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Conservation

Life History Studies of Caribou in Spatsizi Wilderness Park 1977 - 78

By A.T. Bergerud and H.E. Butler
November 1, 1978

Parks Branch Report

Province of British Columbia

Ministry of Recreation and Conservation

PARKS BRANCH

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Victoria
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November 1, 1978

Dear Reader:

The following report, "Life History Studies of Caribou in Spatsizi Wilderness Park 1977-78" was produced for the British Columbia Parks Branch by Dr. A.T. Bergerud and Ms. H.E. Butler. This study makes a significant contribution to our understanding of the resources of Spatsizi Wilderness Park and will undoubtedly broaden our management perspective. However, this study is just one of an ongoing research program within the Park, and as such, should not be viewed as definitive government policy.

Yours very truly,

J.D. Anderson,
i/c Environmental Management.

LIFE HISTORY STUDIES OF CARIBOU IN SPATSIZI

WILDERNESS PARK 1977-78

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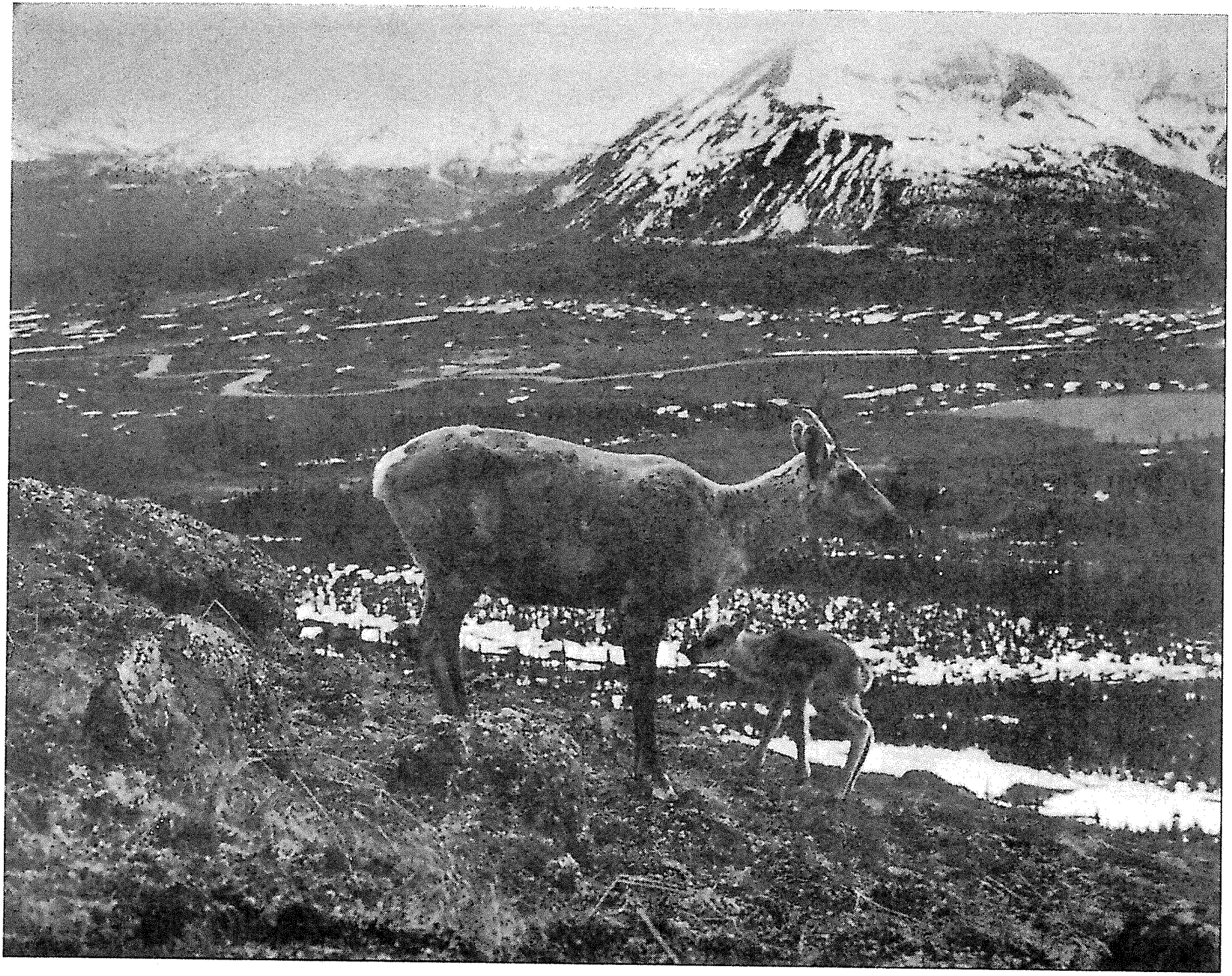
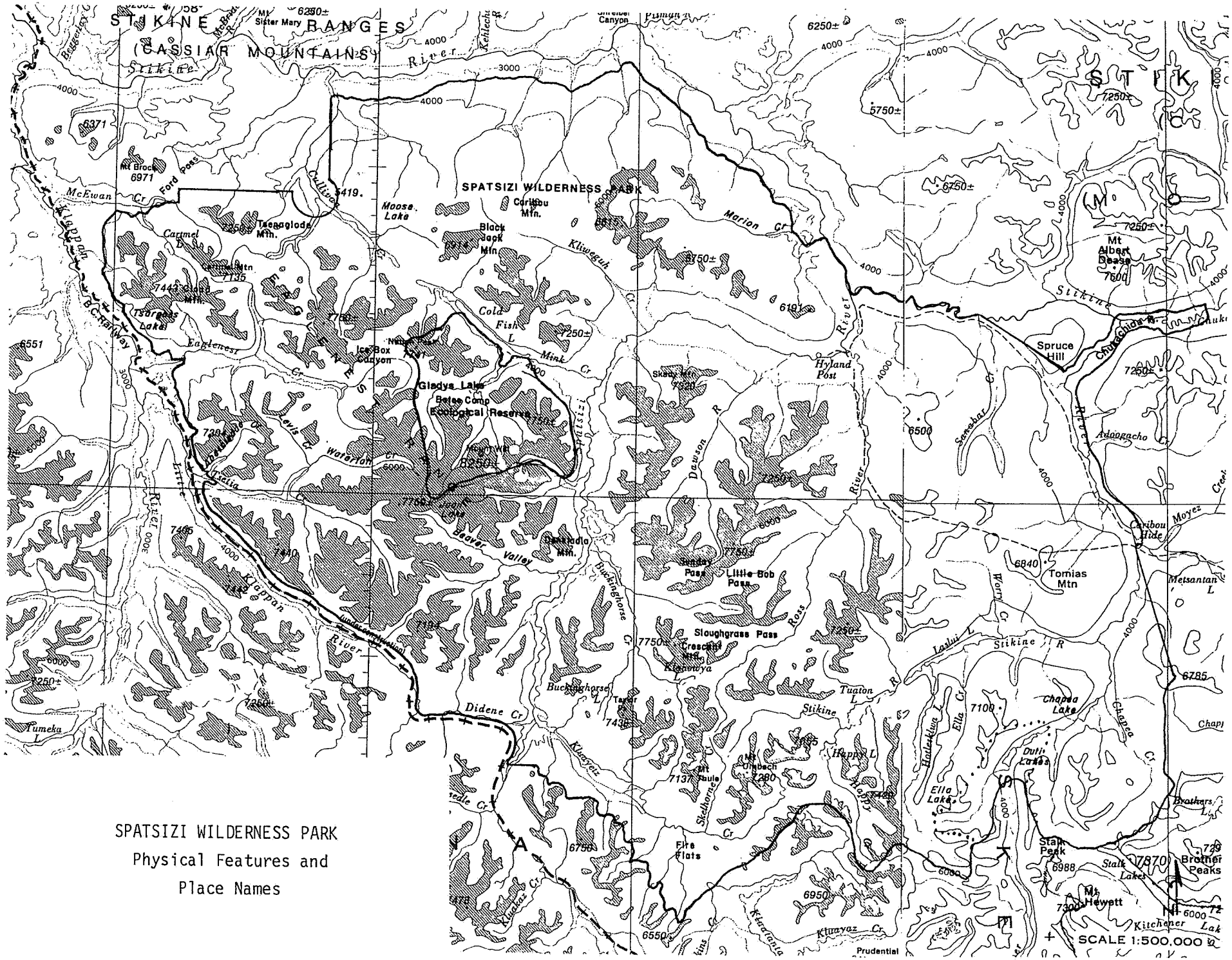


An old-lady with friend at birth site, 5800 feet, Fire Flats below.



SPATSIZI WILDERNESS PARK

Physical Features and

Place Names

ABSTRACT: We studied the life history of caribou in Spatsizi Wilderness Park from May 25-July 30, 1977 and October 7-22, 1977. From February 3 to February 10, 1978, a wolf census was conducted and the calf production determined for moose. Caribou calving occurred from about May 28 to June 9, 1977. The peak was possibly June 3-4. At least 83 percent of the females gave birth, but by July 1 about 87 percent of the calves were gone. There was no evidence of calf mortality from windchill or stillbirths. Predators - grizzly, wolves and possibly wolverine were hunting caribou calves and we believe predators caused the calf loss. Miscellaneous information is presented for caribou food habits, distribution, behaviour, range, and morphology. The wolf population was estimated at 64-75 wolves in 3200 square miles. Calf moose comprised 7 percent of the February population. Caribou, and likely moose, are probably declining at a 9 percent rate. The primary cause of the decline is poor calf survival in both species. If predation pressure on the recruitment of caribou and moose is not reduced, we predict further decline. Hunting contributes a small portion to the decline. The caribou herd is threatened by road development outside the Park. One road north of the Park along the Stikine will likely intercept migrating caribou from Caribou Mountain and provide legal and illegal hunting access. A second road (Omineca North Road) is planned to reach Black Lake Mine and Lawyers Pass. Lawyers Pass is possibly the crossroads for the largest herd of caribou left in B.C. We argue that access, through increased mortality, will cause further decline of these herds.

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ACKNOWLEDGEMENTS

We would like to acknowledge the assistance of G. Hazelwood who went ahead and found financial support for this work. We apologize for not doing a better job - we made some mistakes and had logistic and weather problems. We have gained from our experience and next time around will be better. We would also like to thank our assistants, D. Miller and D. Newell. Our appreciation is also extended to C. Simmons and R. Bruns for their thoughtfulness and flying expertise.

INTRODUCTION

We investigated the life history of the woodland caribou *(Rangifer tarandus caribou)* in Spatsizi Wilderness Park during the summer and fall of 1977 (Table 1). The primary objective was to investigate the population dynamics of the herd - to decide the population trend and the reproduction and mortality parameters affecting this trend. When it became apparent from the summer studies that predation was important, the senior author returned to the Park in February in the hopes of counting wolves *(Canis lupus)* and alternate prey, moose *(Alces alces)*. Also, we asked R. Bruns to conduct aerial searches for caribou and wolves in December and January.

A second objective was to investigate adaptive strategies of woodland caribou relative to reproduction (both calving and rutting), and escape strategies relative to insects and predators. This work is being done by H.E. Butler as a partial requirement for the degree of Doctor of Philosophy. She plans to compare the behavior of caribou in Spatsizi with other populations of woodland caribou in North America. By using the comparative approach, one can discern adaptive modes that are not apparent from single population studies. By knowing which components of the environment are the selective forces and the range of adaptive response of the species, one may use this information to predict adaptations and propose hypotheses about untested populations. We are interested in the functional and evolutionary significance of these strategies. This work has just begun and any results reported here are just a bare-bones initial analysis subject to reinterpretation later.

METHODS

Weather

We established two weather stations - the major concern was to evaluate the possibility of windchill on calf survival. One station was established at 5500 feet on a flat aspect approximately 100 feet from a SSE slope. The other station was located approximately .75 mile from the second station, downslope at about the 4500 feet contour in Buckinghorse valley. Both stations consisted of a hygrothermograph, a totalizing anemometer and a rain gauge. Both hygrothermographs and anemometers were placed 2-3 feet above ground level so as to record representative weather to which calves were exposed (see Appendix D).

Insect Abundance

The abundance of insects was measured by collecting flying insects in a sweep net. A sample consisted of 100 sweeps as the observer walked a transect near camp. Sweeps were made when convenient with the exception that early and late time periods were excluded (normally done between 10:00 a.m. and 4:00 p.m.). The transects were walked on dry sites, usually in the vicinity of *Betula*-grass communities. The sweeping technique seemed to under-represent biting insects. We also subjectively rated the abundance of biting insects based on harassment to ourselves and additionally sometimes recorded bites or insect landings on an exposed hand or arm for 1 minute.

Vegetation Analysis

It was not our intent to do a comprehensive vegetative survey. We were interested in securing enough data to try to understand vegetative factors affecting distribution. Also, the caribou in Spatsizi are renowned for their large size - could this be simply explained by superior nutrition during the growing period than found in other caribou herds?

On Fire Flats, we measured the frequency of plant species and percent cover within plant associations by examining square meter quadrats in the second week of July. First, a uniform plant association was selected, then a site for the first quadrat was selected by tossing a stick, hat or other object. Four more m^2 quadrats were then established radiating from the initial one in the four primary compass directions (E,N,S,W). This method has been used in Newfoundland by Ahti (1959) and Bergerud (1971).

The extent of plant associations on Fire Flats was determined by recording the linear feet that crossed the associations on perpendicular transects. These transects were paced in the second week of July.

We were also interested in the abundance of arboreal lichens between north and south slopes in the subalpine life zone, and in the boreal forest. Fire Flats is in the subalpine life zone, whereas the north slope of Caribou Mountain is in the boreal forest (Rowe 1972). One arboreal lichen transect was run downslope from tree-line to Fire Flats on the north side of the valley, and one transect was run in a like manner down the south facing mountains adjacent to Fire Flats. A third transect was traversed on the north side of Caribou Mountain.

On these transects, we counted all trees within 1 metre of our line-of-travel. Data recorded included D.B.H. (diameter breast high), species (alpine fir or species of spruce), height and lichen loads. Lichen loads were classified as light, medium, and heavy. One tree was cut down and the lichens picked and weighed to help standardize the light, medium, heavy categories. Increment borings were secured from some trees.

The forage in several m^2 quadrats was picked and weighed green and air dried, to gain some appreciation of biomass. Leaves of birch *(Betula glandulosa)* and *Salix* sp. were plucked from the stems in a manner similar to how a caribou might strip the leaders. The following species were collected and sent to the Ministry of Agriculture for chemical analysis:

1. *Betula glandulosa*
2. *Carex aquatilis*
3. *Festuca altaica*
4. *Salix planifolia*
5. *Salix barclayi*
6. *Stereocaulon paschale*

Since we found that caribou prefer to feed in low shrub communities, we recorded the height of shrubs on transects across Fire Flats. Height classes recognized were:

¼ m tall
¼ - ½ m tall
½ - 1 m tall
1 m tall

We kept some notes on plant phenology - flowering and leafing, etc. In addition four lupines *(Lupinus arcticus)* were checked daily, the number of heads in bloom counted and the number of heads with seed pods counted (June 10 to July 14).

Food Habits Analysis

Two rumen samples were analysed - one to represent the summer diet (July 12) and one the fall diet (October 16 - see Osmond-Jones et al. (1977 for methods). On July 15, a transect was walked across an area of heavy use, and every 10 feet, the species in front of the right foot was recorded and noted whether it had been stripped by caribou. On October 18,

25 feeding craters were examined at Tomias Mt. and the species present recorded. In addition, throughout the study, we recorded the plant associations where caribou were seen feeding.

Measurements of Animals

Animals collected were measured using the measurements outlined by Dauphine (1976: 15). Some other measurements were also listed - total length (B), shoulder height (B) and hindfoot (B). These are measurements used by Bergerud since 1956. The total length (B) was measured from the tip of the nose along the dorso-medial line to the last tail vertebrae - the tape was not stretched tight but followed the body contours. Hindfoot (B) was measured along the plantar surface from the tip of the hoof (the hoof bent down parallel to the lower leg bones) to the distal tip of the large metatarsus. Shoulder height (B) was from the tip of the hoof to the dorsal surface of the thoracic vertebrae (the leg was pulled out for a maximum measurement).

We also measured cast antlers found on the ground. In most cases, female antlers could be told from male antlers based on smaller beams and lack of palmation on the brow and bez points.

Capturing Animals

We attempted to capture animals with Capchur dart gun equipment but were unsuccessful (Table 2). If it is desirable to capture caribou in the future, the best technique is to ambush them at salt licks. If the caribou are within a half-mile of a lick they will frequently come to the lick during bouts of feeding. The most heavily utilized lick on Fire Flats is located about .5 miles from the southeast end of Kluayetz Pond on the north side of Kluayetz Creek. It can be easily seen from the air. Another successful technique should be to land with a helicopter near females with young calves. We tried the technique on June 10 but it was then too long after calving. We found the animals extremely difficult to stalk - probably only male groups should be attempted by the stalking method.

Scat Collections

During the course of the work we recorded miles walked so as to relate predator abundance to a mile/scat index. In addition, 166 wolf scats were analysed for food content and 21 grizzly scats. The methods are described in a separate report by D. Newell.

Scats were separated into 5 age classes: fresh, medium old, leached, bleached, and old (Table 3). We feel the scats classified as fresh to bleached were less than four months old. The bleached scats were the oldest of this group but they should still not have been older than 4 months for the following reasons:

1. Bleached wolf scats were found August 2 at a den used by wolf pups. Animal remains at the den appeared to be fresh this year - bones were still connected by tissue.

2. Four bleached wolf scats were found that contained the hooves of caribou calves.

3. Scats collected at Hyland Post were mostly bleached and most contained hair, yet observations by Bergerud, Bruns and others indicate that wolves in this area hunt primarily moose in late winter.

4. Bleached scats collected at Tuaton and Buckinghorse Lakes again contained mostly caribou, yet hunters left several moose carcasses at these areas in the fall.

5. Bleached scats were found at the remains of moose calves that died from 9-14 months of age (predator kills) yet the scats usually had caribou hair. We believe wolves revisit or visit moose remains, possibly to gnaw on bones.

6. We found less old scats than bleached ones (Table 3). Old ones should be the most abundant without decay. However, old scats were rapidly disappearing.

7. Bleached scats were found only in dry sites - in wet sites they were already gone - this suggests a rapid decomposition.

8. Bleached scats were found containing remains of rodents that hibernate.

9. Bleached scats were found at a moose kill where there was plenty of animal tissue and odor still left.

For these reasons, we believe scats that we collected, that were compact, round and not crumbly represented primarily the diet of wolves during the growing season. In another year, we would not collect the old amorphous scats. Scats with mold suggest decay under wet conditions - possibly snow.

PHYSICAL CHARACTERISTICS

The caribou in Spatsizi have a reputation for large body size: many of the top trophies have come from Cold Fish Lake. We collected one female in July that weighed 310 pounds. This female was both old and without backfat, yet she was large (Table 4). M. Sather measured hunter-killed caribou at Spatsizi in September 1976. For males, his measurements were:

	Male 1	Male 2	Male 3	Male 4	Male 5
Total Length (inches)	92.9	87.0	83.9	85.8	88.6
Heart Girth	61.0	66.9	65.0	61.8	77.2
Hind Foot	24.8	-	-	-	-
Shoulder Height	-	-	-	-	63.3

R. Collingwood provided measurements of two hunter killed males in September 1977. They were:

	Male 1	Male 2	Spatsizi $\bar{x} \pm$ sd(n)	Average (Banfield 1974) $\bar{x}$
Total Length	80	81	86 $\pm$ 5(7) in.	71 in.
Heart Girth	60	62	65 $\pm$ 6(7) in.	
Hind Foot	23	23.5	27 $\pm$ 5(3) in.	20 in.
		Shoulder	63 in.	43 in.

We captured two newborn calves. One weighed 20 pounds (Table 4). A sample of two is minimal, but both calves were very large compared to caribou in Alaska, N.W.T., or Newfoundland (Skoog 1968, Kelsall 1968, Bergerud 1971b). There is no reason to doubt the generalization that caribou in northern B.C. are exceptionally large. In A.T. Bergerud's experience, the size ratio between males and females seems greater than in other populations he has looked at. We need weights from males also.

Our measurements of male and female antlers failed to show any differences in size between Caribou Mtn. and Level Mtn. for either females or males (Table 5). We found an antler of a male at Buckinghorse Lake which was 53½ inches long, and one at Level Mtn. which was 52¼ inches long (the largest antlers we found). The greatest difference noted between the two populations was the burr size (length x width) of females 5.0 (Fire Flats) versus 5.6 (Level Mtn.) (Table 5), but the difference was not significant ($t_S = 0.9715$). Hence none of the measurements are likely to differ. Figure 3 shows the antlers of a representative sample of females. For the most part, female antlers are about the size of female antlers A.T. Bergerud has seen in Newfoundland. Female antlers shed many years earlier (told by lichen growth on the antlers) were the same size as the present antlers.

In Table 4, we compare the antler size of the males harvested in 1977 with the cast antlers found. The latter should be a random sample of the population. There was no difference - the hunters at Cold Fish were not selecting the largest animals. This may relate to the rareness of males in the population or possibly the mode of hunting of the outfitter. There was one very nice trophy secured at Cold Fish with a total length of about 47 inches. The ages of the animals shot were (based on wear of molars and premolars):

3-4 years	2 males
4-6 years	5 males
7-9 years	2 males
10+ years	1 male

In September 1976, A.T. Bergerud classified 294 females as to whether they had antlers. He counted 290 with antlers (99%). The females were shedding their velvet the last of September:

	% in Velvet
September 28	26 (n = 74)
29	8 (n = 25)
30	2 (n = 48)

Thus they shed their velvet about 2 weeks before estrus. In Newfoundland and Gaspe, Quebec, the females also shed their velvet in the two weeks prior to breeding (Bergerud 1976).

In Table 6, we show antler growth between males, barren females and parous females. Antler growth is a truly remarkable physiological feat. Inches are added almost overnight. The length of growing antlers can be used to separate fertile and non-fertile females at calving time (Table 6).

The picture we feel, is that there is far less synchrony in antler shedding and growth in this population than elsewhere. Hatler (pers. comm.) reported large males with hard antlers in March 1976, an unusual event as in other population large males shed their antlers in November or December. We also saw bald adult males June 5 and June 12, when most other males had at least 8 inches of antler growth (Table 6). Sex and age classes seem to be considerably more out-of-phase here than elsewhere (c.f. Skoog 1968, Bergerud 1976).

BEHAVIOUR AND DISTRIBUTION

Spring Migration

Bergerud flew on May 20 and May 22 looking for migrating caribou. We felt that our field camps should be placed in the path of the migrating animals. It was assumed that animals would be migrating from the winter range on the north side of Caribou Mountain and the upper Stikine river (Caribou Hide area). Thus flight lines were flown both north and south of the Stikine. Very few caribou were found anywhere. The following caribou were seen:

1. Dawson Creek
   May 22: 8,4,6
2. Laslui-Tuaton
   May 20: 4,4,7,1,4,4,7
   May 22: 17,7,5,6,6,1,1 and 4 wolves
3. Upper Ross R.
   May 20: 7,4
   May 22: 2,2
4. Buckinghorse Creek
   May 22: 3,3,10,8
5. Kluayetz Creek
   May 22: 21,2,7
6. Caribou Mtn. 8 miles N.W. of Hyland Post
   May 20: 6,3
9. Lawyers Pass
   May 20: 7
10. Sturdee R.
   May 20: 1,1,2
11. Mt. Terraze
   May 20: 2
   May 22: 2,2 and a sow Grizzly with 3 cubs
12. Caribou Hide and Metsantan
   May 20: 7,4,2,3,2
13. Kutcho Creek
   May 22: 2,1

Totals were: May 20 = 82, and May 22 = 117, mean group size was 4.5. In 1976, A. Sinclair flew flight lines May 25, 26, and 27 and saw 96 animals. Groups seen were 19,1,3,2,1,5,2,1,1,3,1,1,1,1,5,1,4,3,5,3,4,2,1,2,1,2,3, 2,2,3,4,2,1,3, and 1. Mean group size was 2.7.

In both years, the animals seen were in the open and feeding in lichen - *Festuca* communities, and were in valleys leading from the lower Stikine country toward Fire Flats (Fig. 5). However, in 1976 the animals were still far from Fire Flats, whereas in 1977, even though it was one week earlier in time, there were no animals at Fire Flats, and most animals were still quite far to the north.

Movement from the winter range to calving areas in 1977 was (1) up the Stikine River then towards Fire Flats via Happy Lake or the Skelhorne corridor, (2) up Dawson Creek across Griffith Pass to Buckinghorse Lake and the Flats, and (3) up the Ross R. to Klahowya Lake (they did not go from the Ross to the Skelhorne) then to Buckinghorse and the Flats. There were no caribou traveling up the Spatsizi River, but in 1976, Sinclair saw three aggregations along this river.

Many of the groups never reached Fire Flats prior to calving, even though they assembled there post-calving. Some caribou moved directly from the Buckinghorse dry benches and the upper Stikine Flats into the mountains.

On May 20, 1977 there were snow blocks at Buckinghorse Lake, Skelhorne corridor, Happy Lake Pass and Kluayetz Creek Pass. Caribou were feeding on dry lichen-grass benches 5-10 miles downstream from the passes. On May 22 there were a large number of tracks across the Buckinghorse Pass - we found 21 caribou at the end of these tracks on the Kluayetz Flats. There were also tracks across Griffith Pass. Three tracks also crossed the Happy Lake Pass. These tracks were followed 18 miles. The animals came through the pass and turned southeast toward Kluayaz Lake. The snow line on May 22 was at 4500 feet. Thus the Kluayetz Pond and Fire Flats were covered with snow. Some animals came through the passes at either end but kept to the lower ground. As the snow line retreated, animals moved towards Fire Flats up the Kluayetz Creek and Kluatantan River.

Why were so few animals seen in May in both 1976 and 1977? The caribou that were seen were feeding in the open. There was snow in the woods and the available foods were lichens, especially *Stereocaulon paschale*, that were out in the open. There were no caribou up high in 1977 in May. In July, there were 364 animals on the Flats in 1976, and perhaps 250 in 1977. There were also 50 animals on the Stikine Flats in July 1976, and a post-calving aggregation on Caribou Mtn. on July 4, 1976 of 67 females (Osmond-Jones et. al. 1977).

When we searched for animals on the ground near Buckinghorse Lake, the last week of May, we did find some animals on forest edges. Other caribou moved through tree cover as they travelled past Buckinghorse Lake on the way to the Flats. In 1977, we probably saw sufficient caribou on May 20 and 22 to account for the animals that concentrate at Fire Flats. The counts in 1976 were closer to the time of calving (mean aggregation was 2.7 versus 4.5 in 1977) and animals may have been dispersing to calving locales.

Aerial surveys in neither year found animals that could in any way account for the animals that concentrate on Tomias Mtn. and Caribou Mtn. in the fall. These rutting grounds must be magnets drawing animals from extremely long distances. Possibly, when we talk about resident caribou in the Park, we should relate this to calving and post-calving groups (less than 400 caribou).

The caribou on the rutting grounds (about 1600 caribou) appear to be in the Park for a few weeks in September and October only. Further, the animals that winter in the Park approximate the post-calving concentration and not the rut gatherings.

Another question - did the caribou in 1976 reach the mountains adjacent to the Flats by calving time even though they had considerably farther to go than did animals in 1977? This latter sequence implies a rapid movement at the last moment. Biologists were in the area June 8-9 and saw in the vicinity of Thule and McCumber Creeks 39 caribou (1 calf). They also received a report from the B.C.R. employees that caribou had just moved into the area during the past week. Later in July, Hazelwood and Pojar saw 11 caribou (3 calves) on the mountain west of Buckinghorse Lake on July 14, and 3 cows and 1 calf on Taylor Mtn. July 15. Cows with calves would not have traveled to these mountains after calving. The data suggest that animals reached the adjacent mountains in both years even though 1976 was a late-phenology season and 1977 an early phenology year.

A second objective of the spring flights was to classify females as to the possession of antlers. In other caribou populations, barren females shed their antlers in March-April while parous females retain theirs until the time of calving (Skoog 1968, Bergerud 1976). Thus a pre-calving tally of antlers should provide insight into fertility. I tried the technique on 18 caribou at Dawson Creek on May 22. There were 7 females without antlers, 2 females with 2 antlers and 2 females with 1 antler. Hence some pregnant females had already shed their antlers even though calving was a week away. The technique was abandoned. However, in another year, I think the technique should be tried again about May 1. If it is valid, it provides an easy, quick method to determine pregnancy percentages for large sample sizes.

Calving Behaviour

Caribou disappeared from the Buckinghorse Flats between May 27 and 28 (Table 7). We saw our first new calf on June 5. Calving probably started by May 29 or 30. Calving was over by June 9, a flight on June 10 failed to reveal any young calves.

We visited a number of birth sites. Generally, the caribou selected south aspects (Table 8). Females were alone at calving. We saw 2-4 females together on Umbach Mtn., (Table 9) but each of these animals went up on the mountain alone. Presumably it was an independent seeking of high elevations that brought them together on the ridges. Tradition may also be a factor - returning to the same area in subsequent years.

The birth sites all had good visibility. Some were at the highest point on a ridge, some overlooked cliffs. All animals selected relatively flat areas for parturition. The parturition sites could be told by many tight piles of winter-type pellets. Vegetation was usually scarce or absent (Tables 10 and 11). A female in the Turnagain had selected a site in which the entire surface of the mountain was rock - A.T. Bergerud could see no sign

of vegetation from the air. Some of the parturition sites appeared to increase the vulnerability of caribou to accidental encounters with predators. For example, animals would calve on a razor back - the only travel route for other caribou and predators would be along the same route. If predators were using sight to locate females, these high exposed positions would make them more vulnerable. However, if predators search by scent, then being high, would frequently result in scent passing over a predator. We noted that at Thule Mtn., wolves travelled frequently along a trail perhaps 500 feet below where a cow and calf were. These wolves did not detect this calf until we flushed the female and she relocated herself at a lower elevation.

Caribou sought peaks and high south aspects (Table 8, Fig. 3). Since the prevailing winds are from the south, this selection reduced the detection by predators.

Wind Direction	Days Wind Recorded From:		
	Camp 1	Camp 2	Total
South	7	15	22
East	1	9	10
West	5	2	7
North	4	4	8
Southeast	9	2	11
Southwest	14	4	18
Northwest	7	-	7
Northeast	1	5	6

However, we think the primary reason animals select high elevation may include:

1. dispersal from other prey such as moose - bears may be hunting moose at low elevation
2. dispersal from each other and thus spreading the risk of encounters by predators
3. nearness of escape cover

We saw two escape flights of cows and calves and these involved caribou running long distances and seeking higher, ever more steep environments. When the caribou calve, they select bare ground - they can be no higher than where bare ground is. But snow is continually melting, and following calving, new escape areas continue to emerge. We have now recorded calf survival after a late winter in 1976, and early winter in 1977. The caribou did not fare much different between the two years.

We noted 2 of 14 calves crippled on Fire Flats and one cripped calf in the mountains. Two of the animals appeared to have broken their front leg. This percentage is extremely high and these calves were extremely vulnerable to predation. These injuries must be part of the price the animals pay for calving in such rough terrain. We watched females lead calves up into terrain where goats were found, and where the slopes were so steep they had to zigzag to climb. We also saw them go up inclines or over rock faces where the calves could not follow. It was an extremely tough environment - both food-wise and weather-wise. Predator escape seems the only rationale - bulls and barren females remained below, feeding on new green growth.

Post-calving Behaviour

Following calving, caribou began to group on the Flats. The first large group of 25 animals was seen June 12 near Thule Creek. The herd continued to build after that day until a peak was reached on June 29 of 236 animals (Table 12). We learned to recognize several animals and saw them on many different days. The herd decreased after June 29, but again increased July 8-9. This increase appeared to be due to new animals - probably mostly females from the mountains. Several new calves joined the herd. The herd then went down quite fast and was gone when we left July 15 (Table 14). On July 14 we noted 33 caribou far to the southeast, near Merry Creek. Some animals had gone that way. We saw caribou moving up Thule Mtn. on July 2. D. Miller saw 14 animals on Umbach Mtn. on June 25 and 6 caribou on July 6. Five males were seen leaving Fire Flats up the Skelhorne Creek on July 6 also.

Our hypothesis was that the Fire Flats post-calving aggregation would disband with the emergence of warble flies. However this year, they were gone by mid-July, whereas in 1975 and 1976, animals were common on the flats at this time. We did not note warble flies by the time we left on July 15. The hypothesis we now present is that the caribou left earlier in 1977 than 1976 because of differences in mosquito numbers. There were few mosquitoes on the Fire Flats in mid-July 1976 (Hatler, pers. comm.). The entire phenology in 1977 was 1-2 weeks advanced over 1976. Mosquitoes first became bothersome in 1977 about June 11 (Tables 15,16,17) but they really became bad in the first week of July (Table 16) when the herd started to disperse. It may be more complex than this - for example, warble flies likely require moist substrates to pupate. Part of the adaptive strategy of caribou might be to use drier, high elevation habitats where warbles would have reduced survival at pupation. But against this, if warbles emerged on wet sites at Fire Flats and caribou had left for the snowfields, there could be a dispersal advantage.

We had hoped to gain insight into the functional significance of the post-calving aggregation. The Fire Flats gathering may be the largest in B.C. There may also be large herds at the Liard Plateau, Level Mtn. and Kawdy Mtn. Some possibilities are:

1. Caribou gather at Fire Flats simply because they calve nearby and early grass and then willows are most abundant on the Flats. The basic tactic is the location of the calving ground - animals seek first good calving areas, and then congregate on the nearest extensive green forage.

2. Animals come from long distances to Fire Flats because of the excellent greens and willows.

3. Animals gather at Fire Flats because of some distinctive features of the Flats. Two distinctive features are the many salt licks (Fig. 4) and the many streams. These streams may be of value in predator interactions.

4. The caribou gather on the Flats for reasons of socialization (Miller's hypothesis 1974). The distinctive feature is the large open areas for visibility (and of course good food would need to be available - this would exclude Tomias, Caribou Mtn., etc.).

5. They gather at the Flats for reasons not to be explained by the present environment. It is a tradition and has its roots in the history of the race.

6. Females gather together as an anti-predator strategy (Bergerud 1974b).

We have not come very far in our understanding. We know males come to the Flats equally as do females. We know that females without calves come as well as females with calves. We also know that there are other post-calving gatherings at Caribou Mtn. and the upper Stikine flats. The little insight we have suggests to us that hypothesis 6 is weakened by the data at hand, while hypothesis 1 is enhanced. Tagging and movement studies, and maybe even experimentation (homing experiments) may be needed to advance farther. Caribou gatherings in other locales seem to involve areas with few licks and streams (No. 3). Only by knowing the animals in intimate detail will we move closer to understanding why this area is home for 2 months of the year.

The calving areas that we located on aerial flights include:

1. Fire Flats, Buckinghorse Mtn., Taylor Mtn., Thule Mtn., Umbach Mtn., South Mtn., and the mountain south of South Mountain.

2. West end of Crescent Mtn.

3. Tuaton Peak and Bowsprit Peak

4. Caribou Mtn. above Hyland Post

5. Mt. Terraze

6. Edozadelly area

7. Turnagain area (near Wolverine Lake)

Other calving areas are discussed in the report to Fish and Wildlife.

Table 9 shows our best data on movement of females to calving areas and faithfulness to area in the absence of disturbance. One female was seen on the peak June 3 and the first calf was seen June 6. This calf and another were thought to be born June 5. These animals vacated the mountains after June 17 (Table 9).

Calf behaviour was studied. Table 12 shows the percent success of calves attempting to suckle. The drop in success in the fifth week of life may represent a weaning attempt by the dams. Table 13 describes the frequency and duration of suckling. The frequency of suckling decreases during the fifth and sixth weeks of life. Mean duration of suckle bouts seems to have stabilized by the fifth week.

During the study, A.T. Bergerud was greatly impressed with the wariness of the caribou in general. They are far more wary than caribou in Newfoundland (where there are no wolves). This supports the view that predator-prey interactions increase the fitness of prey to predator encounters. Predation pressure is on the conspicuous animals - these may be the sick, crippled, old, young or healthy - whoever is conspicuous is taken - he who zigs when he should have zagged. These animals, under extreme predator selection, are experts in escape. By being proficient in one area, they may be less plastic in behaviour in another area (or as C. Krebs says, you can't be a super mouse - you can't be an expert at everything).

The animals at Spatsizi appear better able to see shapes than other caribou A.T. Bergerud has investigated - they even take flight when seeing a person stalking behind vegetation (they had to look through the vegetation). If, analyzed, flushing distances between Newfoundland caribou and Spatsizi caribou would be expected to be different.

Females with calves on Fire Flats were extremely watchful (these of course were the successful mothers). On June 29, A.T. Bergerud watched as D. Miller walked into a herd of 116 females. The two females with calves both broke from the herd immediately and ran away. The remaining 114 females (most had udders but no calves) milled around for perhaps fifteen minutes. The mass of numbers (the group effect), indecision or whatever, prevented them from taking flight quickly. On several days herds on the flats were watched. If an animal was standing while the rest were bedded, it was commonly a female with a calf. In contrast, up high on the hills, the females seemed less watchful. These contrasts support the view that wolves were interacting with animals more frequently on the Flats.

The Fly Season

Figure 5 shows how the animals move uphill in July and August to escape flies and possibly mosquitoes. Females appear to seek higher elevations before males do.

During the fly season, caribou seek snowfields. We do not know if the herds we looked at this summer (Spatsizi, Level, Liard and Atlin) have nose bots, (but we did see caribou at Atlin pushing their noses into the snow, a common defense against nose bots). However, warble flies are abundant, and the erratic running that people report in the summer is caused by warble fly attack.

Caribou actually weigh more in July, before fly attack than in August. By July 24 in Spatsizi (Caribou Mtn.), caribou were utilizing snow patches and were being bothered by warble flies. Just how the snow patch serves as escape habitat from warbles is not clear. The air temperature above the snow patches is only 1 degree Celsius lower than the surrounding air temperature (Atlin). We saw that warbles were able to find and harass caribou on snowfields (Atlin, Caribou Mtn.). The snowfields were utilized as bedding places at Level Mtn. and Caribou Mtn., but at Atlin, animals always just stood on the snow, thus were unable to gain much advantage of the cooling effect of the snow.

Caribou bothered by flies always grouped together, and all stood in the center of the snowfield facing one direction with the wind on their flanks. This formation would be broken by sudden dashes of the group across the field, usually followed by a return to the center. Single caribou tended to stay closer to the edge of the snowfield. Caribou at Atlin also utilized high, windswept ridges to gain fly relief. On the Liard Plateau, there was no snow available, but we did not have much time to make behavioral observations on caribou. At Level Mtn., there were many snowfields, but they were only lightly utilized by the caribou. Weather during our observations periods at Level was similar to that at Atlin, but we were at Level Mtn. a week earlier.

The Rut

On October 8, a helicopter survey was made of Tomias Mtn. The following was seen.

97-100 caribou, 13 big males, 6 calves

3 males

62 caribou, 5 males, 2 calves

59-62 caribou, 4 big males, 3 calves

24-27 caribou, 4 big males, 2 calves

1 male

1 female

300 caribou, photographs showed 400+, about 6 calves

175-181 caribou, 3 calves

55-59 caribou, 10 males, 5 calves

3 males

80-81 caribou, and 11 calves

2 females

1 male

1 male

56 caribou, 11 males, 1 male calf

34 caribou, 4 males, 3 calves

65-69
92-95 9 calves, 16 or more males

This caribou concentration was thus over 1200 animals and represents the greatest concentration in British Columbia. There were few calves, so the next census will show a decline in numbers if indeed there is little exchange between populations.

We camped at Worry Creek adjacent to Tomias Mtn. from October 9-22. We found the going tough and failed to get much data. However, our observations suggest that breeding was in progress on October 12. We know that breeding occurred on October 15 and 16 as well, and that the caribou left Mt. Tomias on the evening of October 16 (Table 18). The rut therefore, lasted about five days. This seems very short, but it is similar to breeding in Newfoundland where the rut is usually October 11-16. Our data therefore indicate that the peak of calving will be May 30-June 3 in 1978.

The fact that the caribou left so abruptly after October 16 clearly indicates breeding was over. This sequence suggests calving will be earlier in 1978 than in 1977. The gestation period of caribou is 229 days (Bergerud 1975). We should add 3 days for variation in gestation periods.

In other caribou populations, the date of calving varies little between years (Lent, 1964, Bergerud 1975), and maybe we are overlooking something here. Even the gestation period might be slightly longer for such a large animal.

The short breeding season is of concern. The sex ratio of the population is very skewed to females. The Spatsizi caribou herd breeds in mating herds rather than rutting companies - that is, all the males are present at breeding and are unable to dominate small groups of females (Bergerud 1974a). This is the strategy caribou have to effectively use when there are few males. Breeding aggregations would be small and more dispersed if there were more males. If all the females came into heat from October 12 to 16, then each male must have bred a female nearly each day for all to be served. Our data show only about 1/3 of the males courting females from October 12-16 (Tables 18, 19). There still seems to be sufficient males for females to conceive in first estrus.

The rapid departure of animals from the rutting grounds on October 16-17 suggest that this grouping and this location are functions of rutting. Some populations breed while migrating, others breed prior to migrating. These animals breed and then immediately go. There was lots of snow on Tomias at this time. Snow is the sign-stimulus that releases migration in other caribou. Hence, it all seems to suggest that these open mountain tops are not very good habitats for food. Yet animals must come from very long distances for the rut. The use of these areas are more to be explained in the history of the race than the present environment, they are phylogenetic, not ontogenetic traditions. If the above reasoning has some merit - the animals can adapt less rapidly to habitat disturbance of these rutting areas than they can, for instance, to loss of winter range. They are always changing winter range. Rutting ranges may be the most critical and weakest link in the annual habitat cycle for caribou.

The Winter

The pattern that appears to be emerging is that, there are many winter ranges - some will be used one year, others, another year. This pattern is seen elsewhere also. Kelsall (1968) shows maps for barren-ground caribou that relate to the number of years that a winter range was used.

Luckhurst (1973) and Sinclair in 1976 found good numbers of caribou on the back side (northern) of Spatsizi Plateau. This is a winter range that is usually used. But this year (1977), there could not have been more than 50 animals in this whole area in February. Actually, Brock Mtn. has been the most consistent winter range used. Animals were there 1972, 1973, 1976, 1977 and 1978. Animals also winter along the Stikine and Spatsizi Rivers. Animals have even been in the Eaglenest range in some winters (1973). We located many antlers of males at Buckinghorse and Tuaton Lakes - clearly in some winters, caribou are this far upstream. However, there were no antlers at Fire Flats. On that side of the mountains the snow is too deep (see Luckhurst 1973).

This winter, there could not have been more than 150 animals in the Park (see Appendix B for details) yet there were 1600 caribou there during the rut. I searched for the missing caribou in February and March without success.

The winter census suggests that the caribou on Caribou Mtn. in October (350+) may have split - 50-75 went to Brock Mtn. and 250 went north, crossed the Stikine and went up Kehlechoa to the Turnagain country (see Appendix B, December 16).

Where did the Tomias caribou winter? A.T. Bergerud's feeling is that they went north to the Kechika Map sheet. In March, he flew the Frog River to see if it could be an avenue. There were wintering caribou along the Chukachida River. The Frog does look like a travel route but it does have almost canyon-like features at one spot (Lunar Creek also). The Spruce Hill - Albert Dease area seems like the best route north - there are trails up the north-south river, that is, west of Mt. Dease. The flat plateau at the head of the river would be easy to navigate. Flights should be made next October after the rut along the Stikine and Chukachida River looking for caribou.

Data gathered by R. Bruns of caribou seen this winter and observations of Brock Mtn. and on the Turnagain suggest that aggregations remain together and in the open in November and December. Also in Region 7, Elliot has counted the Pink Mtn. herd in December and outfitters report animals visible on mountain tops in early winter. We think a lot can be learned by more aerial flights in the October-December period. Deep snow and crusting in February-March may cause animals to scatter and seek arboreal lichens.

We noted that the flat plateaux 12 miles N.N.W. of Spruce Hill are not too far from Tomias Mtn. J. Holmes reported 1200+ caribou from this area in 1973. Now he estimates 150. This is an extreme drop. Tomias Mtn. and these plateaux are not that far apart that exchange or shifts could not occur. We are counting on our censuses of Tomias and Lawyer's Pass in 1978 to be used against others counts later to detect trends. But we really do not understand movement between rutting ranges and whether all the caribou have even now been counted.

The conclusion is that a lot of winter ranges are outside the Park. The winter area appears so extensive that Park enlargement would never be sufficient to embrace the winter locations of caribou in all or even many of the winters.

RANGE STUDIES

Table 20 shows the abundance of plant communities at Fire Flats. This table underestimates the *Betula* component (see transect location, Fig. 4). The composition of each community is described from plot data in Appendix C. Some biomass figures are shown for some of the preferred food species in Table 21. Figures 6 and 7 are aerial photographs of the Fire Flats area.

On the winter range, we were primarily interested in the relative abundance of terrestrial and arboreal lichens between the Fire Flats area, which is in the subalpine zone (Rowe 1972) and the north side of Caribou Mountain which is in the boreal forest (Rowe 1972). We know that the Fire Flats area is not used in the winter whereas Caribou Mtn. is a common winter range. Of course, a primary reason for the use of Caribou Mtn. over Fire Flats is snow depth (possibly four feet versus two feet) and the gradual slope of the north side of Caribou Mtn.

