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WINTER HABITAT USE BY MOUNTAIN GOATS

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: John W. Schoen

Project No.: W-17-10 Project Title: Big Game Investigations

Job No.: 12.4R Job Title: Winter Habitat Use by Mountain Goats

Period Covered: September 1, 1977 through June 30, 1978

SUMMARY

Several capture techniques including leg-hold snares, drop nets, and darting from a helicopter were tested for effectiveness in capturing mountain goats northwest of Juneau. Darting the animals from a helicopter proved to be most effective. During December 1977, five goats (three females and two males) were successfully captured by this method. M99 was used as the immobilizing agent along with its antagonist M50-50. Dosages used were 2.5 to 3.0 mg. per goat. Each animal was ear tagged, its sex and age were determined and it was instrumented with a radio collar.

Telemetry techniques were evaluated for efficiency and accuracy in locating instrumented goats. A twin yagi antenna system was chosen as the most efficient. When this system was utilized, total flight time to locate all goats from the Juneau airport and return averaged about one hour. Locations of instrumented individuals were confirmed visually for 82 percent of these observations.

Sizes of seasonal home ranges were determined for each individual by connecting outer points of location. Home ranges were largest during winter, decreased substantially in size through spring, then became increasingly larger again in the summer.

Seasonal habitat use was assessed by determining the proportion of time goats were located with respect to specific landscape attributes. Throughout winter 1977-78, they inhabited alpine tundra areas above 2,500 ft. (762 m) on westerly and southerly exposures. During spring, they moved down below 2,500 ft. on southerly rock face and upland brush and conifer habitats. They began dispersing throughout June and July into alpine and rock terrain generally above 3,000 ft. (914 m). As summer progressed, they made increasing use of northerly aspects.

CONTENTS

BACKGROUND

Mountain goats (*Oreamnos americanus*) are indigenous to the coastal mountains of the Southeastern Alaska mainland and also occur on Baranof Island where they were successfully introduced in 1923. Southeastern goats have generally been thought to inhabit high alpine meadows and rocky cliffs during the summer and forested areas throughout the winter. Although the mountain goat is considered an important and distinctive member of the wildlife fauna of Southeastern Alaska, relatively little specific information is available on its seasonal habitat requirements. Previous investigations are limited primarily to those of: Klein (1953), who undertook a reconnaissance study of goats in Alaska; Ballard (1975), who evaluated survey techniques; and Fox (1977), who studied summer goat activity and habitat preference as a basis for assessing survey techniques.

In Southeastern Alaska, most mountain goat range is located on National Forest lands. The U.S. Forest Service has recognized the lack of data available on the habitat requirements of mountain goats (Forest Service 1976). With implementation of the Southeast Alaska Area Guide (U.S. Forest Service 1977), the frame-work for rapid incorporation of sound biological data in resource allocations has been established. The Forest Service and the State of Alaska have become committed to provide the necessary data. In light of the apparent statewide decline of goat populations (Merriam 1965, ADF&G 1975 and 1976), an assessment of habitat requirements prior to substantial habitat manipulation (eg. timber harvest on winter range) is particularly important. A considerable amount of summer observational data have been gathered on a goat population near Juneau through Job 19.23R. Therefore, additional monitoring of this population, especially during the winter period, is expected to provide a more complete understanding of the year-round habitat relationships of this sample population.

OBJECTIVES

To develop capture and telemetry procedures suitable for monitoring mountain goat movements and determining habitat use in Southeastern Alaska.

STUDY AREA

The study area lies between Mendenhall and Herbert Glaciers, approximately 12 mi. (19 Km) northwest of Juneau (Fig. 1). This area encompasses approximately 30 $mi.^2$ (48 Km^2) and is characterized by a variety of topography and habitat types. Elevations range from 200 ft. (61 m) to over 5,000 ft. (1524 m). Steep, timbered slopes rise above valley bottoms forested with mature conifers and riparian hardwoods. The rocky upper slopes are vegetated by sparse conifers, willows and alders, while the ridges are characteristically alpine tundra. At the highest elevations, permanent ice and snow predominate.

The climate of this area is generally typical of Southeastern Alaska, reflecting a strong maritime influence. The upper elevations are usually snow covered for 7 to 9 months of the year but intermittent rain and clearing occur through the summer.

This area supports a population of about 75 goats. Hunting is permitted from October 1 through November 30 with a one goat bag limit. Generally, hunting pressure has been relatively light.

The study area is similar to many areas in northern Southeastern. Unlike some goat ranges, however, it is not immediately adjacent to tidewater.

PROCEDURES

Capture Techniques

Various techniques have been employed for capturing goats. These include portable traps including Clover traps (Rogers 1960, Wadkins 1971, Richardson 1971, Hebert and Cowan 1971, and Rideout 1974), dropnets, pentraps, and darting (Rideout 1974). The techniques tested in this study included baiting and snaring, drop nets and darting from a helicopter.

BAITING AND SNARING Bait used for snaring included ground apple mash and salt blocks located in areas frequented by goats. Snares were modified Aldrich leg-hold snares set along frequently used goat trails and bait stations. Snares were checked daily.

DROP NETS A drop net was manufactured from a 10X20-ft. (3-6 m) piece of purse seine web. This was attached to a PVC pipe at the front and weighted on the other three edges to form a belly in the center. A bridle assembly was rigged to attach to a drop hook on an Allouett helicopter. The net flared out behind the helicopter while in flight and dropped with a forward motion when released.

DARTING FROM A HELICOPTER The immobilizing drug M99 was delivered utilizing a Palmer Cap-Chur gun. A Hiller 12E aircraft was used for this operation with the gunner sitting at an open door on the right side of the aircraft. Goats were first located and their vulnerability and

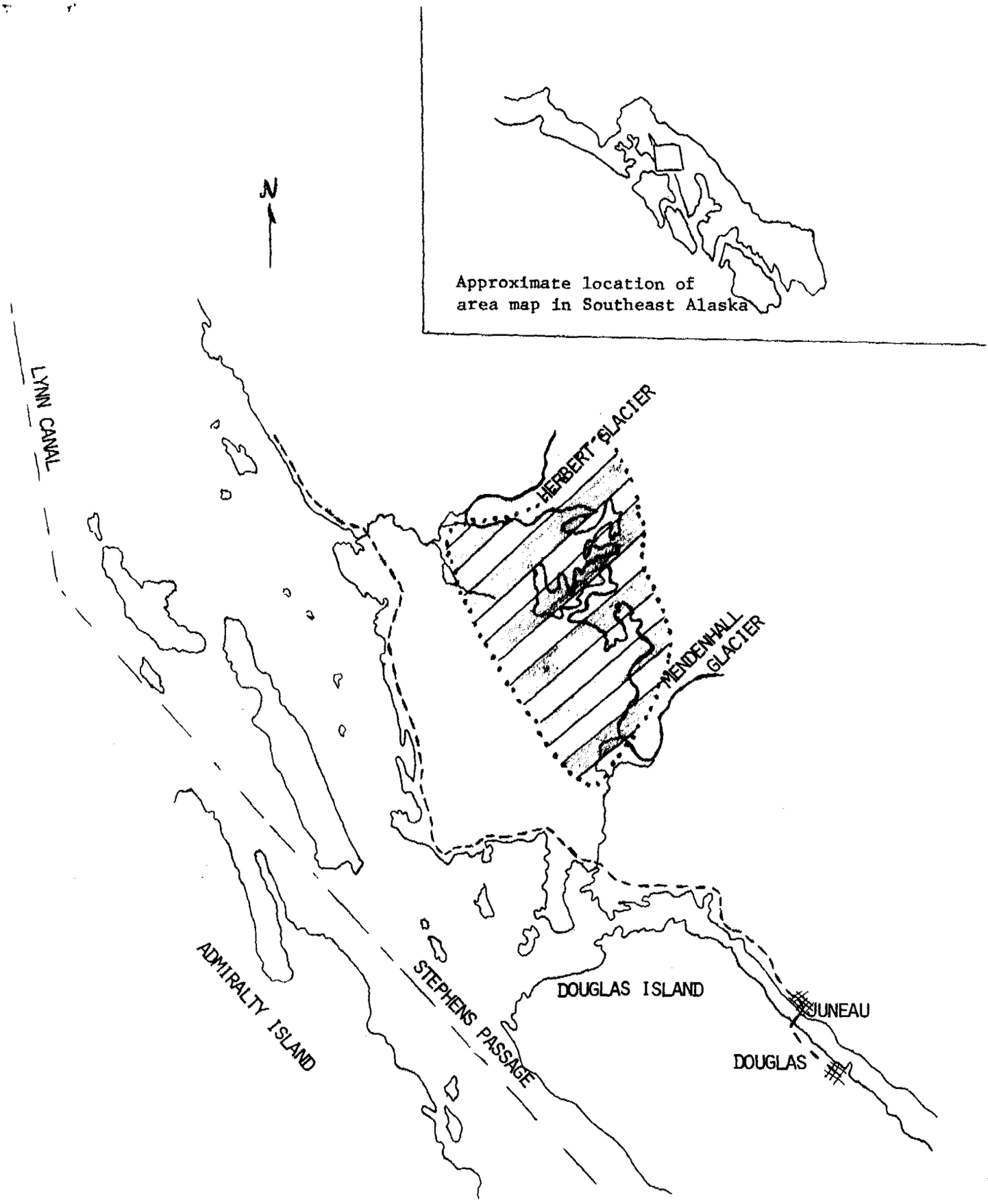

Figure 1. Location of the study area (crosshatched region).

safety assessed. If they were on flat to moderate topography and near deep snow, the helicopter would be flown towards them low and slow. Generally at about 25 to 50 ft. (8-15 m) from the goat, the helicopter would flare and the shot would be taken. If the shot was successful, we would move from the vicinity and wait for the animal to go down. Once the animal was immobilized, a radio collar was attached, it was ear tagged with a numbered plastic roto tag, its age and sex determined, and standard body measurements were recorded (Fig 2). At completion of handling, the antagonist M50-50 was administered.

Telemetry Techniques

Telemetry equipment was purchased from A.V.M. Instrument Company, Champaign, Illinois. This consisted of a 12-channel receiver and 12 radio collars transmitting on the frequencies 150.700 through 150.975 MHz. Initially, our antenna system consisted of a single three-element yagi antenna taped to the belly of the aircraft pointed in the direction of flight. This was later updated to two, two-element yagi antennas (Telonics Co., Mesa, Arizona), one mounted on each wing, pointed off the wing perpendicular to the aircraft fuselage. These were connected to a right/left switchbox located in the cockpit.

Monitoring of radio-collared goats was scheduled for once per week but averaged about three times a month because of weather or other commitments. Telemetry flights were usually flown between 0800 and 2000 hours during periods of clear skies, or high overcast and light winds. Once a signal was picked up, a pattern would be flown to locate the general direction of the signal. We then flew towards the signal until it peaked as we flew over it then suddenly fell off. Using this technique we could generally locate the animal's position to within a 25 acre (10 ha) grid. Several flights over this area normally provided us with a visual observation of the animal. All our telemetry flights were conducted in a Helio Courier. Both pilot and observer wore headsets. Telemetry flights averaged about an hour and one half total flight time from the Juneau airfield.

Home Range and Habitat Use

A map of the study area was overlayed by an X, Y grid coordinate system (Fig. 3). The size of each grid was 25.6 acres (10.4 ha). At each goat location the following data were recorded: individual's identification, date, time, grid coordinate (X, Y location), slope, aspect, elevation, habitat type, temperature, precipitation, wind condition, snow condition, terrain, group composition, behavior, and other marked individuals within that group (Fig. 4). Seasonal home ranges were determined by drawing lines between outer points of locations forming convex polygons (Jennrich and Turner 1969). Areas of home range were then estimated from the resulting convex polygons.

Personnel _____

MOUNTAIN GOAT - CAPTURE DATA

Specimen #_____ Date_____ Time_____

Location _____

Weather: Temp_____Sky_____Precip_____Wind_____

Elevation_____Slope_____Aspect_____Habitat_____

Sex_____ Age Estimate_____

Horn Rings_____ Teeth_____

Measurements: (cm)

Body L._____ Tail L._____ Total L._____

Hock L._____ Heart Girth_____

Weight Estimate_____ Neck Circumference_____

Female Lactating_____ Horn L._____ Spread at tips_____

Hair Sample_____ Blood Sample_____ Pellet Sample_____

Ectoparasites _____

General Condition _____

Marking:

Roto-Tag #_____ Ear_____ Color Flag_____

Metal Tag #_____ Ear_____ Color Flag_____

Radio-Collar #_____ Frequency_____

Color of Collar_____ Other Marks_____

Capture Technique _____

Drug_____ Dose_____ Time:Inject_____,Down_____,Up_____

Other goats present _____

Remarks: _____

Figure 2. Sample capture form.

