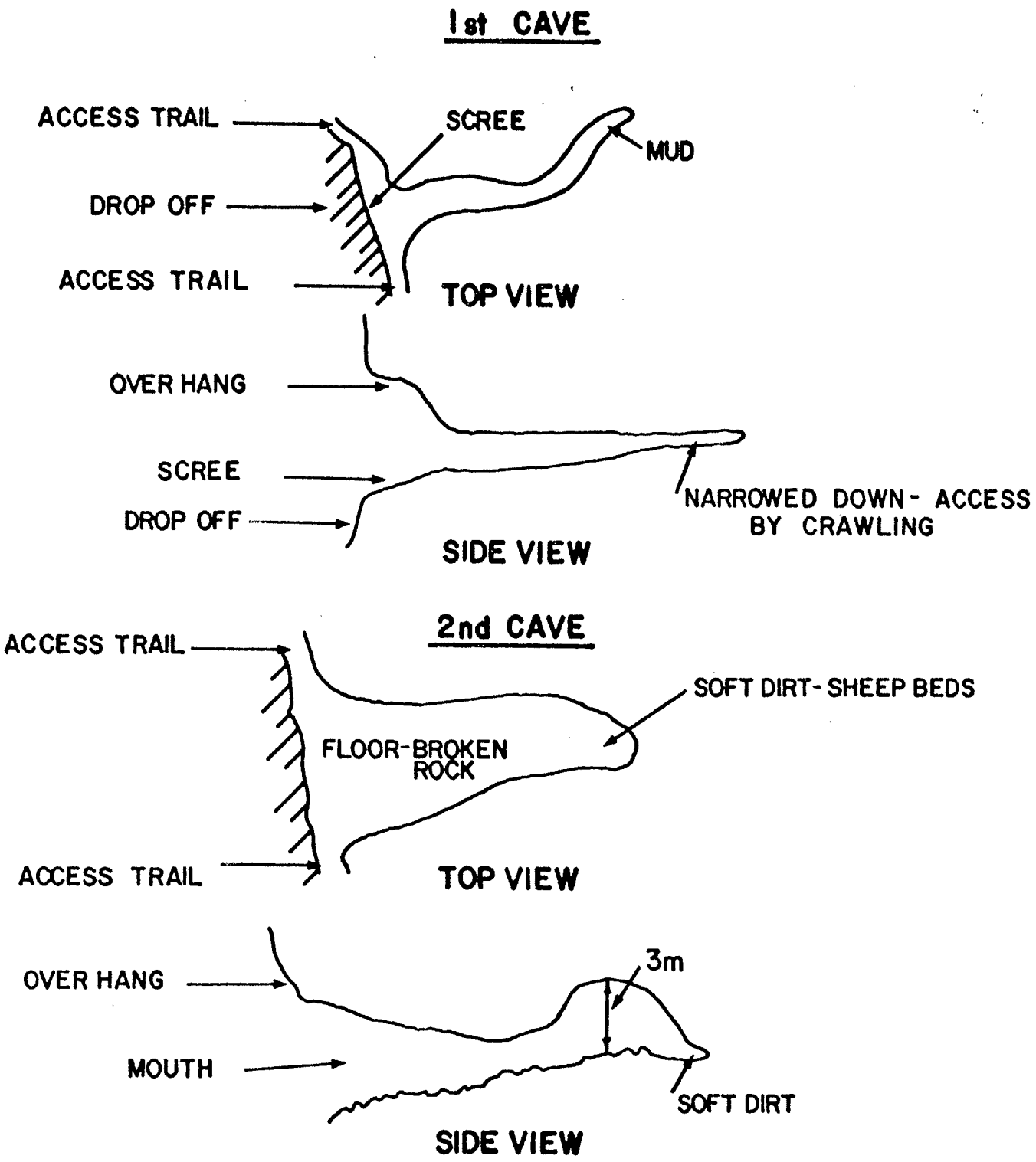

Figure 6. Diagrams of two caves used by Dall's sheep in the Nahanni Range, NWT in June 1985.

The second cave was on the west side of the range below the top of an east/west lying ridge. Access to the cave was easy from both above and below. The mouth was approximately 10m across with a height at the front of approximately 2.5 m. The cave sloped upwards at about a 30 degree angle for approximately 40-45m. It leveled off somewhat at the back of the cave. The back cavern had a ceiling of about 3-4 m in height. Evidence of sheep bedding was located in the back cavern. The back edge was fairly dry whereas the remainder of the cave was wet with water dripping from the ceiling. The temperature was cool and no insects were evident. There was no evidence of licking anywhere within the cave. This cave had 14 ewes and lambs, and a 1/2 curl ram in it when located.

