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Studies of Radio-collared Caribou in the Spatsizi Wilderness Park area, British Columbia

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ABSTRACT

This report summarizes findings from one year of approximately bi-monthly contacts of a sample of radio-collared caribou in and near northern Spatsizi Wilderness Park, British Columbia. Following a heavy snowfall in December, the animals dispersed to nearby mountains, some outside of park boundaries. Most spent the bulk of the winter in wind-blown uplands, moved down to forested low-lands during spring, then gradually moved upslope and most were again at or near timberline by the end of August. Observations of the collared animals, especially females with calves, indicate that annual rut counts, designed to provide data on changes in numbers and recruitment potential, may be seriously biased.

Table of Contents

List of Figures

List of Tables

List of Appendices

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1. INTRODUCTION

The work reported here is part of a projected long term study on the ecological relationships among several species of large mammals in the Spatsizi Wilderness Park area of northern British Columbia. The long term objectives focus upon predator-prey relationships, emphasizing the wolf (Canis lupus), and have been described previously by Haber (1979), in a review of biological information available for the area through December 1978. Haber noted that one of the most pressing needs in the context of the proposed studies was "to secure better density estimates for the upper Stikine-Spatsizi wildlife populations, moose and caribou in particular, as soon as possible".

Following government funded observations of low calf ratios among several rutting herds of caribou (Rangifer tarandus) in northern British Columbia, including the Spatsizi area, that species attained a high public profile in the late 1970's. Before then, knowledge of caribou distribution and numbers throughout the province had accrued only through scattered, mostly anecdotal records from knowledgeable and interested residents and from occasional, locally intensive surveys by government wildlife personnel. In 1977, for the first time, an extensive survey was conducted, covering "most of the herds" in the northwestern quarter of the province during the rutting period and many of the remaining northern herds during the following winter. The resulting report (Bergerud 1978), is a synthesis of those counts with spring and summer observations from several important caribou areas, including Spatsizi, and a review of all accumulated caribou data, province-wide. The major conclusions were that British Columbia caribou were in a period of major decline, the provincial population having apparently decreased by 40-50% within the decade, and with the

mule deer (Odocoileus hemionus), grizzly bear (Ursus arctos), and wolverine (Gulo gulo). All except deer occur in at least representative numbers throughout the Spatsizi area (see Haber 1979). However, initial studies were directed toward caribou both because of the public focus noted above and because it was evident that, as the most mobile species, it was the one to best define eventual study area boundaries.

The Spatsizi Wilderness Park area includes three alpine plateau areas on which numbers of rutting caribou may be found each fall. They are Caribou Mountain (essentially the Spatsizi Plateau proper) in the north, Tomias Mountain to the east, and Edozadelly Mountain in the southeast corner (see Figure 1). Largely because there is little historical information for Edozadelly, Bergerud (1978) considered only the Tomias and Caribou Mountain groups in his discussion of Spatsizi caribou. He felt that the two were essentially separate throughout the year, noting that the former "probably winter along the Upper Stikine" and the latter "probably winter on the north side of (Caribou Mountain) and (in the vicinity of) Mt. Brock". He believed the Caribou Mountain herd had declined by about 40% to something on the order of 400 animals and implied that a decline of about the same magnitude was also applicable to the Tomias herd. Bergerud and Butler (1978) nevertheless pointed out that, at 1200 animals, the 1977 Tomias rutting group represented the "greatest (caribou) concentration in British Columbia".

Largely for practical reasons, the smaller "Caribou Mountain herd", as defined by distribution during the rut, was selected as the sub-population of primary interest in this study. A greater proportion of the herd could be marked, was closer to road access (Highway 37) and commercial air service centers (Iskut, Dease Lake), and was the more isolated from several known traditional rutting areas outside of the park, mostly east and south of Tomias. Also, information on range and movements of this group was considered a high priority in terms of possible

vulnerability to impending developments in the area, particularly damming of the Stikine (see Bergerud and Butler 1978).

The primary objectives of this initial field project were to:

1) Determine movements, seasonal habitat use and annual range of the rutting herd selected.
2) Provide a beginning evaluation of the assumptions and results of current inventory procedures.

Radio transmitter collars were attached to 15 adult caribou on the Caribou Mountain rutting area in fall 1980. Following pages describe research effort and results over the first full year of monitoring the activities of those animals.

2. THE STUDY ANIMAL

According to Bergerud (1978), all British Columbia caribou are referrable to the subspecies R.t. caribou (woodland caribou) and he discourages use of the subspecific designations of Cowan and Guiguet (1963), namely R.t. montanus and R.t. osborni. Bergerud's comments are based upon the definitive taxonomic statement for the species (Banfield 1961).

There are nevertheless some important differences between caribou in different areas. Bergerud (1978) distinguishes between the two British Columbia types noted above on the basis of winter food habits, the "montanus" type in the south relying primarily upon arboreal lichens and the more northern "osborni" type apparently using mostly terrestrial vegetation including lichens. The species, even where it exists in mostly forested areas, appears to require open or semi-open habitat during at least part of the year. Patterns of fire, drainage and latitudinal climatic gradients act to produce such openings in all areas, while in the mountains of western North America the added effects of elevation are present (see Edwards (1958). In short, regardless of whether or not various caribou may be taxonomically distinct, some may be ecologically distinct, living

and behaving differently in localized climates and habitats.

All of the above is germane to the subject of comparing findings in this study with published results for caribou elsewhere. The woodland type has been studied most in the relatively low elevation (mostly below 1000m), flatland boreal forests of eastern Canada, including the muskeg and barrens of Newfoundland (Bergerud 1971 and others), some 1200m "uplands" on the Gaspe Penninsula, Quebec (Bergerud 1973), muskegs of northeastern Manitoba and Northwestern Ontario (Fischer et al. 1977), the Slate Islands in Lake Superior, central Ontario (Cringan 1957, Bergerud 1978 and pers. comm.), and the extreme lowland (350m forests and bogs of southern and central Manitoba (Stardom 1975, Shoesmith and Storey 1977).

Although I am aware of no published studies of woodland caribou in Saskatchewan, the animal is present there (Cringan 1957), doubtlessly occupying the same type of boreal forest lowland habitat described for caribou studies in adjacent areas of Manitoba (Shoesmith and Storey, op cit.) and Alberta (Fuller and Keith 1981). Among studied caribou, the first mentioned here which have opportunity to inhabit ranges above 1200m is a group on the eastern slopes of the Rocky Mountains in west-central Alberta, currently being observed by Bloomfield et al.(1981). Although some of those animals have been recorded in upland areas, their seasonal habitat use is yet to be described. It will be interesting to see whether observed patterns there would suggest ecological affinities with the low elevation "woodland" types in the east, or whether they behave more like those farther west.

West of the Rockies, Edwards (1958) described caribou distribution in relation to landform in British Columbia, based particularly on his experience with the species in several locations in the southern half of the province. Studies on the Southern caribou over the years have focussed on their relationships with mature forest habitat, e.g., see Freddy and Erickson (1975) and Johnson et al.(1977) re the "International Boundary" or Selkirk

herd, and several papers on the animals inhabiting the deep-snow, Columbia forest environments of Wells Gray Park (Edwards and Ritcey 1959, 1960; Edwards et al. 1960). Findings reported in those documents form the basis for the ecotypic separation of B.C. caribou as mentioned earlier, i.e., those using arboreal lichens in winter (the southern herds) and those depending, in winter, primarily upon terrestrial vegetation, including lichens. Observations by Bloomfield (1980) indicate that animals as far north as the Prince George area at the north end of the Columbia Mountains are ecologically similar to the southern types.

The caribou of northern British Columbia have been little studied. Edwards (1958) was apparently not aware of any particular difference in habitat use between the herds with which he had experience and most northern herds. An exception, as he pointed out, was evident in existence of three "atypical" winter ranges in northeastern B.C. These were in lowland (below 650 m) boreal forest, and he speculated that the animals involved might constitute the western-most "population" of the eastern woodland subspecies.

As noted earlier, recent overview studies in northern B.C. (Bergerud 1978, Bergerud and Butler 1978) have confirmed that caribou in at least the Stikine and Arctic drainages are of the "terrestrial lichen" ecotype. Observations of caribou and habitats in the southwestern Yukon Territory (Oosenbrug and Theberge 1980) suggest that animals there inhabit environmental circumstances similar to those in the Spatsizi area, and respond to them similarly in terms of seasonal use. Descriptions of caribou distribution and movements in Alaska (Hemming 1971) suggest that some of the minor herds in the southeastern corner of that state (especially the Mentasta and Chisana groups), may be continuous with the Yukon caribou mentioned above which, in turn, appear to have a more or less continuous distribution east to the Cassiar Mountains and, therefore, with the caribou of this study. Skoog (1968) felt that all Alaskan caribou were one population, and designated them as the

"barren-ground" subspecies R.t. granti, therefore the affinities of northern British Columbia animals may be more to the north than to the south. This is not a new idea; based on examination of specimens and observed herd movements, Murie (1935) believed that might be the case. Although Banfield (1961) described just four subspecies of North American caribou, he indicated that "intergrades" may occur where the ranges of two types overlap.

It is clear that it can be difficult to know just which caribou one is studying; the key would appear to be more in the description of habitat than in morphology of the animals. In the context of the present study, comparable published reports on telemetry studies of caribou are available from some lowland forest areas, i.e., typical habitat of the "woodland" subspecies (Shoesmith and Storey 1977, in Manitoba; Fuller and Keith (1981) and Bloomfield et al. (1981) in Alberta. I am aware of none for upland habitat similar to that in the Spatsizi area.

3. THE STUDY AREA

3.1 General Description (Boundaries)

The original intent was to let the movements of the caribou define the boundaries of the study area. Based on what we "knew" about the animals already, the minimal predicted boundaries were the Klappan River on the west, the Stikine River on the north and east, and the Spatsizi River to the south. After one year of study, the actual (still provisional) study area is essentially the total area portrayed in Figure 1. The study began and has centered on the relatively flat, rolling alplands of the Spatsizi Plateau near the park's northern border. However, over the ensuing months, activities radiated out from there, with the caribou, west into the Eaglenest Range in the northern Skeena Mountains, north to the southern Cassiar Mountains, and south at least to plateau country near the headwaters of the Stikine River. The drainage of the Stikine, itself, appeared to be the only common thread to the recorded meanderings of the marked animals.

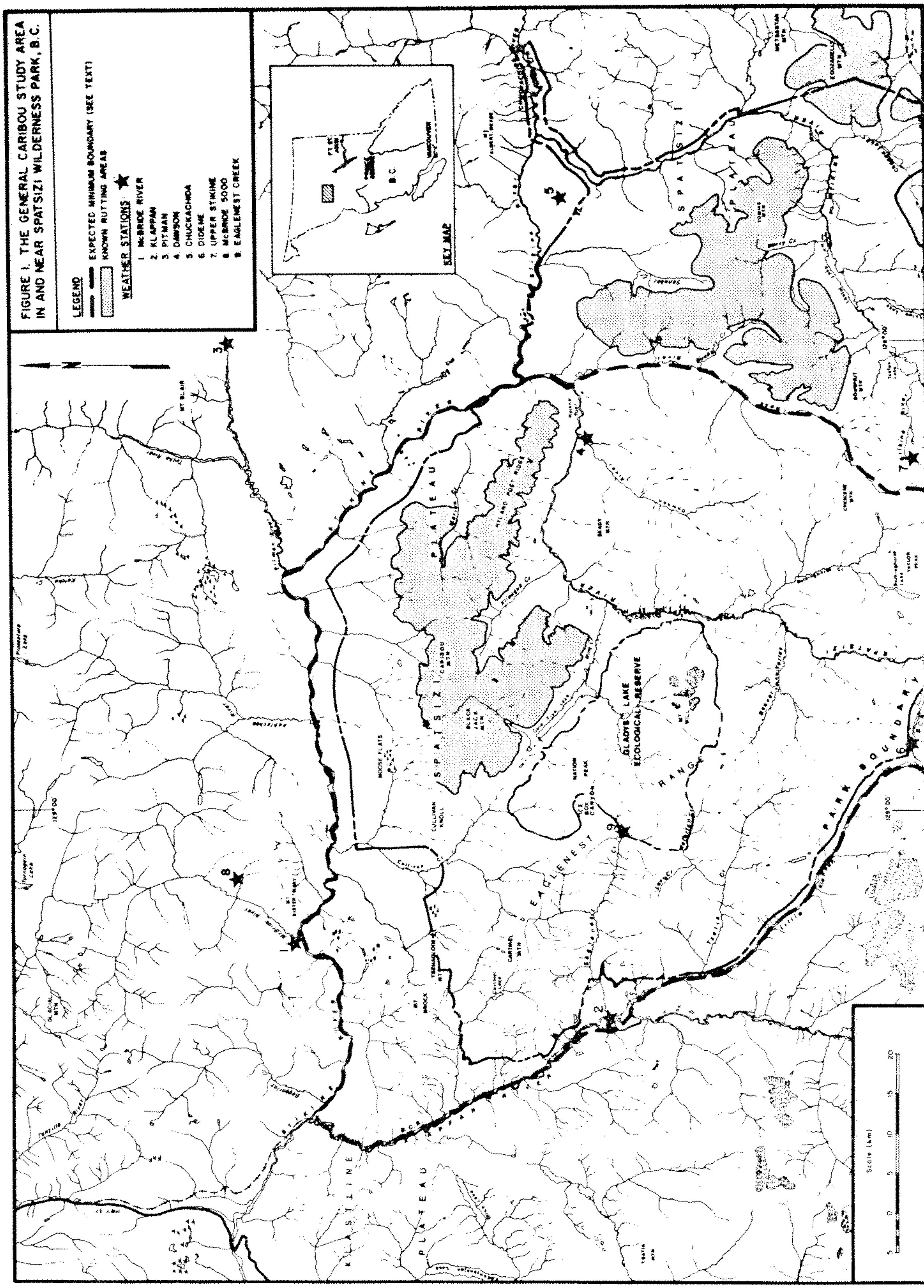


FIGURE I. THE GENERAL CARIBOU STUDY AREA IN AND NEAR SPATSIZI WILDERNESS PARK, B.C.

Although I believe we accurately recorded the extreme movements to the west, north and east, the actual southern boundary is not known; one animal was out of contact for several months and the southern boundary of the map in Figure I encloses only the area where she reappeared.

3.2 Physiography

As described by Holland (1964), the Spatsizi Plateau is an area of "wide, drift-filled valleys and open, gently rolling upland surfaces". One of seven distinct sub-units of the Stikine Plateau, it is "almost entirely underlain by sandstone, shale, conglomerate and minor coal of Upper Cretaceous and Paleocene Age". Apparently the desert-like mesas and rimrock tablelands in this area represent the remnants of pre-pleistocene surface erosion, accomplished mostly by local rivers which had been powered by gradient increases during a major uplift in Pliocene times.

Both the Eaglenest Range, which "passes by transition" into the Spatsizi Plateau at its northern end, and the Stikine Ranges of the southern Cassiars were subject to the same late tertiary canyon-cutting described for the plateau. The entire study area was then covered by 2000 m or more of ice during the Pleistocene, which continued the erosion history. The present topographical differences between these two mountain ranges and the plateau is apparently due primarily to their differences in geological composition. Like the plateau lands, the Eaglenest Range is underlain primarily by sedimentary material, but in this case the principal rocks are argillite, shale and dark greywacke. The last of these is fairly erosion-resistant and it therefore remains to form many of the rugged peaks and ridges in these mountains. The Stikine Ranges, on the other hand, have a core of granitic rocks (the Cassiar batholith). Of Jurassic or Cretaceious age, these rocks intrude folded sedimentary and volcanic rocks of more ancient origin. In both of the ranges just described, the primary visual evidence of pleistocene glaciation is the late stage (cirque glacier)

scalloping of peaks and ridges.

The major valleys through both the plateau country and the neighboring ranges are similar in character (wide) and elevation (1050-1250 m), although the overall relief is considerably less on the plateau. Most of the plateau surfaces in the area lie between about 1525 and 1675 m, and enclose few elevational prominences above 2100 m. In the Eaglenest Range many peaks rise above that level, up to a maximum of 2360 m on Nation Peak, which is within the study area. The Stikine Ranges include many higher, rugged peaks, some exceeding 2700 m, but those within the study area are mostly below 2000 m. They are more gentle in profile, and are therefore more similar to the plateau lands south of the river.

3.3 Climate

The study area lies within the "northern and central plateaus and mountains" physiographic region of Holland (1964). The climate of this broad area is categorized by Schaefer (1978) as having "long, cold winters and short, cool summers with moderate precipitation which is well distributed throughout the year". In support of this description, he notes that "mean annual temperatures below $0^{o}C$ in the northern valleys with even lower values on the slopes indicates the severity of the climate". Precipitation averages about 400-500 mm annually in the valleys, and up to 900 mm in the mountains, with more than half in the form of snow.

The only permanent weather station near the study area is at Dease lake, a lowland site about 100 km to the northwest. Data from this station span more than 25 years, thus the "normals" calculated from these data are fairly instructive. In June 1979, a series of smaller weather stations with recording equipment were established in the Stikine drainage to provide data for feasibility studies relating to dam proposals downstream. Several of these are within study area boundaries (Figure 1).

Table 1 provides a comparison of weather features during the study year (October 1979 through September 1980) with the 25-year normal at Dease Lake. Although the year was generally above

Table 1. 1980-81 weather[a] in comparison to the 25 year "normal", Dease Lake[b], British Columbia

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Mean Daily Temp (°C)													
Normal	1	-8	-15	-19	-13	-7	0	6	11	13	11	7	-1.2
1980-81	3	-4	-22	- 8	-10	-2	-2	8	15	20	20	13	2.7
Number Days with Frost													
Normal	25	29	31	31	28	31	29	20	5	1	3	11	244
1980-81	22	30	31	31	28	31	30	14	3	0	1	12	233
Mean Total Ppt. (mm)													
Normal	34	32	30	28	26	21	12	21	38	54	54	44	394.4
1980-81	30	13	90	8	26	17	35	60	68	34	53	40	472.4
Mean Snowfall (cm)													
Normal	19	34	33	30	29	23	12	5	1	1	T	1	186.9
1980-81	10	13	109	11	36	17	37	0	T	0	0	T	233.4
No. Days with Meas. Ppt.													
Normal	12	13	13	13	12	9	8	9	12	13	14	15	143
1980-81	18	11	16	11	9	10	14	11	20	10	13	18	161

[a]All monthly data rounded to nearest whole figures (°C, cm, mm). These data are from Environment Canada (Atmospheric Environment Service) series "Canadian Normals", provided from files of Air Services Branch, B.C. Ministry of Environment, Smithers Office.

[b]Dease Lake, the closest permanent weather station, is approximately 100 km northwest of the study area center, and is considerably lower in elevation than most valley bottoms within the study area.

average in mean temperature, it was also considerably wetter than usual. The differences were most pronounced in December (snowfall 3x normal) and April through June (precipitation 2-3x normal, with most of that in April coming as snow).

From the standpoint of caribou biology, one of the most important weather considerations is the amount and quality of snow actually on the ground in a particular place (see Edwards 1956, Pruitt 1959, Henshaw 1968, Stardom 1975). The "snowpack" (snow depth) factor may be altered by many environmental variables, including wind, exposure to insolation, and ambient temperature. Most weather stations are selected at least partly with a view toward minimizing these effects, and the sites from which we have data are not exceptional. In other words, snow depth data used in this report represent the potential amount that animals could have been contending with at the times and places indicated. Because a caribou's site selection criteria are probably nearly opposite to those used by climatologists, the animals were likely contending with less in most instances.

Figure 2 provides a comparison of snowpack data for the study area at Dease Lake and means for two altitudinal categories of the B.C.Hydro (B.C.H.) weather stations. Except for the larger value for April at the valley bottom B.C.H. sites, the snow depth pattern for these followed that at Dease Lake fairly closely, while the higher elevation B.C.H. sites showed a pattern of higher snow accumulation, over a longer period. The latter pattern would be expected and was documented for a previous year (Wyborn 1980) for upland sites closer to Dease Lake.

The preceeding observations provide some justification for using Dease Lake data, particularly that relating to precipitation, in discussion of weather effects within the present study area. However, local variations do occur and these show up clearly in Appendix 1, a comparison of snowpack data over two years, including the study year, at Dease Lake and nine B.C.H. sites. The locations of these nine sites are illustrated in Figure 1, and their characteristics are summarized in Appendix 2. The lower Spatsizi Valley,

particularly in the vicinity of Hyland Post, is commonly regarded as a local "oasis", with less precipitation and generally more sunshine than surrounding areas. The snowpack data for the single station in that area, Dawson River, tend to support the contention, with values generally below those of lower sites, including Dease Lake. Eaglenest Creek, the highest B.C.H. station accumulated less snowfall in the two years for which there are data than did the somewhat lower sites of "upper Stikine" (Skelhorne Creek) and "Didene" (Fire Flats). These provide hard evidence for the formerly subjective observation that snow accumulation, and probably snowfall is greater as one proceeds south in the Skeena Mountains in this area. Ungulate distribution, especially in winter, generally reflects that fact.

Local temperature variations, and their significance, can not be discussed in any detail here since the B.C.H. data have yet to be analyzed. One important temperature effect to consider, however, is the freeze-thaw regime of lakes and rivers in the study area. As pointed out by Osmond-Jones et al. (1977), lakes in the area remain frozen well into the spring, and 10 June is given as an estimated thaw date for Coldfish Lake. During the study year, Coldfish Lake and both the Spatsizi and Stikine Rivers were still open on 28 November but cold, windless weather then set in (several days of $-40^{\circ}C$, or colder) and by 6 December the lake was frozen and the rivers had extensive ice shelves along the shore. Both rivers, but especially the Spatsizi, showed reduced amounts of open water in following weeks and both were essentially ice-bound by 2 January, although a few open leads remained in the Stikine between the McBride and Kehlochoa Rivers throughout the winter.

Some time between 3 and 20 May, both rivers had opened up, and were flowing high and free on the latter date. Most lakes in the area, however, were still frozen on 30 May. Coldfish Lake on that date had some open water around the edges, and was beginning to look "rotten", but tracks indicated that moose had recently been walking on it. By 8 June it was completely open.