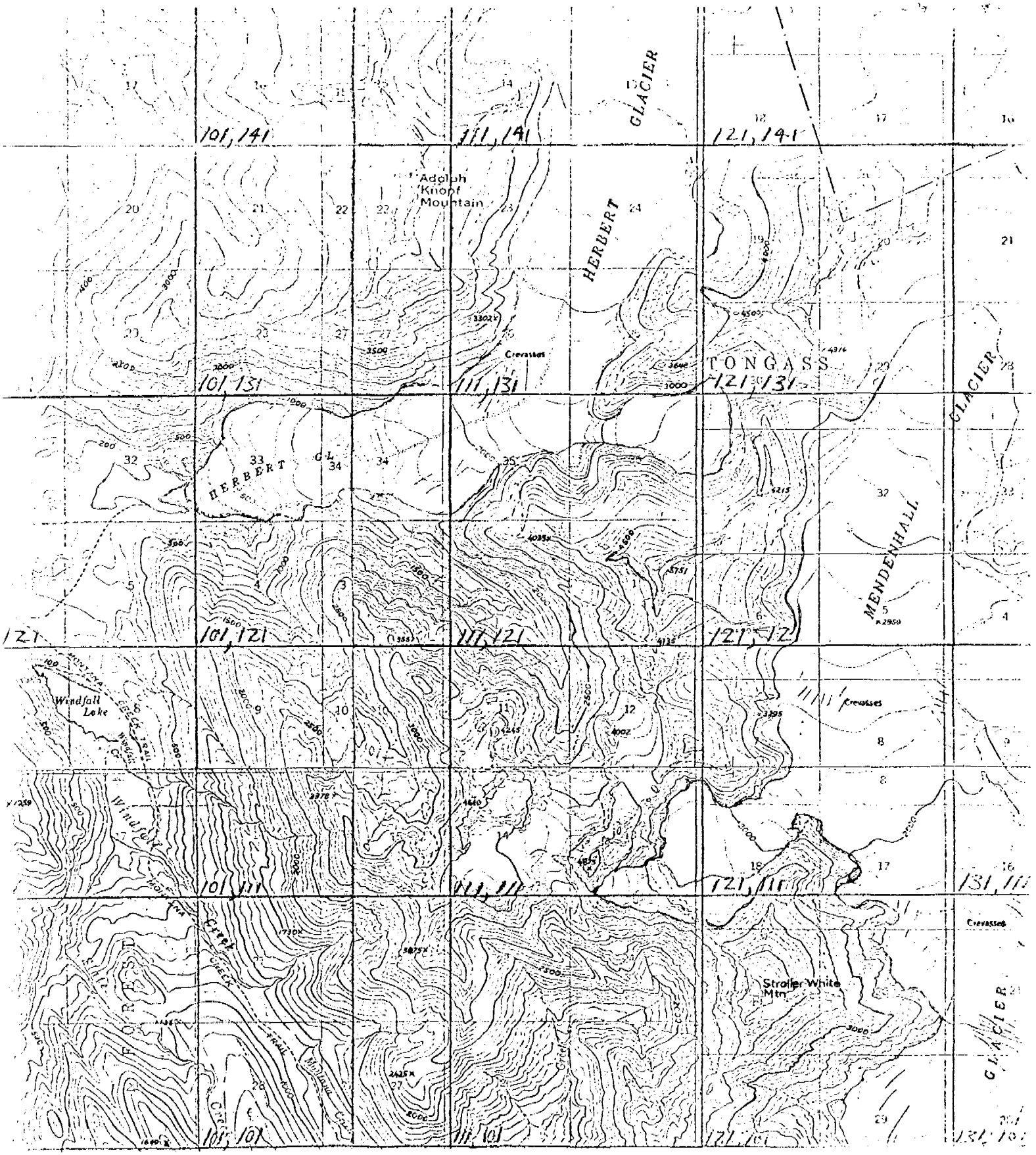

Figure 3. Map of study area (scale 1:63000) overlayed by grid coordinate system.

Page _____

a _____ Date _____ Time: Begin _____ End _____

ot & Observer(s) _____

e of Plane _____ Sky _____ Temp _____ Wind _____

..t. ip	Elev.	Slope	Aspect	Habitat	Terrain	Snow	# Goats Ad	Yr	Kd	Behav.	Marked Goats

ev:
ndred ft.
Slope:
. Flat
. Gentle
. Moderate
Steep
. Very steep

Aspect:
Flat-N-NW
W-SW-S-
SE-E-NE

Habitat:
1. Tundra
2. Meadow
3. Cliff-Rock
5. Ice-snow
7. Brush
8. Old growth conif

Terrain:
1. Smooth
2. Broken
3. Very broken

Behavior:
1. Watch obs.
2. Flight from obs.
3. Bedded
4. Stand
5. Forage
6. Travel

Figure 4. Sample field survey form.

RESULTS

Capture Techniques

BAITING AND SNARING During the first several weeks of September 1977, two technicians were employed to set out bait stations consisting of apple mash and run a set of leg-hold snares. The bait stations received no use either during this period or earlier in August. Previously, salt blocks had been set out by Joe Fox in conjunction with his graduate research on goats in the same study area. He observed no use of these throughout the summer. Snares, which were checked daily for a week, failed to capture any goats. This technique was considered inefficient in terms of time, manpower and success and was subsequently abandoned.

DROP NETS On August 31, after several practice sessions, a test was made using a drop net cast from a helicopter. Four actual drops were made on small groups of goats. Although several attempts were nearly successful, no goats were captured using this technique. With considerable improvement, this technique could probably produce successful results, however, it was considered too dangerous for the terrain we were working in and was abandoned.

DARTING FROM A HELICOPTER This technique was first tested on stationary objects then put to use during December 1977. Capture results utilizing this technique are summarized in Table 1. Of all animals where shots were attempted, eight (73%) were hit and six of those (75%) were immobilized. Two goats which were hit were never immobilized. Five goats (63% of those actually hit) were successfully captured and instrumented. After being hit, one goat moved into an inaccessible area where she became immobilized and remained for one and a half to two days before she fully recovered and left the area. No known mortality occurred as a result of any of our capture efforts.

A summary of age and sex of captured goats and times required for immobilization and duration of sedation are presented in Table 2. Captured animals represented a good cross section of the population: one yearling and two adult females and two adult males. Dosages of M99 varied between 2.5 mg and 3.0 mg. The average time from injection to immobilization was approximately 15 minutes. Duration of sedation averaged about 53 minutes. While immobilized, all goats remained very calm with their eyes closed. Following intramuscular injection of the antagonist M50-50, the average time of recovery was eight minutes.

Location Telemetry

The five goats instrumented with radio collars during December 1977 have been located by aerial telemetry about three times monthly. Each of the individuals had been located an average of 21 times through July 1978. Use of a twin yagi antenna system (one antenna mounted off each wing) proved to be the most efficient method of radio location.

Table 1. Capture results - darting goats from a helicopter.

Date	# Shots	# Hits	# Immobilized	# Successfully Captured
12-13-77	5	3	3	3
12-21-77	5	4	2	1
12-22-77	1	1	1	1
Totals	11	8	6	5

Table 2. Age and sex of captured goats and immobilization results using the immobilization drug M99 and the antagonist M50-50.

Goat #	Date	Age (years)	Sex	Time from injection to immobilization (minutes)	Duration of paralysis (minutes)	Dosage (mg)
1	12-13-77	1	female	10	30	2.5
2	12-13-77	6	female	20	45	2.5
3	12-13-77	3	male	20+	90+	3
4	12-21-77	6	male	13	58	3
5	12-22-77	5	female	13	40	2.5

Table 3. Average home range size by sex and season for five radio-collared mountain goats.

Sex	Home Range Size in Acres (hectares) Dec.-Mar.	Apr.-May	June-July
Male	1268 (513)	371 (150)	400 (102)
n locations	18	13	12
Females	1323 (535)	90 (36)	546 (221)
n locations	29	18	18
Total	1295 (524)	202 (82)	488 (197)
n	47	31	30

Since this system was installed our flight time from the Juneau airfield and return has averaged about one hour. The average search time for each goat, including a visual confirmation, averaged just under 10 minutes. Visual confirmation of radio-collared individuals has averaged 82 percent. Currently we are usually able to locate the signal without visual confirmation to within a 25 acre (10 ha) area. The accuracy of location is affected, however, by both topography and vegetative cover. More work will be done to refine the level of accuracy for specific cover and terrain conditions.

Home Range

Home ranges were calculated for each of five marked goats for three seasons: winter (December-March), spring (April-May), summer (June-July). Figures showing individual home range areas are presented in Appendix A. A summary of home range size by season and sex is presented in Table 3.

During the winter period home ranges for males and females were relatively similar in size, averaging 1,295 acres (524 ha). Although size of home ranges decreased considerably during spring for all animals, home ranges of males were about four times as large as those of females. The average home range size for all animals during spring was 202 acres (82 ha). Size of home ranges increased throughout June and July. The average home range size for all animals during this period was 488 acres (197 ha), and sizes of areas used by males and females were more equivalent. Although males increased the size of their home ranges only slightly over spring, home ranges of females became six times larger. Winter home ranges were generally larger than those of the other two seasons. At the time of this writing, however, the summer season represented only the first two months and we might expect home ranges to increase in size over the remainder of the season.

Considerable individual variability was observed within the female portion of our sample of marked goats. During the winter, goat #5 had a home range less than one-fourth as large as either of the other two females. This individual had a summer home range which was more than three times larger than those of the other two females. Variability between the two males was less than that observed in the females.

Habitat Use

Habitat type: A summary of use of different habitat types by season and sex is presented for five radio-instrumented goats in Table 4. During the winter period most goat use was concentrated in alpine tundra and rock habitat types. Males spent more time in the tundra areas and females occurred most often in rocky regions. Other habitat types used during this period included subalpine meadows, upland brushy areas and old-growth conifer.

Table 4. Summary of radio-instrumented goat use of different habitat types by sex and season. Figures are presented as percent use.

Habitat Types	Season								
	December-March			April-May			June-July		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Alpine Tundra	77.8	25.9	46.7	7.7	5.6	6.5	41.7	33.3	36.7
Subalpine Meadow	0	11.1	6.7	0	0	0	0	0	0
Rock or Cliff	16.7	55.6	40.0	38.5	77.8	61.3	33.3	38.9	36.7
Permanent Ice-Snow	0	0	0	0	0	0	0	5.6	3.3
Snow Patch	0	0	0	0	0	0	16.7	0	6.7
Upland Brush	0	3.7	2.2	30.8	5.6	16.1	8.3	22.2	16.7
Old-Growth Conifer	5.6	3.7	4.4	23.1	11.2	16.1	0	0	0
n locations	18	27	45	13	18	31	12	18	30

During spring, use of habitat types changed substantially. Comparatively few observations of instrumented goats occurred in tundra habitat. Most instrumented goats were located in rocky-cliff habitat during this period. More than 75 percent of the females located were in this habitat type. This was about twice the use males made of this type. Substantially more use was made of upland brush and old-growth conifer types during this season by both sexes as compared to the winter period.

During June and July instrumented goats were located most frequently in alpine tundra and rocky-cliff habitats. Use of these habitat types was similar in both sexes. Upland brush areas also continued to be used. Both sexes were also located on snow patches or permanent snow fields, but most use of these types was by males.

Elevation: A summary of elevations used by radio-collared goats is presented by sex and season in Table 5. These figures represent the percent occurrence of marked goats in 500 ft. (152 m) elevation intervals. Table 6 presents mean elevation, range and standard deviation for marked goat locations also by sex and season.

From December through March the sexes occupied similar elevations. The mean elevation of marked goat locations during this period was 3,100 ft. (945 m). Seventy-one percent of all locations occurred above 3,000 ft. (914 m). Only four percent of the locations of marked individuals occurred below 2,000 ft. (610 m).

During April and May, radio-instrumented goats occupied areas substantially lower in elevation. The mean elevation for all goats was 2,300 ft. (701 m). Males averaged about 400 ft. (122 m) higher than females during this period. In direct contrast to the winter period, about 71 percent of all locations occurred below 3,000 ft. (914 m).

Radio-collared goats began moving to higher elevations during June. The mean elevational distribution of marked goats during June and July was 3,000 ft. (914 m), with males occupying elevations about 400 ft. (122 m) higher than females. Males were located 83 percent of the time above 3,000 ft. (914 m) while females were located at this elevation only 50 percent of the time.

Slope: A summary of goat locations with respect to steepness of slope is presented in Table 7. During winter male and female use of slope was quite similar. Sixty two percent of all locations occurred on steep to very steep slopes (31°+). Spring use of slopes varied little from winter use except that females spent about 10 percent more time on steeper slopes. During the summer period, however, both sexes greatly increased their use of more moderate topography.