The sheep observed in the Liard Range during both the 1984 survey (Ferguson et al. 1985) and the 1987 survey (Figure 7), were located in the northern 2/3 of the range. Sheep were scattered along this section of the range although in 1987 there was some concentration in the area around and south of Matson Creek. In 1984 two concentrations were found, one at Matson Creek and another about 20km south. Both sides of the range seemed to offer a suitable combination of escape terrain and vegetated slopes. Ewes with lambs tended to be located along the tops of talus slopes and on the lower portions of cliffs. Rams and ewe/yearling group were more likely to be found on the tops of ridges.

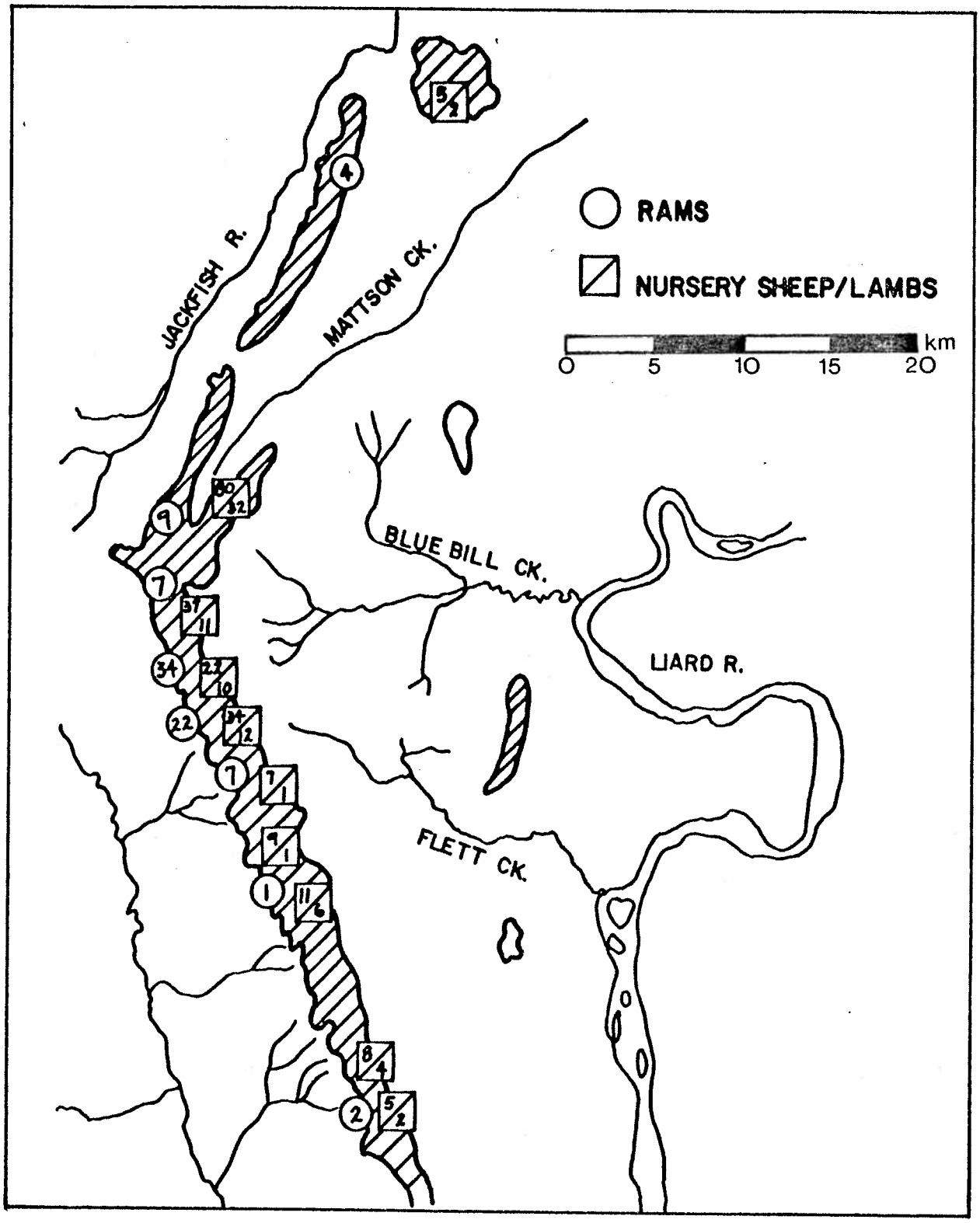

Figure 7. Distribution and abundance of Dall's sheep in the Liard Range, NWT in June 1987.