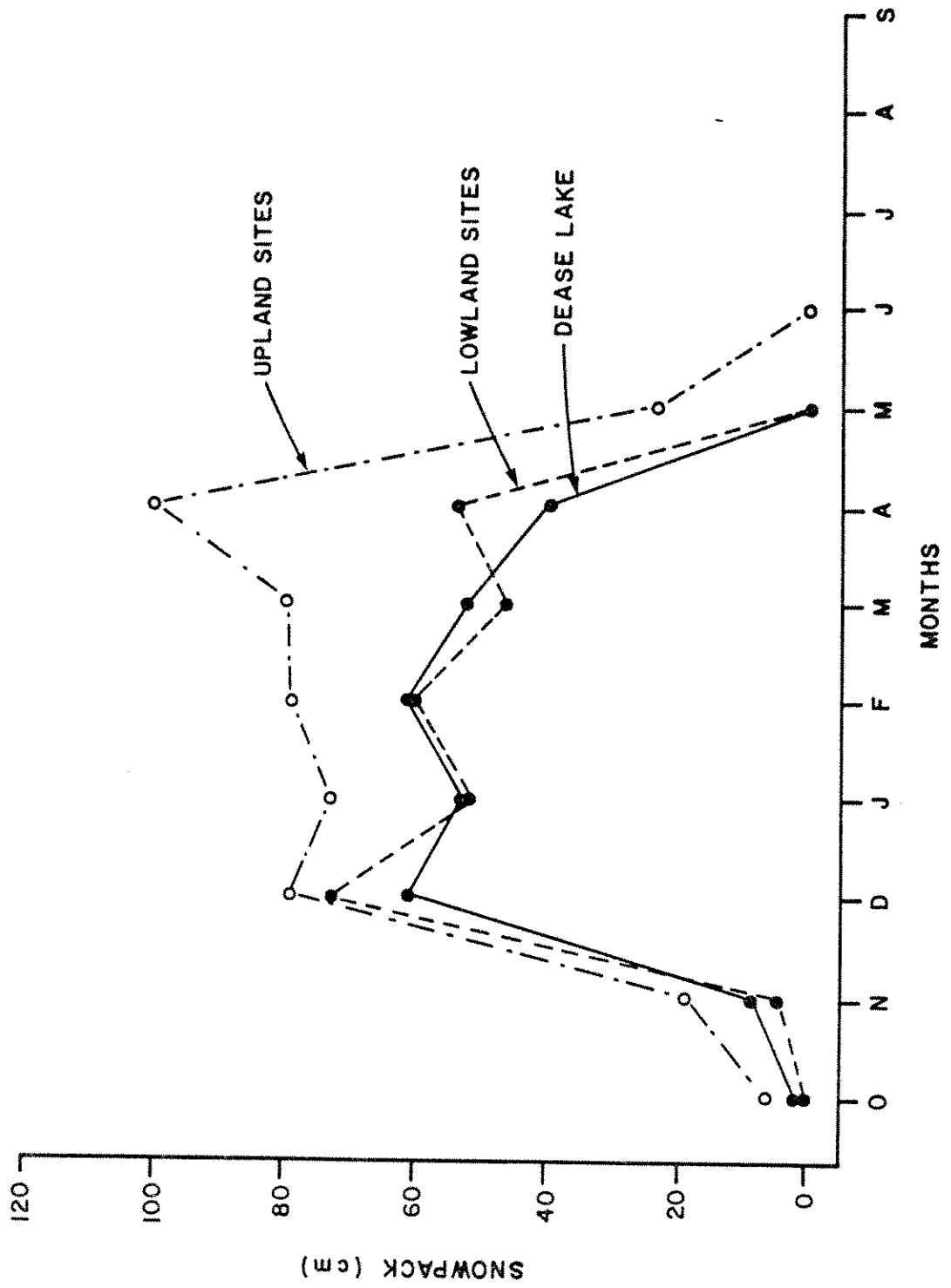

UPLAND SITES
LOWLAND SITES
DEASE LAKE
SNOWPACK (cm)
120
100
80
60
40
20
0
O
N
D
J
F
M
A
M
J
J
A
S
MONTHS

Figure 2. Monthly snowdepths, October 1980 through September 1981, at Dease Lake and at representative sites in a caribou study area, Spatsizi Wilderness Park and vicinity, British Columbia. The figures for upland sites are means for Eaglenest Creek and McBride 5000 (mean elevation = 1512 m) the two upland stations nearest wintering caribou, while those for lowland sites are means for five stations (McBride, Klappan, Pitman, Dawson, Chukachida, mean elevation = 945 m). See Figure 1 and Appendices 1,2 for locations and characteristics of these stations.

3.4 Soils and Vegetation

As explained by Young and Alley (1978), the harsh climate of the northern and central plateaus and mountains region results in frost action being one of the more important factors among the geomorphic processes of soil formation in the area. Among the frost-related processes they list are frost shattering, cryoturbation, solifluction, nivation, permafrost development and avalanches which, they say, have "produced large masses of colluvium which mantle the plateaus and mountain slopes, and an environment in which the materials are constantly in motion either down slope or churning". Characterizing the dominant soil landscapes in the area as "pedogenically youthful", these authors described factors which produce the different soil groups present, and these include local geological (base composition) and climatic variations as well as various glacial effects.

Several soil landscapes are described, including gray luvisol and two kinds of brunisol types in the wide valley bottoms dominated by spruce, the humo-ferric podzol type of most steep slopes in the boreal black and white spruce biogeoclimatic zone and in certain subalpine situations, and cryosols on higher, colder (alpine) sites. These all vary and intermingle in complex patterns determined by the interplay of the different parent materials with the variables of slope, exposure, microclimate, and in some cases biotic factors to support an equally variable vegetative cover.

The most intensive botanical survey in the area is that of Pojar (1977), within the present study area in the (then) 32,800 ha Gladys Lake Ecological Reserve (see Figure 1). While the reserve lies exclusively within the Eaglenest Range, many of the plant associations described, including most if not all of the major ones, also occur in the Spatsizi Plateau and Stikine Ranges portions of the study area.

Vegetation in the study area is assignable to three of the Biogeoclimatic Zones of Krajina (1969). The Boreal White and Black Spruce (BWBS) Zone occurs primarily along the valleys of the lower Spatsizi and Stikine Rivers, manifesting itself as fairly continuous

spruce-dominated forest in the area (Pojar, pers. comm.). Most of the remaining valleys and lower mountain slopes, up to about 1700 m, are in the subalpine or Spruce-Willow-Birch (SWB) Zone, while the unforested uplands are in Krajina's Alpine Tundra (ATy) Zone.

Pojar (1977) identified eight forest, seven shrub and six herb community types within the SWB Zone at Gladys Lake, including "open Picea glauca (white spruce) and Abies lasiocarpa (subalpine fir) forest...dense thickets of medium to tall shrubs, mainly Betula glandulosa (dwarf birch) and Salix spp. (willow)"...and frequent aspen stands, grasslands and various wetlands. Many of these associations occur in climax situations. However, several, post-fire forests of lodgepole pine (Pinus contorta), aspen (Populus tremuloides) and balsam poplar (Populus balsamifera) also occur commonly.

The Alpine Zone at Gladys Lake includes at least two shrub and 12 basically herb (alpine tundra) community types, including some grassland and mixed lichen/grassland types of considerable importance to grazing ungulates including the caribou.

In his summary, Pojar (op. cit.) affirmed that the Spatsizi area has "high vegetation diversity" with the 35 community types mentioned earlier existing in a complex mosaic, due in the subalpine zone to factors such as "variable topography, soils, microclimate and frequency of disturbance by fire and geomorphological processes (mainly fluvial)", and in the alpine zone to factors such as "avalanches, solifluction, gelifaction (and)...patterns of snow accumulation".

4. STUDY METHODS

4.1 Capture and Handling

Eighteen caribou were captured and handled over the period 21-28 October 1980. A Bell Jet Ranger helicopter was used to locate the animals, to distribute the capture crew to suitable "ambush" sites, and then to gently herd animals into range so

they could be immobilized with drug-bearing darts. Although we "developed" this herding technique independently, on site, it appears that it has been used at least twice before, in Alberta and Quebec (Haigh 1979).

The immobilizing drug used was M-99 (etorphine hydrochloride) mixed with a tranquilizer (Rompun). We experienced a single mortality during the capture work, a male calf which was hit accidentally by a shot intended for its mother. The dart wound rather than the drug was the cause of death. One other animal, an adult female, apparently injured a leg when it slipped on the ice of a small alpine pond where the drug took effect.

All animals were thoroughly examined, vital processes were monitored for reaction to the drug, wounds were cleansed and antibiotics were administered. For all but two of the adult animals, a complete set of body measurements were obtained. We intended to weigh all of the animals by suspension from the helicopter in a cargo net, but this procedure was judged to be too traumatic for the animals and we terminated it after the third weighing. Of the sixteen adult animals handled, eight were sufficiently anesthetized to enable extraction of a tooth (I_1) for age determination purposes, and the ages of six others were estimated from a combination of body size, tooth wear and antler characteristics.

In all, seventeen animals were released alive. This included two young adult males, two mature adult males, one female calf, and twelve adult females, including the injured one. The calf and one adult female were marked with ear flags and a bright vinyl collar, respectively; the remaining fifteen were fitted with radio-transmitter collars at individual frequencies in the 148 MHz range (from Telonics, Telemetry-Electronic Consultants, Mesa, Arizona, see Appendix 5).

Table 2 summarizes capture success in terms of flying time, capture attempts and darts fired during the eight days of operation. These data translate to an average cost, exclusive of crew salaries and radio collar purchase, of about $840 per captured animal.

Appendix 3 describes visual and frequency characteristics of the marking devices attached to the 17 animals which were released alive. Appendix 4 provides technical data on drug dosages and effects for the animals captured. Finally, because the capture and handling activities were unusually successful and smooth-running, a more detailed narrative of this phase of the project is given in Appendix 5, as an aid to those contemplating similar work.

4.2 Aerial Radio-Tracking

Between November 1980 and October 1981 a total of 22 flights were conducted over the study area for the purpose of locating the radio-collared animals. One of these flights (29 January) was by helicopter, chartered for another purpose, and it was the least extensive of all surveys in terms of search effort. The other surveys were in a Cessna 180, chartered from Telegraph Creek Expediting Ltd. (7 flights) and a Cessna 185 from Alkan Air (14 flights). Tracking flights were generally 4-6 hours in duration, depending largely upon point of origin. Actual on-site tracking usually consumed 3-4 hours.

Tracking equipment (all from Telonics) consisted of a TS-1/TR-2 programmable scanning type receiver, used in the fixed-wing aircraft with a pair of RA-2AK, two-element Yagi antennae, one on each wing strut. Antennae leads were joined in a Tac-2 RLB control unit, enabling the user to switch back and forth from left to right, or to use both antennae simultaneously. Application on the helicopter involved strapping a single antenna to the main communication mast at the front. Generally the dual (fixed-wing) arrangement was more sensitive (signals received over distances up to 65 km in line-of-sight situations) and directional than the helicopter application, although once a rough location had been determined, visual contact was more easily obtained from the helicopter.

Topographical obstructions may completely damp out a signal over a very short distance, thus the process of scanning for

Table 2. Capture success data, Spatsizi Caribou Project, October 1980.

Date	Capture Attempts	Darts Fired	Animals Captured	Darts Recovered	Flying Time[a] (Hours)
21 Oct	4	5	1	3	3.0
22 Oct	9	4	2[b]	2	3.9
23 Oct	5	12	4	6	3.9
24 Oct	4	6	3	5	4.3
25 Oct	2	2	2	2	1.6
26 Oct	3	4	2	2	2.5
27 Oct	4	6	2	3	3.7
28 Oct	2	2	2	2	2.0
Totals:	33	41	18[b]	27	24.9

Capture Attempts/successful capture[c] = 1.9

Darts fired/successful capture = 2.4

Flying time (hours)/successful capture = 1.5 (not including logistica time;
1.8 overall

[a]Flying time, on site, used specifically to find and capture caribou. An additional 5.4 hours were consumed by ferry time and other logistical aspects of the work (total = 30.3 hours).

[b]One animal, a male calf, was hit accidentally and died from the dart wound.

[c]Denominator is 17, the number of animals captured and released alive

signals was best done from very high altitude, up to 3800 m over very rugged terrain. On the other hand, tracking individual signals often requires flying low, taking advantage of the shielding effect of knolls, ridges and sometimes the body of the aircraft to learn where the signal is coming from. In the mountainous terrain of the study area, signals often "bounce" and interpretation can be difficult. Techniques for sorting out such signals were developed largely by "feel" and experience, neither of which can be adequately transmitted on paper.

Once a signal was received, an animal was "tracked" until seen, or until we were satisfied that additional passes were not likely to yield a sighting (e.g., in heavy timber). Occasionally we had to terminate a particular search without obtaining a satisfactory location point for the animal; in such cases we simply recorded the fact of contact in a general location. For most contacts, however, it was possible to designate a location with reasonable accuracy even if no animals were seen. The exact tolerances in such cases probably vary with the terrain, but judging from locations of dead animals or lost collars relative to locations plotted on previous flights, we were usually within about 1 km. In many cases, plotting on the 1:250,000 scale flight maps was probably less accurate than the actual radio-location on the ground.

Data gathered for each satisfactory contact location included broad habitat type (alpine, subalpine shrub, conifer or deciduous forest, or "other"), estimated elevation (nearest 25 m), aspect and when animals were seen, snow depth and group size. Although flying conditions occasionally allowed determination of group composition, this was usually not possible in the fixed-wing aircraft except for very small groups.

4.3 Other Activities

Most information other than that obtained directly in the tracking work described above was by incidental observation during the tracking flight or by reports from other observers. The exception was the annual inventory of caribou in the Spatsizi

Park area, conducted under the auspices of the British Columbia Parks Branch both for park management purposes and as a contribution to the present study. Following the example and advice of Bergerud (1978; pers. comm.), management agencies in British Columbia have recently been seeking comparable data on numbers and composition of northern caribou herds through counts of fall concentrations of the animals on the traditional upland rutting areas. The 1981 count was carried out in a series of flights between 9 and 11 October, focussing on two such rutting areas, Caribou Mountain to the north (the source area for the caribou instrumented in this study) and Edozadelly Mountain to the south.

Areas above timberline were searched intensively from east to west on Caribou Mountain and from west to east on Edozadelly, usually in a zig-zag pattern up and down slope. The distance between and extent of these cross-contour lines depended upon topography (as it affected the likelihood of missing animals) and upon the presence of caribou tracks in the 10 cm or more of snow cover which existed over most of the areas covered. Once located, animals were counted and classified as follows:

1) large bulls (those bearing a mature complement of antlers, usually including a palmated brow tine ("shovel")
2) medium bulls (those distinguishable as males by antler development, but with smaller antlers and with a simple brow tine)
3) small bulls (males not distinguishable from females by antler development; these were classified as such on the lack of a black vulval patch when viewed from the rear)
4) adult females (those with calves and/or those with the vulval patch)
5) calves (young-of-the-year)
6) unclassified adults (animals which were at least yearlings, but for which sex could not be determined)

7) unclassified (caribou for which no age or sex classification was possible, i.e., none of the previously listed 6 categories could be applied with certainty).

Where conditions were suitable, larger groups (about 25+) were classified from the ground using a 20x spotting scope. In each case, whether from the air or from the ground, an attempt was made to observe a group until both observers obtained counts and classifications which agreed. Such agreement was obtained for large and medium bulls, and for calves, in every case.

Counts on Caribou Mountain were supplemented by observations of radio-collared animals during the surveys, and by results of routine radio-tracking flights by fixed-wing aircraft both before and after the helicopter counts (on 8 and 12 October). Other species observed during the helicopter surveys were also counted and classified when it did not interfere with the caribou work.

5. RESULTS

5.1 Physical Characteristics

Table 3 lists characteristics of the 17 animals handled, marked and released alive for subsequent tracking and observation. The four males included two young ones, one age 2 years by cementum annuli and the other believed to be the same by tooth wear, and two mature animals. One of the latter was a prime animal with many antler points, long beams and a broad shovel, although it was only 5 years old. The last was an older animal (10 years) whose antlers were apparently regressing (few points, relatively simply brow point, but long beams). This animal had obviously participated in the fall 1980 rut, and had suffered a facial wound which was badly abscessed; as noted in Appendix 5, this wound was carefully treated before the animal's release.

As shown in Table 3, the four males were fairly close in most body measurements except shoulder height, in which the two mature males appeared to be significantly larger. The old male

Table 3. Physical characteristics of 17 caribou captured in northern Spatsizi Wilderness Park, 21-28 October 1980.

Animal No.	Date Capt.[a]	Sex	Age[b]	Wt. (Kg)	Measurements[c] (cm)									Antler Points		Calf Pres.
					T.L.	Tail	H.F.	Ear	Shdr. Hght.	Circ. Neck	Heart Girth	Antlers L	Antlers R	L	R	
0	21	F	5	145	204	20	57	15	112	62	137	43	42	4	5	yes
1	22	F	2	-	193	17	59	17	105	56	136	31	30	4	3	no
2	23	F	3	-	197	11	56	13	117	58	136	41	36	3	5	no
3	23	F	Ad	-	191	18	56	15	121	53	127	24	28	3	4	no
4	24	F	Ad	-	-	-	-	-	-	-	-	10	10	1	1	no
5	24	F	13	-	212	19	59	13	118	50	123	33	36	3	3	yes
6	25	F	Ad	-	217	16	66	16	118	63	136	43	34	4	4	no
7	26	F	Ad	-	206	15	57	13	124	54	129	46	41	3	4	yes
8	27	F	8	-	203	16	55	13	122	62	141	-	-	0	0	no
9	28	F	(Ad)	-	211	15	61	15	117	61	134	44	43	4	2	no
10	23	F	(Ad)	-	-	-	-	-	-	-	-	-	-	3	4	no
11	28	F	Ad	-	201	13	60	15	124	63	136	39	39	6	7	no
12	26	F	C	-	-	-	-	-	-	-	-	-	-	1	1	-
13	23	M	2	-	214	16	60	16	125	74	142	50	49	8	7	-
14	24	M	(Ad)	175	221	19	62	14	113	67	137	56	51	11	9	-
15	25	M	10	245	228	20	63	15	142	78	144	99	93	8	11	-
16	27	M	5	-	220	19	64	16	140	80	138	80	86	15	11	-

[a] Date of capture in October 1980.

[b] Ages: numbers are age, in years, as determined by annuli in cementum of first incisor; Ad refers to animals believed 4+ years by tooth wear and other characteristics; (Ad) = animals believed young adults (2-3 years) by tooth wear and other characteristics; C = calf (young-of-the-year).

[c] Measurements: T.L. = total length, along curve of spine; antlers = length of main beam.

was 60 kg heavier than the single young male which was weighed.

The adult-sized females varied in age from 2-13 among the five from which we obtained teeth, and two of the remaining seven were believed young (2-3 years) by tooth wear. Just three (ages 5, 13 and "unknown adult") had calves with them when they were captured. One of the females (No. 8) was bald, i.e., without antlers; the others had antlers varying from 10 cm spikes (adult No. 4) to moderate-sized beams with 6-7 points (No. 11) to antlers nearing the size of those on the small males (No. 7). The antlers of most females, even the younger ones, had 3-5 points.

Bergerud (1978) noted that Spatsizi caribou calves were 6-8 pounds heavier at birth than their barren-ground counterparts in some Northwest Territories herds. Our measurements, though of a relatively small sample, indicate that this size difference carries on into adulthood, and tends to confirm that the caribou of this study are among the largest known. Compared with results from Dauphine (1976), the small Spatsizi male was heavier than the heaviest among 17 from the Kaminuriak herd, and the single female weighed at Spatsizi was more than 30 kg heavier than the heaviest among 76 in the barren-ground study. Likewise, the Spatsizi animals were much larger than the Kaminuriak samples (both sexes) in all standard body measurements. However, measurements and weights of the Spatsizi animals are near, or perhaps only slightly larger, than those recorded for a small sample of woodland caribou from northeastern Alberta (Fuller and Keith 1980).

5.2 Animal Survival and Radio-tracking Success

Of the fifteen animals fitted with radio collars in October 1980, nine were still alive and/or carrying functional transmitters in October 1981. Appendix 6 provides a short narrative history over the tracking period for each of these animals, and for the two which received only visual markers. Fates of the six which did not produce data over the entire year can be briefly summarized as follows:

1) Animal No. 9, adult female--did not recover from a leg injury suffered during capture and died, possibly by predation, before the first tracking survey.
2) Animal No. 5, 13 year old female--died between capture

and first tracking flight; eaten by and possibly killed by wolves.

3) Animal No. 10, young adult female--moved from the capture location, but apparently died or lost its collar before the first tracking flight; the collar was never found.
4) Animal No. 13, 2 year old male--collar broke off, before or just after the first tracking flight.
5) Animal No. 6, adult female--contacted regularly over the fall and winter, but apparently killed by predators just before or at calving time (late May).
6) Animal No. 15, 10 year old male--contacted at intervals throughout the winter, but died in about March, apparently of causes other than predation.

Clearly the first four involve events (mortalities or malfunctions) which cannot be certified as unrelated to the capture and handling. The last two, however, apparently represent "natural" mortality, giving a figure for the adults in this small sample of 2/11=18.2%.

Table 4 provides a summary of contacts for each of the original 15 collared caribou over the 22 tracking flights. As indicated, of the nine yielding data over the entire year, two (a young male and a 2 year old female) were contacted on all 22 flights. The remaining seven were each "missed" on three to six of the tracking flights. For the eleven animals found alive in more than one location over the tracking period there were a total of 222 possible contacts (9 x 22 for the animals still extant in October 1981, plus a maximum of 14 and 10, respectively, for the female and male which died later in the year). We actually received signals on 187 of 222 possible, for an overall tracking success of 84%.

Due to what we came to realize as a "low sightability" of this species, especially in some kinds of cover, only 80 of the 187 individual contacts (43%) resulted in actual sightings of

Table 4. Contacts with radio-collared caribou on 22 tracking flights, Spatsizi Wilderness Park and vicinity, November 1980 - October 1981.

