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WINTER HABITAT USE BY MOUNTAIN GOATS

BY
John W. Schoen

Volume II
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-11, Job 12.4R

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(Printed December 1979)

JOB PROGRESS REPORT (RESEARCH)

State:	Alaska		
Cooperators:	J. W. Schoen, O. C. Wallmo, R. D. Taber, J. L. Fox, M. D. Kirchhoff		
Project No.:	W-17-11	Project Title:	Big Game Investigations
Job No.:	12.4R	Job Title:	Winter Habitat Use by Mountain Goats
Period Covered:	July 1, 1978 through June 30, 1979		

SUMMARY

During this report period the study area was expanded to include the east portion of Berners Bay to Eagle Glacier, approximately 40 km northwest of Juneau. Fifteen additional goats were captured and instrumented. Thirteen animals were captured from a helicopter using the immobilizing drug M99 and two were captured from the ground. To date, we have 433 relocations of 20 instrumented goats. Within the marked population we have had one confirmed radio failure, one disappearance, two mortalities, and four hunter kills.

Several home range patterns were described and home range integrity is discussed. Observations of marked goats indicated a lack of integrity within goat groups.

Results of seasonal habitat use by goats were summarized by attribute from January 1, 1978 to date. During spring, goats moved to lower elevation, steep, southerly exposed rock-cliff, brush, and forest habitat. Throughout summer, they dispersed to a variety of habitat types, primarily rock-cliff and alpine, with an increase in elevation and greater use of northerly exposures. During fall, goats moved down in elevation but continued to utilize northerly exposures and inhabit forest, alpine, subalpine, and rock-cliff habitats. Throughout winter, goats utilized a wide range of elevations, concentrating at mid-elevations and southerly exposures on alpine and rock-cliff habitats with lesser use of forested habitat. Goat use of most habitat attributes varied significantly ($P<.01$) between seasons. However, goats substantially utilized steep, broken terrain throughout the year. Although we have determined that some goats make substantial use of forested habitat during fall-winter-spring, much remains to be learned about forest/goat relationships.

CONTENTS

BACKGROUND

Background and justification for this mountain goat (*Oreamnos americanus*) study were outlined previously (Schoen 1978).

OBJECTIVES

To develop capture and telemetry procedures suitable for monitoring mountain goat movements and determine habitat use by mountain goats in Southeast Alaska.

STUDY AREA

A description of the Herbert-Mendenhall study site was previously reported (Schoen 1978). During this report period a second site was chosen to provide a greater variety of habitat situations from which to evaluate habitat use. The area north of Eagle River to the mouth of Berners Bay (Fig. 1) was selected as a second site. This area (which we will refer to as Berners Bay) is more representative of coastal goat habitat situations, and also has a greater abundance of commercial quality old-growth forest than does the Herbert-Mendenhall area which is a more interior site. The Berners Bay site is approximately 40 km (25 mi) northwest of Juneau. A variety of topographic conditions are represented with elevations ranging from sea level to 1676 m (5500 ft). This site includes approximately 15 km (9 mi) of shoreline with steep, forested slopes rising to alpine. The estimated goat population in this area is 75 to 100 animals.

PROCEDURES

Procedures for this work were outlined earlier by Schoen (1978). Additional or revised procedures implemented during this report period follow.

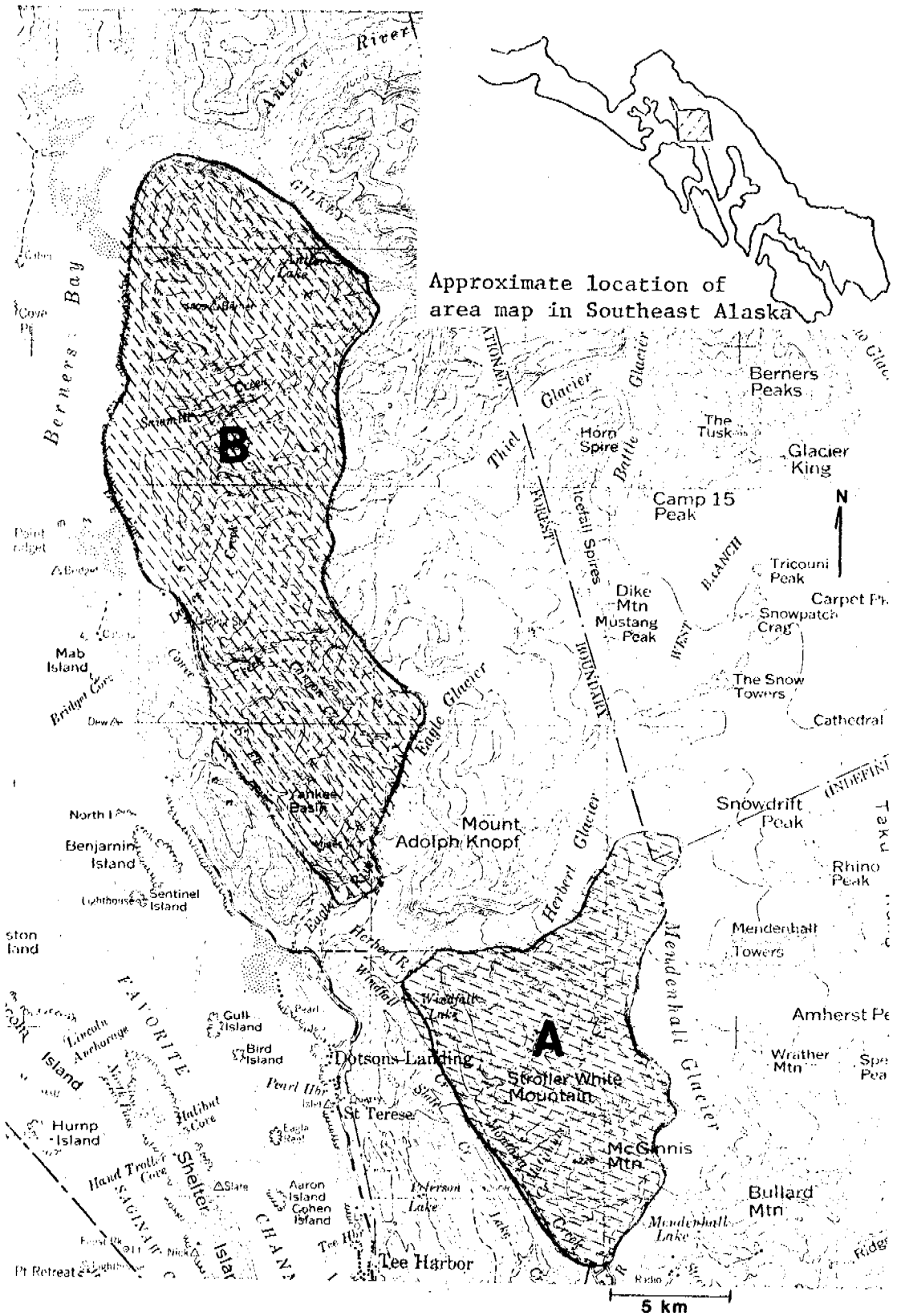

Fig. 1. Location of study areas. A. Herbert-Mendenhall, B. Berners Bay

Capture Techniques

Darting goats from a helicopter using the immobilizing drug M99 continued to be our major method for capturing goats. This technique, when used during winter, may bias our sample toward goats wintering in open alpine areas (those areas accessible by helicopter). Because of our interest in monitoring a representative cross section of goats, we also pursued goats on foot with a capture gun loaded with M99. This work was conducted by University of Washington student Joe Fox in conjunction with his Ph.D. research on winter habitat use by goats and was confined primarily to forested areas below 762 m (2500 ft). In addition to this ground work, we also initiated helicopter captures during the late spring and summer in an attempt to capture goats off their winter range.

Telemetry

Ten additional transmitters and a 200 channel TR-2 receiver and scanner (used in conjunction with deer research Job 2.6R) were purchased from Telonics Company (Mesa, Arizona). All goat relocations were made from a Helio Courier fixed-wing aircraft using a pair of two-element yagi antennas. One antenna was mounted below each wing perpendicular to the fuselage and both were connected by a right-left switchbox. From January 1978 through June 1979, instrumented goats were relocated, on the average, once every 10 days. Since July 1979 relocations have averaged once per month.

Home Range and Habitat Utilization

A map of the two study sites was overlayed by an X,Y-grid coordinate system. Grid size was 10.4 ha (25.6 a). This coincided with the accuracy with which the instrumented animals could be located considering both the accuracy of the antenna system and accuracy of determining the location on 1:63,360 scale maps. Thus, for each animal we have a record of all locations which can be broken down by any given time period (season) and plotted on a map according to its X,Y coordinates.

Landscape attributes determined at each location were defined as follows: elevation was recorded to the nearest 30 m (100 ft) from the aircraft altimeter; slope and aspect were determined from the map; slope was recorded to the nearest 5 degrees; and aspect was recorded as flat, north, northeast, east, southeast, south, southwest, west, northwest, or ridgetop.

Fifteen general habitat types were defined as follows: beach; beach-fringe forest (old-growth forest less than 91 m [100 yd] from beach); old-growth spruce-hemlock forest (uneven-aged and silviculturally overmature); early successional clearcut (0-15 years); mid-successional clearcut with deciduous or conifer species dominating (16-30 years); even-aged second growth with deciduous or conifer species dominating (31-200 years); deciduous brush (e.g., slides and avalanche chutes); muskeg; subalpine; alpine; rocky outcrop-cliff; permanent ice-snowfield; and frozen lake or river.

Over-story canopy coverage was estimated from the air and recorded to the nearest 5 percent. The character of the terrain was recorded as either smooth or broken. The percent snow cover and depth of snowpack in the general vicinity of the animal were estimated from the air. Snow type was described as soft, hardpack or crusted.

Location accuracy was estimated as follows: position accurate to within 10.4 ha (25.6 a) and landscape attributes accurate; position accurate but landscape attributes uncertain; and position accurate only to within 40 ha (100 a) and all landscape attributes uncertain. A sample data form and code are presented in Appendix I.

Telemetry data were entered into the University of Alaska computer network's Honeywell computer and stored for immediate retrieval. The computer was accessed through the time-sharing system with a Teletype Model 43 terminal located in the Juneau office. Telemetry data were collected in a format acceptable for entering immediately on the Teletype terminal and then stored in a permanent file called GOATDATA. A plotting routine and packaged retrieval system utilized this data file.

The plotting program, adapted from Koepple et al. (1975), used a Tektronix desktop plotter to produce two-dimensional plots of goat movements. It plotted for each individual any combination of the following: points of location, location points successionally connected by lines, an elliptical home range plot around these points including an area calculation, and a home range ellipse alone. This ellipse, originally proposed by Jennrich and Turner (1969), represented a 95 percent confidence ellipse, corrected for orientation on a two-dimensional grid. The elliptical home range model is based on the assumption of a bivariate normal distribution. Ford and Krumme (1979) pointed out that it has not been conclusively demonstrated that any home ranges conform to this assumption, and it probably represents an oversimplification in the majority of cases. For our purposes, the ellipse represents a reasonable and systematic technique for portraying the seasonal home ranges of goats in a general manner. Although this program calculates the area of the ellipse, it would be an inaccurate estimate because of the extreme three-dimensional character of the landscape utilized by goats. For this reason, we have not presented measures of area.

The Statistical Package for the Social Sciences, SPSS, (Nie et al. 1975) was used to evaluate the data on goat habitat use. The primary SPSS procedures used were Frequencies and Crosstabulations. Frequencies calculated means, ranges, standard deviations, and variances, and generated tabular frequency distributions and histogram plots. Crosstabs produced two-way crosstabulations of variables and computed a chi-square statistic which tested whether a systematic relationship existed between the habitat variables and seasons.

RESULTS

Capture Techniques

Fifteen goats were captured during this report period, 4 males and 11 females. The age, sex, location and status of all goats captured to

date are presented in Table 1. Seven additional animals were captured in the Herbert-Mendenhall area, and eight more in the Berners Bay area. Since December 1978, we have used a standard dosage of 3.5 mg of M99 per goat. The average time from injection to immobilization was 12 minutes. All except two were captured using a helicopter. Two animals were captured by stalking on foot with a capture gun. This technique was time consuming and not nearly as efficient as using a helicopter. One advantage of the ground operation, however, was that goats inhabiting forested habitat had a greater likelihood of being captured than when the helicopter technique was used.

Eight helicopter trips were taken to capture 13 goats (Table 2). The number of goats captured on each trip ranged from zero to four and averaged 1.6 goats per trip. Twenty-five shots were taken and 17 animals hit for a 68 percent success rate. Of those animals hit 88 percent were captured. The others did not respond to the immobilizing drug. No animals died as a result of capture or handling. The flight time per trip averaged about 2.5 hours.

Location Telemetry

From December 1977 through October 1979, 433 observations have been recorded for 20 marked goats. The number of relocations per individual averaged 22 with a range of 1 to 57. Sixty-nine percent of these relocations resulted in a visual observation of the marked animal. Ninety-four percent of the relocations were estimated to be accurate to within 10 ha and were used in our analysis of habitat use.

To date, we have had one confirmed radio failure following almost 2 years of performance. In addition, one animal (number 26) disappeared and we have assumed, following a thorough search of the surrounding area, that this was also the result of radio failure. Two animals were presumed dead during fall 1978. Their transmitters continued functioning from the same location for several months. Both animals (adult females, numbers 2 and 5) inhabited very steep, rugged terrain and were never recovered. Cause of death was unknown. During the fall 1979 hunting season, four goats were killed by hunters, three from Herbert-Mendenhall and one from Berners Bay. Currently, 12 goats still have operable transmitters, 5 at Herbert-Mendenhall and 7 at Berners Bay.

Home Range and Habitat Utilization

The movements of five goats during the period January through December 1978 and 13 goats January through October 1979 are presented in Appendix II. During these periods the mean, greatest airline distance moved between any two points of location by any single goat was 6 km (3.8 mi). The maximum and minimum distances moved were 11.6 km (7.3 mi) and 3.2 km (2.0 mi), respectively. Excluded from this breakdown were five goats whose locations spanned less than 8 months.

Several home range patterns have emerged from our plots of summer and winter goat locations. Some individuals inhabited discrete winter

Table 1. Age, sex, location, and current status of captured mountain goats and immobilization results using M99.

Goat #	Area	Date	Age (years)	Sex	Time from injection to immobilization (minutes)	Duration of paralysis (minutes)	Dosage (mg)	Current Status
1	Herbert	12-13-77	1	female	10	30	2.5	transmitting
2	Herbert	12-13-77	6	female	20	45	2.5	dead
3	Herbert	12-13-77	3	male	20+	90+	3	radio failure
4	Herbert	12-21-77	6	male	13	58	3	hunter kill
5	Herbert	12-22-77	5	female	13	40	2.5	dead
78	Herbert	12-26-78	6	female	10	65	3.5	transmitting
81	Herbert	12-26-78	1	female	13	40	3.5	transmitting
11	Herbert	12-26-78	5	male	10	27	3.5	hunter kill
26	Herbert	12-26-78	5	female	12	54	3.5	?
7	Berners	12-27-78	9+	female	7	32	3.5	hunter kill
79	Berners	12-27-78	7	male	8	80	3.5	transmitting
16	Herbert	3-27-79	7	female	?	?	3.5	hunter kill
65	Herbert	4- 1-79	8	female	?	?	3.5	transmitting
83	Berners	4-10-79	8	male	10	65	3.3	transmitting
32	Berners	6-15-79	9	female	10	?	3.5	transmitting
86	Berners	6-16-79	7	male	15	28	7.0[1]	transmitting
82	Herbert	6-22-79	2	female	10	60	3.5	transmitting
9	Berners	7-25-79	7	female	20	40	3.5	transmitting
31	Berners	7-25-79	11	female	15	45	7.0[1]	transmitting
33	Berners	8-21-79	8	female	19	30	3.5	transmitting

[1]shot twice

Table 2. Mountain goat capture attempt and success from December 1978 to July 1979.

Date	Shot	Hit	Captured	Technique
12-26-78	4	4	4	helicopter
12-27-78	4	2	2	helicopter
3-27-79	1	1	1	ground stalking
4- 1-79	1	1	1	ground stalking
4-10-79	2	1	1	helicopter
4-11-79		No shots		helicopter
6-15-79	4	2	2	helicopter
6-22-79	2	1	1	helicopter
7-25-79	5	4	2	helicopter
8-21-79	2	1	1	helicopter
Totals	25	17	15	

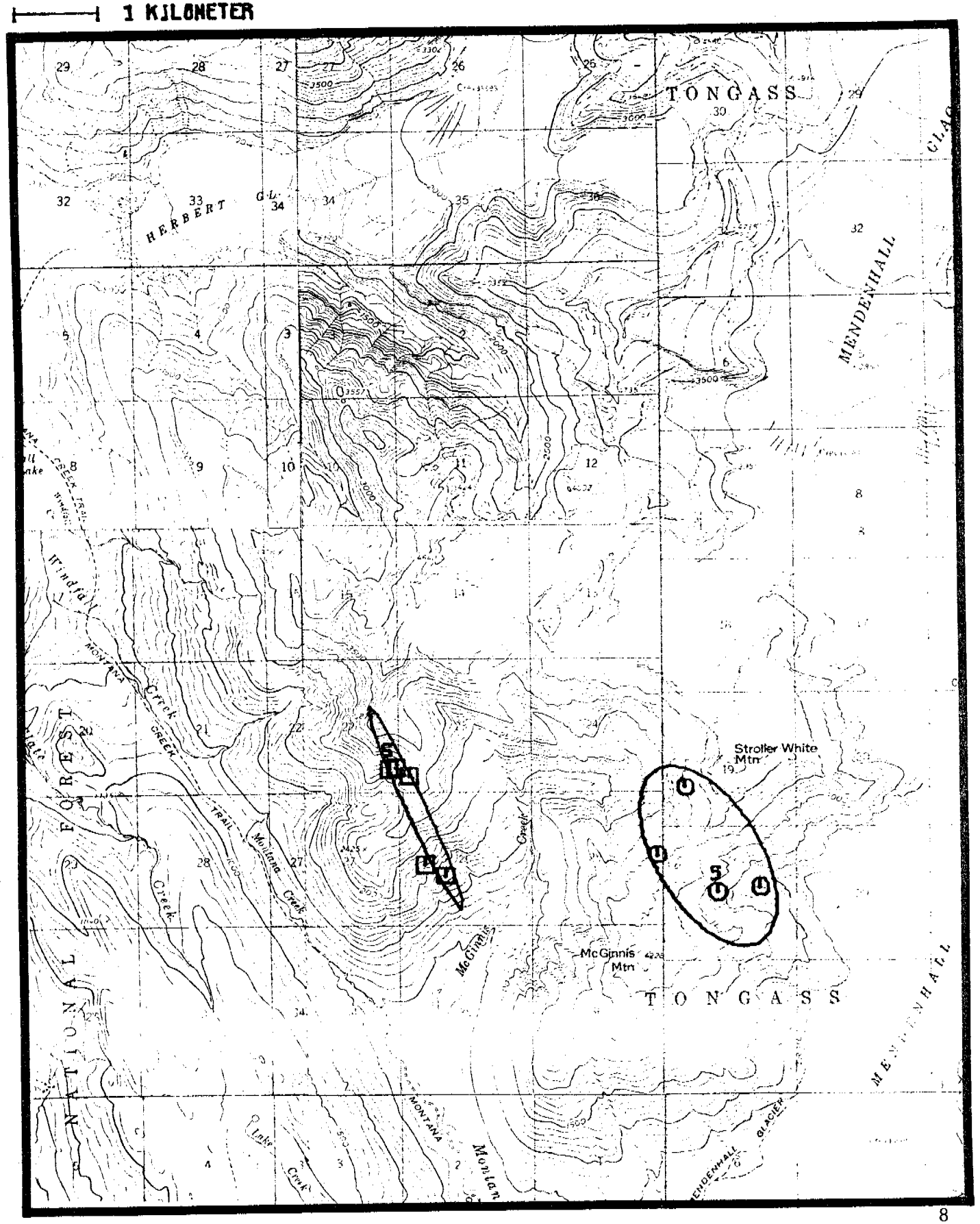

Fig. 2. Plot of goat movements.