Sheep observed on the Tlogotsho Range were concentrated on the north and northeast ridges (Figure 8). These areas were characterized by steep cliffs intersected by well-vegetated hanging troughs and topped with a well-vegetated plateau. Ewes with lambs were located on the north- and east-facing cliff faces. Ewe groups without lambs and ram groups were often located on top of the plateau and in the bottom of the creek valleys.

No sheep were observed on the ridge just north of Jackfish River. This area was a gently rolling plateau with relatively gently sloping valleys on either side. The central portion of the range was not surveyed due to time limitations, however, the topography was similar to that of the southern range and few, if any, sheep were expected to be located there at the time of the survey.

Productivity

The lamb:nursery sheep ratios observed during the surveys were variable among ranges and as well as among years (Table 3). The 1984 surveys had very high lamb:nursery sheep ratios with the remainder of the surveys having more "normal" ratios. The ratios determined for the Nahanni Range were very low, however, it is felt that this figure is not accurate as lambs were likely missed when they were in caves.

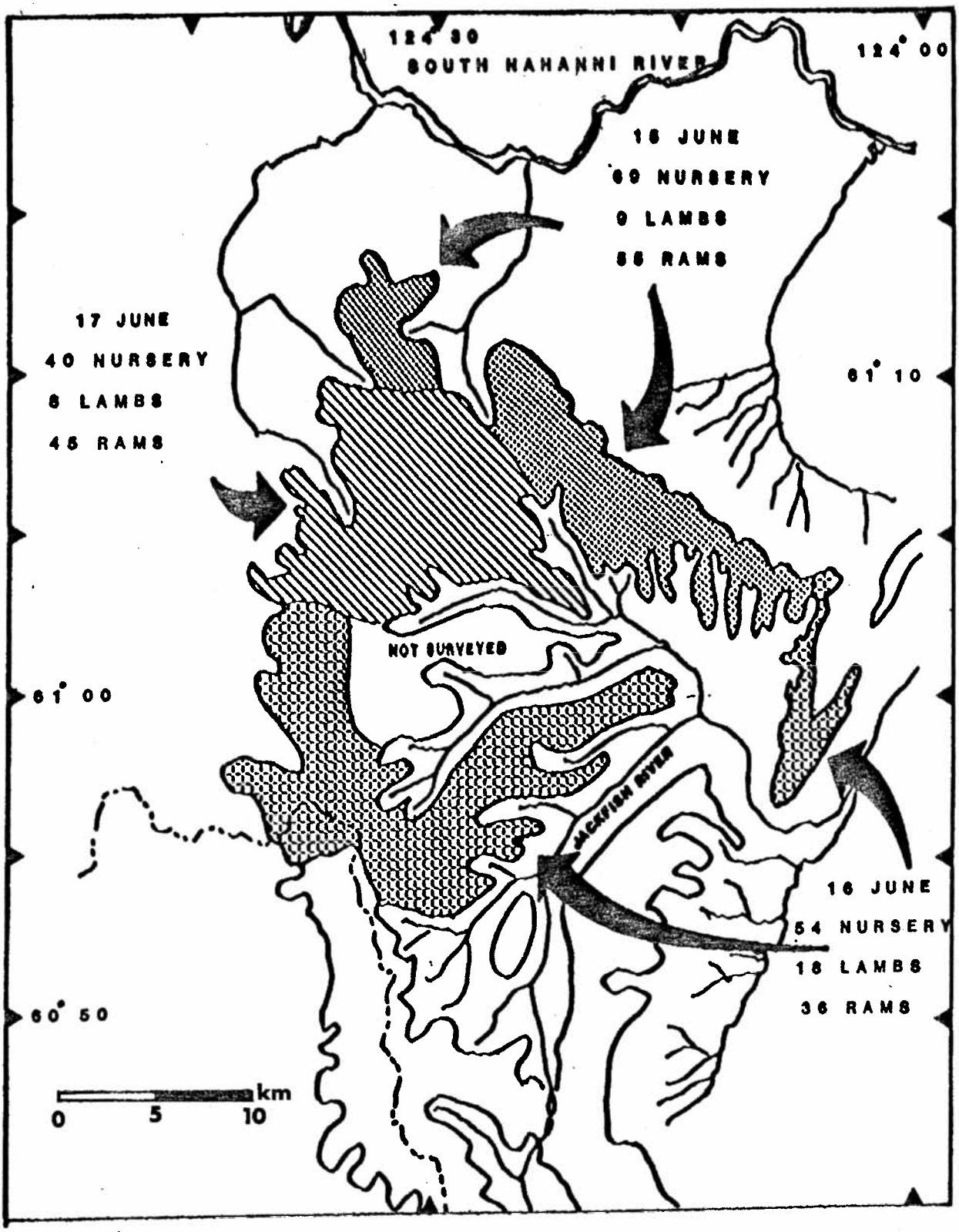

Figure 8. Distribution and abundance of Dall's sheep in the Tlogotsho Range, NWT in June 1988.

Table 3. Lamb:nursery sheep ratios of sheep observed in the south Mackenzie Mountains, 1984-1988.

Mountain Range	Year	Lambs:100 Nursery Sheep
Kotaneelee	1984	66
Liard	1984	60
Liard[a]	1986	30
Liard	1987	37
Canyon	1986	25
Nahanni	1986	7[b]
Tlogotsho	1988	21

[a] C. Gates (pers. comm. 1986)
[b] Underestimate.

Trophy quality

The degree of curl was only recorded during two of the surveys: the Liard and the Tlogotsho. The numbers and proportion of rams with the various horn sizes is listed in Table 4. As many sheep hunters can attest, the determination of sheep horn size can be difficult enough from the ground. It can be even more difficult from a helicopter. These proportions are, therefore, approximate. There is no doubt, however, that there was a higher proportion of full curl rams on the Tlogotsho Range than on the Liard Range. A large number of the full curl rams located on the Tlogotsho Range were within the boundaries of Nahanni National Park.

Table 4. The degree of horn curl in Dall's sheep observed in the Liard and Tlogotsho ranges in 1987 and 1988.

Degree of Curl	Liard Range	Tlogotsho Range