Flight No.	Date	Individual Status Per Flight[a]																
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	22 Nov	0	X	X	(X)	0	X	X	X	X	-	X	-	0	X	X	(X)	(X)
2	28 Nov	X	(X)	X	X	X	-	X	(X)	0	-	-	-	(X)	-	(X)	(X)	X
3	6 Dec	X	X	0	0	X	-	0	X	X	-	-	-	-	-	(X)	(X)	X
4	22 Dec	0	X	0	X	X	-	0	(X)	X	-	-	-	-	-	X	0	0
5	2 Jan	(X)	X	X	X	X	-	0	X	(X)	-	-	-	-	-	X	(X)	X
6	15 Jan	X	X	X	0	X	-	(X)	X	(X)	-	-	-	-	-	X	(X)	X
7	29 Jan	0	(X)	(X)	(X)	(X)	-	(X)	X	(X)	-	-	-	-	-	X	0	(X)
8	16 Feb	X	X	X	(X)	X	-	(X)	0	(X)	-	-	-	-	-	X	X	X
9	28 Feb	(X)	X	(X)	(X)	(X)	-	(X)	0	(X)	-	-	-	-	-	X	X	X
10	17 Mar	(X)	(X)	(X)	(X)	(X)	-	(X)	0	(X)	-	-	-	-	-	X	X	X
11	29 Mar	(X)	X	(X)	X	(X)	-	X	0	0	-	-	-	-	-	X	-	X
12	16 Apr	0	(X)	(X)	(X)	(X)	-	X	X	(X)	-	-	-	-	-	X	-	X
13	3 May	0	X	(X)	(X)	X	-	X	X	X	-	-	-	-	-	X	-	X
14	20 May	X	X	X	X	X	-	X	X	X	-	-	-	-	-	X	-	X
15	30 May	0	X	0	0	X	-	-	X	0	-	-	-	-	-	(X)	-	X
16	9 Jun	X	(X)	(X)	X	0	-	-	X	0	-	-	-	-	-	(X)	-	X
17	18 Jun	X	X	(X)	X	0	-	-	(X)	(X)	-	-	-	-	-	X	-	X
18	26 Jun	X	(X)	(X)	(X)	0	-	-	X	(X)	-	-	-	-	-	(X)	-	(X)
19	24 Jul	X	X	X	X	0	-	-	X	(X)	-	-	-	-	-	X	-	0
20	30 Aug	(X)	(X)	(X)	(X)	0	-	-	X	(X)	-	-	-	-	-	(X)	-	0
21	8 Oct	(X)	(X)	(X)	(X)	X	-	-	X	X	-	-	-	-	-	(X)	-	0
22	12 Oct	(X)	(X)	(X)	(X)	(X)	-	-	X	X	-	-	-	-	-	(X)	-	X

[a]Status: the vertical columns represent data over all flights for each individual animal (numbers 0-16); 0=known or believed alive, but not contacted (no signal received) on the date indicated; X=contacted, but not seen; (X)=contacted and at least one live caribou seen in the vicinity of the strongest signal; hyphens indicate the animal is dead, has a non-functional transmitter, or status is unknown. Note: Animals 11 and 12 did not have radio collars.

animals at the location of strongest signal intensity. In many of these cases the collar itself was not seen. The dark green collars on the males showed up well, but the white vinyl collars on the females, even with colored tape bands attached, were almost invisible against their light-colored necks for most of the year. The exception was in July and August, when the animals are in darkest pelage.

5.3 Movements

The term "movements", as used here, refers to the straight line distance between successive contacts of the collared animals. The distances represent minimum movements since the animals would not have traveled in straight lines over long distances and apparent short movements might in some cases have been the result of a roughly circular meandering over the interval between contacts, bringing animals back near their points of commencement. Thus, the most reliable information may be for those instances in which the interval between contacts was shortest.

Figure 3 depicts the extent and distribution of detected movements over the study year. Combining results for the two sexes, this figure shows peaks in long distance movements (>25 km) in late December-early January, late May-early June, and to a lesser extent in the fall (August through October). Figure 4, which portrays mean movements between contacts for each sex, indicates that both males and females were involved in the long-distance winter movements, while the May-June peak was attributable primarily to females. The fall "peak" is largely the contribution of a single male which had been "missing" during several previous flights, but finally reappeared in October some 65 km from where he had last been contacted.

The winter movement was almost certainly a response to weather, particularly the abnormally heavy snowfall in December (see Table 1 and Figure 2). The 6 December flight was completed as the year's major snowtorm was beginning. On that date there was just a trace of snow (about 1 cm) on the Hyland Post airstrip and little more than 10-12 cm in surrounding uplands. Between 6 and 11 December

it snowed nearly continuously, depositing 80 cm of powder snow at Dease Lake during that time period and only an additional 4 cm from then until the next flight (22 December). On that flight, the snowpack at Hyland Post was 60 cm, after settling, and caribou movements had been so extreme that we were able to locate only 6 of the 11 still carrying transmitters at that time. The average detected movement for these was about 30 km (range 20-42, see Appendix 7). Four of those missed on 22 December were relocated on the next flight (2 January), at an average of 39 km from their previous contact locations and the last finally reappeared on 15 January, 40 km from where she had last been seen.

Although we know that the bulk of the month's snowfall occurred over a 4½ day period, and can suspect that this was the primary stimulus to the recorded long distance movements, we don't know how most of these movements occurred, i.e., as relatively quick, directional movements beginning during or just after the storm, or as gradual, steady movements over the whole contact interval. However, one female (No. 8) moved 54 km in the 11-day period between 22 December and 2 January, all through heavy snow.

There is little doubt that the peak in movements detected in late May and early June represents the dispersal of the females to widely scattered areas in preparation for calving. Because our observations were more intensive during this period, with shorter intervals between flights, I feel confident in stating that these movements were usually accomplished as fairly direct journeys over a short time period.

The bottom graph of Figure 4 and several columns of Appendix 7 treat these data in terms of "mean daily" movements, calculated by dividing the total observed distances between contact locations by the interval, in days, between contacts. These figures show that most of the observed movements over the entire year could have been accomplished by steady, consistent progress of as little as 1-2 km per day. Interestingly, the highest figures for this mean daily movement are for the winter and spring (female) movements discussed above, and for the shortest contact interval, the four

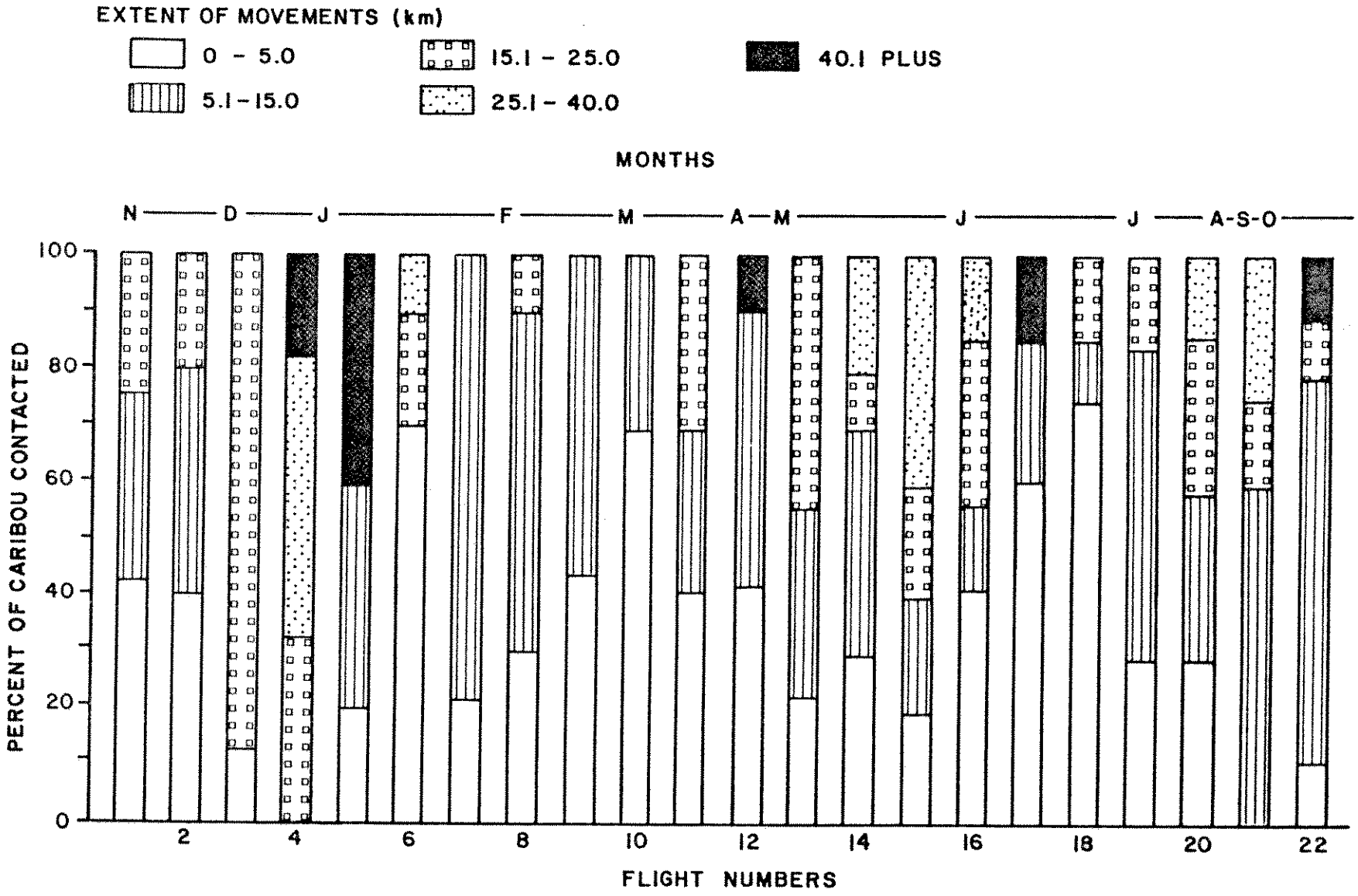
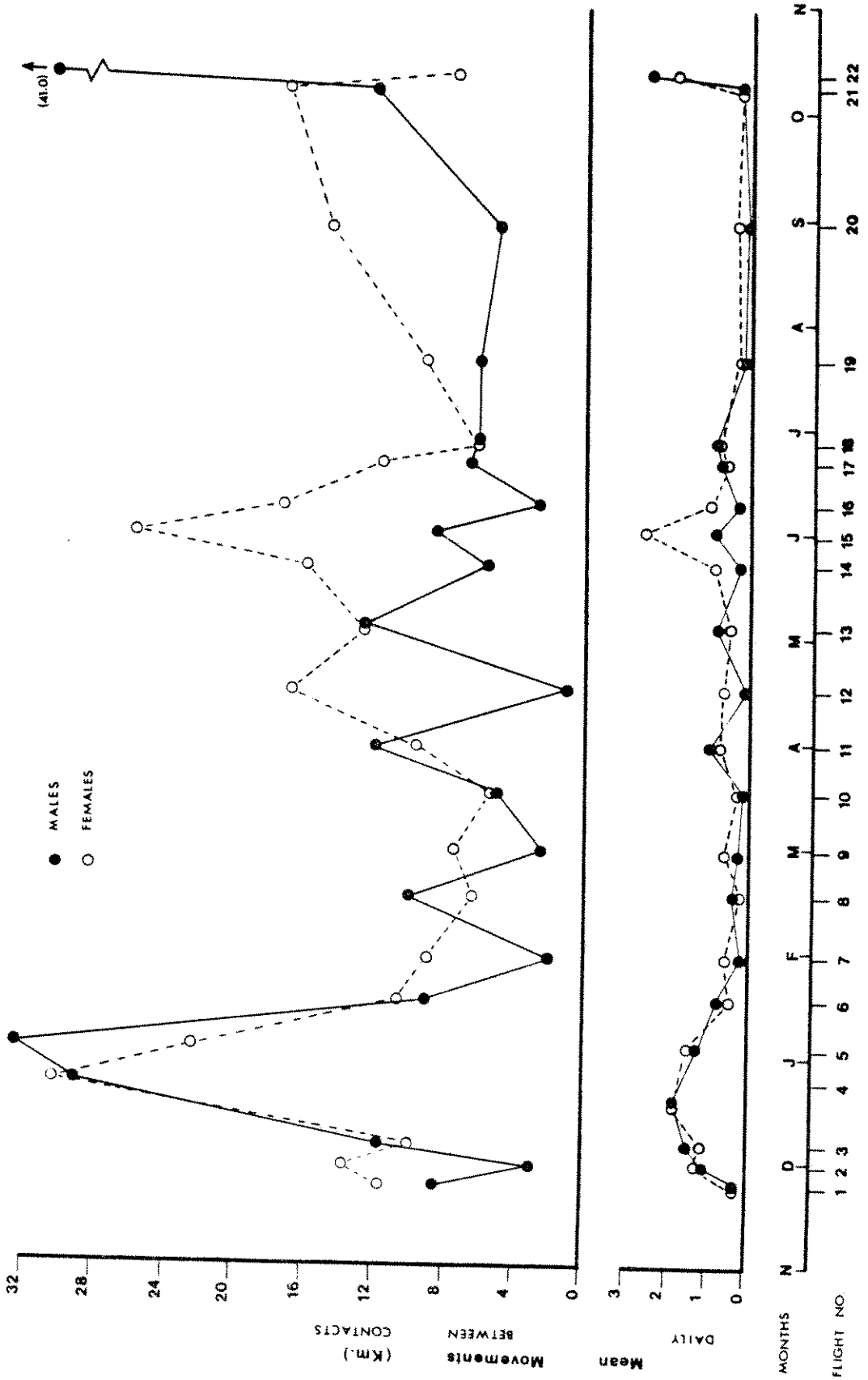


FIG. 3 EXTENT OF MOVEMENTS BY RADIO-COLLARED CARIBOU BETWEEN CONTACTS, NOV. 1980 - OCT. 1981

Figure 4. Mean movements of radio-collared male and female caribou, as detected on 22 tracking flights in Spatsizi Wilderness Park and vicinity, British Columbia, November 1980-October 1981. The "daily" movements were calculated by dividing total observed distance moved by an animal between contacts by the time interval, in days, between those contacts (see text).


(41.0)
MALES
FEMALES
32
28
24
20
16
12
8
4
0
Movements
BETWEEN
CONTACTS
(Km.)
3
2
1
0
Mean
DAILY
N
D
J
F
M
A
M
J
J
A
S
O
N
MONTHS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
FLIGHT NO.

days between 8 and 12 October (flights 21 and 22, see Figure 4).

Appendix 7 presents the detailed results of movements calculations for the 22 tracking flights including for each sex: sample sizes, mean contact interval, ranges, means and standard deviation figures for both total and "daily" movements, and direction. Because these calculations are based on a relatively small sample of marked animals (mean of 8.5 contacts per tracking flight), variability is high for many. For example, among 7 females contacted on 15 January, one had not moved at all in the 11 days since the previous contact, while another (as noted above) moved 54 km in the same time period. The fact that variability is least for the winter and spring peaks suggests that the observed differences for these times, at least, are real. It should be noted that in many cases the collared animals were accompanied by others which probably traveled with them, thus mitigating somewhat the concern about small samples. This was particularly true for the large winter movement.

5.4 Seasonal Distribution and Annual Range

As noted in the section dealing with inventory, the fall distribution is the primary location reference for caribou in northern British Columbia (see Bergerud 1978). It is for this reason that the capture program was carried out in the fall, and subsequent contacts of marked animals are here considered in relation to their capture locations. Figure 5, a plot of distances from individual capture locations for each monitoring flight, again depicts the long distance dispersal from the rutting area in late December-early January (mean of about 40 km for both sexes), but indicates that much of the movement recorded after that period brought the animals back closer to Caribou Mountain. It should be noted, however, that some of the animals did not approach their locations of capture during the study year, remaining 30 km distant, or more, even during the following rut period.

Figure 6 introduces a directional component to the movement data, showing animal locations relative to the geographical center

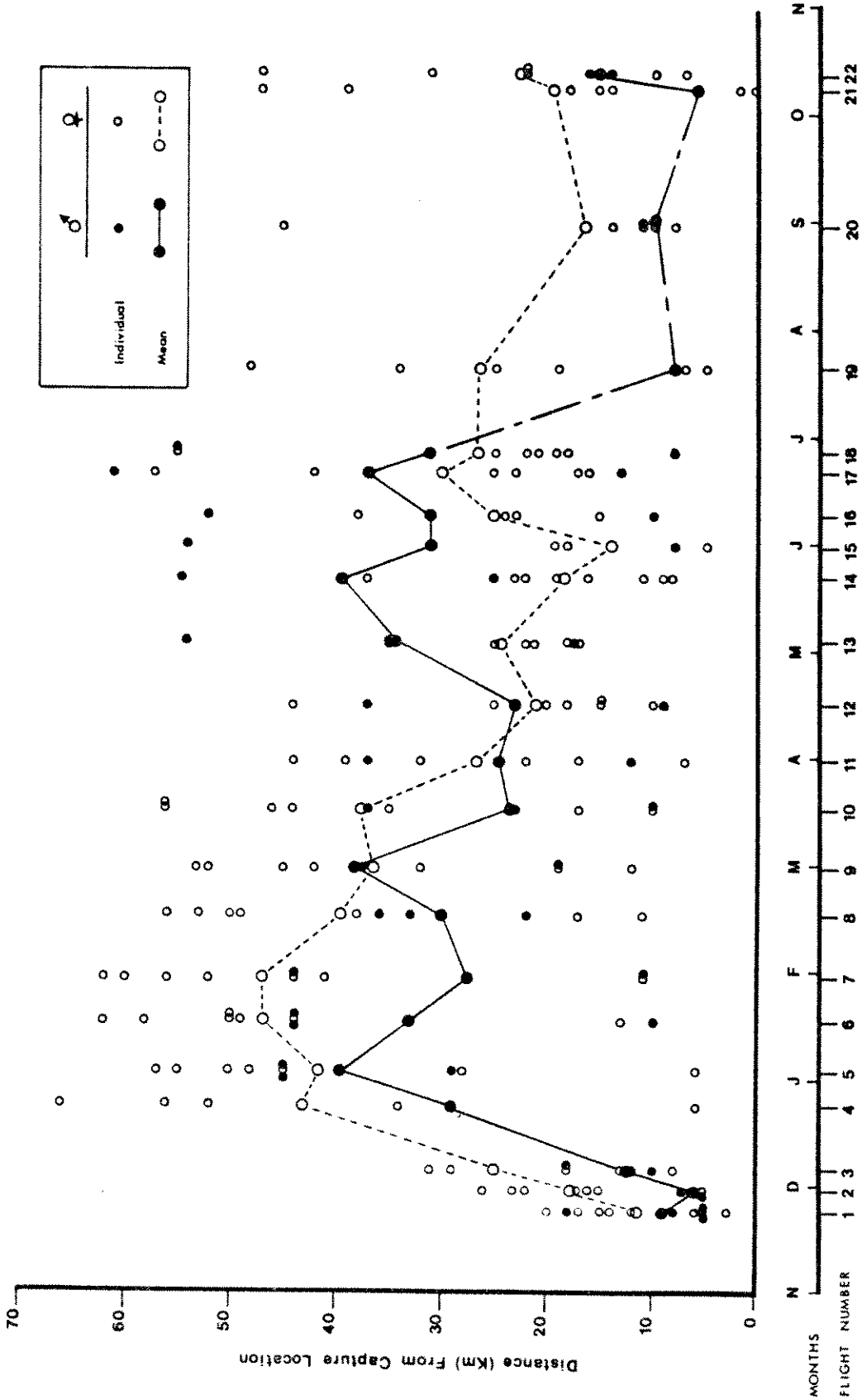

♀
♂
Individual
Mean
Distance (Km) From Capture Location
0
10
20
30
40
50
60
70
MONTHS
N D J F M A M J J A S O N
FLIGHT NUMBER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

Figure 5. Seasonal changes in distance from capture locations, radio-collared caribou, Spatsizi Wilderness Park and vicinity, British Columbia, November 1980-October 1981.

All individual contacts are shown; solid and dashed lines represent means of the individual values for males and females, respectively. The broken line for males from July through the first October flight indicates a period over which only one male was contacted.

of all capture locations for thirteen monitoring flights throughout the year. As shown, the major December movement described earlier was oriented primarily to the west, although a few animals crossed the Stikine River and moved into alpine areas to the north. Most of those in the west gradually moved back toward Caribou Mountain during the winter, while those in the north made no significant movements back until April. Animal locations south of the capture center were first recorded in June, and all involved females which had apparently dispersed to these areas for calving. Although there was a tendency for these collared animals to move back to Caribou Mountain as the summer progressed, three of the nine females still extant in fall, one year after capture, did not return to that rutting area.

Owing primarily to the summer dispersal described above, females generally occupied larger ranges ("minimum home range" of Dalke and Sime 1938) than did males over the study year. As shown in Table 5, the female areas were more variable than were those for males, ranging from 225 to more than 1200 km^2, although a single female (No. 8) contributed the bulk of this variability. Without that extreme area, which included both the farthest north and farthest south locations for the animals of this study the mean annual range for females drops from 612 to 526 km^2, with the attendant standard deviation dropping by 43 per cent (from 287 to 163). Figures 7 and 8 depict some of these ranges geographically for females and males, respectively. As shown, the combined area covered by just three animals of each sex during the year constitutes a significant proportion of the northern half of Spatsizi park, and in some cases includes areas outside of the park boundaries.