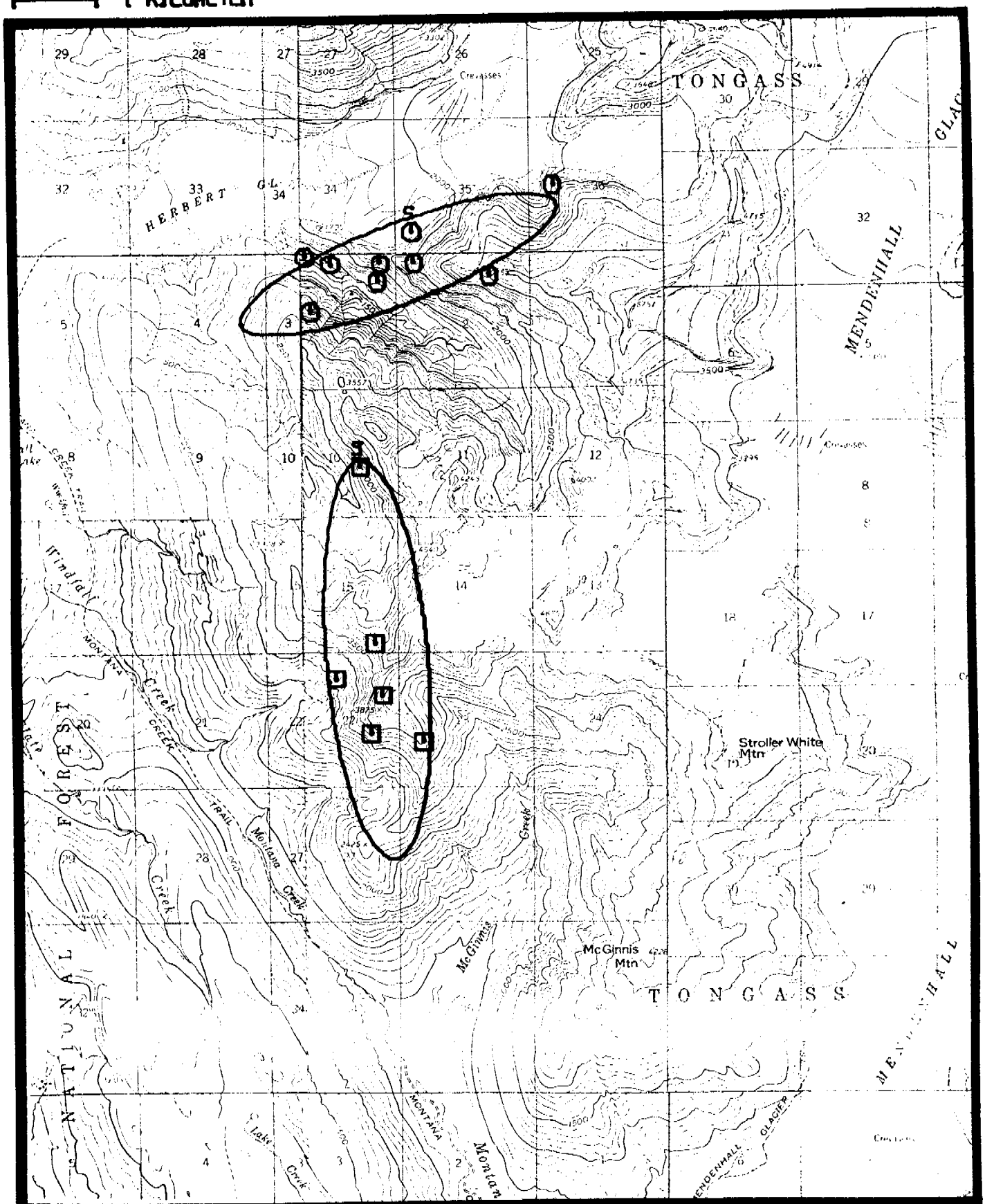

Fig. 3. Plot of goat movements.

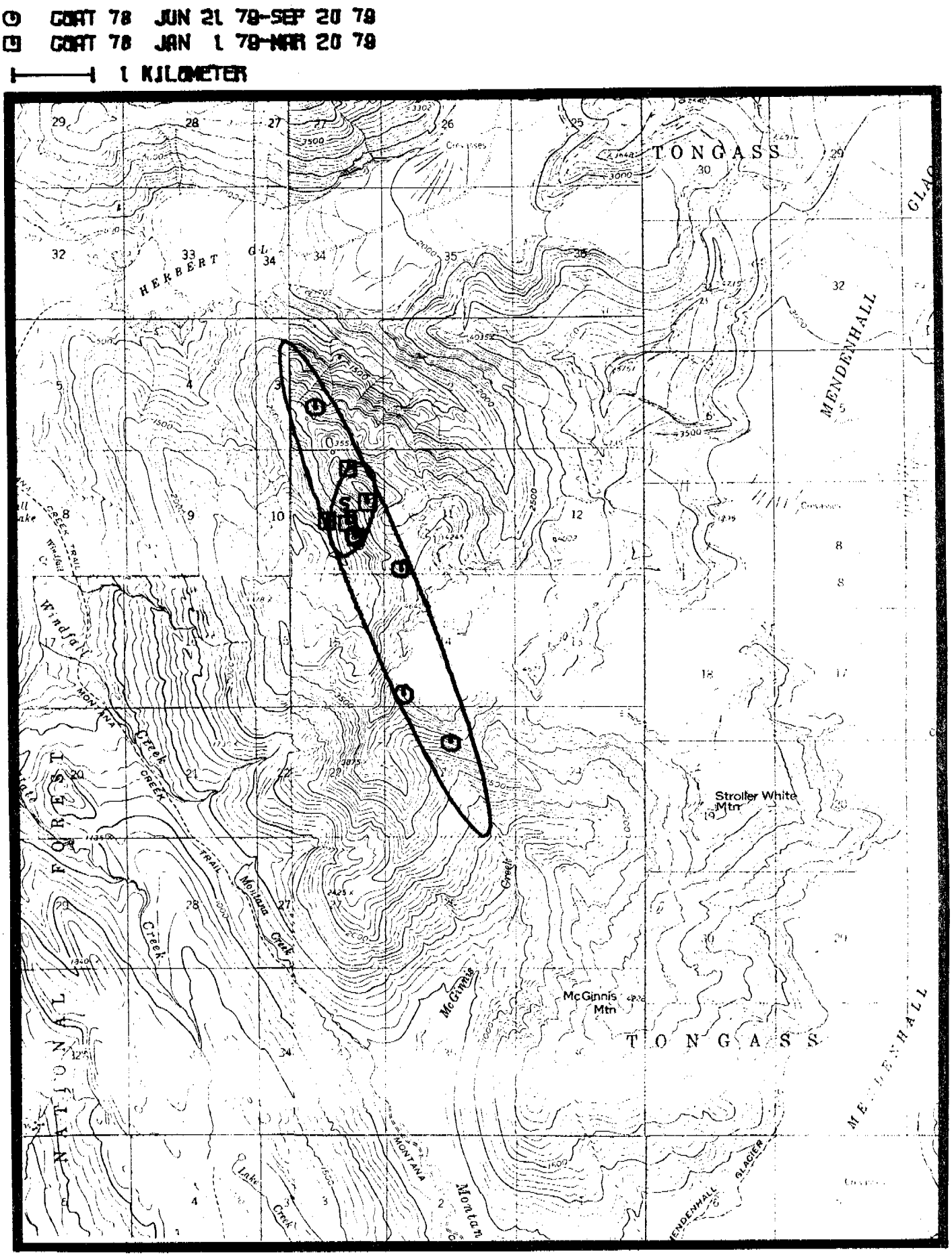

Fig. 4. Plot of goat movements.

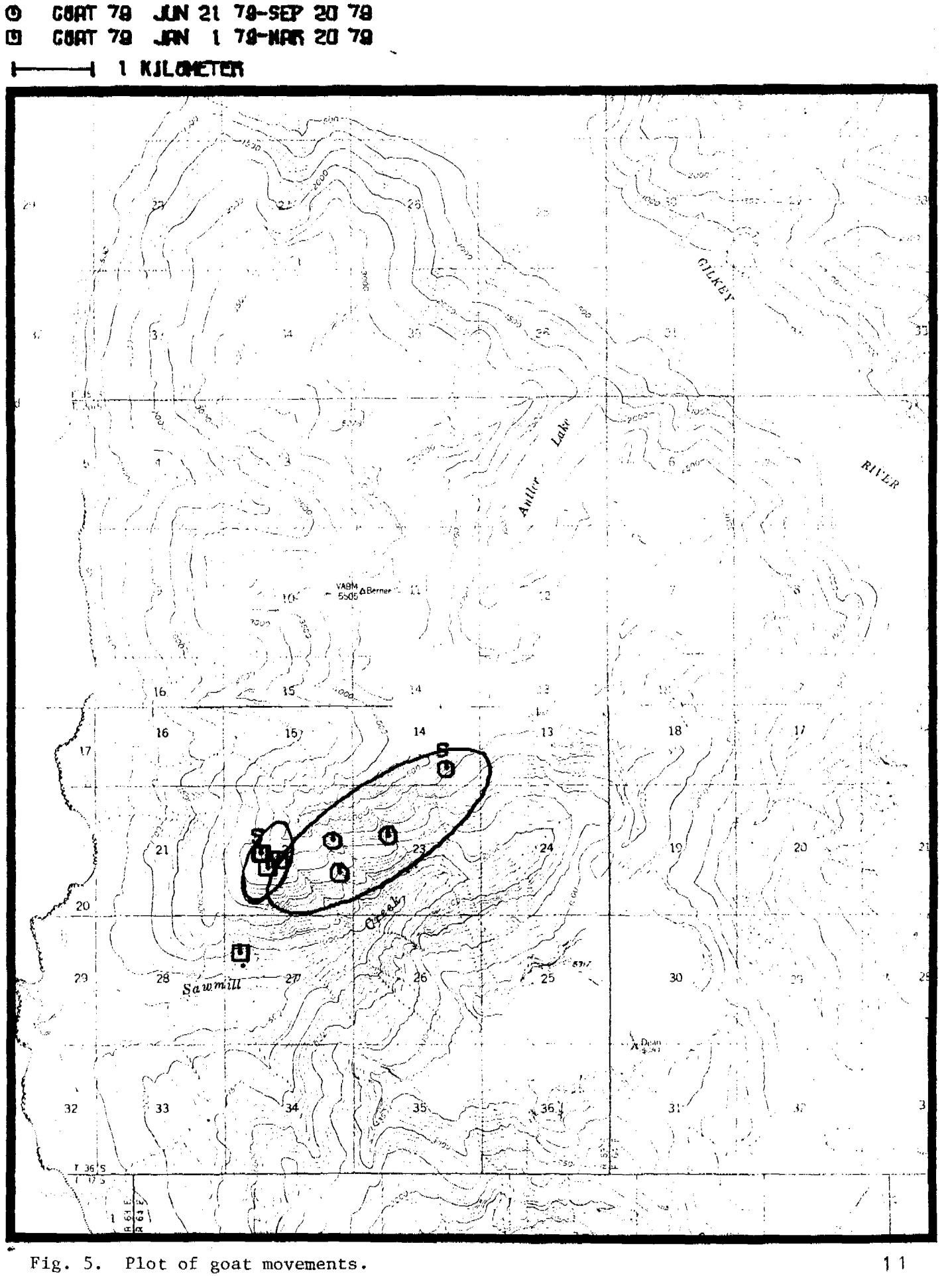

Fig. 5. Plot of goat movements.

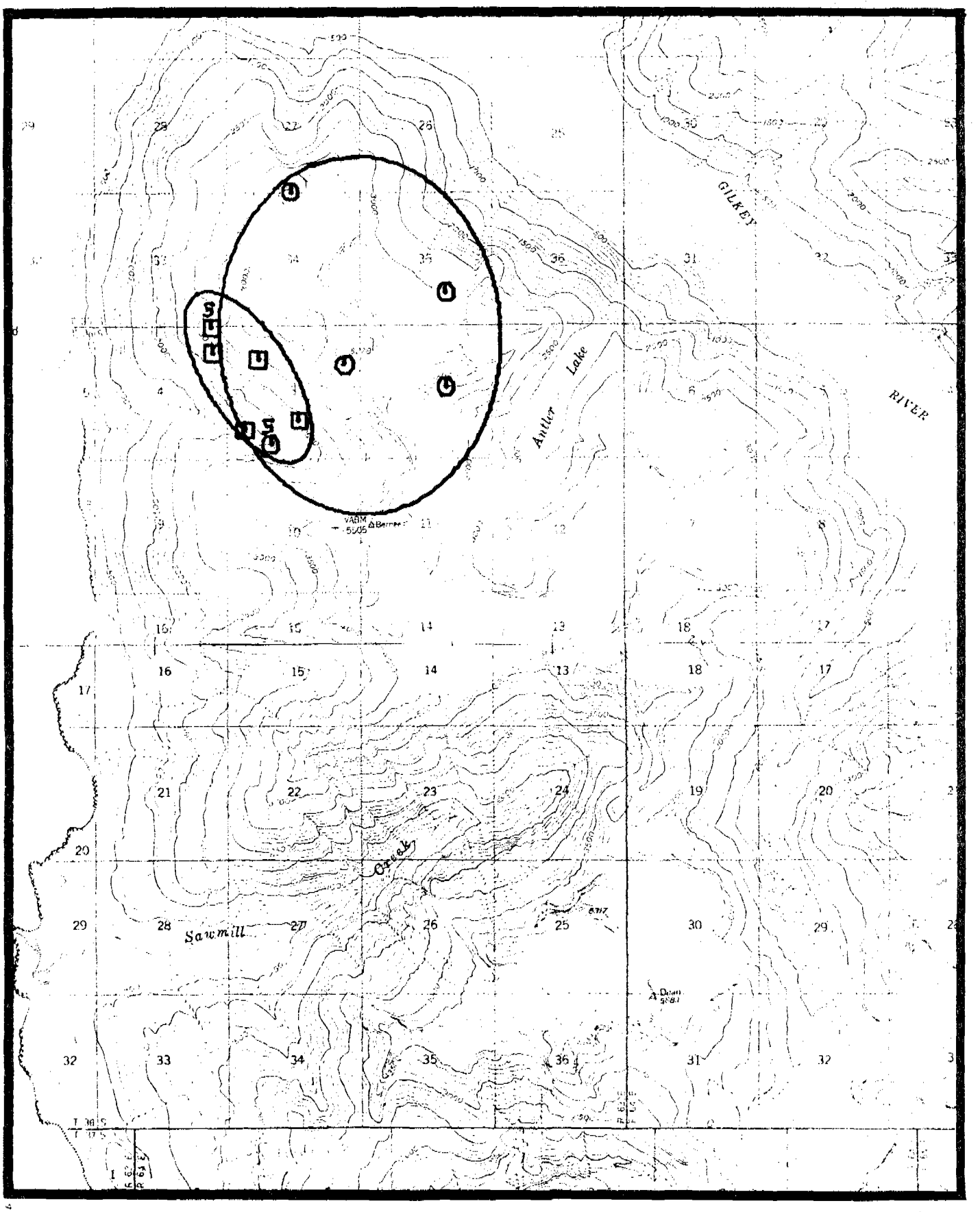

Fig. 6. Plot of goat movements.