Aspect: Instrumented goat use of aspect is summarized in Table 8. From December through March goats of both sexes occurred predominantly (53.3%) on southerly exposures. Northerly exposures were used (6.6%) to a much lesser degree. Females occurred frequently during this period on ridgetop situations.

Table 5. Summary of radio-instrumented goat use of elevation by sex and season. Figures are presented as percent use.

Elevation (feet)	SEASON								
	December-March			April-May			June-July		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1000-1400	0	0	0	7.7	22.2	16.1	0	5.6	3.3
1500-1900	5.6	3.7	4.4	15.4	33.3	25.8	0	0	0
2000-2400	0	7.4	4.4	30.8	5.6	16.1	0	22.2	13.3
2500-2900	22.2	18.5	20.0	7.7	16.7	12.9	16.7	22.2	20
3000-3400	50.0	37.0	42.2	23.1	5.3	12.9	41.7	22.2	30
3500-3900	16.7	29.6	24.4	7.7	16.7	12.9	41.7	22.2	30
4000-4400	0	3.7	2.2	0	0	0	0	5.6	3.3
4500-4900	0	0	0	7.7	0	3.2	0		
5000-5400	5.6	0	2.2	0	0	0	0		
n locations	18	27	45	13	18	31	12	18	30

Table 6. Mean, range, and standard deviation of elevations used by marked goats by sex and season. Elevations are represented in feet.

	December-March	April-May	June-July
Male			
Mean	3200	2500	3300
Range	1900-5000	1400-4500	2600-3800
S.D.	659	901	365
n locations	18	13	12
Female			
Mean	3100	2100	2900
Range	1600-4000	1000-3600	1200-4200
S.D.	563	889	733
n/o cabins	27	18	18
TOTAL			
Mean	3100	2300	3000
Range	1600-5000	1000-4500	1200-4200
S.D.	597	900	636
n locations	45	31	30

Table 7. Summary of radio-instrumented goat use of slope by sex and season. Figures are presented as percent use.

Slope (degrees)	December-March			April-May			June-July		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0	5.6	18.5	13.3	0	5.6	3.2	0	5.6	3.3
1-15	5.6	7.4	6.7	7.7	11.1	9.7	8.3	16.7	13.3
16-30	27.8	11.1	17.8	30.8	11.1	19.4	58.3	33.3	43.3
31-45	55.6	55.6	55.6	46.2	72.2	61.3	16.7	44.4	33.3
46+	5.6	7.4	6.7	15.4	0	6.5	16.7	0	6.7
n locations	18	27	45	13	18	31	12	18	30

Table 8. Summary of radio-instrumented goat use of aspect by sex and season. Figures are presented as percent use.

Aspect	December-March			April-May			June-July		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Flut	0	0	0	0	5.6	3.2	0	0	0
N	0	7.4	4.4	0	0	0	0	5.6	3.3
NE	5.6	0	2.2	0	0	0	0	11.1	6.7
E	0	0	0	0	0	0	0	0	0
SE	5.6	3.7	4.4	38.5	5.6	19.4	41.7	0	16.7
S	27.8	11.1	17.8	30.8	16.7	22.6	8.3	0	3.3
SW	38.9	25.9	31.1	23.1	61.1	45.2	0	44.4	26.7
W	16.7	29.6	24.4	7.7	5.6	6.5	41.7	11.1	23.3
NW	0	0	0	0	5.6	3.2	8.3	22.2	16.7
Ridge	5.6	22.2	15.6	0	0	0	0	5.6	3.3
n locations	18	27	45	13	18	31	12	18	30

Table 9. Frequency of occurence of marked goats by terrain type.

Terrain	April-May			June-July		
	Male	Female	Total	Male	Female	Total
Smooth	7.7	22.2	16.1	25.0	16.7	20.0
Broken	92.3	66.7	77.4	58.3	66.7	63.3
Very Broken	0	11.1	6.5	16.7	16.7	16.7
n locations	13	18	31	12	18	30

During the spring period, use of aspects other than southerly ones fell off substantially. Eighty-seven percent of all goat locations were on southerly exposures.

Throughout June and July use of southerly aspects decreased. At this time, 47 percent of all goat locations occurred on southerly exposures. In contrast to the other two periods, use of northerly exposures increased substantially to 27 percent. The greatest change, however, occurred in the females which were located on northerly exposures 39 percent of the time.

Terrain: Terrain was subjectively classified as smooth, broken, and very broken. The frequency of occurrence of marked goats with respect to this attribute is summarized in Table 9 from April through July. This attribute was not recorded prior to April.

Approximately half to three quarters of all marked goats located during both seasons were in broken terrain. Males increased their use of both smooth and very broken terrain during June and July as compared to spring, while use of broken terrain consequently diminished. Female use of broken terrain remained the same through both seasons, however, during summer females increased their use of very broken terrain while decreasing their use of smooth terrain.

DISCUSSION

In February 1977, the First International Mountain Goat Symposium was held in Kalispell, Montana. As Ballard (1977) noted at that meeting, substantially more research is needed before our knowledge of mountain goats is equivalent to that of other big game species. With large scale habitat changes and exploitation by man on the increase, it is imperative that we now learn more about basic goat biology. A logical approach is to first gain an understanding of the goat and its natural habitat, then determine how that relationship is impacted by factors such as habitat degradation, hunting, and intensive predation. This paper summarizes results of our first year's effort in developing capture and telemetry procedures suitable for monitoring goat movements and determining habitat use. These are not final results.

Of the several capture techniques attempted, darting goats from a helicopter proved most efficient. This technique is most effective, however, when goats are found or can be forced into areas of deep snow, slowing their movement and thus making them more vulnerable to darting. In an area with a medium to high goat population and moderate terrain with snow covered slopes, estimated flight time including period of searching should average less than one hour per goat. This operation is best performed with a Hiller 12E or equivalent aircraft, pilot, shooter, and assistant.

The immobilizing agent, M99, and its antagonist M50-50 proved to be efficient and safe drugs for immobilizing goats. One major problem, however, was the length of time between injection and immobilization. Possibly this time could be reduced by increasing the dosage of M99. This requires further investigation.

Aerial location telemetry proved quite feasible throughout the study period. The twin yagi antenna system increased our efficiency and accuracy over the single yagi system. One major drawback of aerial telemetry, however, was that all the recorded observations were made only during good flying weather. Our sample is biased by the lack of observations during stormy or heavy overcast conditions. This situation could be alleviated to some extent by implementing some on-the-ground telemetry work.

Home ranges were largest during winter, decreased substantially in size during April and May, then expanded somewhat throughout June and July. Difference in home range size between sexes was most significant during April and May. The much smaller female home range during this period may be a manifestation of the latter stages of pregnancy and parturition. Both adult nannies had young of the year during the summer of 78. The peak of parturition appeared to occur the last week of May. Average summer (June and July) home ranges were smaller than winter home ranges. To some degree, this probably reflects the shorter duration of observation period rather than a reduced range of movements during the summer. Following the compilation of location data collected during August and September, I anticipate sizes of home range areas will be more similar to those of the winter period. Rideout (1977) reported sizes of summer-fall and yearly home range areas for male and female goats from the Sapphire Mountains of Montana. Those of adult females averaged 19.8 Km^2 during summer-fall and 24.0 Km^2 throughout the year. Male home ranges averaged 17.6 Km^2 during summer-fall and 21.5 over the entire year. Because our study began in December 1977 we do not yet have comparable figures. Smith (1976) reported average winter-spring home range areas for adult females of 158 acres (64 ha).

From an ecological standpoint it is of far greater significance to determine how an animal actually uses its home range than to simply describe its geometry. This may be done by comparing utilization of specific landscape attributes to their availability either within the home range or within the study area as a whole. Although this procedure is beyond the scope of the present report, it is anticipated that such an approach will be utilized in a final analysis. The direction I have taken here has been to present data which represent the proportion of use instrumented goats made of specific attribute variables during a given period of time. For example, I have presented the proportion of use goats made of various elevational intervals during winter, spring and early summer. I have made the assumption that each location represents a sample point of goat use and that the total of sample points for any given time period gives us an indication of goat use in general. It is important to recognize, however, that these data are preliminary in

nature and that our sample size is relatively small both in terms of total points and individuals representing various sex and age classes. Subject to the above limitations, I will present a general picture of winter through early summer habitat use for radio-instrumented mountain goats inhabiting the mainland coast northwest of Juneau, Alaska.

Throughout winter most goats inhabited alpine tundra or cliff habitats between 2,500 and 4,000 ft. (762-1,219m) elevation. These were primarily on moderate to steep slopes with southerly or westerly exposures. Initially, I had anticipated that the goats utilized lower elevations with a forest canopy. However, it is most reasonable that they would occur where forage was most available and, during this particular winter, this was on the higher, windblown southwesterly slopes. In general, it was a mild winter with lower than normal snowfall. The higher windblown slopes generally had less snow accumulation than the mid elevations around 1,000 to 2,500 ft. (305-762m). Rideout (1977), in fact, observed that in western Montana mountain goats utilized high elevations near their summer range during mild winters. During severe winters, however, he found that they utilized much lower elevations. Chadwick (1973) and Smith (1976) also pointed out the importance of snow cover in influencing habitat selection of goats in Montana. It would be premature at this time, then, for us to develop any generalizations about the winter habitat use of goats in this region. We may find, for example, that they make extensive use of low elevation forests during winters of high snow accumulation in the alpine. During such winters in the past, goats have actually been observed at tidewater.

During spring (April and May), instrumented goats moved to lower elevations. Most goat locations occurred below 3,000 ft. (914m), with over half of all locations below 2,500 ft. (762m). These also occurred predominantly on steep, southerly exposures. The most heavily utilized habitat type was rock and cliff, however, upland brush and old-growth conifer habitats were also utilized more than during winter. This change in habitat use is presumed to be a direct response to availability of green forage. At this time, the snow pack was receding from the lower elevations and spring green-up was occurring. An on-the-ground evaluation indicated heavy use of grasses and forbs in the early stages of development. These occurred in greatest abundance near rock outcroppings on south facing slopes. These areas were also described as being important to goats during spring by Klein (1953). Although Klein, reported an early move toward higher elevations, I observed the opposite. This may have been the result of the previous mild winter which allowed the goats to winter at higher elevations.

During early summer (June-July), instrumented goats began to disperse from their relatively small spring ranges. Over half the locations occurred above 3,000 ft. (914m) with males occupying higher country than females. As the summer progressed, goats made increasing use of northerly aspects, a substantial change from either of the previous seasons. Alpine tundra and cliff habitats received the bulk of their use. During this period, the goats appeared to be responding to lush summer

vegetation. Smith (1976) concluded that high quality forage and thermoregulatory behavior were the primary factors influencing habitat selection on summer range. Goats in the Juneau area, during hot days, were often observed bedded down on permanent snow or snow patches.

Through the period of study, no marked goats were observed outside of the study area. In fact, the greatest airline distance moved by any goat from December through October was five airline miles (8Km) by a billy three years of age. Although the study population, thus far, has been relatively distinct, there appears to be little herd integrity. Based on observations of marked individuals, it appears that individual goats move freely in and out of larger groups. Large groups probably represent goats which have aggregated around a mutually attractive resource rather than aggregating for social purposes.

It is apparent that much individual variability exists in the habitat utilization and movements of our sample of marked goats. This has been demonstrated in elk (*Cervus canadensis*) by Schoen (1977) and is reasonable when it is considered that each individual responds to its own unique set of environmental conditions which vary from region to region and home range to home range. We will also make the underlying assumption that each individual utilizes its home range in an optimal manner. Thus habitat utilization can be expected to vary both spatially and temporally. It is important that we recognize this variation as we develop a general understanding of the seasonal habitat use of mountain goats in Southeastern Alaska.

RECOMMENDATIONS

1. This study should be broadened to include a larger sample of instrumented goats better representing general age and sex classes.

2. It is recommended that an additional study site be established within the Juneau vicinity which will represent an area immediately adjacent to a coastal situation.

3. Additional effort should be made to investigate the possibilities of increasing the speed of the immobilization period.

4. It would be desirable to contract a computer analyst to assist in developing a computer program with which to aid us in our habitat use analysis.

5. It would also be valuable to hire a technician to develop a basic habitat map of the study area suitable for computer analysis.

6. Finally, the Forestry Sciences Lab (USFS, Juneau) is planning to support a University of Washington graduate student, Joe Fox, to conduct on-the-ground studies of winter habitat use by goats in the Juneau vicinity. The Department should make every effort to cooperate with the lab in these studies.