How does the Fire Flat drainage differ from the Caribou Mtn. drainage? Vegetatively, the Caribou Mtn. area contains *Ledum groenlandicum, Potentilla fruticosa* and *Arctostaphylos rubra*, not observed on Fire Flats; as well as a small amount of *Vaccinium uliginosum* (see Table 22). In addition, both *Vaccinium vitis-idaea*, and *Linnaea borealis* were found to be much more abundant on Caribou Mtn. than observed on Fire Flats. Arboreal lichens were more abundant at local sites on Fire Flats than on Caribou Mtn., while terrestrial lichens were more generally abundant in alpine areas on Caribou Mtn. At least larger, more continuous areas on Caribou Mtn. contained terrestrial lichen communities. Both areas contain large meadows, and *Festuca altaica* is present and widespread in both.

We believe the major difference of the two drainages is the vast table top areas (rolling) of alpine and bog birch and lichen communities in the Stikine while Fire Flats is more broken up with *Betula-Salix-Festuca altaica* bottomlands. The Stikine bottomlands are more generally treed and support more trembling aspen stands on southern slopes. Subalpine fir predominates on Fire Flats, while spruce and lodgepole are the almost exclusive conifers at Caribou Mtn. Spruce does not appear to have any more arboreal lichens than either lodgepole or subalpine fir, in fact, we would almost say it has less, especially than lodgepole (at least along Spatsizi and Stikine rivers).

D. Miller described caribou range at Tuaton Lake in May 1977 thusly:

1. Much more terrestrial lichen forage than I've seen available to woodland caribou in the Selkirk Mtns., Manitoba and in Glacier Nat. Park, Montana.

2. Generally, *Stereocaulon paschale* predominates in low meadows with *Cladina mitis* next and *Cladina alpestris* most abundant in among willows and bog birch. *Cladina uncialis* is present most everywhere that *C. mitis* is, but in lower amounts. *Peltigera apthosa, P. malacea* and *Nephroma articum* are fairly abundant in wet meadows. *Cladina rangiferina* is also well represented, but not in the usual dense patches. *Cetraria nivalis, C. cucullata* and *C. islandica* are spotty and not really abundant, more on slopes of benches (drier sites).

C. islandica and *C. nigricans* are scattered around more than the other two *Cetraria* sp. and since their browner color is less conspicuous, I believe they are more abundant than the other two - present everywhere, but only *C. gracilis* and possibly *C. crispata* are in dense clumps especially among shrub cover. The horn form of *C. gracilis* (var. *elongata*) is especially noticeable in about 3 inch high growths and in lush clumps.

3. Arboreal lichens are not abundant and only of conspicuous abundance in wet sites on old white spruce. *Alectoria jubata* (or possibly *frenata*) is predominant (very black colored, non-shiny fruticose lichen). An *Usnea* sp. is present but uncommon and *C. crispata* and *Paramelia* sp. are present. I've found only two sites where arboreal lichens are worth noting, one about 2 miles southwest of Tuaton Lake at 4700 feet and the other 3½ miles northwest at the same elevation. Height of *Alectoria* is about 3 feet from the ground. No signs were observed of caribou use.

4. *Stereocaulon tomentosum* is present but in small amounts on rock or gravel in exposed dry sites.

Another comparison we made was of arboreal lichens between north and south slopes on Fire Flats. Table 23 provides the results. In general we expect more tree lichen on more moist north slopes than drier south slopes (see Fig. 13). Our results were not clear on this point (Table 23).

North and south slopes do provide real contrasts in microclimate. Caribou in Spatsizi generally calved on south slopes. We saw only one calf on a north slope (Table 8). North slopes of course have much more snow at calving than south slopes.

In winter, caribou are most frequently on north or northeast slopes. Snow depths are less, crusting less frequent, more terrestrial lichens available and a lower tree line than on south slopes (Fig. 13). There are likely less trees on north slopes and hence less tree lichens but the trees that are present are more scattered and hence provide more edge effect (Fig. 13).

FOOD HABITS

One of the questions that we were interested in, was how to explain the large size of caribou in Spatsizi compared to the small body size of other races. Is nutrition a factor?

The food habitats of caribou change as plant phenology changes. The spring of 1977 was early - perhaps a week earlier than normal and 2 weeks earlier than 1976, which was a late year. Below we show general phenology information. In Table 24, we show the phenology of lupines *(Lupinus arcticus)* located at the look-out of our east camp (near the first rapids on the Kluayetz Creek). Some important phenology dates were:

May 20	snow line 4500 feet
May 30	some leaves on *Betula glandulosa*
June 1	snow line 5000 feet, south aspect
June 9	*Festuca altaica* 4 inches tall
June 12	first summer droppings of males
June 15	snow line 5500 feet, south aspect
June 17	*Festuca altaica* 8 inches tall and in flower
June 20-21	caribou eating willow extensively
July 1	caribou eating *Betula* extensively
July 13	browsing on *Valeriana sitchensis* and *Equisetum* sp.

The food habits of caribou were straight forward. When we arrived, caribou were eating dried *Festuca*, and *Cladonia* and *Stereocaulon* lichens (Table 25). The first week of June they sought green *Festuca:* summer-type droppings of males were located at 4000 feet on June 9. Next *Carex aquatilis* became available and was sought out. Then, the caribou began stripping willow leaves. *Salix planifolia* and *Salix barclayi* (Table 25) were preferred, while *Salix glauca* and *S. commutata* were not utilized. Interestingly, *Betula* leafed before *Salix* but the animals continued to eat green *Carex* and *Festuca*. One rumen sample collected July 12 showed a high percentage of grasses and sedges (Table 26).

In general, the June diet is mostly grasses and sedges (Table 25) and the summer diet, deciduous browse *(Betula* and *Salix)*. This sequence is the same for other caribou populations (Skoog 1968, Kelsall 1968, Bergerud 1972). On Fire Flats, willow was preferred over birch and was heavily utilized (up to 33 percent of the leaders stripped - Table 27). Probably in August, more *Betula* is taken than willows because the caribou are higher, near snow fields.

By October, after leaf-fall, the animals switch to a lichen diet (Table 28). The location of shed antlers of males indicate that caribou are frequently feeding on the *Festuca-Stereocaulon* flats in the early winter. A major difference in diet between caribou in B.C. in the boreal forest, and caribou elsewhere, is the lack of evergreen shrubs in B.C. Evergreen shrubs cannot be important in the winter diet - in their place, more grasses and sedges are

consumed. The two most important unknowns are: (1) the relative abundance of green sedges and grass versus dry grass and sedges, and (2) the abundance of terrestrial lichens versus arboreal lichens in late winter. Caribou appear to be more in the open before Christmas than after.

We had expected that the animals would show nutritional "wisdom" in their food selection. The following was expected:

1. animals would select a wide variety of plants

2. animals would visit receding snow to partake of rapidly growing late plants of high quality

3. animals would move up slope following the receding snow line and take advantage of the new growth appearing

4. plants selected in the Spatsizi area would be extremely high in protein (%N x 6.25)

None of these predictions came true. First the animals selected very few species - mostly willows, birch, grass and *Carex*. This is a fairly monotypic diet compared to, for example, the summer food habits of caribou in Newfoundland (Bergerud, 1972). The caribou usually bypassed the rich forb communities. For example, A.T. Bergerud watched caribou walk across a rich forb community to feed on dry grass and lichen on July 12. H. Butler watched caribou walk through a rich forb community on July 4 to feed on birch and willow. Even in July, animals were feeding on lichens out on the dry benches of Fire Flats. Animals did not visit receding snow fields for new growth - when they did seek higher elevations, it may have been to avoid insects.

The animals continued to take willows and birch throughout the summer and fall - there was little variety in the diet.

The chemical composition of the diet was not strikingly rich (Table 29) (c.f. Bergerud, 1977). In fact, all the species are low in protein, except *Betula*, when compared to protein levels reported for other caribou populations (Bergerud 1977).

All in all, the large size of the Spatsizi caribou cannot be explained by the selection of high quality summer diets. The female we collected on July 10 was actually skinny - her greatest back fat depth was only 6 mm.

The observations to date suggest that the reason for the large size of these animals is not to be explained by the current nutritional environment. It was our impression that female caribou at Level Mtn. and Atlin had larger antlers than at Spatsizi. Certainly, the Spatsizi caribou are not giants compared to the other herds in northern B.C. The Level Mtn. and Atlin animals are just as large and may be larger. Both Atlin and Level Mtn. areas appear to have less plant variety than Spatsizi - habitats are more xeric in both places, with less ground seepage, fewer salt licks, and less willow. This strengthens the view that historical reasons involving the genotype are more important than the developing phenotype.

POPULATION DYNAMICS

To understand the population dynamics one needs information on birth-rates (m_x), death rates (q_x), or survival (s_x), population size and mortality factors. The birth rate can be determined from udder counts in the 3 weeks following birth (Bergerud 1964), and possibly by classifying females as to presence or absence of antlers prior to calving (Skoog 1968, Bergerud 1976). Mortality is much more difficult - as a general rule, caribou herds subject to adult predation usually decline if the calf increments are 10 percent or less (Bergerud 1974c). From this we can infer that adult mortality is frequently of the order of 10 percent also. Herds with few or no natural predators of adults have been found to have a natural adult mortality rate of 5-6 percent (Bergerud 1967, 1971b and Skoog 1968). Caribou can be censused by aerial techniques but this should be checked by calculating the expected population between counts based on recruitment and death rates (see Siniff and Skoog, 1974).

Natural and hunting mortality are mostly additive. In a herd of 1000 caribou let us compare hunting and non-hunting options.

	1000 Caribou	
	Hunting	No hunting
Hunter harvest	100	None
Natural q_x (10%)	900 x .10 = 90	1000 x .10 = 100
Caribou surviving	810	900

There of course can be a population point reached where hunting and natural mortality are compensatory. If a herd is greatly reduced by hunting, a point will be reached where the natural mortality rate will decline - it will be unprofitable for predators to still seek caribou - predator numbers themselves may also decline. It also works the other way. If predators take the first 100 animals there are only 900 left for the hunter. However, of the 100 taken by predators, probably 5 or 6 would have died in the absence of predation (1000 x .05 = 5 or 6). Predators use what would die naturally from accidents, social interactions, etc. plus an added component of 4 to 5± percent.

Birth Rate

We classified 227 females as to parous-nonparous; 82 percent were fertile and gave birth to young (Table 30). This technique probably slightly underestimates pregnancy rates since we started to classify before calving (perhaps 3 days before the first calf) and further, since females conceiving in a second estrus period would not be recognized as pregnant at this time by our technique. There is also a strong bias in that parous females went up on the mountain sides to calve, while the nonparous females stayed low in the valleys. Our counts were made primarily at low elevations at Buckinghorse and Fire Flats.

A fertility of 82 percent is slightly low compared to other populations in North America (Bergerud 1974c). It is low because there are few young pre-puberty females in the population to account for non-pregnant animals. The lack of young females is due to the poor calf survival from 1973 to 1976 (Table 31). It is the presence of these young females in other herds that reduces the parous percentage - these females are missing at Fire Flats and thus provide no explanation for the low rate.

If most of the females are mature 3+ year old animals I would expect a pregnancy rate of 90-95 percent (Bergerud 1971b). Is the low rate due to the above mentioned biases or is it real? We only captured two calves, one was born June 18 and was probably conceived in a second estrus. Also, we will show later, a late influx of females with calves on about July 8 to the Fire Flats post-calving herd - these could be late born calves. Thus we have the possibility of: (1) a slightly low pregnancy rate which is really valid, (2) the low rate is an artifact of sampling of low elevations, or (3) the low rate is an artifact of sampling early and the rate is actually higher when second estrus females are added. Whether the last option is favorable or unfavorable to caribou is an interesting question. For example, grizzly bears take lots of calves and also seem to give up hunting after the first estrus females have calved.

Calf Mortality

Large numbers of females gave birth this year but since 1973 there have been few calves in the herd in the summer and fall (Table 31). We made a lot of calf:adult counts this spring and summer but it is difficult to decide which count is most valid. Biases involved (1) continued mortality of calves, and (2) the fact that successful mothers were often in the mountains, while females who lost their calves gathered in the area that we would best sample. At Fire Flats, July 2 and 6-14, Bergerud classified a sample of 730 animals (many animals counted twice) that contained 29 calves or 4 percent of the herd. D. Miller and D. Newell classified 213 animals at Caribou mountain the last two weeks of July. They found 9 calves (4 percent). On October 7, Hatler classified 213 animals on Caribou Mt. and found 11 calves (5 percent). On October 8, Bergerud and Hatler classified 15 calves in 197 caribou (8 percent). The total is 26/410 = 6.3 percent. On October 8, Bergerud classified 51 calves in 1114 caribou on Tomias Mtn. (4.6%). Thus we have

Caribou Mtn. July 4% ⟶ October 6.3%

Fire Flats-Tomias Mtn. July 4% ⟶ October 4.6%

Thus the mortality had all occurred by early July. The October counts included nearly all the population. The proportion of calves in the Tomias Mtn. count in September 1976 was 7.2 percent (n = 503). Since we counted nearly all the Tomias herd in September 1977, there appears to have been a decline in survival since 1976. The poor survival of calves is also supported by the ratio of large antlered males to small antlered males (immature). In September 1976, the ratio was 1:0.14 (n = 142). In Newfoundland, the ratio of large to small males was 1:0.70 for eight years (Bergerud 1974b).

We need to measure the survival of calves from fall (5 months old) to the next spring (12 months old). Miller (1975) has shown that calves are more susceptible to predation than adults during their first winter of life. Data for the winter of 1975-76 and 1976-77 are available. In July and August, 1975, there were +5% calves (Table 31). The percent of yearlings in June and July 1976 was 4 percent (n = 255) (Osmond-Jones 1977). The Tomias Mtn. percent calves in September 1976 was 7.2 percent and our count at Fire Flats in June and July 1977 was 5.7 percent (Table 32). The 1976-77 counts we believe are more accurate than the 1975-76 count, and represent a larger sample size. This latter comparison suggests a 1.5% decrease in the 1976 cohort between 5 and 12 months of age.

These yearling counts should be made in June (possibly July). By August, after 2 months of growth in the second summer of life, long-yearlings are increasingly difficult to distinguish from adults (see Osmond-Jones et al. 1977, Table 1).

Adult Mortality

We have no way of measuring adult natural mortality. R. Bruns tried to repeatedly count the Brock Mtn. caribou from the air, from November 19 to January 18, in order to get data on this point. The comings and goings of animals prevented detection of population change from mortality.

The second best way to measure adult mortality is to use the regression formula presented by Bergerud (1978) where $Y = 13.8 - 0.3865X$, and Y is adult natural mortality and X is calf recruitment. Substitute 5 percent (Table 31) for X and we get an adult q_x estimation of 12 percent. Thus comparing natural mortality of 12 percent and a recruitment of about 5 percent, since at least 1973 (Table 31), the population should be declining annually at about 7 percent, excluding hunting mortality.

It is difficult to gauge the impact of hunting mortality - the population has been declining and the harvest decreasing. A high harvest was 78 animals in 1975. This year only 12+ animals were taken at Cold Fish and none by guided hunters at Tomias Mtn. If we assume an annual mean harvest of 30-50 animals, based on 1500 animals, this is 2 percent. A natural loss of 7 percent plus a 2 percent hunting loss suggests the population is declining at 9 percent per year.

Causes of natural mortality of adults should include predation, death in parturition and fighting between males (Bergerud 1971b). We located no dead females on aerial surveys on June 10 and 11 when many calving areas were searched. No ravens were seen to suggest carcasses. Further ground studies at Worry Creek in October produced no evidence of mortality of males by fighting (locked antlers). A survey of many rutting grounds by helicopter September 28-30, 1976 produced no evidence of dead animals. But, on October 8, we located two dead caribou - 1 male and the other probably a female (antlers not seen from air). There were grizzlies eating at both carcasses. We could not tell if these were predator kills or deaths from social interactions - the fact that one was likely a female supports the predation hypothesis.

We found the remains of 39 dead caribou at Spatsizi and Level Mtn. (Table 33). The sex ratio of the 29 was 24 males to 7 females. We believe these animals died in early winter (prior to male antler casting) and that the primary cause was predation. The fact that we did not find many dead males at Tomias suggests that the cause of death is not social interactions or crippling from hunting. Many more caribou rut on Tomias than Caribou Mtn. yet dead animals were much more common at Caribou than Tomias Mtn. (Table 33). Also Tomias Mtn. was heavily hunted in 1975 and 1976 (R. Farnell, pers. comm.).

There are biases looking for bodies based on antlers. Obviously males are more visible. However, there is a strong bias against males - that is they are without antlers for 4 months whereas females are without antlers usually for only a few weeks (Bergerud 1976).

The large sample of males came from Caribou Mtn. That mountain is known as a winter range, whereas caribou desert Tomias Mtn. as soon as the rut is over (pers. files). Males are at a low point in their annual energy cycle immediately post-rut (Dauphine 1976). Moose, the alternate prey, are scattered and are not immobilized by snow at this time. October to December should be a prime time for wolf predation on caribou bulls. The remains of males with polished antlers has also been reported for the Burwash-Upland herd in the Yukon (Oosenbrug 1976) and for the Telkwa herd in British Columbia (Theberge and Oosenbrug 1977). The former herd is lightly hunted.

Haber (1977) studied wolf predation on caribou in Mt. McKinley for eight years. He reported more males killed than females during the summer. B. Kjos (an outfitter who does a lot of aerial survey work) reported (pers. comm.) that he finds more males dead from predation than females in the autumn.

The sex ratio of 4 herds in B.C. with good calf recruitments was 1.8, 2.6, 1.6, 2.5 and for eight herds with poor recruitment: 3.2, 3.7, 3.5, 3.5, 4.2, 3.9, 2.8, 3.4 (Bergerud 1978). This comparison indicates that natural mortality is greater for males than females. Bergerud (1971b) found males dying at a greater rate than females in Newfoundland. The shorter life expectancy of males (Miller 1974, Bergerud 1971b) and the fact that the sex ratio at birth is 52:48 (males;females) whereas for adults it is usually 35:65, all indicate the greater q_x of males (see Kelsall 1968, Skoog 1968, Bergerud 1971, 1967).

Thus both hunting and predation, we believe, are heavily weighted to males. The sex ratio of males in the Park is very skewed from the expected ratio of 1:2 to 1:4 (Table 34). This extremely unbalanced sex ratio is a reflection of poor recruitment. If there was good recruitment coming in each year at a 52:48 ratio, the adult ratio would be nearer 1:2. As long as the natural mortality rate of the herd is greater than recruitment, the higher natural mortality rate of males will continue to move the ratio towards females - whether light hunting of males contributes much to the imbalance when there is poor recruitment can be argued - a computer analysis of this sequence would be instructive.

The shock of this study was the finding of the very high frequency of caribou hair in the wolf scats collected - 73 percent of the scats contained caribou as the major item and only 10 percent contained moose (Table 35). Recall our argument that these scats represent the summer food habits of wolves, not the winter (see Methods). Both the wolves hunting the Fire Flats area and the wolves travelling from Hyland Post to Cache Creek were eating mostly caribou. Most of the scats contained hair of adult caribou, not calves. In 17 scats defecated before calving, 53 percent contained adult caribou remains (Table 36). All the fresh scats we examined contained caribou as the major item (Table 37).

There is a second way to check the preference of caribou over moose by wolves in the summer. Single wolves can hardly be successful in securing either adult moose or young moose calves because of adult moose defense. But single wolves were quite successful with caribou adults or young (see Haber 1977, and Table 38). In Alaska, a pack hunting mostly moose averaged 3.7+ adult wolves, while a pack hunting caribou averaged 1.3 adults (Table 38). We saw a group of four wolves May 22 prior to caribou calving in a high moose density area at Tuaton Lake. The eight wolves we saw after that time were all singles (Table 39). Three of the singles were seen to chase caribou (Appendix A). The wolves we saw after calving could not have been seriously hunting moose, they were not socially organized for such an endeavor. The mean pack size of wolves seen May to August in 1976 was 1.6 (packs were 1,1, 2,1,1,1, and 4) (Osmond-Jones et. al. 1977). The latter group of 4 was seen July 30 and could have been an adult with pups. Both the scat analysis and the mean aggregation size suggest that game other than moose is the primary summer food.

Is it possible for predators to cause a natural mortality rate of 12 percent of the adults? The following assumptions were made *a priori* to the calculations:

1. Wolves live on caribou as their main food item for 5 months of the year (June, July, August, September and October).

2. Caribou comprise 70 percent of the diet (Table 35).

3. Wolves need 6 lbs./day (see Peterson 1974, Haber 1977, Kuyt 1972 and others).

4. There is 20 percent wastage from ungulate weight on-the-hoof to that consumed (Pimlott 1967).

5. Caribou calves being light, hardly enter into the calculations - mostly calves are taken to the dens for pups.

Considering all this, then we have: 5 months x 30 days x 6 pounds x 70 percent - 20 percent wastage = 788 pounds of caribou needed per wolf. Each wolf might do quite well with 2 caribou (400 pounds each) per 5 month season (though this is a long time between meals). Consider that there are 40 wolves on this regime (see wolf section) thus 80 caribou are needed. Now how many caribou belong to the Park proper? The Fire Flats herd should be included - 250 to 300 animals, and caribou at Tuaton and Caribou Mountain also. Consider that

all the Caribou Mtn. animals counted in the rut are involved with these 40 wolves. In all, we have possibly 700 animals or more: 80 eaten/700 present = 11 percent. The 12 percent natural mortality figure is in line. Please note that we believe that natural mortality from factors other than predation and predation losses are not additive. Wolves take those that would die naturally in the absence of wolves and probably utilize those they found dead from other causes.

This scenario generates all kinds of difficulties and points to the need for much more work. Just consider (1) the serious interaction of grizzlies and single wolves at carcasses. (2) The fact that calves are getting larger during the summer and making a more meaningful prey contribution. (3) Animals killed by hunters and left in the country. However, these calculations do not help the belief sometimes heard of high wolf densities (1 wolf/10-25 square miles). Such densities do not seem reasonable considering the caribou biomass, or for that matter, the entire ungulate biomass available in the Park.

The preliminary copy of the wolf distributions map (B.C. Fish and Wildlife) shows large areas of the province, including the Park with wolves abundant at densities over 1 wolf/30 square miles. We doubt that such densities are that common. These densities may have been generated from work done by Sumanik where he flew river courses and counted wolf tracks. Winter densities on rivers would certainly be high, but wolves scatter over a much larger area in summer. Wolf densities, if to be meaningful, must relate to prey biomass and must include the area of the year-round territories of packs.

Causes of Calf Mortality

Calf mortality was extremely high in 1977. At calving, the population per 100 animals was composed of about 5 yearlings, 22 males and 73 females. Of the females, 82 percent gave birth, adding 60 calves to the population, calves became 38% of the population. By July 14, calves represented only 5% of the herd. In a little over one month, 92 percent of the calves were dead. On May 27 and 28, the females left the flats and went up into the mountains to calve. We could hardly find any caribou on the flat (Table 7). When we realized the females were high giving birth, on June 5, we immediately began to see newborn, healthy calves. In June, we observed 32 females with 24 calves in the mountains (Table 40). I exclude pregnant females waiting to give birth. Thus at least 75 percent of the females had viable calves. We saw another 17 females (groups of 8 and 9) that were accompanied by several calves, but we could not get an accurate count of the calves. All the females seen without calves were seen several days after calving: June 10 - 1 female, June 14 - 1, June 16 - 1, June 19 - 3 and June 20 - 1. If all the females up high were parous, only 25 percent of the calves were gone by the time we observed them.

There is a bias in the 75% figure for females with viable calves. We saw more of the successful mothers when we looked at the mountains. Those mothers that had lost their calves came down into the valley. We saw one female on Thule Mtn. that had her calf with her on June 17. On June 19 we saw her searching for her calf (two wolves had passed through the nursery site on June 18). On June 20, this female left the mountain. Five females that we recognized as having lost their calves on the flats, actively looked for their calves and responded to our artificial calf grunting for 1 - 2+ days after their calves were gone. Thus, the lag between calf-lost and return to the flats was possibly 1 - 2+ days. If calves had been sick or incapacitated but alive, females would not be expected to leave the hillsides.

Could these missing calves have died of stillbirth while most of the females produced vigorous young? It seems highly unlikely - we do not know of anything in the literature to suggest this kind of mortality. We did not observe any females up high with retained placentas suggestive of Brucellosis. We did see about 5 different parous females on Fire Flats with some blood in the anal-vulval area. One of these females was accompanied by a calf. Four blood samples that we secured, (a July female, 2 September males and an October female) were negative for Brucellosis. Dr. I. McT. Cowan who has had extensive experience in the matter of disease in ungulates in B.C. indicated that it was extremely unlikely that Brucellosis would be a problem. If there had been dead calves, we think we might have seen some sign of ravens up high. Also some females might have been expected to remain high near their dead calves, although, without the stimulus of grunting and motion from the calf, the maternal bond may have failed to materialize. We located 9-18 birth sites (Table 8) without seeing signs of dead calves. We cannot imagine a stillbirth explanation of this magnitude. Such an explanation of course, would not explain the continued loss of 62 percent of the calves by mid-July.

Could the calves have died from windchill? Calf q_x, mortality, from weather has been reported in the N.W.T. (Kelsall 1968). The worst day during the calving interval was June 8 (most all the calves were born by then). The minimum temperature reached 0 degrees Celsius at 5500 feet and winds were up to 24 km/hr. (15 mph for 4 hours). These parameters give a windchill (cooling watts/m^2) of 1125. Windchill has occurred for barren-ground caribou with prolonged windchill of 1100 units for several days (Kelsall 1968). The caribou calves in the N.W.T. weigh 6-8 pounds less than Spatsizi caribou. Normal daily minimum windchill at Spatsizi was 900 watts/m^2. There is no possibility of windchill mortality in 1977. We doubt that windchill has been an important factor in other years on calf mortality. The females select a high elevation environment to calve - where it is colder and has twice the wind speeds and precipitation received at lower elevations (Table 41, Figure 8). If windchill was important, reproductive fitness would be enhanced by calving at lower sites.

We found no calves dead from accidents. Many of the calving areas were only 1-2 miles from the post-calving aggregation on Fire Flats and we covered this area in our work.

We are left by way of exclusion with predation as the cause of calf mortality. Exclusion is a weak way to reach a conclusion - there may be another explanation which is new-under-the-sun, but we think we have covered all angles. We had in June, at least 75% of the parous females that we saw with viable young in the mountains, but by July, when most of the herd was on the flats, (or in October, when the entire population was classified) we had only 8% of parous females still with calves.

Predators were common in the calving locales in the mountains (Table 39, Fig. 3). During the period of calving about May 27 to June 10, we saw 11 predators (1 predator/1.4 days). After calving from June 11-July 15, we saw 7 predators (1 predator/5 days). Let us look at each mountain from north to south that we made observations on.

Buckinghorse Mtn.

On May 26, A.T. Bergerud climbed the mountain west of Buckinghorse Lake. A wolf track was seen at 5500 feet.

Taylor Mtn.

On June 2, a sow and yearling cub grizzly were seen going straight up and over Taylor Mtn. On June 5, H. Butler spotted 9 caribou on Taylor Mtn., many of these had calves. When A.T. Bergerud reached the calving area on June 9, there was only 1 female and 1 calf remaining. The sow and yearling bear tracks were everywhere criss-crossing the calving areas. These bears were hunting for caribou. There was no marmot colonies available and no green vegetation.

Middle Mtn.

On June 5, a female and newborn calf were seen halfway up the mountain. The calf was watched on June 6. The next day, the female and calf were gone. When the birth site was visited on June 12, a fresh bear scat was found, without caribou hair. On June 6, a black bear was seen on this mountain at 5500 feet. On June 10, H. Butler watched a bear chase 7 caribou at 4100 feet near the base of this mountain, and a wolverine was seen at this time also. Grizzly and wolverine tracks were found on the mountain, both seen from the ground and from the air.

Thule Mtn.

On June 4, a grizzly bear moved by the camp on Kluayetz Creek, tracks of the bear were found later on the mountain. D. Miller also found grizzly tracks on Thule Mtn., and these tracks were checked to make sure they did not visit a marmot colony. Wolves were commonly up on the mountain. Fresh tracks were found whenever we got up there. Fresh tracks were found June 6, June 19, June 23 and July 7. Wolves were heard howling June 5, June 21 and June 25. Wolf tracks on June 19 were in the vicinity of where a young calf had been. Scats found on Thule Mtn. contained caribou hair.

Umbach Mtn.

Umbach Mtn. was kept under heavy surveillance by D. Miller and D. Newell from June 3 to June 17 (Table 9). One bear (probably) a grizzly was heard in dense vegetation on the mountain side on June 7, and wolverine tracks were seen. The three females that gave birth on the mountain were largely undisturbed by predators since 2 of the females remained in a small area from June 3 to 16 (Table 9). In between June 16 and 17, they shifted nearly a mile into rougher terrain, and hence may have contacted a predator.

South Mtn.

D. Miller visited this mountain on June 25 and found many grizzly tracks, scats and old wolf scats. On June 11, an aerial survey showed grizzly tracks everywhere in the vicinity of caribou tracks. The grizzly tracks were higher than a marmot colony.

Females with large udders and no calves started to arrive on Fire Flats shortly after calving. The first definite female with an udder and not pregnant was seen June 5. She was in tree cover moving from either Thule or Middle Mt. to the Flats. The first large group of females that had lost their calves was seen June 12 at the junction of Thule and McCumber creeks. There were 17 females with udders and no calves, 1 female with a calf and 4 barren females. For several days, the females who had lost their calves were to the north of camp. We believe these were females that calved on Buckinghorse, Taylor and Middle Mtns. and probably lost their calves to grizzly (the sow and the yearling). H. Butler saw 9 females and some calves on Taylor Mt. on June 5, but when A.T. Bergerud visited the mountain on June 9, they were gone and this is the same day that 2 females without calves showed up in the valley.

Predator activity (mostly wolf) was heavy on Fire Flats. We noted the presence of wolves, either fresh tracks, howling, or animals at about 2 day intervals. Four unsuccessful chases were seen on caribou by single wolves.

We observed 14 different calves on Fire Flats. We could recognize these calves by the antlers and molt characteristics of the dams. Five of the 14 calves disappeared within 1-4 days after arrival (Fig. 9). We believe wolves were responsible for the loss of these calves.

Besides the loss of these calves, there was evidence that other females were still losing their calves after the middle of June. For example, on June 22, there were 3 females with very large udders (must have just lost their calves). On June 29, 116 females were flushed and one calfless female began to grunt (only parous females which have recently lost calves grunt). A female was seen running through a herd grunting on July 5. On July 11, one female with a large udder and no calf was seen and another female advanced toward A.T. Bergerud when given an imitation calf grunt. On July 13, another female with a large udder was seen. These calves that were lost at the end of June and during July were probably killed by wolves. A.T. Bergerud flew many calving areas in the Park on June 11. He found grizzly tracks were common in calving areas but no bear were to be seen. The bears came during the week of calving (the first week of June) and then they went, probably, back to the lowland. A grizzly seen on June 27 walked through a herd of about 150 caribou without bothering them.

Our best guess of the effects of predation is:

Taylor Mtn.	9+ calves to grizzlies
Middle Mtn.	3 calves to bears and wolves
Thule Mtn.	5 calves to wolves
Umbach Mtn.	possibly only 1 calf killed
South Mtn.	grizzly killed calves
Fire Flats	5 calves taken by wolves
mountains in general	10+ predator kills after June 10 by wolves

The sequence is: bear predation is at high elevation and wolf predation at low elevation. With the present data, both predators are seen as being equally important.

We are not bear biologists, but bear experts we have talked to say calf predation by bears is a learning process. The sow and yearling cub that we saw on June 2 would be an example. She was passing the experience onto her offspring. Bear predation on caribou calves is considered serious for the Western Arctic herd and the Porcupine herd (J. Davis, D. Roseneau, pers. comm.). Both bears and wolves probably completely consume calves (wolves may transport calves to their dens). Thus one cannot expect to find remains.

The four wolverine scats collected at Spatsizi contained no caribou hair. The 49 wolverine scats we collected from Level Mtn. from a den site in caribou habitat, showed only 12 (20%) with caribou hair. This wolverine was scavenging from a wolf den site and may have obtained caribou meat from there.

The analysis of wolf scats did not clarify the relative role of wolf predation on adults versus calves as hoped. In the sample of 166 scats, 105 were considered by D. Newell to contain the hair of adults, while at least 16 (10%) had fine caribou hair which we believe is calf hair. In 17 scats defecated before calves were born, 9 contained caribou hair (Table 36). These must have come from adults. Applying this correction factor to the 149 remaining scats (166 - 17 = 149) we have (149 x 9)/17 x = 79 scats with adult hair. There were 121 scats with caribou hair; 9 were precalving. Thus there were 33 scats that may have contained calves (121 - (9 + 79) = 33 calves). This is a conservative comparison since undoubtedly some of the 149 scats were also defecated before calving. The sequence we have compares favorably with Haber's (1977) observations in Alaska:

	McKinley, Alaska animals killed	Spatsizi scats
Adults	36 (77%)	79 (71%)
Calves	11 (23%)	33 (29%)
	47	112

There are many reasons for not recording calf hair in scats: (1) it may be less abundant, thus masked by adult hair, (2) not recognizable, and (3) calves may be transported to the den for the pups. Next year it would be advisable to make a large scat collection in May to further compare the percent caribou hair before and after calving.

Population Trends

For the purpose of discussion, let us consider two groups; the caribou that rut on Caribou Mountain and winter on the north side of that mountain and Brock Mtn., and those that rut on Tomias Mtn. (Blueberry Mtn.) and winter along the upper Stikine river. The Caribou Mtn. herd has apparently declined.

Fred Harper (1972) counted 254 caribou on Brock Mtn. in February 1972. R. Bruns counted about 135 during the winter of 1976-77 (47 percent change). A. Luckhurst counted the caribou on Caribou Mtn. in March 1973, and tallied 433 animals. In March 1976, A. Sinclair flew almost the identical transects as followed by Luckhurst and 313 animals. Actually Luckhurst flew 175 miles and Sinclair about 200 miles. If we adjust the 1973 figure for 200 miles, Luckhurst might have seen 494 caribou. Another adjustment is probably needed, Sinclair left the flight lines often to circle for more animals (Bustard pers. comm. to Hatler). Luckhurst's and Sinclair's surveys were conducted in early March and the plotted animals show a similar distribution - the counts seem comparable, and this comparison suggests a 40% decline (Fig. 10).

R. Collingwood (outfitter) has provided summer counts of the caribou on Fire Flats 1973-1977. These animals are part of the Tomias group. His estimation shows a drop from 600-650 in 1973 to 250 maximum in 1977 (pers. comm.) (see Fig. 10). His estimation for 1977 of a maximum of 250 is close to our maximum count of 236 animals on June 29. June 29 was the only day that there was over 200 animals on the Flats in June or July. Collingwood's estimation in 1976 of 250-300 is below a ground count made by Hatler of 336, and an aerial count by G. Hazelwood of 364. Collingwood's estimation in 1975 is close to an actual count made by Carswell of 342. Finally, Collingwood's estimate of 600-650 in 1973 is supported by comments made by a Vancouver lawyer, J.L. Lau, who felt the 1977 population was only half or less, than that he observed in 1973. He observed the herd for several days in July of both years. These data from Fire Flats, Brock Mtn. and Caribou Mtn. all suggest a decline of perhaps 40-50 percent in the Park in the last 5 years.

The Caribou Mtn. herd was counted from the air by G. Hazelwood (1976 and pers. comm.) in late September at 212 animals and on October 7, 1977 at 348 caribou. I think a herd of 100 seen by Hazelwood before the count of 212 was missed in the later tally. G. Hazelwood (1976 and pers. comm.), Bergerud and Hatler counted the Tomias herd by helicopter on September 29, 1976 at 953 animals and October 8, 1977 at 1208. These counts of Caribou Mtn. and Tomias in 1976 and 1977 cannot be considered to show an increase. The caribou were counted too early in 1976, before all the groups had reached the rutting grounds.

Our view is that the population has declined from a high point in the early 1970's by about 40-50 percent. This is based on the counts of Harper, Luckhurst, Sinclair and Bruns, and also the overall estimates of Collingwood and Lau. A decline of this magnitude is also suggested because there have been few calves since at least 1973 (Table 31). Natural adult mortality should be 12 percent, hunting mortality perhaps 3 percent, and recruitment 5-6 percent. Thus for five years we could have a decline of 45 percent $(12 + 3) - 6 = 9$, $9 \times 5 = 45$.

The decline of the Fire Flats population appears to be too steep to be explained by natural mortality of adults and poor recruitment (Fig. 4). One possibility is that animals were taken illegally during the construction of the B.C. railroad grade and after. An illegal kill of at least 50 animals is certain. Also animals were taken in season, along the grade (B. Bailey, C.O. pers. comm.). One construction camp was located on the Garner Creek

Pass to Fire Flats and many animals were seen near the camp. T.A. Walker flew up the proposed grade route in June 1972 and reported lots of caribou on the Skeena River Flats - these animals may have joined the Fire Flats animals in earlier years. There is also a major pass 6 miles west of Mt. Klappan. I have not been able to check it for caribou leads. Caribou may have moved through there on their way to and from the Tumeka Lake country. This year we saw a few caribou on the Didene Creek Flats - these animals could also have reached Fire Flats and been more numerous in the past. The B.C.R. grade was put "to bed" October 25, 1977 when the Klappan bridge went down the road on a truck, but things will never be as before.

Although the herd has probably an r value of -0.09, its potential for growth is high. The adult sex ratio in September 1976 was 1 male to 3.4 females (n = 640). A summer classification in 1976 gave 1 male to 4.2 females (Osmond-Jones et.al. 1977). The fertility of the herd in June was 82 percent (n = 227). Yearlings represent 5-6 percent. Assume a sex ratio of 1:3.4 then the potential r_m of the herd is:

5 yearlings	5 yearlings
73 females x .82 =	60 calves
	73 females
22 males	22 males
$r_m = 60/160 = 0.38$	160 total

The normal r_m for caribou is .30 (Bergerud 1971b).

WOLVES AND MOOSE

We attempted to census wolves during February 3-10, 1978. Snow conditions were not good. The winter in general had been mild, snow depths were low and moose, hence wolves, were widely scattered. Besides this, there was little new snow during the census. Most of the streams shown on the 1:250,000 map were flown between the junction of the Klappan and the Stikine to the Chukachida and Metsantan. The northern boundary of the census area was the Stikine River and the southern boundary, the Klappan, B.C.R. grade, Didene Creek, Kluayetz Cr., Tuaton Lake and the Stikine River. One flight line included Chapeau Cr., Chappelle Cr., Sturdee River, Firesteel River, and Lawyers Pass to Metsantan.

The only advantage of no new snow was that wolf tracks were everywhere, having accumulated for 1-2 weeks. Wolves had been up nearly all the water courses in the northern half of the Park (Fig. 11). The southern half of the Park had deep snow and there were no moose or wolves there (Fig. 11). The lack of new snow created a bias in that wolf tracks could only be recognized on river courses. When wolves left rivers and went overland, their tracks got confused with ungulate tracks. There were so many tracks off of river beds that it was impossible to sort things out. The maze of tracks does indicate that there are few, if any, moose populations that are going to be untested by wolves.

Wolves are definitely hunting moose in late winter, contrary to their preference for caribou in the summer (Table 37). R. Bruns tallied moose kills in December and January - these added to the kills we saw gave 3 caribou, 1 horse, and 12 moose. In March, flying in Region 7, I recorded 7 moose kills and J. Elliot recorded 5 more moose kills. In the surveys in Region 7, we were searching for caribou so the data are conservative relative to moose.

The wolves seen during the February census included:

The Upper Stikine Pack. This group included 14 wolves (11 black and 3 grey), seen near the junction of Chapeau and the Stikine (Feb. 6). This group was seen twice, two days apart in the same area. They had a moose kill. Tracks led on the stream (10 miles) from Caribou Hide to the kill.

The Spatsizi River Pack. This pack had 5 animals (4 black, 1 brown on Feb. 6). They had a moose kill 9 miles upstream (brown wolf seen) from Hyland Post, they also scavenged a moose 2 miles below Hyland Post. The moose was not killed by wolves because:

1. it was frozen intact
2. had melted into the snow
3. was not dismembered
4. had not bled prior to death
5. was fed on after freezing - hence preference for rib cage and internal organs (the "hollow-out look" that Haber (1977) describes)

Cullivan Creek - Cold Fish Pack. On February 9, 7 wolves (4 black, 2 grey, 1 white) were at a moose kill on Cullivan Creek where the horse trail from Caribou Mountain and that from Cold Fish join and cross the creek. Also, two grey wolves were seen near Ford Pass by D. Hatler on the fly-in, February 3.

Eaglenest Pack. On February 9, 2 grey wolves were seen on the B.C.R. grade approaching McEwan Creek. Their tracks extended back almost to Eaglenest Creek. There were no wolf tracks on the Klappan. Their new travel route is the grade. Railroad engineers make straighter travel routes than does nature.

Besides these observations, R. Bruns searched for wolves for us during December and January, 1977. He saw the following:

December 15: 14 wolves (5 black, 9 grey) on mountain east of Joe Mutz Pass (we saw 13 tracks in this area)

December 13: 1 black wolf near Holmes Camp

January 15: 3 grey wolves at a moose kill on Moose Flats (north side of Caribou Mtn.

January 18: South of Dease Lake and northeast of Kluey Lake, 5 wolves on a moose kill (2 black and 3 grey) outside census area.

Data unknown: 6 tawny wolves at moose kill on Eaglenest Creek.

Now we should estimate the size of the packs. The Spatsizi pack has at least 5 animals. We noted 10-12 tracks on the Ross R. This could be 5-6 animals going up and back down (most of the wolf trails in this survey dead ended at the head of the moose distribution on each stream). However, the manner in which the tracks spread just in one direction only suggested 10-12 animals. D. Hatler saw 11 animals in this pack last year (Osmond-Jones et.al. 1977). This pack likely contains 10-12 animals. It hunted the Spatsizi, Dawson, Ross and Kliweguh Cr. Mink Creek seems to be the boundary line with the Cold Fish pack. Probably, the junction of the Spatsizi and Stikine is the boundary line with the Stikine pack. J. Holmes (pers. comm.) indicated three packs meet at this junction and our census supports this view (Fig. 11).

The Stikine pack contained at least 20 animals (14 seen and 6 tracks on the Chukachida R. We combine these groups because last year this pack contained 29 + 7 animals in September (Tomias Mtn.) and had 36 animals in the winter (Osmond-Jones et.al. 1977). Also twenty-nine animals were seen March 5, 1976 (16 black, 11 grey and 2 more). Again, C. Simmons saw 38 animals in this pack in October 1973, on Tomias Mtn. This year, Hazelwood reported 16 wolves were harvested from this pack at Fishing lakes on the Finlay R. We now estimate this pack at 22 animals based on 16 tracks and 6 tracks. Even though this pack has been reduced, this will not affect the population estimate. That is because, a large proportion of the area traveled by this pack (Chukachida, Edozadelly, and Finlay River) is outside the census area.

The Cold Fish - Cullivan pack contains at least 14 wolves, seen by R. Bruns. There were no white wolves in this group, yet the group we saw on Cullivan had a white wolf. R. Bruns has seen a white wolf frequently at Cold Fish Lake. Thus the seven wolves may be a subdivision of the Cold Fish pack, especially since we saw 13 tracks near the original sighting of 14. There were a lot of other tracks about, especially down McEwan Creek and Hatler saw 2 grey wolves on February 3. The pack is estimated at 14-21 animals with the higher number favored.

The Eaglenest pack was not seen in February. R. Bruns saw 6 very distinctive tawny wolves in this group this winter. Our survey revealed 4 tracks and 2 grey wolves. The pack is estimated at 8 wolves.

The Marion Creek pack was also not located. There were tracks all along Marion Creek, and several places downstream - tracks counted were 6+,5,7,7,7, and 7. The pack is estimated to contain 7 wolves, and to range from the junction of the Stikine and Spatsizi down to the Pitman River. At least half the range of this pack is outside the census area.

A wolf den was found by a hiker between Kliweguh and Marion Creeks this year. Droppings of pups were present. A pack of four was seen there on July 30, 1976. We hypothesize that if we had studied at Caribou Mtn. instead of Fire Flats, we would have possibly seen more wolves than bears.

The Kehlechoa pack was also not seen in February. The 3 wolves seen by Bruns on Moose Flats may be this pack since wolf trails lead up from the Stikine to Moose Flats. Track counts were 5,5, and 2-4. Much of the range of this pack is outside the census area.

In summary, the number of estimated wolves is:

Spatsizi Pack	10-12
Stikine Pack	20-22
Cold Fish Lake Pack	14-21
Eaglenest Pack	8
Marion Creek Pack	7
Kehlechoa R. Pack	5
	64-75 wolves

This census total does not include single wolves: other groups must have been missed. Against this, 4 of the 6 packs go outside the census area. We leave it at that, 64-75 wolves in about 3200 square miles, or 1 wolf/43-50 square miles. This density agrees with that which Haber found in Mt. McKinley Park (Haber 1977) and what Rausch (1967) reported for the Nelchina basin. Both areas have a prey biomass similar to Spatsizi Park.