less than 1/2	20 (23%)	18 (13%)
1/2 to 3/4	27 (31%)	46 (44%)
3/4 to Full	29 (33%)	42 (31%)
Full or more	10 (12%)	30 (22%)
Total rams	86 (100%)	136 (100%)

DISCUSSION

Survey Methods

The survey method used in this study was a census of all the sheep on these ranges. As has been demonstrated in studies of moose (Gasaway et al. 1986) and with caribou (D. Heard pers. comm.) visual surveys always miss a portion of the sheep in the area. Factors affecting sightability of the sheep include: sheep moving into the trees, the use of caves, jagged cliff faces, weather conditions and group size. Sheep in treed areas or travelling to, or from, licks in the trees are unlikely to be spotted no matter how much effort is spent looking.

During the survey of the Nahanni Range in 1986, many of the sheep were located in or near caves. Of the five lambs observed during the survey, four were not seen until they came out of caves after the helicopter had passed. All ages and sexes of sheep seemed to be using the caves, but it appeared that ewes with lambs were consistently associated with caves. The number of sheep counted in the Nahanni Range was, therefore, undoubtedly low as were the number and proportion of lambs in the population.

A group of five rams was also found in a cave in the Canyon Range in 1986. However, the geology of the Canyon range is such that caves are relatively rare, unlike the Nahanni Range, and it is unlikely that as many sheep were missed during the Canyon Range survey.

The proportion of lambs in the population was also likely under-represented in the survey of the Tlogotsho Range. During this survey the majority of the lambs located were in groups of 1 to 2 ewes located on or along cliffs where they were very difficult to see. Most of the other sheep were located in heavily vegetated cirques or along the vegetated slopes above the cliffs and were much easier to spot.

Weather was not a problem in any of the surveys covered by this study because, for safety reasons, we did not fly unless the conditions were excellent. Ferguson et al. (1985) did have problems with weather when attempting to survey the Tlogotsho Range in 1984. During this survey strong winds caused severe turbulence which prevented searching most of the range.

Abundance and Distribution

Previous information on abundance and distribution is only available for two portions of the study area: the Tlogotsho Plateau and the area around Prairie Creek.