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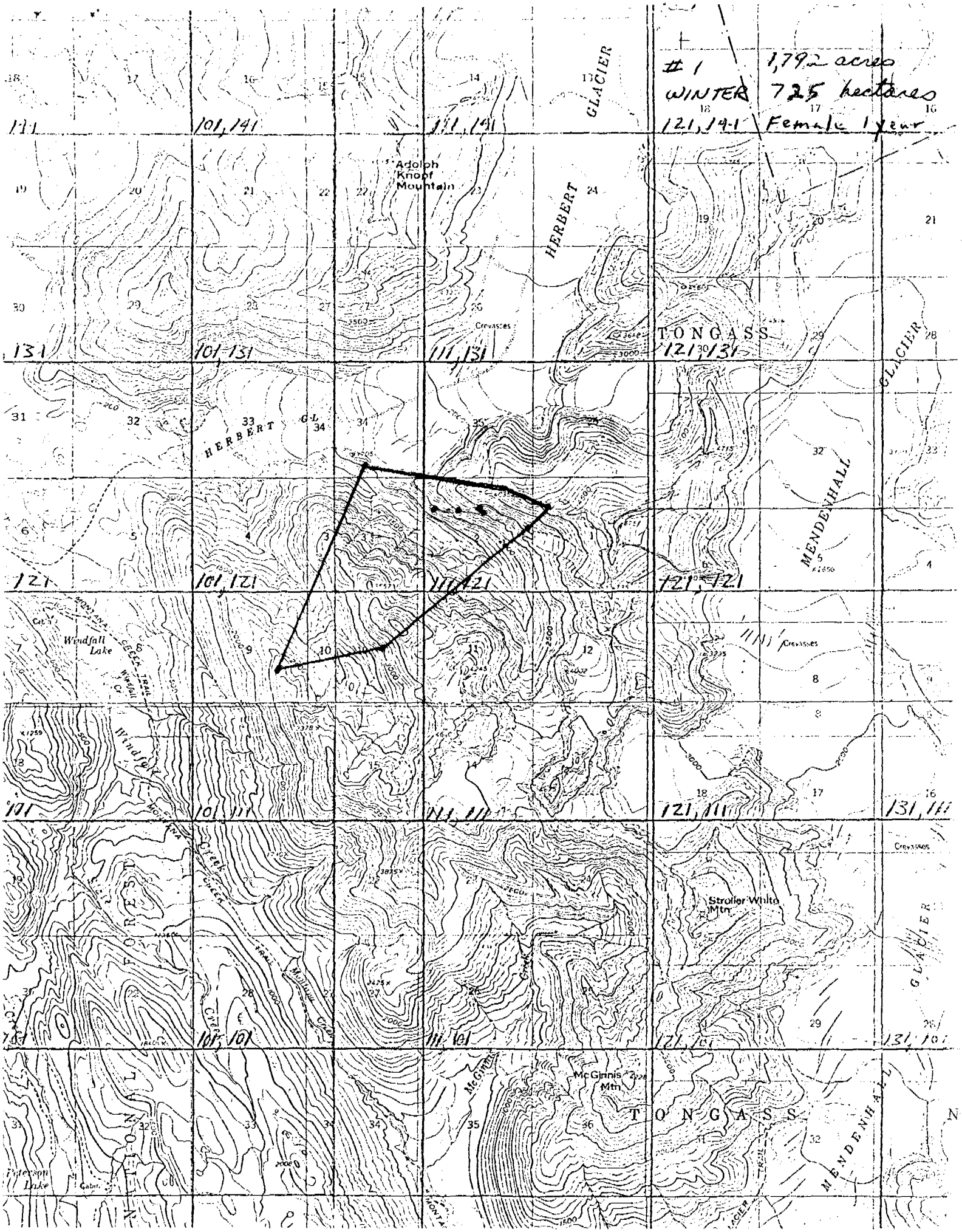
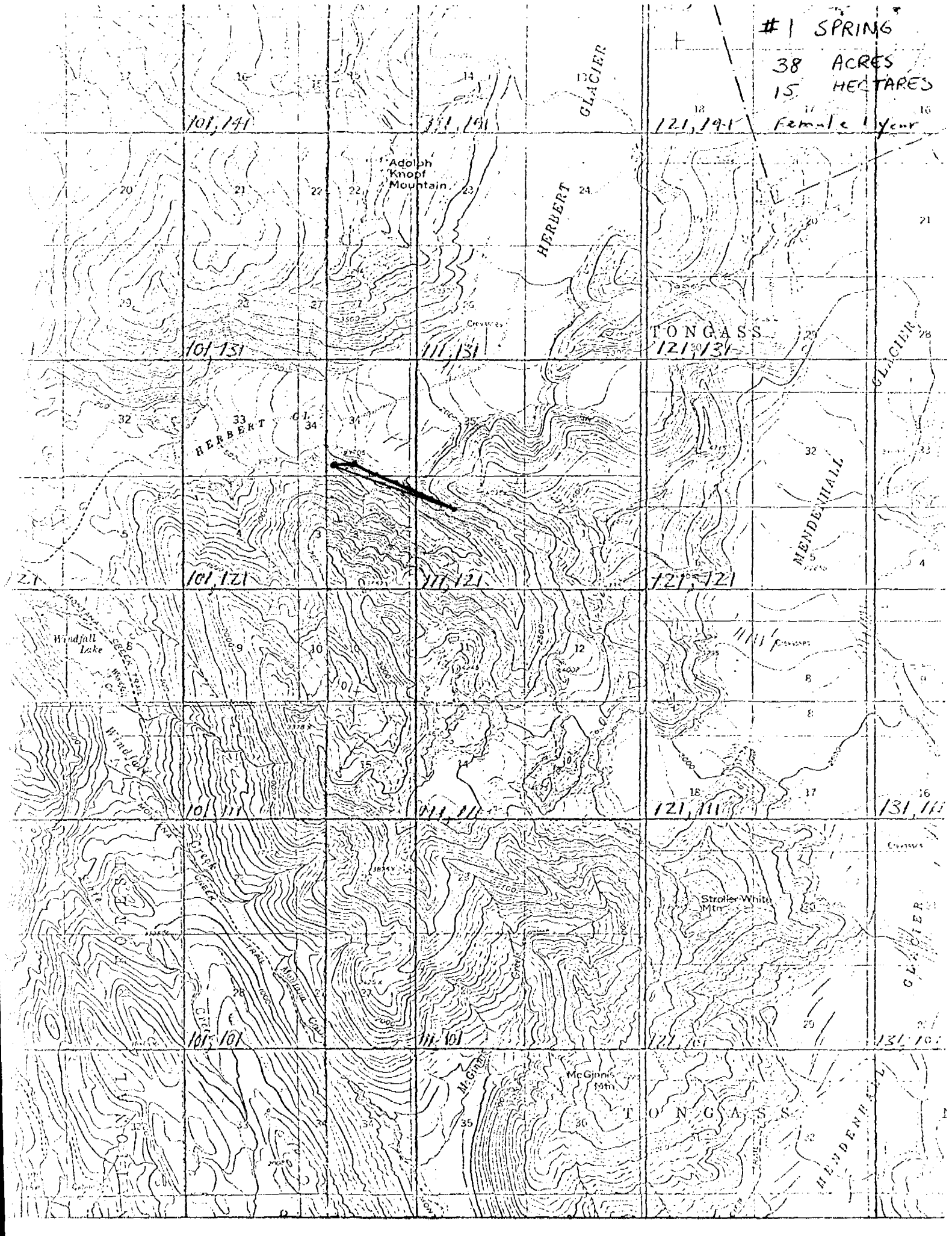
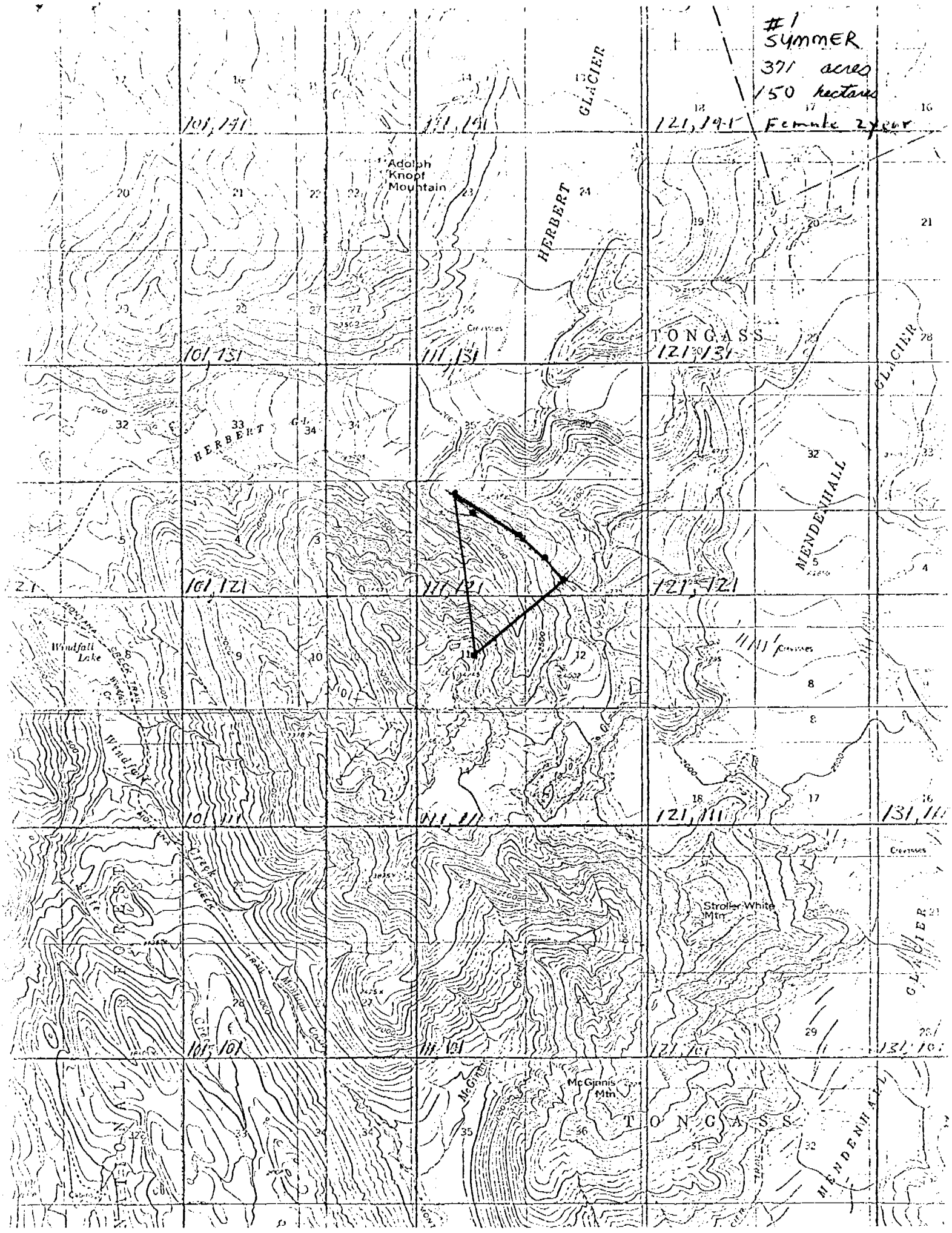
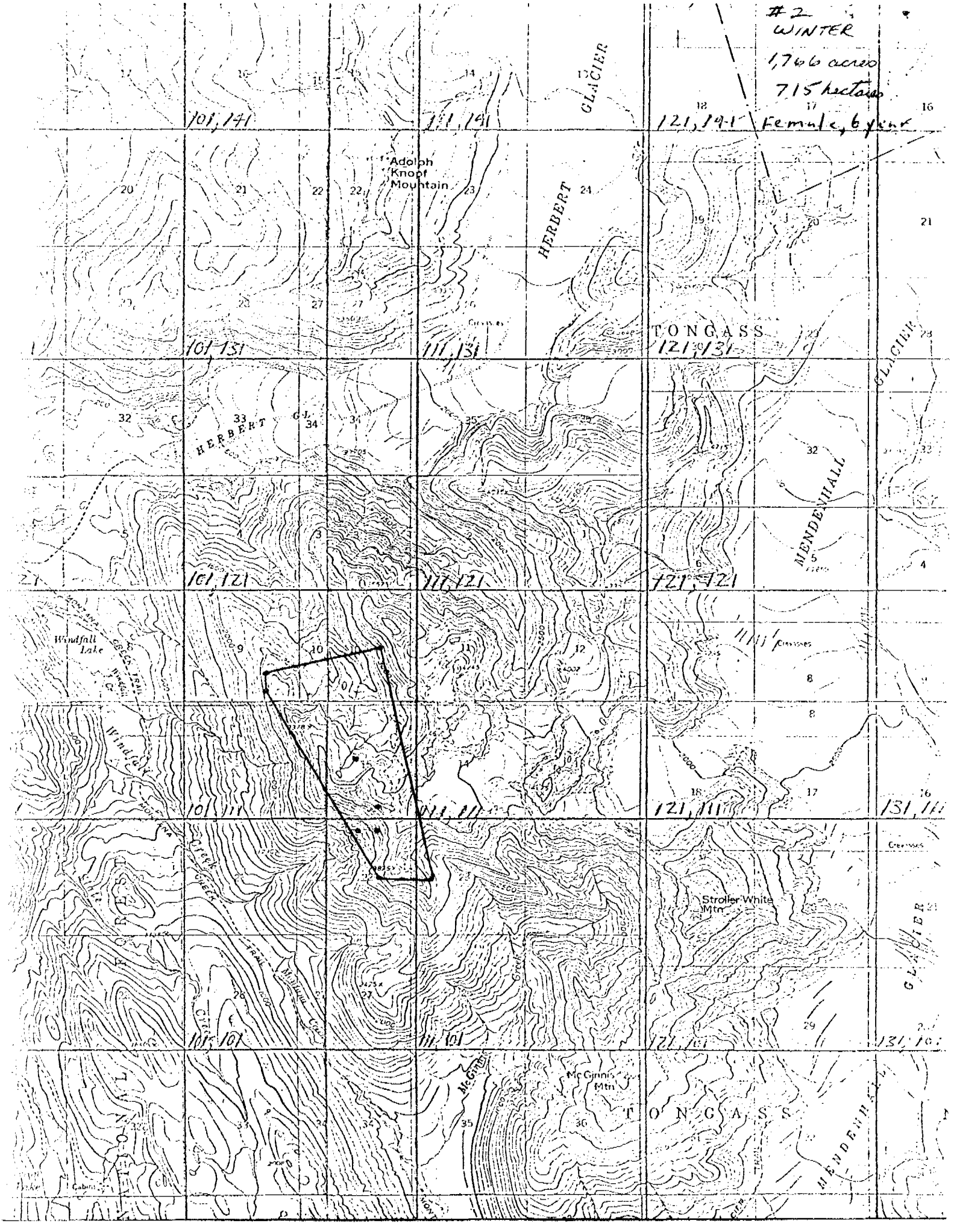
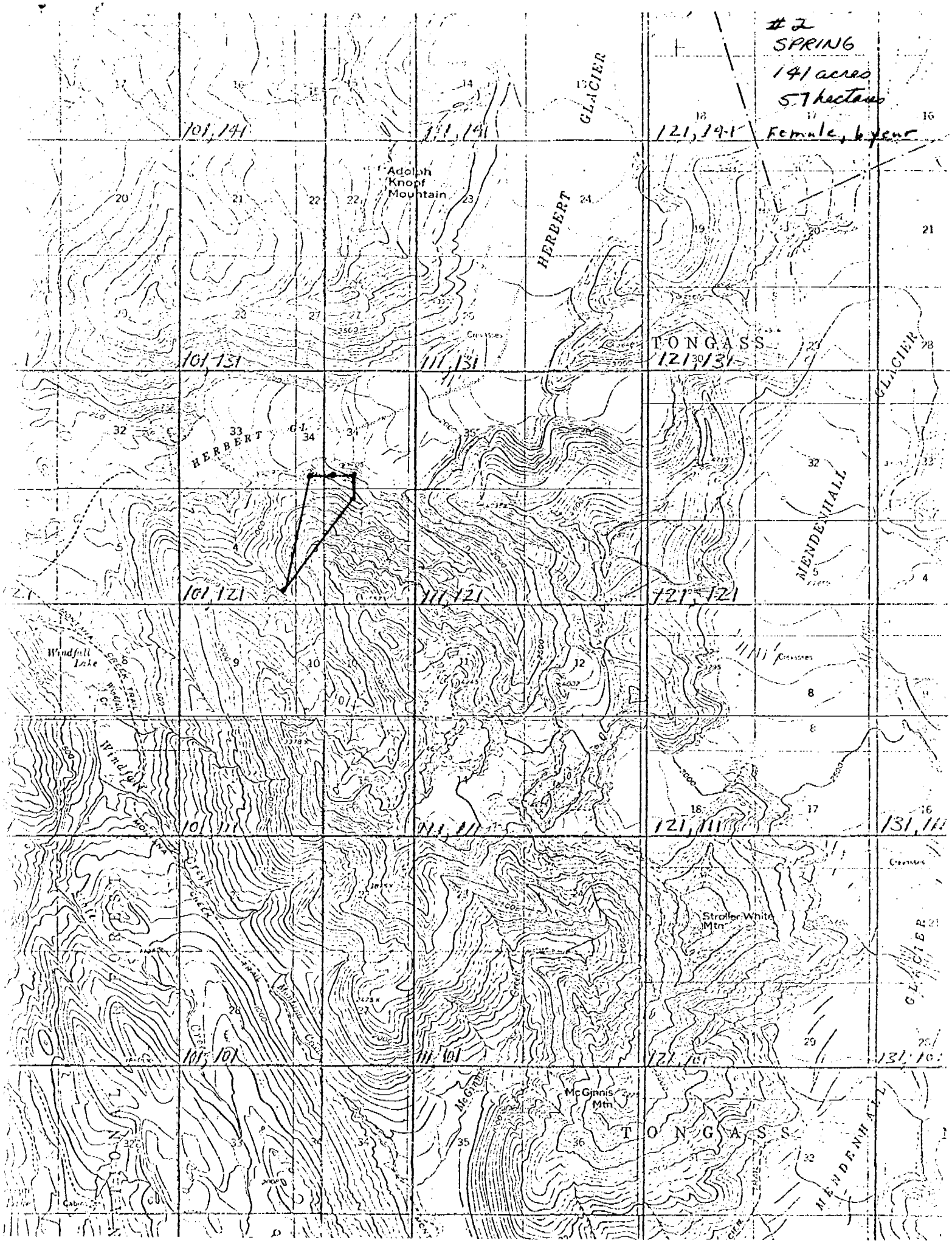
APPENDIX A: Home Ranges of Individual Instrumented Goats by Season