Another way to approach a count of wolves is to determine the ungulate biomass. Wolf biologists are now talking about a relationship between the abundance of ungulates and the numbers of wolves (Van Ballenberghe et.al. 1975 Haber, 1977, Collin and Mech, 1978). Haber (1977) has regressed territory size on ungulate biomass for 8 studies (or ungulate prey per square mile). Below we calculate the prey biomass for the 3200 square miles based on estimates and data from Osmond-Jones et.al. (1977):

Prey Present	Pounds/Animals	Biomass (lbs.)
1500 moose	800	1,200,000
700 caribou	350	245,000
300 sheep	130	39,000
600 goats	160	96,000
3,100		1,580,000

This provides 494 lbs/square mile or one prey item/square mile. This yields an expected territory size of 900 square miles of year round range. Our study area should contain 3-4 territories. The Spatsizi and Cold Fish territories are in the Park. Perhaps one-half of the Marion, Stikine, Kehlechoa, and Eaglenest Packs are in the census area. Thus there is $1+1,+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}=4$. However, the packs are larger in Haber's study, about 20 animals. Based on the prey biomass, we might expect to have 3-4 territories, each with perhaps 20 wolves, or by this method 60 to 80 wolves.

The weakness in the calculations is the moose estimation. We had planned to count moose in February but, lack of funds, time, and good snow dictated that the attempt be shelved. Bergerud has accurately counted moose in Newfoundland (Bergerud and Manuel 1969) and in Ontario (Bergerud and Wyett, 1976), and believes it is quite possible in Spatsizi. The work should be done when the animals are scattered and new snow is frequent. Probably December is the best month.

Data from this wolf census plus observations made by Bruns in other years indicate heavy predation on moose. R. Bruns feels the moose population has declined in the past few years. T.A. Walker found a low moose population when he started in this area in 1948, and wolves were common.

One does not need to count moose to decide whether the population is increasing or decreasing. The method is to compare recruitment versus natural mortality of adults. The natural mortality of moose is not well known but Peterson (1974) estimated it at 13 percent for Isle Royale. Since moose have a higher intrinsic rate of increase (r_m) than caribou (.34+ versus .30), mortality should be higher. The adult q_x for caribou is perhaps 10 percent (Bergerud 1967). The 13 percent q_x seems reasonable for moose. Wolfe (1977) estimated the q_x for adult moose at 10 percent but his data was collected possibly when the moose were increasing. To be conservative, we should use 13 percent.

We counted moose calves February 3-10 to measure recruitment. We secured 7.4 percent moose calves in a sample of 216 animals. The sample may be biased to females since the work was concentrated along wolf travel routes and cows are thought to stay lower than bulls when snow cover builds. Wolves kill more cows than bulls (Wolfe 1977) which also suggests females are more common along rivers. Our classification should be conservative.

Now 7 percent is not the recruitment. Wolves kill calves about twice their abundance in the population during the first winter of life. (Haber 1977, Wolfe 1977, Peterson 1974). Recruitment should be measured in May - after wolf packs split up for denning and at about the time the first moose calf is born, perhaps, the third week in May. Hence, wolves would continue to reduce the calf recruitment for 3½ months, February to May (even yearlings are more vulnerable than adults, Peterson 1974).

Let us calculate this reduction based on 1500 moose. These are the estimates:

1389	adult moose	(92.6%)
111	calf moose	(7.4%)

Wolves take 0.67 moose/month/wolf (Mech 1966), or for Spatsizi, we have 64 wolves x .67 x 3.5 = 150 moose. The population minus the kill is:

1389 - (.85 x 150)	=	1261	(93.5%)
111 - (.15 x 150)	=	89	(6.5%)
1500		1350	

Hunting of moose probably takes 100 animals (3 outfitters and resident hunting up the Stikine R.). Thus a possible scenario from year 1 to year 1 + 1 is:

1500 - 100 = 1400 x .87 = 1281 plus 89 calves = 1370

(1500 - 1370)/1500 = -8.7 percent

The population is probably declining at a rate of 9 percent a year which is the same as that calculated for the caribou herd. However, unlike the caribou herd, the sex ratio of the moose population still seems to be unaffected (below). Knowledge of the sex ratio of the recruits and wolf kills should be secured.

	Adult	
	Bulls	Cows
Moose seen 1976 (Osmond-Jones et.al. 1977)	27	26
Moose seen in this study (Table 42)	28	29
	50:50	

Note in Table 42, that in 59 moose there were only 2 yearlings (3%). Calf mortality is not the last word in measuring recruitment.

In summary, we see two predation seasons:

June-October	Caribou adults and calves most important, more stags taken than does.
November*-May	Moose adults and calves are most important, more cows taken than bulls (Wolfe 1977, R. Bruns pers. comm.)

In both species, calves are likely taken at twice their abundance. Both species appear to be rapidly declining.

*In November-December caribou are probably more vulnerable - migration and snow are factors.

MANAGEMENT

Range Management

We have no specific recommendations for range management. Both summer and winter foods are abundant. Caribou use a natural rotation. Some winters, they will winter in the Park in larger numbers than others. Our only concern is that fire not be excluded from the natural ecosystem. This point is discussed in more detail in the report submitted to Fish and Wildlife. Eight benefits of fire include:

1. fire causes a mosaic of vegetation which ensure forage availability under different snow conditions and provides open areas for escape.
2. fire reduces tree cover, hence increases spring melt.
3. fire opens up closed canopies allowing lichen cryptogams to develop.
4. fire destroys Krumholz vegetation at snowline that traps snow and reduces the relative abundance of terrestrial lichens.
5. fire reduces bryophyte competition for terrestrial lichens.
6. fire renews plant growth including lichens.
7. fire increases plant variety.
8. fire can increase the amount of green food in winter and early greening of food in spring.

Fire is a normal and necessary process of the boreal forest and its exclusion is unnatural (see review by Kelsall et.al. 1977, Methuen et.al. 1975, Zackrisson 1977).

If Spatsizi is indeed a wilderness park, then fires should be allowed to run their course. There is a great deal of literature on this subject. We do not review it here - one could start with the bibliography presented by Kelsall et.al. (1977).

Summer foods for caribou seem abundant. The willow flats are essential. A problem that might develop some day is overbrowsing by moose. Caribou strip leaves leaving stems intact hence cannot hurt willows as much as moose, which conceivably could alter food supplies.

Flooding the Stikine

A dam on the lower Stikine would back water up to the edge of the Park. Such a waterway would greatly increase access to the Park, and would provide a better route for poachers to reach the winter ranges. This winter we found that the Brock Mtn. caribou frequently travelled down the ice on the creek that goes through Ford Pass to the Stikine. Caribou have been frequently reported at the mouth of the McBride River. These animals, we believe, rut on Caribou Mtn. We predict that the Caribou Mtn. herd will receive increased hunting by such flooding.

The Stikine - Turnagain Road

A forestry-mining road is being planned along the north side of the Stikine. This road will go upstream and then turn north to the Turnagain mining properties. The route north will likely be up the Kehlechoa or Kutcho River. This road is a disaster for the Caribou Mountain herd. This winter, very few caribou wintered on the north side of Caribou Mountain. On December 16, R. Bruns counted 244 caribou along Kutcho Creek over to Letain Lake. The percentage of calves in this herd was similar to that secured at Caribou Mtn. in the fall, 4% (10/244). Further, the animals were stretched out along Kutcho as if they had come from the south. Also, the percent calves of caribou that A.T. Bergerud saw at Turnagain in September-October was 13 percent calves and there were far less than 244 animals. In February A.T. Bergerud saw caribou tracks along Kehlechoa Creek. Tracks were along both forks, some all the way to the bogs at the head of Kutcho Creek. We have a caribou travel route here. We believe caribou cross the Stikine in some winters and go to the Turnagain country.

Now if a road is built up either Kehlechoa or Kutcho and the above hypothesis is correct, then the Caribou Mtn. herd is wide open to increased access and illegal hunting. It is no good to say that the road will be closed to hunting and adequate law enforcement will be provided - law enforcement is never adequate. Nor will the road be closed to the public - public roads are always open to the public. An unplowed road is still accessible to snow machines.

This road must be halted until the caribou distribution pattern is known. It may be more advisable to approach the mining properties through Caribou Pass via Tanzilla Butte. That area is already scarred by tractor roads. Also, should not the public be in on the decision of whether transportation of jade is more important than caribou from Spatsizi Park?

Omineca North Road

Another mining road is approaching the Park from the south. The Omineca North road is now halted at Moose Valley 70 km south of Lawyers Pass. The road is halted temporarily because of shortages of funds. The immediate goal of this road is the mine at Black Lake (Fig. 12). However, highway personnel are talking about pushing the road through Lawyers Pass and down the Stikine to link-up with the Stikine Forestry road. Spatsizi Park would be encircled.

First, most of the caribou that rut in the Park, winter outside the Park. At present we do not know where they go, but we know the Stikine is a major artery and that in some winters, large numbers winter on ranges near the upper Stikine.

Again, caribou winter along the lower Chukachida. Also the possibility exists of a major travel route north for Tomias and Lawyers Pass caribou, by the mouth of the Chukachida - up the river west of Albert Dease and over the flat plateau hunted by J. Holmes. The area of Spruce Hill may be an important cross road. A road down the east bank of the Stikine seems like a disaster to us.

At the present time, the road is to be terminated at Black Lake Mine. Around Black Lake Mine is the largest herd of rutting caribou left in British Columbia - some 2500 animals (Fig. 12). The story of caribou declines is the story of access - even with all the best intentions - when the country is opened up the herds are over-harvested, be it legal or illegal hunting.

The issue of this road versus the future of the largest herd of caribou left in the province is so vital that we suggest there should be a public inquiry into the matter. We understand the main thrust of the road is to get machinery into Black Lake so as to enlarge the airstrip. Is there no way this machinery can be flown into the present air strip or driven across the tundra in the winter? Even if the machinery had to be flown into Thutade Lake and a road built from there, this would leave a broken stretch of road and save the herd from access.

Extensions to the Park

It goes without saying that the Park is not self-sufficient when it comes to caribou. This winter there could not have been more than 75 caribou wintering in the Park. The fact that 2 of 11 park management units (A and K) are outside the Park (Osmond-Jones et.al. 1977) is self-explanatory. Area A includes Brock Mt. This winter the only good number of caribou were at Brock Mtn. (Appendix B), yet Brock Mtn. is outside the Park. The Brock Mtn. caribou probably rut on Caribou Mtn. Maybe we cannot hope to contain within the Park, the range of the Tomias caribou herd, but we could strive to protect the Caribou Mtn. herd. Brock Mtn. should be included in the Park.

Area K of course contains Lawyers Pass. This we believe is the most important travel route now existing in B.C. The herd at Lawyers Pass (includes Tomias caribou) is the largest left in the province. If K was included in the Park, the Park would be secure from road access to the east. A road is being considered through Lawyers Pass.

We hypothesize that Tomias caribou sometimes move north after the rut. Spruce Hill may be the route across the Stikine - Spruce Hill needs to be included.

Fire Flats is the largest post-calving gathering that we know of in B.C. The herd has rapidly declined (Fig. 10) - the B.C.R. grade may be a factor. The southern boundary of the Park should be extended out to the grade.

Hunting and Predator Control

K. Joy in memorandum, state that Parks needed the following information:

1. inventory
2. determination of sustained yields
3. determination of carrying capacity
4. evaluation of the impact of hunting

5. knowledge on predator-prey relationships
6. ecological relationships between hunted and unhunted populations
7. rates of recovery of species
8. fluctuation of population

We have some ideas on these points and should discuss them since Parks seeks such information.

Our only contribution to inventory is our count of 64-75 wolves in Spatsizi Park and some surrounding locales. This figure is lower than Hazelwood's estimation of 100 wolves (Park files). We think our count is closer to the true value - it is also the one predicted by prey biomass. We do not think wolves have seriously declined. However, there may have been more wolves a few years back when we believe moose and caribou were more abundant.

The major inventory needed is to census the moose and bears. Moose can be counted (Bergerud and Manuel, 1969), and we would have attempted it this year if funds and snow conditions had both worked out. To count bears will require tagging and resighting methods.

The sustained yield of moose and caribou depend on calf survival. At the present time, neither species has any surplus available for harvest - both species are declining. Nor do we believe that there will be any surplus in the future. Again, we do not believe that one can expect surplus in a system with an undisturbed, self-regulating predator population (Bergerud 1978). Possibly if a large section of the Park burned, moose might escape a predator limitation and have a surplus. The harvest of caribou is small, but it adds to the rate-of-decline. The biological answer to the hunting question is easy - there are no surpluses available for either moose or caribou, and hunting should cease.

On the matter of carrying capacity, we differ from other biologists and think that the dispersal of moose and caribou relative to predation sets the carrying capacity - a carrying capacity set by food is at a higher ceiling than dictated by dispersal and predators. That spacing, which provides a sufficient spreading-of-riches so that recruitment equals adult mortality, could be considered the carrying capacity. For a pure wolf-caribou system, Bergerud (1978) argues that the carrying capacity is 1 caribou/square mile and 1 wolf/100 square miles. A caribou-moose-grizzly-wolf system might have a caribou density of 1 wolf/50 square miles and 1 caribou per square mile and 1 moose per square mile. The present wolf population seems about right, but the caribou may be down by half and the moose down by a third. We are thinking of caribou that really live in the Park, by definition let us say those that calve in the Park. We think recruitment in caribou and moose should be managed for positive growth so that the herds increase to 1 caribou and 1 moose/square mile. For positive growth, the recruitment would likely have to exceed 10 percent for both species. At this density, both species may be able to better approach a recruitment similar to natural adult mortality. Of course, grizzly predation complicates the whole situation. In any case, we do not see any room for hunting unless predators are reduced.

At the present time, the Park is getting poorer in several species - less caribou and moose each year, next the wolves will decline. Possibly bears are increasing, sheep seem to be less from the early days of T.A. Walker.

If hunting is an important recreational component of the Park, we think wolves will have to be reduced. However, grizzlies are also involved and it cannot be predicted without more research if wolf reduction without grizzly reduction will give positive recruitment - it does seem likely though.

A major influence on a decision of predator control is to decide if the fauna in the Park will be intensively studied. There is merit in having an undisturbed predator-prey system somewhere in B.C. for scientific study. A study at this time would naturally focus on the decline of undisturbed populations; at what densities will the decline halt - what will happen to the predators? If predators were removed, the increase phase of population growth would be studied - recovery of ungulates and predators. If there is little prospect of money for research, then it would seem most appropriate to halt the decline. People do want to see wildlife in a Wilderness Park.

K. Joy has asked about population fluctuation and rates of recovery.

"The observ[illegible]ldom ever stable - they are going up or down. Caribou were is not bas[illegible] on the level of caribou population in paragraph 4, page 45, information from T.A. Walker."

the bears.

When we tamper with populations, we can get some appreciation of recovery rates by knowing the intrinsic rate of increase for each species (r_m). Very roughly, the r_m for each species discussed here is .15 for grizzlies (Peterson 1975), .30 for caribou (Simkin 1965, Bergerud 1971b), .34-.40 for moose and .60 for wolves (Mech 1970). If we had a 100 grizzly bears and everyone lived and produced at a maximum, we could expect 118 next year (18/118 = 15). Grizzlies take far longer to recover from our tampering than anything else. Wolves bounce back. After extensive wolf control in the 1950's, wolves recovered in 3 to 6 years (data from Sumanik, pers. comm. and D. Eastman). Assume the following r_m's and start with 100 animals for each species, then in 5 years you would have:

	r_m	
bear	.15	100 ⟶ 229
caribou	.30	100 ⟶ 598
moose	.34	100 ⟶ 811
wolf	.60	100 ⟶ 9766

However, a more realistic r for caribou (wolves reduced, grizzlies not disturbed) is probably r = .10. If we now have 700 caribou and want 1200, it will take 11 years. Wolves would have to be controlled for 11 years.

If it is decided that the Park should have more caribou and moose, and wolves are to be removed, we think the upper Stikine pack and Spatsizi River packs should be removed. Food habits of the Cullivan Cr. - Cold Fish pack should be studied. If they are taking caribou - they should be removed. These territories would have to be constantly policed to prevent new packs from getting started. There would be enough wolves left to assure a speedy recovery of the wolves whenever that end was desired.

There are no right and wrong answers; it is all so complex that predictions are impossible. No matter what, we would like to continue to work in the Park and study predator-prey interactions. We are searching for funds to put radio collars on caribou calves to study the relative roles of grizzly and wolves in calf survival. Inaction does not solve much, except reduces criticism. The only thing we think that we can predict is that, if nothing is done, there will be less and less game. Predator-prey cycles take a long time.

TABLES

List of Tables

Table 1. Schedule of Work in 1977-78[1]

Date	Area	Objectives
May 25-June 3	Buckinghorse Lake & Tuaton Lake	Migration and calving behaviour
June 4-July 15	Fire Flats	Calving behaviour, post-calving aggregating behaviour and summer food habits
July 19-30	Caribou Mtn. and Hyland Post vicinity	Winter range investigations and scat collections
October 7-8	Caribou Mtn. & Tomias Mtn.	Aerial classification and census
October 9-22	Tomias Mtn. (Worry Cr.)	Study rutting behaviour
November 29-January 18	Spatsizi River, Brock Mtn., Caribou Mtn.	Aerial search for caribou and moose
February 3-10	All river courses in Park	Aerial census wolves and classify moose
March 2	Rocky Mt. Trench to Park	Aerial search for winter range of caribou

[1]We include some observations of caribou relative to insects secured from Atlin, August 13-19.

Table 2. Darting Attempts Compared Between Techniques

Technique	Man-Days	Shots Fired	Shots/Day
1. Stalk in willows and in hilly terrain	7	2	0.3
2. Stalking salt licks at edge of timber[1]	3	2	0.7
3. Calling females in that are searching for lost calf	< 1	1	1.0
4. Ambush at salt lick	1½	2	1.3
5. Rapid approach into large herd[2]	< 1	3	3.0
6. One person drives a large herd within range	< 1	2	2.0
7. Fire from helicopter	< 1	5	5.0
8. Land helicopter near newly born calf	1	-	-

[1]technique will only get ♂♂

[2]good possibility won't catch animals by knock-down, difficult to keep track of darted animal

Table 3. Classification of Wolf Scats as to Age

Class	Description	Total Found	Percent
Fresh	Moist	10	6
Medium	Dried	9	5
Leached	Mostly hair	23	14
Bleached	White	63	38
Old	Crumbly, mold, flat	35	21
Unclassified	-	26	16

Table 4. Measurement of Caribou

	Newborn Calves		Adult ♀ [2]	Adult ♀ [1]
	June 7	June 18	July 10	Oct. 16
Head length	-	8.75	17.75	17.25
Hind foot (B)	14.5	14.25	24.5	24.75
Hind foot (D)	16.0	10.25	16.0	17.00
Shoulder height (B)	27.5	24	52.5	50.00
Shoulder height (D)	23.0	-	44.25	44.00
Heart Girth	20	19.25	50.5	53.7
Ear length	3.5	3.75	5.5	6
Tail length	2.5	4.0	6	5.75
Total length (B)	34.5	35.5	81.5	82
Total length (D)	-	35.0	79.0	77.25
Neck	-	9.0	17	21
Weight (lbs.)	20	20 (est.)	310	-

[1] old incisors show dentine, back fat 1.5 cm, 76 warble scars

[2] age 10+, weight 310 lbs. She had no back fat, very little mesentery and kidney fat, but blood chemistry indicated that she was in good condition. Total warble scars visible was 65 old, 17 fresh and 6 warbles maggots still under skin.

Table 5. Comparison of Antler Size Between Spatsizi & Level Mt. Populations

MEAN MEASUREMENTS	1977 Season	Spatsizi		Level Mt.
		Caribou Mt.	Fire Flats	
MALES				
Total Length (cm)	101.9 (24)	103.0 (34)	105.7 (37)	102.1 (35)
Total Points	13.2 (24)	12.3 (9)	12.9 (38)	13.4 (26)
Burr (WXL) (cm^2)	-	-	23.0 (25)	21.0 (37)
Weight (kg)	-	-	3.3 (33)	-
Brow Length (cm)	30.1 (22)	28.8 (7)	29.9 (24)	27.9 (45)
Brow Width (cm)	13.2 (22)	4.2 (7)	13.9 (14)	14.0 (42)
Bez Length (cm)	45.8 (24)	36.9 (8)	41.4 (29)	43.4 (46)
Bez Width (cm)	22.4 (24)	15.7 (3)	16.5 (16)	13.0 (11)
% Brow Palmate[3]	63 (24)	71 (7)	64 (33)	59 (46)
Smallest Diameter of Beam	15.4 (24)	-	15.2 (28)	15.9 (51)
FEMALES				
Total Length (cm)	-	-	37.3 (18)	36.3 (15)
Total Points	-	-	4.4 (18)	4.8 (14)
Burr (WXL) (cm)	-	-	5.0 (20)	5.6 (17)
Weight (gms)	-	-	152.4 (17)	163.4 (15)

[1]Two ♀♀ antlers Atlin: TL = 53.4, 42+; burr = 500, 672; wt. = 310, 258 gms; points 5, 6.

[2]many antlers at Level Mt. old and lost weight

[3] $\geq$ 5 cm

[4]antlers in this table all found in the field, most cast, some attached to skull

[5]Fire Flats ♂ antlers found at Buckinghorse and Tuaton Lakes; no shed antlers on Flats.

Table 6. Mean Height of Growing Antlers (inches velvet)

Time Period	Males			Females		Yearlings	
	large	medium	small	barren	fertile[1]	male	female
May 20-31	13.8(12)	6.6(13)	3.2(12)	2 (16)	1.4(10)	.8(2)	.7(3)
June 1-7	14.6(11)	8.5 (4)	4.6 (7)	3 (4)	1.0 (2)	3.5(1)	2 (1)
June 8-14	16.3 (3)	8.0(3)	4 (1)	4 (5)	2.0 (8)	1 (2)	2.5(5)
June 15-21	23.1(15)	15.5(19)	6.4(13)	5.1(13)	2.4(12)	4 (1)	-
June 22-30	25.3 (9)	17.1(22)	6.6(11)	6.1(17)	1.2(27)	4 (2)	3.4(4)

[1]Of fertile females those retaining hard antlers, or bald with no visible antler growth yet were: May 20-31: 46 of 65; June 1-7: 19 of 21; June 8-14: 21 of 29; June 15-21: 84 of 96; June 22-30: 28 of 55.

Table 7. Sex Ratio of Caribou on Lowlands, Buckinghorse Lake and Tuaton Lake

Date	Males Seen	Females Seen	Ratio ♀/♂	
May 25	3	20	6.7	
May 26	7	21	3.0	4.8
May 27	12	65	5.4	
May 28	26	23	0.9	
May 29	4	7	1.8	1.2
May 30	1	7	7.0	
May 31	5	3	0.6	
June 1	12	0	0.0	0.3
June 2	1	2	2.0	

Table 8. Elevation and Aspect of Birth Sites

Birth Sites			Possible Birth Sites		
Area	Elevation (ft)	Aspect	Area	Elevation (ft)	Aspect
Thule Mtn.	5600	SW	Taylor Mtn.	5500	SE
Thule Mtn.	5700	Top	Crescent Mtn.	5500	W
Thule Mtn.	5800	SW	Terrace Mtn.	5500	W
Umbach Mtn.	6100	Top or S	Terrace Mtn.	5500	W
Umbach Mtn.	6200	Top or S	Thule Mtn.	5600	E
North Side	5700	N	Wolverine L.[1]	5500	NE
N. Thule	5600	?	Wolverine L.	5500	S
Middle Mtn.	5400	SW	Wolverine L.	5100	S
Umbach Mtn.	5500	SW	Wolverine L.	5700	N
Mean	5733	S & SW		5488	S,SE,E

[1]Turnagain area

Table 9. Highlight of Watching Females on Mt. Umbach

Days	Caribou Seen	Location on Umbach
June 3	1 ♀	West Peak 6500'
4	1 ♀	"
5	1 ♀	"
5	1 ♀	East Ridge 6500'
6	1 ♀ "C"[1] and newborn calf and 1 ♀	East Ridge
6	1 ♀	West Ridge
7	♀ "C" and calf and 1 ♀	East Ridge
8	♀ "C" and calf	"
8	♀ "A" and ♀ "B" and 2 calves	West Ridge
8	♀	NW slope 5000'
9	♀ "C" and calf	East Ridge
10	" " and 1 unknown	" - last day seen
10	♀♀ "A" and "B" and calves	West Ridge
11	"	"
12	"	"
13	" and 1 unknown	"
14	" "	"
15	" "	"
16	♀ and calf	Meadow north of W. ridge
16	2 ♀ and 2 c and 4 unknowns	NE slope Umbach 6000'
17	♀ "A" and "B", calves and 1 unknown	Small ridge NW Umbach 5500' - last day seen
19	♀ and calf (newborn)	
25	5 ♀♀'s, 5 calves & 4 unknowns	1st main ridge N. of Umbach Mtn.

[1] 3 females were identified - A, B, C.
A and B shed their antlers about 8 days after parturition.

Table 10. Plant cover on areas most frequented by cow-calf pairs on Umbach Mtn.

	Percent Plant Cover				
	West Ridge			East Ridge	
Plot Number	1	2		1	2
Rocks and earth	5	10		10	30
Lichens-general[1]	50	50		40	50
Lichen species:					
Brown horn	1	1		5	5
Green horn	1	3		5	5
Primary thalli	15	5		10	5
Cetraria cucullata	-	1		15	5
C. nigricans	1	1		1	5
Cladonia nivalis	15	20		15	20
C. uncialis	15	10		20	20
Stereocaulon paschale	30	30		20	1
Peltigera malacea	-	1		5	2
Solarina	-	-		-	5
Dactylina	-	1		-	2
Thamnolia	15	30		10	15
Non-lichen group[1]	50	50	Height Inches	80	50
Dwarf willow	5	2	.75	-	-
Moss	50	60	.25	30	35
Forb-white vein on green leaf	2	2	1.5	1	-
Saxifrage	1	2	1.0	-	-
Forb - carrot like	2	2	1.0	5	2
Composite	5	1	.75	5	2
Bunchgrass - tall	30	25	3.0	30	25
Moss campion?	-	-	.25	30	35
Grass sp. - wide blade	-	-	3.0	-	2

[1] % browse on lichens: West Ridge Plot 1 - 90%, 2 - 95%; East Ridge 1 - 50%
% browse on non-lichens: West R. 1 - 5%, 2 - 5%; East Ridge 1 - 0%

Table 11. Vegetative analysis of three birth sites at Mt. Umbach (above 5500')

Pellet Piles	Site 1 23 (in 30 X 50')	Site 2 30 (2 areas 30 X 50)	Site 3 23 (in 32 X 50')
% Rock	15%	5%	25%
Empetrum spp.	< 5%	0	0
Carex and grass	25%	40%	40%
Saxifraga sp.	2%	0	0
Heather	2%	0	0
Dryas	2%	0	0
Bryophytes	15%	< 2%	10%
Other forbs	< 1%	5%	< 1%
Lichens	30%	40%	20%
Lichens			
Stereocaulon	common	common	common
Cetraria nivalis	dominant	dominant	present
C. islandica	present	present	present
C. cuculata	present	present	present
Cladonia mitis	present	present	present
C. uncialis	present		present
Lobaria linata	present		
Solarina sp.	present	present	present
Pedesaria sp.	present		
Peltigera sp.		present	present
Thamnolia sp.		present	present
Dactylina sp.	present		present
natural shed female antler	No	Yes	Yes

Table 12. Calf suckling success

Calf age (days) (approximate)	Number of all attempts	Successful attempts	Percent success
0-7	26	21	80.8
8-14	30	22	73.3
15-21	38	30	79.0
22-28	8	6	75.0
29-35	27	16	59.3
36-42	5	4	80.0

Table 13. Duration and frequency of suckling

Calf age (days) (approximate)	Mean duration (seconds) of suckling bouts	Mean interval between suckling bouts (minutes)
0-7	36.5 (31)[1]	59 (28)
8-14	56.8 (18)	101 (22)
15-21	46.3 (24)	94 (30)
22-28	29.3 (4)	95 (6)
29-35	30.5 (17)	138 (16)
36-42	30.0 (2)	277 (4)

[1] 31 = sample size

Table 14. Observations of Caribou on Fire Flats

Date	Time	Total Caribou	Group Size		Remarks
			Mean	Max.	
June 16	4:00 p.m.	67	-	-	
June 17	7:15 a.m.	93	15.5	47	
June 18	9:00 a.m.	138	34.5	66	
June 18	3:00 p.m.	133	11.1	20	
June 19	8:00 a.m.	159	17.7	47	
June 19	5:30 p.m.	128	21.3	85	
June 25	2:15 p.m.	121	24.2	65	
June 27	2:30 p.m.	192	24.0	83	40 males, 130 females
June 29	4:00 p.m.	236	29.5	116	
July 1	8:00 p.m.	141	23.5	54	
July 2	6:40 p.m.	148	29.6	66	6 calves
July 5	12:45 p.m.	137	19.6	58	
July 6	4:00 p.m.	85	17	44	1 calf
July 7	2:30 p.m.	75	15	45	2 calves
July 8	?	96+	16	53	5 calves, 23 males, 71 females
July 9	10:00 a.m.	92	18.4	72	7 calves, 15-20 males
July 11	-	72	14.4	41	2 calves, 16 males
July 12	-	65	21.7	42	3 calves, 14 males
July 13	-	58	11.6	39	1 calf, 9 males
July 14	-	39	?	-	2 calves & 11 males, 33 more caribou far away
July 15	-	25	?	-	

June 20 - a herd of 20 males; June 22,1 calf; June 28, 3 calves

June 27 & July 8-13 - 120 ♂ : 404 ♀ = 1.3.4

July 2 - July 14 - 29 calves (n = 730) = 4%

July 8 - new caribou arrive on Flats

Table 15. One-minute-arm tests by D. Newell

Mosquitoes				Mosquitoes			
Date	Time	Bites	Fly-over	Date	Time	Bites	Fly-over
June 17	10:15 a.m.	0	0	July 7*	10:30 a.m.	0	2
	2:00 p.m.	0	0		2:00 p.m.	5	0
June 19	10:10 a.m.	2	2	July 8	11:00 a.m.	1	0
	3:55 p.m.	0	0	July 9	11:45 a.m.	2	3
June 20	10:00 a.m.	0	0		2:00 p.m.	7	2
	2:20 p.m.	0	0	July 10	9:55 a.m.	1	1
June 21	9:25 a.m.	0	0	July 11	10:45 a.m.	1	4
	2:00 p.m.	0	0		2:30 p.m.	4	2
June 22	10:00 a.m.	0	0	July 12	10:30 a.m.	2	1
	1:05 p.m.	0	0		2:10 p.m.	3	2
June 23	9:45 a.m.	0	0	July 14	9:15 a.m.	0	0
	2:00 p.m.	0	0				
June 25	10:15 a.m.	0	0				
	2:00 p.m.	0	0				
July 6	2:30 p.m.	0	0				

*½ hand and arm exposed by D. Miller 30 sec. 32 bites

Table 16. Subjective Comments on Mosquitoes

May 28	1 mosquito seen
May 30	1st mosquito bites
May 31 - June 10	few insects seen
June 11	mosquitos bad at B.C.R.
June 12	mosquitoes bothering. 1 minute arm test = 2 mosquito bites; 1 fly cross over
June 13	mosquitoes biting around camp; 1 minute arm test 1 mosquito bite, 2 flies land
June 17-18	hot, lots of mosquitoes
July 3	6 mosquito bites and 4 flies fly over arm in 1 minute
July 4	8 mosquito bites in one minute
July 8	mosquitoes bad
July 9	mosquitoes bad

Table 17. Insects caught per 100 insect sweeps

Date	Camp 1				Camp 2			
	Weather Temp., Wind	Insects Mosq.	Flies	Others	Weather	Insects Mosq.	Flies	Others
5/25	40°F, 5 mph	0	0	0	no sweep	-	-	-
5/26	warm, 5 mph	0	6	1	warm, light	0	0	0
5/27	cool, 5 mph	0	0	2	no sweep	-	-	-
5/28	no sweep	-	-	-	?	0	0	6
5/29	cool rain	0	0	0	no sweep	-	-	-
5/30	no sweep				normal, low	0	0	0
5/31	wind nil	0	0	0		0	0	4
6/1	no sweep				no sweep	-	-	-
6/2	?	0	7	0	no sweep	-	-	-
6/3	no sweep	-	-	-	no sweep	-	-	-
6/4	no sweep	-	-	-	no sweep	-	-	-
6/5	no sweep				no sweep	-	-	-
6/6	no sweep	-	-	-	no sweep	-	-	-
6/7	no sweep	-	-	-	no sweep	-	-	-
6/8	cool	2	2	0	no sweep	-	-	-
6/9	warm, 5 mph	2	15	0	no sweep	-	-	-
6/10	no sweep	-	-	-	mild, nil	0	0	7
6/11	warm	22 mosq. types			no sweep	-	-	-
6/12	no sweep	-	-	-	hot, light	-	-	10
6/13	no sweep	-	-	-	cool, nil	1	0	27
6/14	hot, light	40 mosq. types			no sweep	-	-	-
6/15	hot, nil	51 mosq. types			no sweep	-	-	-
6/16	warm, light	1	0	10	cool, moderate	0	5	0
6/17	warm, moderate	1	1	2	hot, nil	0	1	0
6/18	no sweep	-	-	-	warm, nil	4	21	2
6/19	no sweep	-	-	-	mild, light	5	2	0
6/20	warm, nil	4	1	0	cool, moderate	5	4	0
6/21	no sweep	-	-	-	cool, light	0	0	0
6/22	cool, moderate	0	7	0	cool, moderate	1	3	
6/23	no sweep	-	-	-	mild, light	0	0	13
6/24	no sweep	-	-	-	no sweep	-	-	-
6/25	nil	17	7	0	cool, light	0	0	2

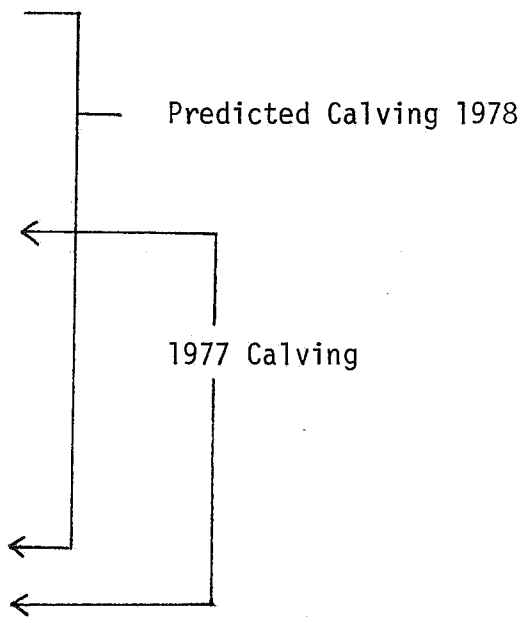
Table 17 (Cont'd.)

Date	Camp 1				Camp 2			
	Weather	Insects			Weather	Insects		
	Temp., Wind	Mosq.	Flies	Others		Mosq.	Flies	Others
6/26	no sweep	-	-	-	no sweep	-	-	-
6/27	no sweep	-	-	-	no sweep	-	-	-
6/28	cool, nil	2	4	8	no sweep	-	-	-
6/29	no sweep	-	-	-	no sweep	-	-	-
6/30	no sweep	-	-	-	no sweep	-	-	-
7/1	no sweep	-	-	-	no sweep	-	-	-
7/2	no sweep	-	-	-	no sweep	-	-	-
7/3	warm, light	1	2	5	no sweep	-	-	-
7/4	cool, nil	8	8	0	no sweep	-	-	-
7/5	normal, nil	3	21	0	no sweep	-	-	-
7/6	no sweep	-	-	-	hot, light	3	4	10
7/7	no sweep	-	-	-	no sweep	-	-	-
7/8	no sweep	-	-	-	no sweep	-	-	-
7/9	hot, light	9	10	1	warm, nil	5	0	4
7/10	no sweep	-	-	-	mild, nil	0	0	5
7/11	no sweep	-	-	-	mild, moderate	1	0	1
7/12	no sweep	-	-	-	warm, low	13	0	13
7/13	no sweep	-	-	-	no sweep	-	-	-
7/14	no sweep	-	-	-	mild, nil	0	0	5
7/15	cool, light	7	12	1	no sweep	-	-	-

Table 18. Decline of mating herd Mt. Tomias
October 8-18

October 8	400+	seen from air
October 12	260 ↙ 40	counted 260 (36 large males), 13 males tending, also a herd nearby leaving (40 animals) with only 1 large male
October 15	182	in 182, 41 large stags of which 11 are tending
October 16	50 ↙ 25 ↓ 15	In 50 caribou. 18 large stags of which 6 are tending. Nearby are groups leaving of 25 & 15
October 17	4	I can find only 4 scattered caribou

If Breed:	Then Calve:	But Calving 1977 was
October 8	May 25	
9	May 26	
10	May 27	Predicted Calving 1978
11	May 28	
12	May 29	
13*	May 30	
14*	June 1	
15*	June 2	1977 Calving
16*	June 3	
17	June 4	
18	June 5	
19	June 6	
20	June 7	



* prime breeding days

Table 19. Behavior activity of males at Worry Creek on October 15-16

Displays[1]	October 15 182C 41 ♂		October 16 50C 18 ♂	
	2:15 p.m.	2:50 p.m.	4:15 p.m.	4:20 p.m.
Hock rub	2	-	-	1
Panting	3	1	1	-
Tending	9	5	4	1
Bushgazing	6	3	3	5
Reclining	8	3	1	1
Feeding	1	4	2	1
Standing	6	1	4	3
Walking	3	-	1	-
Nosing Ground	3	1	-	-
Fighting	-	2	2	-
Running	-	1	-	-
Pawing	-	2	-	-
	41	23[2]	18	12

[1] See Bergerud 1974a for descriptions

[2] Can't see all

Table 20. Transects on Fire Flats

Species	Transect Number				Total	Percent
	1	2	3	4		
1. Salix sp., Betula, Festuca				4[1]	4	0.1
2. S. planifolia	323	149	151	91	714	25.8
3. S. glauca, Festuca forbs	23	9	76	295	403	14.6
4. S. glauca, Betula, Festuca	242	-	67	-	309	11.2
5. Betula, Festuca, cryptogams, some Salix	-	-	52	34	86	3.1
6. Poa, Carex, Potentilla, Artemisia	14	-	-	-	14	0.5
7. Festuca, grass, cryptogams	82	-	-	-	82	3.0
8. Festuca, Luzula, Lupinus, Senecio, Ranunculus, Rumex	72	281	121	83	557	20.1
9. Heracleum, Epilobium, Thalictrum	20	-	-	-	20	0.7
10. Carex, Eriophorum, marsh	98	4	8	63	173	6.3
11. Festuca, forbs, lichens	30	319	-	13	362	13.1
12. Salix, forb, Lupinus	-	-	-	41	41	1.5
					2,765	100

[1] No. of times sampled

Table 21. Biomass figures for preferred food species, Fire Flats.

Species	Plot Number	Date	Weights(g)[2]	
			Wet	Dry[1]
Festuca altaica	2	July 9	115	36.5
	4	July 12	13	2.8
	5	July 9	18	7.5
	6	July 9	75	17.1
	8	July 11	100	29.2
	12	July 12	52	16.5
Lichens (general)	5	July 9	2173	-
	7	July 11	1342	-
Stereocaulon paschale	5	July 9	727	
	7	July 11	450	161.8
Carex aquatilis	1	July 8	45	15.6
	9	July 11	110	29.3
	10	July 12	211	69.3
Salix planifolia	3	July 8	95	11.9
Salix barclayi	10	July 12	160	45.4
	12	July 12	188	52.1
Betula glandulosa	6	July 9	155	41.5
	11	July 12	62	14.0
	12	July 12	62	16.4

[1] air dried

[2] weights from all four quadrats pooled

Table 22. Vegetation Plot from Caribou Mtn. (north slope)

SPATSIZI

Vegetation Plot in Big Birch, lichen-Festuca Community (½ m ht)

July 25/77 by D. Miller.

Species	Quadrat Number				
	1	2	3	4	5
Betula	20	80	70	90	80
Salix	30	-	-	-	-
F. altaica	10	5	20	5	-
Starflower	tr	-	tr	-	-
Artemisia	5	-	-	-	-
lichens	95	80	70	80	80
finger lichens	/	/	/	-	/
Cladina rangiferina	/	/	/	/	/
C. alpestris	/	-	-	-	-
C. mitis	/	/	/	/	/
Cladonia amaurocraea	-	/	/	-	-
C. uncialis	/	-	-	-	-
Thamnolia	-	-	-	/	-
Stereocaulon	/	-	/	-	-
Cetraria alpestris	/	-	/	-	/
C. nivalis	/	/	/	/	/
C. cuculata	/	/	/	/	/
Peltigera malacea	/	-	/	-	-
C. cornuta	/	-	/	-	/
Lupine	-	tr	tr	-	5
Disturbed ground	5	10	10	20	80
Moss	20	30	30	15	40
rock	tr	-	-	-	-
Vaccinium vitis idaea	-	5	tr	5	5
P. apthosa	-	/	-	/	/

Table 23. Arboreal Lichen Abundance on the South Side of Thule Mtn. (T) and the North Side of Caribou Mtn. (C)

Tree Heights (feet)	Lichen Load[1]							
	None		Light		Medium		Heavy	
	T	C	T	C	T	C	T	C
< 6	1	4	-	-	-	-	-	-
6-10	5	1	3	2	-	-	-	-
11-20	5	7	27	6	-	2	-	-
21-30	1	4	7	14	2	-	-	-
31-40	-	-	5	-	6	-	-	-
41-50	-	-	6	-	2	-	1	-
> 50	-	-	3	-	4	-	1	-

[1] heavy > 10 grams/ft.
medium 5-10 grams/ft.
light < 5 grams/ft. (based on sample tree weighed)

Table 24. Lupine Phenology (South Slope, 4200 feet)

Date	No. of flowering heads			
	Plant 1	Plant 2	Plant 3	Plant 4
6/4	0	0		
6/10	11	3		
6/13 (6:10)	14	4		
(21:59)	18	7		
6/14	25	9		
6/15	33	12		
6/16	-	-	0	10
6/17 (7:55)	33	12	0	12
(20:35)	39	14	2	14
6/18	39	15	3	28
6/20	39	15	3	30
6/21	39	16	4	32
6/23	39	16	4	33
6/24	39	16	4	33
6/25	39	16	4	33
6/26	39	18	6	34
6/28	39	19	7	35
6/29	40	19	8	35
7/1	40	19	8	35
7/3	40 (16 have seed pods)	19 (5 seed pods)	8 (0 seed pods)	36 (8 seed pods)
	No. of seed pods			
7/5	17	6	0	8
7/7	21	7	1	8
7/10	32	13	1	18
7/11	33	14	4	24
7/11	33	15	5	24

Table 25. Caribou feeding in plant associations below 5000 feet.

Number of Caribou Aggregations Seen

Time Period	Salix Betula Festuca	Betula Festuca	Festuca	Festuca Forb Lichen	Salix Betula Carex	Salix Carex	Carex	Total
May 25-31	11	21	6	5	2	1	0	46
			Festuca-Lichen					
June 1-7	6	6	3	0	2	0	0	17
		Festuca						
June 8-14	3	2	1	0	1	1	1	9
				Festuca-Carex				
June 15-21	9	4	1	0	6	1	0	21
			Festuca-Carex					
June 22-30	1	0	1	1	3	9	3	18
						Salix-Carex		
July 1-17	0	3	0	0	1	2	0	6
				Salix-Betula[1]				
July 8-14	0	0	0	0	1	4	0	5
					Salix-Betula			
Total	30	36	12	6	16	18	4	122

Sequence: dry Festuca and Lichens → green Festuca → Festuca and Carex → Salix and Carex → Salix and Betula

A.T. Bergerud notes caribou start to feed on Betula July 1

Table 26. Food found in seven caribou rumens

	Percentage Separated						
	1 July 12	2 Sept. 10	3 Sept. 12	4 Sept. 17	5 Sept. 17	6 Sept. 25	7 Oct. 16
Grasses and sedges	53	5	5	27	29	50[2]	21
Terrestrial lichens	23	2	2	11	14	3	tr.
Betula glandulosa	10	33	22	47	46	-	8
Salix spp.	13	56	70	4	5	32	26
Other broad-leaves	2			4	tr	3	42
Bryophytes	-	2	tr	4	6	12	3
Mushroom	-	2	1	2	-	-	-
	101	100	100	99	100	100	100

[1]rumens 2-6 from Osmond-Jones et.al. 1977

[2]Luzula spp.

Table 27. Food species utilized on Fire Flats (based on transect July 15)

Random Transect	Contacts	% Used
Salix planifolia	17/84	20
Salix glauca	0/18	0
Salix barclayi	3/19	16[1]
Carex aquatilis	1/21	5
Carex sp.	0/18	0
Ranunculus	0/23	0
Betula glandulosa	2/33	6
Festuca and others	1/37	3
Misc. herbs	0/62	0

Site Selected Heavy Use

Salix planifolia 8" tall	10/35	29
Salix barclayi 8" tall	9/27	33
Salix spp. 8"	2/8	25

[1]all on edge of community

Table 28. Examination of 26 feeding craters in 6 inches (15 cm) of snow in a grass-sedge-lichen community at 5000' (1524 m) Mt. Tomias, October 18, 1977.

Plant Species[1]	Frequency in Craters
Lichens	
Cetraria nivalis	58
Stereocaulon paschale	35
Thamnolia vermicularis	31
Cetraria islandica?	12
Cladonia uncialis	12
Cladonia rangiferina	8
Cladonia mitis	42
Cladonia spp.	15
Gramnoids	
Luzula arcuata	62
Festuca brachyphylla	
Poa arctica	
Hierochloe alpina	31
Woody Plants	
Vaccinium ulignosum	4
Empetrum sp.	15
Lycopodium sp.	4
Bryophytes	19

[1] Compare with rumen No. 7 in Table 26.