Figure 9 shows locations of animals on survey flights of 15 January 1981, after winter dispersal and on 26 June 1981, after calving. Also shown are known and/or suspected calving locations for the seven females known alive in early June. The figure summarizes the major distribution pattern for the collared caribou during the study year, indicating:

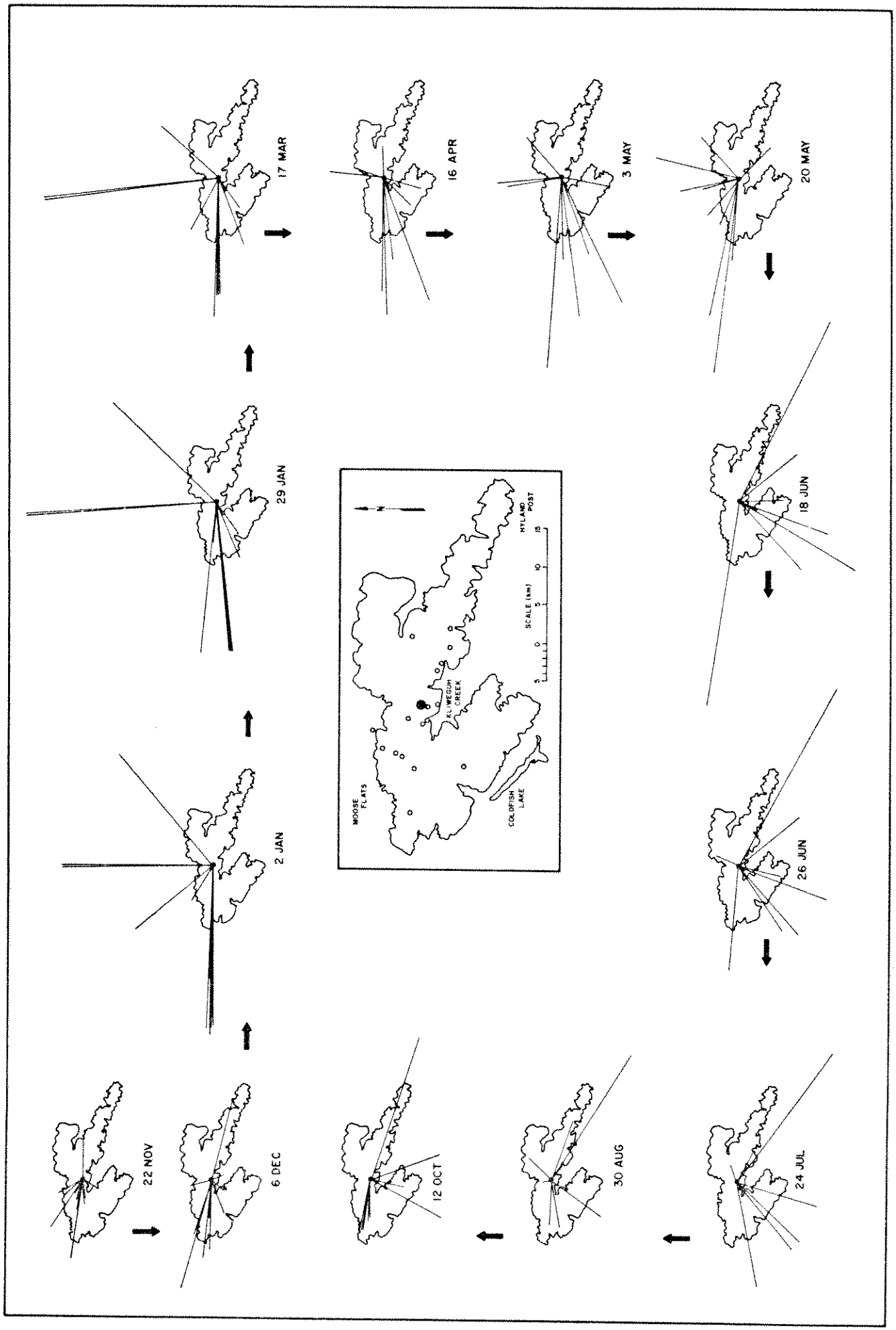

17 MAR
16 APR
3 MAY
20 MAY
29 JAN
18 JUN
2 JAN
26 JUN
22 NOV
6 DEC
12 OCT
30 AUG
24 JUL
MOOSE FLATS
KLIWEGUH CREEK
COLDFISH LAKE
NYLAND POST
SCALE (km)
5 0 5 10 15

Figure 6. Seasonal changes in distribution of radio-collared caribou, Spatsizi Wilderness Park and vicinity, British Columbia, November 1980-October 1981.

The inset in the center shows the capture locations (open circles) of 17 caribou captured in October 1980 and the geographical center of these locations (closed circle). The area shown is that enclosed by the 1525 m (5000') contour line in this area. The lines on the smaller scale figures are drawn from the capture center to the location of each caribou contacted on the dates indicated.

Table 5. Range occupied by radio-collared caribou[a] in Spatsizi Wilderness Park, October 1980-October 1981.

Animal No.	No. Contacts	Annual Range (Km^2)[b]
Females		
0	16	225
1	22	697
2	19	455
3	19	537
4	16	698
6	11	581
7	18	487
8	18	1217
Mean		612
Std. Dev.		287
Males		
14	22	353
15	8	291
16	18	457
Mean		367
Std. Dev.		84
All		
Mean		545
Std. Dev.		269

Flight Date	No. Contacts	Area Occupied (Km^2)[c]
1980		
28 Oct	17	110
22 Nov	12	178
28 Nov	10	216
6 Dec	8	236
22 Dec	6	394
1981		
2 Jan	10	1516
15 Jan	10	1941
29 Jan	9	1682
16 Feb	10	1573
28 Feb	9	1994
17 Mar	10	1062
29 Mar	8	758
16 Apr	7	654
3 May	9	932
20 May	10	877
30 May	5	832
9 Jun	7	692
18 Jun	8	758
26 Jun	8	1718
24 Jul	7	1066
30 Aug	7	452
8 Oct	8	887
12 Oct	9	653

[a]Data only for collared caribou known to be alive for each contact indicated.

[b]Minimum area polygon for each animal defined by connecting locations of all contacts for that animal in the study year.

[c]Minimum area polygon for all animals contacted on flight indicated.

1) The extreme dispersion in winter, with most of the animals in the Eaglenest Range to the west and a few in the Three Sisters Range to the north.
2) The movement back south, by females, for calving. Note that both males present on the two dates (No. 14 and No. 16) had not moved far from their winter locations by the end of June, and in both cases had actually wandered north. All of the females, on the other hand, had moved well to the south (usually southeast) between the two dates.
3) The relatively minor movements of females between calving (early June) and the late June survey flight.

5.5 Habitat Use

Although detailed habitat studies were not among the objectives of this work, a look at seasonal distribution of caribou within various broad habitat categories is important as it relates to inventory potential. The intention here is to identify those times of the year when the animals are occupying habitats in which they are most likely to be seen. As shown in Figure 10, during the year of this study collared females were found in open alpine habitat most consistently in late February-early March, and again in mid-April. Most were also found near the lower edge of the alpine zone at the end of August. Because actual vegetative "cover" may vary at the same elevation between contact locations, Table 6 provides supplementary information by cover type. These data confirm that animals were in the least obscuring vegetation during flights between the end of January and mid-April, and again in late August. Occurrence in the subalpine (spruce-willow-birch) zone suggests potential "sightability" generally greater than for forested habitats, but actual sightability within that zone varies with the distribution and density of the occasional conifer clumps, with shrub height and with animal activity (animals lying down may be hidden by relatively low shrub cover).

Results for males (Figure 10) are less instructive due

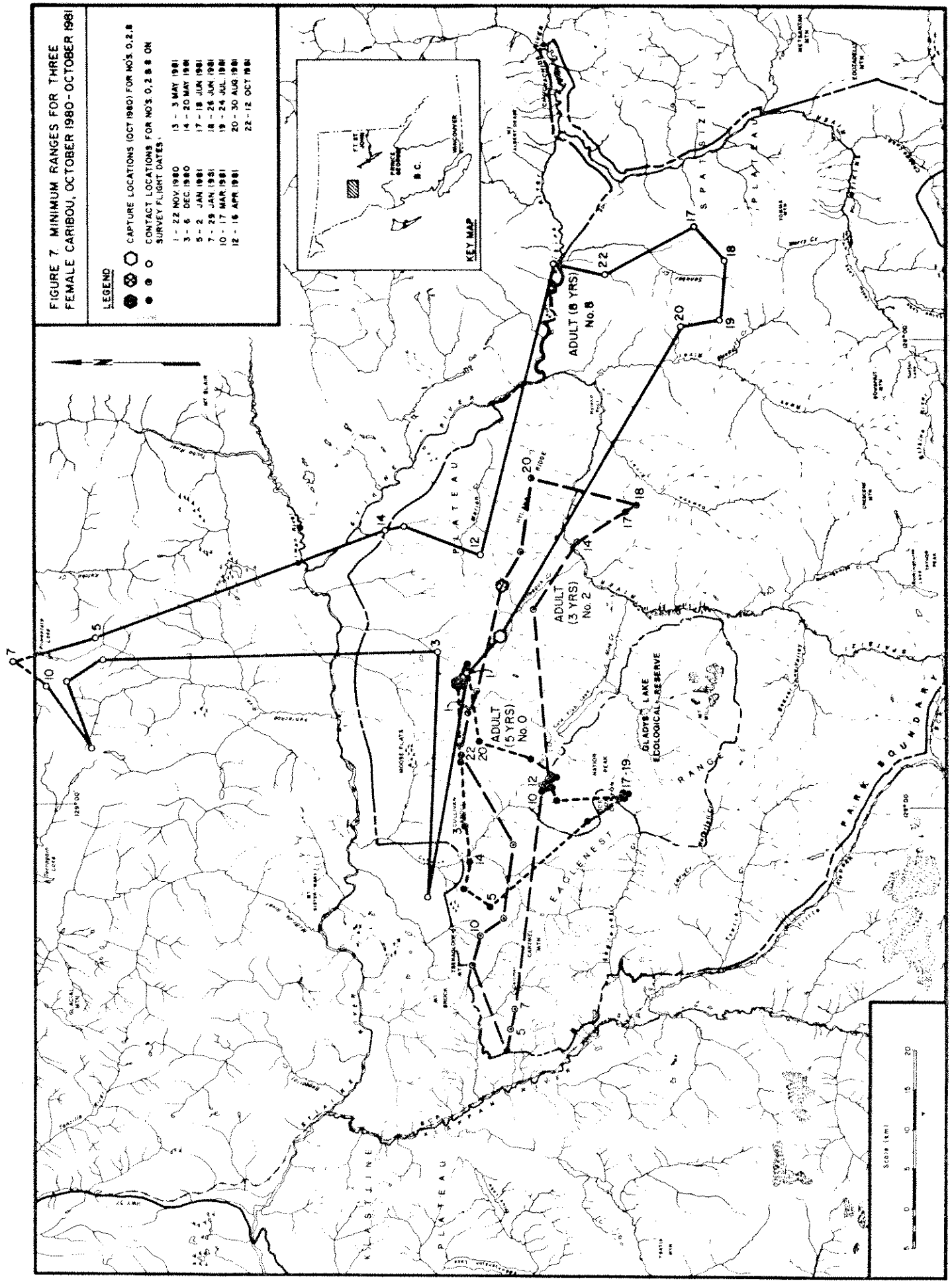


FIGURE 7. MINIMUM RANGES FOR THREE FEMALE CARIBOU, OCTOBER 1980 - OCTOBER 1981
LEGEND
CAPTURE LOCATIONS (OCT 1980) FOR NO'S 0,2,8
CONTACT LOCATIONS FOR NO'S 0,2,8,8 ON SURVEY FLIGHT DATES:
1 - 22 NOV 1980
3 - 6 DEC 1980
5 - 2 JAN 1981
7 - 29 JAN 1981
10 - 17 MAR 1981
12 - 16 APR 1981
13 - 3 MAY 1981
14 - 20 MAY 1981
17 - 18 JUN 1981
18 - 26 JUN 1981
19 - 24 JUL 1981
20 - 30 AUG 1981
22 - 12 OCT 1981
KEY MAP
PRINCE GEORGE
VANCOUVER
B.C.
ADULT (5 YRS) No. 0
ADULT (3 YRS) No. 2
ADULT (8 YRS) No. 8
PLATEAU
SPATSIZI
KLASTLINE
EAGLENEST RANGE
GLADYS LAKE ECOLOGICAL RESERVE
MOOSE FLATS
MT. BLAIR
MAYSON PEAK
PARK BOUNDARY
Scale (km)

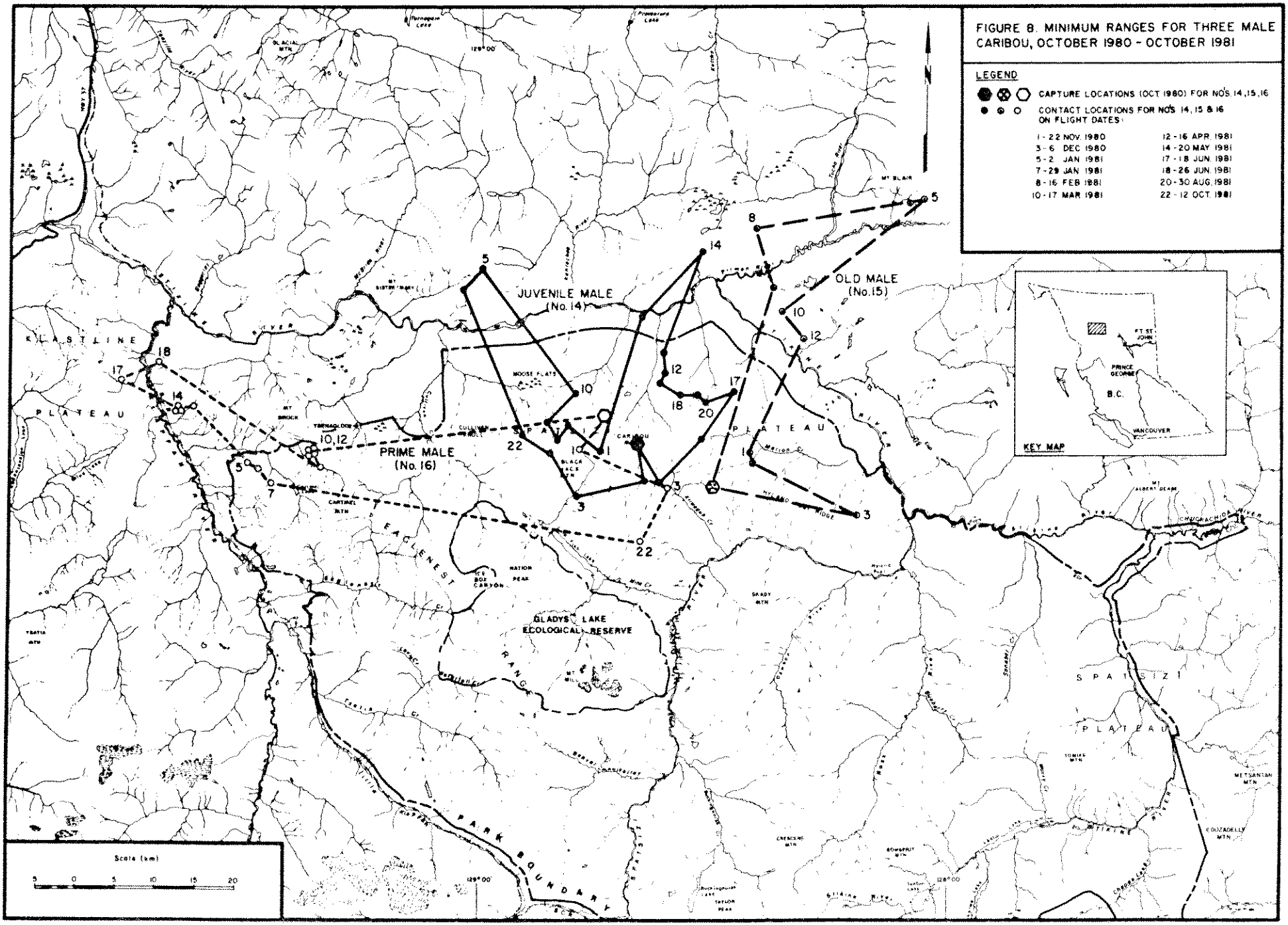


FIGURE 8. MINIMUM RANGES FOR THREE MALE CARIBOU, OCTOBER 1980 - OCTOBER 1981
LEGEND
CAPTURE LOCATIONS (OCT 1980) FOR NOS. 14, 15, 16
CONTACT LOCATIONS FOR NOS. 14, 15 & 16 ON FLIGHT DATES:
1 - 22 NOV. 1980
3 - 6 DEC 1980
5 - 2 JAN 1981
7 - 29 JAN 1981
8 - 16 FEB 1981
10 - 17 MAR 1981
12 - 16 APR. 1981
14 - 20 MAY 1981
17 - 18 JUN. 1981
18 - 26 JUN. 1981
20 - 30 AUG. 1981
22 - 12 OCT. 1981
JUVENILE MALE (No. 14)
OLD MALE (No. 15)
PRIME MALE (No. 16)
KEY MAP
FT. ST. JOHN
PRINCE GEORGE
B.C.
VANCOUVER
KLASTLINE PLATEAU
SPATSIZI PLATEAU
GLADYS LAKE ECOLOGICAL RESERVE
PARK BOUNDARY
Scale (km)
0 5 10 15 20

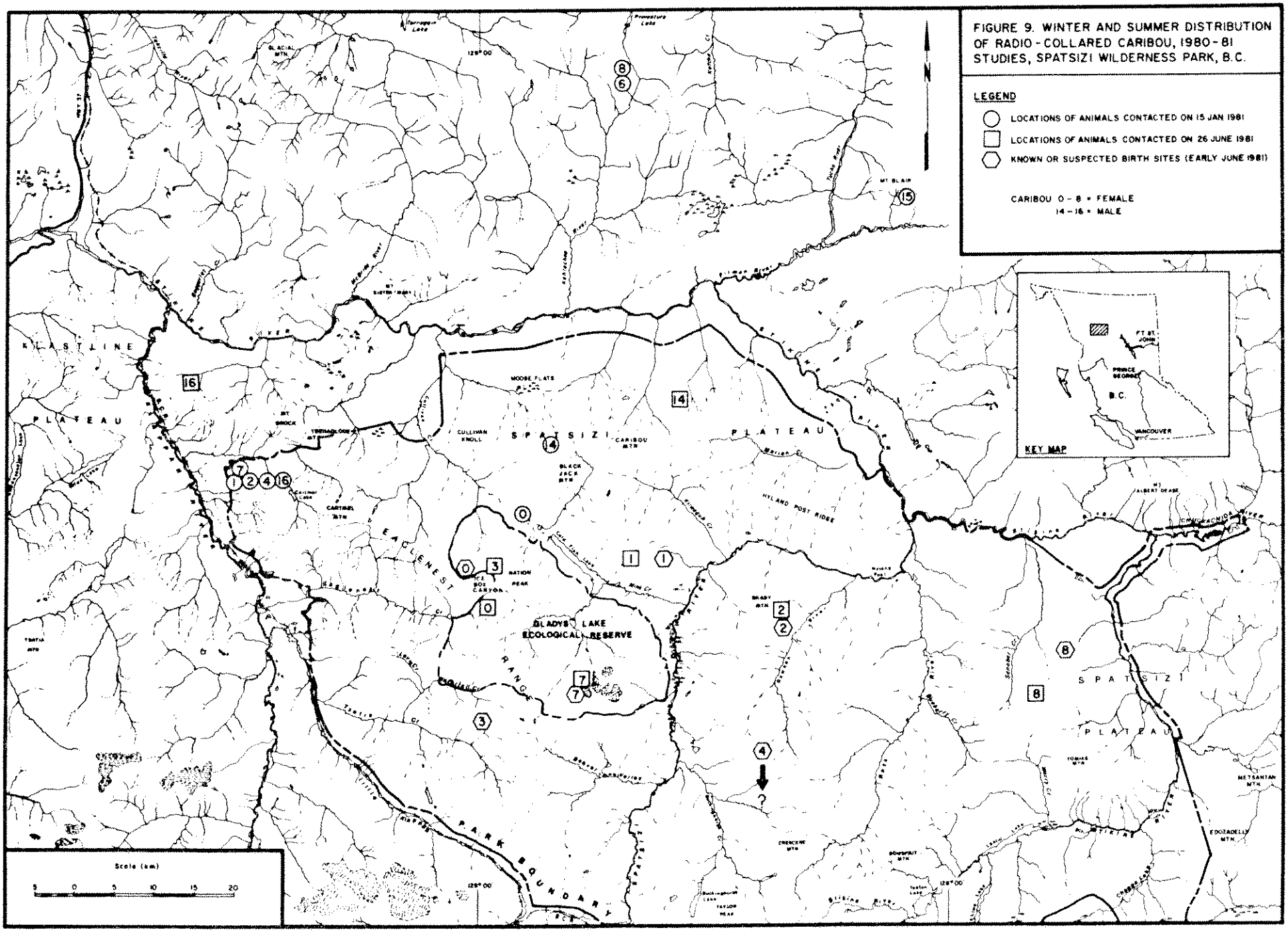
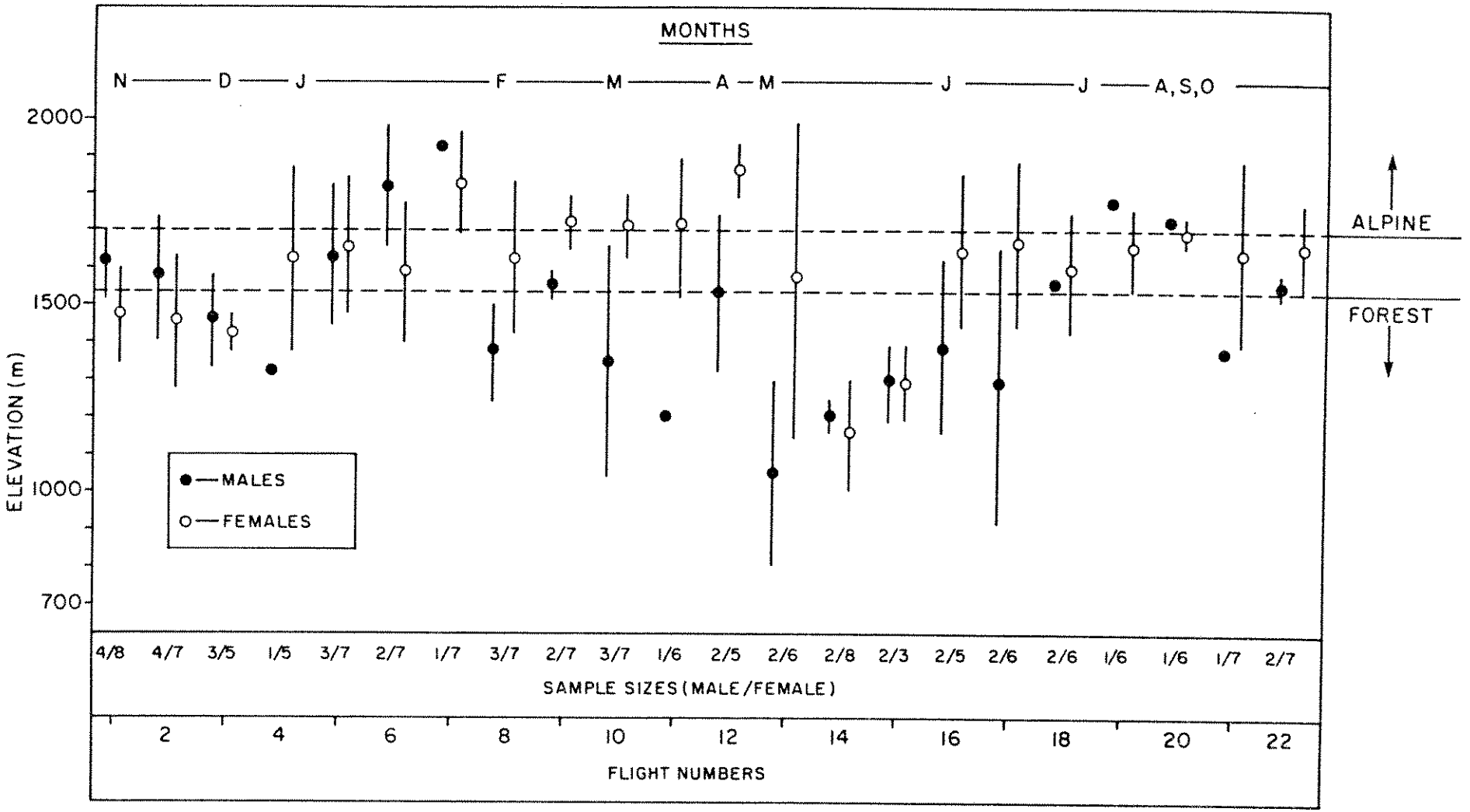