The Tlogotsho Plateau was surveyed for Parks Canada by Scotter et al. (1971) in 1970 and 1971. Simmons (1982) conducted both winter and mid-summer surveys of the Tlogotsho Plateau in the early 1970s, and Kozachenko (1983) conducted aerial surveys of the area in August 1982.

Kozachenko (1983) counted 168 sheep on the northern portion of the Tlogotsho Plateau in August 1982. A total of 226 sheep

were located in the same area in June 1988. It is not possible to determine if this reflects a change in population, a seasonal change in distribution or observer differences. In mid-summer Simmons (1982) located sheep in the lush, rolling core area of the Tlogotsho Plateau, while very few sheep were seen in this area during this study and all of these were rams. This suggests a change in seasonal distribution. Most of the sheep observed were along the north and west edges of the plateau in close association with escape terrain. We expect the sheep to move into the core area later in the summer once lambs have increased in size and mobility.

In 1981 41 sheep were located around Prairie Creek (Beak Consultant Ltd. 1981). We located 35 sheep in the same area in June 1986. In both studies sheep were observed at a mineral lick at Adit #3 on the mine site. This subsample of the Canyon Range suggests that the population is likely stable.

Productivity

Estimates of lambs per 100 nursery sheep were obtained for the Tlogotsho Plateau in August 1978 (Cooper 1978) and in August 1982 (Kozachenko 1983). These counts were 43:100 and 40:100, respectively. The count from June 1988 (21:100) does not compare favourably with these figures. Although, the 1988 figure may be an underestimate it is still likely that lamb production was poor in 1988.

Lamb production observed during the surveys of the other areas was much higher. The ratios of 66:100 in the Kotaneellee Range and 60:100 in the Liard Range documented by Ferguson et al. (1985) in 1984 were similar to those found on Sheep Mountain (Hoefs and McTaggart-Cowan 1979), a highly productive sheep area in the southern Yukon. This population averaged 64.3 lambs per 100 ewes during a four-year study. Productivity in the Liard was lower in 1986 and 1987 (Table 3), but these figures are still similar to the average productivity documented in Alaska (Nichols 1978) and central and southern Yukon (Hoefs 1978).

Harvesting

Three categories of hunters hunt in the study area. General Hunting Licence holders (GHLs), resident hunters, and non-resident hunters. GHL hunters are primarily natives from Fort Liard and Nahanni Butte, although some GHL hunters from other communities such as Fort Smith and Hay River have hunted sheep in the past two or three years (R. Graf pers. comm.). GHL holders can harvest sheep of any age or sex. No statistics are available for the harvest by GHLs, but it is likely less than 15 per year (G. Bohnet pers. comm.).

Resident hunters can only harvest rams with a curl of 3/4 or more. Accurate records of the resident harvest have been kept since 1982 using both a Hunter Harvest Questionnaire and Ram Plug Records. Comparison of the two sources indicates that all

successful sheep hunters return their questionnaires thus providing additional information on their hunts. An analysis of the questionnaire data suggests that even unsuccessful sheep hunters return their questionnaires promptly. It is assumed, therefore, that the data from the questionnaires accounts for all of the sheep hunters and that those persons purchasing a sheep tag but not returning their questionnaire did not hunt. There will likely be the occasional exception to this assumption but the exceptions will be rare.

Since 1982 an average of 5.4 sheep have been taken annually from the study area by resident hunters (Table 5). The harvest has tended to be concentrated in the Liard and Nahanni ranges. Access to these areas has most likely been by helicopter because fixed wing aircraft which could land in mountainous areas have not been available for charter. Some access has been made by foot (mainly Liard Range) and by fixed wing aircraft into Etanda Lakes (Kotaneellee Range) and the Tlogotsho Plateau.

Table 5. Resident hunter Dall's sheep harvest in the southern Mackenzie Mountains, 1982-1987.

Mountain Range	Year 82/83	83/84	84/85	85/86	86/87	87/88[a]
Canyon	-	-	-	-	1	-
Liard	2	1	2	4	1	1
Nahanni	2	2	3	1	-	1
Kotaneellee	-	-	-	3	-	-
Tlogothsho	3	1	-	-	1	1
Totals	7	4	5	8	3	3

[a] Preliminary figures

Resident hunters spent an average of 5.5 days hunting (n=44 range 2-10) (Table 6). There was no correlation between the number of days hunting and the success of the hunt. Most of the hunts (approximately 75%) took place in August.