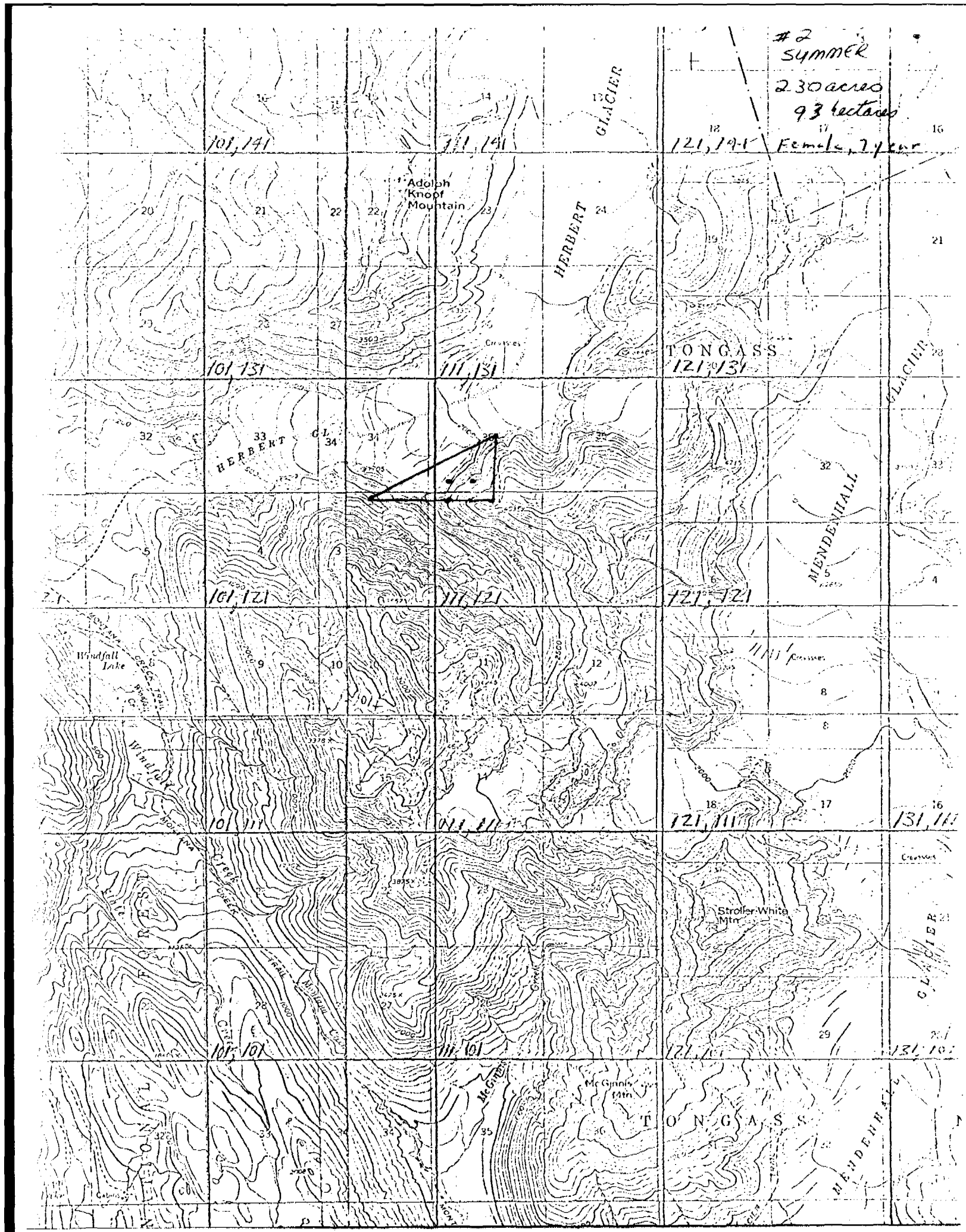

#1
1,792 acres
WINTER
725 hectares
Female 1 year
Adolph Knopf Mountain
HERBERT GLACIER
TONGASS
MENDENHALL GLACIER
Windfall Lake
Windfall Creek Trail
Crevasses
Stroller White Mtn
McGinnis Mtn
Gabin
Lake

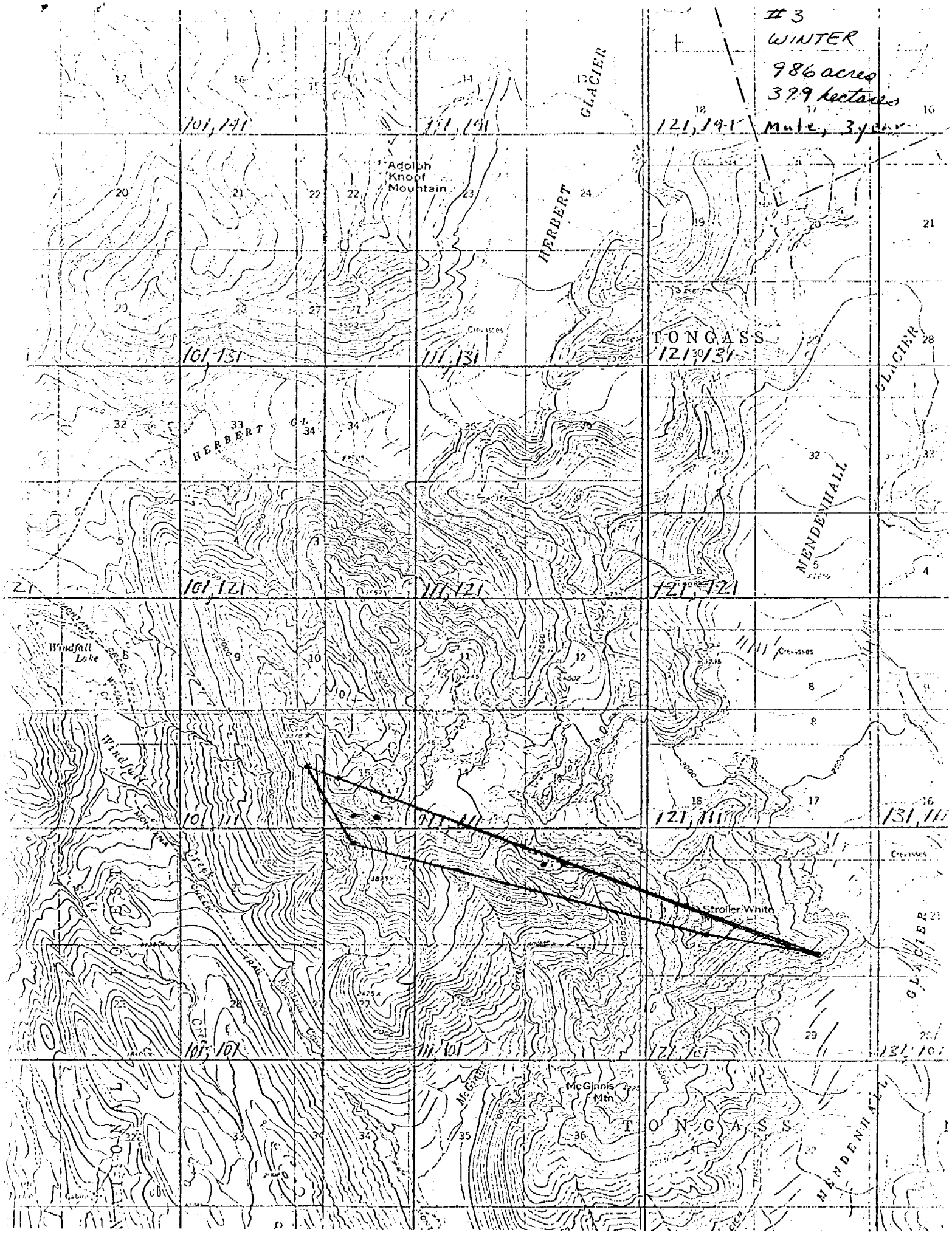

#1 SPRING
38 ACRES
15 HECTARES
Female 1 year
101,141
111,141
121,141
Adolph Knopf Mountain
HERBERT GLACIER
101,131
111,131
121,131
TONGASS
HERBERT GL.
MENDENHALL GLACIER
101,121
111,121
121,121
Windfall Lake
101,111
111,111
121,111
131,111
Stroller White Mtn.
McGinnis Mtn.
101,101
111,101
121,101
131,101