FIGURE 9. WINTER AND SUMMER DISTRIBUTION OF RADIO-COLLARED CARIBOU, 1980-81 STUDIES, SPATSIZI WILDERNESS PARK, B.C.
LEGEND
LOCATIONS OF ANIMALS CONTACTED ON 15 JAN 1981
LOCATIONS OF ANIMALS CONTACTED ON 26 JUNE 1981
KNOWN OR SUSPECTED BIRTH SITES (EARLY JUNE 1981)
CARIBOU 0 - 8 = FEMALE
14 - 16 = MALE
KEY MAP
Scale (km)
SPATSIZI PLATEAU
KLASTLINE PLATEAU
EAGLENEST RANGE
GLADYS LAKE ECOLOGICAL RESERVE
PARK BOUNDARY


MONTHS
N
D
J
F
M
A
M
J
J
A,S,O
2000
1500
1000
700
ELEVATION (m)
ALPINE
FOREST
MALES
FEMALES
4/8 4/7 3/5 1/5 3/7 2/7 1/7 3/7 2/7 3/7 1/6 2/5 2/6 2/8 2/3 2/5 2/6 2/6 1/6 1/6 1/7 2/7
SAMPLE SIZES (MALE/FEMALE)
2 4 6 8 10 12 14 16 18 20 22
FLIGHT NUMBERS

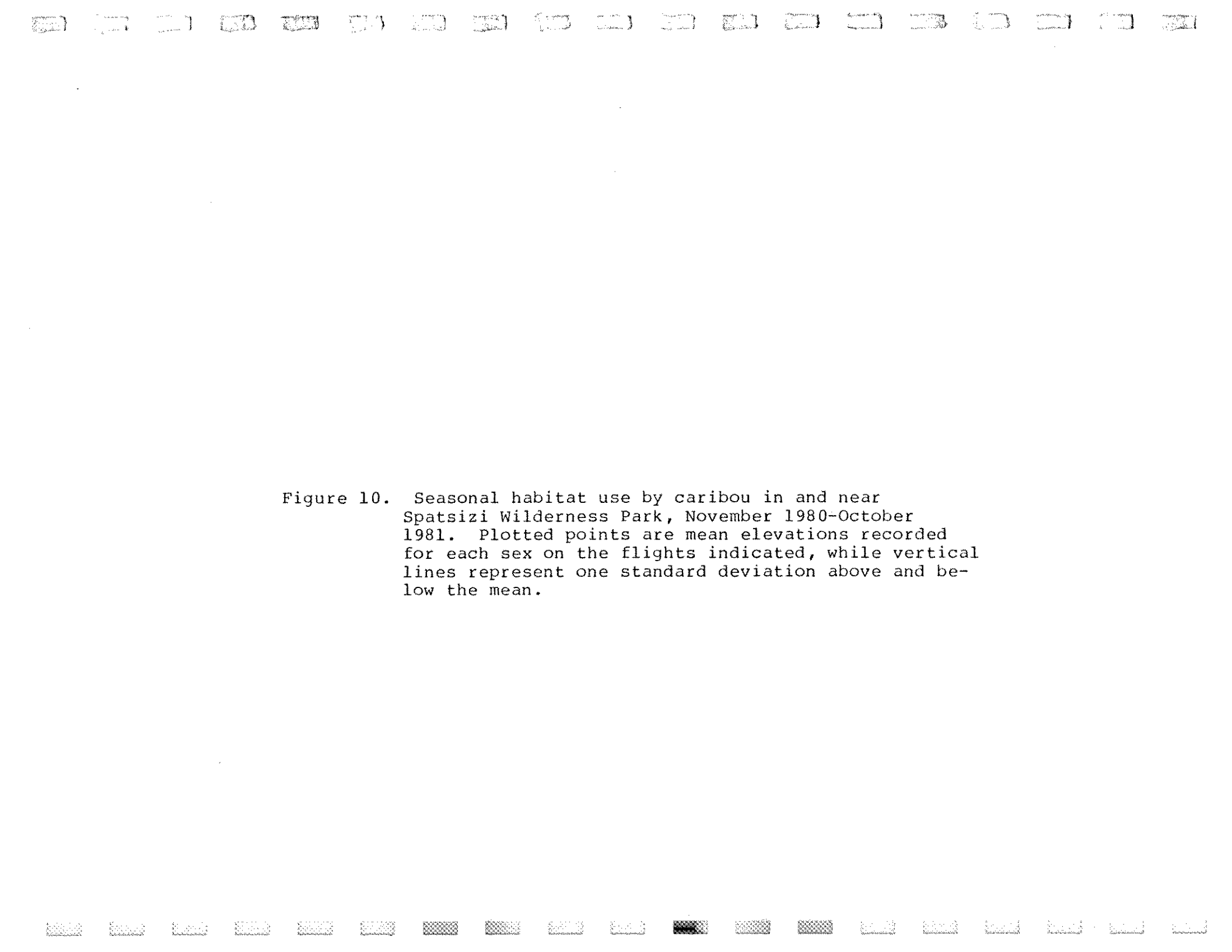


Figure 10. Seasonal habitat use by caribou in and near Spatsizi Wilderness Park, November 1980-October 1981. Plotted points are mean elevations recorded for each sex on the flights indicated, while vertical lines represent one standard deviation above and below the mean.

Table 6. Habitat use by radio-collared caribou[a] in Spatsizi Wilderness Park and vicinity, November 1980-October 1981.

Tracking Flight Date	N[b]	Per Cent Occurrence[c] in habitats[d]			
		Alpine	Shrub	Forest	Other
22 Nov	12	25	58	17	-
28 Nov	11	36	46	18	-
6 Dec	8	13	50	37	-
22 Dec	6	50	-	50	-
2 Jan	10	50	-	50	-
15 Jan	9	44	-	56	-
29 Jan	10	80	-	20	-
16 Feb	8	50	-	50	-
28 Feb	8	100	-	-	-
17 Mar	10	80	-	20	-
29 Mar	7	71	-	29	-
16 Apr	7	86	-	14	-
3 May	8	38	-	62	-
20 May	10	-	-	100	-
30 May	5	20	-	80	-
9 Jun	7	42	29	29	-
18 Jun	8	50	13	37	-
26 Jun	8	61	13	13	13[e]
24 Jul	7	71	-	29	-
30 Aug	7	86	14	-	-
8 Oct	7	71	-	29	-
12 Oct	9	78	-	22	-

[a]Sample consists of those contacts in which animals were seen or signal was not near an edge in the habitat concerned.

[b]Number of contacts (both sexes combined).

[c]Numbers in table body are proportions of "N" recorded in the various habitat categories.

[d]Habitats: alpine - herbaceous or bare, above 1700 m; shrub - mostly dwarf birch-willows, below 1700 m and usually adjacent to alpine, i.e., above "timberline"; forest - predominantly tree covered, either deciduous or conifer; other - as noted.

[e]Lowland sedge meadow.

primarily to the small sample size. The two to three animals involved were found higher in early winter and appeared to have moved downslope to heavier cover during the later winter peak of female occurrence in the alpine zone. Only one male was contacted on the late August tracking flight, but it, like the females, was at high elevation on that occasion. A variety of circumstances prevented observations for September, so the distribution between the late August flight and the time of the rut survey was not documented. As will be noted later, the rut appears to have occurred earlier in fall 1981 than in other years, so that the surveys on 8 and 12 October were post-rut. At these times, as shown in Figure 10 and Table 6, both sexes were fairly high on the mountain, but variation was moderately high with 20-30 per cent of the animals occupying forested habitats on those dates.

Table 7 summarizes occurrence of caribou, as recorded on tracking flights, in terms of "aspect" (direction of slope). As shown, highest incidence among the collared animals was generally on north-facing slopes and the lowest on slopes facing east. However, the inventory biologist hoping to eliminate the necessity for observing all sides of the mountain will find little source of encouragement here, and even less in the more detailed (flight specific) data on Appendix 8. It appears that some of the animals usually proved to be exceptions, and even where agreement was good for all animals within flights, there was no clear trend between them. The closest situation to a trend was the relative concentration on north-facing slopes in late winter-early spring.

5.6 Calving

As reported in the previous section, the collared females moved gradually back toward Caribou Mountain from their wintering areas by early spring, then dispersed into the mountains again. The tracking flight of 20 May 1981, the fifteenth such flight in this study, was the first single flight on which all the mobile collars were contacted. On that date the eight remaining females

Table 7. Summary of aspect (direction of slope) occurrences for radio-collared caribou, Spatsizi Wilderness Park and vicinity, 1980-1981.

Direction of Slope[a]	Proportion of Occurrences per Flight[b]				
	0	1-25%	26-50%	51-75%	76-100%
North	0	2	8	8	4
South	0	7	12	2	1
East	8	10	4	0	0
West	4	9	9	0	0

[a]Quadrant (90°) with the direction indicated acting as center.

[b]Percentages for each column represent categories for proportions of caribou contacted on each tracking flight (22 total) on slopes of the direction indicated. Numbers in body of table are number of flights for each direction in which the percentage pertained, e.g., under "North" there were 0 flights on which 0 animals occupied north-facing slopes, 2 flights on which 1-25% of them did so, etc.

were distributed at scattered points averaging 21 km from the capture center (Figure 6), and all but one of these to the north of that location. All were contained within 575 km^2, the smallest area since the winter dispersal and, depending upon the location of No. 4 thereafter, probably the smallest area during 1981. By comparison, these same females had occupied an area of almost 1100 km^2 at an average distance of 46 km from the capture center on 15 January.

Most of the movement to calving areas apparently took place between 20 May and the end of the month. Following the 100 per cent tracking success on that date, we contacted only four of the eight females believed alive on 30 May and six on the next, weather-plagued flight, 8-10 June. By 18 June it was apparent that we were dealing with only seven females, No. 6 having died during May. Of those remaining, the approximate locations of calving were determined for six (see Figure 9); animal No. 4 remained out of contact until seen south of the Spatsizi River with a calf in October. The minimum area covered by the calving sites was apparently in excess of 800 km^2 and the average distance to capture center from the six sites actually located was 31 km.

Details of observations for each female, presented in narrative form in Appendix 6, are summarized in Table 8. There is no reason to suspect that any of the collared animals gave birth before 30 May or after 10 June; calves seen with animals No. 1 and No. 2 on 8 June were estimated to be no more than 2-3 days old at that time. Those females seen with calves did not move far in the first week or two following birth, particularly while the calves remained alive. Thus, even though No.'s 0 and 3 were never seen with calves their temporary faithfulness to a relatively small area after the late May dispersal strongly suggests that they did give birth. Birth sites for these, and for No. 7, whose calf was later seen, is inferred to be the location of contact on the 8-10 June flight. The location shown (Figure 9) for No. 8 is the location at which her calf was first seen, but this was probably not the actual birth site. With this background, Table 9 provides a

Table 8. Observations of radio-collared female caribou during and after the calving season, Spatsizi Wilderness Park and vicinity, 1981.

Animal No.	Status on Tracking Flights[a]																				
	30 May			9 June[b]			18 June			26 June			24 July			30 Aug			8-12 Oct[c]		
	S	D	N	S	D	N	S	D	N	S	D	N	S	D	N	S	D	N	S	D	N
0	A	-	-	B	0	-	B	5	-	B	5	-	B	5	-	D	17	5	D	18	9
1	B	3	-	B	0	-	B	1	-	C	4	4	B	20	-	D	15	5	D	19	35+
2	A	-	-	C	0	1	C	3	1	D	1	4	B	17	-	D	14	1	D	32	20+
3	A	-	-	C	0	1	B	5	-	D	18	1	B	27	-	D	30	6	D	33	35+
4	A	-	-	A	-	-	A	-	-	A	-	-	A	-	-	A	-	-	C	?	18[d]
7	B	17	-	B	0	-	C	0	1	B	2	-	B	4	-	B	?[e]	-	C[f]	5	1
8	A	-	-	A	-	-	C	0	1	C	5	24	C	12	1	D	12	2	B	13	-

[a] S=status: A=not contacted (no radio signal received); B=contacted, but not seen; C=seen with calf; D=seen without calf.
D = distance, in Km, from inferred birth site.
N = number of adult caribou in group, including female indicated.

[b] Actual flight was conducted partly on 8th and partly on 10th, interrupted by bad weather.

[c] Results combined for two flights with short interval between; D (distance) is shortest recorded and N (Number) is smallest recorded on those two dates.

[d] Count incomplete because of flying conditions; total of 24 with minimum of 6 calves.

[e] Location incorrectly mapped, but probably same as previous flight.

[f] Seen from helicopter on 10 October, but not on either tracking flight that month.

description of each of the calving situations observed. As shown, just two of six were known to be in the alpine situations characterized by Bergerud and Butler (1978) as caribou calving sites in Spatsizi.

To summarize the data in Table 8 in terms of calving success, all seven of the collared females were known or suspected to have had calves, but only two (28.6%) had not lost them by the time of the October survey. Of the five which lost calves, two (No.s 2 and 3) did so within two weeks of birth, one (No. 1) apparently lost hers between 26 June and 24 July, and the other two (No.s 0 and 8) probably still had theirs well into August. Cause of losses could not be determined; the first two might have been related to the very wet, cold weather of late May-early June 1981, but the other three, at least, were most likely due to predation.

5.7 Numbers

As noted in the introduction, a primary focus in this work was consideration of methods and timing for determining population size and composition of northern British Columbia caribou. Table 10 summarizes relevant observations, in that context, during tracking surveys. Generally, the largest number of groups were located, both by radio-tracking and by incidental sightings, during the late winter-early spring period. Further, although there was considerable variation, mean group sizes tended to be among the largest recorded during that period. The smallest group sizes were from late spring through summer, with males occuring singly or in small groups and females dispersed in mostly solitary fashion for calving at that time. Consistent with the above observations, the largest absolute counts recorded on tracking flights were in the winter period. Because the fixed-wing aircraft was poorly suited for close observation under most conditions, most animals could not be classified. Hence, the composition information listed in Table 10 shows only that animals were best classified in the summer, when group sizes were smallest and when distinctive characteristics such as antler growth or presence of small calves

Table 9. Description of calving sites[a] used by radio-collared female caribou, Spatsizi Wilderness Park, spring 1981.

Animal Number	Elevation (m)	Habitat[b]	Aspect[c]	Comments
0	1825	1	S	Very steep, boulder-laden slope in box canyon
1	1375	2	SE	Mostly subalpine shrub, but with scattered spruce-fir and good patches of terrestrial lichens
2	1475	2	E	Dwarf birch-fir krummholz
3	1575	2	SW	In or near a thick patch of subalpine fir
4	-	-	-	Unknown
7	1875	1	E	Steep, rocky slope on back side of Mount Will
8	-	-	-	Birth site not known; calf first seen on a grassy ridge at the edge of an alpine plateau at about 1450 m.

[a]Known or inferred sites; see text.

[b]Habitat: 1=alpine, 2=subalpine shrub

[c]Aspect = direction faced by slope bearing site.

Table 10. Group sizes and total counts of caribou observed during radio-tracking surveys, Spatsizi Wilderness Park and vicinity, November 1980-October 1981.

Flight Date	No. Groups Seen[a]			Group Size Frequencies					Group Mean	No. Animals Seen[b]					
	W	W/O	All	1-5	6-10	11-25	26-50	51+		M	F	Y	A	U	Total
22 Nov	4	1	5	1	3	-	-	1	16.2	2	2	3	-	115+	122+
28 Nov	5	2	7	2	3	2	-	-	8.7	-	1	1	-	59	61
6 Dec	3	1	4	2	1	1	-	-	10.0	-	-	-	-	39	39
22 Dec	1	1	2	1	-	1	-	-	10.0	-	3	2	-	15+	20+
2 Jan	3	2	5	1	-	3	1	-	15.8	-	-	3	-	76	79
15 Jan	2	0	2	-	-	1	1	-	26.0	-	-	-	-	52	52
29 Jan	6	9	15	2	5	4	3	1	26.9	5	-	80	318	-	403[c]
16 Feb	2	3	5	-	-	3	1	1	36.4	-	-	-	-	182+	182+
28 Feb	5	8	13	2	3	4	3	1	22.1	-	-	6	23	259+	288+
17 Mar	4	1	5	-	-	1	3	1	48.4	-	-	-	-	217+	217+
29 Mar	2	4	6	1	-	2	1	2	41.2	-	-	-	-	247+	247+
16 Apr	5	10	15	3	2	4	3	3	25.7	-	-	-	-	386	386
3 May	2	3	5	-	3	-	1	1	19.4	-	-	-	-	97	97
20 May	0	3	3	3	-	-	-	-	1.3	-	-	-	2	2	4
30 May	1	0	1	1	-	-	-	-	1.0	1	-	-	-	-	1
9 Jun	3	2	5	5	-	-	-	-	2.4	2	3	2	3	2	12
18 Jun	3	2	5	5	-	-	-	-	2.2	1	4	4	2	-	11
26 Jun	6	4	10	7	-	2	1	-	7.1	7	7	5	37	15	71
24 Jul	1	1	2	2	-	-	-	-	2.0	-	2	2	-	-	4
30 Aug	6	3	9	5	2	-	-	2	16.6	4	16	1	-	128	149

(continued)

Table 10. (continued)

Flight Date	No. Groups Seen[a] W	W/O	All	Group Size Frequencies 1-5	6-10	11-25	26-50	51+	Group Mean	No. Animals Seen[b] M	F	Y	A	U	Total
8 Oct	5	1	6	1	1	2	2	-	19.8	-	-	-	-	116	116
12 Oct	4	0	4	1	-	1	1	1	34.0	-	-	6	18	110	134

[a]Groups seen: W=with collars, i.e., found by telemetry tracking; W/O=no collars, i.e., seen incidentally to tracking studies; All=W and W/O.

[b]M=males, F=females, Y=young-of-the-year, A=unclassified adults, U=unclassified, T=total; note that not all observations were readily separable to groups so that total does not always = group mean x number of groups; the plus (+) by some numbers indicate an incomplete (minimum) count.

[c]The 29 Jan flight was by Bell 206 helicopter; all others were from a Cessna 185.

were often visible.

Table 11 presents results of the fall rut surveys in Spatsizi Wilderness Park during the study period. As described in the methods section, Caribou Mountain, the main rutting location in the area covered by the radio-collared caribou of this study, and Edozadelly Mountain were selected for the main inventory effort. A few incidental observations were also recorded from the uplands of Tomias Mountain, which lies on the flight line between the two areas.

Caribou and Edozadelly Mountains were flown intensively, covering the total area above timberline as completely as time and budget allowed. The objective was to locate and classify, to the degree possible, all animals present. In short, these surveys fail to be total counts only as affected by factors which influence observation of the animals (e.g., visability bias, activity of the animals, cover, weather, observer experience and/or competence) and these factors are assumed to be more or less the same from year to year. However, it should be noted that the distribution of animals during the rut surveys was different on both areas, in 1981, from what it had been in previous years (Hatler, personal data). This difference is described more completely in the discussion. Also in 1981, little rutting activity was seen among groups observed on either area, and it was evident that the peak of the rut had passed a week or more earlier.

5.8 Observations of Other Species

Opportunities to observe other species often arose during the various activities associated with capturing, monitoring and counting caribou, and these were usually recorded. The exception was when caribou were in sight and in a situation which required all of the observer's attention. Appendix 9 details, by species, all such sightings recorded during the year of study. Following paragraphs briefly summarize the data of Appendix 9.

Moose

At least a few moose were seen on most radio-tracking flights,

Table 11. Classification Summary for Spatsizi Caribou Surveys, 9-11 October 1981.

Location	Males				Females	Calves	Uncl. Adults[a]	Uncl.	Total
	Large	Medium	Small	Total					
Caribou Mountain									
Number	16	14	13	43	92	21	78	0	234
Per Cent	(7.5)[b]			(20.2)[b]		(9.0)[b]			
Edozadelly Mtn.									
Number	10	6	8	24	20	8	109	0	161
Per Cent	(6.5)[b]			(15.7)[b]		(5.0)[b]			
Tomias Mountain									
Number	3	1	1	5	6	3	-	75+	89+[d]
Per Cent	(21.4)[c]			(35.7)[b]		(21.4)[c]			

[a]Unclassified adults = animals older than one year, but sex not determined.

[b]Proportion of males among adults.

[c]Proportion of total number classified to age.

[d]Minimum number, of which only 14 carefully classified.

although sightings were particularly rare from about mid-March through the end of July, suggesting the least distributional overlap between caribou and moose at that time. The heavy snow of early December resulted in a major concentration of moose in valley-bottom habitats, but many had dispersed back to elevations near timberline by mid-January, as the snowpack settled, and they remained more or less dispersed for the remainder of the winter.

Mule Deer

Only two live deer were seen during the study period, a doe and fawn near Hyland Post on 24 October 1980. The deep snow conditions after early December were apparently particularly hard on deer, and "several" dead ones were reportedly seen during a search for dead and dying horses 10 km downriver from Hyland Post in February 1981 (M. Melissen, pers. comm.). Although tracks were common along the lower Spatsizi River in the fall in previous years (unpubl. data), I saw none in that season in 1981 and was near to concluding that mortality the previous winter had been complete for this small deer population. However, guide D. Houser (pers. comm.) reported seeing a fresh set of tracks in early October 1981, indicating that at least one animal had survived.