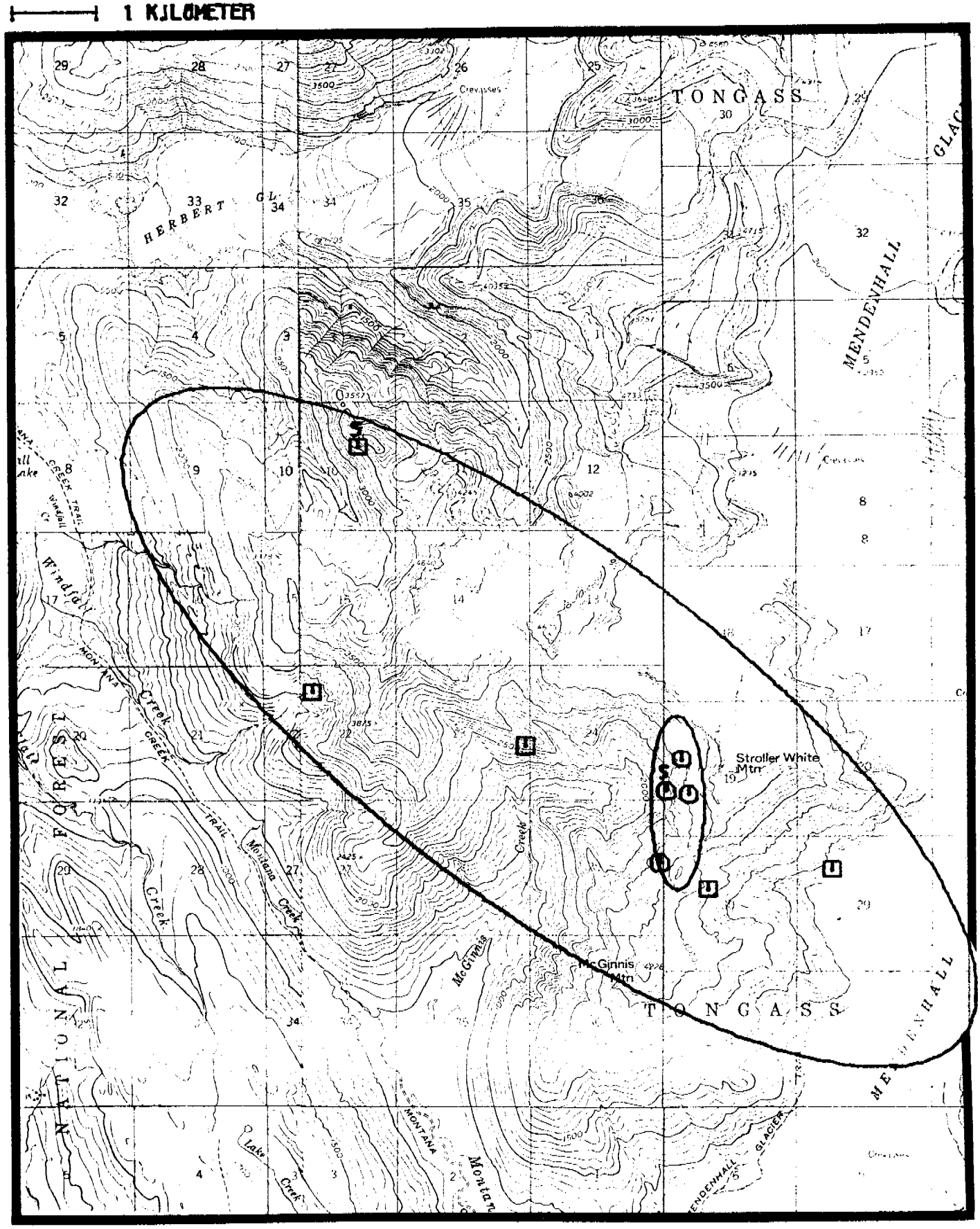

Fig. 7. Plot of goat movements.

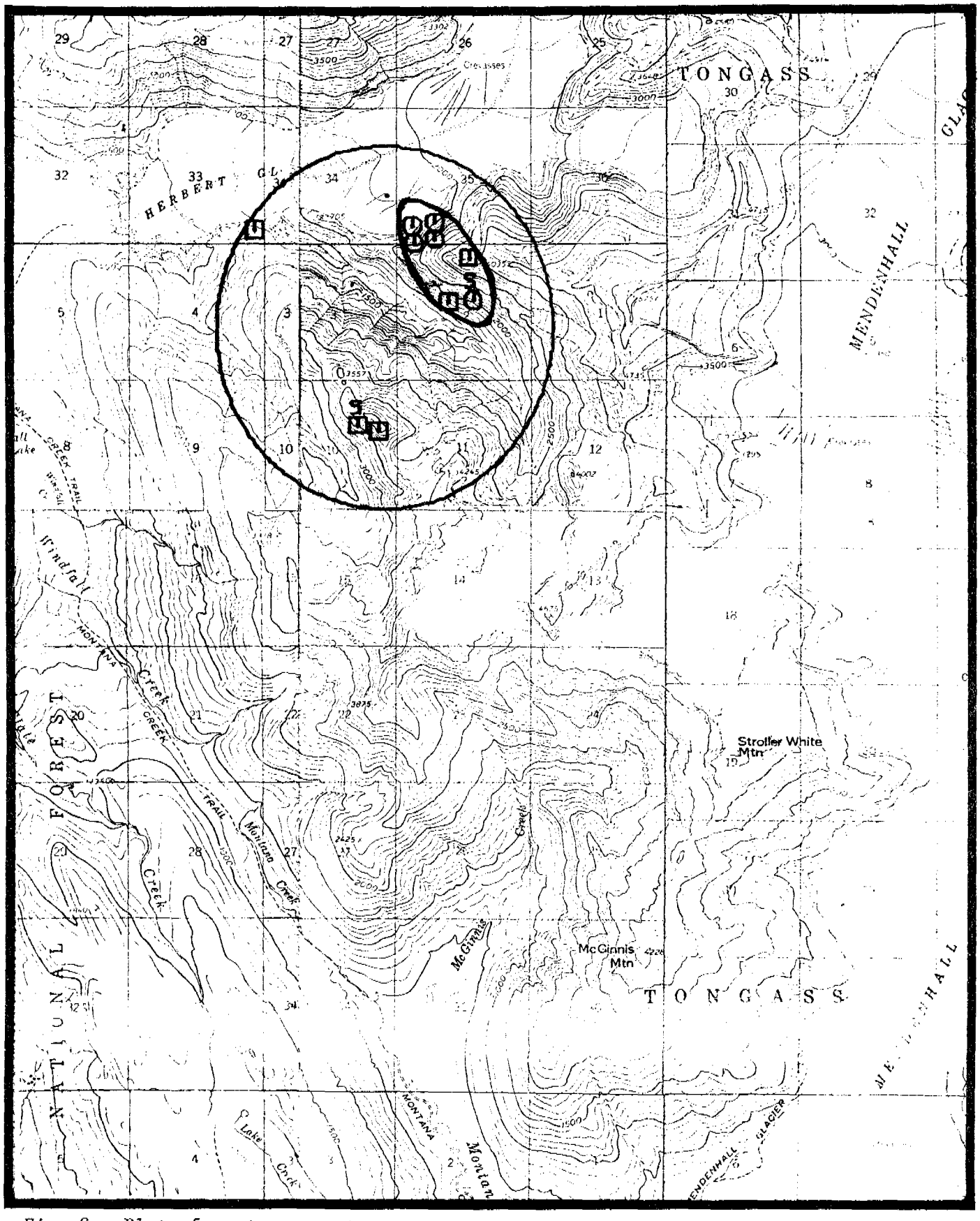

Fig. 8. Plot of goat movements.

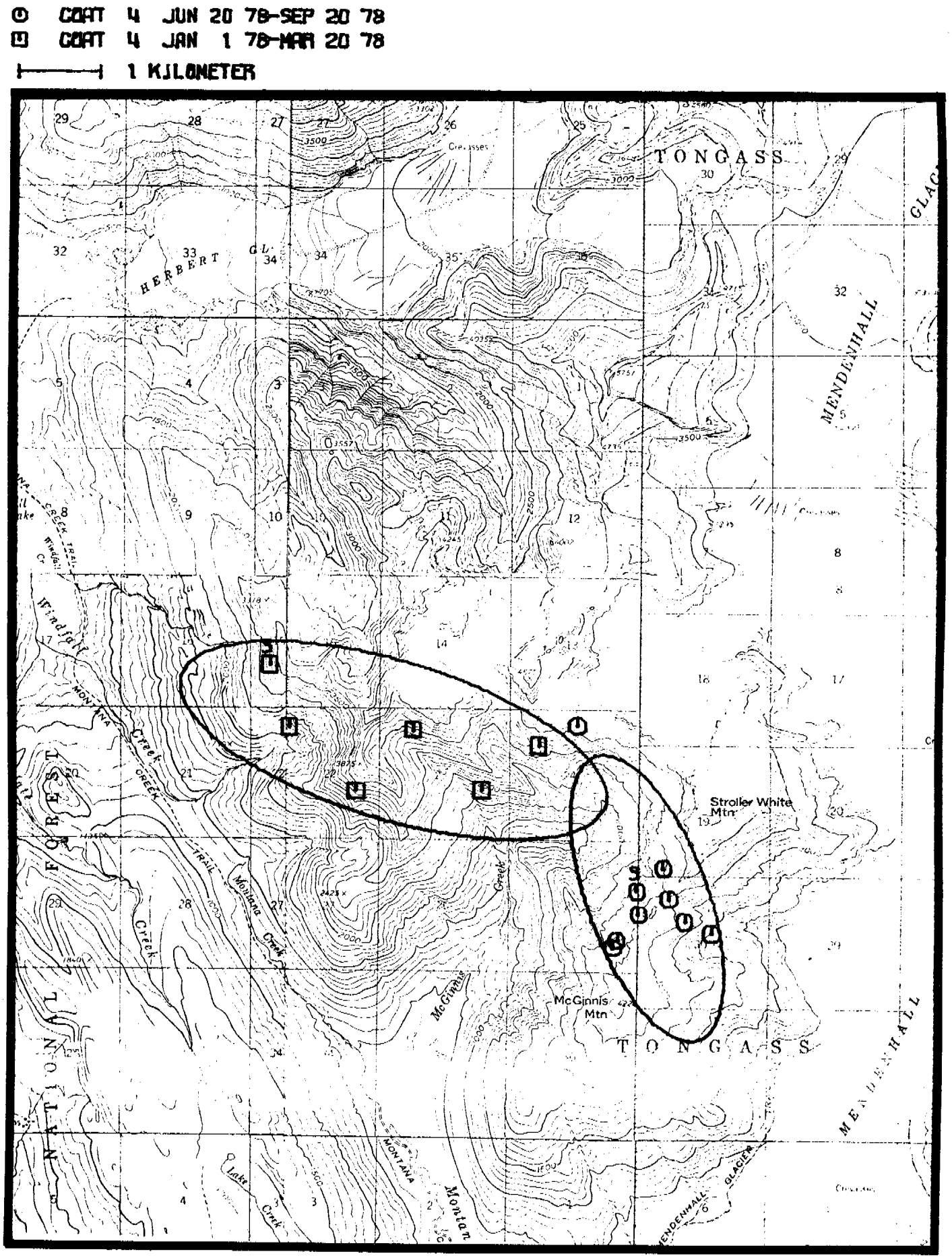

Fig. 9. Plot of goat movements.

and summer ranges (Figs. 2, 3), while others had overlapping ranges. In the majority of cases, summer ranges overlapped the smaller winter range (Figs. 4, 5, 6). However, the movements of some individuals (Figs. 7, 8) indicated the opposite trend with widely dispersed winter relocations overlapping a relatively small summer range. Spring ranges were generally small while fall ranges were much larger, reflecting wide ranging movements presumably associated with the rut.

We had three goats (numbers 1, 3, and 4) with 2 consecutive years of relocation data. This gave us an opportunity to evaluate home range integrity. For goat number 4 (Figs. 2, 9), an adult male, we observed a similar home range pattern during the summers of 1978 and 1979. The orientation of the winter home ranges was less similar than summer, in that relocations during 1978 were more widely dispersed than during 1979. The relative location within the study site of the two winter ranges, however, was generally similar.

Mountain goat number 3 (Figs. 7, 10), an adult male, also had overlapping summer home range areas during the 2 consecutive years 1978 and 1979. As was the case with number 4, number 3's winter ranges were less similar than during summer. During 1978, number 3's winter relocations were clumped in two distinct areas separated by 2.4 km (1.5 mi). The following year, although several relocations overlapped those of the previous winter, most relocations were widely dispersed reflecting a wider range of movement.

The summer and winter ranges of goat number 1 (Figs. 8, 11), an adult female, were generally confined to the same region of the study site during consecutive years. However, summer movements were most dispersed during 1978 while winter movements were most dispersed during 1979.

To date there has been no indication that any marked animals have moved out of the study site. It appears that most animals inhabit a particular portion of the site during most of the year. The greatest movements occurred during fall, coinciding with the rut.

Seasonal habitat use by instrumented mountain goats was evaluated with respect to the following attributes: elevation, slope, aspect, terrain, habitat type, percent canopy cover, and percent snow cover. The data which follow were collected from December 1977 through October 1979. Because of the small sample size, data collected for the same season of 2 different years are evaluated together.

A seasonal summary of goat use of elevation is presented in Table 3. The mean elevation of goat relocations was lowest during spring and fall and highest during summer and winter (Table 4). During spring and fall, 32 percent of all relocations occurred below 610 m (2000 ft). Throughout winter and summer, only 14 and 15 percent of the relocations occurred below this level. During summer, 26 percent of all relocations

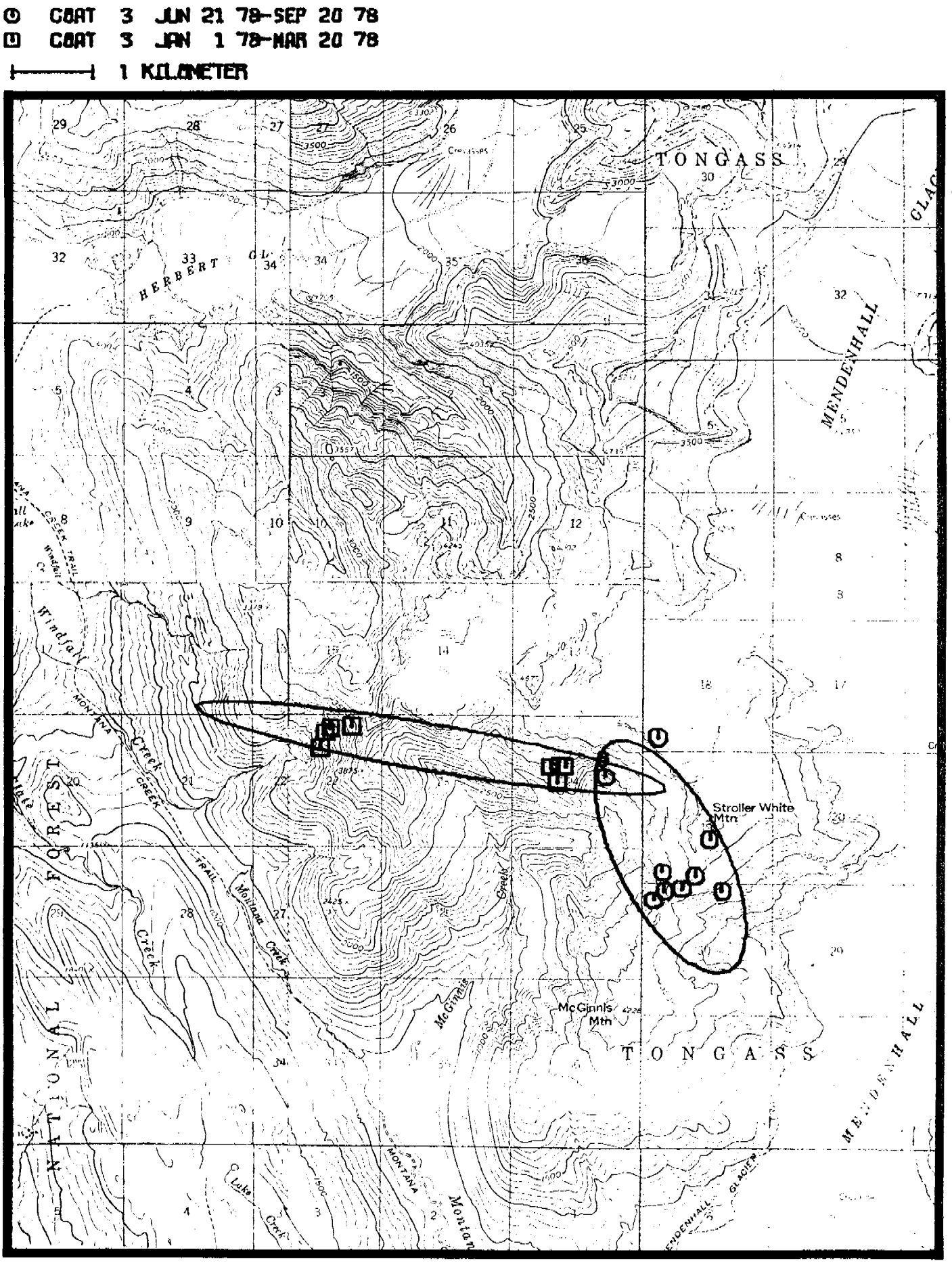

Fig. 10. Plot of goat movements.