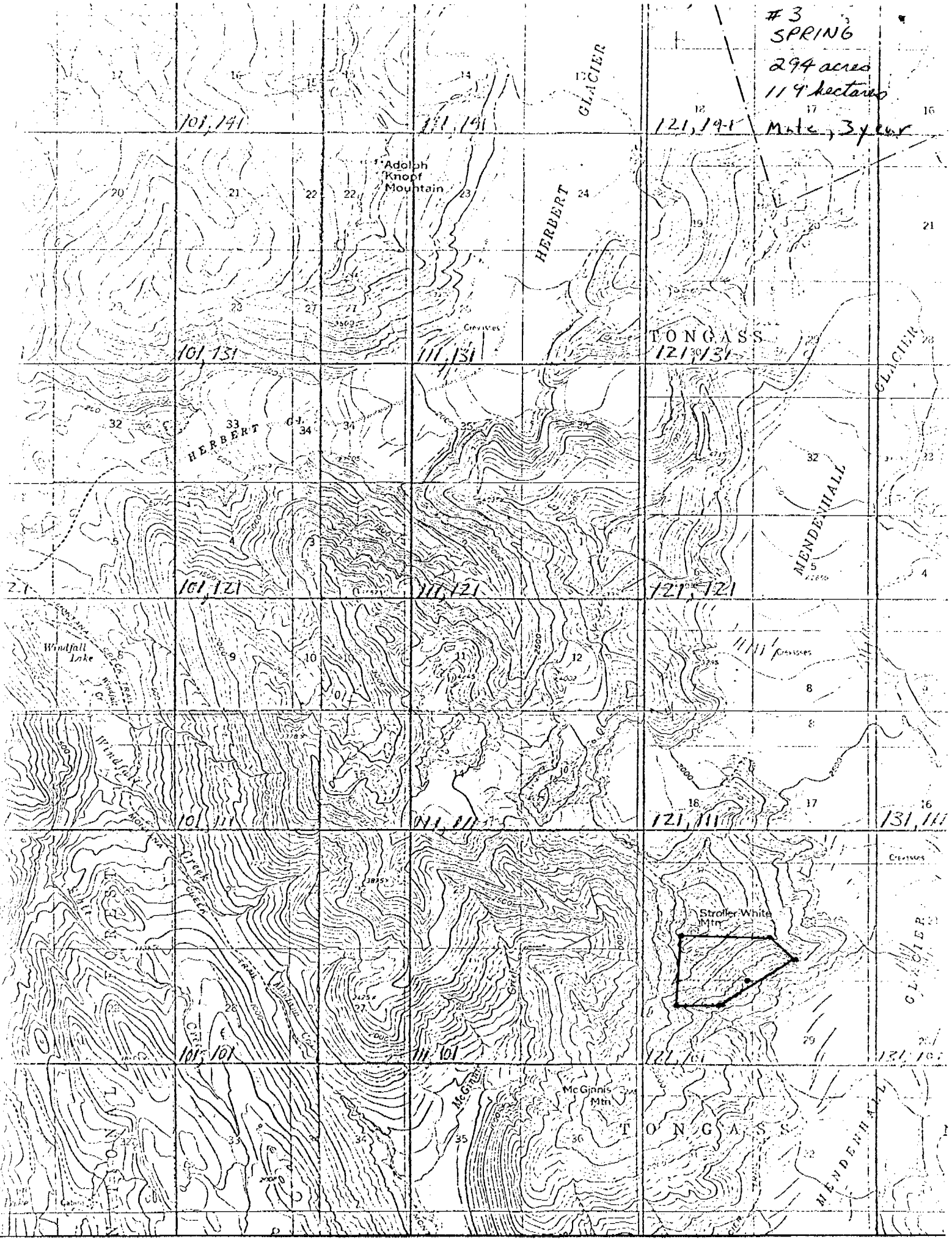

#1
SUMMER
371 acres
150 hectares
Female 2 year
Adolph Knopf Mountain
HERBERT GLACIER
TONGASS
MENDENHALL GLACIER
Windfall Lake
Stroller White Mtn
McGinnis Mtn
101, 141
111, 141
121, 141
101, 131
111, 131
121, 131
101, 121
111, 121
121, 121
101, 111
111, 111
121, 111
131, 111
101, 101
111, 101
121, 101
131, 101

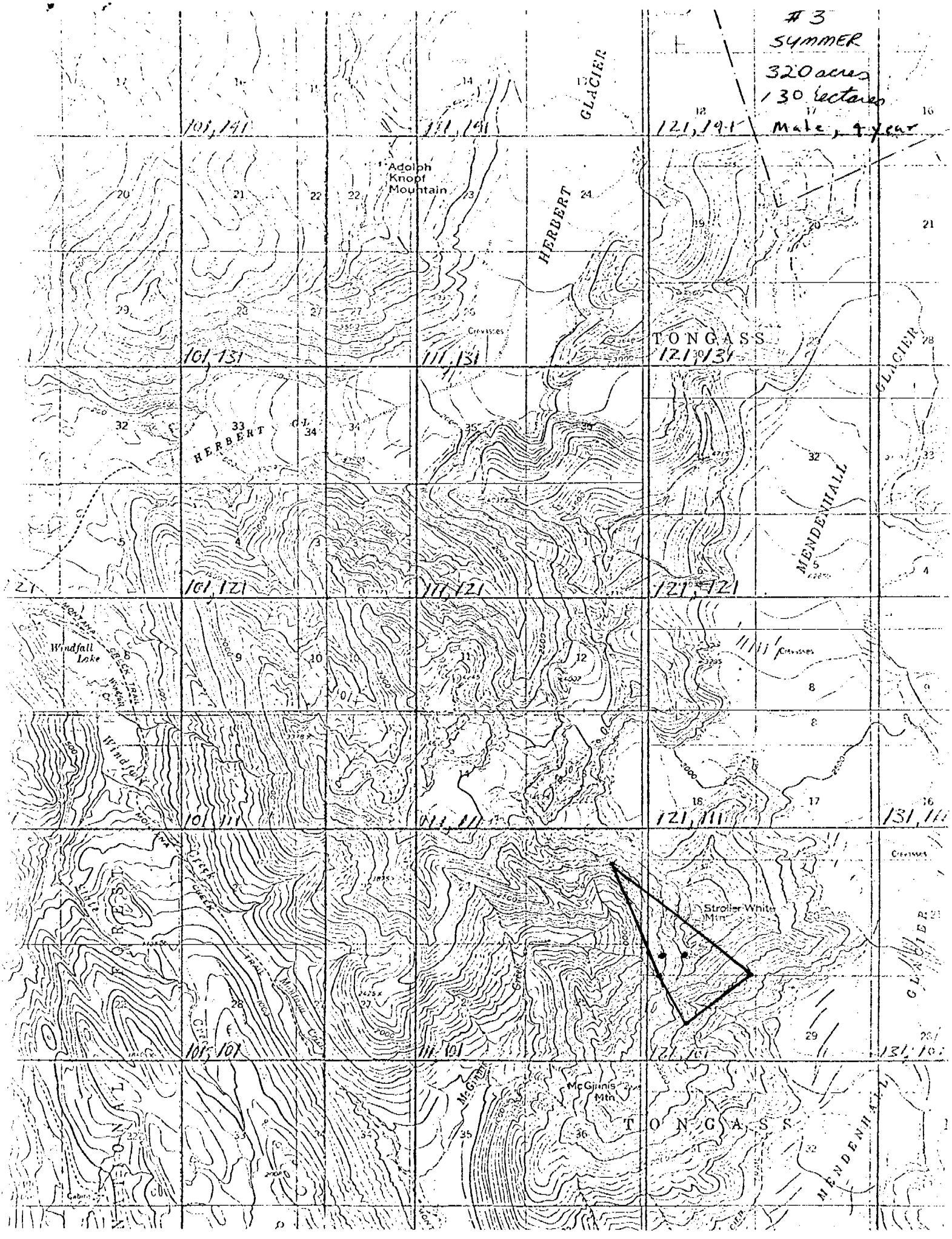

#2
WINTER
1,766 acres
715 hectares
Female, 6 year
101, 141
111, 141
121, 141
Adolph Knopf Mountain
HERBERT GLACIER
101, 131
111, 131
121, 131
TONGASS
HERBERT
GLACIER
MENDENHALL
101, 121
111, 121
121, 121
Windfall Lake
Windfall Creek Trail
101, 111
111, 111
121, 111
131, 111
Stroller White Mtn
Herbert Creek
Herbert Creek Trail
Montana Creek
101, 101
111, 101
121, 101
131, 101
McGinnis Mtn
McGinnis Creek
TONGASS
MENDENHALL GLACIER

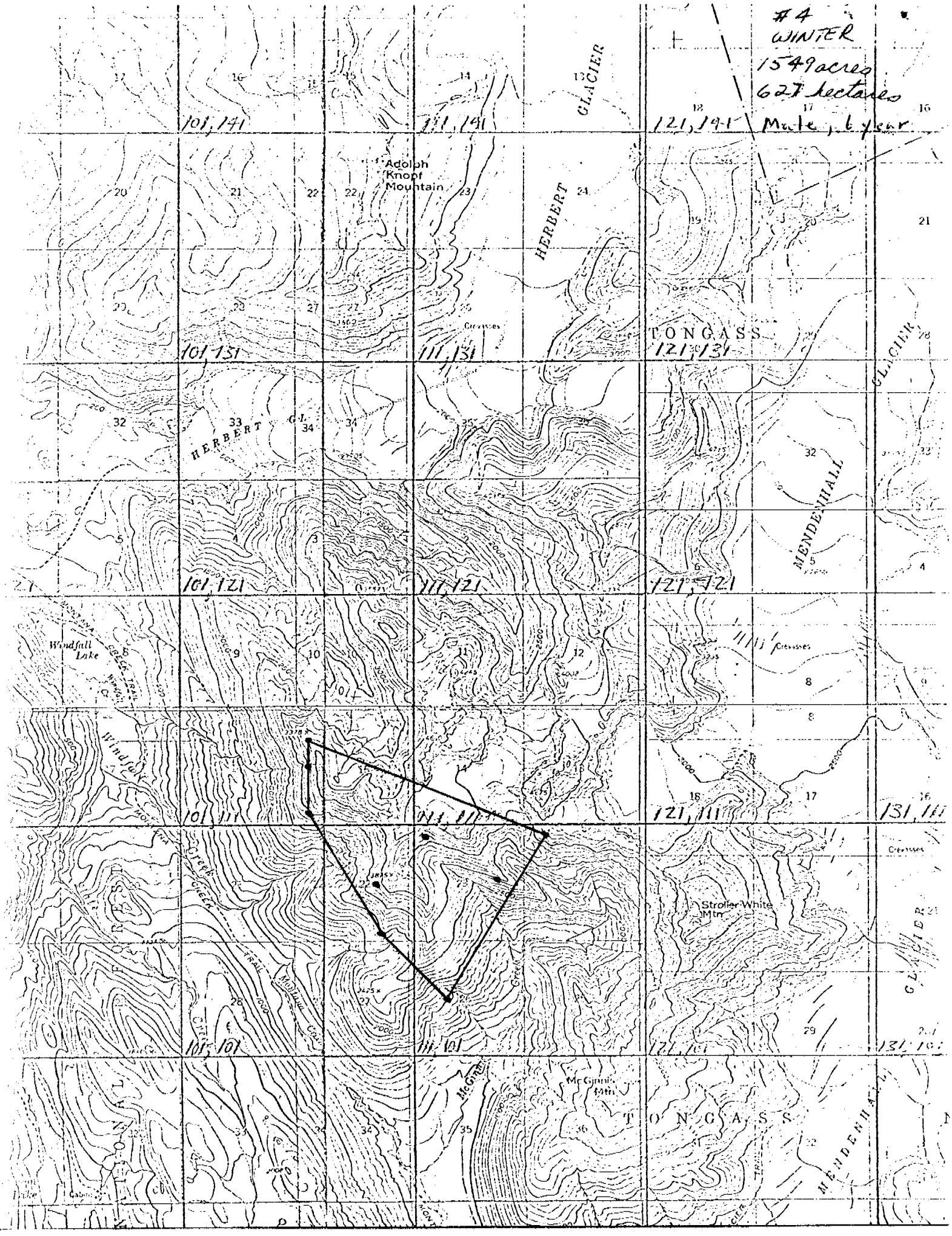

#2
SPRING
141 acres
57 hectares
Female, 6 year
101, 141
111, 141
121, 141
Adolph Knopf Mountain
HERBERT GLACIER
TONGASS
101, 131
111, 131
121, 131
HERBERT G.L.
MENDENHALL GLACIER
101, 121
111, 121
121, 121
Windfall Lake
Windfall Creek
Windfall Harbor
101, 111
111, 111
121, 111
131, 111
Stroller White Mtn.
MENDENHALL GLACIER
McGinnis Creek
McGinnis Mtn.
101, 101
111, 101
121, 101
131, 101
TONGASS