Stone Sheep

Next to moose, sheep were the incidental species recorded most often during the caribou surveys. Most observations involved wintering groups on the south-facing slopes of Hyland Post Ridge and the bluffs of Upper Marion Creek. Largest classified samples were during fall helicopter surveys (21-28 October 1980 and 9-10 October 1981), during which proportions of lambs among total sheep seen were 24.3% and 28.6%, respectively. It appeared that the animals were particularly concentrated, and visible, in late November, doubtlessly in association with the rut; surveys at that time might produce more reliable results than those conducted at other times.

Mountain Goat

Goats were seen only occasionally, and seldom in winter when their white color is particularly cryptic. There are small,

local populations on the north side of Marion Creek and on the bluffs above Mink Creek, and several groups scattered throughout the Eaglenest Range up to, and including, Mt. Brock.

Wolf

Wolves did not seem as conspicuous as in previous years, but all local packs were apparently still present. In winter 1980-81, six animals were seen on the Klappan River near the mouth of Eaglenest Creek, five more were observed on the Stikine River near the mouth of Marion Creek, and trails of similar-sized packs were recorded for the lower Spatsizi River and the Stikine River near its confluence with the Kehlechoa River. Meanwhile, 12 members of the Bug Lake pack (8 black and 4 gray) were seen in the eastern Eaglenest Range in late January and a pack of 15 (4 black and 11 gray) were observed on Caribou Mountain in October 1981. Several of the animals in the latter group, including three of the grays, were pups; whether this represents a color turnover in the Bug Lake pack or fall increase in one of the other packs is not known.

Other

The only bear sightings in the study area were of a sow and cub grizzly near Black Fox Creek on 21 October 1980, and a single black bear near Hyland Post on 20 May 1981. Red foxes were apparently common in the area during the study year, although only two were seen.

6. DISCUSSION

6.1 General

Continuous monitoring of several individual caribou over one annual cycle has produced some insights relative to what we previously "knew" about the animals in northern British Columbia. Nevertheless, it must be acknowledged that information from only one year can provide little more than an assortment of suggested relationships (hypotheses) and direction for continuing work. To attempt generalization from the study results

presented in preceding pages would be unwise; we now know what some caribou did in the study area during the period of observation, but we do not necessarily know what caribou do.

The primary function of this discussion is to interpret findings in relation to previous knowledge, and to either confirm or raise questions, as appropriate to the data. Preparatory to this exercise, it seems necessary to address two possible concerns of "representativeness" of the data in hand:

1) Were the radio-collared animals representative in their behaviour? There is no reason to believe they were not. Collared animals were usually accompanied by one or more animals without collars, and it was always difficult to ascertain which was which.
2) Was the year of study representative? As shown in the section describing climate of the area, there was an unusually heavy snowfall in December and an atypical snowfall in April. Occupation of upland habitats after those events may have been the result of greater than "normal" snow accumulation in the wind-protected and shady forest. As response to specific weather conditions, much of the observed distribution during the study year may not be repeated in other years.

6.2 Movements and Ranges

The documented movements of 20-40 km between seasonal ranges in the Spatsizi area contrast sharply with corresponding movements of 500 km, and more, for radio-collared barren-ground caribou in northern Manitoba and the Northwest Territoties (Miller et al. 1975). It is, however, in the approximate range for movements recorded among instrumented woodland caribou in lowland boreal forests of northern Alberta (Fuller and Keith 1981) and Manitoba (Shoesmith and Storey 1977). Mean annual ranges for the Spatsizi animals (353 km^2 for males, 612 km^2 for females, Table 5) differ considerably from those observed in Alberta (1,196 km^2 for males and 539 km^2 for females, Fuller and Keith 1981).

As shown, the primary difference is in the result for males, and the small sample for that sex at Spatsizi may at least partially account for that difference. Bloomfield et al. (1981), in eastern Alberta, also documented larger ranges for males than for females, although their sample sizes were smaller than those in Spatsizi for both sexes.

6.3 Summer Distribution (Calving)

Bergerud and Butler (1978) described several caribou birth sites in Spatsizi and, with those observations plus records of cast female antlers in similar habitats in many other ranges in northern B.C. (Bergerud 1978), the general impression is that calving at high elevations is the rule. I observed several females with new calves near timberline at Level Mountain (north of Telegraph Creek, B.C.) in 1978 and 1979 (Hatler, unpubl. reports, B.C. Fish and Wildlife Branch, Victoria). In this study in the Spatsizi area, just two of five radio-collared animals are known or suspected to have given birth above that level (Table 9). The well-defined dispersal and altitudinal variability suggested for female caribou at calving time during this study help explain the difficulties experienced by biologists searching for newborn calves in the area (Bergerud and R. Page, pers. comm.).

6.4 Herd Mixing

For reasons which will be discussed in the section on inventory, it is important to know the extent to which adjacent herds remain separate. In the case of barren-ground caribou, herd identification is on the basis of distribution during the calving season. Those animals sharing a common calving ground are considered to be members of the same herd (see Calef 1978). In British Columbia herds are generally identified by their distribution during the rut (Bergerud 1978). During the current study, one collared female from the "Caribou Mountain" herd is known to have joined with members of the Tomias herd to the south. Further, two of Bergerud's marked animals from the Tomias herd (an adult with a color marker and a calf with a radio-collar) are known to

have moved, in winter, onto or through range occupied by the Caribou Mountain herd (B. Fuhr; R. Page, pers. comm.). Finally, the color-marked Tomias caribou indicated above and four instrumented animals from Caribou Mountain all were found to have crossed the Stikine River, north into an area of potential overlap with the Turnagain herd(s). I have previously documented movements by radio-collared calves (and presumably their mothers) of more than 70 km from their capture sites on Level Mountain, to locations which put them in areas of potential overlap with at least two other herds, the Kawdy and Swan Lake herds to the north (Hatler, unpubl. report, B.C. Fish and Wildlife Branch).

Jakimchuk and McCourt (1975) described mixing of two herds of barren-ground caribou, with members of the Fortymile Herd occasionally moving north with the Porcupine herd and with a substantial number of the former having become "permanent" members of the latter, owing to their continued use of the Porcupine calving grounds. Discussing these same two herds, LeResche (1975) stated that "interchange of animals with other herds has taken place, and changes in distribution have occurred several times in recorded history". In short, there is no good reason to expect northern British Columbia herds, as defined above, to remain discrete from each other, and our initial observations confirm that they do not.

6.5 Inventory

As noted in the introduction, concern for B.C. caribou populations during the mid-to late 1970's led to questions about our ability to assess them. Accordingly, one of the objectives of this work was to provide a beginning evaluation of caribou "inventory" methods and results in northern B.C. Following comments deal with the assumptions behind and factors affecting counts rather than the actual mechanics of the counts. The fall 1981 survey on Caribou Mountain (see Table 11) serves as the basis for discussion:

6.5.1 Distribution and Timing

As discussed in a previous report (Hatler 1981), the October 1981 survey was apparently "late" in that rutting

activity was clearly over. Further, distribution of animals on the Caribou Mountain rutting range (Fig. 1) was grossly different from that at the same time in other years in my experience. It was also different from that found later in the fall, during the capture period and November tracking surveys in 1980. The primary difference was that during the 1981 survey period, animals were concentrated in the western half of the area, instead of dispersed over the whole area. The cause and significance of this difference is not known, but it applied also to the Edozadelly rutting area on the same survey (Hatler op. cit.). One possible effect of concentration is that less area had to be searched intensively, i.e., our ability to find animals may have been more efficient than usual.

6.5.2 Numbers

Table 12 lists the total numbers of caribou seen on comparable rut season surveys in recent years. The relationship between these numbers and the actual number of animals assignable to the Caribou Mountain herd is not known, except that in each case the number is less than the "real" total. Except for the 14 October 1979 count, which was severely hampered by bad weather, the lowest and the highest counts were obtained in 1977. Using the higher number as a baseline, one would postulate a decline in numbers between that year and the present. However, there is no sound reason for choosing that count as the baseline; evidence from the radio-tracking results indicates the possibility that animals seen on that day might have come from another area, or alternatively, could have gone elsewhere in subsequent years.

For comparisons of counts on the same area in different years to have any validity in terms of measuring population changes, a necessary condition is that animals seen in that area in year 1 will most likely also be there in year 2. In this case, of nine radio-collared animals which were captured

among the Caribou Mountain post-rutting herds in October 1980, three (33.3%) were present in the Spatsizi Park area, but had not returned to Caribou Mountain by the tracking flight of 12 October 1981. If this sample is representative, up to one-third of the animals in the 1980 count (3 of 7 females = 43% and 0 of 2 males) may have emigrated to other rutting areas, or may not have attended a rutting area in 1981. Were these replaced in part by immigrants from other rutting areas?

Of the six collared animals known to be present on Caribou Mountain, five were actually seen during the course of the surveys without their having been detected electronically beforehand.

Although the collared sample is too small for firm conclusions, this result suggests that most of the animals actually present on the mountain (83.3%?) were seen during the surveys. A Lincoln Index type of projection on these data would indicate that there were approximately 282 animals present; however, again, the question of how this may be compared with the 1980 data to arrive at conclusions related to caribou survival between the two years depends upon the extent to which emigration (of which we know that some occurred) was balanced by immigration (none can be documented).

The above discussion treats factors which may result in underestimation of study populations. It was also evident in our surveys that under conditions in which it becomes necessary to back-track over areas already counted, duplicate counts are almost certain to occur. In this case, low cloud covered some of the ridges we knew should be surveyed, so we left them temporarily and returned when viewing conditions improved. One small herd, recognizable due to the presence of the smaller of our two collared bulls, was seen at three different locations several km apart (once on the 9th and twice on the 10th). This group consisted of 13, 14 and 16

Table 12. Results of caribou counts (total numbers) on the Caribou Mountain rutting range, Spatsizi Wilderness Park, British Columbia, 1977-1981.

Date	Number Seen	Observers[a]
Late September 1977	212	Hatler and Hazelwood
7 October 1977	348	Hatler and Hazelwood
14 October 1979	227	Hazelwood and McGregor
22 October 1979	195	Eastman and Webb
29-30 September 1980	273	Hatler and Jones
21-22 October 1980	219	Hatler and Page
9-10 October 1981	234	Hatler and Jones

[a]Unpubl. reports, B.C. Fish and Wildlife Brqnch and/or Parks Branch, Victoria.

individuals on the three contacts, and it would almost certainly have been counted all three times had the collared animal not been present. Another group of 43, the count obtained carefully from the ground, was later seen as two separate groups (33 plus 15 = 48) going in opposite directions less than an hour later. Again, the presence of collared animals (two in the original group, with one going to each of the subsequent groups) made "correct" interpretation possible, i.e., that this was a duplicate sighting. Without the presence of the collared animals it would have been tempting to include at least the smaller group as "new". Interestingly, the two collared animals involved, No. 1 and No. 3, were back together again in a group of about 40 near the site of the original observation two days later (12 October). To summarize this part of the discussion, it is likely that our count would have been inflated by at least 30 and maybe even 45 animals without the presence of collared animals to set us straight.

As indicated, biases in both directions are possible and evidence from the presence of the electronically marked animals indicates that, at least during counts in bad weather, both may be in effect at the same time. The overall conclusion is that we can not document local population changes with the routine fall counts we have been employing in this area. The question of whether we can do it all (and if so, when, how and at what expense) can not be answered without more marked animals and more intensive (replicated) observations.

6.5.3 Classification

The 9.0% calf ratio among observed animals on Caribou Mountain in October 1981 (Table 11) is lower than that obtained in 1980 (13.6%, N=273 on 29-30 September), but is generally equal to or higher than in other recent past years (6.6% of 227 animals on 22 October 1979; 9.2% of 195 animals eight days earlier (14 October 1979); 4.9% of 175 and 7.6% of 197 in two counts in October 1977.

Bergerud (1978) argued that "the most important management tool is measurement of annual recruitment" and he recommended counting calves during the rut to obtain this information. The primary objective of the fall classification counts has been to obtain data on recruitment potential. The assumption is that females with calves are as likely to appear in the rutting herds as are those without. We now have reason to question that assumption. Of the seven collared females which were still alive and bearing functional transmitters, four were known and three were suspected to have produced calves. By the time of the October count, only two still had their calves, and neither of these came to the Caribou Mountain rutting area. The other female which did not return to the Caribou Mountain rut was one which apparently lost her calf on Tomias Mountain in about July, and then joined a rutting herd there. The four females which did return to Caribou Mountain in fall 1981 were all seen without calves.

Of the two females which did not lose their offspring, one (No. 7) remained alone with the calf high in the Eaglenest Range throughout the summer and fall. When seen on 10 October, she was still high in an alpine basin (about 6000') and there were no other caribou tracks in the area. She had hard antlers with a small amount of clinging velvet, thus she had apparently gone through at least a first estrus. There is a good chance that she was not bred this year. The other female (No. 4) was missing from late May until 8 October, when a signal was received from the head of the Dawson River. She was finally seen on 12 October, north of the above location but still south of the Spatsizi River, in a group of 24 (of which a minimum of 6 were calves). There were no large or medium bulls in that group, although it seems more likely that a wandering male might have found this group at the right time than is the case for No. 7. Without radio collars, neither would have been found by biologists, because those areas are not surveyed in the fall.

Both of these animals were originally captured on Caibou Mountain and should be assumed to be p art of "that hered". If they and the animals accompanying them had been seen in the October classification count, the calf ratio would have changed from 21 of 234 (9.0%) to a minimum of 28 out of 260 (10.8%). Did we miss more females with calves than those without? In past studies such as those on Level Mountain, I have frequently expressed concern that small groups, which are more widely dispersed and easiest to overlook, appear to support proportionately more calves than do the larger ones. I have also been faced with the necessity to explain spring yearling ratios which were higher than corresponding calf ratios the previous fall (Hatler, unpubl. Level Mountain reports, B.C. Fish and Wildlife Branch, Victoria). The results from observations of the collared Spatsizi animals confirm that the potential negative bias in fall calf counts, should be studied more intensively, i.e., with more marked animals and more regular monitoring.

6.6 Factors Affecting Counts

Again, ignoring the many mechanical, mathematical and human factors which impinge upon our ability to census wildlife (see Caughley 1977) following comments summarize and evaluate those aspects of caribou biology and distribution which may affect our ability to make contact with them in the absence of electronic aids, as during most "normal" aerial surveys. It is my view that every species has a particular set of circumstances (time/place/weather) under which it will be "most vulnerable" to being counted, i.e., when the highest proportion of its local members will be occupying habitats in which it is most readily seen. Bergerud and Butler (1978) contended that "October counts" (in Spatsizi) "included nearly all the population". Yet, in a report of intensive observations of a rutting herd on Mt. Albert, Quebec, Bergerud (1973) noted that there was "constant turnover" with "usually less than one-third of the known individuals present on any one day". The results of the Spatsizi study, as presented above, also give reason

to question whether single counts in October are representative, let alone accurate. This is not to say that the rut counts do not give the best possible results; rather, I contend that we do not know and can not know without examining other times. Observations of radio-collared animals throughout the year enable us to hypothesize other such times to be examined and to rule out many others.

6.6.1 Sightability

During replicated surveys of a known number of moose in enclosures in Alaska, LeResche and Rausch (1974) found that observers saw an average of only 68% of the animals under the best conditions. Caribou are smaller and are more cryptically colored, and sightability is almost certainly less for them than for moose. Several times during the tracking studies animals known present were not seen until after three or more passes with the aircraft. On a few occasions this occurred in very open terrain under conditions thought to be ideal. Regardless of how well the time and conditions for a survey may be selected, a proportion of the animals present will not be seen. Future studies with large numbers of instrumented animals may give some insight into how large and variable this proportion may be.

6.6.2 Distribution

Locations of collared animals throughout the year indicated that the most consistent occupation of alpine habitat was in late winter-early spring, and highest total counts were also obtained then. Thus, that period should be considered for a comparative evaluation with the rut survey in terms of accuracy and precision of survey results.

6.6.3 Group Size

If most caribou groups are large, the accuracy consequences of missing some are greater than if most are small; also, the precision consequences of dealing with mostly large groups are greater in that it is more difficult

to classify all of the animals in such groups. On the other hand, small groups are more difficult to locate, especially if they are widely dispersed. Analysis of tracking results indicated (Table 10) that during the period of greatest visibility (late winter) groups averaged larger than at other times. Whether they were significantly larger must await further studies.

6.7 Implications

As implied on preceding pages, caribou biology tends to be confusing because of the adaptability and mobility of the animals. Whether woodland or barren-ground, it appears that they do not occur in the discrete, well-defined units which managers might prefer. As noted by Hemming (1971) for Alaskan caribou, "they visit some areas annually, and may utilize others only once in a decade. Even preferred areas are used only a few weeks each year". LeResche (1975) added that "individual subpopulations (herds) have never been stable in terms of numbers or range". Skoog (1978) went so far as to speculate that "all the caribou in Alaska (are) one population".

I believe that the same could be true for animals in northern British Columbia. The tendency to treat individual rutting herds as discrete entities tied to the rutting areas may cloud our management thinking. Preoccupation with changing local hunting quotas by 1 or 2 percentage points could result in managers missing the big picture, which might be the whole picture. Caribou need space -- big wilderness. The relatively sedentary, local "herds" in the southern half of the province (Selkirks, Telkwa -- see Bergerud 1978) may be the result of activities far from the assumed area of interest, centered on rutting areas. Linear developments (highways, railways, reservoirs) might tend to cut off movements, selecting for those types with the least wandering tendency. LeResche (1975) noted that many of the smaller Alaskan herds have been repeatedly built up and nurtured by the healthy, wide ranging larger ones. Knowledge of the relationships among the various rutting groups of caribou in northern B.C., and methods for assessing numbers and

composition with confidence, are badly needed.

7. SUMMARY

- Fifteen adult caribou, four males and eleven females, were fitted with radio transmitter collars in northern Spatsizi Wilderness Park in October 1980, and were followed during 22 aerial tracking surveys from then until October 1981.
- Four animals died or lost their collars shortly after capture; of the remaining eleven, two others (18.2%) died apparently natural deaths during the year of observation.
- Most of the animals made movements of 25 km or more during or shortly after a heavy snowfall in early December, then made only minor movements during the rest of the winter.
- Females, but not males, showed another peak in long-distance movements in late May and early June. This was a dispersal to calving areas.
- Most of the animals moved west into the Eaglenest Range and spent much of the winter at or above timberline in that area. Two remained in uplands in the Caribou Mountain area and three moved to areas north of the Stikine River during that period.
- The collared animals were most widely dispersed during January and February; there was a secondary peak in dispersal in June, after calving.
- The mean annual range documented for 8 females was 612 km^2 while that for 3 males was 367 km^2.
- Although the collared animals were designated as part of the Caribou Mountain herd by virtue of their locations in fall 1980, all but two spent the bulk of the year outside the upland boundaries of Caribou Mountain and 33 per cent did not return there at all during the year of study.
- Collared animals were contacted in open upland habitats most consistently in February and March. At least some

were occupying forested habitats during most of the rest of the year, but especially in April and May.

- All seven females still extant in June 1981 are known or suspected to have produced calves, but only two of these (28.6%) survived until October. Causes of loss could not be determined.
- Calving sites were mostly at or below timberline.
- Evidence for mixing among adjacent herds was found; one collared female moved to the Tomias Mountain rutting area in 1981, and the ranges of at least two animals from that area are known to have recently overlapped with that of the Caribou Mountain animals.
- Caribou are censused in this area in the fall, during the rut period, to determine changes in numbers and recruitment potential. Known distribution of collared animals during this period in 1981 suggests that these results may be biased:
  a) only two-thirds of the collared animals known to be present in the general area during the rut survey were actually present in the count area during the count days.
  b) the only two collared females which still had live calves on count day were among those missing from the count area.

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Appendix 1. Monthly snow-pack (cm)[a] at ten weather stations[b] in the vicinity of the Spatsizi caribou study area, October-September 1979-80 and 1980-81.

Station Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Dease Lake												
1979-80	0	0	32	38	49	57	0	0	0	0	0	0
1980-81	2	9	61	53	62	52	40	0	0	0	0	0
McBride River												
1979-80	0	0	24	58	55	55	0	0	0	0	0	0
1980-81	3	7	71	45	63	59	28	0	0	0	0	0
Klappan												
1979-80	0	0	(23)	55	60	65	0	0	0	0	0	0
1980-81	0	5	47	46	55	12	(30)	0	0	0	0	0
Pitman												
1979-80	0	4	44	41	56	60	(14)	0	0	0	0	0
1980-81	2	-	89	60	66	64	64	(15)	0	0	0	0
Dawson												
1979-80	0	1	17	26	51	32	0	0	0	0	0	0
1980-81	1	2	72	48	51	35	(31)	0	0	0	0	0
Chukachida												
1979-80	0	3	30	35	48	69	0	0	0	0	0	0
1980-81	-	6	86	63	71	66	71	0	0	0	0	0
Didene												
1979-80	2	31	44	68	80	95	107	(17)	0	0	0	0
1980-81	12	37	105	89	112	117	131	(37)	0	0	0	0
Upper Stikine												
1979-80	4	27	54	98	110	124	124	(54)	0	0	0	0
1989-81	13	-	120	41	143	-	163	(74)	0	0	0	0

(continued)

Appendix 1. (continued)

Station Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
McBride 5000												
1979-80	0	9	34	56	67	91	80	0	0	0	0	0
1980-81	7	27	74	77	76	77	102	(13)	0	0	0	0
Eaglenest Cr.												
1979-80	0	27	38	71	80	99	82	(9)	0	0	0	0
1980-81	7	11	82	70	80	83	99	(34)	0	0	0	0

[a]Rounded to nearest whole cm; parentheses indicate those instances in which snow cover was not 100% on the study site, i.e., patches of bare ground were present.

[b]Stations listedin order of increasing elevation; see Appendix 2 for descriptions of physical features of each. Data from files of Air Services Branch, B.C. Ministry of Environment, Prince George, B.C.

Appendix 2. Characteristics of nine recording weather stations for B.C. Hydro dam feasibility studies, Spatsizi Wilderness Park and vicinity, British Columbia.