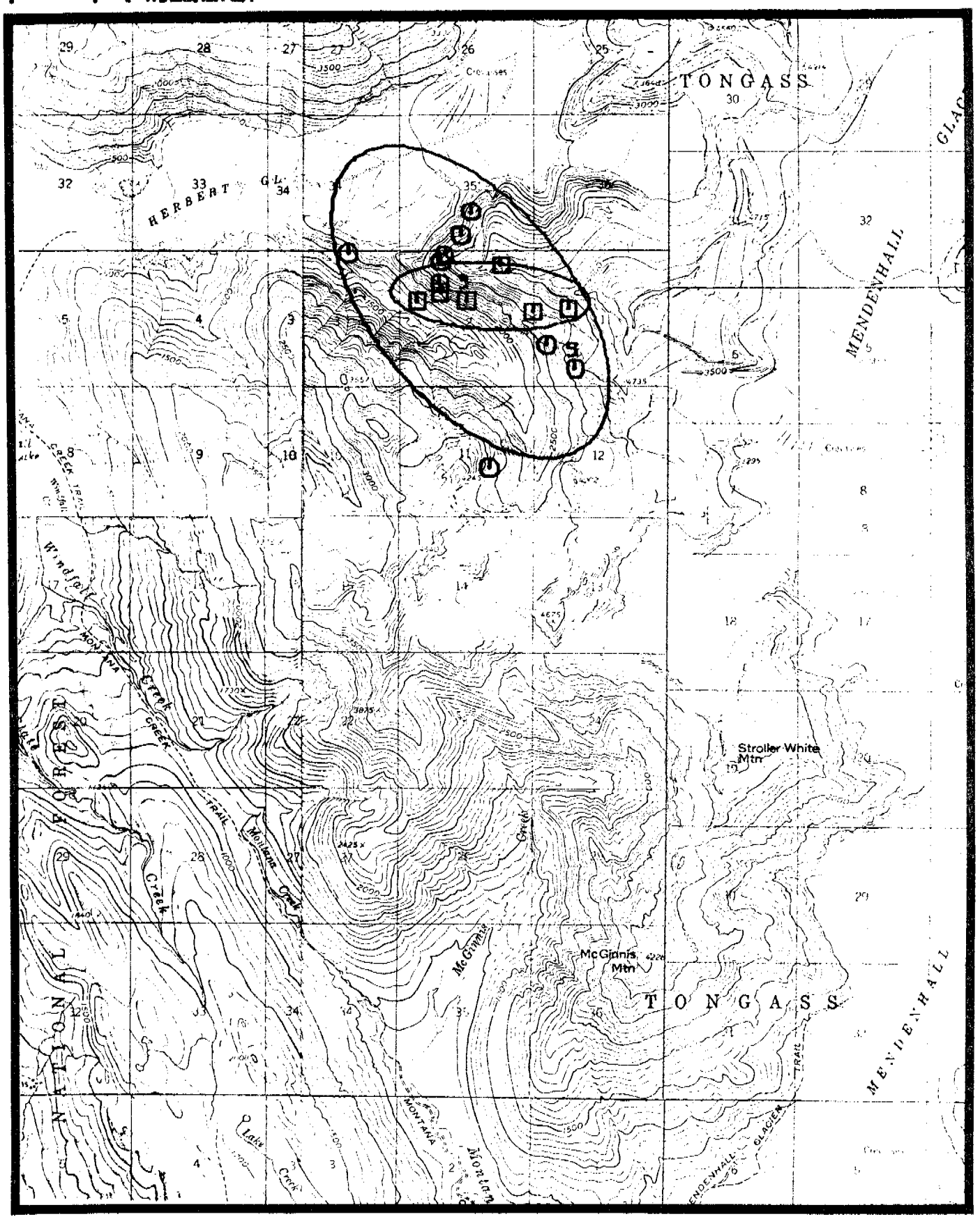

Fig. 11. Plot of goat movements.

Table 3. Seasonal summary of relocations of radio-instrumented goats relative to elevation.

* C R O S S T A B U L A T I O N O F *
RELEV ELEVATION FT. BY SEASON
* *

RELEV	SEASON	Spring 1.	Summer 2.	Fall 3.	Winter 4.	ROW TOTAL
2. 501-1000	COUNT 1/	7	1	0	2	10
	COL PCT	4.2	0.8	0.	2.0	2.4
3. 1001-1500	COUNT	20	7	7	5	39
	COL PCT	12.0	5.9	18.9	5.1	9.3
4. 1501-2000	COUNT	26	10	5	7	48
	COL PCT	15.7	8.5	13.5	7.1	11.4
5. 2001-2500	COUNT	41	10	12	12	75
	COL PCT	24.7	8.5	32.4	12.1	17.9
6. 2501-3000	COUNT	28	33	6	16	83
	COL PCT	16.9	28.0	16.2	16.2	19.8
7. 3001-3500	COUNT	22	26	6	37	91
	COL PCT	13.3	22.0	16.2	37.4	21.7
8. 3501-4000	COUNT	14	20	1	20	55
	COL PCT	8.4	16.9	2.7	20.2	13.1
9. 4001-4500	COUNT	8	8	0	0	16
	COL PCT	4.8	6.8	0.	0.	3.8
10. 4501-5500	COUNT	0	3	0	0	3
	COL PCT	0.	2.5	0.	0.	0.7
COLUMN TOTAL		166	118	37	99	420
		39.5	28.1	8.8	23.6	100.0

CHI SQUARE = 84.35601 WITH 24 DEGREES OF FREEDOM SIGNIFICANCE = 0.0000

1/ The upper and lower figure in each col. of the table represents the number and percentage, respectively, for that variable during a given season.

Table 4. Mean and standard deviation of elevation and slope of goat relocations during spring, summer, fall, and winter.

Season	Elevation in Meters (ft)			Slope in Degrees		
	Mean	S.D.	n	Mean	S.D.	n
Spring	773(2537)	271	166	39	17.8	157
Summer	927(3041)	257	118	27	13.0	118
Fall	725(2378)	214	37	29	11.7	37
Winter	916(3005)	231	99	30	12.2	99
Year	846(2775)	265	420	32	15.7	411

occurred above 1067 m (3500 ft) while 20, 13, and 3 percent of relocations occurred above this level during winter, spring, and fall, respectively. Goat use of elevation varied significantly ($P<.01$) between seasons.

The mean slope of goat relocations by season is presented in Table 4 and a seasonal summary of goat use of slope is presented in Table 5. The highest mean slope (39 degrees) occurred during spring; while summer, fall and winter were comparatively low (27, 29, and 30 degrees, respectively). During spring, 35 percent of all relocations were on slopes greater than 40 degrees while less than 10 percent of relocations occurred on such steep slopes during any other season. During summer, 29 percent of all relocations occurred on slopes of less than 20 degrees. Goat use of slope varied significantly ($P<.01$) between seasons.

Goat use of aspect is presented by season in Table 6. Use varied significantly ($P<.01$) by season. During winter and spring, 77 and 74 percent of all relocations occurred on southerly exposures. This represented 11 and 8 times, respectively, the proportion of relocations which occurred on northerly exposures. During summer and fall, however, the use of northerly exposures increased by over 4 times to 37 and 46 percent, respectively, and was roughly equivalent to the use of southerly exposures during the same period. Goat use of westerly exposures was greater than easterly exposures during all seasons except fall when it was equivalent. The greatest difference in use (3.5X) between westerly and easterly exposures occurred during winter.

During all seasons, goats were relocated on broken terrain more than 70 percent of the time (Table 7). No significant ($P<.05$) seasonal differences were observed in goat use of terrain.

Table 8 describes the seasonal use of habitat type by goats. Throughout the entire year goats were relocated in rock-cliff habitats more than any other type. This habitat was utilized most (55%) during spring and least (30%) during fall. Alpine habitat was the second most heavily utilized type with its greatest use (40%) occurring during winter. Old-growth forest was utilized most during fall (24%), winter (13%), and spring (14%) with summer use declining substantially (2%). Subalpine habitat was utilized most (16%) during fall with minimal use during other seasons. Brush habitats were used frequently during spring (13%) and summer (14%) with use declining during fall and winter. The only other habitat type used substantially (4%) was permanent ice and snow during the summer season. The use of habitat types varied significantly ($P<.01$) between seasons.

Goat relocations relative to percent canopy cover are described in Table 9. We only began recording this attribute in spring 1979, thus, our sample size is small and the winter season is not represented. Use of open habitats (0-10% canopy cover) represented 84, 78, and 69 percent of all relocations during spring, summer, and fall, respectively. No significant difference ($P<.05$) was observed in canopy use between seasons.

Table 5. Seasonal summary of relocations of radio-instrumented goats relative to slope.

* CROSSTABULATION OF * *
RSLOPE SLOPE DEG. BY SEASON
* *

RSLOPE	SEASON 1/ COUNT / COL PCT	Spring 1.	Summer 2.	Fall 3.	Winter 4.	ROW TOTAL
1. FLAT		2	4	2	4	12
		1.3	3.4	5.4	4.0	2.9
2. 1-10		12	9	2	4	27
		7.6	7.6	5.4	4.0	6.6
3. 11-20		5	21	3	0	29
		3.2	17.8	8.1	0.	7.1
4. 21-30		30	44	12	37	123
		19.1	37.3	32.4	37.4	29.9
5. 31-40		53	29	18	52	152
		33.8	24.6	48.6	52.5	37.0
6. 41-50		27	7	0	0	34
		17.2	5.9	0.	0.	8.3
7. 51-60		9	4	0	2	15
		5.7	3.4	0.	2.0	3.6
8. 61-70		11	0	0	0	11
		7.0	0.	0.	0.	2.7
9. 71-80		8	0	0	0	8
		5.1	0.	0.	0.	1.9
COLUMN TOTAL		157	118	37	99	411
		38.2	28.7	9.0	24.1	100.0

CHI SQUARE = 117.15815 WITH 24 DEGREES OF FREEDOM SIGNIFICANCE = 0.0000

NUMBER OF MISSING OBSERVATIONS = 9

1/ The upper and lower figure in each col. of the table represents the number and percentage, respectively, for that variable during a given season.

Table 6. Seasonal summary of relocations of radio-instrumented goats relative to aspect.

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F
ASPECT BY SEASON
* *

SEASON

ASPECT	COUNT[1/] COL PCT	Spring 1.	Summer 2.	Fall 3.	Winter 4.	ROW TOTAL
FLAT	1.	3	0	0	0	3
		1.8	0.	0.	0.	0.7
N	2.	2	8	2	2	14
		1.2	6.8	5.4	2.0	3.3
NE	3.	10	7	10	4	31
		6.0	5.9	27.0	4.0	7.4
E	4.	4	4	0	2	10
		2.4	3.4	0.	2.0	2.4
SE	5.	39	16	4	12	71
		23.5	13.6	10.8	12.1	16.9
S	6.	20	6	4	10	40
		12.0	5.1	10.8	10.1	9.5
SW	7.	64	26	7	51	151
		38.6	22.0	18.9	51.5	36.0
W	8.	18	20	2	9	47
		10.8	16.9	5.4	9.1	11.2
NW	9.	3	27	5	1	36
		1.8	22.9	13.5	1.0	8.6
RIDGETIP	10.	3	4	3	5	15
		1.8	3.4	8.1	5.1	3.6
	COLUMN TOTAL	166	118	37	99	420
		39.5	28.1	8.8	23.6	100.0

CHI SQUARE = 119.73028 WITH 27 DEGREES OF FREEDOM SIGNIFICANCE = 0.0000

[1/] The upper and lower figure in each col. of the table represents the number and percentage, respectively, for that variable during a given season.

Table 7. Seasonal summary of relocations of radio-instrumented goats relative to terrain.

GOAT TELEMETRY STUDY - ADF&G JUNEAU, AK.
ANALYSIS OF GOAT DATA 12-77 TO 10-79
FILE NONAME (CREATION DATE = 10/30/79)

* CROSSTABULATION OF * *
TERRAIN BY SEASON
* *

COUNT 1/ / COL PCT	SEASON Spring	Summer	Fall	Winter	ROW TOTAL
TERRAIN	1.1	2.1	3.1	4.1	
1. SMOOTH	37	31	4	16	88
	22.8	26.5	11.4	25.0	23.3
2. BROKEN	125	86	31	48	290
	77.2	73.5	88.6	75.0	76.7
COLUMN TOTAL	162	117	35	64	378
	42.9	31.0	9.3	16.9	100.0

CHI SQUARE = 3.55342 WITH 3 DEGREES OF FREEDOM SIGNIFICANCE = 0.3139

NUMBER OF MISSING OBSERVATIONS = 42

1/ The upper and lower figure in each col. of the table represents the number and percentage, respectively, for that variable during a given season.

Table 8. Seasonal summary of relocations of radio-instrumented goats relative to habitat type.

* C R O S S T A B U L A T I O N S O F *
HABITAT BY SEASON
* *

HABITAT	COUNT [1] / COL PCT	Spring 1.	Summer 2.	Fall 3.	Winter 4.	ROW TOTAL
3. OLDGROWTH FOREST		23	2	9	13	47
		13.9	1.7	24.3	13.1	11.2
6. OLD GC CONIF		0	1	0	0	1
		0.	0.8	0.	0.	0.2
8. SECONDGROWTH CON		1	0	0	0	1
		0.6	0.	0.	0.	0.2
9. BRUSH		22	17	2	2	43
		13.3	14.4	5.4	2.0	10.2
10. MUSKEG		0	2	0	0	2
		0.	1.7	0.	0.	0.5
11. SUBALPINE		0	4	6	1	11
		0.	3.4	16.2	1.0	2.6
12. ALPINE		28	22	9	40	99
		16.9	18.6	24.3	40.4	23.6
13. ROCK-CLIFF		92	53	11	42	198
		55.4	44.9	29.7	42.4	47.1
14. ICE SNOW		0	13	0	1	14
		0.	11.0	0.	1.0	3.3
99.		0	4	0	0	4
		0.	3.4	0.	0.	1.0
COLUMN TOTAL		166	118	37	99	420
		39.5	28.1	8.8	23.6	100.0

CHI SQUARE = 129.55075 WITH 27 DEGREES OF FREEDOM SIGNIFICANCE = 0.0000

[1] The upper and lower figure in each col. of the table represents the number and percentage, respectively, for that variable during a given season.

Table 9. Seasonal summary of relocations of radio-instrumented goats relative to percent canopy cover.

CROSSTABULATION OF RCANOPY % CANOPY COVER BY SEASON

RCANOPY % CANOPY COVER	SEASON Spring	Summer	Fall	ROW TOTAL
1. 0-10.	97 / 84.3	57 / 78.1	9 / 69.2	163 / 81.1
2. 11-20.	2 / 1.7	1 / 1.4	0 / 0.	3 / 1.5
3. 21-30.	1 / 0.9	1 / 1.4	0 / 0.	2 / 1.0
4. 31-40.	1 / 0.9	2 / 2.7	3 / 23.1	6 / 3.0
5. 41-50.	4 / 3.5	3 / 4.1	1 / 7.7	8 / 4.0
6. 51-60	3 / 2.6	2 / 2.7	0 / 0.	5 / 2.5
7. 61-70	2 / 1.7	0 / 0.	0 / 0.	2 / 1.0
8. 71-80	1 / 0.9	3 / 4.1	0 / 0.	4 / 2.0
9. 81-90	1 / 0.9	2 / 2.7	0 / 0.	3 / 1.5
10. 91-100	1 / 0.9	2 / 2.7	0 / 0.	3 / 1.5
COLUMN TOTAL	113 / 57.2	73 / 36.3	13 / 6.5	201 / 100.0

CHI SQUARE = 28.25257 WITH 18 DEGREES OF FREEDOM SIGNIFICANCE = 0.0550

NUMBER OF MISSING OBSERVATIONS = 219

1/ The upper and lower figure in each col. of the table represents the number and percentage, respectively, for that variable during a given season.

Goat relocations relative to percent snow cover are presented in Table 10. As with percent canopy cover this attribute wasn't recorded until spring 1979, resulting in similar limitations on sample size and seasonal distribution. Goat distribution relative to percent snow cover, varied significantly ($P<.01$) between seasons. Use of areas free of snow increased from spring through fall.

Seasonal habitat use by goats was evaluated for differences between sexes. The following significant differences ($P<.05$) were observed: summer elevational distribution (females were generally lower); summer distribution with respect to slope (males used steeper slopes); winter distribution with respect to terrain (males used smoother terrain); spring, summer, and winter distribution with respect to aspect (but there were no clear trends discernible); summer distribution with respect to snow cover (females used more snow-free areas); spring and winter distribution relative to habitat type (males inhabited more alpine and forest types while females utilized rock-cliff habitats more).

DISCUSSION

During this report period, we captured 3 times the number of goats than were captured last year. Estimated flight time averaged about 1 1/2 hours per goat. This was about 1/2 hour more per goat than last year. Increased flight time was related to two factors: pilot inexperience and working during spring and summer. Pilot expertise is extremely important in this work. Our experience indicates that goats are captured most efficiently during winter, when utilizing a helicopter. The drawback to this is that our winter sample is biased heavily toward goats wintering in the open alpine. Although it is possible to capture goats from the ground, this technique is much more dependent on chance and is expensive in man hours.

Dosages of M99 were increased to 3.5 mg during this work, compared to the 2.5 mg used last year. The result was a decrease in average time of immobilization from 15 minutes to 12 minutes. This amount of time, although an improvement, is still a problem since a goat can move a considerable distance and perhaps injure itself in a fall if immobilization occurs in rugged or steep terrain.

Telemetry procedures continued to become more efficient as we gained experience with the equipment and flying techniques. The paired antenna arrangement on opposite wings proved very efficient in locating animals and the scanner increased our ability to find an animal which had moved significantly from its last location.

One particular problem encountered this year was that of losing instrumented goats to hunters. We lost a total of four goats, including three out of nine instrumented goats in the Herbert-Mendenhall site. During the previous year no instrumented animals were taken. The major difference between years, presumably, was weather. Fall 1978 was characterized by low overcast, rain, and wind, while fall 1979 was milder and compara-

Table 10. Seasonal summary of relocations of radio-instrumented goats relative to percent snow cover.

* C R O S S T A B U L A T I O N O F * *
SNOCOVER % SNOW COVER BY SEASON
* *

	SEASON				
COUNT 1/ / COL PCT	Spring	Summer	Fall	Winter	ROW TOTAL
	1.	2.	3.	4.	
SNOCOVER					
1.	43	69	19	2	133
0 -25	33.9	63.9	90.5	100.0	51.6
2.	30	17	0	0	47
	23.6	15.7	0.	0.	18.2
3.	30	13	2	0	45
26-50	23.6	12.0	9.5	0.	17.4
4.	7	2	0	0	9
51-75	5.5	1.9	0.	0.	3.5
5.	17	7	0	0	24
76-100	13.4	6.5	0.	0.	9.3
COLUMN TOTAL	127	108	21	2	258
	49.2	41.9	8.1	0.8	100.0

CHI SQUARE = 38.72977 WITH 12 DEGREES OF FREEDOM SIGNIFICANCE = 0.0000

NUMBER OF MISSING OBSERVATIONS = 162

1/ The upper and lower figure in each col. of the table represents the number and percentage, respectively, for that variable during a given season.

tively more conducive to mountain hiking. Aside from seriously impacting our study, we also became concerned about the possibility of overharvesting goats at Herbert-Mendenhall. If we considered the taking of marked animals a direct index of harvest pressure, we would have a 33 percent harvest. It is unlikely that the harvest was this high but, nevertheless, it offered strong evidence that a high harvest may have been occurring. As a result, an emergency closure of this area was put into effect on October 25, 1979. It can be anticipated that as interest in goat hunting in the Juneau area increases, the Department will have to reevaluate its present management policy.