Table 6. Hunting patterns of resident hunters hunting Dall's sheep in the southern Mackenzie Mountains, 1982-87.

	Year				
	82/83	83/84	84/85	85/86	
Mean No. of Days Hunted	6.33	5.75	4.80	5.20	5.88
Full Curl:3/4 curl	6/1	4/0	5/0	7/1	3/0
Proportion of all sheep Hunters who hunted in E/1-8	32.0%	23.5%	41.7%	38.7%	39.1%
Proportion of people who bought tags who hunted	51.8%	44.7%	34.2%	40.3%	48.9%
Proportion of hunters who were successful	77.8%	50.0%	50.0%	75.0%	33.3%

The vast majority of sheep harvested by resident hunters in the study area have been full curl or better with only 2 of 27 sheep taken since 1982, being reported as less than full curl (Table 6). However, no measurements are available for these sheep.

Resident hunters come from communities across the western NWT with Yellowknife, Fort Smith and Norman Wells accounting for most (Table 7). The number of resident hunters has averaged about

10 per year since 1982, with the most being 12 in 1985/86. This reflects a sudden interest in sheep hunting by Yellowknife hunters. The interest did not continue the following year when only 9 resident hunters hunted in the area, only one of whom was from Yellowknife.

Table 7. Home community of resident hunters hunting Dall's sheep in the southern Mackenzie Mountains, 1982-87.

Community	Year 82/83	83/84	84/85	85/86	86/87
Fort Smith	-	2	3	1	4
Yellowknife	-	-	-	6	1
Hay River	1	-	-	-	1
Fort Liard	-	-	-	1	1
Fort Simpson	-	-	-	1	1
Tungsten	-	-	-	1	-
Pine Point	-	-	-	2	-
Inuvik	1	1	1	-	-
Tuktoyaktuk	-	-	-	-	1
Norman Wells	4	2	3	-	-
Rae Lakes	-	-	3	-	-
Fort Franklin	2	2	-	-	-
Fort Good Hope	-	1	-	-	-
Fort Norman	1	-	-	-	-
Total hunters	9	8	10	12	9

The southern Mackenzie Mountains are the most popular sheep hunting area for resident hunters with 30-40% of the total sheep hunters in the NWT hunting in this area (Table 6). The primary reason for this is access. Nowhere other than the Tungsten area does a highway come so close to the mountains. There are also aircraft based at both Fort Simpson and Fort Liard.

Non-resident hunters can only harvest rams with a curl of 3/4 or more. They must also use the services of an outfitter (i.e., they cannot hunt by themselves or with a resident or GHL hunter). A single outfitter area covers the study area. The licence to outfit in Outfitter Area E/1-8 is held by Greg Williams of Nahanni Butte Outfitters Ltd.

Harvest data for E/1-8 have not been consistently reported or compliled. The outfitter's reports have on occasion been submitted without the jaws and hunter kill return booklets. Jaws have also been misplaced or not aged. This lack of data makes it difficult to assess the impact of the non-resident hunting or to determine any changes in the harvest over time.

Based on records that are available, the outfitted hunters have harvested a mean of 12.0 (6.00 SD) sheep per year since 1965. The outfitting area changed hands in 1978. Before 1978 the mean harvest was 7.2 (6.1 SD) sheep per year. The current outfitter has harvested a mean of 15.2 (4.7 SD) sheep per year. The highest reported harvest was in 1987 when 21 sheep were harvested (Figure 9).

Age data are only available for five hunting seasons and only two since 1978 when the current outfitter started. The average age of sheep harvested in 1978 was 9.1 (1.7 SD n=11) and in 1987 it was 9.0 years (1.3 SD n=17). This suggests no change in the average age of the harvest, but without the intervening years no conclusions can be made.

A comparison of a hunted and an unhunted sheep population in

the Yukon suggested that the hunted sheep population could sustain a harvest of mature full curl rams equal to 2-3% of the total population (not including lambs) without affecting productivity or trophy quality (Hoefs and Barichello 1984). The mean ratio for lambs:nursery sheep in their hunted study area was 29:100. Lamb:nursery sheep ratios in the south Mackenzie Mountains have generally been higher than this. However, these figures must be viewed with caution as the ratio can be biased upwards by poor survival of the previous year's calves.