Station Name	Elevation[a] (m)	Latitude and Longitude		Aspect[b]	Topography	Biogeoclimatic Zone[c]
McBride River	775	57°58	129°16	180	valley bottom	Boreal black and white spruce
Klappan	885	57°36	129°26	315	valley bottom	Boreal black and white spruce
Pitman	946	58°02	127°52	180	valley bottom	Boreal black and white spruce
Dawson	1037	57°38	128°12	000	valley bottom	Boreal black and white spruce
Chukachida	1083	57°40	127°36	090	valley bottom	Boreal black and white spruce
Didene	1342	57°17	128°52	180	valley bottom	Alpine tundra
Upper Stikine	1394	57°15	128°19	140	valley bottom	Subalpine Engelman Spruce-Subalpine fir
McBride 5000	1499	58°03	129°09	040	Bench,mtn.slope	Subalpine Engelman Spruce-Subalpine fir
Eaglenest Cr.	1525	57°37	129°00	270	Bench,mtn.slope	Boreal Black and white spruce

[a] Nearest whole m

[b] Direction station faces, with 000=N, rotating clockwise.

[c] Designations from Krajina (1965), and applied to these sites by the climatological study team (T. Muirhead, pers. comm.); it is likely that the three highest stations, at least, would be more properly assigned to Krajina's spruce-willow-birch zone (J. Pojar, pers. comm.).

Appendix 3. Radio transmitter and visual marker characteristics on caribou captured in Spatsizi Plateau area, 21-28 October 1980.

Animal Number	Radio Collar Data				Other Markers
	Colour	Number	Markings[a]	Freq.[b]	
0	white	0	numbers only	.010	-
1	white	1	1 black, 1 green band	.020	-
2	white	2	3 black bands	.030	-
3	white	3	2 green bands	.041	-
4	white	4	1 wide red band	.050	-
5	white	5	1 red, 1 black band	.060	-
6	white	6	1 wide yellow band	.081	-
7	white	7	1 wide green band	.070	-
8	white	8	2 black bands	.090	-
9	white	9	2 red bands	.120	-
10	green	0	black number on yellow	.181	-
11	-	-	-	-	orange collar
12	-	-	-	-	ear flags[d]
13	green	1	black number on yellow	.211	-
14	green	2	black number on yellow	.200	-
15	green	3	red number on yellow	.149	-
16	green	4	red number on yellow	.170	-

[a]Coloured bands parallel to the axis of animal's body.

[b]148.XXX MH_z

[c]Fluorescent orange collar with black "X" on sides.

[d]Fluorescent red on left ear; fluorescent green on right.

Appendix 4. Technical data[c] relating to immobilization of 18 caribou in Spatsizi Wilderness Park, 21-28 October 1980.

Animal No.	Sex	Age[a]	Dosage (mg) M99	Dosage (mg) Rompun	Temp (°C)	Heart Rate	Resp. Rate	Time (min)[b] Ind.	Time (min)[b] Rec.	Time (min)[b] Down	Comments
0	F	5	3	40	40.8	20	15	<20	1.5	76	Satisfactory
1	F	2	3	50	40.7	27	17	<20	15.0	85	Ataxic after recovery (excess Rompun)
-	M	C	3	50							Dead consequent to jugular-carotid laceration
2	F	3	3	50	41.0	44	13	16	16	79	Ataxic after recovery (excess Rompun)
3	F	Ad	3	50	-	-	-	10	R	-	Sedate and ataxic (excess Rompun)
4	F	Ad	6	60	-	-	-	-	R	-	Inadvertently struck by two darts, reversed quickly
5	F	13	3	50	40.0	36	10	8	2.5	28	Injection into fat pad, incomplete immobilization
6	F	Ad	3	50	40.2	34	14	12	-	-	Sedate after reversal (excess Rompun)
7	F	Ad	3	30	-	-	-	12	1.5	35	Superb
8	F	(Ad)	3	50	42.2	78	17	20	1.5	31	OK, rather light, nice recovery
9	F	(Ad)	3	30	-	-	-	>20	-	30	Light, would not rise after recovery (leg injury?)
10	F	(Ad)	3	50	-	-	-	>20	-	-	Under-dosed, did not go completely down, nice recovery

(continued)

Appendix 4. (continued)

Animal No.	Sex	Age[a]	Dosage (mg) M99	Dosage (mg) Rompun	Temp (°C)	Heart Rate	Resp. Rate	Time (min)[b] Ind.	Time (min)[b] Rec.	Time (min)[b] Down	Comments
11	F	Ad	3	30	-	-	-	-	1.5	65	Standing, excellent recovery
12	F	C	3	30	-	-	-	6	-	-	Animal reversed, but left in sternal recumbancy, head up, still heavily tranquilized
13	M	2	4.5	70	40.5	28	30	<15	12	55	Ataxic after recovery, (excess Rompun)
14	M	(Ad)	4.5	70	40.7	46	18	14	12	55	Sedate and ataxic, (excess Rompun)
15	M	10	4.6	40	40.8	36	36	21	1.5	76	Excessively long induction, facial abcess
16	M	5	4.7	50	41.3	26	20	<30	R	-	Incomplete recovery, animal very deep at one point

[a]See Table 3 for explanation of age categories.

[b]Time in minutes from strike of dart to induction (Ind.), from injection of antidote to recovery (Rec.) and total time from induction to recovery (Down).

[c]Compiled by D. Pitt-Brooke, D.V.M.

Appendix 5. Detailed account of capture, handling and marking procedures, and materials, for caribou project, Spatsizi Wilderness Park, October 1980.

The following account of the caribou capture work is designed to serve as a logistical and methodological guide for those who might be planning similar work.

GENERAL:

Operating from facilities near the capture area (Hyland Post in the lower Spatsizi River Valley), we captured 18 caribou between the morning of 21 October and the early afternoon of 28 October 1980. Approximately 1.5 hours of helicopter time was required for the capture of each animal (see Table 2, this report).

PERSONNEL:

D. Hatler, Project Leader, former regional wildlife biologist for northwestern quarter of B.C.

R. Page, graduate student biologist, experienced in the capture and handling of caribou

D. Pitt-Brooke, D.V.M., specialist in animal immobilization procedures

T. Brooks, pilot, Highland Helicopters Ltd., Smithers, B.C.

METHODS AND MATERIALS:

Capture

Caribou were spotted from the air (Bell 206 "Jet Ranger" helicopter) and, based on several factors (location, topography, presence of desired animals) a decision was then made as to whether to attempt a capture. Having made the decision to attempt, Page, Pitt-Brooke and myself were landed at some distance from the animals (300 m up to 2-3 km, depending upon topography and wind conditions), where we then dispersed to hiding spots near the landing area. We attempted to stay within sight of each other, but beyond the normal trajectories of our immobilizer darts (40-60 m). Whether or not we could see each

Appendix 5. (continued)

other on every occasion, we each took pains to know where the others were, and no darts were fired in those directions. (Safety in the use of a very dangerous drug was the paramount consideration, both in the field and during preparation of the loaded darts back at base camp).

The pilot then proceeded to gently herd the caribou towards the hiding spots. Emphasis in the above sentence is on the word "gently". Animals which are hard pressed by the machine are likely to break away to some other direction; those which walk by the hidden gunners can be darted while those which run by will usually be missed; those which are overly excited are likely to respond less favourably to the drug and/or may be harmed. Brooks developed the herding technique admirably: one of the adult males was "escorted" almost 3 km, and it walked the entire distance.

Within the limits of "gentleness" in herding, the pilot attempted to keep the animals in the vicinity of the hidden gunners until they had scored a hit, or had shot all their darts. A signal (arms outstretched horizontally) was devised to alert the pilot and the others on the ground that a hit had been made. Upon seeing this signal, ground personnel unloaded dart guns and left their stations, the pilot picked them up and all proceeded to some distant point, sometimes aerial hovering, to watch and wait for the drug to take effect.

Some tentative conclusions on the herding are as follows:

- adult bulls were the easiest to bring within darting range, adult females without calves were next and adult females with calves were the hardest (wildest).
- animals were herded uphill more readily than down or laterally.
- animals herded better and were less wary on open terrain than in timber or high brush habitats. The

Appendix 5. (continued)

most successful hiding places were behind boulders on open tundra.

- once a group of animals has become aware of the hidden gunners, there is no point in continuing a capture attempt on them at that location, and it appeared that groups tried again later in the day at another location were less responsive to the helicopter than they had been the first time.

Capture Materials

Palmer "Cap-chur" equipment (Canadian distributor Arnold Nasco Co., Guelph, Ontario) was used to deliver the drug to the animals. This included two rimfire charged rifles using the low range (green) charges and two CO_2 powered pistols. Syringes were thoroughly cleaned, dried, lubricated and assembled the night before. The drug was prepared and added in the morning, just prior to departure, with two "standard" doses (one for females and one for males) in color coded darts. A fairly long needle, 3-4 cm, is preferable.

Most hits were with the rifles, at ranges from about 10 to 35 m and, because they cause less damage, are preferred at such ranges. Only one animal was hit and not subsequently captured. In this case the dart was fairly low on a hind leg, possibly in tissue where absorption was unusually slow.

The immobilizing drug was etorphine hydrochloride (M99), used in combination with the tranquilizer Rompun. All darts intended for females were loaded with a standard dose of 3 mg. of M99, while those for males ranged from 4.5 to 4.7 mg. (see Appendix 4). For the three animals actually weighed, the effective doses were as follows:

Animal No. 0, 5 year old female, 145 Kg. - 0.020 mg/Kg
Animal No. 14, young adult male, 175 Kg. - 0.026 mg/Kg
Animal No. 15, 10 year old male, 245 Kg. - 0.019 mg/Kg

One female was inadvertently hit with two darts, thus

Appendix 5. (continued)

doubling her effective dose, but she was quickly reversed with an injection of the antidote and apparently suffered no ill effects. As shown in Appendix 4, Rompun was delivered to the animals in quantities ranging from 30-50 mg. for females and 40-70 mg. for males. Based on post recovery observations, we recommend 35 mg. as a good average dose for females and 40-45 mg. for males.

Animal Handling

Induction time for the drug was variable depending upon a number of factors, but especially the location of the dart on the body and body size. Some females proved to be larger than expected. Most animals took at least 10 minutes for induction, a few took 20 or more and two (which we nevertheless did manage to capture) never did go completely down. Both of the latter became hyper-excited (a known symptom of underdosing with M99), and both travelled up to 2 miles before stopping. These were both lost from view in the helicopter and had to be tracked on the ground. Without snow cover, neither of these would have been captured, although presumably both would have recovered from the drug. From the standpoint of recovering drugged animals, it was best to operate away from heavy vegetative cover and it was easier to keep track of animals in small groups (less than 20) than in large ones.

Once an animal was seen to be down, the collaring crew approached on foot from a distance of 300 m or more. The helicopter was allowed to closely approach drugged animals only for weighing (3 occasions) and in emergency situations (twice, to quickly get to calf caribou which had been accidentally struck by darts). Upon being reached, the animal was assisted to sternal recumbancy if it had not taken that position on its own, and a blindfold was applied. We

Appendix 5. (continued)

then fitted the radio collar or other marking device, took variety of measurements (see Table 3) and if the animal seemed adequately drugged, removed an incisor tooth for age determination. Teeth were obtained from 8 of the 16 adults handled, and rough age was estimated for 6 others by a combination of tooth wear, body size and antler characteristics.

Meanwhile, Pitt-Booke extracted the dart, using a small scalpel incision to free the barb if required, and flushed the resulting wound with an antibiotic ointment (Strepenco, from Rogar-STB) and usually also administered an injection of intramuscular antibiotic (Strepenalean, from MTC Pharmaceuticals). One animal, a 10 year old male, had a large facial abcess, presumably suffered during the rut. This wound was also attended, by lancing, draining, thorough flushing and an extra dose of antibiotic.

Effects of the drug were monitored through observation of rectal temperature, heart and respiration rate, behaviour and extent of eruction, the last as an indicator of freedom from bloat. For the animals monitored during the Spatsizi project, average rectal temperature was 40.8^{o}C, with a range of 40.0 to 42.2^{o}C, average heart rate was 31/minute (range = 10-36).

When all work had been performed, Pitt-Brooke administered a large dose of the M99 antidote, Diprenorphine (M50-50, 10 mg. for females and 16 mg. for males) and the animal was then allowed to rise and go on its own time. Time from injection to recovery averaged about 6 minutes, but was much quicker when an intraveneous (jugular) injection was achieved (1-4 minutes with most less than 2 minutes) than when the injection was intramuscular (12-15 minutes). In several cases, when animals remained ataxic and unusually sedate due to an apparent excess of Rompun, an intramuscular dose of the stimulant Dopram was given immediately following the administration of M 50-50.

Appendix 5. (continued)

Animals were in hand for an average of 54 minutes. The range in this case was 28-85, with the trend toward shorter times as we gained experience and procedures became routine.

David Pitt-Brooke has prepared a very detailed report on the Spatsizi caribou capture work, including much of the data presented above, but also presenting a discussion of factors to consider in selection of drugs and doses, explanations of how the various drugs work, and a complete checklist of items required or deemed useful for a project of this kind. His report is available from the Spatsizi Association upon request.

Marking

One adult female was fitted with a bright orange neck collar and a female calf was outfitted with small bright ear flags secured with Ketchum ear tags. All the rest were instrumented with radio transmitter collars in the 148 MH_z frequency range (from Telonics Telemetry-Electronics Consultants, 1300 West University Drive, Mesa, Arizona 85201). The ten collars designed for females were constructed of 2 inch wide, relatively rigid urethane belting, while the five for males were of a flexible rubber inpregnated dacron, sewed in a series of gathers thereby allowing the stretching necessary to accomodate neck swelling during the rut.

All transmitter-collar packages were of the Telonics "Configuration 5B" design. Although these have performed admirably, it is now evident that the mortality sensor option would be well worth the small extra cost involved in having it installed. We expended needless hours monitoring some collars long after they had ceased to be carried by live caribou.

Appendix 6. Summary of movements and status of radio-collared and visually marked caribou, northern Spatsizi Wilderness Park and vicinity, October 1980-October 1981.

Animal No. 0

Adult female, age 5, with calf when captured on 21 October 1980, contacted on 16 of 22 tracking flights, animal and signal still alive on 12 October 1981.

Shortly after tagging she began a northwestward movement, crossing Cullivan Creek in November (the only animal to do so). She went as far west as Un-named Mountain (2 January), then moved back south and spent the rest of the winter, through March, on the eastern slopes of the Eaglenest Range (above Bug Lake). She was out of contact on two April flights, probably deeper into the Eaglenest Range, but reappeared in the Cullivan Creek valley north of Coldfish Lake on 20 May. She was next contacted at about 6000' on a steep, rocky slope west of Nation Peak, Eaglenest Range, on 10 June, and she is presumed to have had a calf there, although she was not seen. By 18 June she had moved a few km around a ridge to the south, taking up residence in a thick patch of stunted alpine fir on a NE-facing slope at the head of Eaglenest Creek. She was still present in that location on 24 July, and since she had not been seen on any of three flights on which she had been contacted there, she was feared dead. However, on 30 August she was seen north of Blackjack Mountain with 5 other animals. If, as suspected, she did have a calf in the Eaglenest Range, it was no longer with her on that date. In October she was among the post-rutting companies back on Caribou Mountain.

Animal No. 1

Young adult female, age 2, no calf when captured on 22 October 1980, subsequently contacted on all 22 radio-tracking flights, and still alive and sending signals in October 1981.

Appendix 6. (continued)

After capture she moved gradually westward, ending up on the northwest end of Cartmel Mountain, overlooking McEwan Creek, by the end of December. She stayed there in January, but then moved out to Un-named Mountain where whe remained until the second half of April. Moving south from there through the Eaglenest Range, she then turned back north and was contacted in heavy timber east of Moose Flats on 20 May. However, she then made a large movement back to the south, this time ending up just east of the goat bluffs over the confluence of Mink Creek and with Spatsizi River. She was still in the general vicinity and still had the calf on 26 June, but had moved across the valley into the Gladys Lake area (Eaglenest Range) by 24 July. She was not seen on that occasion, but was again seen on 30 August, near the head of Ambush Creek back on Caribou Mountain, and at that time the calf was no longer present. She stayed on Caribou Mountain, presumably participating in the rut there, and was seen there on both October flights.

Animal No. 2

Adult female, age 3, without calf when captured on 23 October 1980, contacted on 19 of 22 tracking flights, and still alive and functioning in October 1981.

Like No. 1, she moved northwest out to Cartmel Mountain after the big snow in December, spent the month of January there, and then moved out to Un-named Mountain and remained there until about the end of March. She was located on the eastern slope of the Eaglenest Range on two flights in April, and on 3 May, but then moved southeast and was south of the Spatsizi River, across from the mouth of Kliweguh Creek by 20 May. She was seen up the Dawson Valley at about timber-line with a tiny, new calf on 8 June, and the two were still together in roughly the same area on the 18th. However, she lost the calf sometime during the following week, and was seen in alpine habitat with four other adults on Skady Mountain on the 26th. She then moved across the Spatsizi back on to

Appendix 6. (continued)

Caribou Mountain, occupying the Hyland Post Ridge area during July and August. She was contacted and seen among the post-rutting herds on the west end of Caribou Mountain in October.

Animal No. 3

Young adult female, estimated 2-3 years old by tooth wear, no calf present when captured on 23 October 1980, contacted on 19 of 22 tracking flights, still alive on 12 October 1981.

This was the most sedentery of the collared females during the study year, moving off the Caribou Mountain block only during the calving season. She spent most of the winter (at least the end of January through 3 May) in alpine habitat immediately NE of Coldfish Lake. On the 20th of May she was found on the north side of the plateau, above Moose Flats, but she then turned back south and went deep into Eaglenest Range, to the head of Tsetia Creek, where she presumably had a calf. She was located there twice (9 and 18 June), but not seen until 26 June, at which time she was found alone at the head of Eaglenest Creek, near Nation Peak. She was farther north yet, still in the Eaglenest Range, in July, but moved back onto Caribou Mountain in August and was among the post-rutting groups seen there in October.

Animal No. 4

Adult female, no calf present when captured on 24 October 1980, contacted on 16 of 22 tracking flights, contacted and seen alive on 12 October 1981.

She made an extreme movement to the west after the heavy December snowfall, ending up on the mountains west of Mt. Brock, but she eventually moved across McEwan Creek and joined several other animals on the NW end of Cartmel Mountain. As with most of the others, she stayed there through January, but then moved back east, spending February and probably most of March on Un-named Mountain. She was on the east slope of

Appendix 6. (continued)

the Eaglenest Range, over Bug Lake, on 29 March, but had moved across the valley to the ridge NW of Coldfish Lake by mid-April. She stayed in that general area, moving a bit north of timbered slopes above Moose Flats, where she was located at the end of the month, but she then disappeared. She was not contacted again until 8 October, this in Griffith Creek at the head of the Dawson River. She was not seen on that occasion, but on 12 October she and her calf were seen among a group of 24 (at least 6 calves) a few km north of the Griffith Creek location. It is evident that both October contacts were of this group in a northward movement from calving areas unknown, possibly somewhere between Buckinghorse Lake and Fire Flats.

Animal No. 5

Old adult female, age 13, accompanied by a calf when captured on 24 October 1980, no certain movement after the first location post capture, confirmed dead on 10 October 1981.

The precise history of this animal can not be determined. It moved north off the plateau after capture, and was contacted but not seen in timbered habitat near Moose Flats on the first tracking flight (22 November). There was no significant movement from that area on any subsequent flight, and the badly chewed collar, a scapula, and several wolf scats containing caribou hair were found in a small birch bog at about 4400' in that area in October 1981. It is possible that the animal spent up to several weeks foraging in this area before being caught by the wolves, but the fact that none of the others remained in timbered habitat past mid-December makes this unlikely. The most plausible interpretation is that she died (was killed) sometime between capture and the first tracking flight, and there is a strong possibility that her death was in some way related to handling during capture.

Appendix 6. (continued)

Animal No. 6

Adult female, no calf present when captured on 25 October 1980, contacted on 11 of 14 tracking flights made before her death in May 1981.

She moved only a bit northwest of Caribou Mountain in November, then was completely out of contact in December. By mid-January she was found to have crossed the Stikine and continued on more than 60 km north, to the King Mountain area. She remained there through the middle of March, and then on 29 March was contacted, but not seen, about half way back toward Caribou Mountain, somewhere along the Kehlochoa River. The next good location was along the Stikine River, but still on the north side, on 3 May. By 20 May she had crossed the river and the signal came from a fairly open stand of timber, with abundant ground lichens, not far from the previous location. There was no further movement from that area and on 10 October 1981 it was confirmed that she had died there. The collar, which was badly chewed, was picked up about 300 m south of the river, at the edge of a small willow swamp in mature spruce-aspen habitat. No animal parts of scats were found, but is is believed that she was killed by wolves.

Animal No. 7

Adult female, calf present when captured on 26 October 1980, contacted on 18 of 22 tracking flights, contacted and seen alive on 8 October 1981.

As with several of the others, she moved northwest after the December snow, ending up on Cartmel Mountain and remaining there until at least mid-January. By mid-February she had disappeared, probably somewhere in the western Eaglenest Range, and was not contacted again until 16 April. She was contacted but not seen on a high razorback ridge on the northeast corner of Cartmel Mountain on 3 May, and then moved north out of the mountains to the flats north of Ford Pass by 20 May and then to

Appendix 6. (continued)

the west-facing side of the Coldfish Lake valley by the end of that month. She was contacted on all subsequent flights in the general vicinity of Mt. Will-Gladys Lake. She was seen with a small calf there on 18 June, and it was still present the next time visual contact was made, on 10 October 1981.

Animal No. 8

Adult female, age 8 years, no calf present when captured on 27 October 1980, contacted on 18 of 22 tracking flights, still alive and signaling on 12 October 1981.

This was the most mobile of the collared animals. She had moved only a short distance west of Cullivan Creek by 22 December, but in the following 11 days she traveled across the Stikine and on northward for 54 km, ending up in the general location at which No. 6 was to appear two weeks later (a barren, rocky ridge east of Proventure Lake in the Upper Kehlochoa River area). She wintered in that general area, leaving for points south sometime in the last half of March. She was still north of the Stikine on 29 March and while not located precisely, is believed in retrospect to have been somewhere along the lower McBride River. She doubtlessly migrated back by a different route than that taken by No. 6, which was contacted along the Kehlochoa River during this time. By 16 April she was back on Caribou Mountain, and was seen in a group of 13 near the head of Marion Creek. However, she moved north down off the mountain by the end of the month, and then disappeared. It turned out that she had turned south, and headed back upriver, and she was relocated, with small calf accompanying, on 18 June. This was in alpine habitat east of Sanabar Creek, near the headwaters. The calf was still present on the 26th and was seen with her again, farther south on the Tomias Mountain uplands, on 24 July. However, on 30 August she was seen in company with a medium-sized bull and the calf was clearly no longer present. She stayed on Tomias Mountain

Appendix 6. (continued)

throughout the rut period, and was contacted in the Sanabar Creek area on both 8 and 12 October 1981.