Several seasonal home range patterns were presented. Individuality was considered important in accounting for differences in home range patterns. Although area figures were presented for 1978 data, we considered it inappropriate to attempt this because of the difficulty of calculating surface areas in extreme three-dimensional topography. As far as home range differences between sexes, we consider our sample too small and individual differences too great to develop any specific trends. We have observed, however, that during most of the year adult billies often remained alone or occurred together in small billy groups isolated from most nannies and kids. Stroller White Mountain in the Herbert-Mendenhall site was an example of an area used primarily by adult males. Our observations of marked goats during the past year indicated a lack of integrity within goat groups. None of our marked individuals appeared to develop permanent associations with other individuals outside of nanny-kid relationships.

Results of seasonal habitat use by goats were summarized by attribute. During spring, goats generally moved to lower elevation, steep, southerly exposed rock-cliff, brush, and forest habitats. We presume there is a direct response at this time to the appearance of new green vegetation. Throughout summer, goats dispersed to a variety of habitat types with an increase in elevation and greater use of northerly exposures. The most heavily used habitat types at this time were rock-cliff and alpine habitats. During this period more than any other, food is abundant and widely distributed throughout the area and goats responded accordingly. During fall, goats moved down in elevation but still utilized northerly exposures and inhabited forest, alpine, subalpine, and rock-cliff habitats. Because of marginal flying weather during both falls, our sample was small and our evaluation of habitat use correspondingly limited. Throughout winter, goats utilized a wide range of elevations, concentrating at mid-elevations and southerly exposures on alpine and rock-cliff habitats with less use of forested habitat.

Goat use of most habitat attributes varied significantly ($P<.01$) between seasons, indicating a high degree of seasonality in goat hatitat selection. During all seasons goats utilized broken terrain much more than smooth terrain, suggesting perhaps a year-round preference for escape terrain. The yearly average for slope used was in excess of 30 degrees, also indicating a tendency toward using steep, inaccessible

country. We have yet to examine a complete yearly cycle of use relative to snow cover and canopy cover. The data we have indicate increasing use of snow-free areas from spring through fall, obviously corresponding to snow melt. Relative to canopy cover, most relocations occurred in habitats without canopies. As we increase our sample, we will evaluate canopy in relation to specific habitat types such as old-growth forest and subalpine. Although we briefly outlined differences in habitat use between sexes, we recognize the limitations of these data because of small sample size and the high degree of individual variability.

In order to better evaluate the potential impact of forest management on mountain goat habitat, goat use of forested habitat has been of particular interest in the development and implementation of this investigation. Our initial assumption was that by instrumenting goats with radios we would be able to record their use of all available habitat types, even those, such as forests, where goats were not visible. The results of our investigation to date indicate that some goats do utilize the forest, mostly during fall, winter, and spring. This was particularly the case with three animals.

Several problems were encountered in our approach to goat forest use. Based on ground observations and local reports, we considered there may have been more goats utilizing forested habitat than were indicated by our data. One possible bias was that, up until this year, all our instrumented goats were captured during winter in open alpine areas. If there are several subpopulations of goats, some more inclined toward alpine habitat and some toward forest habitat, we were certainly biasing our sample toward alpine goats. Also, all of our captures and telemetry relocations were conducted in good flying weather. Perhaps during periods when the weather prohibited us from flying, goats may have made greater use of one habitat type than another.

We considered several approaches to circumvent the above problems. One was to capture goats on their summer range during the late spring and summer. By doing this we improved our chances of capturing some goats which wintered in the forest. The results of this work are unknown at this time. During this report period we also entered into a three-way cooperative agreement with the Juneau Forestry Sciences Lab (Pacific Northwest Forest and Range Experiment Station, USDA Forest Service) and the College of Forest Resources, University of Washington. As a result of this agreement, a general ground reconnaissance of winter goat range was begun during winter 1979 (Fox 1979a). The results of this work indicated that ground-based radio-tracking and observations of goats inhabiting the forest were not practical. Having learned this, we then attempted to derive information about forest use by goats from indirect methods, primarily pellet-group counts. The results of this work indicated that goats do make extensive use of some forest sites. Goat use of forests was most abundant in steep, broken terrain and became less abundant in steep, smooth terrain and less steep smooth terrain, respectively (Fox 1979b).

Our knowledge of goat habitat use is increasing. However, we recognize that substantial differences in habitat use exist between seasons, individuals and geographical areas. Our major emphasis at this point is directed at winter habitat use by mountain goats. We are especially interested in better defining the importance of forested habitat to wintering goat populations.

ACKNOWLEDGEMENTS

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Joe Fox was involved in most of the ground work associated with this program as well as capturing several goats. Charlie Wallmo and Matt Kirchhoff cooperated in all phases of this investigation and contributed greatly to this project.

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PREPARED BY:

John W. Schoen
Game Biologist

APPROVED BY:

Director, Division of Game

SUBMITTED BY:

Nathan P. Johnson
Region I Research/Management Coordinator

Research Chief, Division of Game

Appendix I. Sample data form and data code for mountain goat telemetry locations. loaded _____

Mountain Goat and Black-tailed Deer Location Data

Header Information

Animal | Survey Type | Observer | Date (yr.,mo.,day) | Julian Date

Weather Data

Air Temp. | Wind Dir.(deg.) | Wind Speed(mph) | Clouds(%) | Precip.

+- F

Location Data

Number | Elev.(ft) | Habitat | Canopy(%) | Terrain | Slope(°) | Time(hr)

Snow Cover(%) | Snow Depth(in) | Type | Group Size | #M | #F | #Ad. | #Juv.

Accuracy | Animal Location | Aspect

Appendix I. Cont.

Black-Tailed Deer/Mountain Goat Telemetry

DATA CODES

Animal	Survey Type	Observer	Clouds	Precipitation
1=goat 2=deer	1=aerial 2=ground	1=John 4=Jack 2=Matt 5=Charlie 3=Nate 6=Gordon 7=Dave	% Cover	1=no rain 2=intermittant rain 3=steady rain 4=snow

Wind Direction	Wind Velocity
° Magnetic 0, Variable=111	MPH

Habitat
01=Beach
02=Beach fringe (old growth forest less than 100 yards from beach)
03=Old growth conifer forest
04=Early successional clearcut (0-15 years)
05=Mid successional clearcut (16-30 years); deciduous dominating
06=Mid successional clearcut (16-30 years); conifers dominating
07=Even aged regrowth (31-200 years); deciduous dominating
08=Even aged regrowth (31-200 years); conifers dominating
09=Deciduous brush (slide or avalanche chute)
10=Muskeg
11=Subalpine
12=Alpine tundra
13=Rocky outcrop; cliff face
14=Permanent ice-snowfield
15=Frozen lake-river

Canopy	Terrain	Snow Cover (%) and Depth (in)	Snow Type
% cover	1=smooth 2=broken	(in general vicinity of animal	0=no snow 1=soft 2=hardpack 3=crust

Accuracy
1=accurate location within 25 acres-habitat accurate
2=accurate location within 25 acres-habitat uncertain
3=accurate location within 100 acres-habitat uncertain

Animal Location (from map)
First 3 values are the X (EW) coordinate
Last 3 values are the Y (NS) coordinate

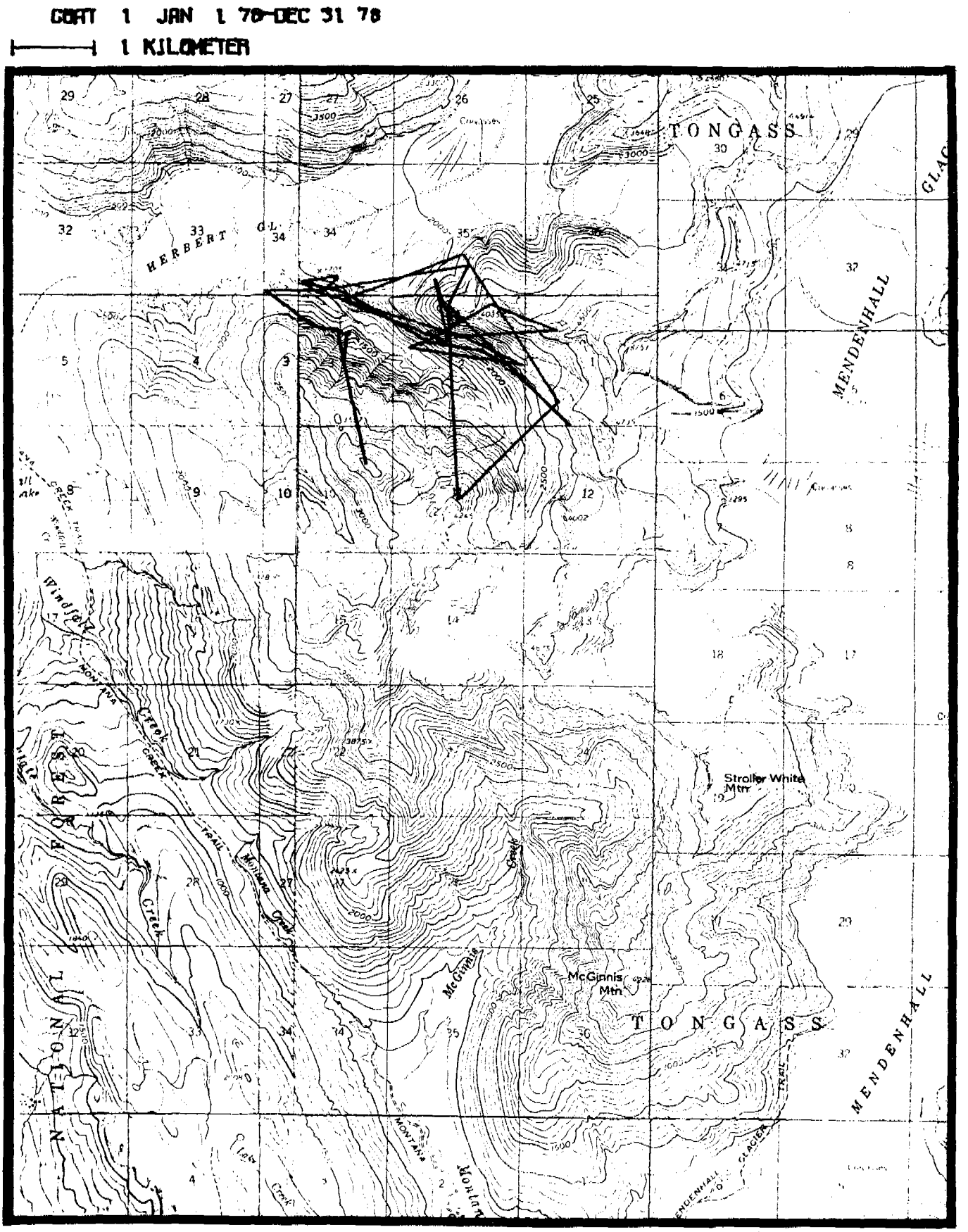
Aspect (from map)

01=Flat	04=E	07=SW	10=Ridgetip
02=N	05=SE	08=W	
03=NE	06=S	09=NW	

Slope
degrees-#contour lines/grid
1-15 = 1-2
16-30 = 3-5
31-45 = 6-9
46+ = 10+

Group Size
# of individuals observed in each class within group

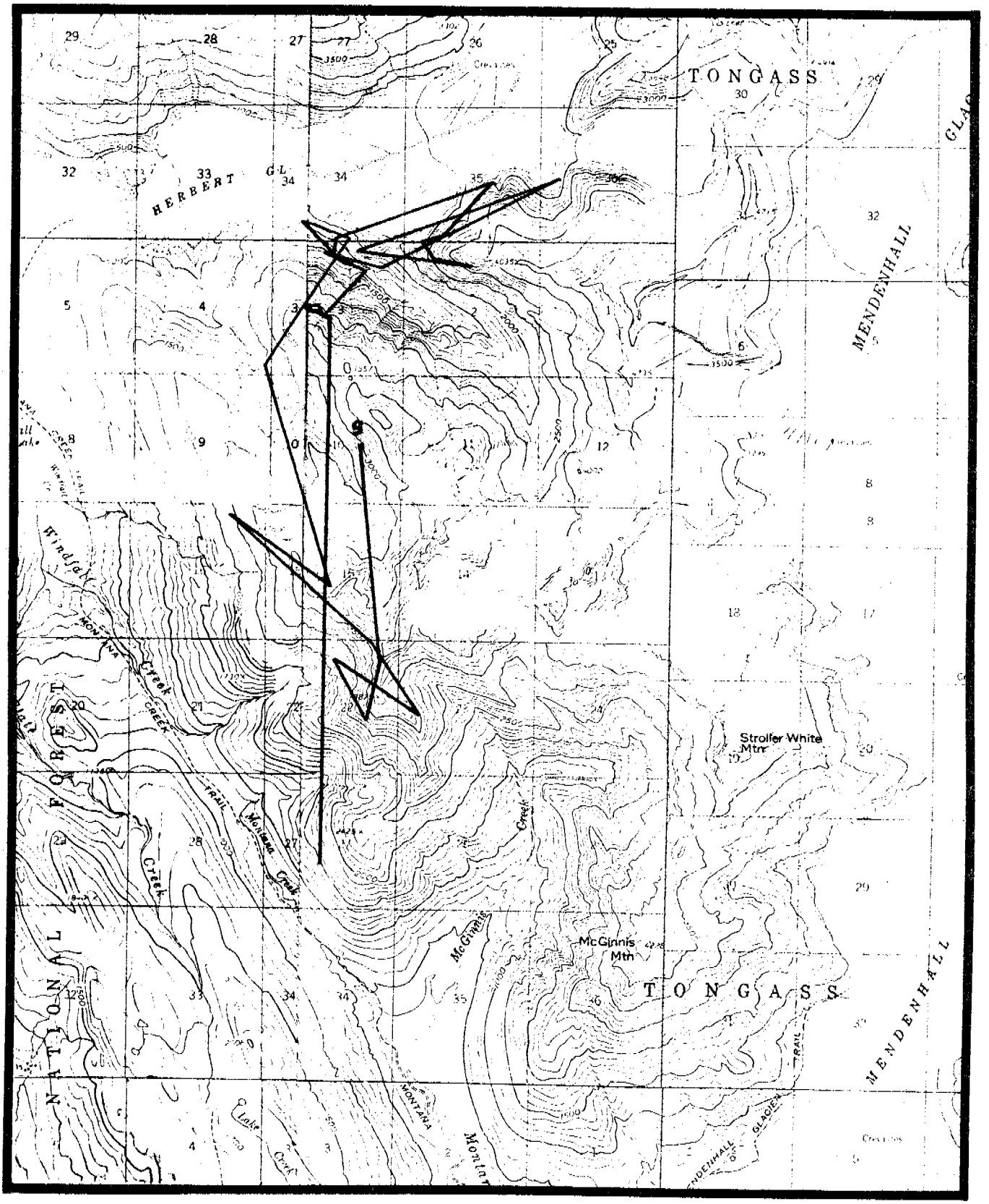
Appendix II. Plots of movements for radio-instrumented mountain goats from January 1978 through October 1979.



Appendix II. Cont.

COAT 2 JAN 1 78-DEC 31 78

1 KILOMETER



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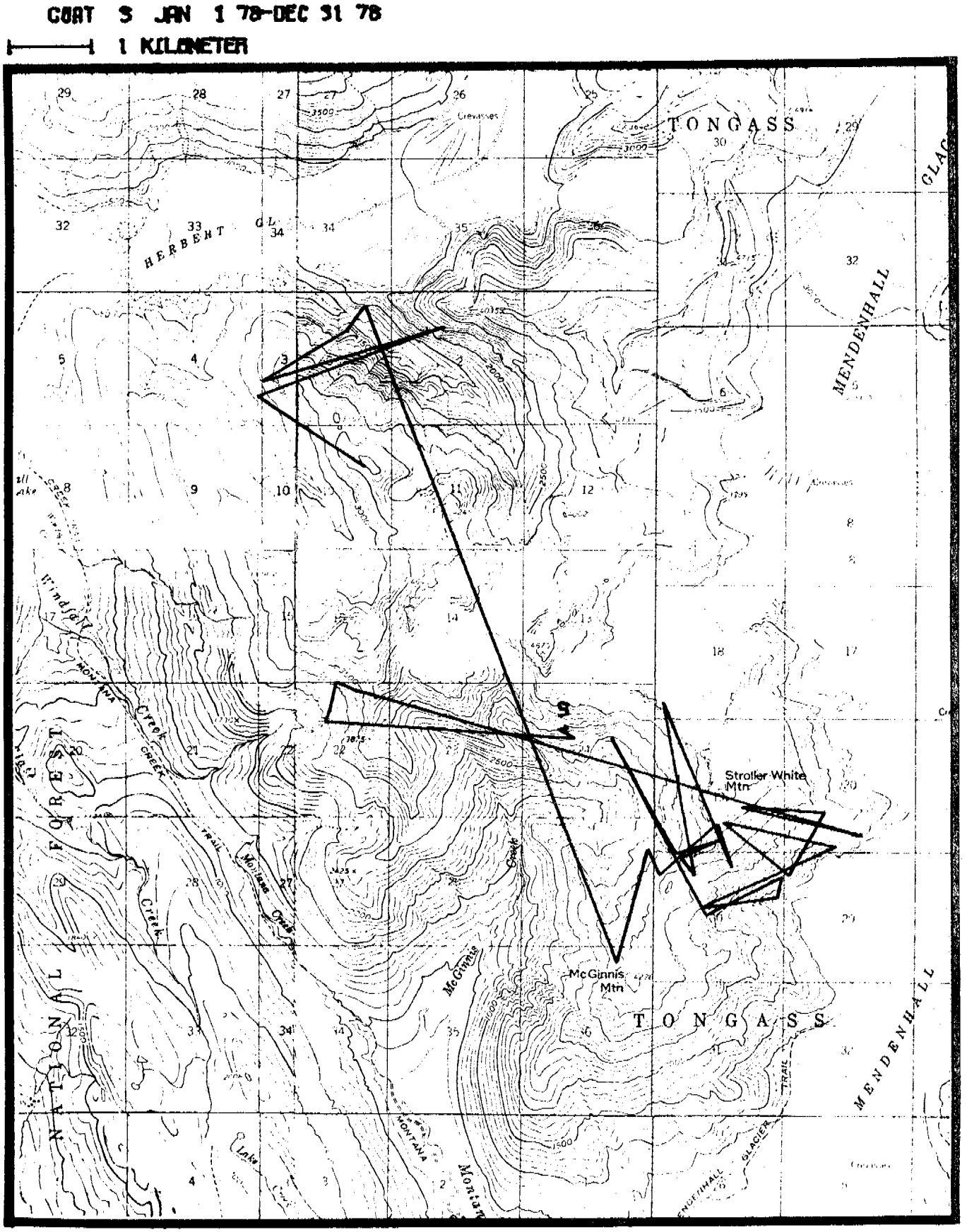