Table 29. Chemical Composition of Important Plant Foods - Fire Flats ≃ July 12

Chemicals	Plant Species					
	Betula glandulosa	Carex aquatilus	Festuca altaica	Salix planifolia	Salix barclayi	Stereocaulon paschale
Nitrogen(% N)	4.17	2.35	2.03	3.25	2.73	1.12
Calcium(% Ca)	0.52	0.45	0.23	0.60	0.89	0.15
Phosphorous(% P)	0.47	0.24	0.24	0.35	0.25	0.11
Copper(Cu ppm)	9	8	6	7	6	3
Iron(Fe ppm)	92	1067	68	213	196	269
Manganese(Mn ppm)	1065	333	509	368	180	171
Zinc (Zn ppm)	362	42	39	124	84	63
Magnesium(Mg %)	0.33	0.21	0.10	0.26	0.36	0.05
Potassium(K %)	0.98	1.21	1.16	1.06	0.98	0.23
Boron(B ppm)	20	12	15	18	16	12
Sodium (Na ppm)	23	67	23	21	18	87
Acid Detergent Fiber (%)	22.2	33.0	33.1	26.1	21.7	17.8

Table 30. Fertility of Females Based on Udder Counts

	Classified Bergerud		Classified Butler		Total Percent
	Parous	Nonparous	Parous	Nonparous	Parous
Week of:					
May 25-31	38	9	11	4	79
June 1-7	4	4	13	3	71
June 8-14	20	4	33	8	82
June 15-21	22	2	2	0	92
June 22-30	19	5	24	2	86
Total	103	24	83	17	82
Percent Parous	81%		83%		

Table 31. Percentage Calves in the Spatsizi Provincial Park Herd 1951-1977

Date	Sample Size	% Calves	Data Source
Aug.-Sept. 1951	29)	10)	T.A. Walker (pers. comm.)
Aug.-Sept. 1952	14)	14)	T.A. Walker (pers. comm.)
Aug.-Sept. 1953	38)	13)	T.A. Walker (pers. comm.)
Aug.-Sept. 1954	11) 198	18) 11%	T.A. Walker (pers. comm.)
Aug.-Sept. 1955	24)	17)	T.A. Walker (pers. comm.)
Aug.-Sept. 1956	45)	7)	T.A. Walker (pers. comm.)
Aug.-Sept. 1957	17)	5)	T.A. Walker (pers. comm.)
Wolf Control			
August 1962	117)	25)	Hartman - 1962
August 1963	43[1]) 160	35) 28%	Mundy - 1963
Wolves Abundant (Below)			
July 1973	74[2])	1)	J.T. Lau (pers. comm.)
Aug.-Sept. 1973	162[3])	6)	R. Flemming (F. & G. files)
October 1974	150)	2)	R. Farnell (pers. comm.)
July-Aug. 1975	62[2])	5)	G. Hazelwood, Carswell 1975
July 1975	95[2])	4) 5%	B. Foster (pers. comm.)
Mar.-Apr. 1976	199)	5)	Fish & Wildlife Files - Smithers
July 1976	246[2])	5)	Osmond Jones et al 1977
Aug.-Sept. 1976	521)	4)	Osmond Jones et al 1977
Late Sept. 1976	527)	7)	Pers. files
June-July 1977	311[2])	5)	Pers. files
October 1977	1544)	5)	Pers. files

1. Total caribou classified northern British Columbia in 1963 was 221 (23% calves).
2. Calves already gone July 1973, 1975, 1976 and 1977.
3. Classified at Kitchener Lake outside Park.

Table 32. Percentage Yearlings Seen

Area	Percent Yearlings				
	Bergerud	Butler	Newell	Miller	Total
Buckinghorse Lake	7(5/75)	8(3/36)	-	-	7(8/111)
Tuaton Lake	-	-	14(6/44)	11(8/74)	12(14/118)
Fire Flats	2(4/241)	9(15/160)	5(11/231)	-	5(30/632)
Caribou Mtn.	-	-	0(0/13)	5(9/200)	4(9/213)
Total	3(9/316)	9(18/196)	6(17/288)	6(17/274)	5.7(61/1074)

Table 33. Remains of dead animals found

Skulls	Total Number				
	Large Males	Medium Males	Small Males	Females	Unknowns
Caribou Mountain	6	3	1	2	4
Fire Flats	3	-	-	-	-
Level Mountain	6	1	-	2	-
Tomias Mountain	1	1	-	1?	-
Total	16	5	1	5	4

Length of Antlers ♂♂ (in.)	ON SKULL	NATURALLY SHED
Level Mountain	38.7 (10)	40.7 (25)
Spatsizi	43.2 (7)	40.8 (21)
Total	40.6	40.8

Remains excluding antlers were:

Level Mountain

Caribou, premolars no wear
1 caribou calf 2nd molar erupting
1 caribou mandible 7-9 yrs.
dentary length 270 mm. (♀)
1 caribou premolars no wear
1 caribou mandible 7-9 yrs.
dentary length 320 mm. (♂)

Fire Flats

1 large bull moose (wolf kill)
yg. moose 3rd molar even with bone
yg. moose 3rd molar even with bone
adult moose, little wear
yg. moose 3rd molar even with bone
caribou, 6-7 yrs. mandible 322 mm. (♂)
yg. moose, 1st molar above bone
caribou, 3-4 yrs. diastema 115 mm. (♀)
caribou, 4-6 yrs. ♂ or ♀ ?
yg. moose 2nd molar above bone

Table 34. The adult sex ratio

Season	Males	Females	♀♀/♂♂
Summer 1976	137	581	4.2
Tomias, Sept. 29, 1976	98	382	3.9
Caribou Mtn., Sept. 29, 1976	8	16	2.0
Total 1976	243	979	4.0
Fire Flats, July 1978	120	404	3.4
Caribou Mtn., July 1978	46	167	3.6
Caribou Mtn., Oct. 7-8, 1977	21	73	3.5
Total 1977	187	644	3.4
Grand Total	430	1623	3.8

Table 35. Food items in Wolf Scats collected May 25 to July 25

Food Species	Major Food Item		Second Food Item	
	Scats	Percent	Scats	Percent
Caribou	121	73	-	-
Moose	17	10	-	-
Marmot	14	8	1	1
Mountain goat	2	1	-	-
Unknown mammal	4	2	-	-
Beaver	4	2	-	-
Hare	2	1	-	-
Small rodent	1	1	12	7
Bird	1	1	1	1
Total	166	99	14	9

Areas Searched	Scats Found	Percent containing:	
		Caribou	Moose
Fire Flats	61	72	10
Tuaton Lake[1]	16	88	0
Buckinghorse Lake[1]	26	65	15
Hyland Post[2]	42	76	12
Caribou Mountain	4	100	0

[1] a known place moose were harvested in September

[2] a known area where wolves hunt moose in winter

Table 36. Major food items in wolf scats deposited prior to caribou calving

Date Found	Age Classification	Food Item
5/31	old	caribou
5/29	old	beaver
5/27	old	beaver
5/30	old	marmot
5/26	bleached	moose
5/28	old	moose
5/29	medium	moose
5/25	bleached	caribou
5/30	bleached	caribou
5/30	bleached	caribou
5/25	old	caribou
5/30	bleached	caribou
5/31	bleached	caribou
5/30	bleached	caribou
5/29	bleached	marmot
5/27	old	moose
5/28	old	caribou

9/17 have caribou 53%

Table 37. Major food items in scats classified as fresh or medium

Fresh Scats			Medium-Fresh Scats		
Date	Place	Species	Date	Place	Species
6/25	Fire Flats	Caribou	5/27	Buckinghorse	Moose*
6/5	Fire Flats	Caribou	5/31	Tuaton	Caribou*
6/25	Fire Flats	Caribou	5/28	?	Moose*
6/26	Buckinghorse	Caribou	6/8	Fire Flats	Caribou
6/26	Buckinghorse	Caribou	6/2	Buckinghorse	Caribou
6/30	Kluayetz	Caribou	6/22	Fire Flats	Moose
6/17	Kluayetz	Caribou	6/12	Ellis Cr.	Caribou
6/5	Kluayetz	Caribou	6/16	Kluayetz	Marmot
8/27	Liard Plateau	Caribou	6/17	Fire Flats	Caribou
8/24	Liard Plateau	Caribou	6/23	Fire Flats	Caribou
8/13	Atlin	Caribou	6/22	Fire Flats	Unknown
	(100% C. r = 11)			(54% C. r = 11)	

*before calving

23 leached scats had 14 with caribou

Fresh = moist
Medium = dry, moisture evaporated
Leached = wash of meat material

Table 38. Comparison of the summer hunting habits of two packs in Mt. McKinley Park (from Haber 1977) (based on 8 years)

Species and Age of Kill	Animals Killed	
	Savage Pack (3.7+)[1]	Toklat Pack (1.3)
Caribou		
Adults or yearlings	4	36
Calves	-	11
Moose		
Adults or yearlings	1	1
Calves	11	2

[1]Mean pack size

Table 39. Predators Seen May 22 to October 18

Observer	Species	Date	Seen Chasing	Location
ATB, DRM	Wolves (4)	May 22	No	Tuaton Lake
ATB, DRM	Grizzly (4)	May 22	No	Hotlesklwa Lake
ATB, DRM	Grizzly (1)	May 24	No	Grizzly Creek
ATB	Wolf (1)	May 27	No	Buckinghorse Lake
DRM	Golden Eagle	May 30	No	Tuaton Mtn.
DN	Wolverine (1)	May 30	No	Bowsprit Mtn.
HB, ATB	Grizzly (2)	June 2	No	Taylor Pk.
ATB, HB	Grizzly (1)	June 3	No	Kluayetz Cr.
CS	Wolverine (1)	June 3	No	McCumber Cr.
HB, ATB	Grizzly (1)	June 4	No	Camp (Fire Flats)
DN, DRM	Wolf (1)	June 5	Yes	Kluayetz Cr.
HB	Black Bear (1)	June 6	No	Thule Mtn.
DN	Grizzly (1)	June 7	No	Umbach Mtn.
HB	Bear (1)	June 10	Yes	Thule Cr.
HB	Wolverine (1)	June 10	No	Thule Cr.
DN	Wolf (1)	June 23	No	Ranger Cr.
ATB	Wolf (1)	June 25	No	Buckinghorse Lk.
ATB	Wolf (1)	June 26	Yes	Buckinghorse Lk.
ATB	Grizzly (1)	June 27	No	Kluayetz Cr.
ATB	Wolf (1)	July 1	Yes	Kluayetz Cr.
DM	Wolf (1)	July 4	No	Kluayetz Cr.
DRM, DN	Grizzly (1)	July 8	No	Skelhorne Cr.
DRM	Wolf (1)	July 11	Yes	Ranger Cr.
Lau	Wolves (2)	July 11	No	Fire Flats
ATB, HB	Wolves (6)	Oct. 14	Yes	Worry Creek
ATB, HB	Wolves (6)	Oct. 18	No	Worry Creek

ATB = A.T. Bergerud, DN = D. Newell, HB = H. Butler, DM = D. Miller,
CS = C. Simmons

Color Phase of Wolves:

Tuaton Lake - 2 black, 1 white, 1 gray

Fire Flats - 7 grey + 1

Worry Creek - 10 black, 1 white, 1 grey

Table 39 (Cont'd.)

* Note that wolves and grizzlies seen about equally - thus since we think that there are only 64-75 wolves in an area larger than the Park we don't think the estimate of 80 bears (Osmond-Jones 1977) is conservative.

Table 40. Caribou seen above 5000' (includes only animals from caribou observation cards)

Location	Date	Map	Obs.	Comp.	Aspect	Elev.	Community
Umbach	June 6	25	N	2 ♀, 1 c	on top	6500	grass-lichen (top of Umbach)
Umbach	June 10	26	N	2 ♀, 2 c	on top	6400	dry grass-lichen-moss
Umbach	June 10	28	N	1 ♀, 1 y	E	6500	talus slope-travelling
Mtn. way up Skelhorne Cr.	June 13	32	N	2 adults	on top	6500	grass-lichen
Mtn. up Skelhorne	June 13	33	N	2 ♀, 2 c	SW	6000	dry grass-lichen
Thule	June 14	34	N	1 ♀, 1 u	E	-	lush herb-shrub slope
Umbach	June 14	35	N	2 ♀, 2 c	SW	6400	dry grass lichen (Umbach)
Umbach	June 16	36	N	1 ♀	S	-	moss, lichen, new fescue (North of Umbach)
Mtn. N. of Umbach	June 19	41	N	2 ♀	S	5000	SAF, Empetrum, lichen, talus
N. side Umbach	June 19	42	N	1 ♀, 1 c	W	5500	Salix, grass, moss, hellebore
N. side Umbach	June 20	44	N	1 ♀	W	5300	not feed: SAF, rock
W. Mt. Thule	July 7	57	N	1 ♀, 1 c	S	5000	act. unkn. SAF
Umbach	June 17			2 ♀, 2 c			
Tuaton	May 26	DM-4	M	3 ♂	E	5100	SAF, Betula, Festuca
Umbach	June 3	DM-12	M	1 ♀	S	6500	Alpine } probably same ♀
Umbach	June 4		M	1 ♀	S	6500	Alpine }
Umbach	June 5		M	1 ♀	S	6500	}
Umbach	June 5		M	1 ♀		6400	
Umbach	June 6		M	1 ♀		6400	
Umbach	June 8	DM 16	M	1 ♀	W	5200	SAF Island
Bowsprit	May 30	DM 19	M	5 u	SE	5950	alpine
Tuaton Mtn.	June 1	DM 23	M	3 ♂	E	5100	Betula, Festuca, lichen, SAF
Bowsprit	June 2	DM 24	M	1 u	E	5000	Betula, Festuca, SAF
Umbach	June 16	DM 34	M	♀'s,c's(8)	S	6000	Grass, forb, moss, lichens
South Mtn.	June 25			♀ & calf			
South Mtn.	June 25			3 ♀, 2 c			

u = unknown

Table 40 (Cont'd.)

Location	Date	Map	Obs.	Comp.	Aspect	Elev.	Community
Klahowya Lk.	May 30	H-13	HB	6 ♂	S	5000	Scirpus-lichen
Taylor Pk.	June 22	H-45	HB	2 u	SW	5600	lichen?
Taylor Pk.	June 9	B-26	AB	♀ , c	SE	5500	grass
Thule Mtn.	June 17	B-37	AB	3 ♀, 3 c	SE	6200	Stereocaulon-grass (not green)
Thule Mtn.	June 18	B-38	AB	2 ♀, 2 c	SE	5700	grass
Thule Mtn.	June 19	B-39	AB	1 ♀	S	5500	sedge, forbs (not feeding)
Middle Mtn.	July 2	B-56	AB	2 ♂, 11 ♀, 2 c.	SW	5500	Festuca
Middle Mtn.	June 6		HB	1 ♀, 1 c	SW	5000	birth site
Thule Mtn.	June 18		HB	3 ♀, 3 c	SE	6200	
Taylor Pk.	June 5		HB	♀ & c's(9)	SE	5800	

Note: all ♂'s 5500' and below.

N = D. Newell

M = D. Miller

HB = H. Butler

AB = A.T. Bergerud

Table 41. Comparison of Weather Statistics at two weather stations 4500 feet and 5500 feet at Buckinghorse Lake

Weather Statistics	Dates	4500 ft.	5500 ft.
Mean Maximum Day[1]	May 30-June 9	47.6° F	43.5° F
Mean Minimum Night	May 30-June 9	30.7° F	33.1° F
Mean	May 30-June 9	39.4° F	38.3° F
Mean Wind Speed	May 28-July 15 for 4500	2.2 mph	5.0 mph
Rainfall	May 26-July 15 for 4500	1502 ml.	2425 ml.

[1] Note that in the spring daylight hours far exceed hours of darkness

Table 42. Resume of moose observations May to July

Date	Observer	Location	Elev.	Sex	Age
May 24	ATB	B.C.R. summit	4500	M	A
				M	A
May 25	DRM	Tuaton Lake	4500	F	A
				F	A
May 25	DN	Tuaton Lake - west	5250	F	A
May 25	DN	Tuaton Mtn.	5000	F	A
				M	A
				M	A
May 26	DRM	Tuaton Lake	5200	M	A
				M	A
				M	A
May 26	DRM	Tuaton Lake	4800	M	A
				F	A
May 26	DN	Tuaton Mtn.	5000	F	A
				F	A
May 27	DRM	Tuaton Lake	4600	F	A
May 27	DRM	Tuaton Lake	5300	F	A
				F	A
			5200	F	A
May 27	DRM	Tuaton Lake	4500	F	A
			5000	F	A
				M	A
				M	A
				M	A
May 28	HB	Buckinghorse	4200	M	A
		Creek		F	A
May 28	ATB	Buckinghorse Cr.	4300	M	A
May 28	ATB	Buckinghorse Cr.	4300	F	A
May 29	HB	Buckinghorse Cr.	4300	F	A
May 29	HB	Klahowya Cr.	5250	M	A
				M	A
				M	A
May 29	ATB	Klahowya Lk.	4700	M	A
				M	A

Table 42 (Cont'd.)

Date	Observer	Location	Elev.	Sex	Age
May 29	DRM	Tuaton Lk.	4400	F	A
				F	Y
May 30	DRM	Tuaton Lk.	5300	M	A
			5200	M	A
			5100	M	A
			4700	M	A
May 30	HB	Klahowya Cr.	4300	M	A
				M	A
June 1	DN	Bowsprit Mtn.	4800	M	A
June 6	DRM	Skelhorne Cr.	4500	F	A
				unknown	
June 16	ATB	Kluayetz Cr.	4100	F	A
					C
					C
June 16	HB	Mt. Thule	5200	F	A
					C
June 17	DN	Fire Flats	4500	F	A
					C
				F	Y
June 22	DN	Skelhorne Camp	4500	M	A
June 22	ATB	Kluayetz Camp	4100	F	A
June 23	ATB	Kluayetz Camp	4100	M	A
June 25	ATB	Fire Flats	4500	F	A
					C
June 26	ATB	South Buckinghorse Lake	4500	F	A
June 26	HB	Kluayetz Cr.	4050	M	A
June 29	ATB	Kluayetz Cr.	-	F	A
				F	A
July 10	HB	Kluayetz Camp	4100	F	A
July 11	HB	Kluayetz Pond	4100	F	A
				F	A

ATB = A.T. Bergerud
DRM = D.R. Miller

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APPENDIX A

PREDATOR OBSERVATIONS

Appendix A

Predator Observations:

May 22/77: A.T. Bergerud and D. Miller see 4 wolves at NE end of Tuaton Lake (observations while flying).

May 22/77: A.T. Bergerud and D. Miller see a sow grizzly with three cubs at the south end of Hotlesklwa Lake. She is spotted from a Cessna, in the open, below snowline. She runs.

May 24/77: 8:00 a.m. - 8:05 a.m. A.T. Bergerud and D. Miller see a large brown grizzly bear walking in the willows along Grizzley Creek between its confluence with the Spatsizi and the B.C.R. railroad grade (elev. 4400). The observers are 100 yards and uphill of the bear and there was no wind. They yell at the bear, it stops and looks at them, then jumps into the creek, swims across and resumes walking on the opposite shore.

May 27/77: 4:30 - 4:35 p.m. A.T. Bergerud sees an adult grey wolf near Buckinghorse Lake, at 4300 ft., travelling in the birch-willow flat. It is moving briskly with its mouth open and is ¼ mile from the nearest group of caribou.

May 30/77: 17:30. D. Miller sees golden eagle soaring across Tuaton Mountain. 5 caribou are also on this mountain.

May 30/77: D. Newell sees wolverine near Bowsprit Mountain, and sees fresh tracks from time to time.

June 2/77: H. Butler and A.T. Bergerud 3:10 - 3:15 p.m. Large brown adult grizzly with yearling seen on Taylor Peak at 6500 feet. Tracks are visible leading uphill from 5000 feet elevation. Both climb steadily, cub at her heels. They are on a northwest, 30 degree slope, still complete snow cover. Adult stops and looks back once, cub stops too, then both continue uphill, up and over the peak.

June 3/77: A.T. Bergerud and H. Butler. One large brown grizzly was seen from the helicopter on Kluayetz Creek. It ran from the approching helicopter.

June 3/77: Carl Simmons saw a wolverine near McCumber Creek while flying our camping gear to Fire Flats.

June 4/77: 7:45 - 8:00 p.m. H. Butler and A.T. Bergerud. An adult, dark brown grizzly with a lighter colored head is seen feeding on vegetation 400 feet from camp (Fire Flats). Elevation 4400 feet; dwarf birch and sedge. The bear feeds and walks along the lakeshore, then turns, walking up along a small stream and away from the lake, keeping about 500 feet from camp. It runs a few steps as if startled, but then continues walking. It also looks in the direction of camp once or twice (which is in plain view). The bear is downhill and down wind of the camp. The bear disappears into the woods after crossing the open flat to one side of the camp.

June 5/77: 8:55 to 9:22 a.m. D. Newell and D. Miller. Fire Flats. 5500 elev. 14 caribou (including 3 yearlings, 2 hard-antlered females, and the rest antlerless, or short velvet-knobbed adults) were seen moving northwest, and pausing, looking back. A dark brown adult wolf was trotting about 200 yards behind them. As the wolf quickened or reduced his pace, so did the caribou, walking, trotting or galloping. The wolf stopped, and the caribou stopped. 8 caribou split from the group and head south into shrub, gulleys and small meadows. The wolf then began to chase again and the 8 caribou rejoined the 6 at a gallop. Three more caribou, 2-300 yards ahead of the 6 running caribou, had been feeding leisurely, were alerted by the running caribou and ran ahead of the oncoming band. The caribou then disappeared behind a high bench as did the wolf, but 9 caribou soon reappeared, having circled south and now running southeast. The wolf also appeared still chasing them. 1 caribou, possibly a male, split off from the rear of the group and ran northwest. The wolf continued to chase the remaining 8 animals which were led by a 2-hard-antlered female. The band ran on over a dry bench, then over a patch of snow, then through a water filled gulley, and onto another bench to the east. The wolf slowed down, and ran on the drier bench instead of the gulleys, and finally stopped and sat down. When the caribou were about 300 yards ahead, they stopped and shook the water from their coats. The lead animal (a hard-antlered female) and a yearling were panting hard with their mouths open. The rest of the band (1-hard-antlered female and 5 velvet-knobbed or antlerless animals) were not visually showing signs of exertion. The lead female continued walking quickly in an easterly direction and the wolf moved off among the shrubs, gulleys and small meadows to the south.

June 6/77: H. Butler. 16:42. 5500 feet elevation. Small black bear with brown snout was feeding on vegetation just above treeline on Thule Mtn.

June 7/77: 12:45, 5000 feet elev. D. Newell hears grunting, bear 50' from him, unseen behind a screen of thick subalpine fir, on a S.E. slope of Mt. Umbach. The bear is tearing and shaking a tree. D. Newell yells and the bear leaves. D. Newell passes through the area and the bear returns to the same place.

June 10/77: H. Butler. 14:17. 4100 feet elevation, near Thule Cr. 7 adult caribou (no large stags) had been bedded on a sedge flat since at least 13:15. One was bedded slightly apart (50 feet) from the rest. Most were lying flat on their sides with their heads touching the ground. It was hazy, with a light breeze. When next observed at 14:17, all seven are standing together looking into the woods. They then turn and slowly trot away. A bear (very black in color, but no visible shoulder hump when running) charges out of the sparsely wooded area where the caribou had been looking. The caribou are now at a full run, 2 caribou at the rear of the group split off and run perpendicular to the group after only running 100' with them. They run to the woods while the rest of the group, with the bear following them, runs west down the meadow for 400 feet. Then the caribou group appears to slow down, a couple of individuals look back. The bear is still running fast. 3 caribou maintain a straight course down the meadow, while a 4th zigzags to the side a bit, but rejoins the 3. The 5th caribou (at the rear of the group) changes direction, veering off toward the woods. The bear follows this last caribou, and cuts a corner by splashing through a shallow pond. The bear gains on the caribou. The caribou looks back. The bear maintains speed. The caribou looks back once more before both it and the bear disappear from view in the woods. Last seen, the caribou

was about 300 feet ahead of the bear. Total distance of the portion of the chase that I saw was about 1500 feet. The 4 caribou that ran down the meadow stopped about 800 feet from where the bear turned to chase the last caribou. They walk westwards down the meadow away from the chase site.

June 10/77: 14:33. H. Butler. 4100 feet elevation. A wolverine walks slowly through some shrubs in the area where I last saw the black bear chasing the caribou (see above). It suddenly turns and lopes back into the woods.

June 23/77: 15:40 - 15:45. D. Newell. 4500 feet elevation. A grey adult wolf was seen trotting past a group of 55 caribou. The wolf passed within 75 yards of the nearest caribou without causing any movement on the part of the caribou, although alarm postures indicated they had seen the wolf. The wolf travelled ¼ mile in 5 minutes, crossing Ranger Creek and travelling over low shrub and sedge covered ground, towards the woods.

June 25/77: 20:30. A.T. Bergerud. 4500 feet elevation. Grey adult wolf seen at north end of Buckinghorse Lake. It was travelling in a shrub community along the shore of the lake, 400 feet from the observer.

June 26/77: 16:00 - 16:10. A.T. Bergerud. 4500 feet elevation. A grey adult wolf was seen halfway between McCumber Creek and Buckinghorse Lake. 6 caribou ran from the wolf but the wolf did not give chase and continued travelling away from the caribou.

June 27/77: 15:33. A.T. Bergerud. 4100 feet elevation. A large dark grizzly walked past 150 caribou. The herd spanned both sides of Kluayetz Creek. Those caribou on the same side of the creek as the bear moved away from the bear, while those caribou on the opposite side of the creek in the middle of the herd remained lying down, some turning their heads to look at the bear, and others not alerting. The bear was downwind of the caribou and in clear view of them on the open flat. Several caribou at the edge of the group advanced in the direction of the bear as the bear passed by the end of the group. The bear then swam across Kluayetz and walked through a marmot colony.

July 1/77: 12:05 to 12:15. A.T. Bergerud. 4100 feet elevation. A grey adult wolf approaches 12 caribou bedded on a sedge flat. The wolf sits down in the open, 300 feet from the caribou. The nearest caribou alerts and seems to try testing the wind. The wolf then starts to run, but runs at an angle to the herd. The caribou run also. The wolf runs for 500 feet after the caribou, losing ground especially in the willows. The caribou group split into 9 and 3. The wolf stops, turns and trots back toward Kluayetz Creek. 3 minutes later he is travelling again.

July 4/77: 9:35. D. Miller. Grey wolf with darker back, head and tip of tail, grey on sides of muzzle, ¼ mile from 4 females and 1 female. 9:37. Wolf moves NE away from Caribou. 9:38:15. Wolf moves behind low ridge and out of view. 9:40. Wolf in view trotting N, past salt lick. 9:41. Wolf out of view in shrubs. 9:43½. SW of wolf; 8 caribou are trotting. Wolf not seen again.

July 8/77: 21:45 to 22:10. D.R. Miller and D. Newell. 4500 feet elevation. Large adult grizzly seen ¼ mile from camp walking along Skelhorne Creek. The bear crossed through thick willows 4 feet high and waded through a deep pond 20 feet wide to a *Carex aquatilis* fen community. The bear sniffed at some flagging tape left by D. Newell earlier in the afternoon (he was walking through the vegetative sampling plots). The bear continued to feed, moving north toward a wooded area, scratched his ear with his hindfoot and moved out of view into the woods.

July 11/77: 9:18 - 10:10. D.R. Miller. Fire Flats.

9:18 A greyish wolf with a black back is seen being watched by a group of 14 caribou including 1 calf, 200 yards from the wolf.

9:23 1 caribou lies down.

9:24 Wolf trots west out of sight behind a grassy point.

9:24:15 Wolf reappears. Stops. Looks for a minute. Turns east and goes back behind grassy point and out again on east side.

9:25:30 Wolf moves S.E. on a high bench and down bank to Ranger Creek.

9:36 All caribou in group now lying down, wolf walking in their direction.

9:36:40 Caribou up - smelled or saw wolf 300 yards away.

9:37:20 Wolf on *Ranunculus* community moving east towards caribou.

9:38:20 All caribou watch wolf move east.

9:39:20 Wolf runs at caribou, caribou run.

9:41 Caribou stop in shrubs - wolf far behind.

9:43 A male caribou is just appearing over ridge behind the rest of the group. Wolf closing the gap. All the caribou run again, wolf out of sight.

9:44:20 One part of the caribou group including calf is seen standing and looking S.W. Caribou have travelled 1 mile since start of chase.

9:45 Caribou look west then run again, disappear from view.

9:49 4 caribou reappear, look S.W.

9:50 Caribou out of view.

9:57 6 caribou appear where wolf last seen, run, stop, run, looking N.E.

10:03 This group of 6 trots west. They have now circled the area where the wolf was last seen.

10:05:45 The remaining 8 caribou reappear.

10:08 The male in the group of 8 begins to feed.

10:10 No wolf reappeared.

July 11/77 morning: Lau. Fire Flats. Saw 2 wolves.

October 14/77: 3:00 p.m. 6 black wolves break-out of cover (came up Worry Creek) and chase 6 caribou. Caribou run uphill - wolves get within 300 feet. Caribou split and turn to look back (6 wolves had circled our camp night of October 9-10 and howled - were also lower in valley).

October 18/77: In afternoon on return to camp (Worry Creek) from alpine suddenly came on $\simeq$ 6 wolves. We were within 100 feet and one wolf did nearly a flip trying to get away.

APPENDIX B

WINTER SURVEYS BY R. BRUNS

1977-78

Appendix B - Winter Surveys by R. Bruns

1977-78

Nov. 29	Scout Brock Mtn., McBride River, Kehlechoa River and Knot Pass	1 hour
Dec. 1	Scout Brock meadow and Spruce Mtn.	.5
Dec. 4	Scout Brock Mtn. and Brock meadow	.6
Dec. 13	Brock meadow	.6
Dec. 15	Sanabar, Forfer Lake (near Holms camp and Marion Cr.)	1.0
Dec. 16	Count and classify Turnagain	3.4
Dec. 19	Count caribou in Brock Mtn. area	.8
Jan. 2	Check Brock area	.5
Jan. 14	Check Brock Mtn. and Black Fox meadow	.5
Jan. 15	Tour Brock meadow, McBride, Turnagain, Kutcho and Kehlechoa R.	4.5
Jan. 18	From Hyland Post north to Wolverine and East side of Dease Lake	1.9

GAME OBSERVATIONS

Brock Mountain Area

Study begins Nov. 29 -4^{o} F.

Thirty-six caribou were spotted in the mid-afternoon but their location was in a gorge leading off Brock mountain. They appeared to be all mature animals with one possible yearling. There was a lot of feeding sign on the east, southeast slope of Brock mountain where they had been pawing previously.

There were leads ahead of this herd to the north towards Beauty camp, Ford Pass and Caribou Pass where we located 5 more animals, 4 cows and 1 calf.

I thought they would congregate on Brock meadow as they did last year, where we watched 110 caribou spend the winter beside a small pack of wolves.

December 1 $+5^{o}$ F.

Twelve cows and one year and a half out on Brock meadow. One bull moose east side of Brock meadow. Caribou leads all through the black spruce and small bunches here and there.

There are caribou leads up over Spruce mountain and on Spruce Lake. We landed on Black Fox Lake and all trails appear to be heading towards Brock meadows from there. There is little or no sign to date.

December 4 -20^{o} F.

The caribou are still on the move, nine cows and four bulls heading north along McEwan Creek, and six cows just west of Beauty camp, and four caribou in Ford Pass. Ten cows and two year and a half olds in Caribou Pass heading northwest in leads. Two bull moose in Caribou Pass.

December 13 $+30^{o}$ F.

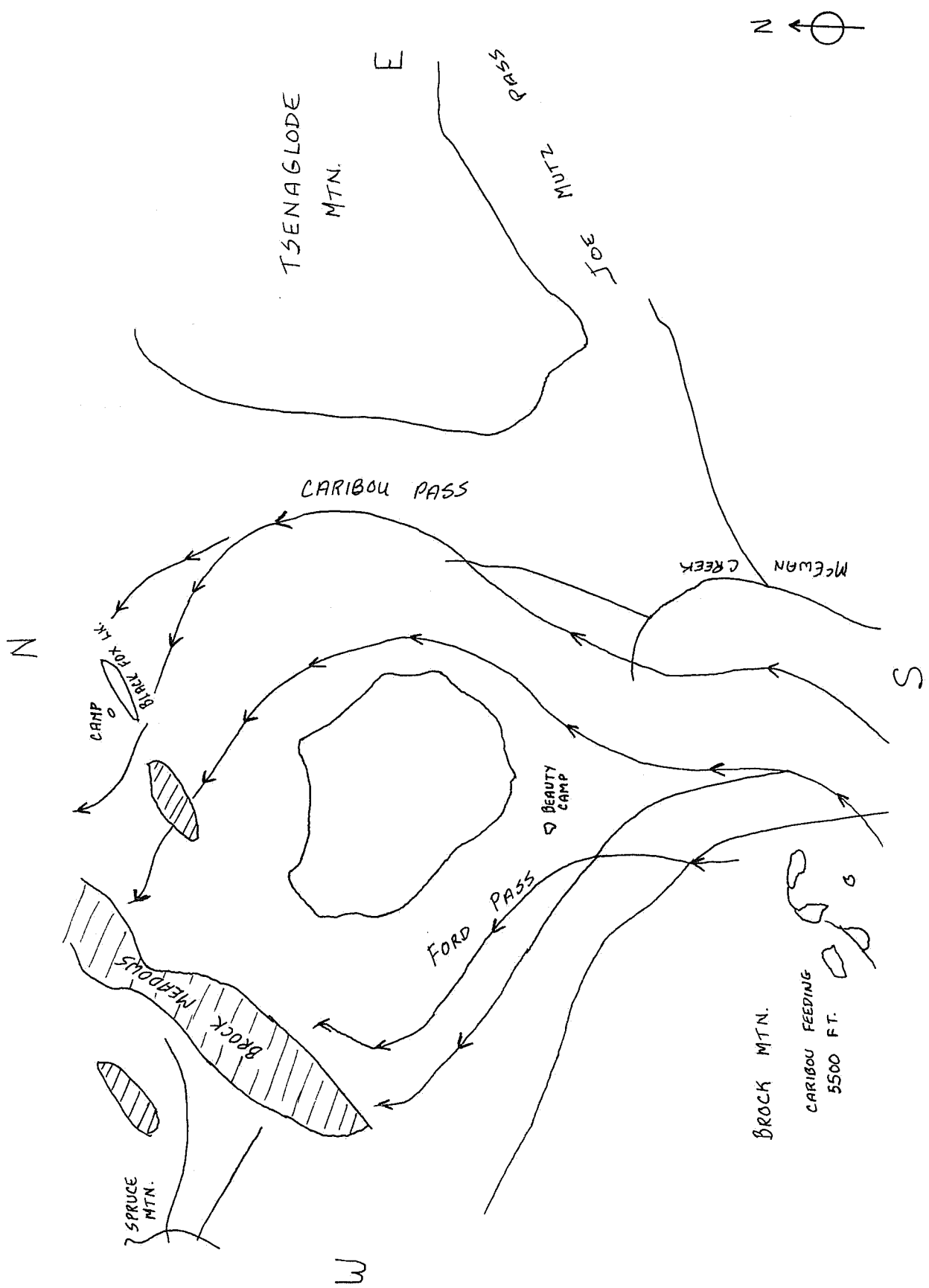
Twelve cow caribou middle of Brock meadows with three bull moose right beside them. All these caribou cows had antlers. Right beside them was a caribou wolf kill, only hair and blood left.

Six cows and four bulls on the north end of the chain of meadows north of Brock meadows. East of Black Fox Lake there were seven cow caribou.

One black wolf on Stikine near Holms camp. The weather is $+40^{o}$ F. after a week of extreme cold to a low of -64^{o} F.

December 16 $+25^{o}$ F.

A quick check on Brock meadows, no caribou. Spruce Mountain, no caribou. We flew across Cullivan and up towards the hot springs, some sign but no caribou. Many wolf leads east of the hot springs and up on the mountain to head of Cullivan. One 7/8 curl ram east side of Airplane Valley. Moose sign south of Donahue Pass to McDonald.


N
E
TSENAGLODE MTN.
MUTZ PASS
JOE
CARIBOU PASS
McEWAN CREEK
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S
BLACK FOX LK.
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FORD PASS
BROCK MEADOWS
SPRUCE MTN.
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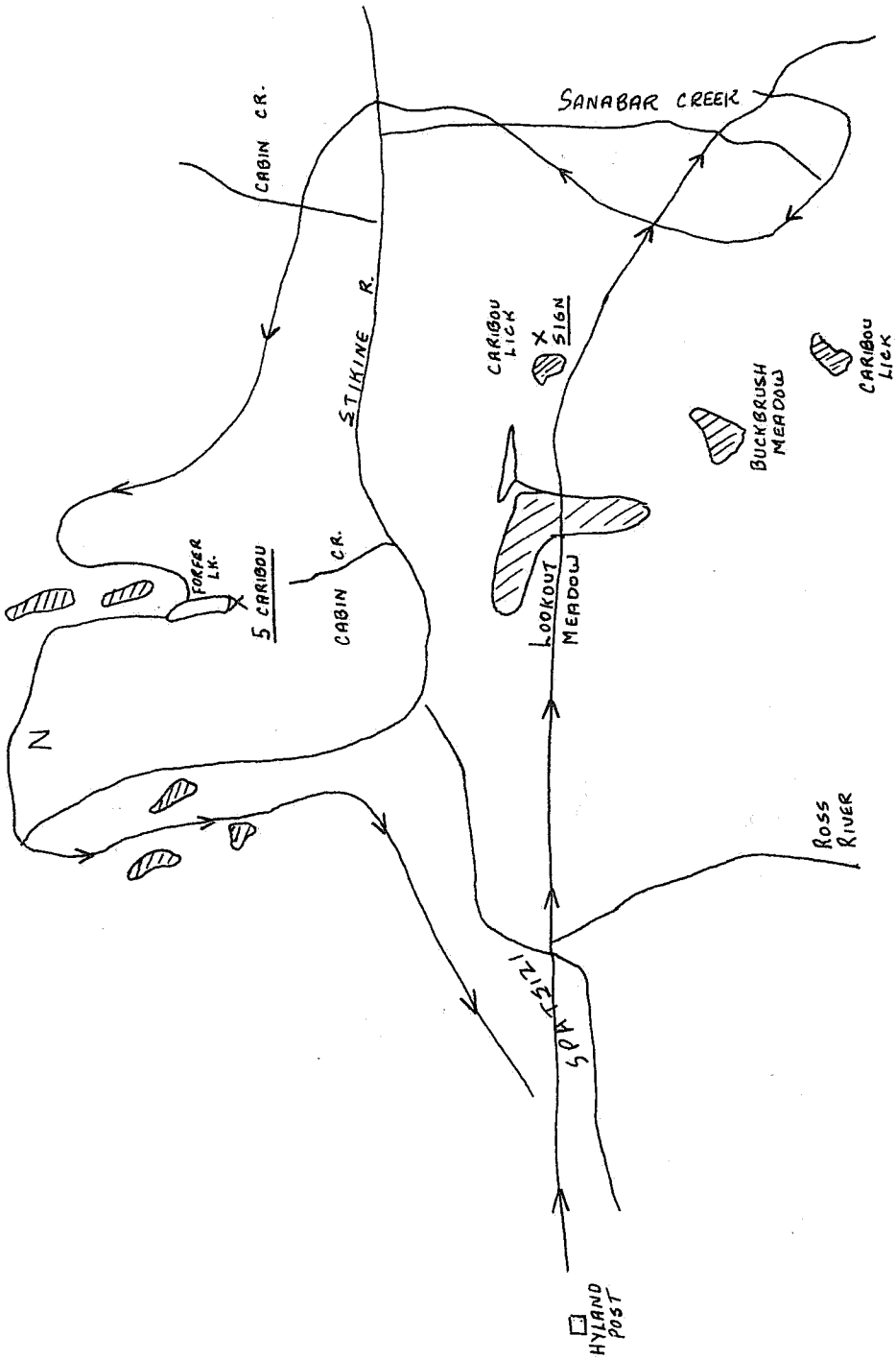
CARIBOU FEEDING
5500 FT.


E
SANABAR CREEK
CABIN CR.
STIKINE R.
CARIBOU LICK
X SIGN
CARIBOU LICK
BUCKBRUSH MEADOW
FORKED LK.
5 CARIBOU
CABIN CR.
LOOKOUT MEADOW
N
S
ROSS RIVER
SPRUCE
HYLAND POST
W

December 15 Temp. 25° F.

A spotting cruise from Hyland Post over Lookout Meadow to Sanabar Meadows, across the Stikine over Forfer Lake and on north over the meadows toward Pitman River, west again across the Stikine and over the meadows on the west side of the Stikine, over Marion Creek and back to Hyland Post.

Just east of Lookout Meadow, at the caribou lick, there was sign of a few and leads east. Sanabar Creek where there were over 50 last winter had only 6 moose. There were no leads or wolf sign on the Stikine and no sign up Cabin Creek.

On the south end of Sanabar Creek we spotted four cows and one calf caribou. By the sign in this local vicinity these were the only caribou around but will check again in a week. Last year there were near thirty at this location.

On proceeding north we spotted seven cow moose and one bull in the meadows towards Pitman River. There was wolf sign but none spotted.

In the meadows north of Marion Creek along the Stikine, two bull moose spotted and one cow.

On a trip to Iskut from Hyland Post on this day I spotted 14 wolves at 6000 ft. level on the mountain east of Joe Mutz Pass. There was one 7/8 curl ram about a mile to the east but no evidence he had been chased.

Turnagain

November 29 -4° F.

Southeast of Knot Pass seven cows and one year and a half. We crossed the McBride and on the West Kehlechoa Lake we saw seven cows and two bull caribou. Some other sign east towards the Kehlechoa River and this peters out as we go up the Kehlechoa River. From here direct to Wolverine strip. As soon as we reached the valley south of Wolverine Lake caribou sign predominant. There were wolf tracks in the high pass between head of Kehlechoa and this valley. We talked to Andy and he said there were about fifty head of caribou right around his camp. He didn't think he had seen any calves. There were some wolves but no packs; one cripple had been coming into camp.

We spotted 37 caribou north of Wolverine strip and north of Kutcho strip. These animals were in bunches from 2 to 8 and on the small meadows in the valley. Occasional wolf leads but no evidence of packs.

No caribou on Turnagain Lakes but some leads at the head of the valley. McBride River had no sign except small fur.

December 16 +25° F.

We are off for Turnagain from Hyland Post and we come across an isolated herd on the Spatsizi north of Airplane landing at Frypan mineral lick and three cows at the head of Frypan Creek. On the lick there were nine cows and one calf. There were no caribou in this vicinity last winter. As we climbed and went over the mountain north of Frypan Creek we could see where they had been feeding in the saddle at the 6500 ft. level just a few days before. North across the Stikine and across the flats just east of Kehlechoa River, occasional wolf leads, moose sign. Six cows at the small lake at the head of Kutcho Creek. Then as we proceed up the valley to Kutcho airstrip there are thirteen cows, one calf and one young bull. Fifty-two cows, 1 calf and 3 bulls one mile south of Kutcho airstrip. One cow moose in this valley. We spotted no wolves but plenty single leads apparently coming off the mountain side. When we talked to Quentin Robbins at Kutcho strip he verified lobo activity, plenty of howling at night. Hiw low temperature had been -38° F. at Hyland Post; it had been -64° F. the previous week. Quentin is going to watch for calves for us.

Airborne again from Kutcho we spot twelve cows, one calf and three bulls. West to Wolverine Lake twelve cows, no calves. There were thirteen cows and one calf right around Wolverine Lake. West of Wolverine Lake ten cows and one bull. We turned south towards the strip from here and located six cows and one bull in the timber south of Wolverine Lake.