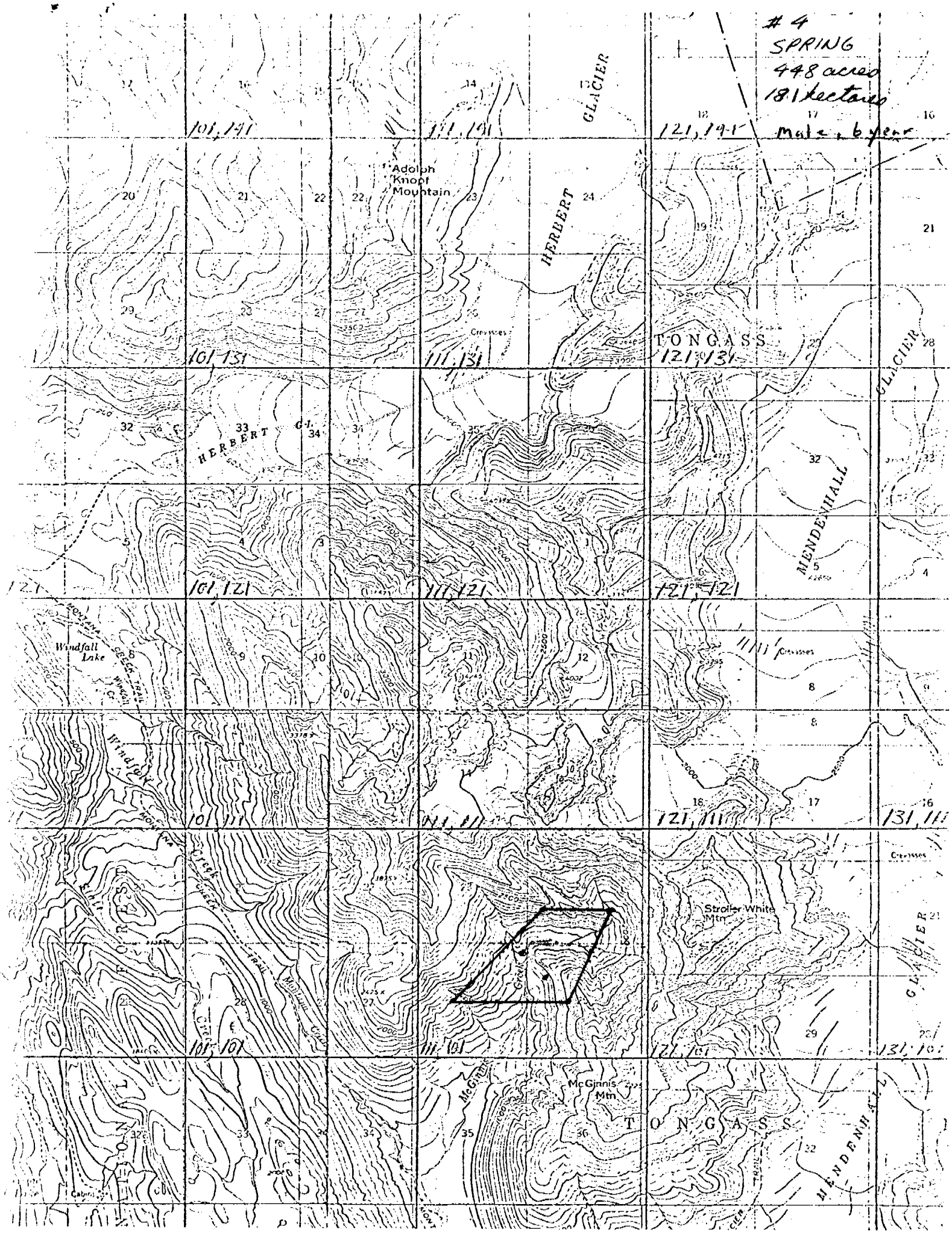

#2
summer
230 acres
93 hectares
Female, 7 year
Adolph Knoof Mountain
HERBERT GLACIER
TONGASS
MENDENHALL GLACIER
Windfall Lake
Stroller White Mtn
McGinnis Mtn
101, 141
111, 141
121, 141
101, 131
111, 131
121, 131
101, 121
111, 121
121, 121
101, 111
111, 111
121, 111
131, 111
101, 101
111, 101
121, 101
131, 101

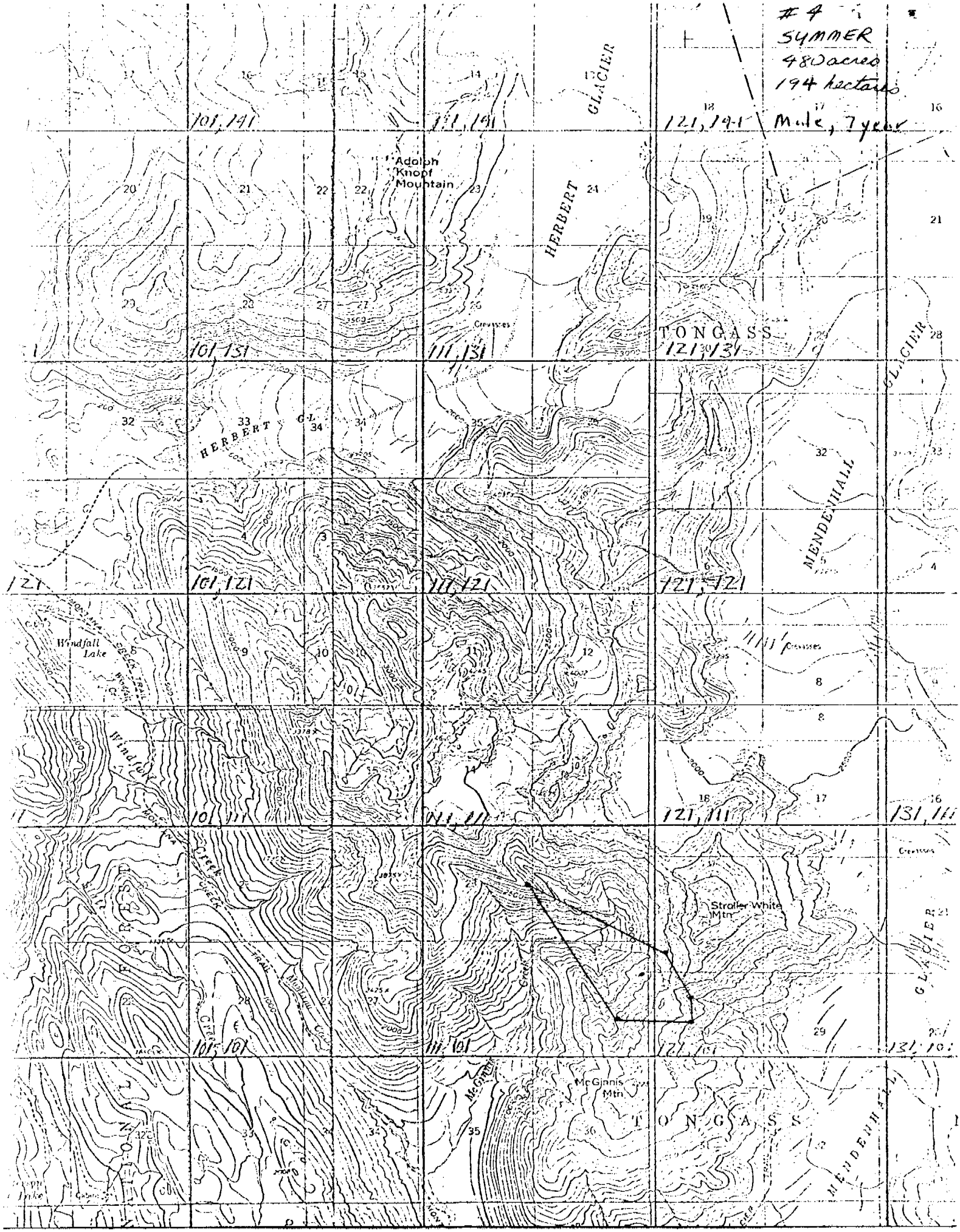

#3
WINTER
986 acres
399 hectares
Mule, 3 year
101, 141
111, 141
121, 141
Adolph Knoof Mountain
HERBERT GLACIER
TONGASS
101, 131
111, 131
121, 131
HERBERT GL.
MENDENHALL GLACIER
101, 121
111, 121
121, 121
Windfall Lake
Windfall Mtn.
101, 111
111, 111
121, 111
131, 111
Stroller White Mtn.
MENDENHALL GLACIER
McGinnis Mtn
101, 101
111, 101
121, 101
131, 101
TONGASS

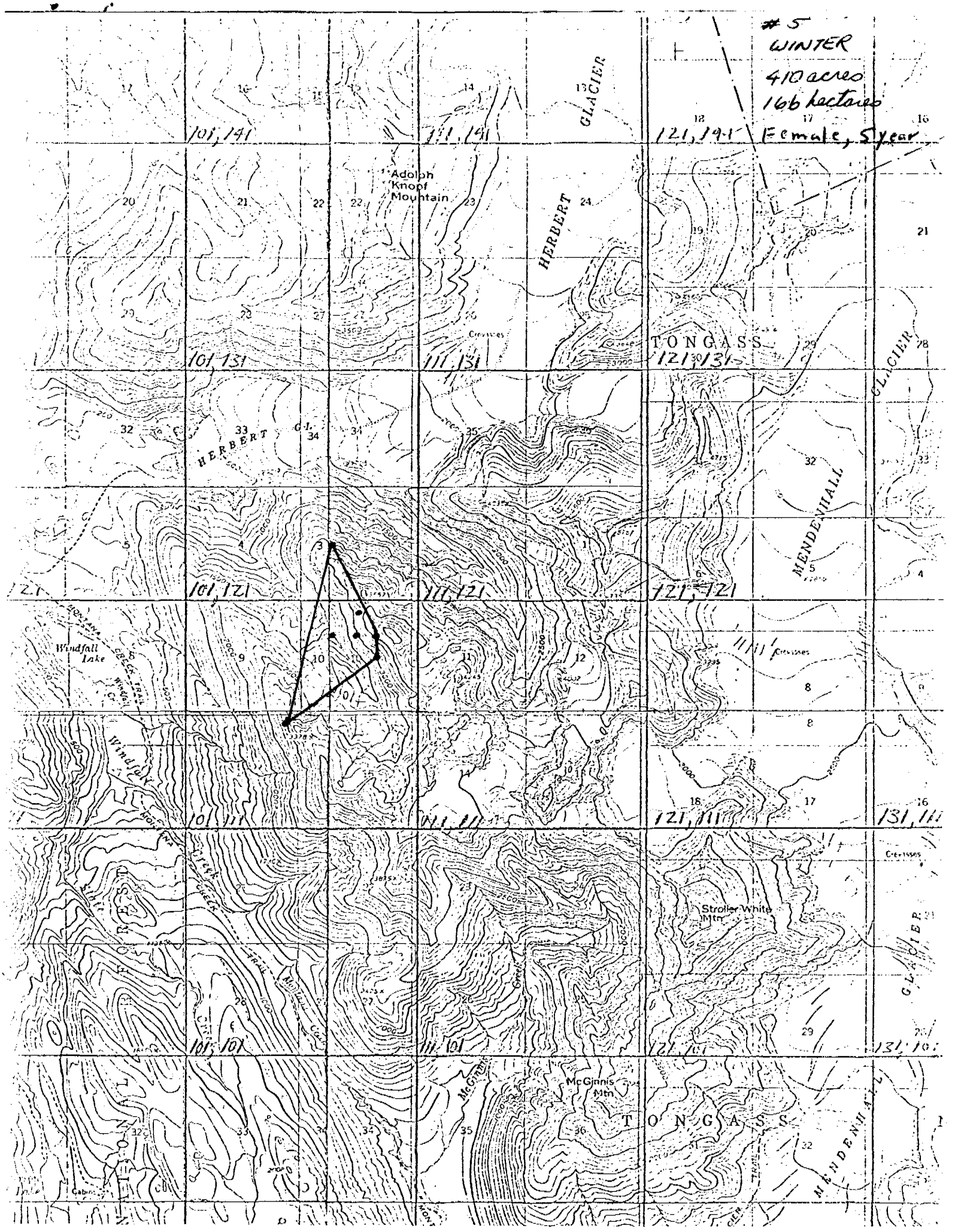

#3
SPRING
294 acres
119 hectares
Mule, 3 year
101, 141
111, 141
121, 141
Adolph Knopf Mountain
GLACIER
HERBERT
TONGASS
101, 131
111, 131
121, 131
HERBERT
MENDENHALL
GLACIER
101, 121
111, 121
121, 121
Windfall Lake
Windfall Cr.
Windfall Cr. Trail
101, 111
111, 111
121, 111
131, 111
Stroller White Mtn.
Creek
Trail
101, 101
111, 101
121, 101
131, 101
McGinnis Mtn.
LYNCH
TONGASS
MENDENHALL