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COAT 4 JAN 1 78-DEC 31 78

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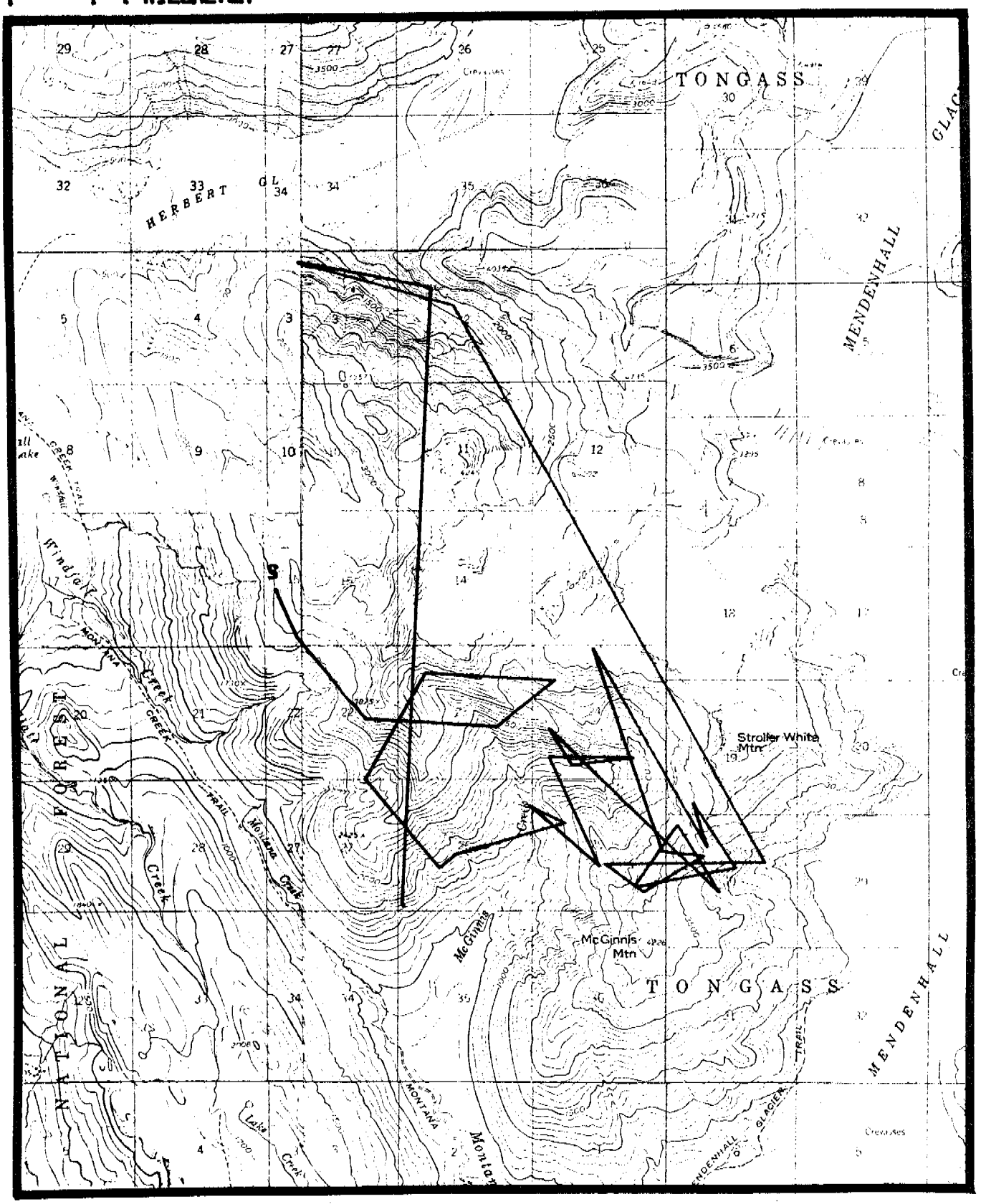

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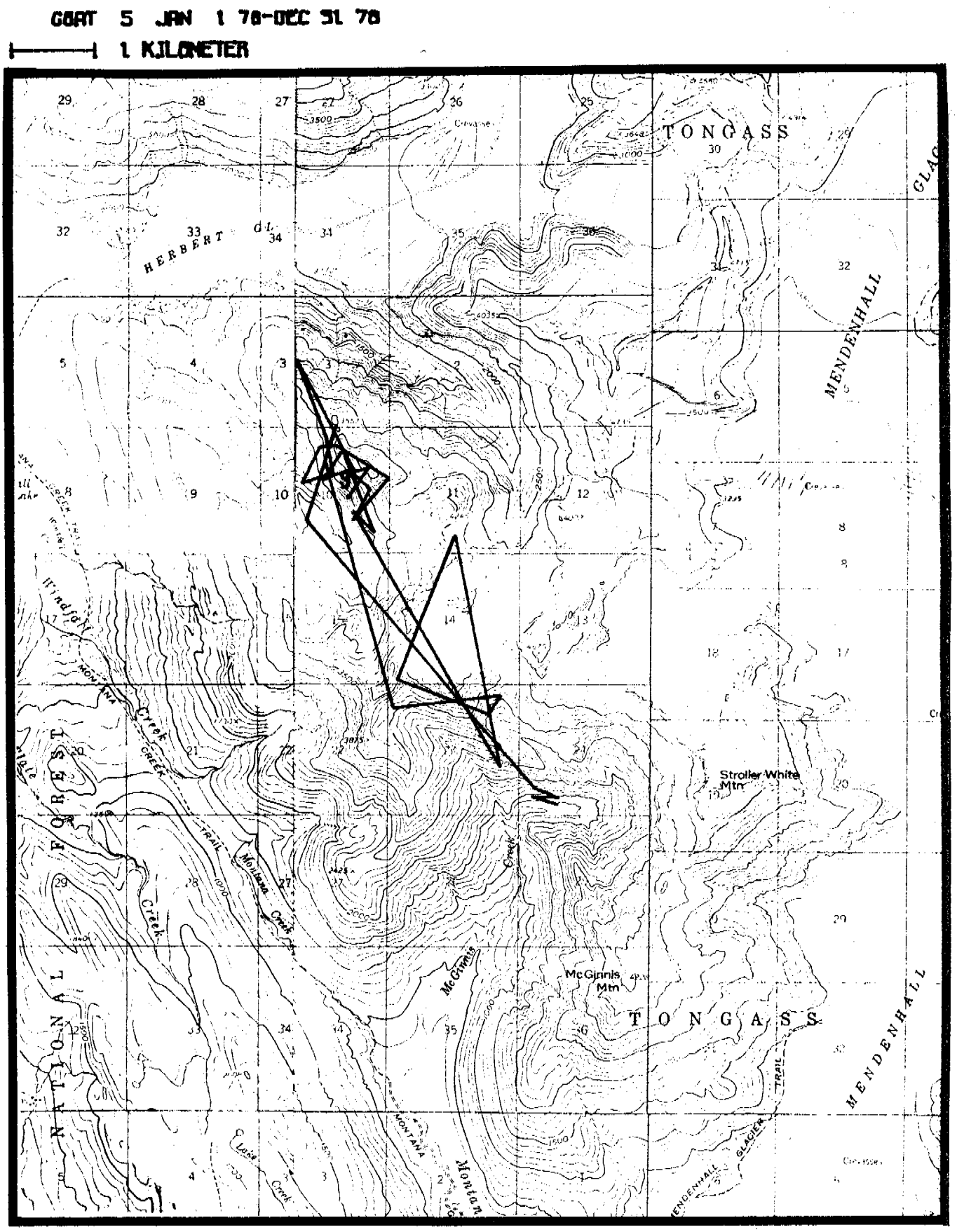

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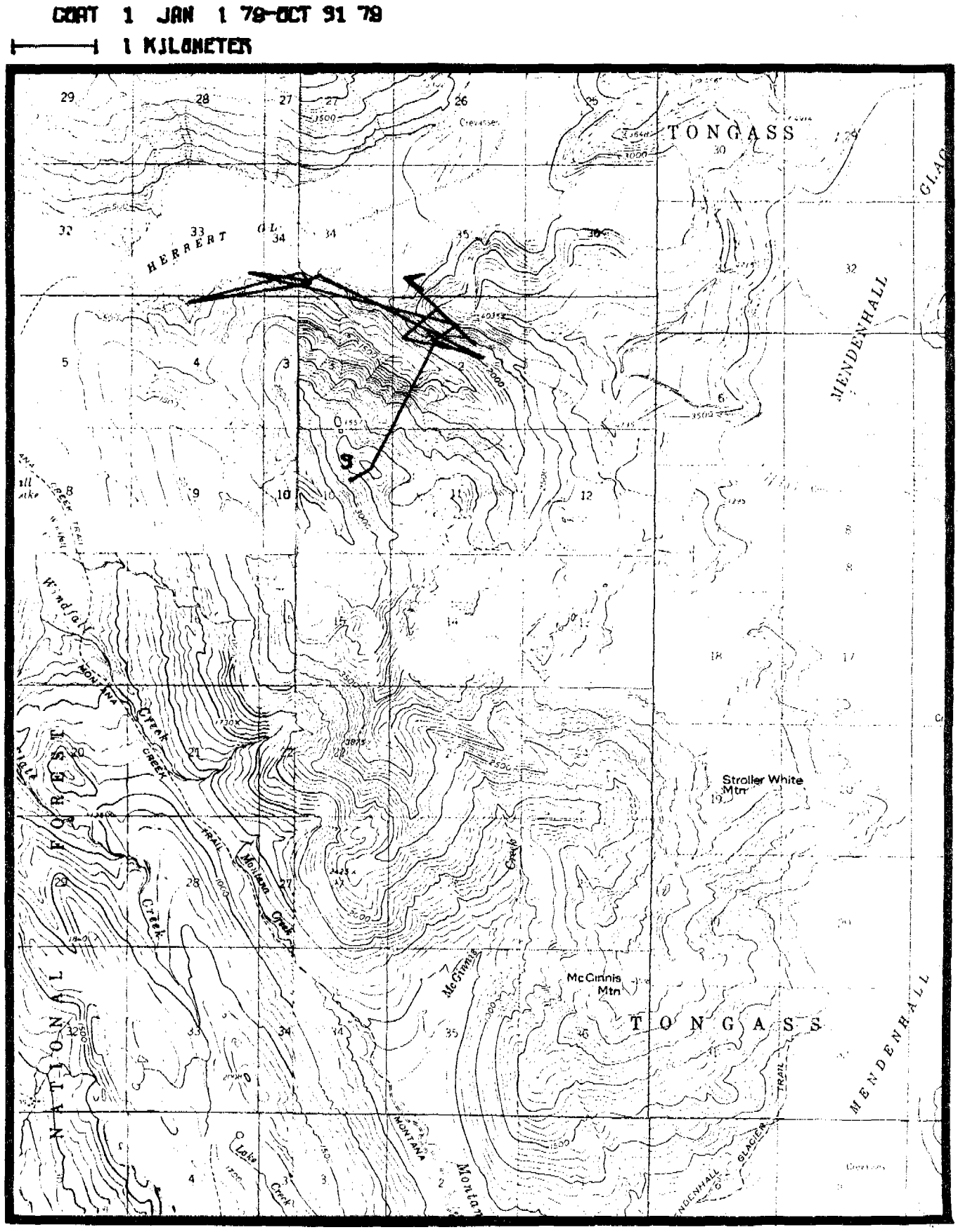
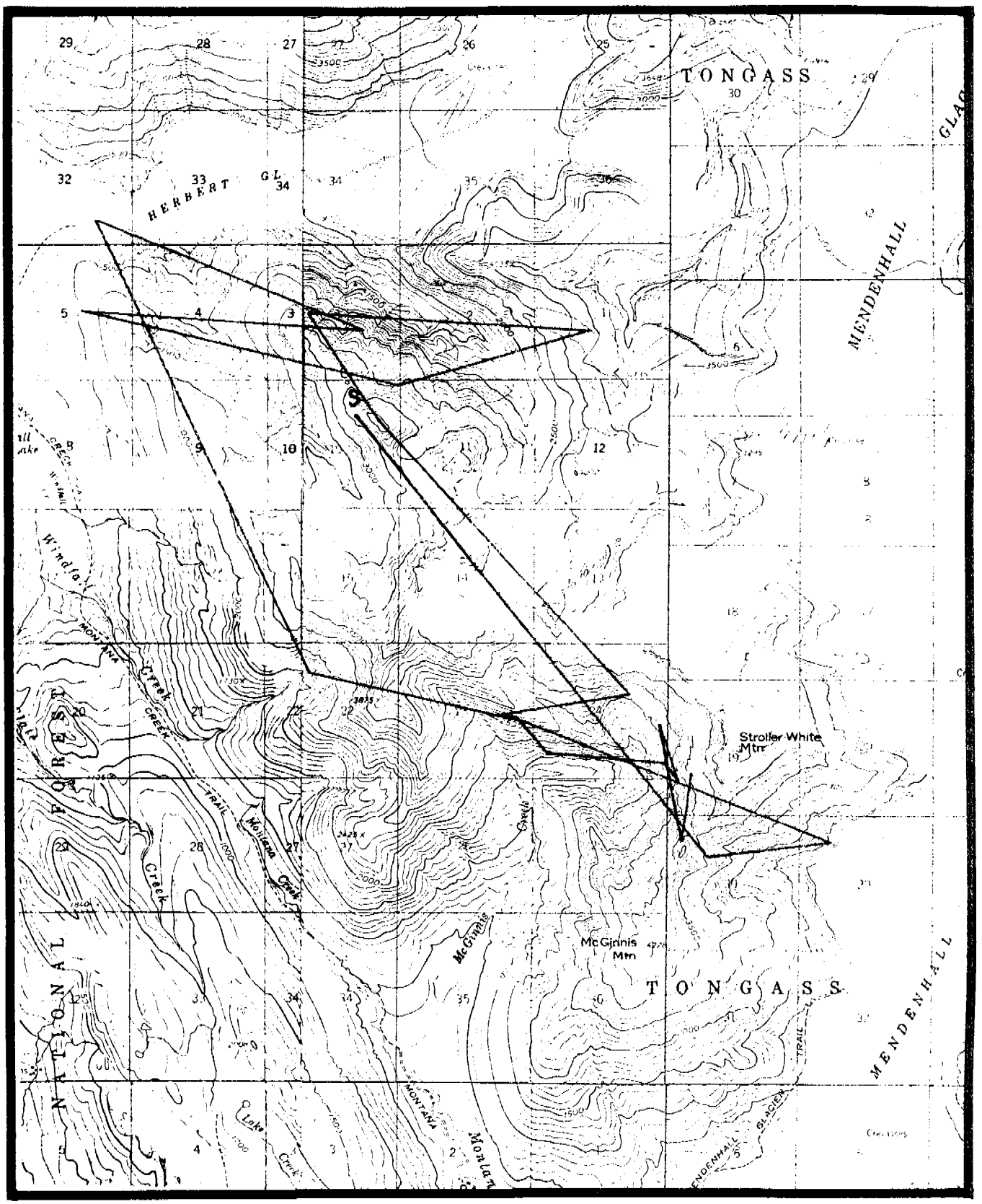


Appendix II. Cont.