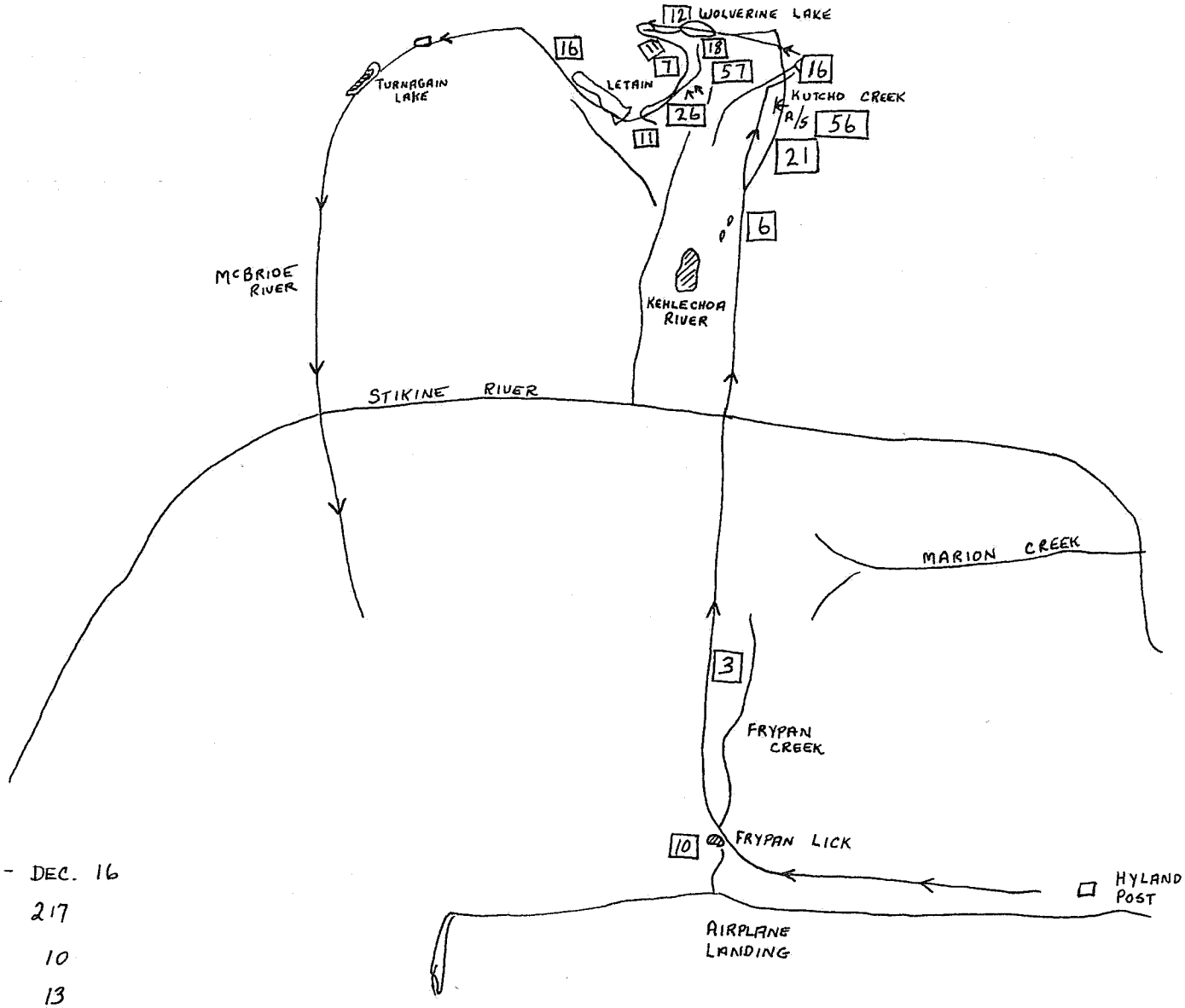
Back in the valley ten cows, one bull and a year and a half calf; one cow and calf by themselves. On three occasions we noted cow and calf located a short distance away from the herd.

Wall to wall caribou from here to the Wolverine strip - eleven with two calves in the bunch and two young bulls, then four cows and one bull. One cow moose and calf then cow caribou and calf.

Just north of Wolverine strip three cows and one bull and one year and a half. Seven cows, two bulls and one year and a half across the valley and nine caribou in the bush, all mature animals.

Andy said there was more wolf activity since we last talked to him but he hadn't noted any kills. He hadn't seen any calves close to his camp but hadn't been too close to the herds. He is watching for calves and keeping an eye on wolf activities; he says he feels they are all singles.

Leaving Wolverine strip to the south we found twenty-four cows and two calves and as we proceed down Letain Creek eleven cows. Letain Lake was barren but in the head of Ferry Creek there were 15 cows and one calf. North down Ferry Creek and west up Turnagain River over the small lakes and south to the head of Turnagain River and Turnagain Lake itself yielded no caribou, moose or wolves. There was some caribou sign on the east side of the valley and the little lakes along McBride River. Some wolf leads.



TURNAGAIN - DEC. 16

COWS	217
CALVES	10
BULLS	13
YEAR + HALFS	4
TOTAL	244

Brock Mountain

December 19 Temp. -18° F.

A cruise of the Brock Mt. area shows a total of 50 caribou. 41 of these were in Caribou Pass and there were two big bulls in the bunch and 8 small bulls and no calves.

There were six of the above mentioned 47 located in Ford Pass and these were all cows but one small bull. The caribou seem to be grouping up more in this area and there is a lot of wolf pack sign. The pack of fourteen wolves has moved towards Brock Mountain but are now high in Joe Mutz Pass. Nine moose at Trout Lake, no visible kills.

South of Black Fox Lake there were three cow caribou.

The six caribou in Ford Pass had two cow moose and one bull right beside them.

January 14/78 -15° F.

On route from Smithers, I came over the Duti River across Ella Lake and saw many caribou leads in Tuaton Lake area. I crossed Worry Creek and crossed Blueberry Mountain and flew down the headwaters of Sanabar Creek. Saw lots of moose sign and three moose without horns.

I went up Kliweguh Creek and saw two moose and quite a few wolf leads. I came down Black Fox Creek and up the valley west of Cold Fish Lake towards Cullivan. I came by Black Fox Lake and through Brock Meadows and Ford Pass then back through Caribou Pass, but saw no caribou. There were nine moose in Brock Meadows area. I climbed up to 6500 ft. level over the east side of Brock on course for Iskut and saw three cow caribou up on SE side of Brock Mt. There was sign of lots of caribou but they had all left.

January 15/78 -25° F.

We left Iskut at 11:30 and saw ten caribou on SE slopes of Brock Mt., 5 bulls, 4 cows and one year and a half. We descended into Ford Pass and on crossing Brock Meadows saw 8 caribou - 4 bulls and 4 cows. On the north end of Brock Meadow we saw 14 cows and no bulls or calves.

On a little lake 2 miles north of Brock we saw one cow, and a little further we saw one cow with one antler, a calf and a bull. We proceeded to Jordans and Betty Burris - my spotter and myself had chat with them. They had seen one caribou on the river and many wolves on the river and their trapping trails. They reported they had stopped trapping because the wolves were following their lines and cleaning the traps and tearing up the coveys. They had seen caribou up on lakes behind Mt. Sister Mary.

We left north up the McBride and saw little sign till six miles up where there was one moose and some wolf leads.

One mile south of Turnagain Lake we saw five cows and two bull caribou. South end of Turnagain we saw four calves, nine cows and one bull. Right on the lake there were four cows, one calf and two bulls. There was little wolf sign; we headed east and saw 2 moose near the headwaters of Kehlechoa River. We headed across to Kutcho and saw 5 moose north of Kutcho strip, one had horns. We proceeded north and ½ mile south of Rainbow Lake saw 31 caribou. There was one calf and three bulls. On the south end of Wolverine Lake we saw seven cows and two bulls.

We stopped at Andy Jensens and he had seen thirty caribou fairly recently. Paul Jensen had seen many wolves and had shot one in the valley south of Wolverine.

We saw one moose south of Andy's cabin. We went down the Kehlechoa River and across the Stikine but saw no tracks.

We proceeded up the creek that drains the east end of Moose Flats and about 2 miles from the flats saw three wolves, all grey. About one mile further west we saw a moose kill. On the east end of Moose Flats there were 22 moose, one with horns on. Further west we saw eight more with horns on. On the north side of Cullivan one moose in the burn. On the north end of Black Fox Lake we saw 2 moose. At Beauty Camp we saw one cow caribou and one moose. It was getting dark so could have been more.

January 18 $+25^{o}$ F.

Proceeding north from Hyland Post I located 16 caribou on the meadows south of Marion Creek. There were eleven in that bunch without horns.

On the east side of the Stikine there was much caribou sign all the way north to the Pitman River. It looked like they were sort of on the move and there was a lot of wolf tracks to follow.

North across the Stikine and across the flats east of Kehlechoa, no caribou sign and the caribou had left the Kutcho and Wolverine Lake country. West and north of Turnagain Lake there was caribou sign, one caribou kill in the creek and out on the ice of Eagle Lake there were seven caribou, one little bull among them, no calves.

One moose kill on the Eagle River. It looked like a very large pack had been there.

Out on Cow Lake, east of Dease Lake, there were eight caribou, one young bull and a possible calf, but not sure. There was considerable caribou sign on the east side of Dease Lake all the way down to Tanzilla Butte.

South of Dease on a moose kill northeast of Hluey Lake were five wolves, two black and three grey. The moose had been killed on an ice flow on a creek.

South of Morchuea Lake no game sign, just skidoo sign.

January 20 $+30^{o}$ F.

We took off Iskut at 10:00 on course for Hyland Post. In Joe Mutz Pass we located 11 caribou in the bottom of the creek running west. There were no calves as far as I could tell.

As we came over Cold Fish Lake we noted a lot of wolf sign on the north shore of the lake all the way down so I figured I'd unload the load at Hyland and come back for a closer look. As we proceeded down the Spatsizi we noted a lot of wolf sign and a kill out on the river.

After we unloaded we headed out to check for more wolf kills. There was a moose kill about 100 yards south of the river 3 miles below Hyland Post. Another moose right on the river at airplane landing. There was quite a bit of caribou sign on Beaverdam Lake but no kills or caribou we could see.

We proceeded west and found an older kill on Little Cold Fish, another moose on the east end of Cold Fish and a fresh moose on the west end of Cold Fish. It is the worst I have seen, five kills in thirty minutes flying.

Fred Abau, my helper, went out on the skidoo to a spot above Hyland Post in the burn and found Flicka (a very strong mare) had been killed after a very long battle in which one black wolf was killed. The horse was all eaten but the mane and tail and the wolf all eaten but a patch of hide. The mare's colt had a wound in the back of the leg but Fred brought it in and we are now doctoring it.

January 22

A trip on the south side of Stikine on the north slope of the Caribou Mt. and Spatsizi Plateau showed no caribou.

8 adult moose on Moose Flats, no calves.

There was caribou sign on the meadows south of mouth of Marion Creek.

Two caribou in Ford Pass (adults). Cow and calf above Beauty Camp. Ten caribou south of Beauty Camp and one calf. There were four adults on the southeast side of Brock Mtn. and four more adults a little further on, as we proceeded across the Klappan.

APPENDIX C

COMMUNITY TYPES - FIRE FLATS

Appendix C

FIRE FLATS

Community type - Carex marshes and fens

July 8/77 Plot #1

Species	Percentage of Species					Wt. grams	
	1	2	3	4	5	Green	Dry
Carex aquatilis	35	40	15	40	30	45	15.6
C. #1 (long, straight)	30	20	25	20	15	15	1.8
C. #2 (short)	10	10	15	5	10	15	2.72
Eriophorum angustifolium	10	5	20	25	15	100	36.75
Mosses	15	10	15	10	20	-	
Sanguisorba	-	10	10	1	tr		
Rubus articus	-	tr	tr	tr	5	5	1.02
Gentian (forb #1-fleshy leaf)	-	-	tr	-	tr		
Forb #2-long 5 leaf, rhysomatous)	-	-	-	-	tr		
Water	-	5	-	-	5		

FIRE FLATS

community type - Festuca altaica and Forb.

July 9/77 Plot #2

Species	Percentage of Quadrat					Weight
	1	2	3	4	5	Green
Festuca altaica (underneath)	0 20	60 10	60 25	40 15	40 5	
	35	30	25	40	40	115
Carex podacarpa	tr	tr	5	tr	tr	
Eriophorum angustifolium	tr	tr	tr	-	-	25
Carex aquatilis	-	-	-	tr	-	
Phleum alpinum	-	tr	tr	tr	tr	-
Delphinium	tr	tr	5	tr	5	13
Artemisia arctica	-	-	40	grass tr	-	
Senecio triangularis	5	5	tr	-	5	
Rumex acetara	tr	-	tr	-	tr	
Rubus arcticus	30 5	10 tr	- tr	15 10	30 15	157 g
Vaccinium caespitosum	60 10	15 15	15 15	20 20	15 15	
Myosotis alpestris	tr	tr	tr	tr	tr	
Siebbaloa (Cetr. islandica)	5	20	5 10	tr	5	
Epilobium angustifolium	tr	tr	10	-	tr	-
Mertemsia paniculata	tr	tr	-	tr	tr	-
Lobaria linata	-	-	-	tr	-	-
Sanguisorba stipulata	tr	tr	tr	tr	tr	-
Potentilla diversifolia	-	-	tr	tr	tr	-
Peltigera apthosa	-	-	10	-	-	13

Plot #2 (Cont'd.)

Species	Percentage of Quadrat					Weight
	1	2	3	4	5	
Ranunculus occidentalis	5	5	10	tr	5	-
Lobaria				5		-
Peltigera malacea	-	tr	tr	tr	-	-
Achillia	tr	-	tr	5	tr	-
Caltha leptosepala	-	-	tr	-	tr	-
Viola (blue)	30 20	45 15	25 15	10 5	25 10	-

FIRE FLATS

Community type - Red stem Willow - Carex

July 8/77 Plot #3

Species	Percent Cover					Weight
	1	2	3	4	5	Green
Salix planifolia	40	50	50	60	40	95
Other willow	tr	-	-	-	-	
Carex podacarpus	20	20	10	10	15	
Moss	95 30	95 10	95 25	95 15	90 15	
Potentilla diversifolia	10	5	-	-	-	
Grass	tr	tr	-	-	-	
Eriophorum angustifolium	tr	tr	-	-	tr	
Rubus arcticus	1* 1*	10* tr*	5* 5*	10* tr	5* 2½	
Violet (blue)	10* tr	15* 5	- -	- -	5* 2½	
Carex aquatilis	-	10	10	15	10	
Siebbaloa	-	10*	-	-	-	-
Myosotis	-	tr*	-	-	-	
Vaccinium	- -	15* tr	- -	- -	- -	
Mertensia	-	tr	-	-	-	
Petasites frigidus	-	tr	-	-	-	
Sanguisorba	- -	- -	5* tr	tr* -	15* 15	
Carex #1, 5 floretsoon stem	-	-	-	-	tr	
Potentilla diversifolia	10* tr	5* tr	- -	- -	- -	
Water	-	-	5	-	-	

Carex, Juncus, Scirpus = 225 g. Forbs = 53 g. Grass = 13 g.

FIRE FLATS

Community type: Salix-Betula-Festuca

Plot #4 July 12/77

Species	Percent Cover					Weight
	1	2	3	4	5	green
S. alaskensis	*5	-	10	-	-	
Salix glauca	-	tr	-	-	tr	
S. planifolia	- -	60* -	- -	40* -	5* 30	
Betula glandulosa	-	-	-	40*	-	
Salix barclayi	85* -	- -	90* 20	- -	- -	
Festuca altaica	5* -	- -	- -	15 tr*	- -	
Senecio (carrot leaf)	-	-	-	5	-	
Epilobium angustifolium	5 1*	- -	- 10	10 tr*	- -	
Valeriana	tr	-	-	tr	tr	
Senecio triangularis	30 5*	20 -	20 tr*	- -	5 -	
Sanguisorbus	5	5	tr	5	5	
Delphinium	tr	-	tr	-	tr	95
Vaccinium caespitosum	-	-	tr	10	tr	
Violet	-	-	-	tr	-	
Moss (ind.)	30	25	40	40	60	
no PLS. Festuca beneath	45*	-	-	-	-	
Peltigera apthosa	-	-	-	-	5	
Carex aquatilis	-	35 5*	-	-	-	

Plot #4 (Cont'd.)

Species	Percent Cover					Weight
	1	2	3	4	5	
Peltigera malacea	-	-	-	-	5	
Ranunculus	-	tr	-	tr	tr	
Luzula	-	tr	-	-	-	
Marsh marigold	-	5	-	5	5	
Water	-	10	-	-	5	
Poa alpina	-	-	tr*	-	tr*	
Blue flower, pinnate campground leaves	-	-	tr*	-	-	
Achillia	-	-	tr	tr	-	
Leaves, ground	15	-	20	10	5	

* = upper strata

FIRE FLATS

Community type: Festuca-forb-cryptogam

Plot #5 July 9/77

Species	Percent of Cover					Weight
	1	2	3	4	5	Green
Festuca altaica	15	-	20	-	5	
	30*	25*	45*	60*	15*	18
Artemisia	5	5	tr	-	5	
	5	-	5*	10*	15*	
Vaccinium caespitosum	15	30	25	20	25	
Siebbaloia	5	15	25	25	20	
Grass	5	tr	-	5	-	62
	tr	tr*	-	tr*	-	
Lycopodium	tr	-	-	-	tr	
Gentian (blue flower)	tr	tr	-	tr	tr	
	tr*	tr*	-	tr*	tr*	
Moss	40	30	20	30	25	
Lichens (general)	70	60	60	50	70	
Stereocaulon paschale	50	60	20	30	50	
Cladina mitis	10	5	40	30	5	
Cladina rangiferina	-	5	5	-	5	
Cladonia uncialis	10	10	5	5	5	
Cl. gracilus	-	tr	5	-	tr	
Cl. cornuta	20	15	10	10	10	
Cl. (cup type)	tr	tr	tr	tr	tr	
Cl. chloarophaea	tr	-	-	tr	tr	
P. apthosa	-	-	5	-	-	
Peltigera malacea	5	tr	tr	5	tr	
Cl. crispata	-	-	-	tr	tr	
Neparona arcticum	-	-	-	15	20	

Plot #5 (Cont'd.)

Species	Percent of Cover					Weight
	1	2	3	4	5	
Cetraria islandica	5	5	5	tr	5	
Cl. conida	tr	-	5	tr	tr	
Forb #3	-	tr*	tr	-	-	
Marsh marigold	-	-	tr	-	-	
Violet	-	-	-	tr	tr	

* = upper strata

FIRE FLATS

Community type - Betula glandulosa-Salix-Forb

Plot #6 July 9/77

Species	Percent Cover					Weight
	1	2	3	4	5	Green
Betula glandulosa	30*	30*	10*	50*	75*	155
Salix barclayi	-	-	5*	25*	-	
Festuca altaica	30**	15**	35**	10**	15**	75
Ranunculus	tr**	tr**	tr**	-	tr**	
Vaccinium caespitosa	60	25	35	40	25	
Phleum alpinum	tr	tr**	tr**	-	-	
	-	-	5	-	-	
Mertensia	5**	tr**	-	-	-	
Sanguisorba	tr	5**	-	-	tr**	
Artemisia	20**	20**	10**	5**	30**	
Valeriana	-	-	19**	25**	-	
Violet (blue)	5	15	tr	15	20	
Rubus arctica	-	5	20	tr	5	Forbs = 600 g
Pyrola	5	10	-	-	-	
Delphinium	5**	-	-	5**	-	
Forb #1	-	-	-	-	tr	
Pedicularis capitata	tr	-	-	-	-	
Moss	95	60	95	80	95	
Lichen (general)	25	-	5	5	0	
Peltigera apthosa	20	-	15	-	-	
Cladina mitis	40	-	-	-	-	
Cladonia amaurocraea	40	-	-	-	-	
Epilobium angustifolium	5**	5**	-	5**	5**	
Cl. cup form	tr	-	-	100	-	

Plot 6 (Cont'd.)

Species	Percent Cover					Weight
	1	2	3	4	5	
Senecio triangularis	5**	-	-	5**	15**	

* = tall strata

** = medium strata

FIRE FLATS

Community type - Festuca-forb-cryptogam (high dry bench)

Plot #7 July 11/77

Species	Percent Cover					Weight
	1	2	3	4	5	green
Festuca altaica	15	20	20	30	25	33(+ grass)
Artemisia	10	20	15	10	15	
Vaccinium caespetosum	30	20	30	30	25	
Myosotis	-	tr	tr	tr	tr	
Siebbaldi	15	5	10	5	10	
Delphinium	-	-	-	tr	-	75
Grass (Phleum)	-	tr	-	-	5	
Potentilla	-	-	-	-	tr	
Lycopodium	15	5	5	-	-	
Forb #1	5	-	tr	-	-	
Rock	-	1	tr	-	-	
Gentian (blue)	tr	tr	tr	tr	tr	
Luzula parviflora	5	tr	-	-	-	
Moss	30	25	30	35	20	
Lichen (gen)	60	50	70	60	75	1342 g
Cladonia alpestris	-	-	-	tr	-	
Stereocaulon paschale	40	15	50	60	50	450
Cladina mitis	20	15	10	5	5	
Cl. rangiferina	5	-	5	5	10	
Cladonia uncialis	20	20	10	5	10	
Cl. gracilis	tr	5	tr	tr	tr	
Cl. cornuta	10	10	10	10	5	

Plot #7 (Cont'd.)

Species	Percent Cover					Weight
	1	2	3	4	5	
Cl. cup type	tr	5	5	tr	tr	
Cl. chlorophaea	-	tr	tr	-	-	
Cl. conida	tr	5	5	tr	tr	
Cl. crispata	tr	10	tr	-	tr	Total
Cetraria islandica	5	10	5	5	5	1342
Peltigera malacea	-	tr	tr	-	-	
P. apthosa	-	5	-	-	-	
Nephroma	-	-	-	10	15	
Viola	tr	tr	-	-	tr	
Rumex	tr	tr	5			
Forb ?	-	tr	tr	tr	tr	

FIRE FLATS

Community type - Festuca-forb

July 11/77 Plot #8

Species	Percent Cover					Weight
	1	2	3	4	5	green
Festuca altaica	5	25	50	5	20	100(+ grass)
Ranunculus	20	20	tr	20	55	73
Delphinium	10	10	15	tr	20	36
Myosotis	5*	5*	5*	tr	tr	
Potentilla	-	-	5	5	-	
Rumex	-	tr	-	5	5	
Forb #2, deeply cleft, whitish	-	tr	5	-	-	
Sanguisorba	15	10	-	10	10	292
Bluebell (Opp. pinnate lvs.)	-	-	-	tr	-	
Vaccinium caeapetosum	35*	35*	35*	15*	25*	
Luzula						
Forb 1						
Forb 2, hairy, long leaf	-	-	tr	tr	-	
Thalictrum	5	-	tr	-	-	
Phleum	tr	-	-	-	-	
Rubus arcticum	10*	5*	10*	15*	5*	
Hairy leaf purple?	-	tr*	-	-	-	
Achillia	tr*	-	5*	tr	tr	
Violet (blue)	15*	10*	20*	10*	5*	
Siebbaldi	-	tr*	tr	-	5*	
Salix barclayi	50	-	-	50	-	
Artemisia	-	15	15	-	-	

Plot #8 (Cont'd.)

Species	Percent Cover					Weight
	1	2	3	4	5	
Stereocaulon paschale	-	tr	5*	-	-	
Cetraria islandica	-	-	10*	-	tr*	
Lobaria	-	25*	10*	-	10*	
Cladonia	-	-	tr	-	tr	
Moss	80	60	50	50	50*	

* = lower strata

FIRE FLATS

Community type - Carex marshes and fens

July 11/77 Plot #9

Species	Percentage of Species in Quadrat					Weight
	1	2	3	4	5	Green
Carex aquatilis	50	30	60	25	40 (+ grass)	110
Sanguisorba	40	20	30	5	30	-
Carex #1 (caespitosa ?)	tr	tr	5	tr	tr	
Carex #2 (no seed head, thin)	-	5	5	tr	tr	112
Eriophorum angustifolium	-	-	-	tr	-	
Salix barclayi	-	-	-	60	-	-
Delphinium	-	-	-	5	-	
Seibbaldi	-	-	-	30*	-	52
Rubus arcticus	-	-	-	15	tr	
Festuca altaica	-	-	-	tr	-	52
Artemisia	-	-	-	5	-	
Viola	-	-	-	5*	-	
Forb unk. (hairy leaf)	-	-	-	5*	-	
Peltigera malacea	-	-	-	tr*		-
Water	10	5	tr	-	2	
Mosses (mostly liverworts - greater than 75% all but plot 4)	90	95	99	90	99	-

* = lower strata

FIRE FLATS

Community type - Red stem willow, Festuca, Linnaea borealis

Plot #10 July 12/77

Species	Percent Cover					Weight
	1	2	3	4	5	green
Salix barclayi - upper	70	60	50	80	60	160
- middle	20	20	15	15	20	
Senecio triangularis	tr*					
Juncus	-	tr	-	-	-	
Moss	90	90	40	80	55	
Water	tr	5	25	15	20	
Peltigera malacea	5	-	-	-	-	
Sanguisorba	20**	15**	20**	10**	15**	
Rubus arcticus	15**	5**	-	15**	5**	
Viola	5	5**	-	5**	tr**	
Myosotis	tr	-	-	-	-	
Artemisia	tr	-	-	-	-	
Carex aquatilis	5	5	25	20	25	211
	20*	20*	30*	20*	35*	
Forb #1	tr	tr	-	-	-	
Legume	tr	-	-	-	tr	

Forbs + other grasses = 32 g.

* = upper strata

** = middle strata

FIRE FLATS

Community type - Betula glandulosa-Salix-Forb-cryptogam

Plot #11 July /77

Species	Percent Cover					Weight
	1	2	3	4	5	green
Betula glandulosa	50*	40*	50*	15*	30* 5*	
Salix #2 - planifolia	50*	-	20*	-	-	
Salix #3 - glauca & others	-	-	-	70*	-	
Poa	-	tr**	tr**	-	tr**	
Festuca altaica	tr* -	15* 5	tr* 10**	- -	tr* 30**	71
Artemisia	25**	-	25**	30**	20**	
Senecio triangularis	tr** 5**	5* -	- -	- -	- -	
Delphinium	tr	tr*	-	tr**	-	
Valeriana	15** -	- -	- -	30** 5*	- -	
Myosotis	-	tr**	-	-	tr**	
Rubus arcticus	5	-	5	10	tr**	
Viola (blue)	10	30	20	5	5	142
Pyrola	5	-	-	10	tr	
Gentian	-	-	-	-	tr**	
Epilobium angustifolium	5**	5*	5**	5**	5**	
Seibbalda	-	-	-	-	tr	
Forb #3 (ref fl.)	-	-	tr**	-	-	
Pedicularis (purple)	-	-	-	5**	-	
Marsh marigold	-	-	5**	-	-	
Forb #4 - Podagonia	-	-	-	-	tr**	
Moss	80	95	95	75	95	

Plot #11 (Cont'd.)

Species	Percent Cover					Weight
	1	2	3	4	5	
Peltigera caina	5	-	50	-	5	
Lichen (gen)	-	-	-	-	10	
Peltigera apthosa	-	5	-	-	-	
Cladina mitis	-	-	-	-	tr	
Cladonia amaurocraea	-	-	-	-	tr	
Cl. rangiferina	-	-	-	-	tr	
Cetraria islandica	-	-	-	-	tr	
Phleum alpinum	-	tr**	-	-	-	
Potentilla	-	tr**	tr**	5**	tr	
Rumex	-	5**	-	-	-	
Ranunculus	tr**	tr**	-	-	tr**	
Vaccinium	40	60	15	30	25	
Pussy toes	-	-	tr**	-	-	
	-	-	5	-	-	
Sanguisorba	tr**	tr**	tr**	tr**	5**	

FIRE FLATS

Community type: Salix-Betula-Festuca

Plot #12 July 12/77

Species	Percent Cover					Weight
	1	2	3	4	5	green
Salix (green glaucous stem, shiny leaf)	-	-	-	25*	-	
Pedicularis (purple)	-	-	-	tr**	-	
Salix glauca	-	-	-	-	tr*	
Salix barclayi	40* -	25* 5**	40* -	- -	40* -	188
Betula glandulosa	30* -	- 5**	25* -	5* -	25* -	62
Festuca altaica	5 tr* 10**	10 5* 60**	5 tr* 10**	5 5* 20**	10 tr* 15**	
Mertensia	-	-	tr**	tr**	-	
Carex aquaticus	-	-	-	-	-	52
Artemisia	- -	25** -	20** -	15** 10*	5 -	
Senecio triangularis	5*	-	5*	tr*	5**	
Epilobium angustifolium	-	5*	5**	-	-	
Delphinium	5* 10*	5* -	- tr**	tr* -	- 5**	
Viola	25	20	5	15	20	
Rubus arctica	25	20	15	15	10	
Vaccinium caespitosum	40	25	10	25	20	
Ranunculus	-	-	-	-	10**	
Sanguisorbus	5**	-	-	5**	-	
Valeriana	5** -	- -	- -	10** -	5** 15	
Blue gentian	-	tr**	-	-	-	

Plot #12 (Cont'd.)

Species	Percent Cover					Weight
	1	2	3	4	5	
Forb #2 (opp. leaves)	tr	-	-	-	-	
Poa	5**	-	-	-	tr**	
Phleum alpinum	tr**	-	tr**	-	-	
Luzula	-	-	tr**	-	-	
Caltha	-	-	-	-	5	
Forb #4 (veined sm leaf)	-	tr**	tr**	-	-	
Moss	90	70	90	90	80	
cup Cladonia	-	-	tr	-	-	
Peltigera apthosa	-	10	-	-	10	
P. malacea	-	5	5	-	-	
Pyrola	-	-	-	-	5	
Myosotis	tr**	-	-	tr**	-	-
Forb #3 (long leaf)	5**	-	-	-	-	
Potentilla	-	5**	-	-	-	
Cladonia conida	-	tr	-	-	-	
Peltigera canana	-	5	-	5	-	

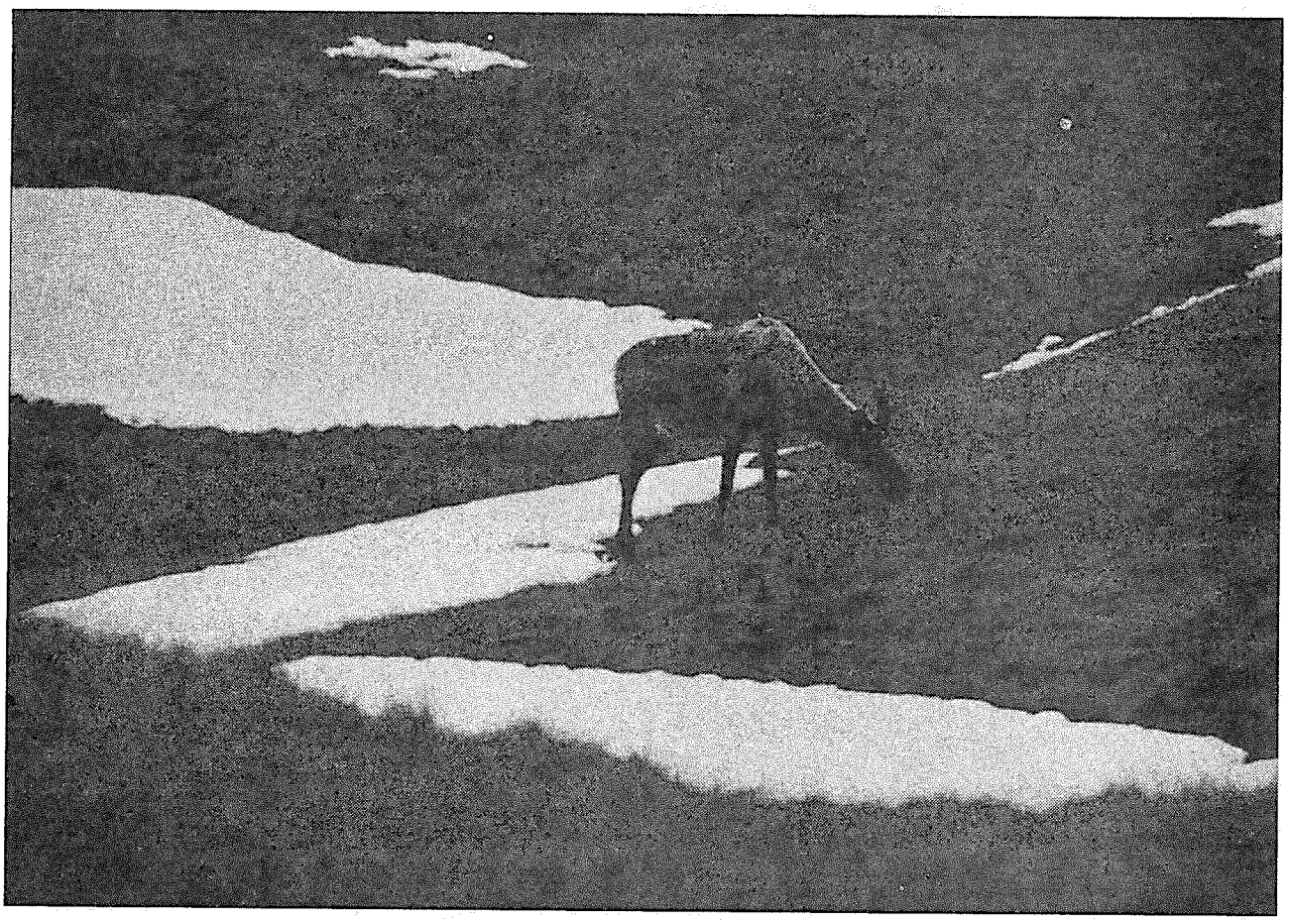
* = upper strata

** = medium strata

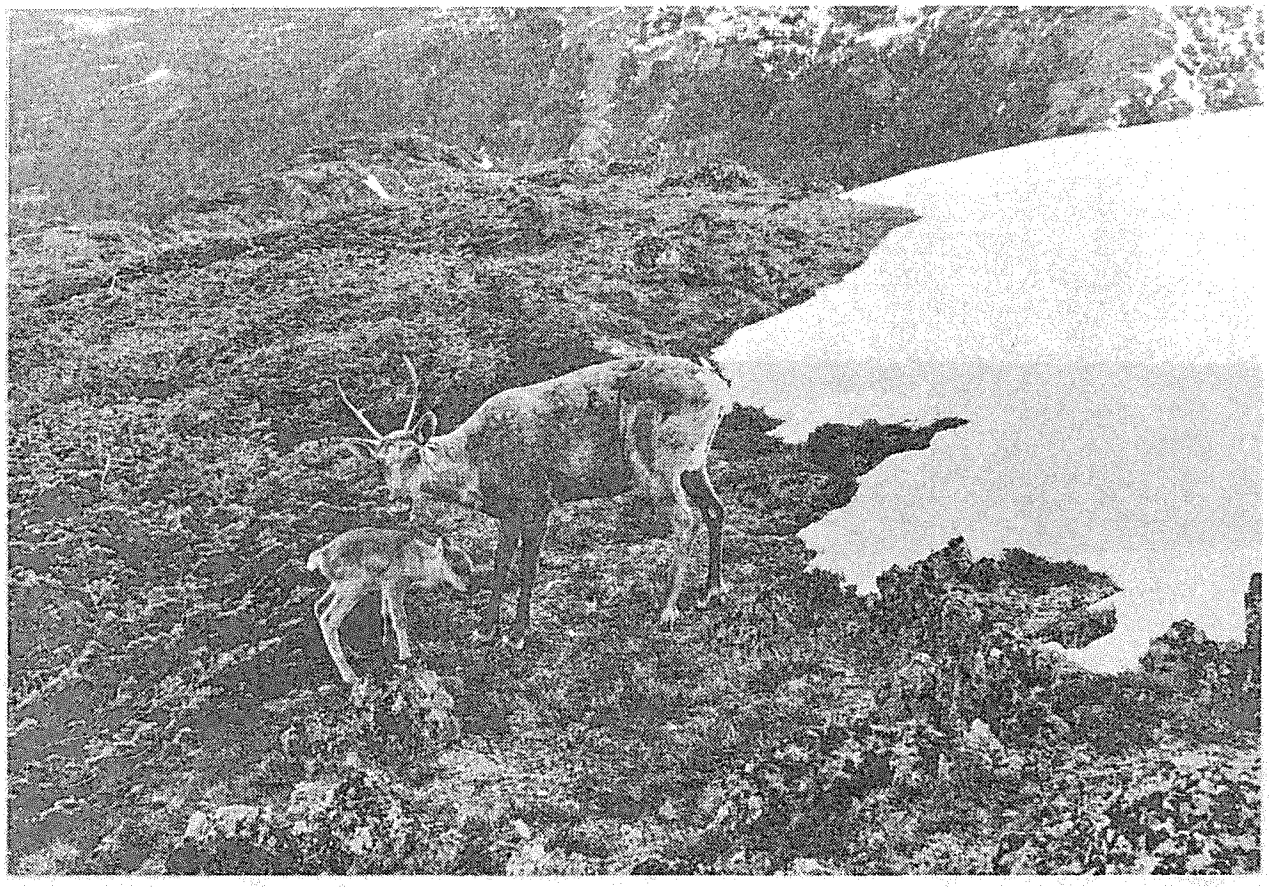
APPENDIX D

PHOTOGRAPHS AND FIGURES

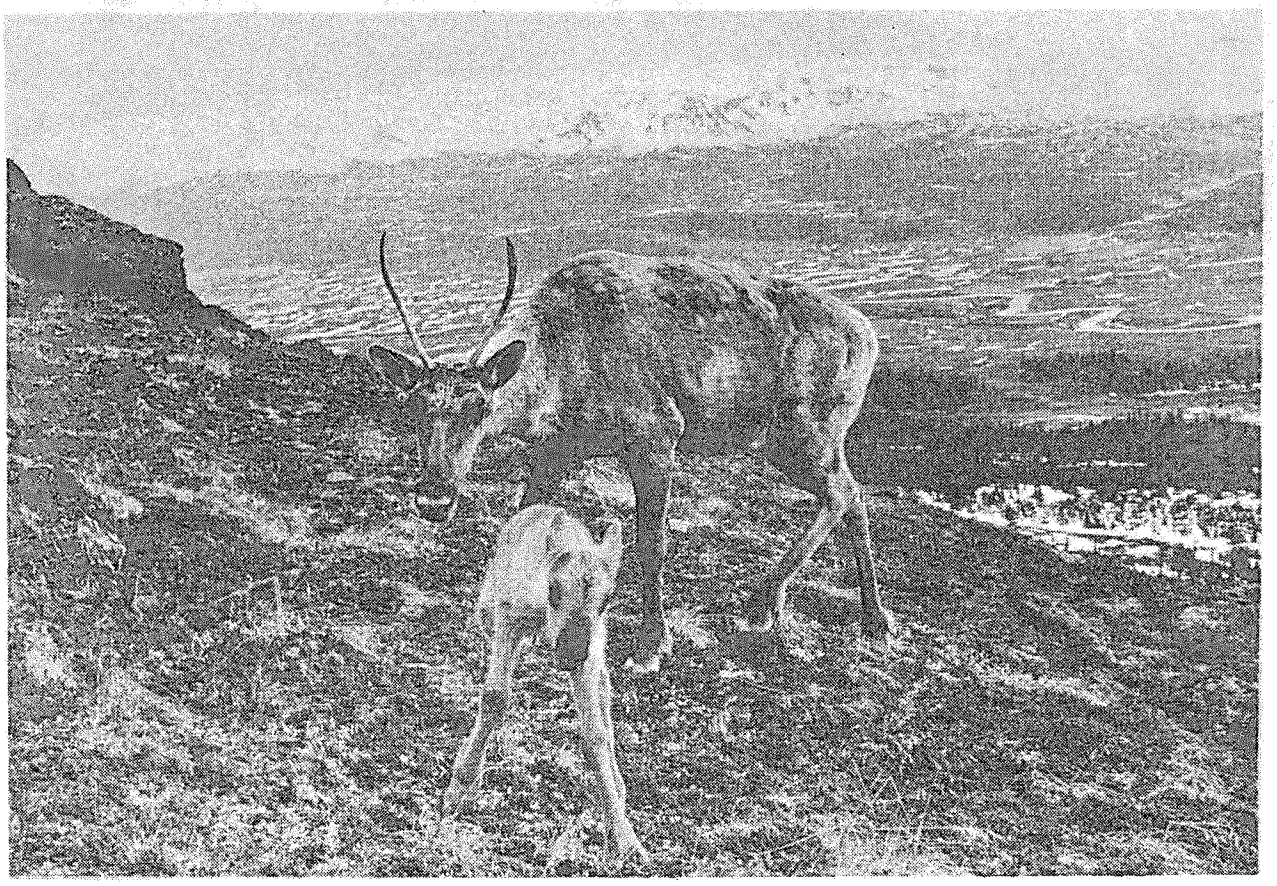
List of Figures



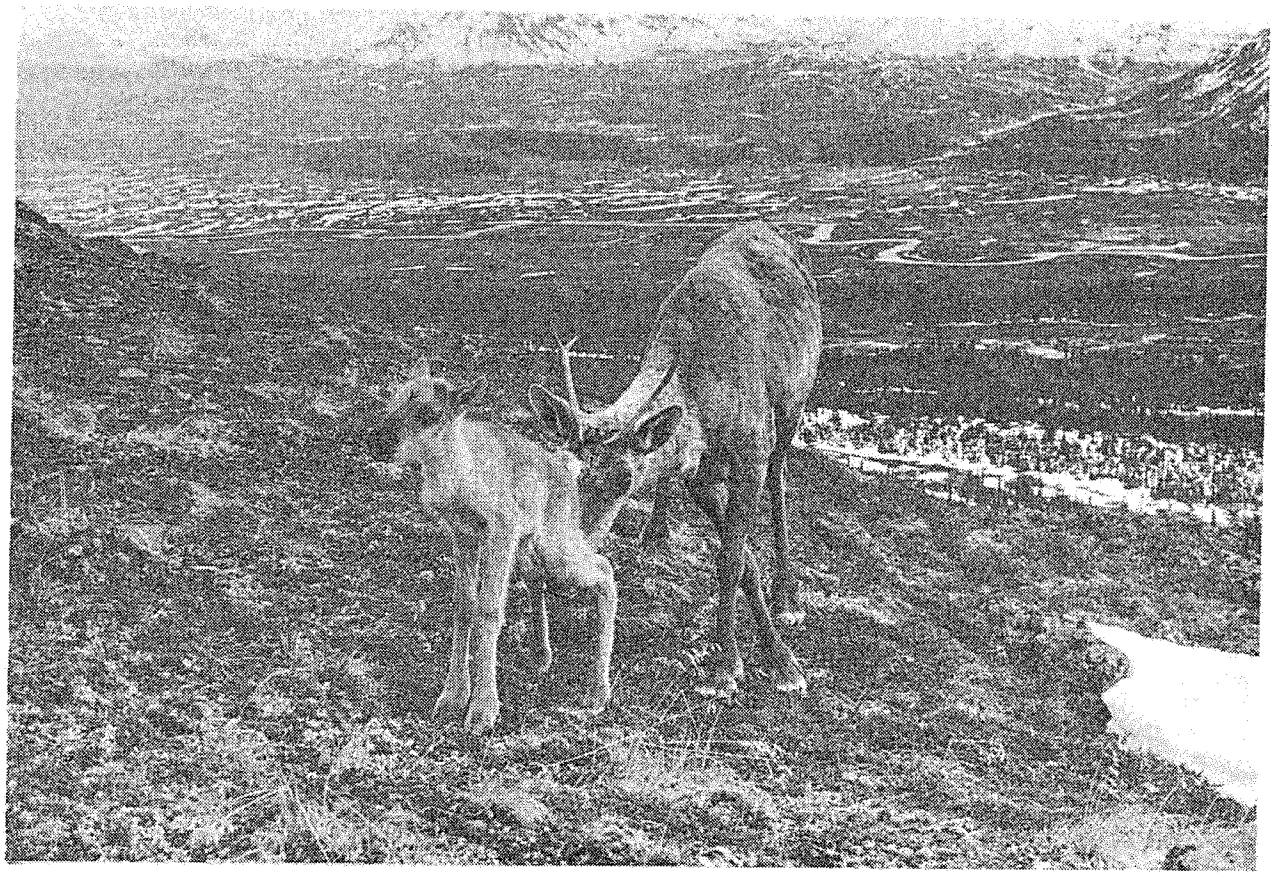
A stag in May feeding on dry *Festuca* and *Stereocaulon paschale*



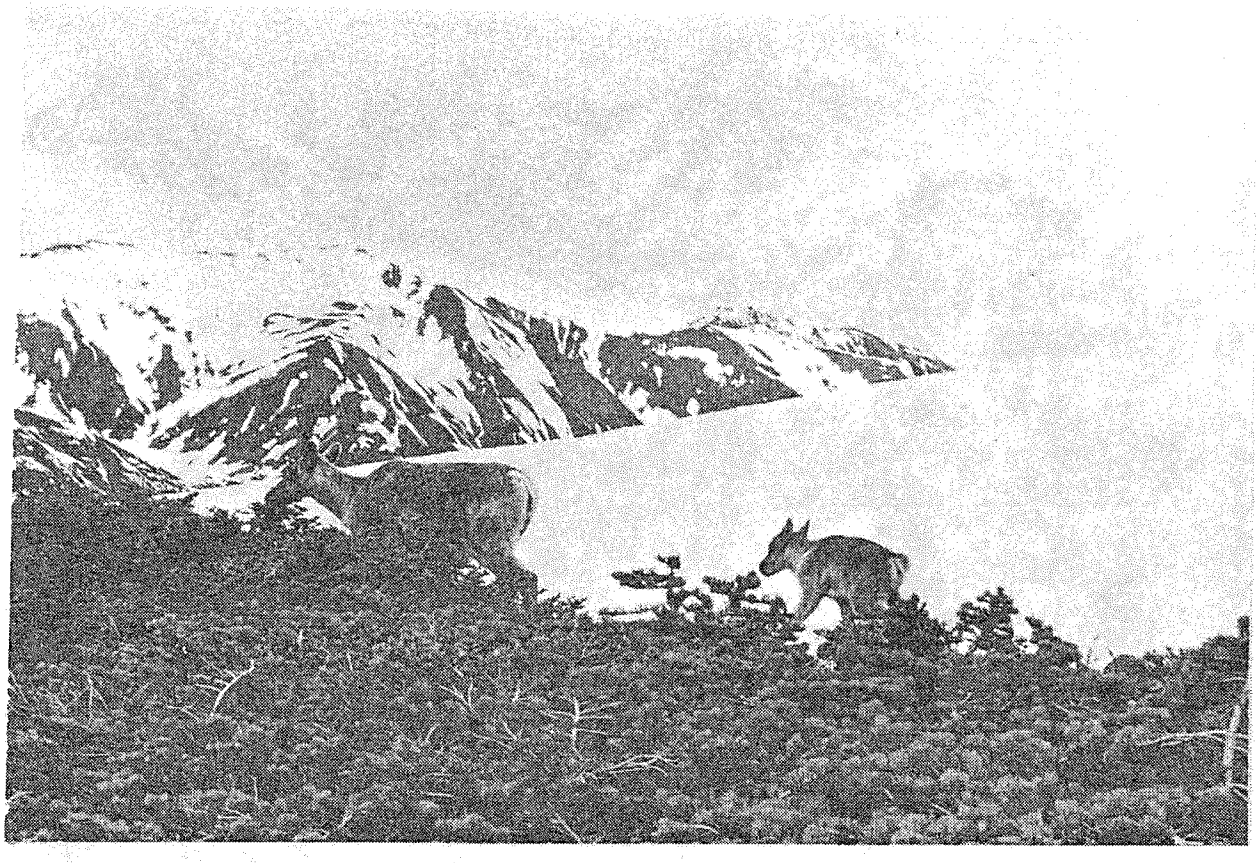
Birthsite of calf - note udder of female