Animal No. 9

Young adult female, estimated 2-3 years old by tooth wear, no calf present when captured on 28 October 1980, died near capture site.

This animal went some distance after being darted, and was down on the ice of a small alpine pond when we caught up to it. It had apparently injured one leg while struggling to stay up and we did not discover that fact until after the antidote had been administered. She was up and had moved a short distance when checked on the following day, but she never moved far from that area and was certainly dead before the first tracking flight. The collar, which had been chewed by predators, was dug out of the snow back about ½ km from the original capture site on 9 October 1981; no animal parts were found at that time.

Animal No. 10

Young adult female, estimated 2-3 years old by tooth wear, no calf present when captured on 23 October 1980, only one location obtained on subsequent tracking flights, as this animal died or slipped its collar shortly after capture.

This animal was unusually large for a female and, in fact, was thought to be a young male until we were well along in the handling process. Due to her size, she had been underdosed and she went 3-4 km before we found her, and then she still never went down on her own. We were unable to obtain any measurements under the circumstances and ended up fitting her with a male collar. Following capture she crossed the head of Kilweguh Creek and moved into a tributary valley to the west, about 4 km from the capture site, and there was no further movement from that point. Whether she had died or simply shed the collar could not be determined, as the transmitter apparently ceased functioning before a helicopter could

Appendix 6. (continued)

be deployed to the area to make the search (no signal received on 9-10 October 1981).

Animal No. 11

Adult female, no calf present when captured on 28 October 1980, marked with a bright orange neck collar on that day (no radio transmitter and she was never seen again).

As with No. 10, she was apparently under-dosed, as she went some distance and never went completely down after darting. She seemed in good health and gave a classic "excitation jump" (Pruitt 1960) when released near the headwaters of Black Fox Creek. This was the last day of the capture expedition, and the first tracking flight was not to follow for almost a month (22 November). Whether she left the area or died can not be determined, but she has not been seen again.

Animal No. 12

Female calf, age 5-6 months, captured on 26 October 1980 and marked with ear flags only (tag no. 2 and red flag on left, tag no. 3 and green flag on right), seen on the second tracking flight, but never again.

Hit accidentally with a dart intended for its mother, it was seen more than a month later in a group which included radio-collared animal No. 1. It stayed near an adult in this group which was presumed to be its mother, and appeared to be in good health. This was on Ambush Hill, about 8 km NE of the capture site. It was not seen again.

Animal No. 13

Young male, age 2 years, captured on 23 October 1980, only one location recorded for this animal after capture due to loss of the collar between first and second tracking flights.

Appendix 6. (continued)

Captured on the Marion Creek side of Hyland Post Ridge, he had moved 19 km NW to the vicinity of the headwaters of Black Fox Creek by the first tracking flight, and then the collar pulled apart at the joint in that general area, possibly while sparring with another bull. The collar was picked up on 29 January 1981.

Animal No. 14

Young male, estimated 2-3 years old by tooth wear and antler development, captured on 24 October 1980, contacted on all 22 tracking flights, still alive and producing radio signals in October 1981.

This animal was relatively sedentery, making two sojourns north across the Stikine River, but then spending most of the rest of the year on or just to the north of Caribou Mountain. He was north of the Stikine in the Mount Sister Mary area on 22 December and 2 January, but then moved back to the north side of Caribou Mountain for the remainder of the winter. He was found on the north side of the Stikine again on 20 May, this time in the vicinity of Schreiber Canyon, but was back on Caribou Mountain 10 days later. He remained in uplands there for the rest of the study period, and was seen 3 times during the rutting surveys between 8 and 12 October 1981.

Animal No. 15

Old male, age 10 years, captured on 25 October 1980, contacted on 8 of 10 tracking flights before his death in about the second half of March 1981.

He stayed in the Marion Creek area for about 6 weeks following capture, but then moved northeast to Mt. Blair (upper Pitman River area) following the heavy snow in December. He stayed there until early February, then made a movement which brought him to a pine ridge surrounded by muskeg east of the Stikine and south of the Pitman. All subsequent signals came from that area, with no evidence that he was actually alive

Appendix 6. (continued)

much past mid-March. On 10 October 1981, his collar was found, intact, among a large quantity of hair and scattered bones at about 3500'. The relatively concentrated remains, especially the large piles of hair, suggests that the animal died here and was scavenged rather than being the victim of predation.

Animal No. 16

Adult male, age 5 years, captured on 27 October 1980, contacted on 18 of 22 tracking flights, still alive and signaling on 12 October 1981.

As with several of the females, he moved northwest to Cartmel Mountain after the big December snow, remained there through January, and then moved out to Un-named Mountain for the rest of the winter (February and March). Unlike the females, however, he did not move around to the east slopes of the Eaglenest Range following that period. Rather, he stayed near Un-named Mountain in April, but then moved west to a sunny aspen slope over the confluence of McEwan Creek and the Klappan River by 3 May. He remained there through 8 June, the signal location changing so little that for the second time since he had last been seen (28 January) he was declared "probably dead". However, he moved west across the Klappan by 18 June, and was then seen with another bull (both with enormous antlers) on one of the mountains west of Mt. Brock on 26 June. He then disappeared, probably into the Eaglenest Range, and was not contacted again until seen by guide Reg Collingwood east of Bug Lake. We saw him in a valley between Coldfish Lake and Kilweguh Creek on 10 October 1981, in a group of 50. He was also contacted, but not seen, in that area two days later.

Appendix 7. Caribou movements between telemetry contact locations on 22 tracking flights, Spatsizi Wilderness Park and vicinity, November 1980-October 1981.

No.	Date	Sex	N[a]	Contact Interval[b]			Movements (Km)						Mean Direction[d]
							Between Contacts			Daily[c]			
				Mode	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	
1	22 Nov	F	8	-	28.7	1.7	5-19	11.5	5.7	0.1-5.7	0.4	0.2	288
		M	4				4-19	8.3	7.2	0.2-0.6	0.4	0.2	276
2	28 Nov	F	7	6	12.1	12.9	3-25	13.7	8.4	0.7-2.5	1.3	0.9	236
		M	3				1-8	3.0	2.6	0.2-1.0	1.1	0.9	152
3	6 Dec	F	5	8	8.8	2.1	5-15	10.0	4.0	0.4-1.9	1.2	0.6	294
		M	3				9-14	11.7	3.1	1.1-1.8	1.5	0.4	116
4	22 Dec	F	5	16	17.3	3.3	20-42	30.2	8.7	0.8-2.6	1.8	0.7	280
		M	1				-	29.0	0.0	-	1.8	0.0	333
5	2 Jan	F	7	11	18.2	9.6	0-54	22.1	21.6	0-4.9	1.5	1.6	330
		M	3				4-52	32.3	25.1	0.4-1.9	1.3	0.8	318
6	15 Jan	F	7	13	16.5	11.1	1-40	10.6	14.5	0.1-1.5	0.5	0.5	30
		M	3				1-24	9.0	13.0	0.1-1.8	0.7	1.0	163
7	29 Jan	F	7	13	14.5	4.7	6-14	8.9	3.4	0.5-0.9	0.6	0.2	57
		M	2				-	2.0	0.0	-	0.2	0.0	154
8	16 Feb	F	7	19	21.6	5.5	1-9	6.3	2.9	0.1-0.5	0.3	0.1	180
		M	3				3-20	10.0	8.9	0.1-0.6	0.4	0.3	275
9	28 Feb	F	7	12	12.0	0.0	3-10	7.3	2.5	0.3-0.8	0.6	0.2	165
		M	2				2-3	2.5	0.7	0.2-0.3	0.3	0.1	285
10	17 Mar	F	7	17	18.1	3.6	2-10	5.4	2.9	0.1-0.6	0.3	0.2	15
		M	3				0-11	5.0	5.6	0-0.4	0.2	0.2	164
11	29 Mar	F	6	12	12.0	0.0	1-21	9.7	8.9	0.1-1.8	0.8	0.7	125
		M	2				0-12	6.0	0.0	0-1.0	0.5	0.7	110
12	16 Apr	F	5	18	19.7	4.5	2-54	16.6	21.2	0.1-1.8	0.7	0.7	34
		M	2				0-2	1.0	1.4	0-0.1	0.1	0.1	180

(continued)

Appendix 7. (continued)

No.	Date	Sex	N[a]	Contact Interval[b] Mode	Mean	S.D.	Movements (Km) Between Contacts Range	Mean	S.D.	Daily[c] Range	Mean	S.D.	Mean Direction[d]
13	3 May	F	7	17	27.5	25.6	1-24	12.5	8.7	0.1-0.8	0.5	0.4	135
		M	2				8-17	12.5	6.4	0.5-1.0	0.8	0.3	301
14	20 May	F	8	17	20.5	11.1	2-29	15.8	10.7	0.1-1.7	0.9	0.7	33
		M	2				0-11	5.5	7.8	0-0.6	0.3	0.4	42
15	30 May	F	3	10	10.0	0.0	11-38	25.7	13.6	1.1-3.8	2.6	1.4	151
		M	2				0-17	8.5	12.0	0-1.7	0.9	1.2	197
16	9 Jun	F	5	9	13.7	5.3	3-39	17.0	13.5	0.3-2.0	1.0	0.7	169
		M	2				0-5	2.5	3.5	0-0.6	0.3	0.4	100
17	18 Jun	F	6	8	10.1	7.8	1-54	11.5	20.9	0-1.9	0.6	0.7	142
		M	2				5-8	6.5	2.1	0.5-0.8	0.7	0.2	331
18	26 Jun	F	6	8	8.0	0.0	0-23	6.0	8.5	0-2.9	0.7	1.1	264
		M	2				5-7	6.0	1.4	0.6-0.9	0.8	0.2	283
19	24 Jul	F	6	28	28.0	0.0	0-16	9.0	6.7	0-0.6	0.3	0.2	279
		M	1				-	6.0	0.0	-	0.2	0.0	148
20	30 Aug	F	6	37	37.0	0.0	5-28	14.5	8.5	0.1-0.8	0.4	0.3	38
		M	1				-	5.0	0.0	-	0.1	0.0	13
21	8 Oct	F	7	39	50.5	32.5	8-40	17.0	12.4	0.2-0.7	0.3	0.2	157
		M	1				-	12.0	0.0	-	0.3	0.0	210
22	12 Oct	F	7	4	15.6	35.0	0-12	7.4	3.6	0-3.0	1.9	0.9	262
		M	2				18-64	41.0	32.5	0.6-4.5	2.5	2.8	112

[a]Number in sample.

[b]Time, in days, between contacts: mode is time since previous flight; mean is average time since last record for animals contacted on flight in question, i.e., including those not contacted on the immediately previous flight; S.D. = standard deviation about the mean.

[c]Mean daily movements, as calculated by dividing observed distance moved between contacts by time, in days, since last contact.

[d]The average direction of movement for the N animals sampled between flight date indicated and closest previous contacts: 0(360)=north, 90=east, 180-south, 270=west.

Appendix 8. Direction of slope (aspect) occupied by radio-collared caribou, Spatsizi Wilderness Park and vicinity, November 1980-October 1981.

Tracking Flight Date	N	Frequency (%), 45° Aspect[b]								Frequency (%), 90° Quadrants[c]			
		N	NE	E	SE	S	SW	W	NW	N	S	E	W
22 Nov	12	33	17	8	-	17	17	-	8	58	34	25	25
28 Nov	11	27	27	-	9	19	-	9	9	63	28	36	18
6 Dec	8	36	-	-	13	25	13	-	13	49	51	13	26
22 Dec	6	17	-	-	33	50	-	-	-	17	83	-	-
2 Jan	10	60	-	-	-	20	10	10	-	60	30	-	20
15 Jan	10	40	-	-	-	10	20	30	-	40	30	-	50
29 Jan	9	45	11	-	-	33	-	11	-	56	33	11	11
16 Feb	10	50	20	-	10	20	-	-	-	70	30	30	-
28 Feb	9	11	11	-	11	33	11	23	-	22	55	22	34
17 Mar	10	70	-	-	-	-	10	-	20	90	10	-	10
29 Mar	5	80	-	-	-	20	-	-	-	80	20	-	-
16 Apr	7	72	-	-	-	-	14	14	-	72	14	-	28
3 May	8	36	13	-	-	13	25	13	-	49	38	13	38
20 May	10	80	-	-	-	20	-	-	-	80	20	-	-
30 May	5	40	-	-	-	20	-	40	-	40	20	-	40
9 Jun	7	14	-	14	30	14	-	14	14	28	44	44	28
18 Jun	8	25	-	25	-	13	-	12	25	50	13	25	37
26 Jun	8	36	-	-	13	13	-	25	13	49	26	13	38
24 Jul	7	58	-	-	14	14	-	-	14	72	28	14	14
30 Aug	7	30	14	-	-	14	14	14	14	58	28	14	14
8 Oct	7	-	28	14	-	44	-	-	14	42	44	42	14
12 Oct	9	56	11	11	-	11	-	-	11	78	11	22	11

(continued)

Appendix 8. (continued)

[a]Sample size = number of contacts (both sexes combined).

[b]Proportion of caribou contacted on slopes facing in direction contained in 45° angle segments with the directions indicated acting as centers of the angles.

[c]Same, with 90° angles.

Appendix 9. Observations of large mammals other than caribou, Spatsizi Wilderness Park and vicinity, October 1980 through October 1981.

Observations listed below were made incidental to searches for and observations of caribou during more than 100 hours of aerial survey time over the general study area. All dates on which observations of other species were possible are listed under the account for moose; only those dates on which observations were actually recorded are shown for the other species.

MOOSE

21-28 October 1980 - during the caribou capture expedition a total of 37 were classified, with the following results: 11 bulls (29.7%). Nine of these were considered "large". 12 calves (32.4%; 46:100 females). Most moose observed during those observations were at or slightly above tree-line, in subalpine shrub habitats. Because there was overlap in areas covered during the period indicated, it is likely that there is some duplication in the above sightings.

22 November 1980 - three moose seen, small bull and cow with calf, all in Marion Creek area.

28 November 1980 - five seen in Kliweguh Creek valley, near timberline (1 male, 1 female with calf and 2 unclassified).

6 December 1980 - one adult female with raised hackles, at 5500' on Hyland Post Ridge.

22 December 1980 - deep snow has apparently forced many to the valley bottom; many tracks along the lower Spatsizi and upper Stikine, and minimum of 13 unclassified animals yarded up at Ross-Spatsizi confluence.

2 January 1981 - four cows with calves seen during the day. A pair seen in a shrub meadow near Forfer Lake across the Stikine east of the study area, were pawing for food beneath the snow when seen. An extensive pawed area in the vicinity

Appendix 9. (continued)

suggested caribou feeding activity, but was doubtlessly made by these moose.

15 January 1981 - nine moose in the willow patch at Hyland Post and five more within 5 km.

28 January 1981 - Klappan River near mouth of Eaglenest Creek - lots of old moose tracks, but no animals seen. Two single, unclassified adults seen at 4700-5000' SE of King Mountain (Cassiar Mountains) - mean snow depth for 10 probes at Wade Lake weather station, nearby = 116 cm. Many tracks along Pitman River (snow depth mean = 55 cm). Also, two unclassified adults seen near weather station at mouth of Dawson River (snow depth = 48 cm). Much evidence of moose pawing noted in lower Spatsizi, and at the Dawson craters had remnants of a low willow in them.

29 January 1981 - unclassified adult at about 4800' in Kliweguh Creek headwaters area, and 2 adults plus a calf at Hyland Post. Moose are no longer concentrated in the valley bottoms.

16 February 1981 - no sightings recorded.

28 February 1981 -moose tracks abundant in entire Spatsizi Valley; cow and calf seen near mouth of Kliweguh Creek and single adult just upstream; near Hyland Post, minimum of 10 seen bedded in burn, all near timberline.

17 March 1981 - other than two dead ones on Stikine ice (see wolf account), no recorded sightings.

29 March 1981 -no sightings recorded.

16 April 1981 - no sightings recorded.

3 May 1981 - no sightings recorded.

20 May 1981 -cow and yearling seen on dry ridge near Hyland Post.

8-10 June 1981 -no sightings recorded.

18 June 1981 - no sightings recorded.

26 June 1981 - no sightings recorded.

24 July 1981 - no sightings recorded.

Appendix 9. (continued)

30 August 1981 -two very large bulls in subalpine shrub habitat north of Caribou Mountain. One had just shed its velvet and the broad white antler palms showed up from about 5 km.

8 October 1981 -no sightings recorded.

9-10 October 1981 - on helicopter surveys of caribou, classified 21 moose in Caribou Mountain area, including 6 bulls (28.6%) and 4 calves (19.1%).

12 October 1981 - one bull, 2 cows and a calf seen in subalpine habitat at Sanabar Creek.

MULE DEER

24 October 1980 - a doe and fawn seen in the burn near Hyland Post.

28 February 1981 - no sightings recorded; sometime in past 2-3 weeks pilot Mel Melissen (pers. comm.) saw a minimum of 2 dead buck deer while searching for J. Holmes' horses (mouth of Spatsizi River area).

9-10 October 1981 - guide Dennis Houser reports seeing one set of tracks near Hyland Post, but no animals. We confirmed general absence of tracks in that area between 8-12 October, indicating heavy mortality (or emigration) during the previous winter.

STONE SHEEP

21-28 October 1980 - a total of 74 sheep classified, with some duplication possible:

Rams, Class II (½ curl horns) or large = 14 (18.9%)

Class II - 2, Class III - 4, Class IV - 5, not classified - 3

Lambs = 18 (24.3%)

Sheep were seen primarily along Hyland Post Ridge and on the various escarpments of the Marion Creek drainage.

22 November 1980 - three groups of 20-25 seen on various bluffs

Appendix 9. (continued)

overlooking Marion Creek. There were large rams in each group, suggesting that the rut was still in progress.
28 November 1980 - the sheep are still bunched up with both sexes in each group. I think that November, a day or two after a snowfall, might be the best time to census sheep in the area. (Two groups, 18 and 30+, unclassified, seen in Marion Creek area).
2 January 1981 - five, including a Class II ram, seen on the un-named mountain near Tsenaglode, and a ewe and lamb seen on Mt. Sister Mary.
29 January 1981 - two Class IV rams near head of Marion Creek.
28 February 1981 - two rams (Class III and IV) seen on Hyland Post Ridge.
3 May 1981 - 13 unclassified, seen on a canyon rim over the west fork of Cullivan Creek.
20 May 1981 - two ewes and one yearling on Hyland Post Ridge.
10 June 1981 - 10 ewes and yearlings on a sheer 7500' pinnacle near Danihue Pass (Eaglenest Range).
9-10 October 1981 - while searching for caribou saw 77 sheep, mostly in Marion Creek. Observations included a minimum of 5 rams Class III or larger and 22 lambs (28.6%).
12 October 1981 - 5 rams, including at least one Class IV, in Dawson Bloc, across from Red Goat Mountain.

MOUNTAIN GOAT

21-28 October 1980 - one adult seen on the cliffs overlooking Mink Creek and a group of four, with one kid, on the low bluffs on the north side of Marion Creek. Other goats were observed in the Cartmel-Mt. Brock area, including 14 on the Un-named Mountain (Tsenaglode area), but no significant classification data were obtained.
2 January 1981 - 5 unclassified animals on goat bluffs on south-facing side of Marion Creek.
20 May 1981 - adult and yearling on Hyland Post Ridge.

Appendix 9. (continued)

18 June 1981 - two nannies, two new kids and a yearling in the Skady Mountain (Dawson River) area; also 5 unclassified seen on west side of Skady Mountain.
9-10 October 1981 - six unclassified on goat bluffs at Marion Creek.

WOLF

21-28 October 1980 - despite the intensive coverage of study area uplands, no wolves were observed. A fresh track was encountered on the north side of the plateau (Ambush Creek area) on 24 October, and tracks of at least four wolves were seen in fresh snow on the ice of Bug Lake on 26 October. A caribou calf which died from a dart wound on 24 October had not been found by mammalian carnivores by the 27th.
22 December 1980 - wolf trail along Spatsizi River from at least Kliweguh Creek to just above Hyland Post. It leads into the bush many times along the way. No kills seen.
15 January 1981 - tracks of minimum of 5 on Spatsizi River near Hyland Post.
28 January 1981 - well-used trail made by minimum of 5 animals along Klappan River, near mouth of Eaglenest Creek; tracks of 4-5 animals from Gray Lake to Hottah Lake, upper Tucho River Valley (snow depth = 78 cm); heavy wolf trail on Pitman River upstream from Mt. Blair; tracks of 4-6 animals on Stikine River near mouth of Kehlechoa River, but not fresh.
29 January 1981 - six animals (5 gray and 1 black) on railway grade beside Klappan River, about 5 km south of Eaglenest Creek; 12 more (8 black and 4 grays) seen at about 6300' on north end of Eaglenest Range, over Cullivan Creek - this likley the Bug Lake pack; one heard howling from burn near Hyland Post, but none seen from the air.
28 February 1981 - trail along Spatsizi River, from woods about 10 km downstream from Kilweguh confluence to about the same

Appendix 9. (continued)

distance above -- track count indicates 6-8 animals. Apparently J. Holmes has lost 40 or more horses this year, as a result of the sudden heavy snow in early December and subsequent crusting. Wolves will likely be sustained artificially as a result.

17 March 1981 - two different kills (moose) on the Stikine River ice below the mouth of Marion Creek; 5 black wolves seen 2 km below Marion Creek.

8 October 1981 - 15 wolves (11 gray and 4 black) seen on Ambush Hill in close proximity to a group of 35+ caribou. The caribou fled on the approach of the aircraft and three wolf pups gave chase, but were quickly outdistanced.

10 October 1981 - single gray wolf on ridge west of Kilweguh Creek.

GRIZZLY BEAR

21 October 1980 - small female with yearling cub on north side of Black Fox Creek. She was basically brown, but with a gold wash on the shoulders; the cub was dark brown with no distinctive markings.

BLACK BEAR

20 May 1981 - single adult traveling along dry esker toward Hyland Post, about 2 km upriver.

OTHER

21-28 October 1980 - judging from tracks, which were seen at nearly every location at which we spent time on the ground, foxes were abundant in the area in fall 1980.

22 December 1980 - set of wolverine tracks at Hyland Post.

29 January 1981 - one red fox seen near headwaters of Black Fox Creek.

17 March 1981 - one red fox along Stikine River just downstream from mouth of Marion Creek.