COAT S JAN 1 79-OCT 31 79

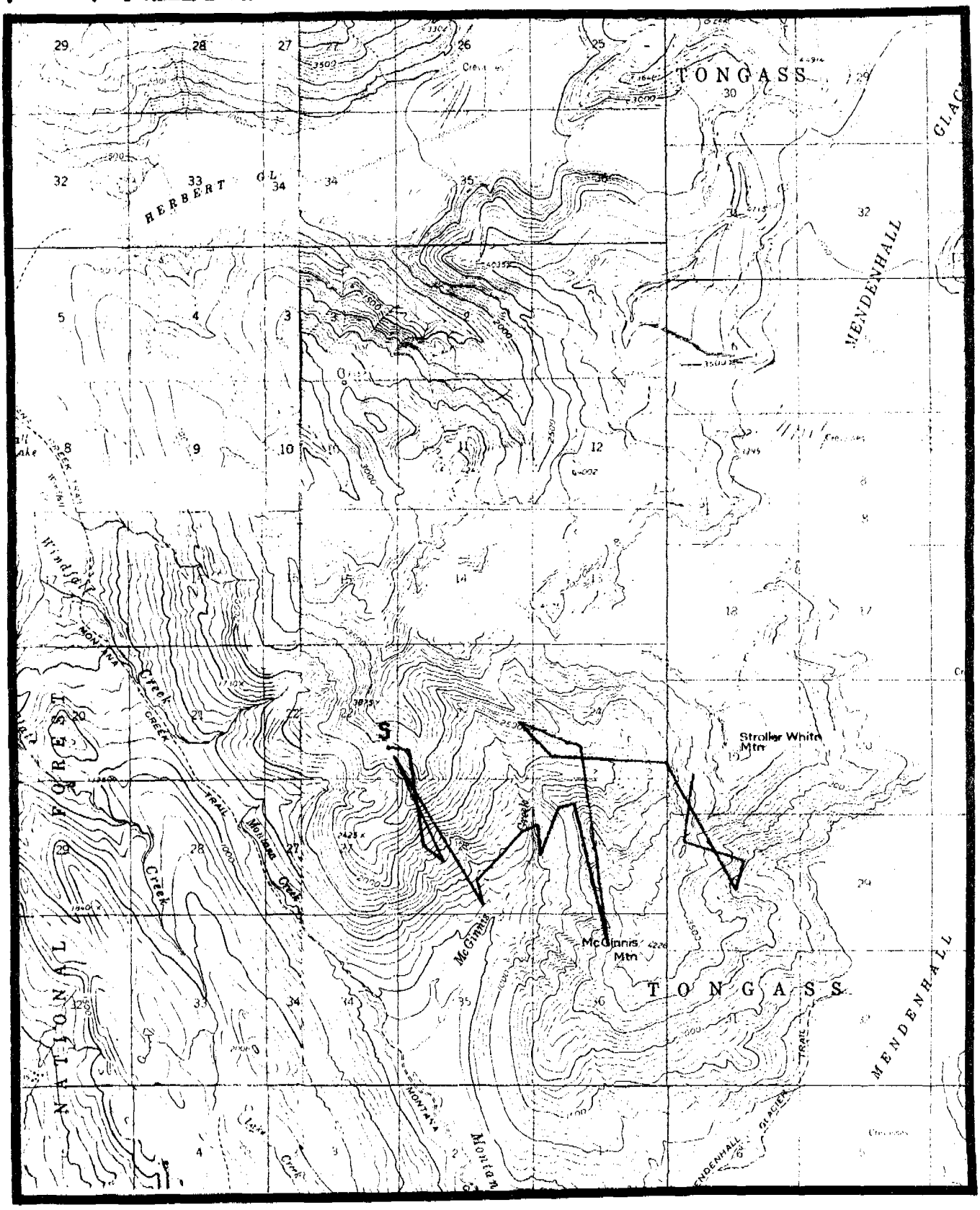
1 KILOMETER



Appendix II. Cont.

COAT 4 JAN 1 79-OCT 31 79

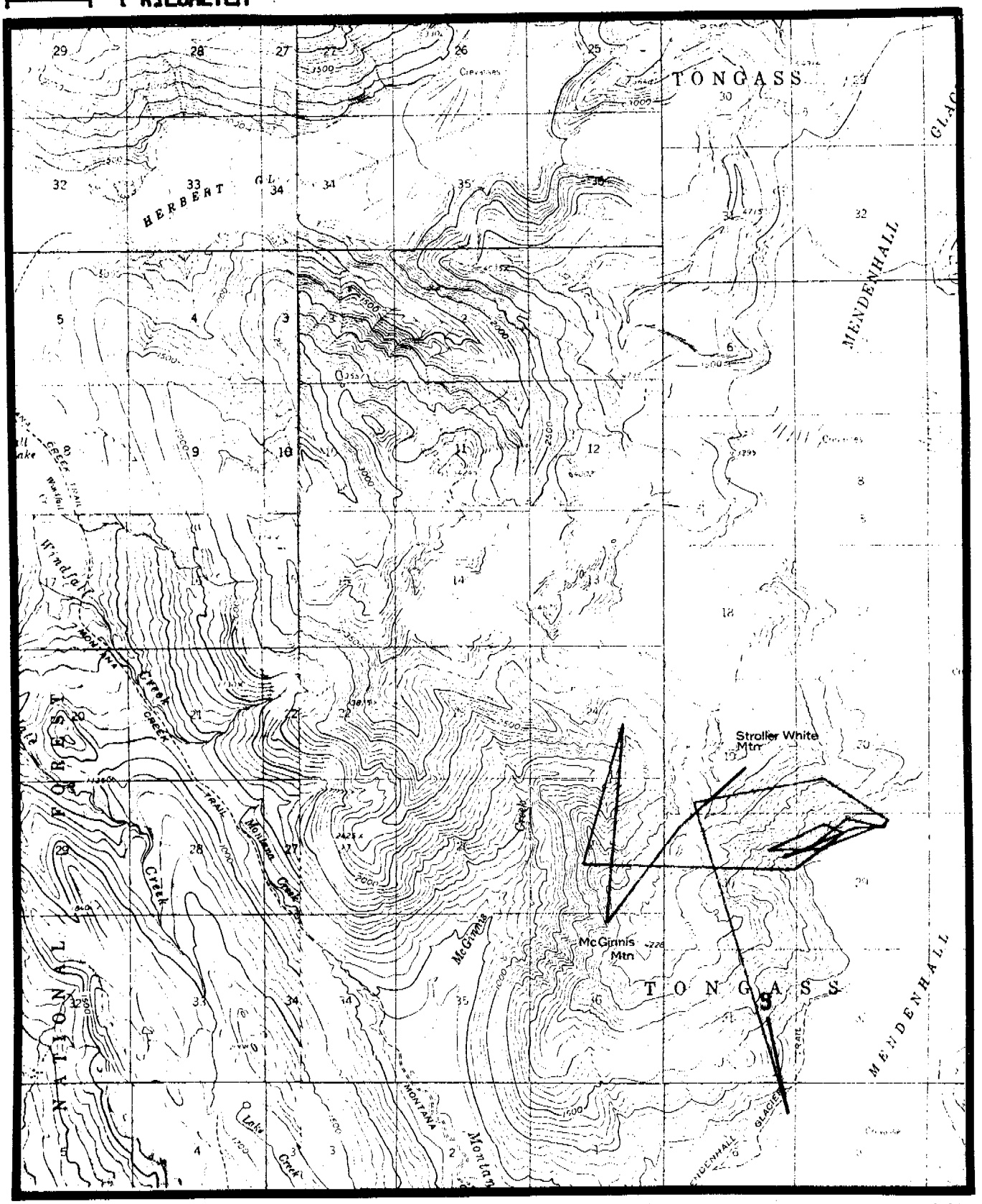
1 KILOMETER



Appendix II. Cont.

COAT 11 JAN 1 78-OCT 31 78

1 KILOMETER



Appendix II. Cont.

COAT 78 JAN 1 78-OCT 31 78

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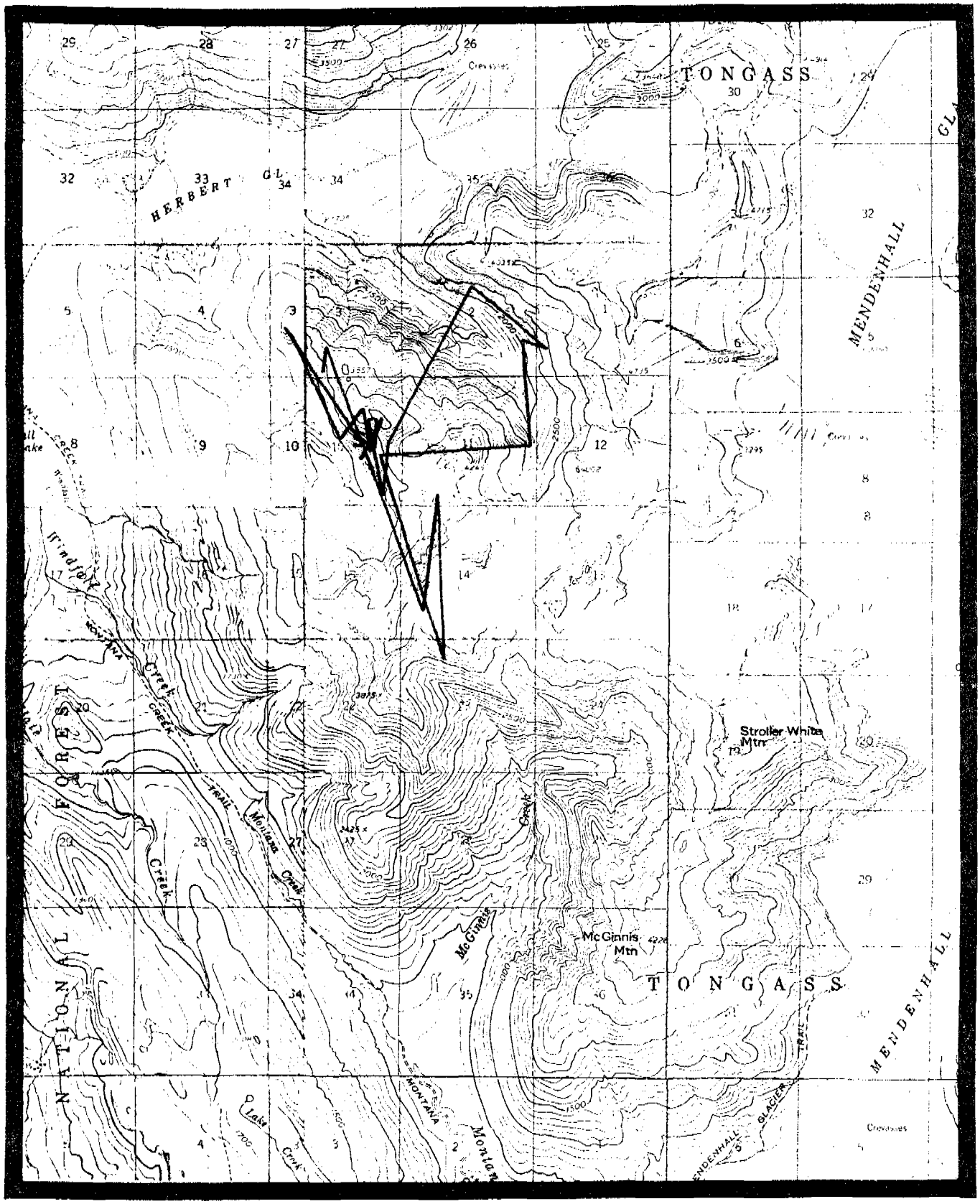

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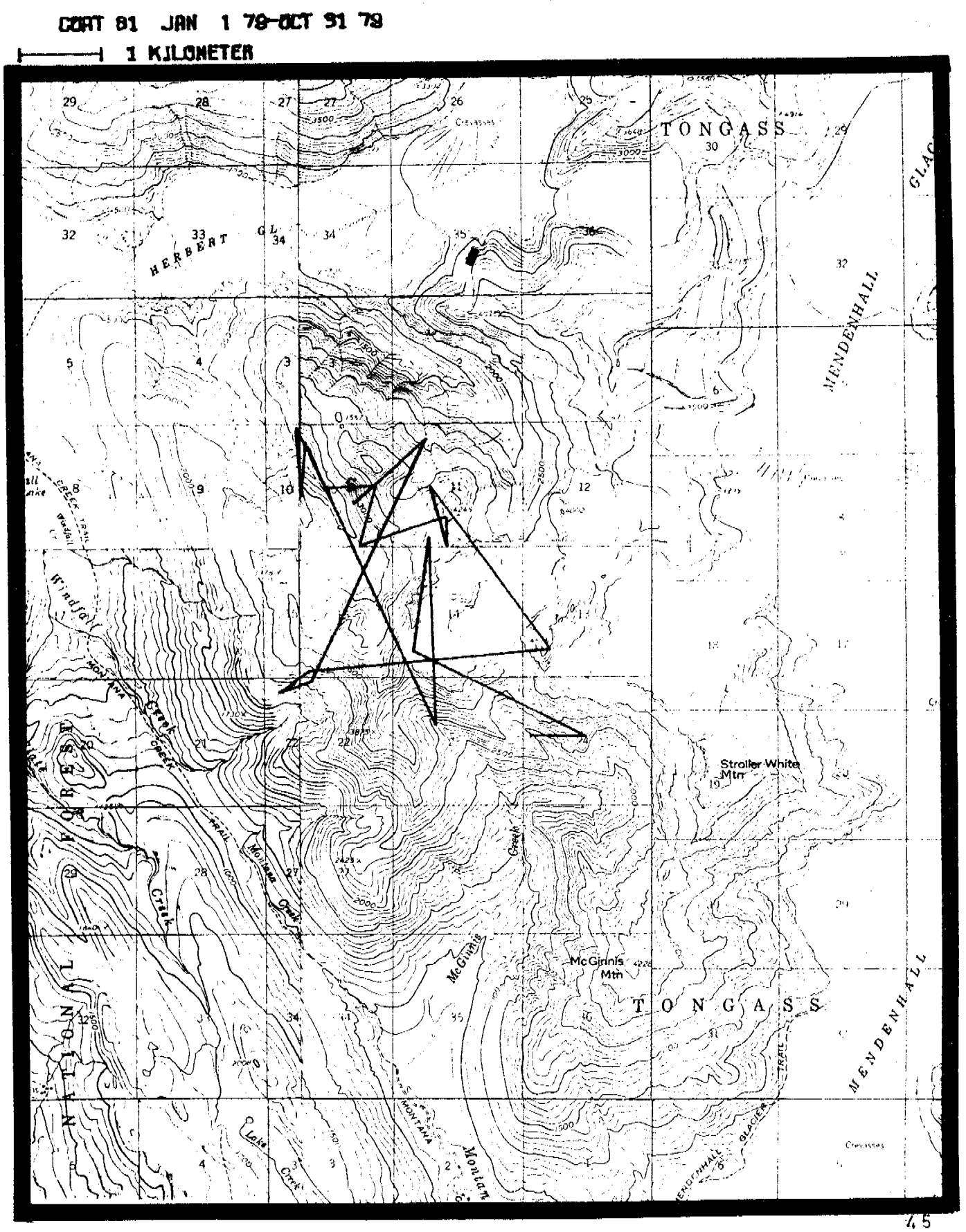

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COAT 78 JAN 1 78-OCT 31 78

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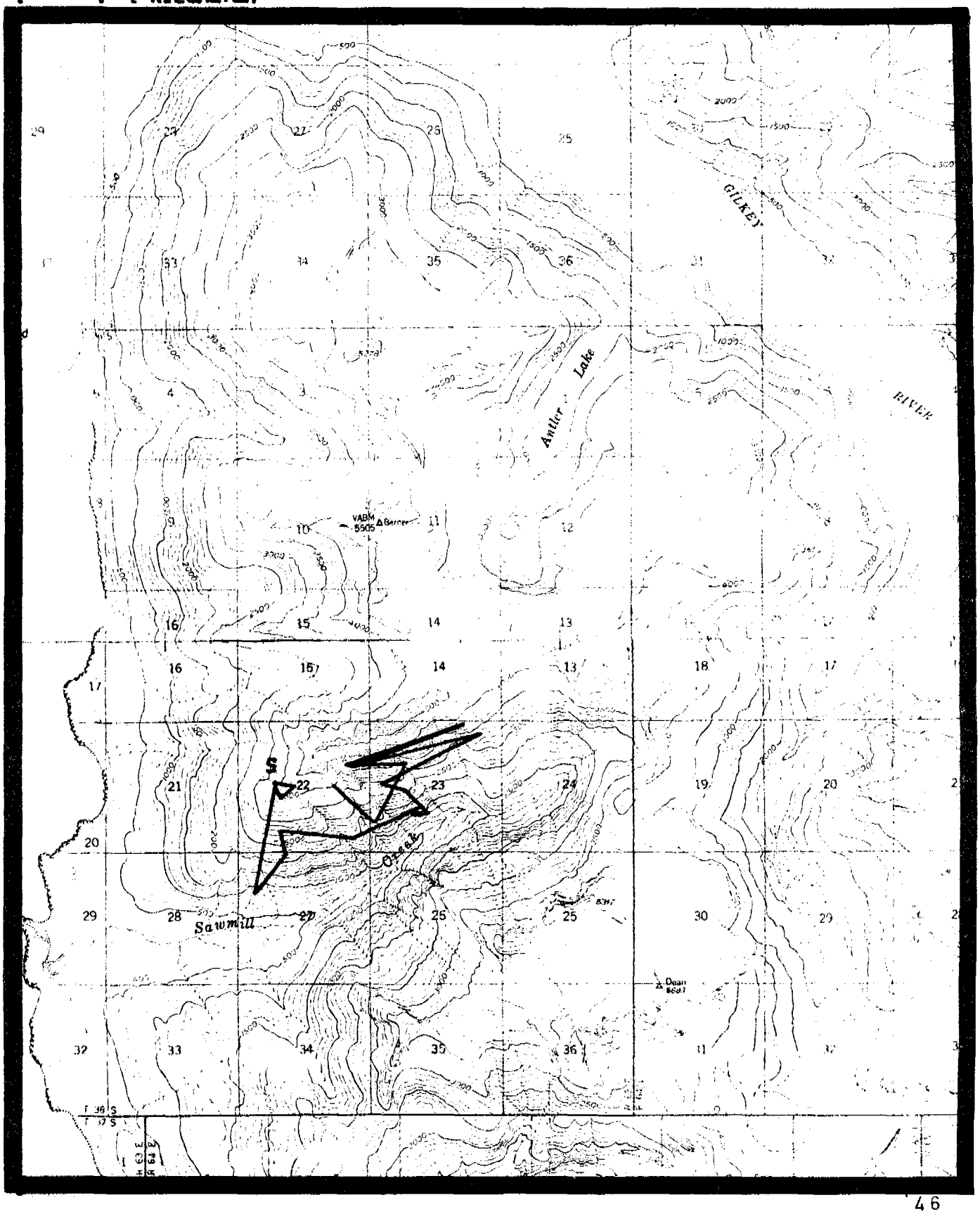

Appendix II. Cont.