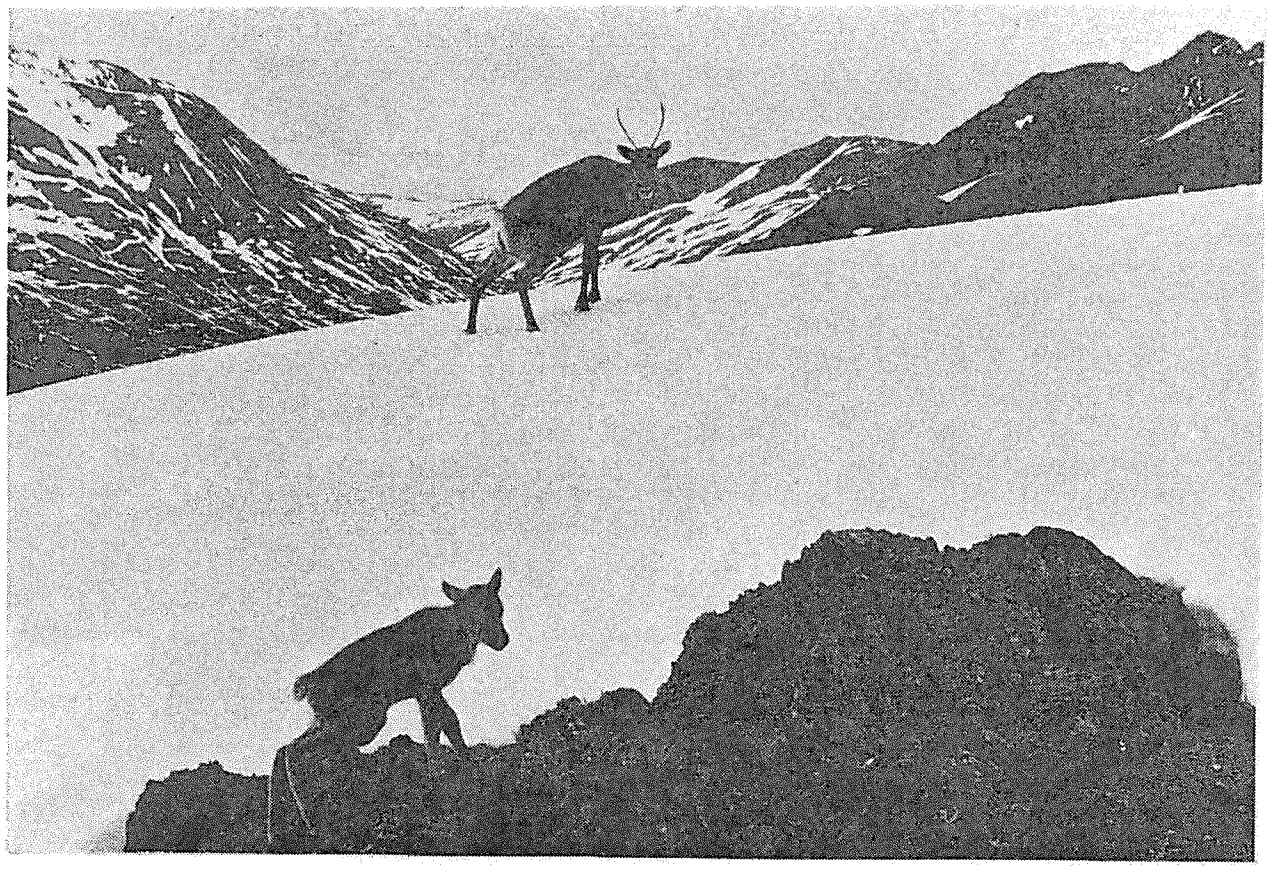
Calf not yet imprinted to female and runs toward observer



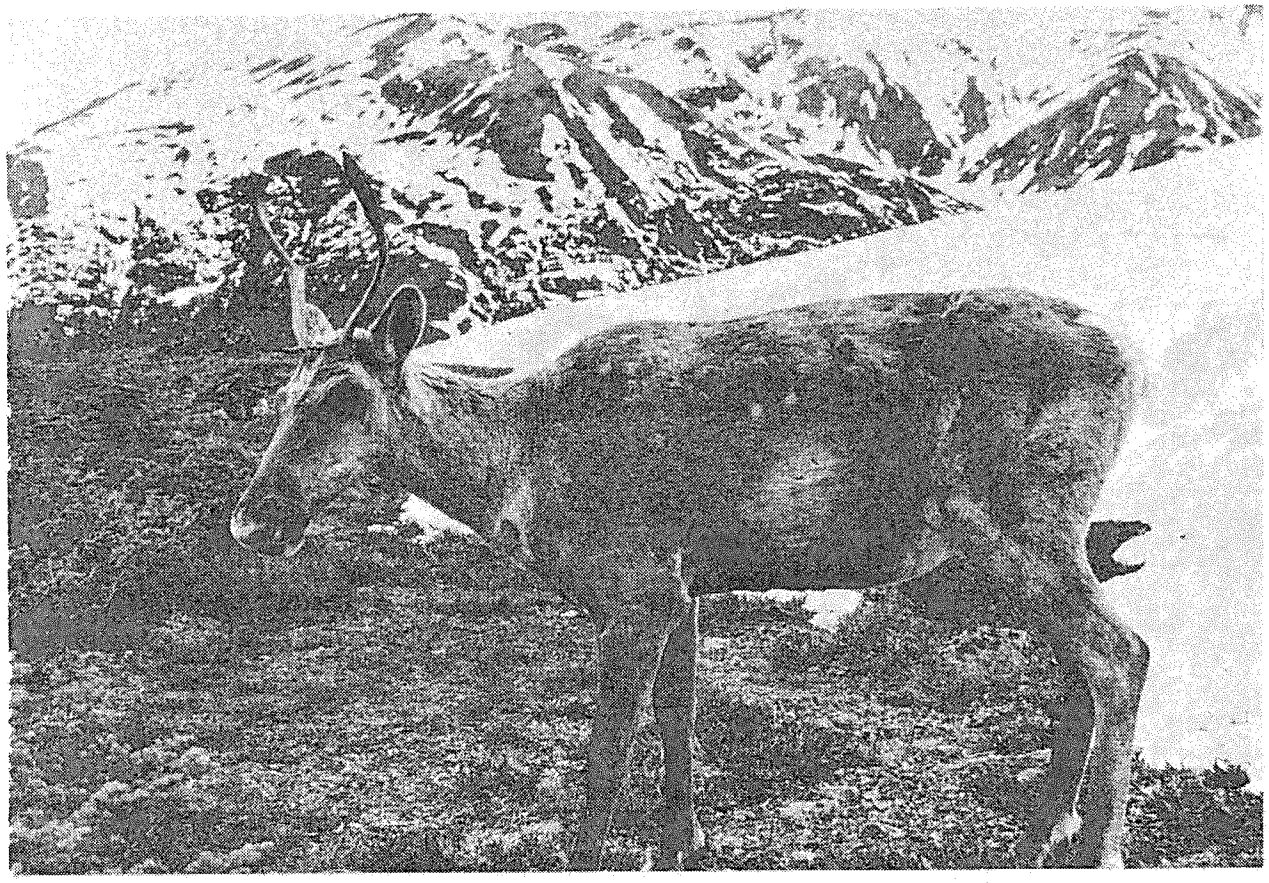
A female smelling her newborn calf - Fire Flats below



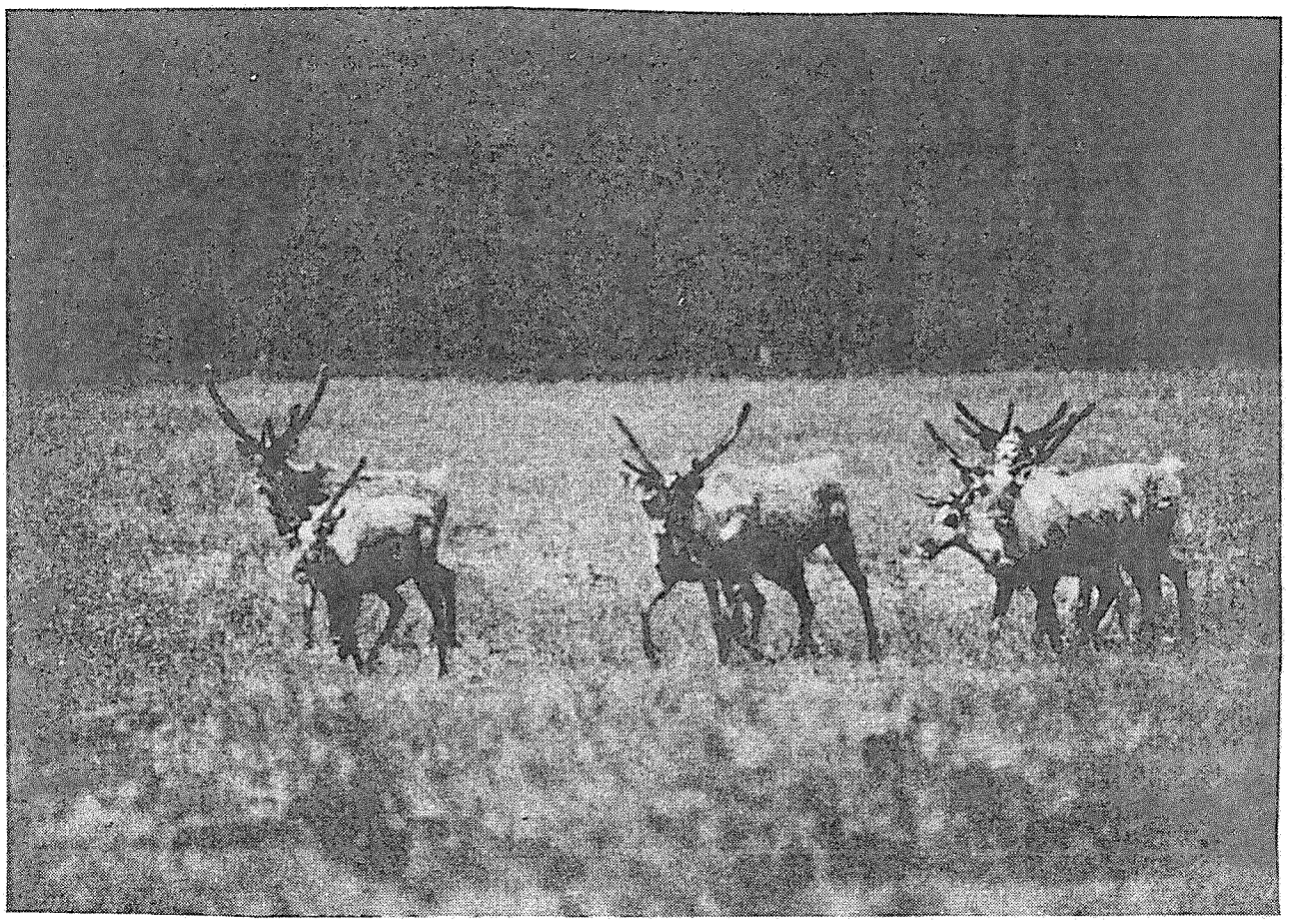
Some of the birth sites selected acted as traps. This site had a rising cliff on one side, a tangle of prostrate fir on one side, a snowfield barrier and a steep slope. Female leads calf away with difficulty.



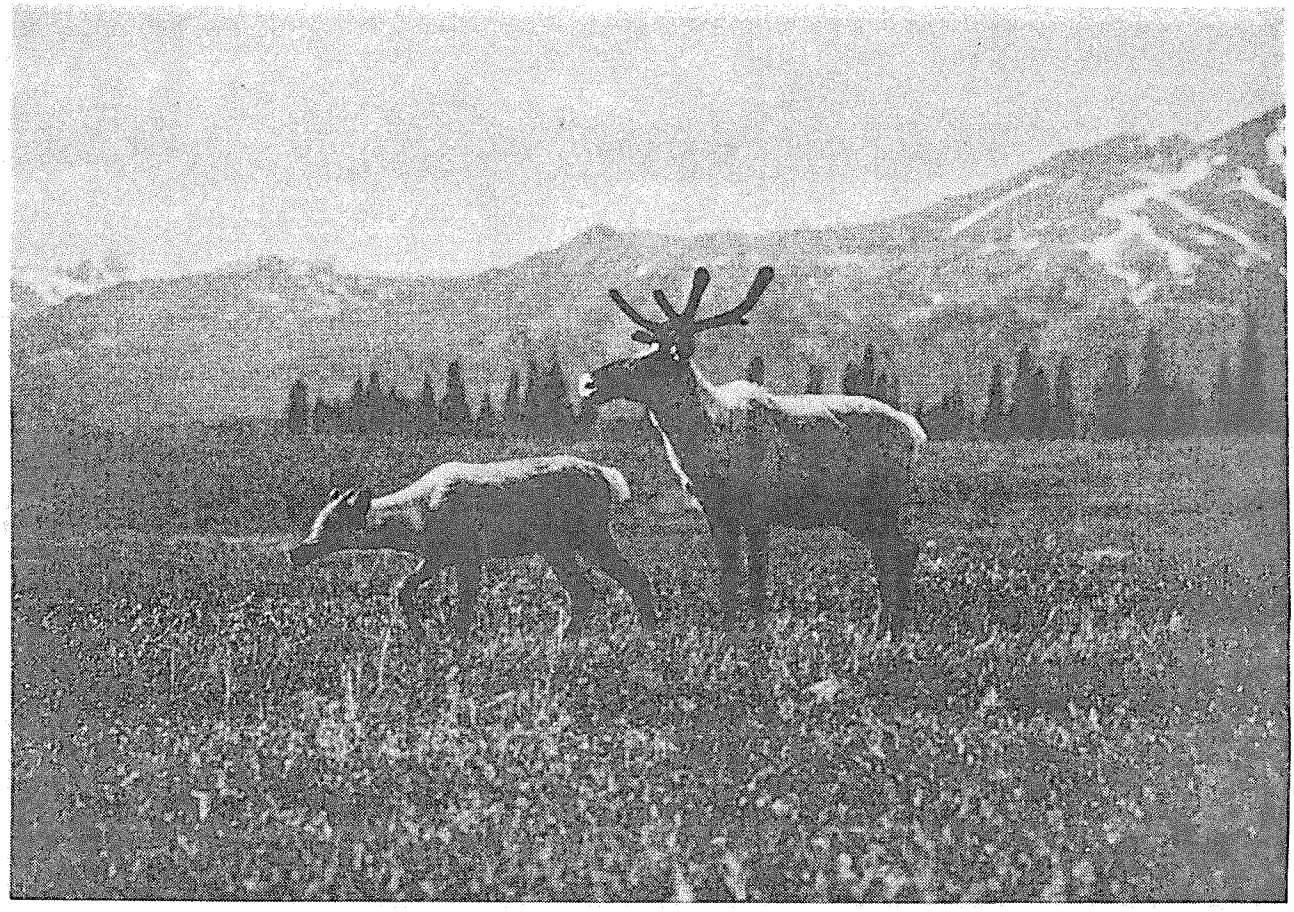
Female urinates while waiting for calf



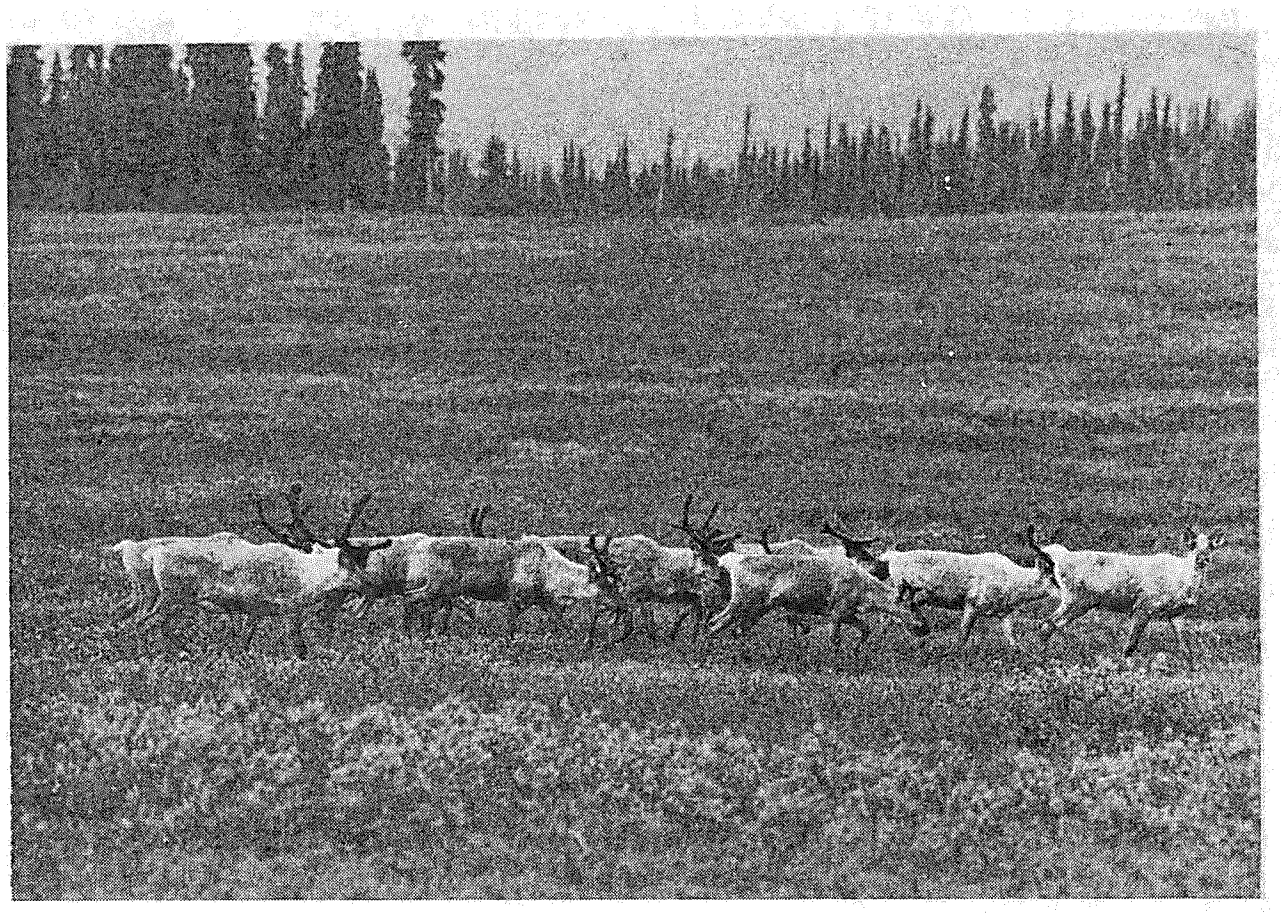
A post-parturent female - note the warble lumps



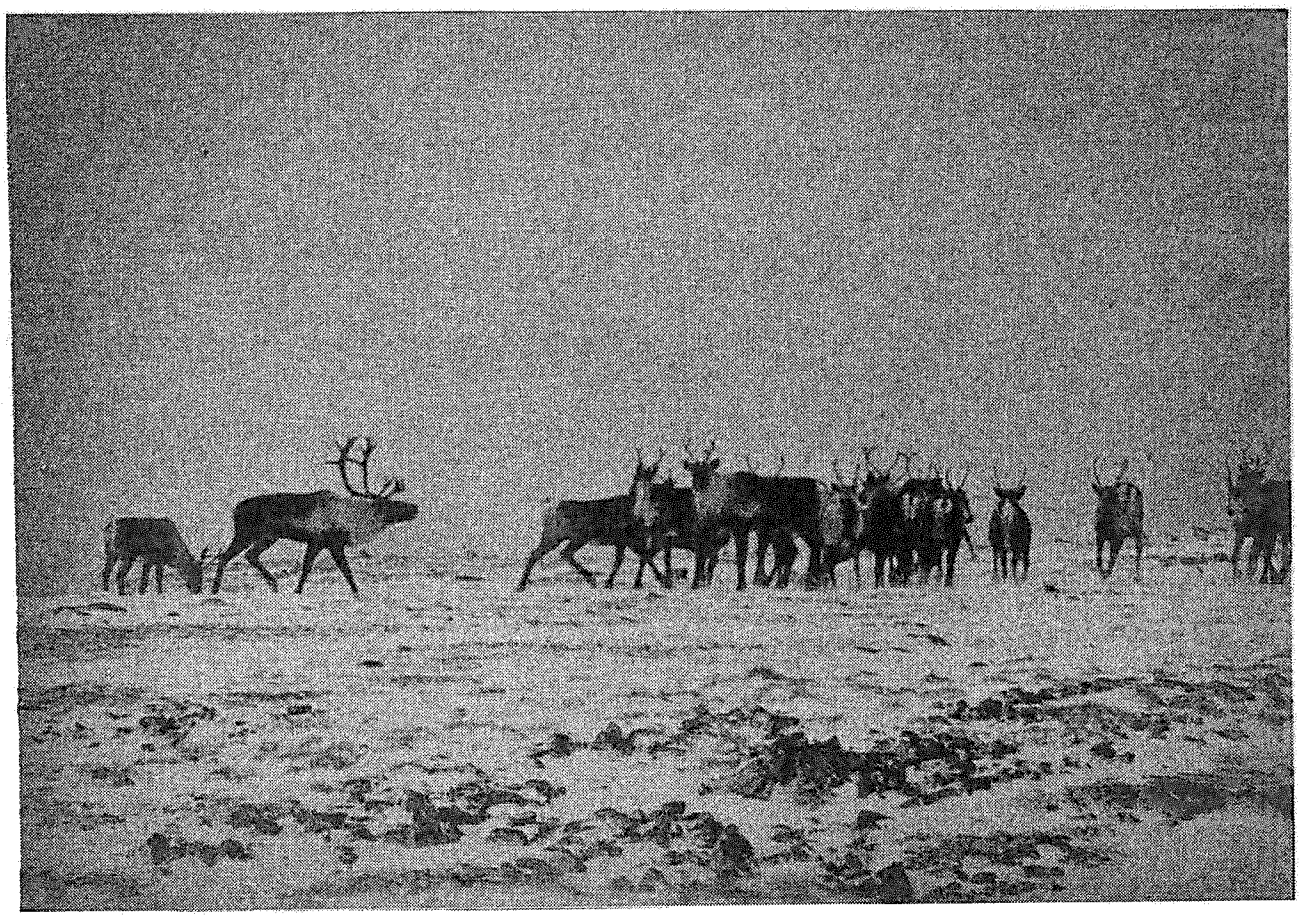
The stag herd in July



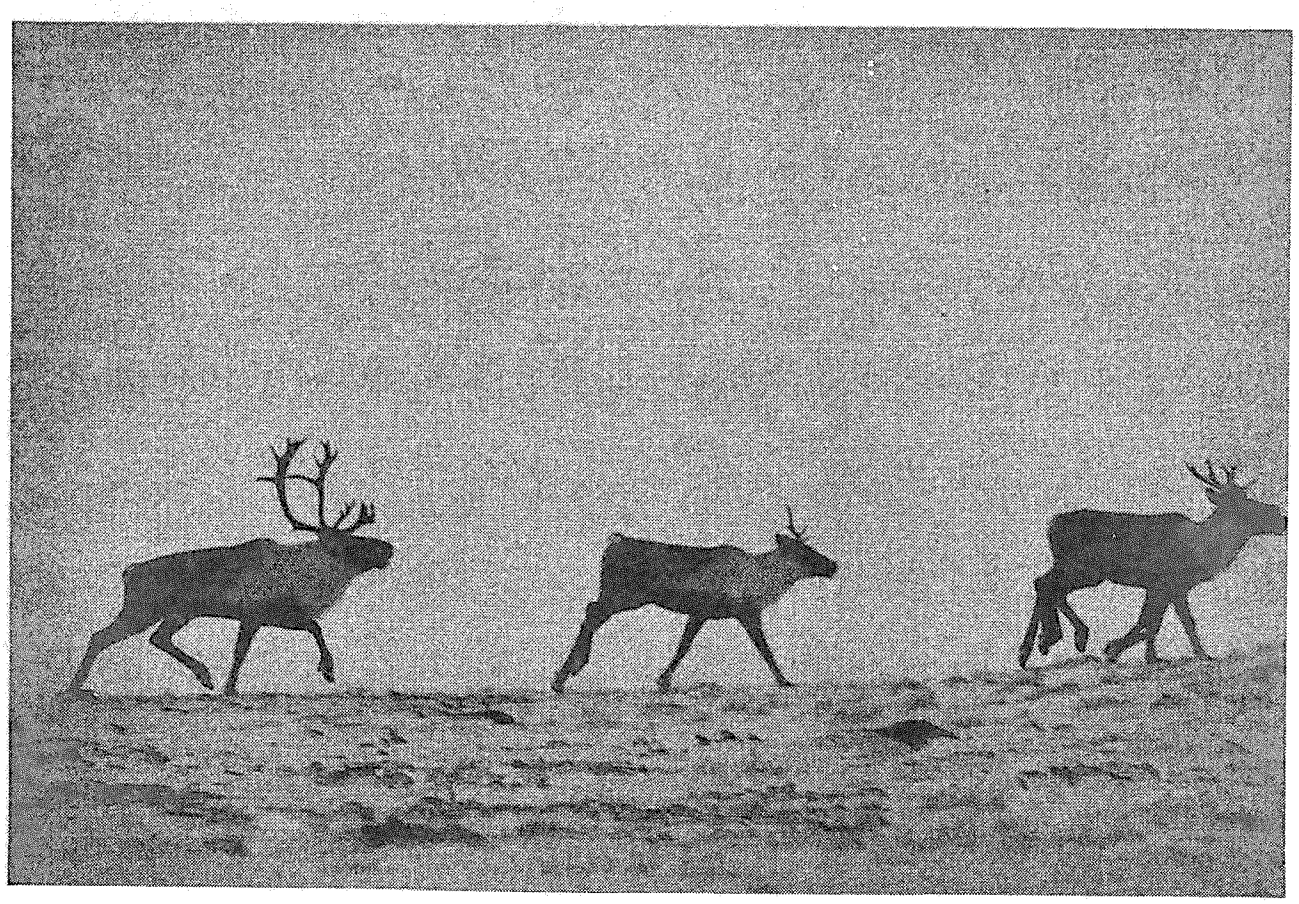
Comparison of size of yearling and medium size stag



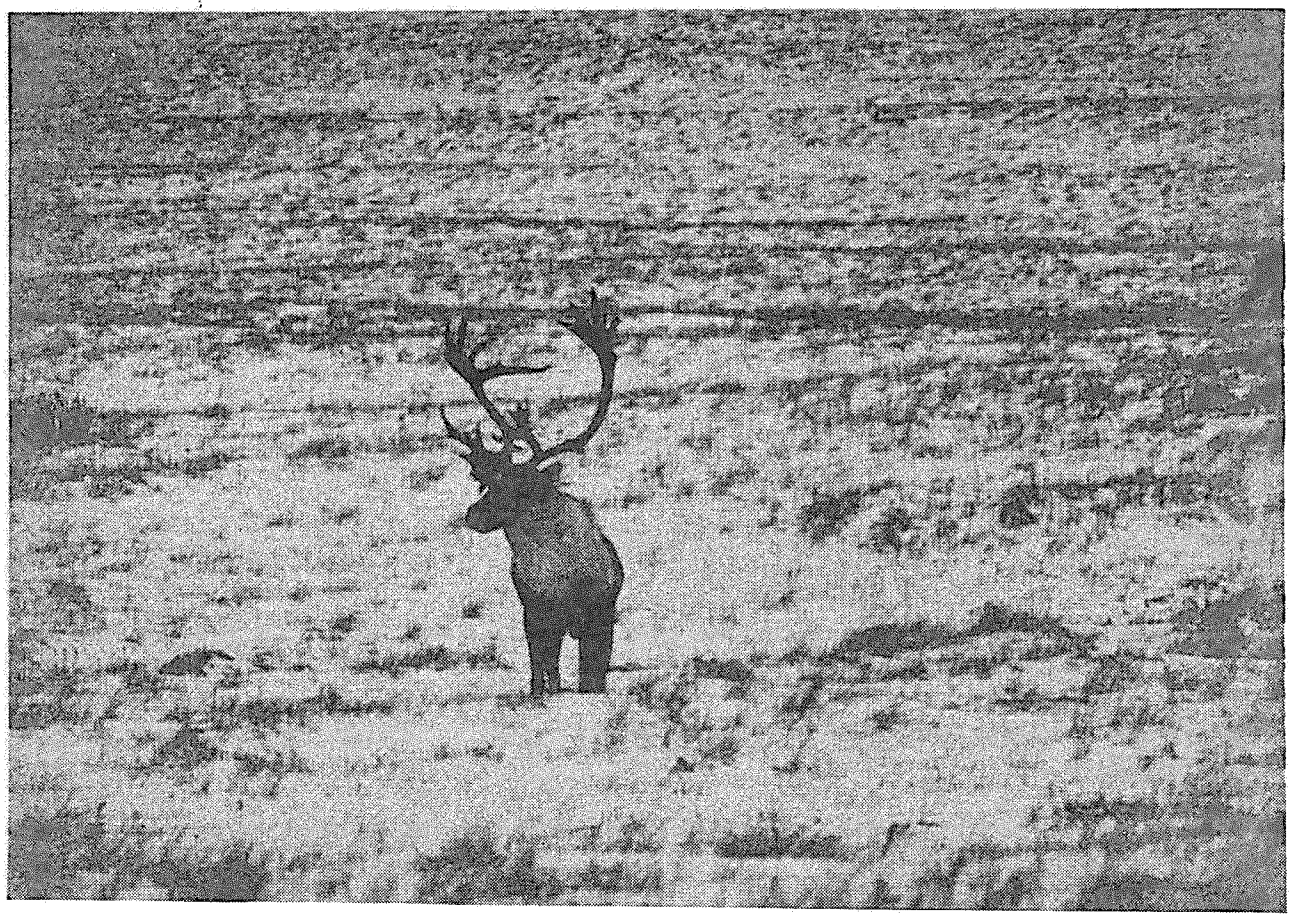
The stag herd at Fire Flats in June



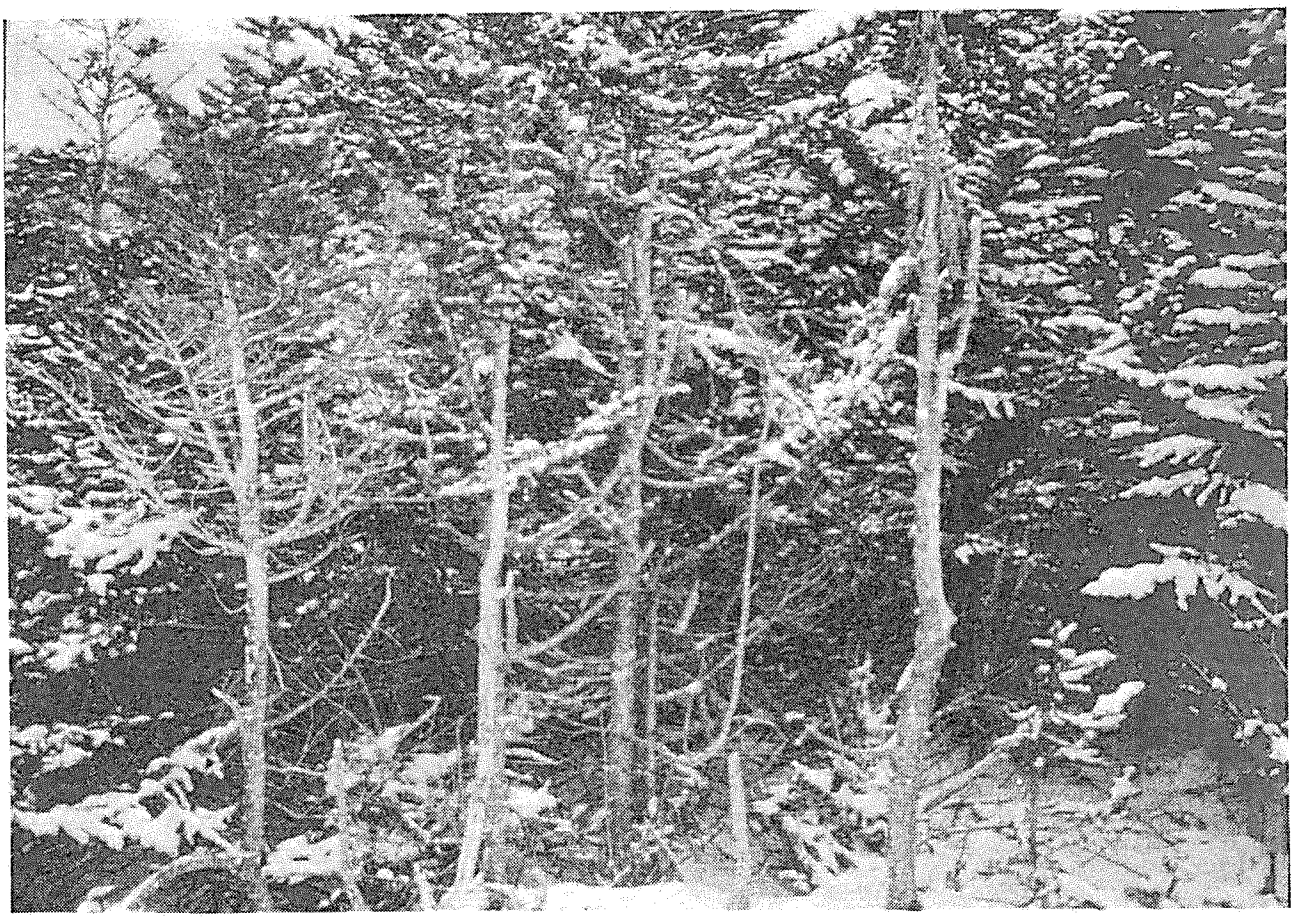
Stag in low stretch, Worry Creek in October



Females running from observer, stag follows them panting



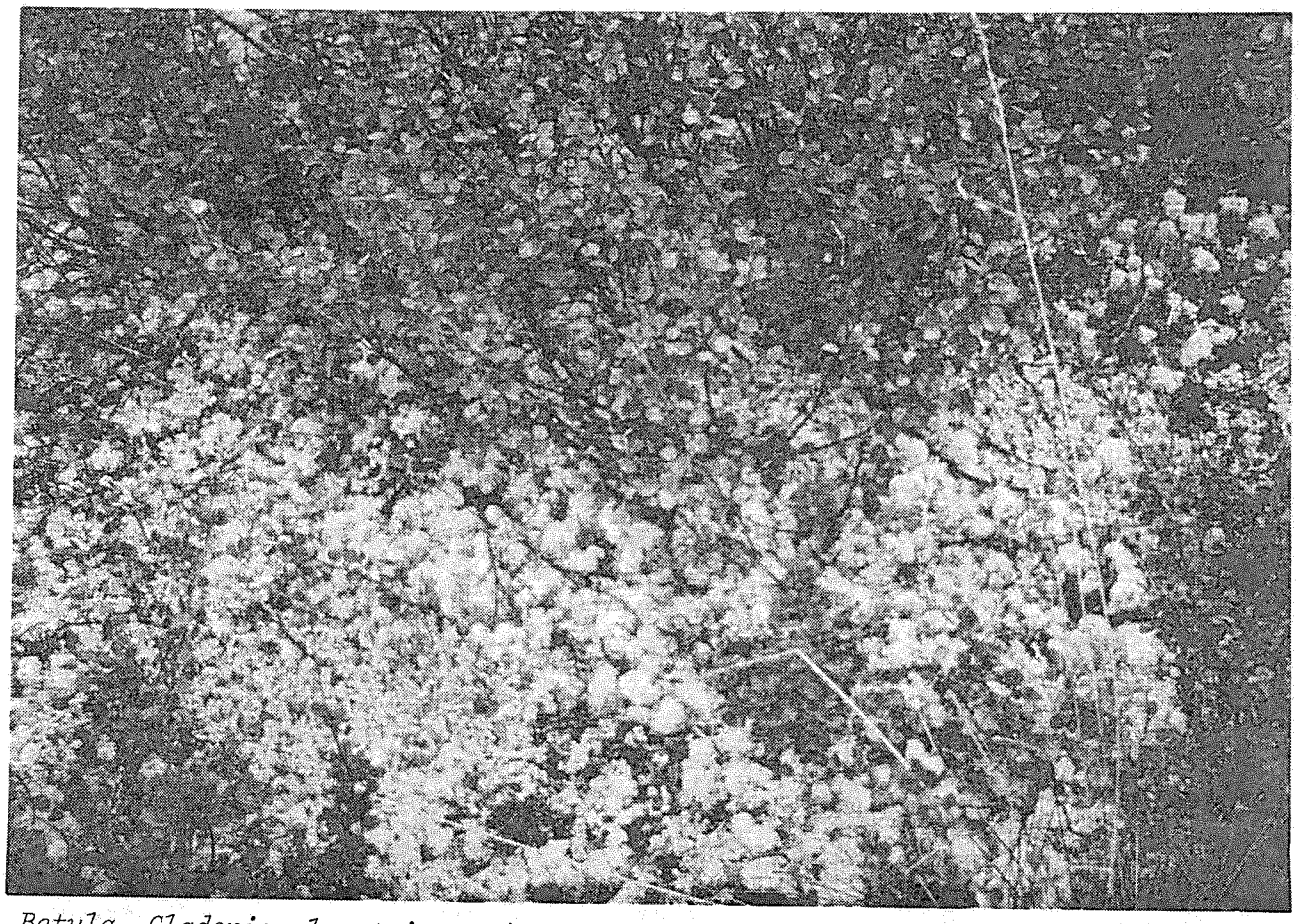
A large male at Worry Creek in October



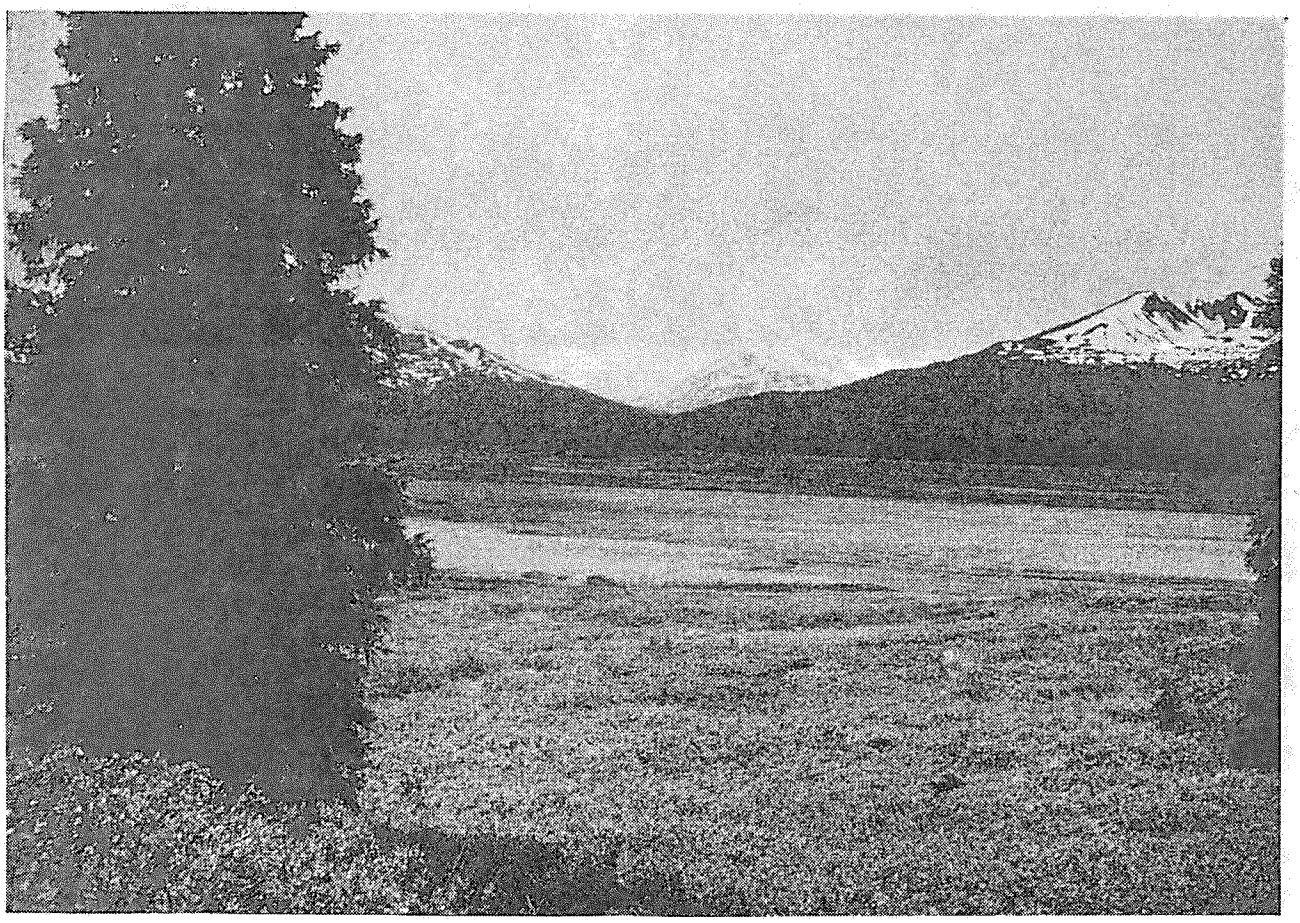
Bush-thrashed trees at tree line, Worry Creek

This *Salix-Carex* Community was the favourite habitat type in June, *Carex aquatilis* and leaders of *Salix planifolia* stripped.

Lichens - mostly *Cetraria nivalis*

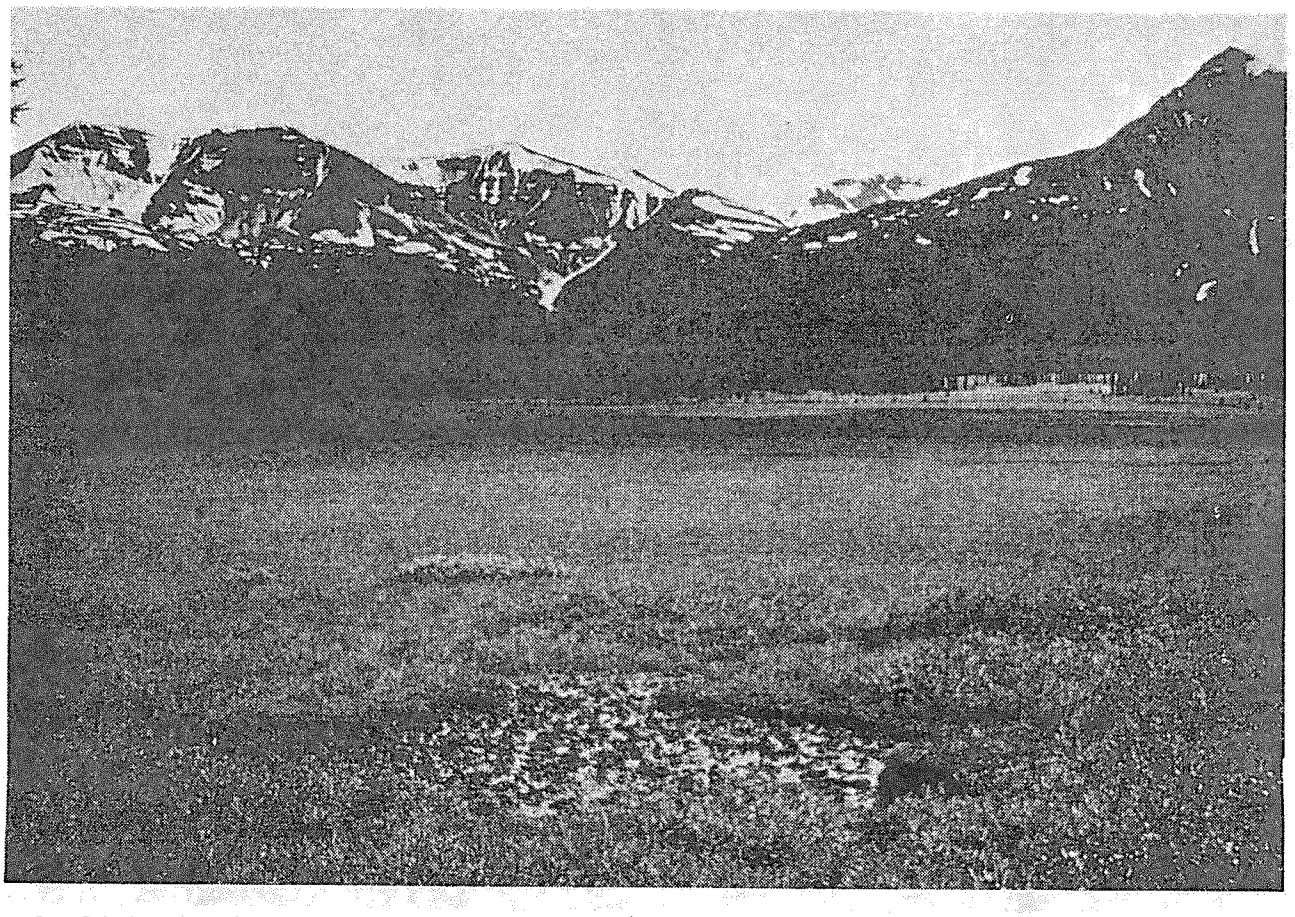


Betula, *Cladonia alpestris*, and *Stereocaulon* community. Snow would probably drift in the birch in winter preventing use of the lichen.