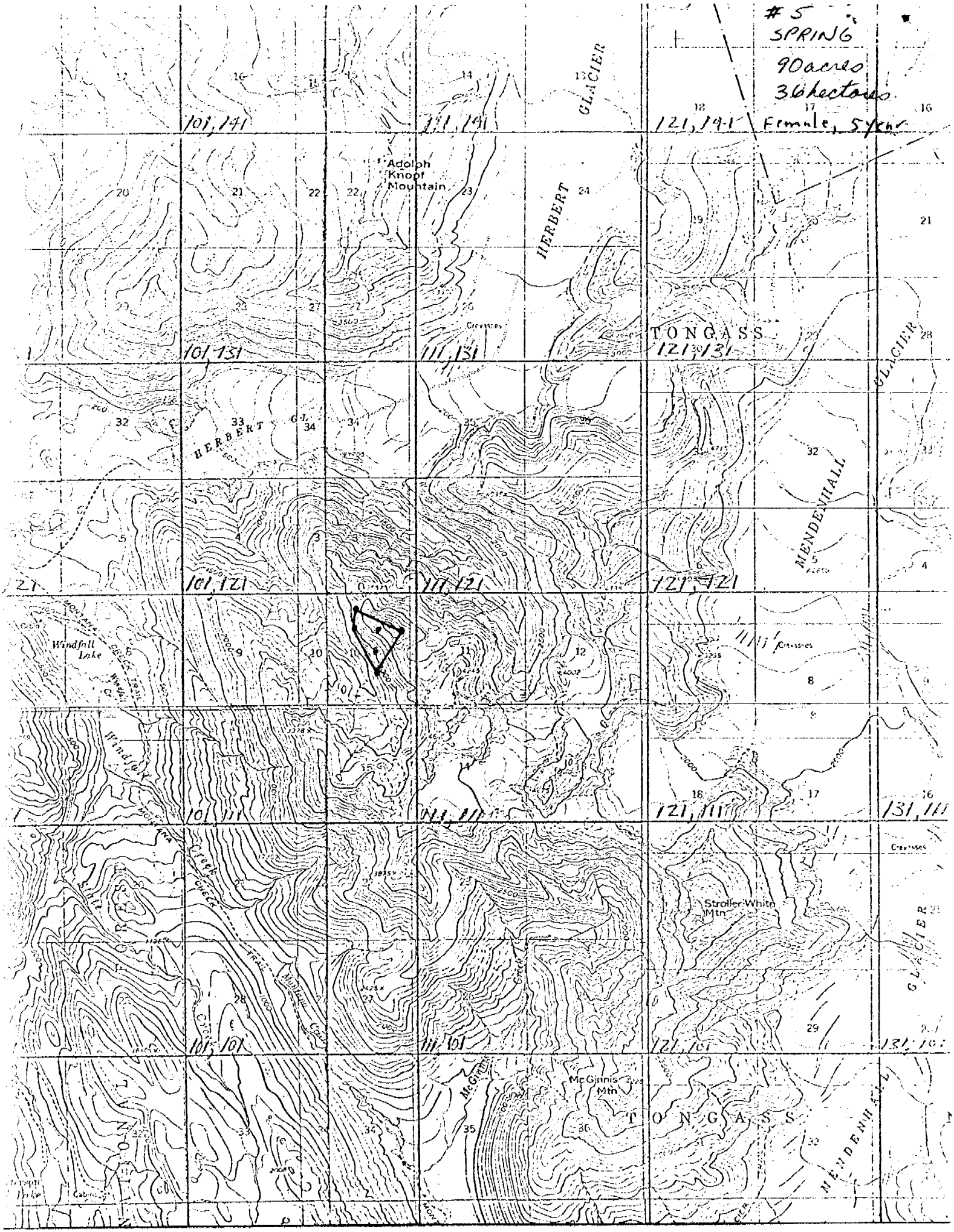

#3
SUMMER
320 acres
130 hectares
Male, 1 year
101,141
111,141
121,141
Adolph Knopf Mountain
GLACIER
HERBERT
TONGASS
101,131
111,131
121,131
HERBERT
MENDENHALL
101,121
111,121
121,121
Windfall Lake
Crevasses
101,111
111,111
121,111
131,111
Stroller White Mtn
101,101
111,101
121,101
131,101
McGinnis Mtn
TONGASS
MENDENHALL

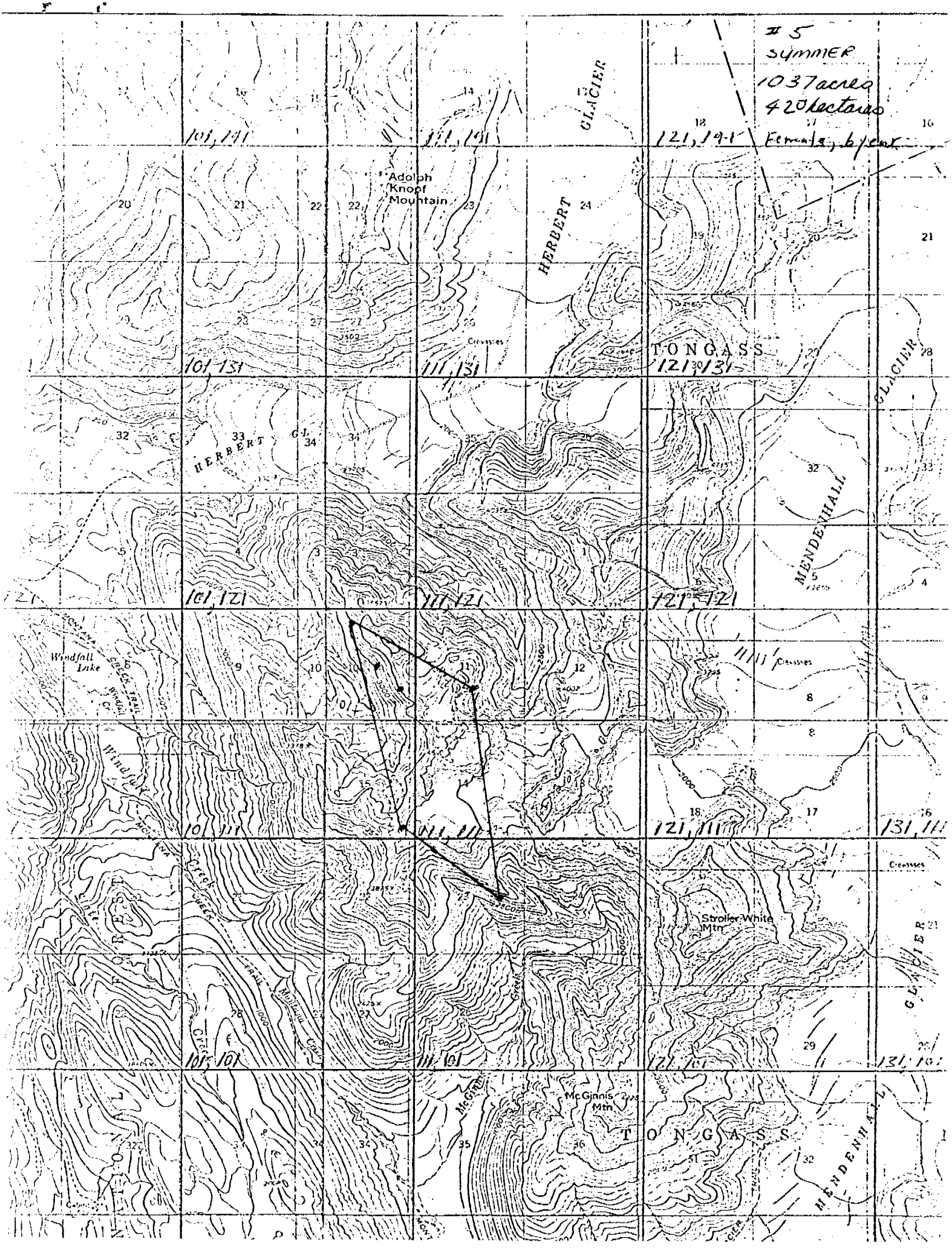

#4
WINTER
1549 acres
627 hectares
Mule, 6 year
Adolph Knopf Mountain
HERBERT GL.
GLACIER
TONGASS
MENDENHALL
Windfall Lake
Stroller White Mtn
McGinnis Mtn
101, 141
111, 141
121, 141
101, 131
111, 131
121, 131
101, 121
111, 121
121, 121
101, 111
111, 111
121, 111
131, 111
101, 101
111, 101
121, 101
131, 101


#4
SPRING
448 acres
181 hectares
male, 6 year
101, 141
111, 101
121, 141
Adolph Knopf Mountain
HERBERT GL.
GLACIER
TONGASS
101, 131
111, 131
121, 131
MENDENHALL
101, 121
111, 121
121, 121
Windfall Lake
101, 111
111, 111
121, 111
131, 111
Stroller White Mtn.
101, 101
111, 101
121, 101
131, 101
McGinnis Mtn.
McGINNIS
TONGASS
MENDENHALL


#4
SUMMER
480 acres
194 hectares
Mule, Tyee
Adolph Knopf Mountain
HERBERT GLACIER
TONGASS
MENDENHALL GLACIER
Windfall Lake
Stroller White Mtn
McGinnis Mtn
101, 141
111, 141
121, 141
101, 131
111, 131
121, 131
101, 121
111, 121
121, 121
101, 111
111, 111
121, 111
131, 111
101, 101
111, 101
121, 101
131, 101


#5
WINTER
410 acres
166 hectares
Female, 5 year
101, 141
111, 141
121, 141
GLACIER
Adolph Knopf Mountain
HERBERT
101, 131
111, 131
TONGASS
121, 131
GLACIER
HERBERT
MENDENHALL
101, 121
111, 121
121, 121
Windfall Lake
Windfall Creek
Windfall Creek Trail
101, 111
111, 111
121, 111
131, 111
Stroller White Mtn
GLACIER
Windfall Creek
Trail
101, 101
111, 101
121, 101
131, 101
McGinnis Mtn
McGinnis Creek
TONGASS
MENDENHALL
GLACIER


#5
SPRING
90acres
36hectares
Female, 5yrs
101,141
111,141
121,141
GLACIER
Adolph Knopf Mountain
HERBERT
TONGASS
101,131
111,131
121,131
HERBERT GL.
MENDENHALL
GLACIER
101,121
111,121
121,121
Windfall Lake
101,111
111,111
121,111
131,111
Stroller White Mtn
101,101
111,101
121,101
131,101
McGinnis Mtn
TONGASS
MENDENHALL GLACIER


#5
summer
1037 acres
420 hectares
Female, 6 year
101, 141
111, 141
121, 141
Adolph Knopf Mountain
HERBERT GLACIER
TONGASS
101, 131
111, 131
121, 131
HERBERT GL.
MENDENHALL GLACIER
101, 121
111, 121
121, 121
Windfall Lake
Crevasses
101, 111
111, 111
121, 111
131, 111
Stroller White Mtn.
101, 101
111, 101
121, 101
131, 101
McGinnis Mtn.
TONGASS
MENDENHALL GLACIER