In the NWT the harvest of rams 3/4 curl or more is permitted. It is, therefore, possible that the harvest could be in excess of the 2-3% figure used in the Yukon (possibly 4-5%) without depleting the population of "legal" rams. This higher harvest, being focused on rams, would be unlikely to reduce productivity of the population. However, as all hunters will endeavour to take a full curl ram, the higher harvest will result in a reduction in the number of full curl rams in the population and, therefore, the trophy quality of the population.

Using the figure of 2-3% suggested by Hoefs and Barichello (1984), the sustainable harvest for the mountain ranges in the study area would be as follows: Kotaneelee Range 1-2, Canyon Range 2-3, Nahanni Range 2-3, Liard Range 6-9 and Tlogotcho Range 6-9. For the entire study area the sustainable harvest would be 17-26 adult rams per year. These figures assume that the harvest of ewes by GHLs is minimal (i.e., less than 5 per year). Because the harvest by GHLs is largely unknown but generally concentrated

in the Liard and Nahanni ranges, harvests by resident and non-resident hunters should remain at the low end of the estimated sustainable harvest.

Current harvest levels have, based on the resident and outfitter's harvest, been below the upper end of the maximum sustainable harvest (Figure 9). It should also be noted that the outfitter's harvest also includes sheep harvested in parts of his area outside the study areas, the proportion of which is unknown.

Development

Three non-renewable resource developments have taken place within the study area. The first is the gas field development at Pointed Mountain northwest of Fort Liard (Figure 1). The field was developed in the 1970s and consists of several well heads, a main camp, collection pipeline system and a pipeline to the south. This site is not, however, located in prime Dall's Sheep habitat and does not appear to have had a significant effect on sheep in the southern portion of the Liard Range.

The second development is the Cadillac Mine on Prairie Creek. This silver, lead-zinc property was first staked in 1928; however, there was little activity until 1958 (Ker, Priestman and Associates 1980). The most recent development activity undertaken by Cadillac Explorations Ltd. was started in 1979. A winter road was built into the site in 1980 and a mill and an accommodation complex were constructed. Financial difficulty and depressed