COAT 7 JAN 1 78-OCT 31 78

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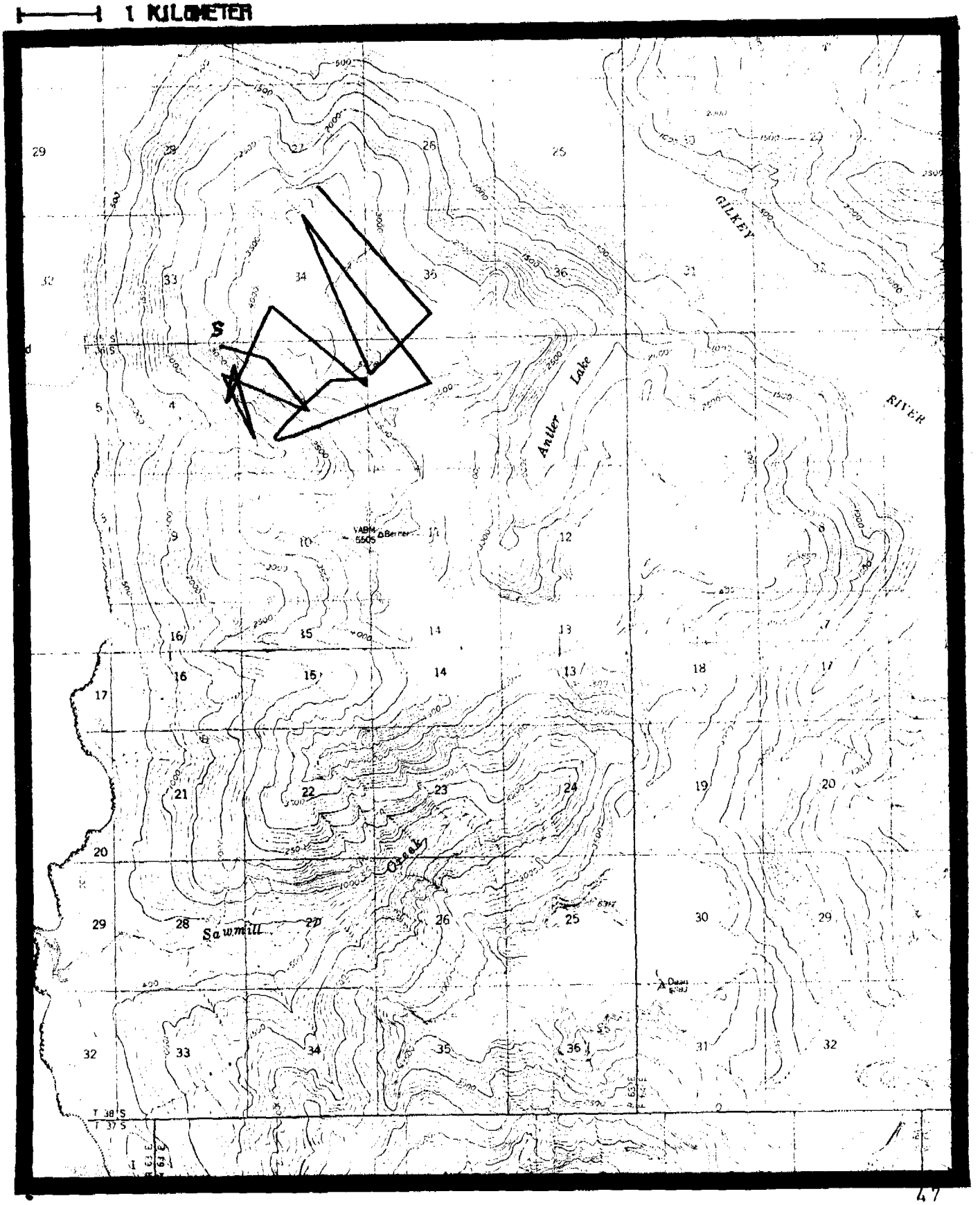

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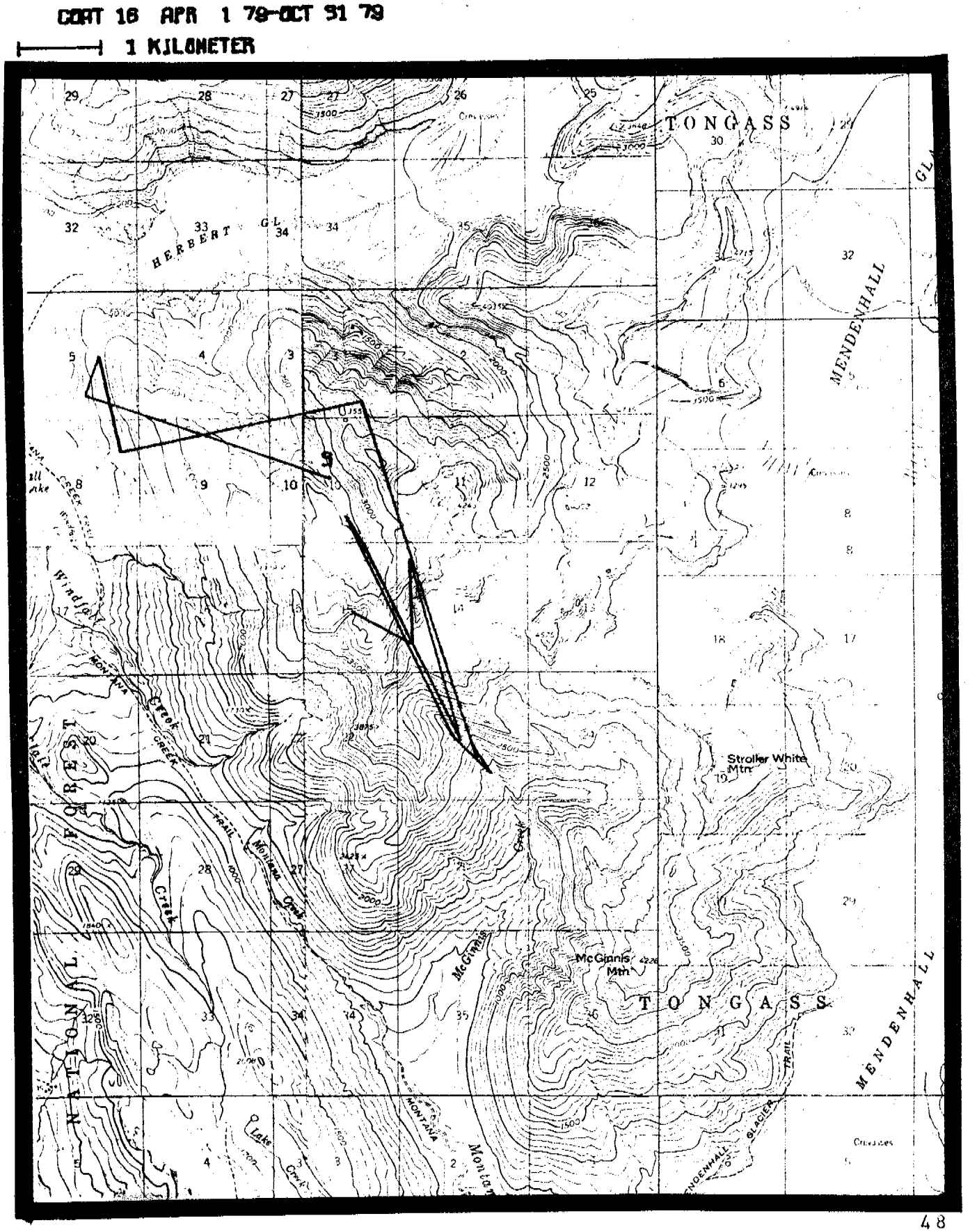

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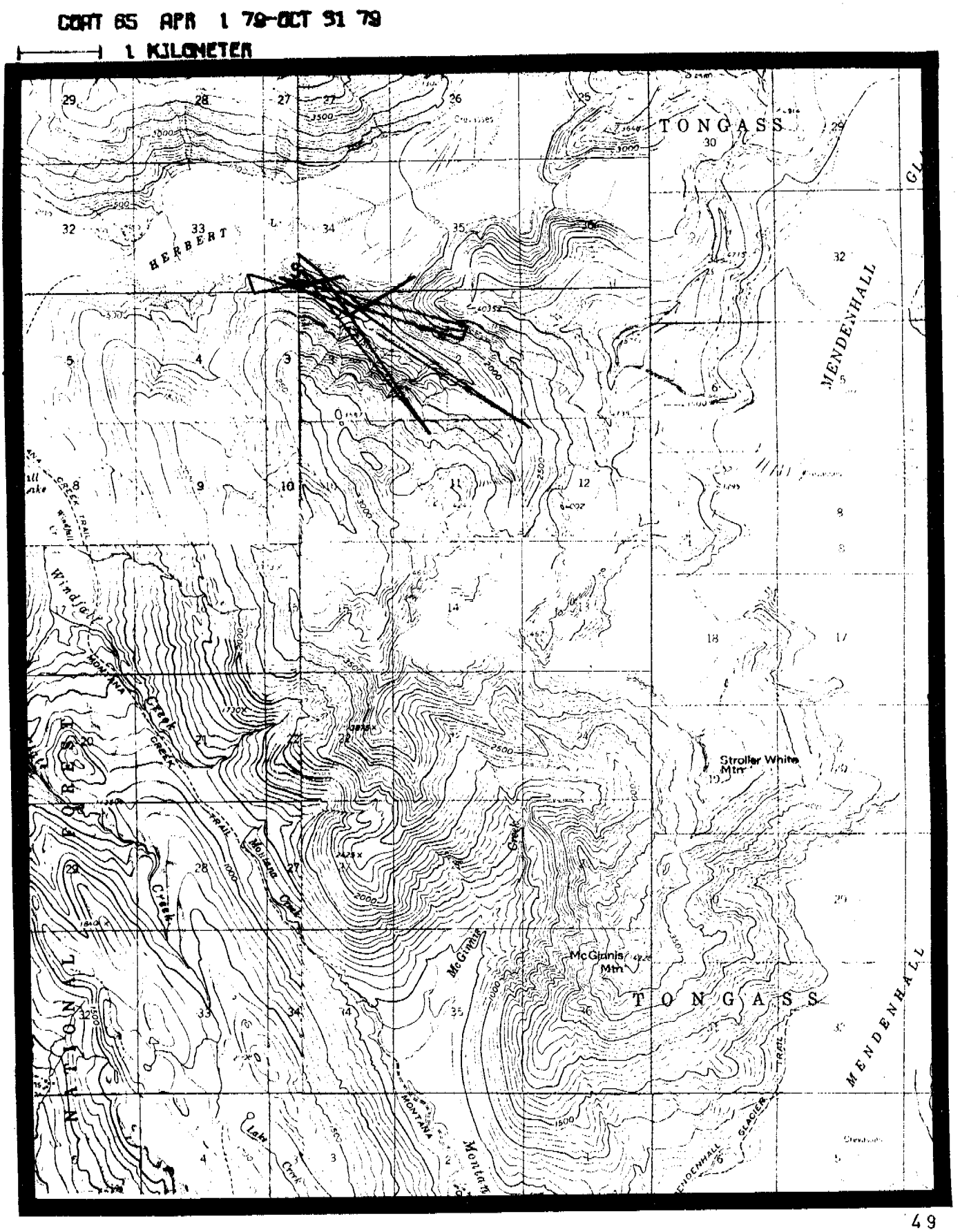

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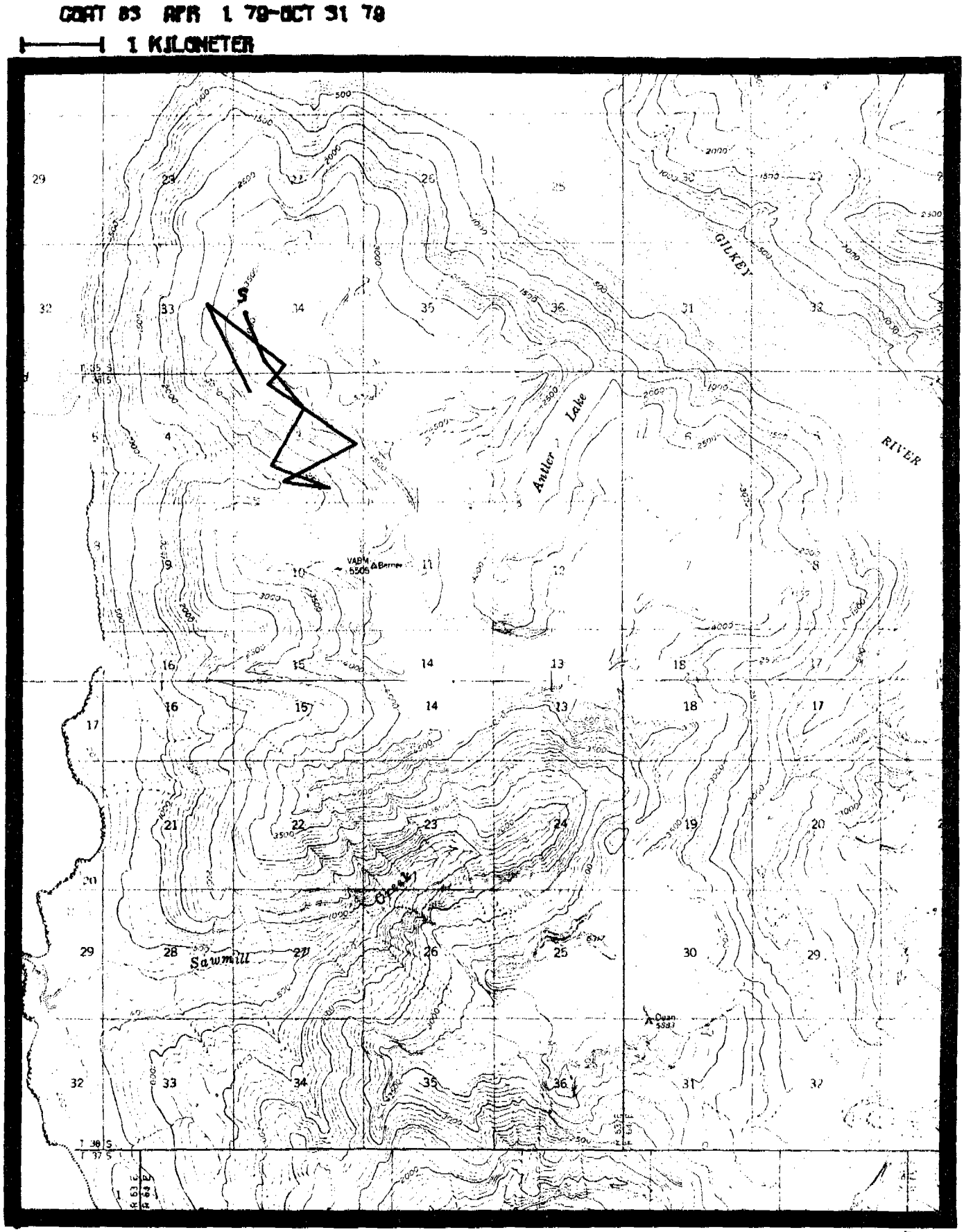

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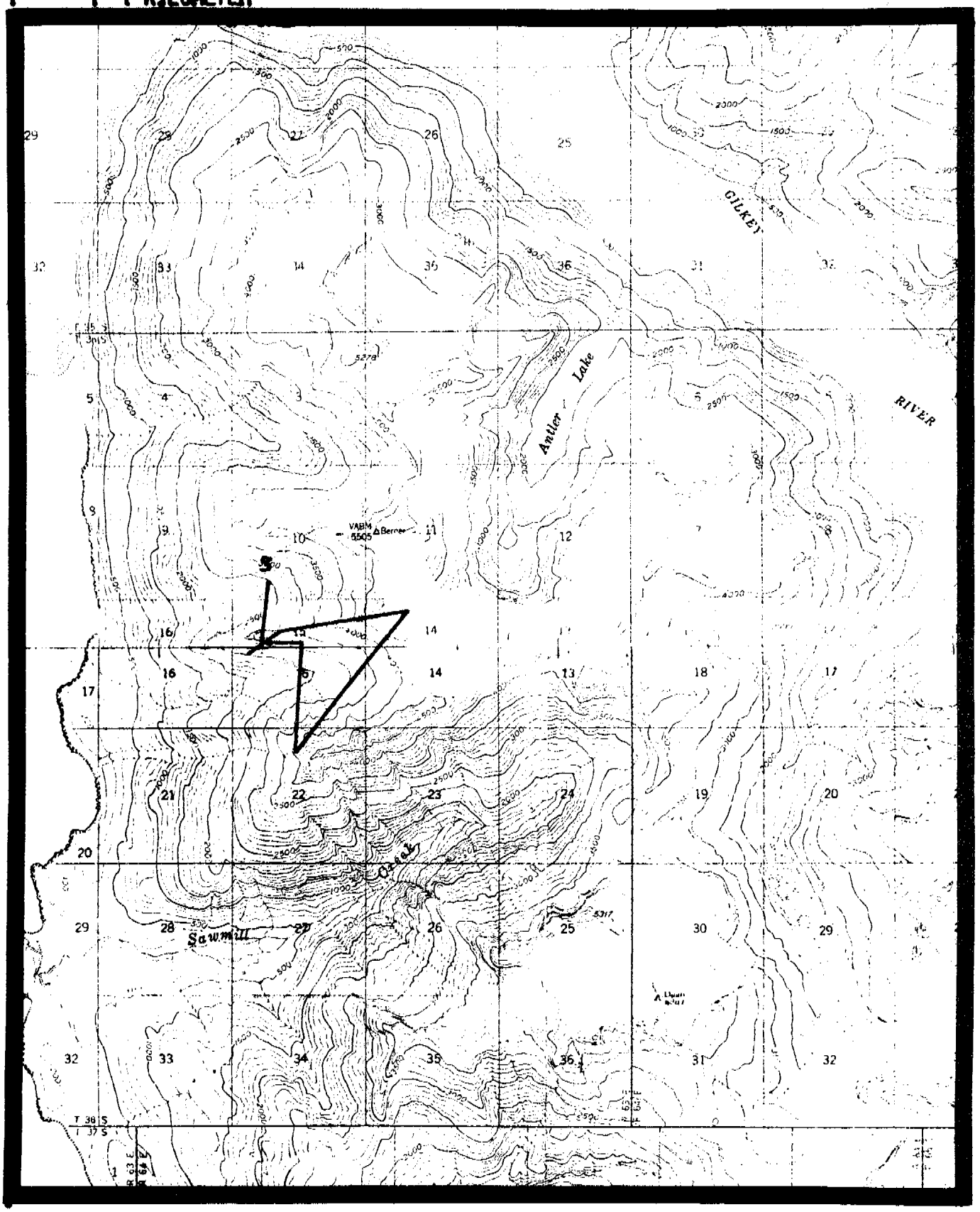

COAT 86 JUN 1 78-OCT 31 78

1 KILOMETER