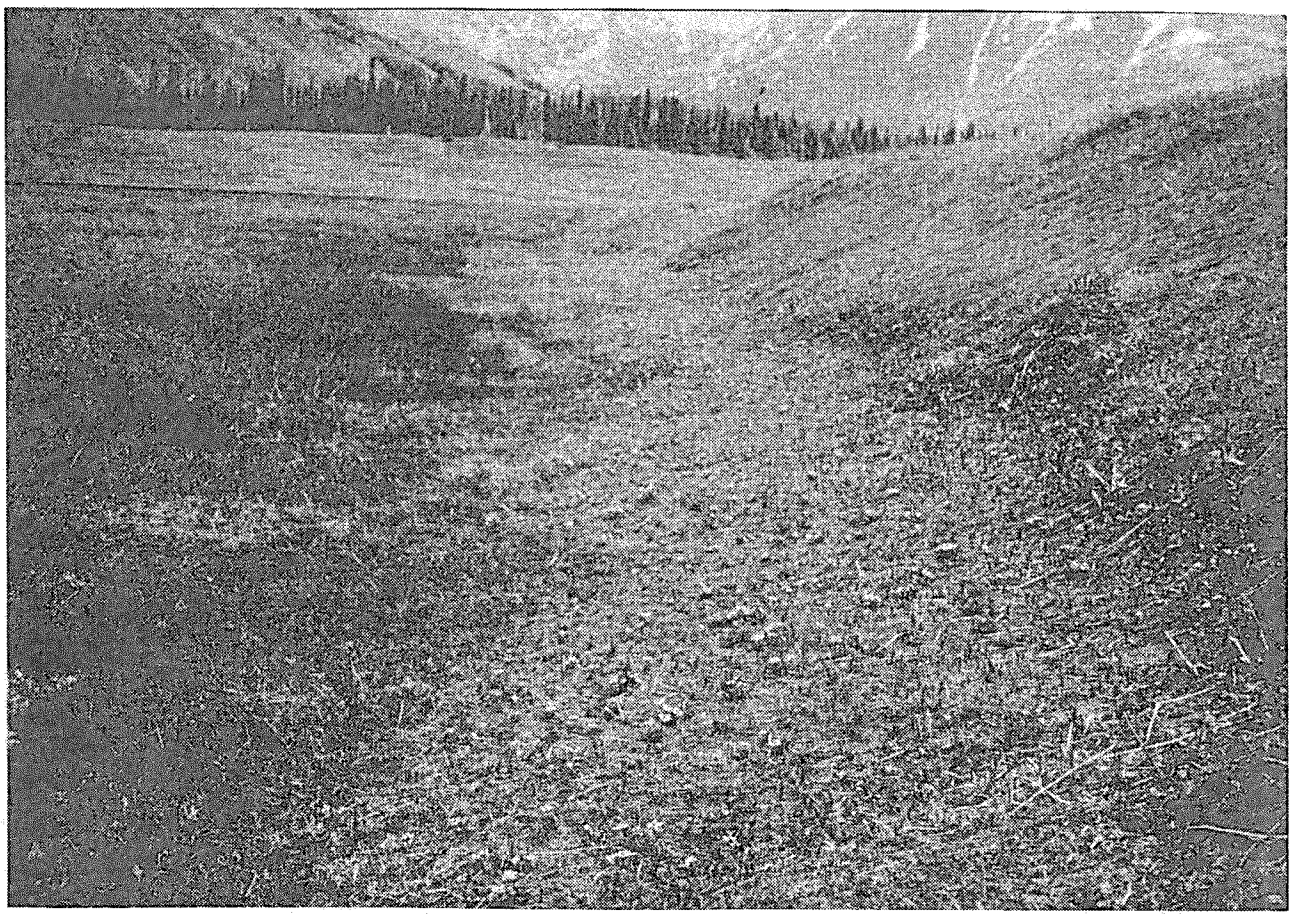


Fire Flats - *Betula glandulosa* community in foreground and *Festuca* community in background.

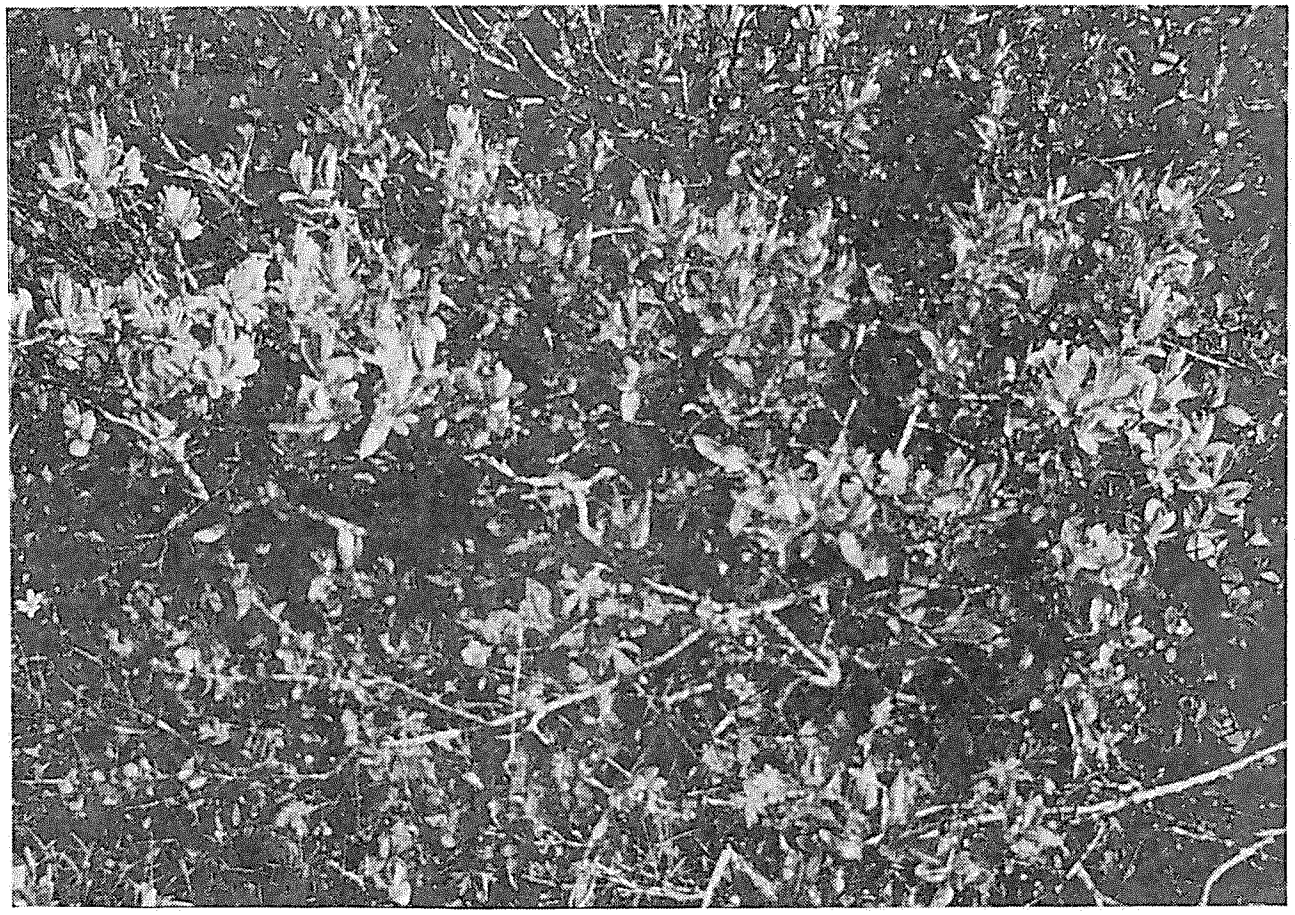
Both *Betula glandulosa* and *Ranunculus* were taken by caribou



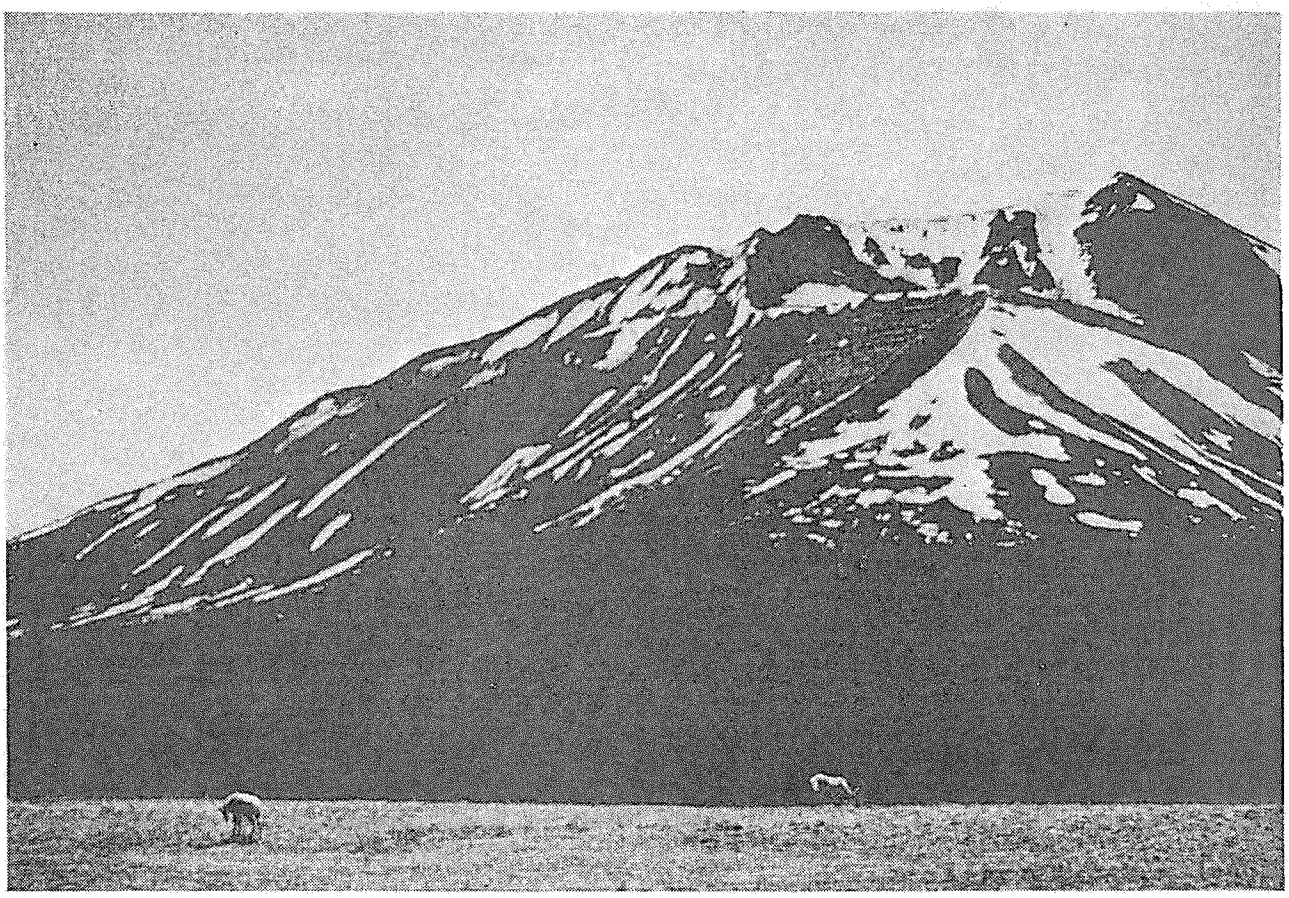
Salt lick at edge of *Carex-Salix* community



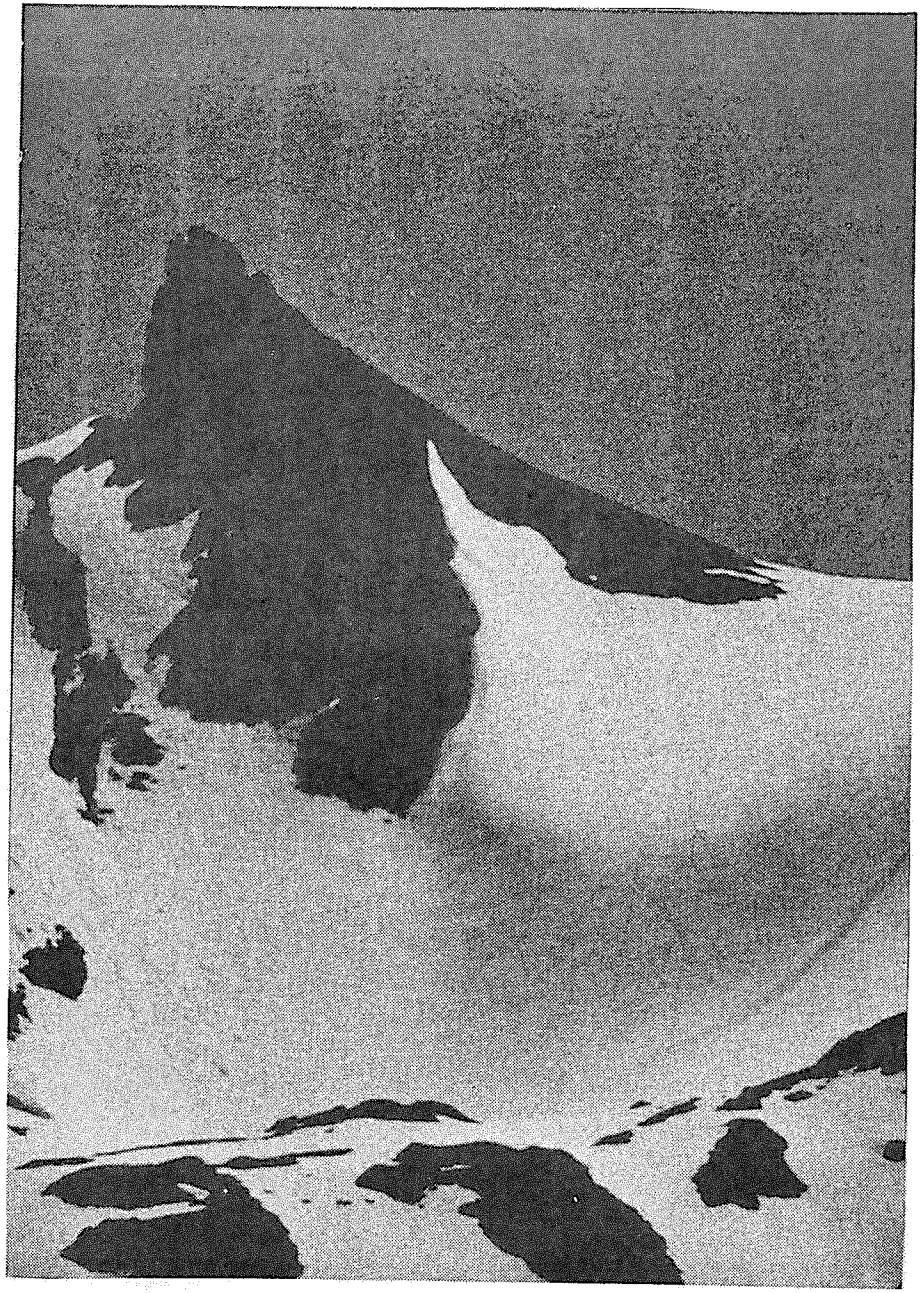
A snowfield community - we thought caribou would use these new appearing plants but they did not.



Salix commutata was a common willow not utilized by caribou

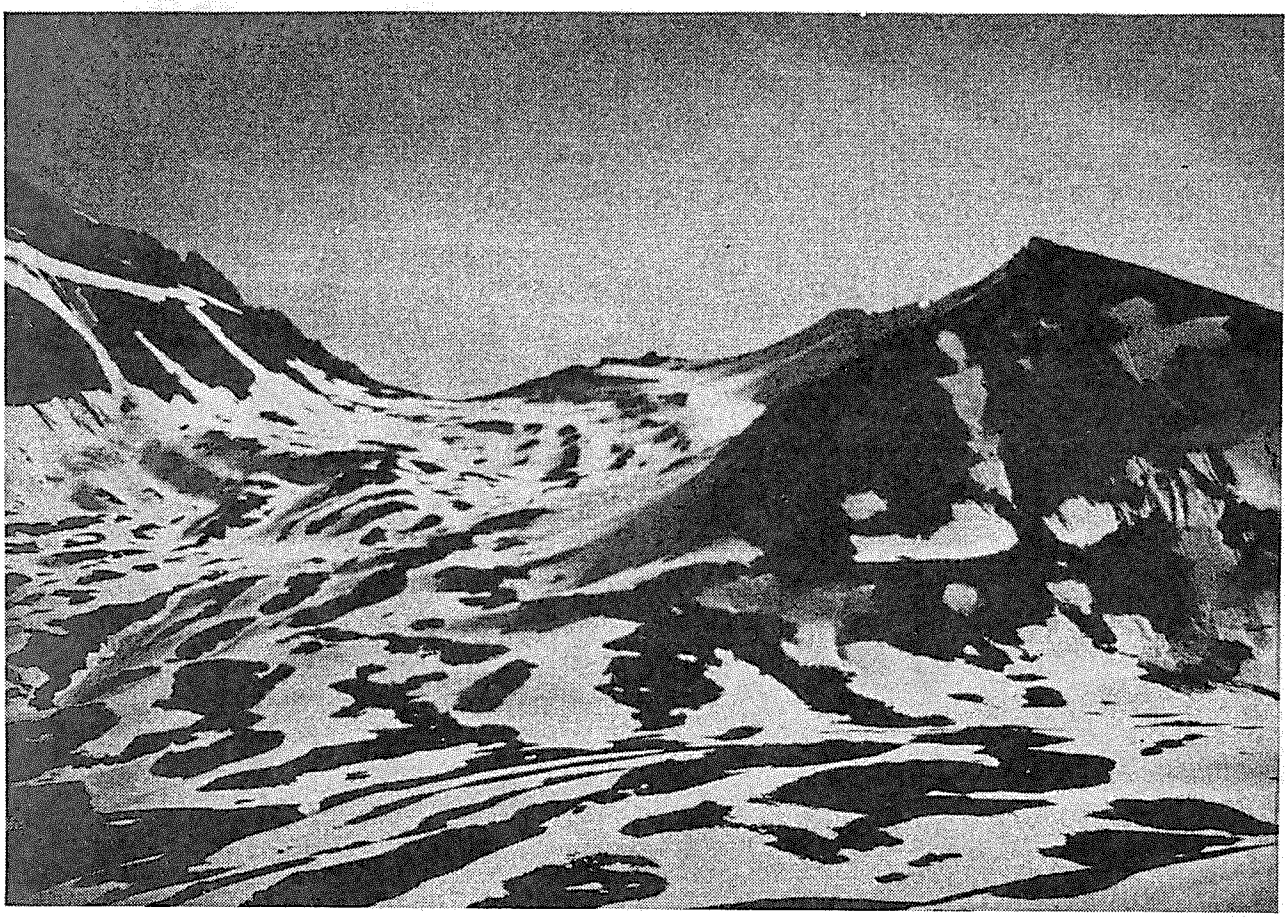


Umbach Mtn., three calves were born on the top

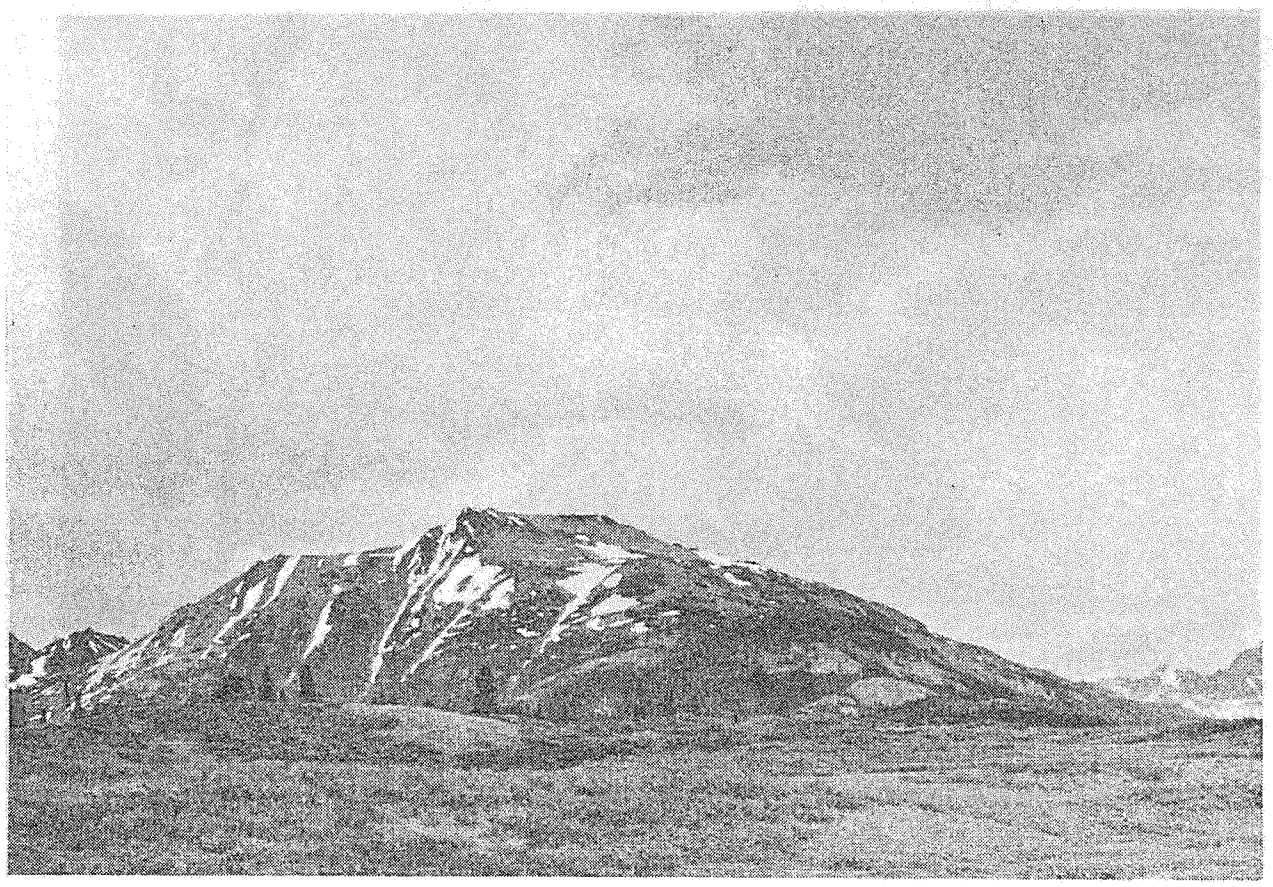


Note the escape tracks of caribou with calves going up the steep slope on Thule Mtn.

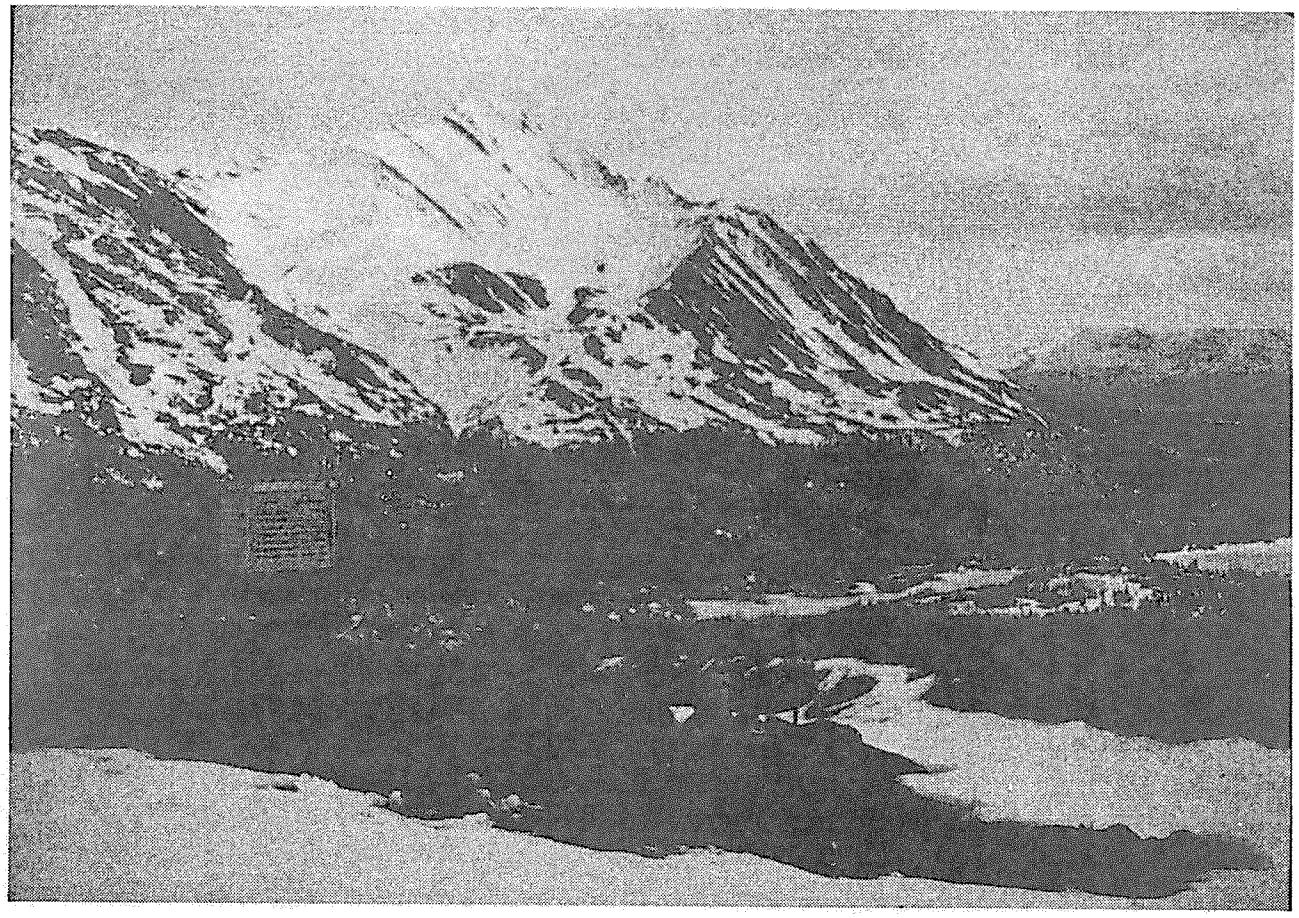
A female gave birth on the bare spot in middle of picture, calves were later seen on ridge at the top of picture.



One calf was born on bare spot in the middle of this picture, Thule Mtn. Three cows and calves were watched on the high ridge to the right - when alarmed, their dams led the calves to more rough terrain on the left.

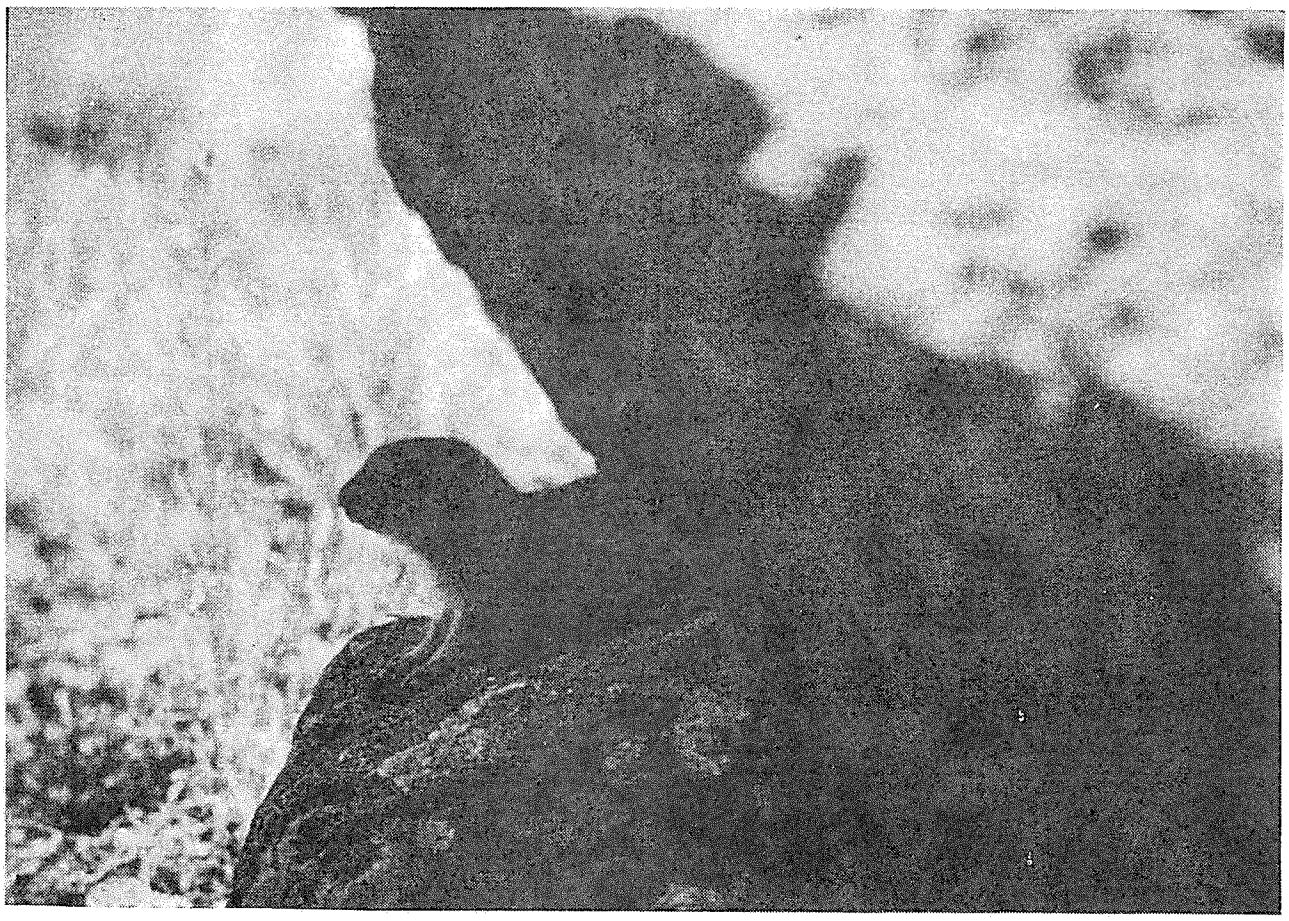


Umbach Mtn. Three calves born on the highest ridge, these animals were watched for 10 days.

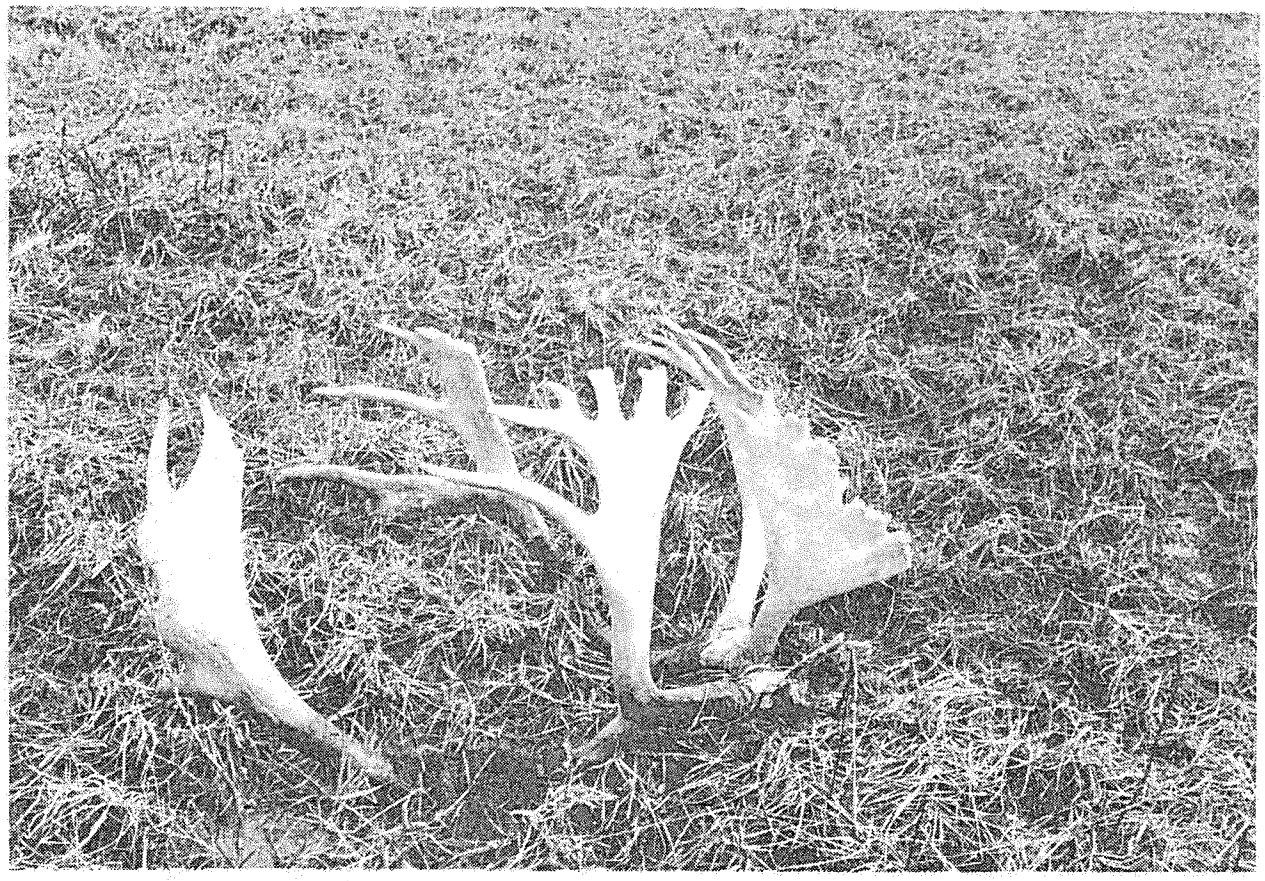


Weather station at 5500 feet, Buckinghorse Lake

A young marmot

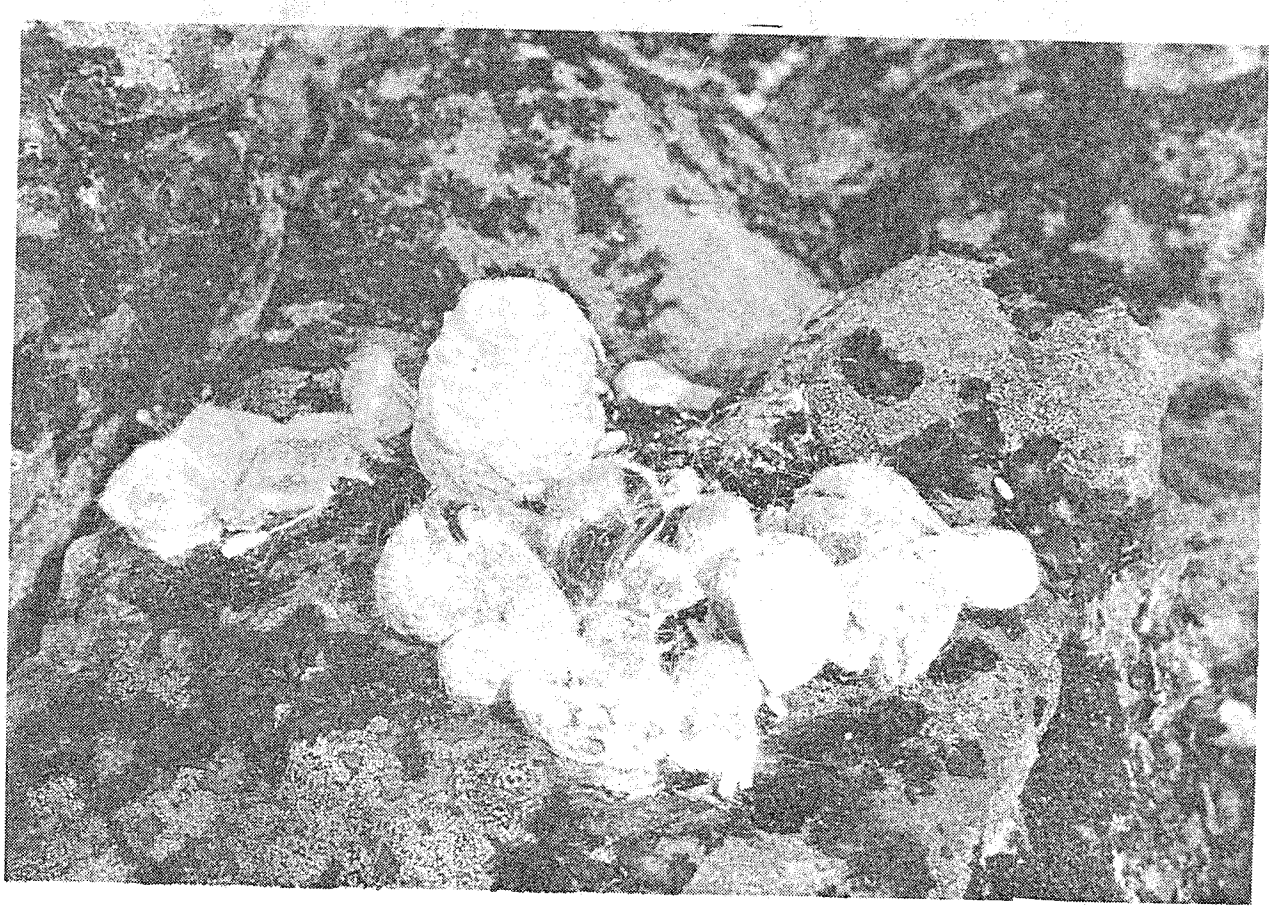


Arctic ground squirrel

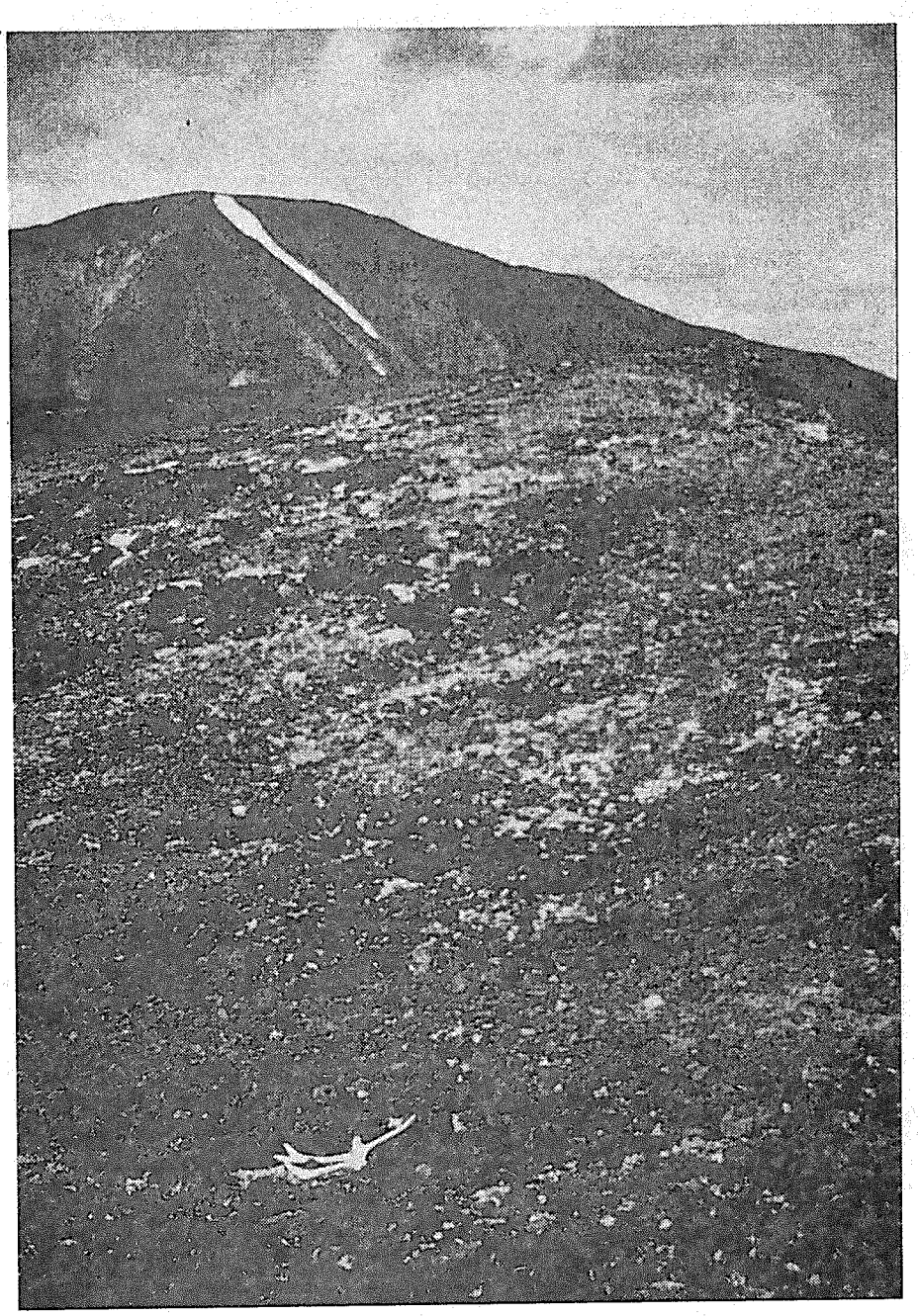


We found the skulls of 31 animals - most were large males that may have died from wolf predation.

A large set of antlers found at Level Mtn.



Wolf scat at 7000 feet at Level Mtn. with calf hooves



A cast female antler in area where caribou calved at Level Mtn.

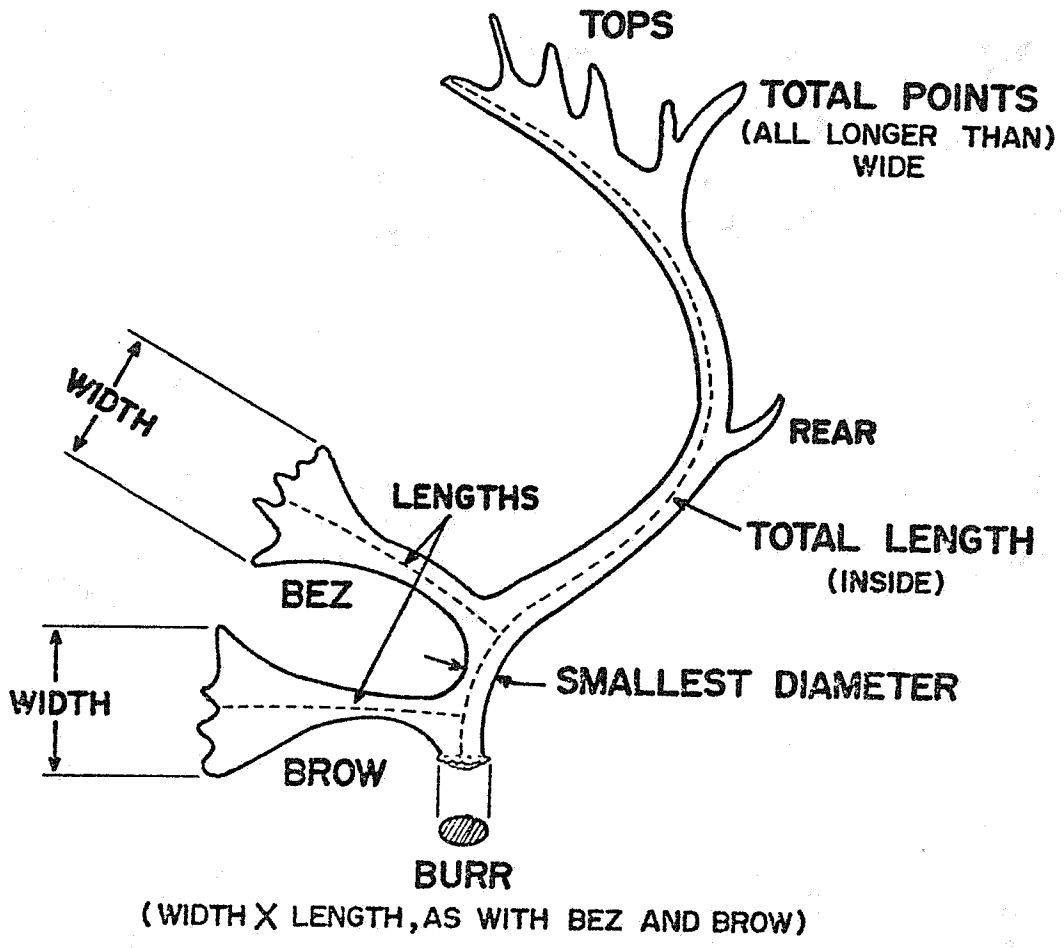


Figure 1. Diagram of antlers showing the measurements taken.