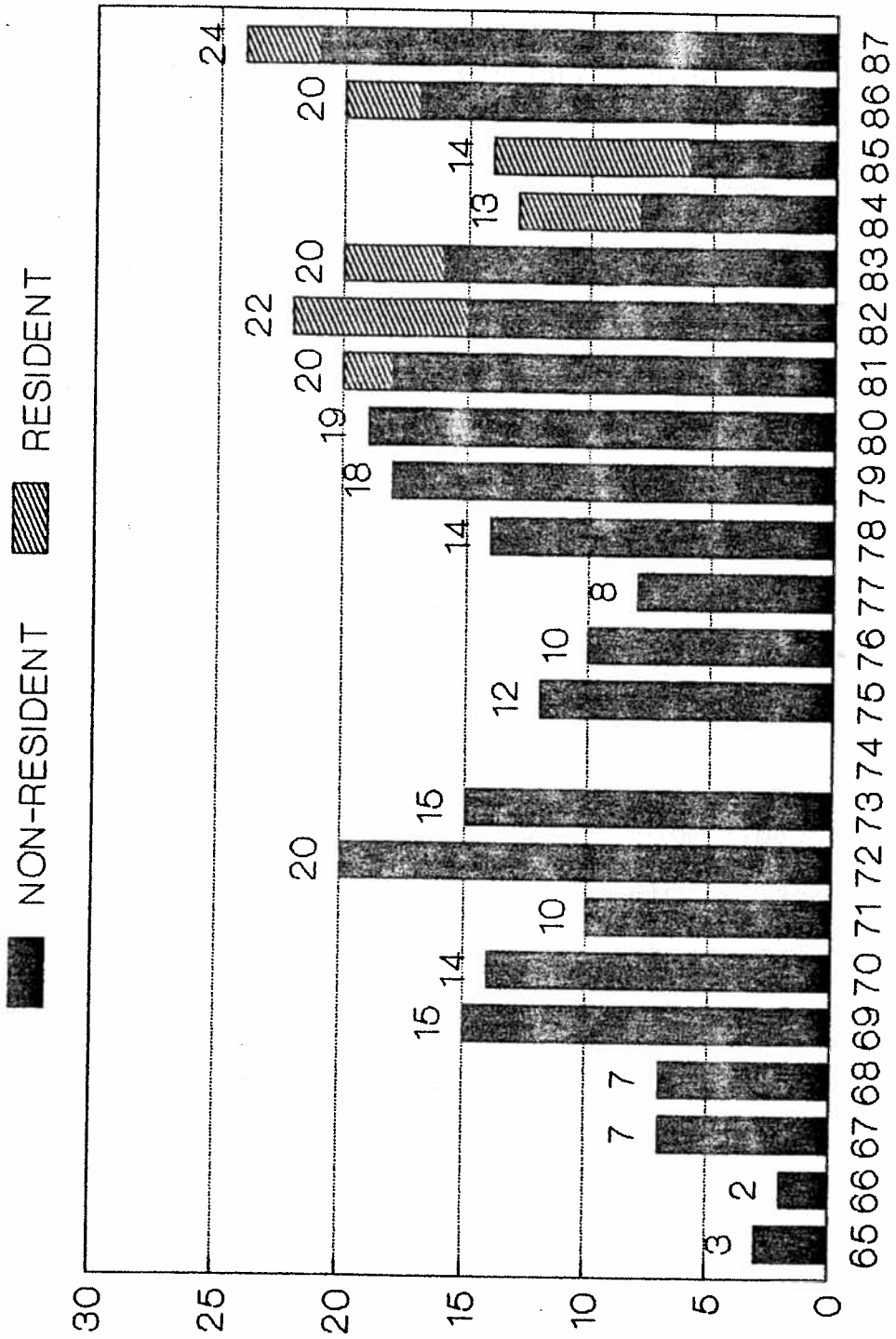

Figure 9. Annual harvest of Dall's sheep in Wildlife Management Area E/1-8 from 1965 to 1987.

world markets resulted in the mine being shut down in 1985. The mine is currently inactive although all the equipment is still in place and given favorable market conditions could start-up quickly.

If the mine does start-up it is likely that an all-weather road and new airstrip will be constructed. These hold the greatest potential for affecting the sheep population. By opening access to the area, harvest pressure in the area could be expected to increase dramatically. There is also the potential for spills of oil or other chemicals along the road and for sheep to be killed by traffic on the road.

Should an all weather road and new airstrip be constructed, hunter access to the area will have to be restricted either by using a quota or lottery system or by restricting use of the road and airstrip to mine vehicles only.

The third development was a gas well drilled at the head waters of the Jackfish River, south of the Tlogotsho Range by Northcor Energy Ltd. of Calgary, Alberta in 1984. The development included a winter road from the Pointed Mountain area north along the Kotaneelee River and Chinkeh Creek, then west and south along the Jackfish River. An airstrip was constructed along the Jackfish River.

The Jackfish River site was abandoned in 1984 as drilling results were negative. The road is still in place but is essentially impassible in the summer because of several river and creek crossings. The airstrip was rendered inoperative by placing

log barriers along its length.

As this development did not result in increased access to the mountain ranges and the well site was located below the tree line away from any important sheep habitat, the impact on sheep in the area was negligible (Ferguson et al. 1985).

RECOMMENDATIONS

1. The Dall's sheep populations in the southern Mackenzie Mountains should be managed to maintain high trophy quality. This can be best accomplished by setting harvest levels based on the availability of full curl rams while still permitting the harvest of rams with 3/4 curl or more.
2. Given the harvest levels indicated by the outfitter returns and resident hunting, it is not necessary to implement harvest quotas at this time. If harvest pressure increases quotas may be required to keep the harvest below 26 adult rams per year. If harvest pressure by GHL hunters on ewes increases, a quota would be required to keep the ram harvest below current levels.
3. A program should be implemented to obtain GHL sheep harvest data from Fort Liard and Nahanni Butte hunters. Ram plug records should be used to determine levels of harvest by GHLs from outside these communities.
4. The harvest data requirements and the process for submitting the data should be explained in detail to the outfitter to avoid any further loss of data.
5. Horn size should be monitored using sheep jigs to detect any change in trophy quality. The ram plug recording system should be modified to include the size data from these jigs as well as kill location data, especially from resident and GHL hunters.

6. Population censuses and evaluations of the proportion of trophy rams in the populations should be conducted on a 3 to 5 year interval.
7. Investigations of productivity, lamb survival and recruitment are required to determine the ability of the population to withstand harvest. This will become increasingly important if the harvest levels stay consistently near the 3% of adult population level.

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