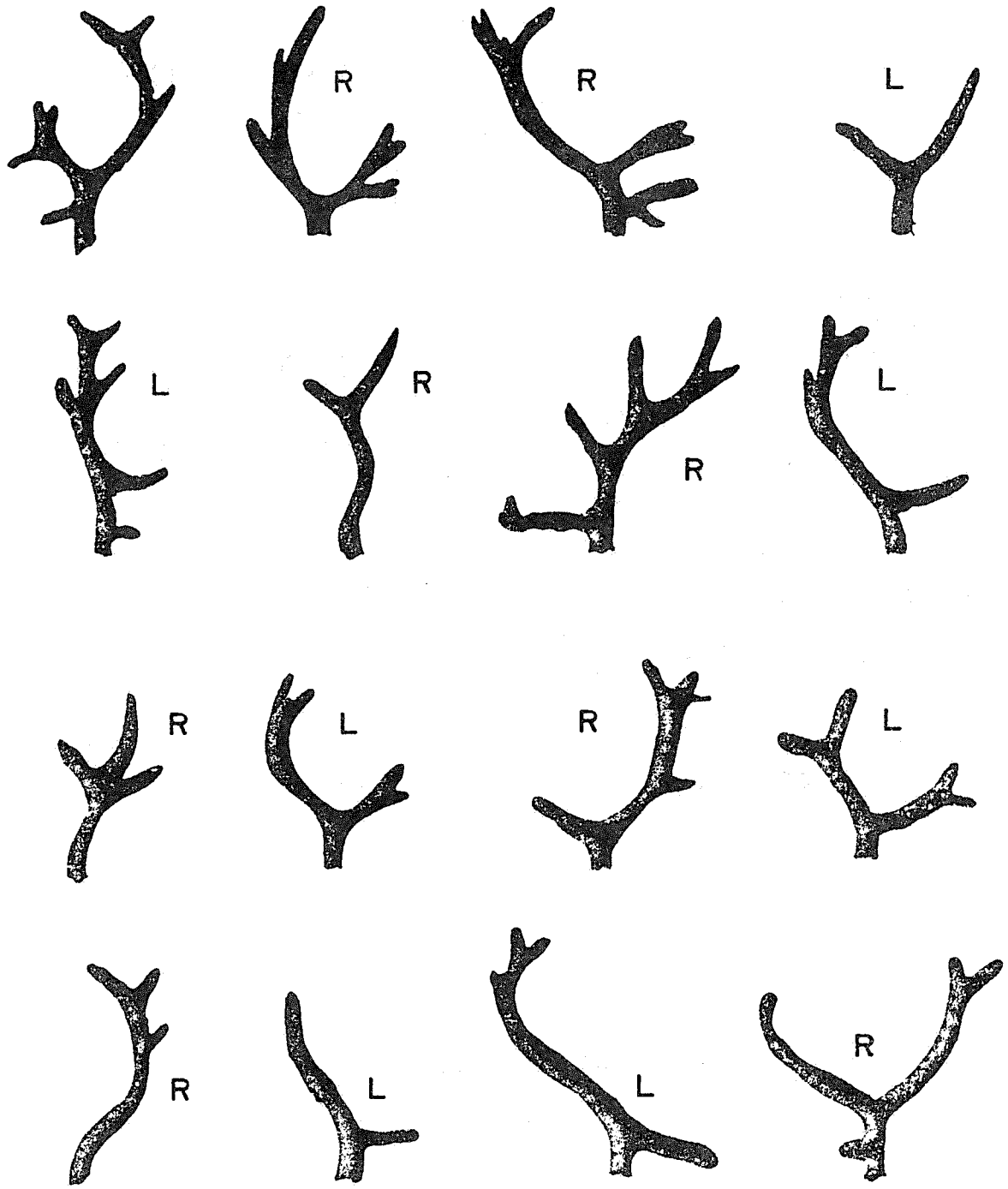
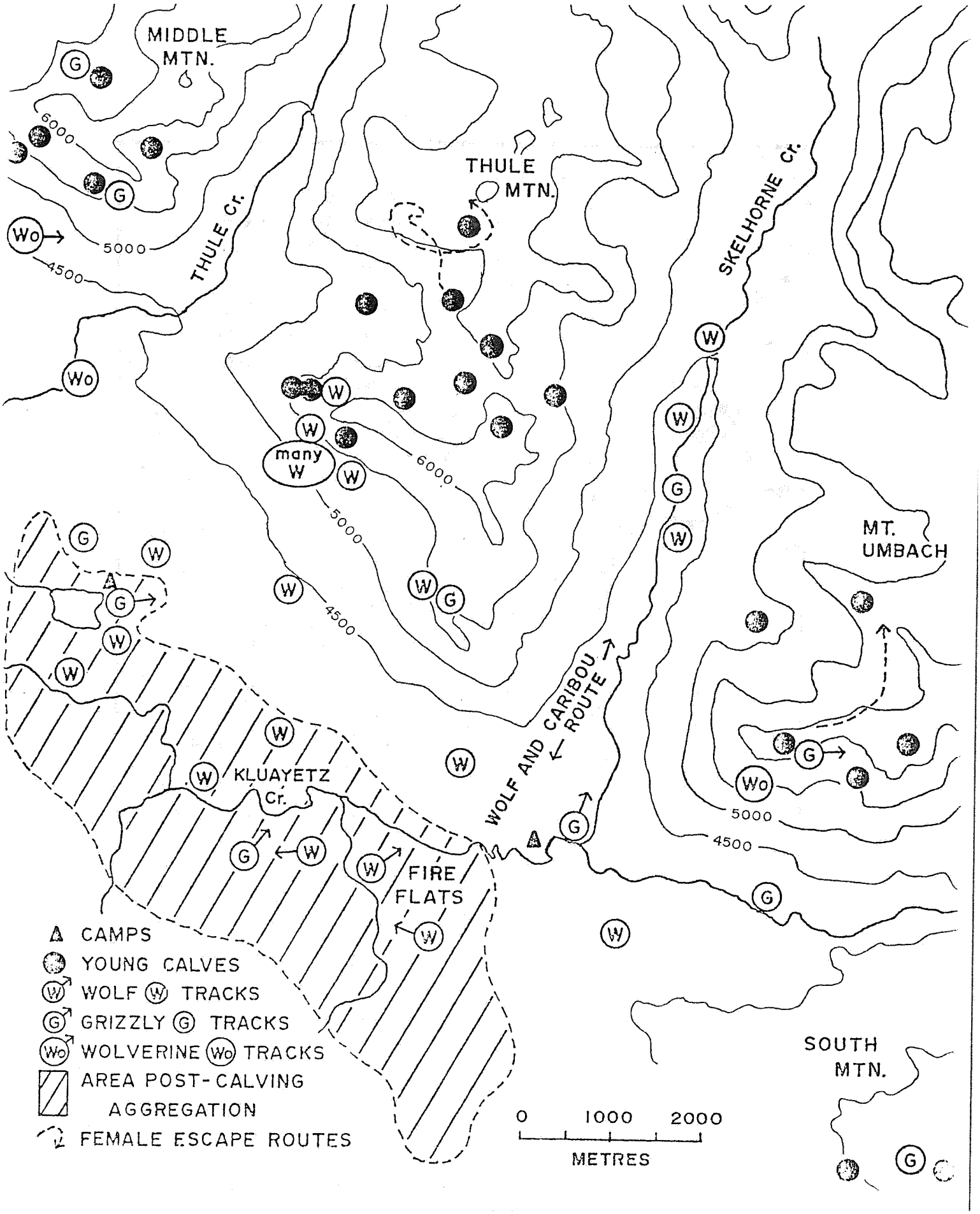


Figure 2. Diagram of antlers of females found on mountains near Fire Flats.

Figure 3. Comparisons of the locations of young calves and predators seen on Fire Flats and surrounding mountains.



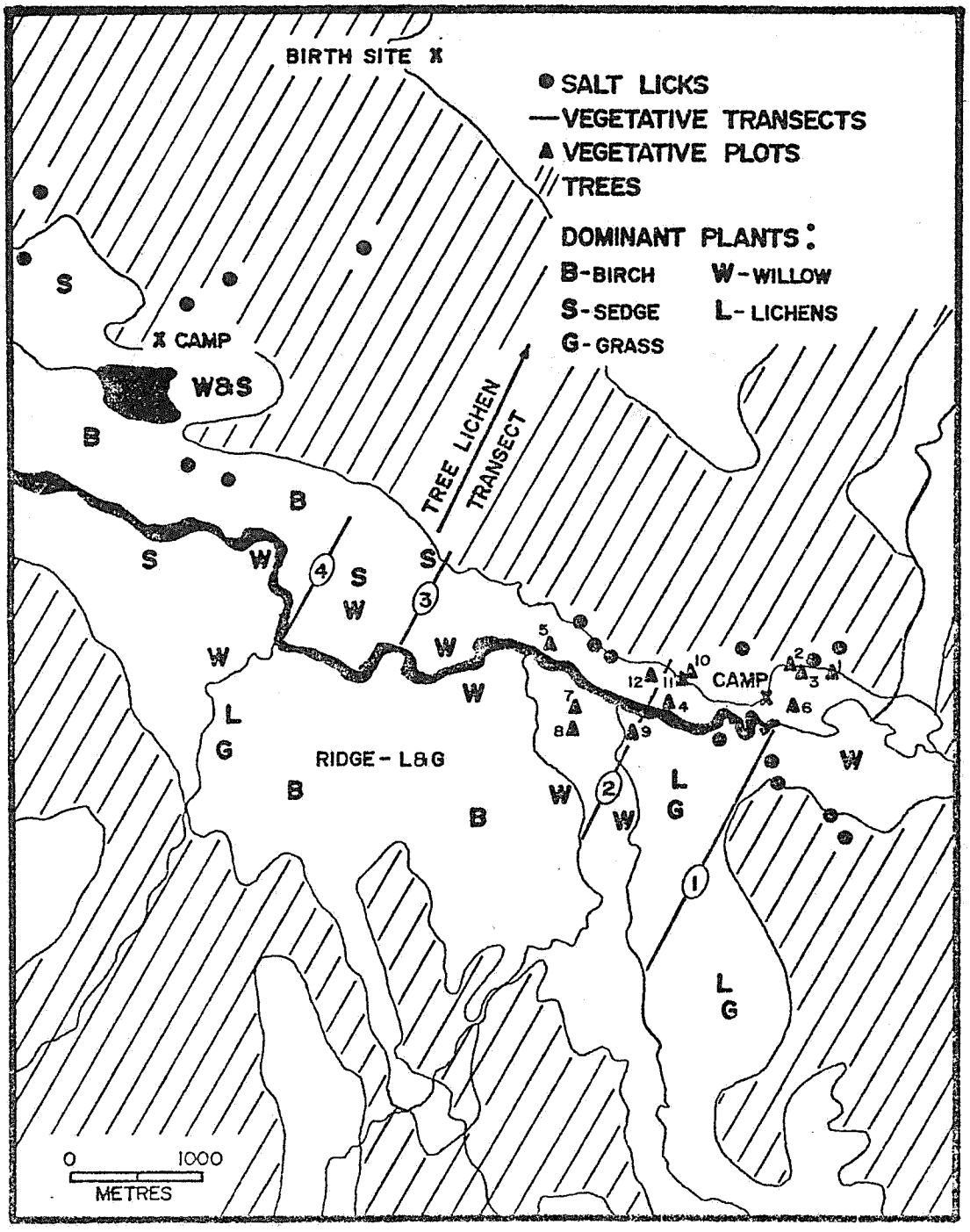


Figure 4. Location of line transects and vegetative plots at Fire Flats. Also shown are the salt licks and major

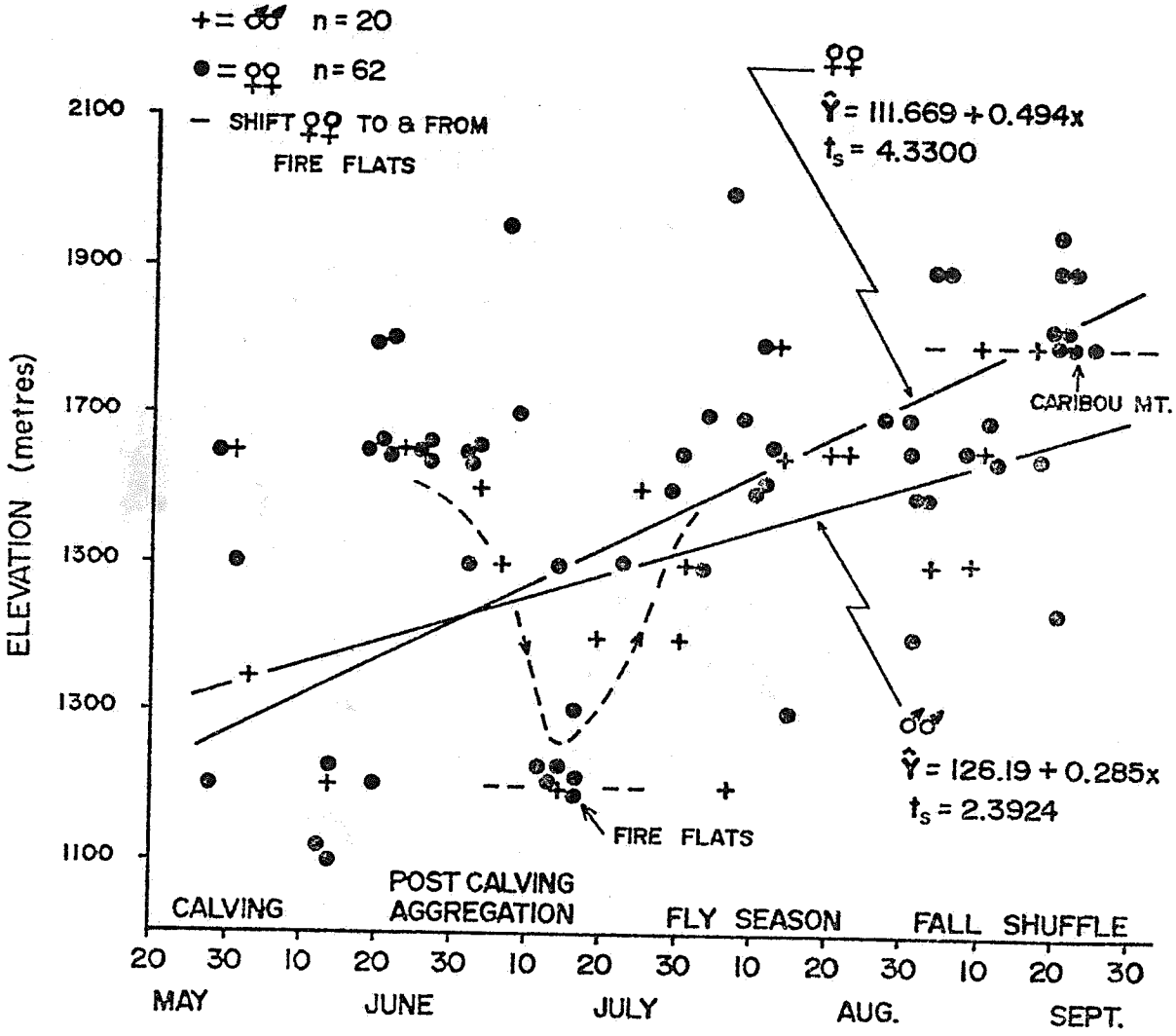


Figure 5. Regression of the elevations at which animals were sighted in 1976, against data.

Figure 6. Aerial photograph of Kluayetz Pond - the community to the east of the lake is *Carex aquatilis - Salix planifolia* - that to the south is *Betula glandulosa - Festuca altaica*.

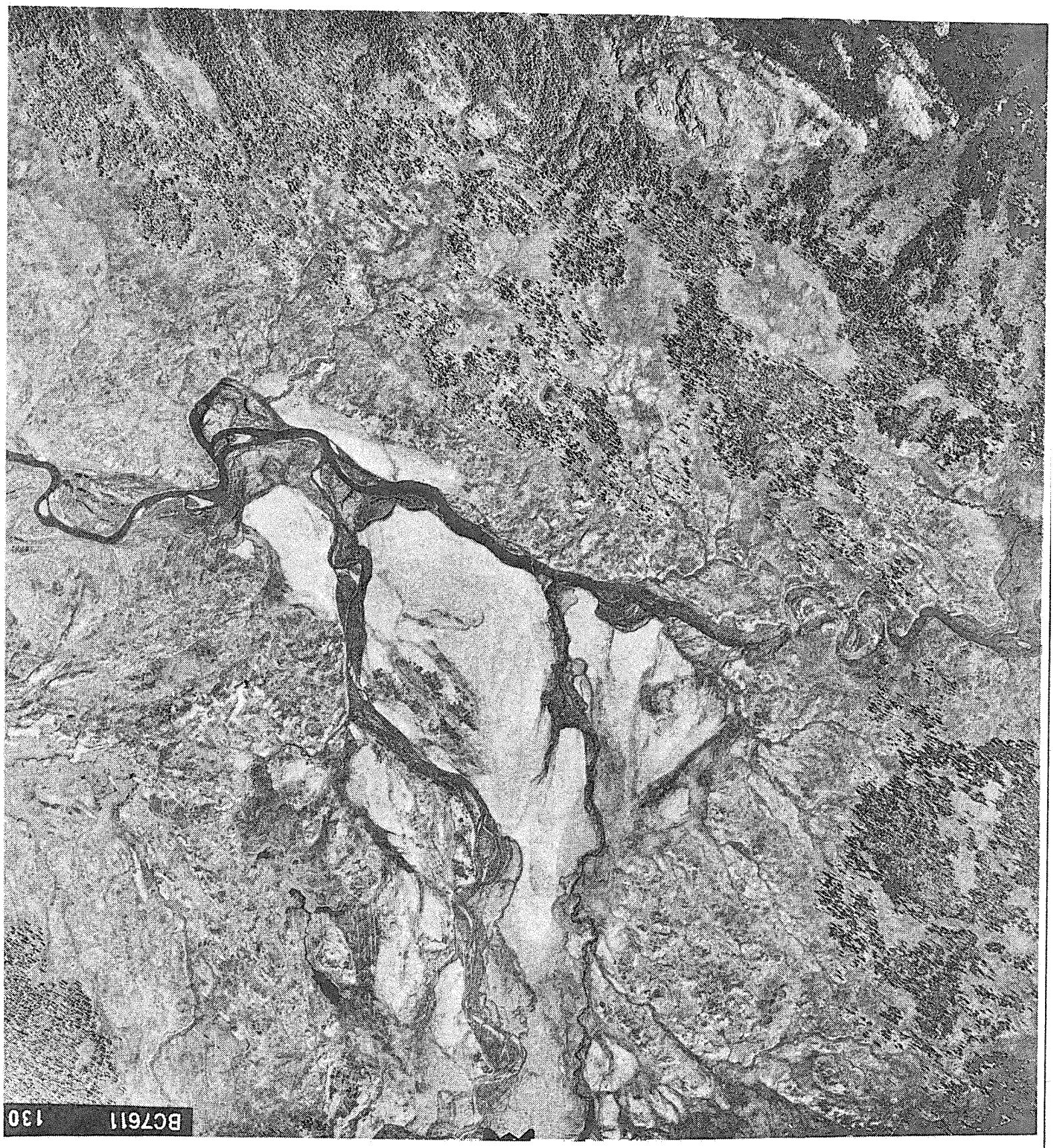


Figure 7. Aerial photograph of Fire Flats. The white appearing community is *Festuca altaica - Stereocaulon paschale*. *Salix* communities are present immediately adjacent to the streams.

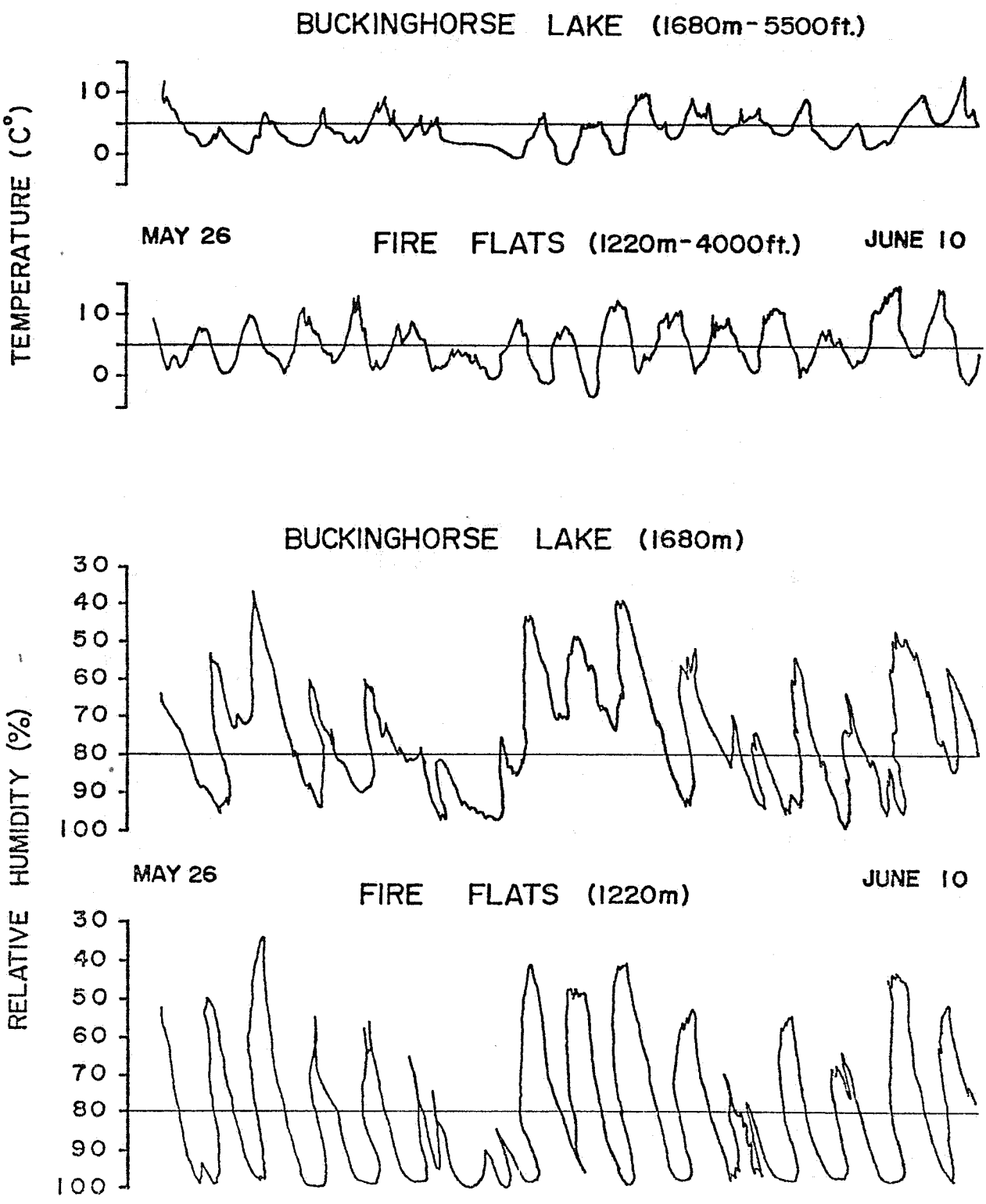


Figure 8. Hygrothermograph reading from 5500' (where calving took place) and at 4500'.

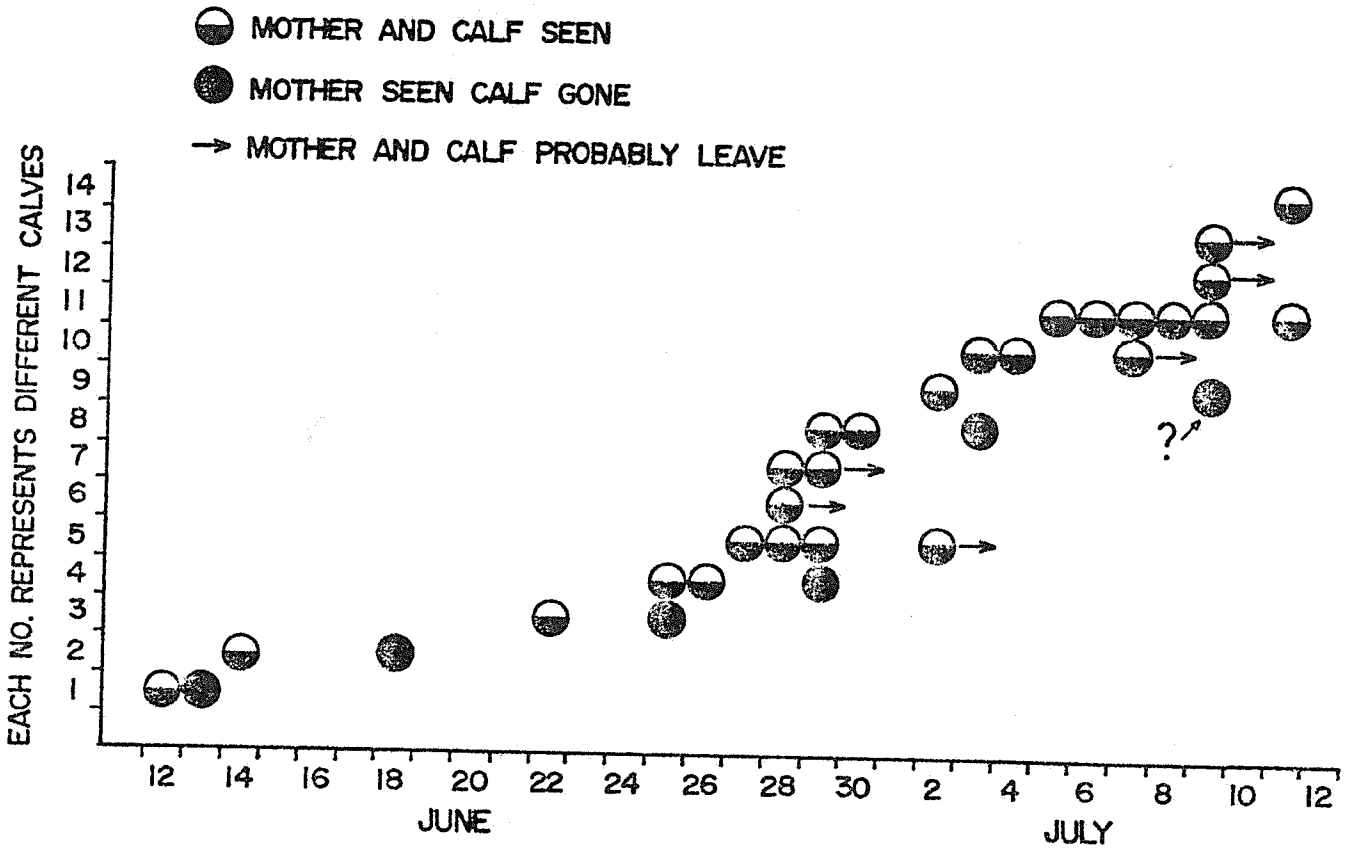


Figure 9. Consecutive sightings of calves on Fire Flats. Five dams lost their calves - other calves left the area with their mothers.

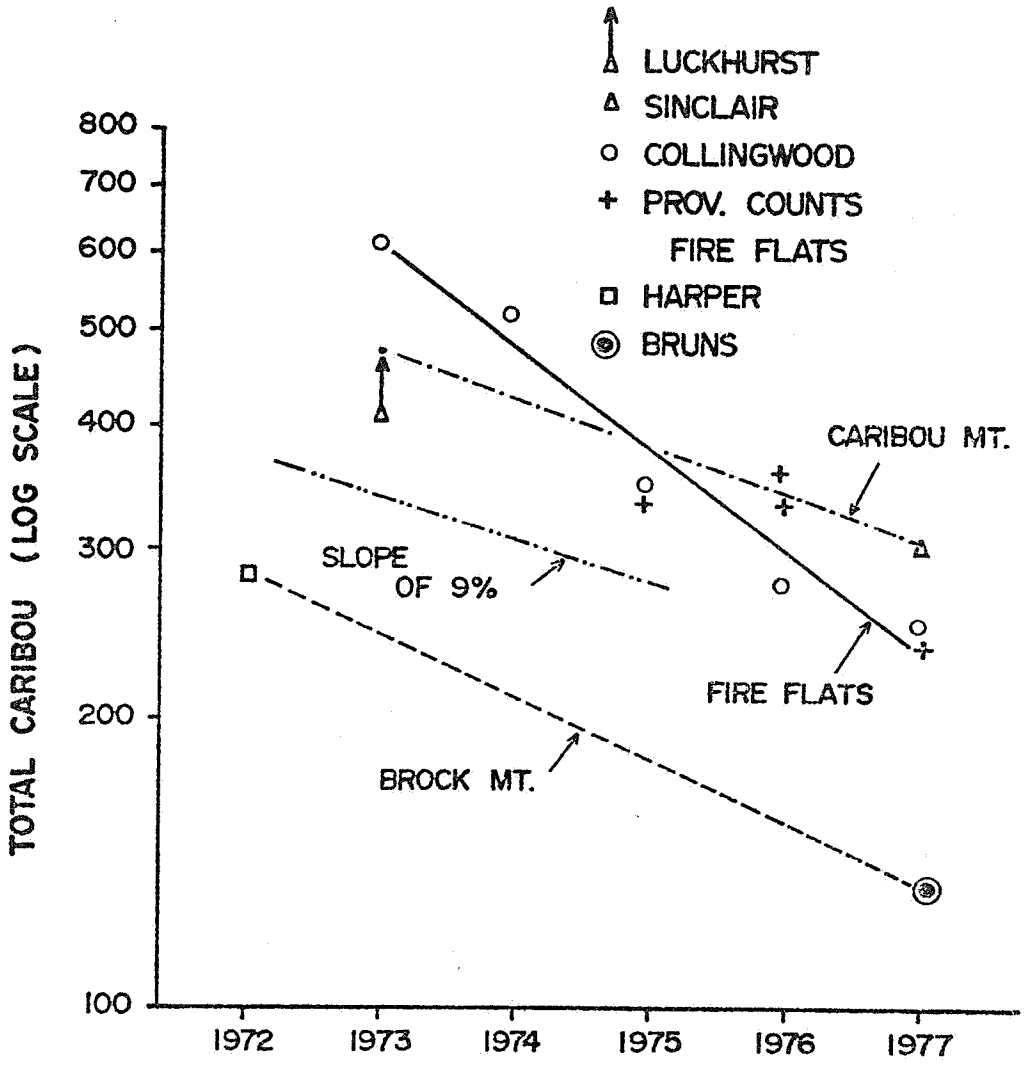


Figure 10. Population trends of caribou in Spatsizi Park.

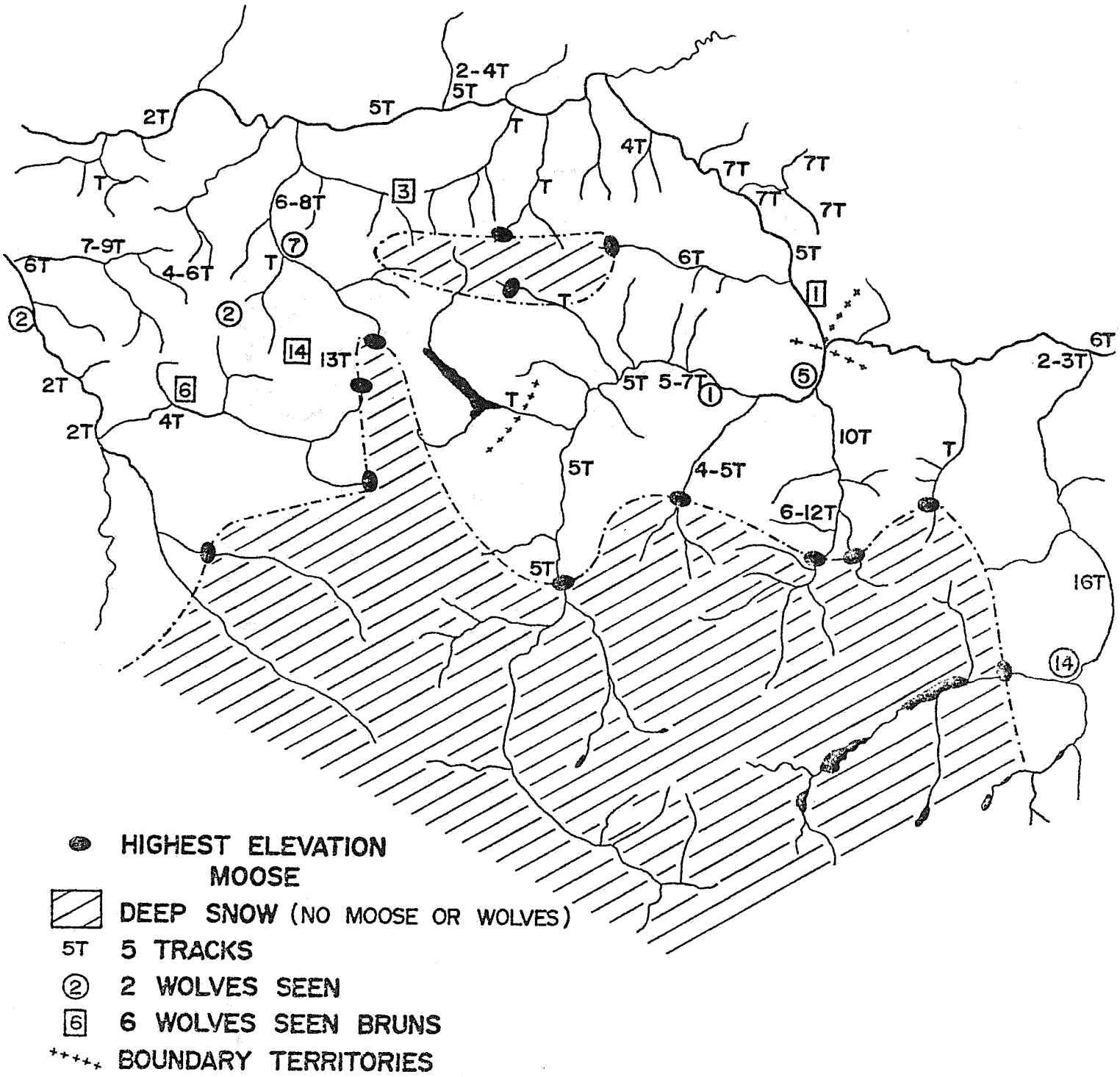


Figure 11. Sightings of wolves and wolf tracks made during the February census. Also included are observations made by R. Bruns for November to January.

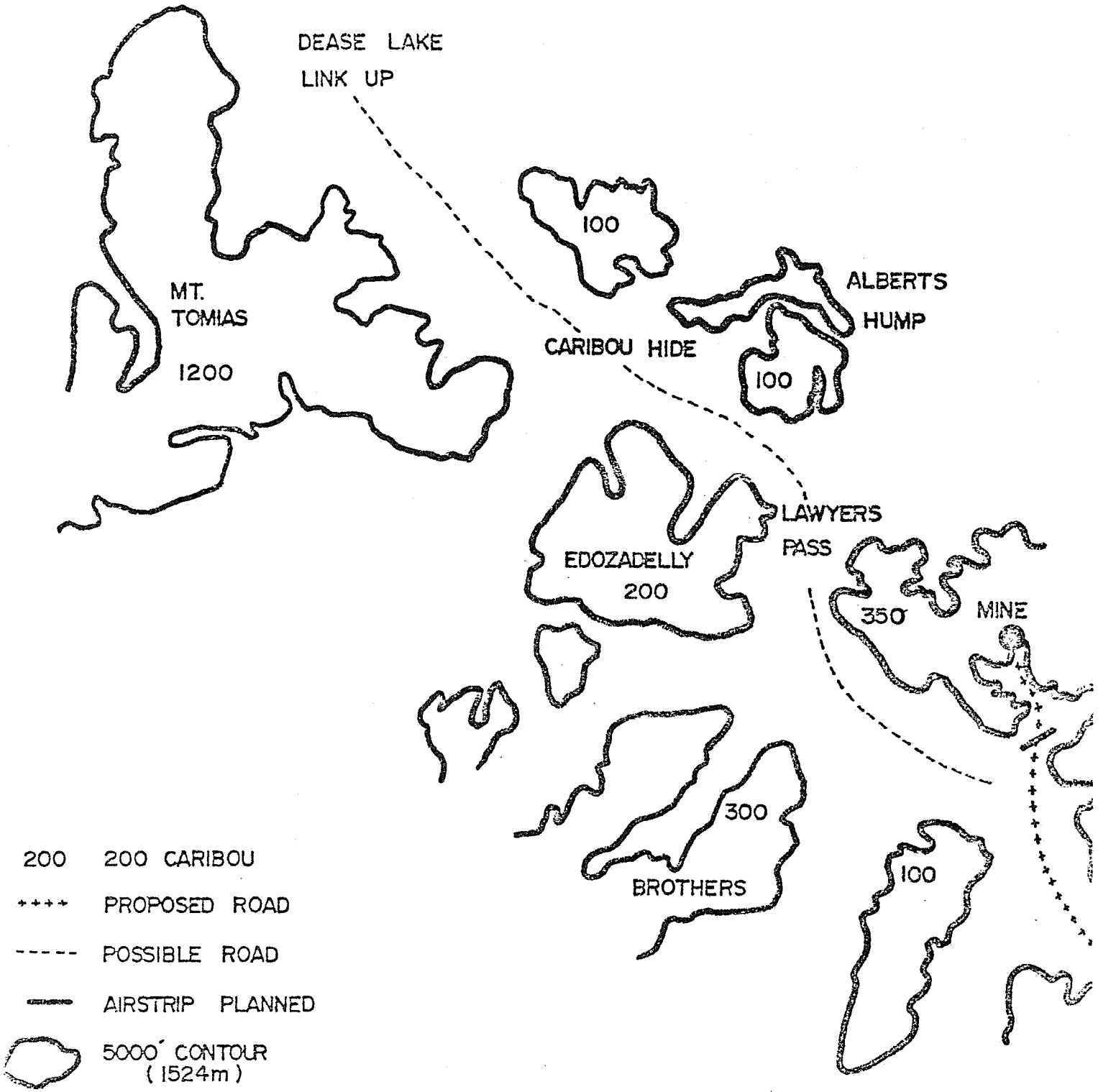


Figure 12. Route of proposed road through the Lawyers Pass area and around the Park.

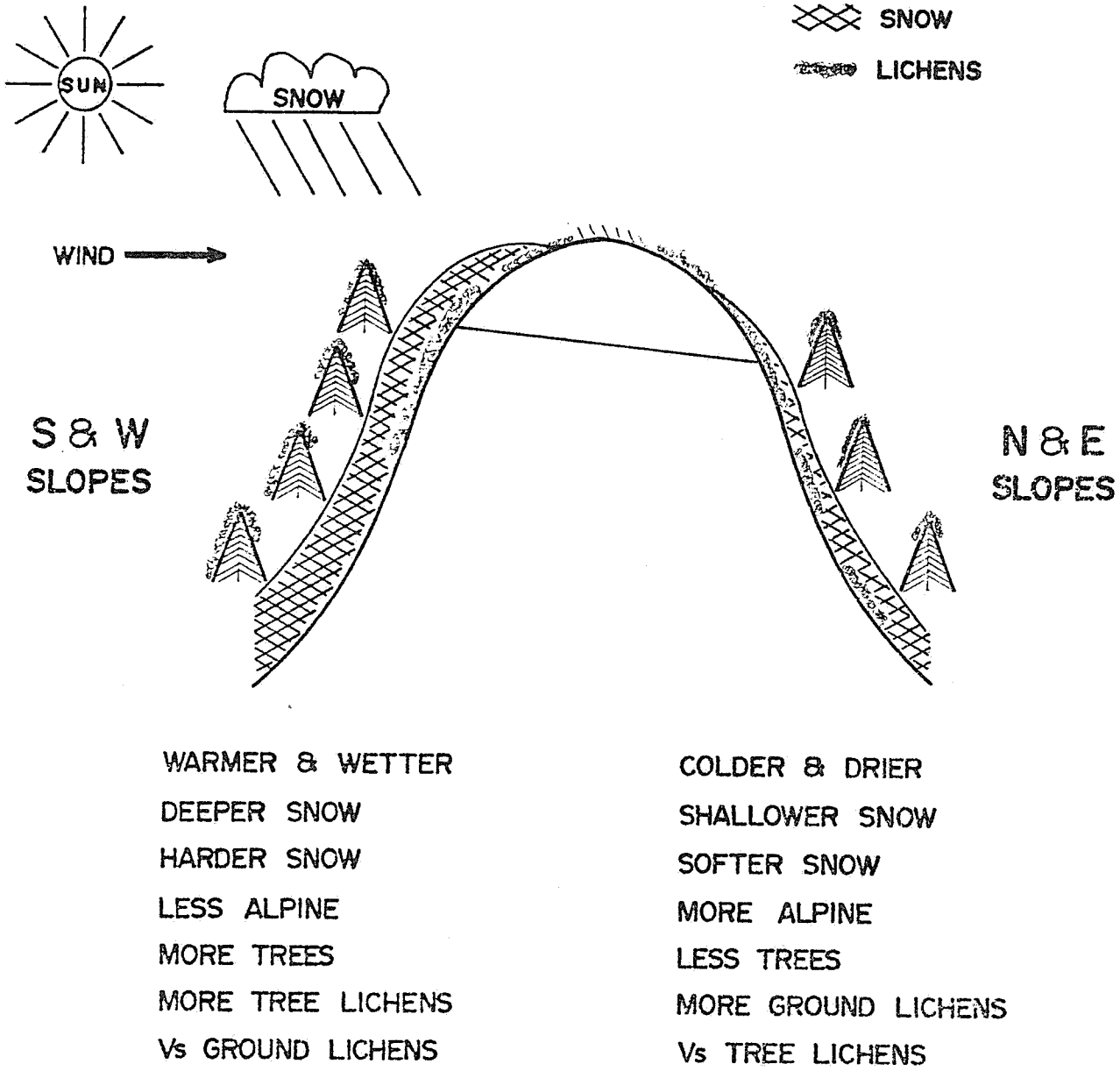


Figure 13. Comparison of north and south slopes.

APPENDIX E

BIRDLIST

Appendix E

Birdlist

Unless otherwise listed, observations are from Fire Flats.

Common Loon: Kluayetz Pond
Canada Goose: one brood, one nest - Buckinghorse Valley
Mallard - one pair
Pintail: distraction behaviour
Blue-wing teal: 1 male seen
Green-wing teal: several pairs
Lesser Scaup: on small pond in Buckinghorse Valley
Barrow's Goldeneye: one female seen
Harlequin: several pairs on river
Surf Scoter: one female in river, one female and three males, about 25 males
Common Merganser: one pair in river
Marsh Hawk: one or two pairs in valley
Red-tailed Hawk: one pair
Golden eagle: one seen from airplane
Bald eagle: one seen at Camp #2
Osprey: fishing on Kluayetz Pond
Spruce grouse: 1 female
Ruffed grouse: at Iskut
Willow ptarmigan: 15 pairs/square mile. Hatch was July 1-7, clutch size: 7,7,7,8,8,8
Rock ptarmigan: 2 pairs on Thule Mtn.
Semi-palmated plover: 3 pairs, one on river, one on flats
Spotted sandpiper: common
Lesser yellowlegs: 2 seen
Least sandpiper: nesting everywhere in *Salix*-sedge
Solitary sandpiper: nesting everywhere in *Salix*-sedge
Northern phalarope: 3 pairs on Kluayetz Pond
Common snipe: common
Herring gull: 2 pairs at Buckinghorse
Short-eared owl: 1 nest at Buckinghorse, 3 pairs on Fire Flats
Rufous Hummingbird: 2 seen
Red-shafted flicker: breeding at Buckinghorse
Black-backed three-toed woodpecker: 1 seen
Olive-sided flycatcher: 2 pairs
Horned Lark: nesting high and dry on flats

Tree swallows: seven pairs near Kluayetz Pond
Gray jay: family at Buckinghorse
Raven: common
Crow: occasional
Black-capped chickadee: seen occasionally
Boreal chickadee: seen occasionally
Dipper: 3 seen
Red-breasted nuthatch: 1 heard
Robin: common
Gray-cheeked thrush: common in forests
Ruby-crowned kinglet: common
Water pipit: several nesting in alpine
Yellow warbler: 1 seen
Myrtle warbler: pair near camp at Kluayetz
Blackpoll warbler: 3 seen
Wilson's warbler: common
Yellowthroat: 2 seen at Buckinghorse
Brewer's blackbird: several around camp
Cowbird: 1 male seen
Gray-crowned rosy finch: 1 male seen
White-winged crossbill: several flocks
Savannah sparrow: common
Slate-colored junco: occasionally seen
Tree sparrow: common
Fox sparrow: 2 seen
White-crowned sparrow: 2 seen
Golden-crowned sparrow: common
Smith's Longspur: several pairs in *Betula*
Bohemian Waxwing: flock seen near camp