VEGETATION and SOME PLANT-ANIMAL RELATIONSHIPS of ECOLOGICAL RESERVE #68, GLADYS LAKE

by

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INTRODUCTION

The Gladys Lake Ecological Reserve was established by Order-in-Council on November 28, 1975. The Spatsizi Plateau Wilderness Park, which surrounds the ecological reserve, was created a few days later. During the preceding summer, the author and wildlife assistant R. Carswell had conducted a reconnaissance survey of the ecological reserve and as much of the surrounding park as possible. Their research involved the collection, inventory, description, and interpretation of plant and animal resources, investigation of major plant-animal relationships, and determination of optimum boundaries for the reserve. The study team was at Gladys Lake from June 19 to September 1, 1975. This report is based on their findings.

LOCATION

The Gladys Lake reserve is a 32,800 ha area in the Spatsizi area of north central British Columbia, about 330 km NNW of Smithers, and 75 km ESE of Iskut (which is on the Stewart-Cassiar highway). Gladys Lake itself lies at 57° 36' N., 128° 47' W., south of Cold Fish Lake (Figs. 1 and 4). The 670,000 ha wilderness park surrounds the ecological reserve and is bounded roughly by the upper Stikine, Spatsizi, Klappan, and Little Klappan Rivers (Fig. 1).

HISTORY[1]

Aside from early explorers such as Samuel Black, G. M. Dawson, and

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[1] See Patterson (1966), Hoagland (1969), Lau (1971), McLellan (1973), and a forthcoming book by T. A. Walker for general accounts of the Spatsizi area.


SPATSIZI PLATEAU
WILDERNESS PARK and
GLADYS LAKE
ECOLOGICAL RESERVE
scale
5 0 5 10
miles
SPATSIZI PLATEAU
Cullivan Cr.
RIVER
Eaglenest Cr.
GLADYS LAKE
Gladys Lake
Ecological
Reserve
62,000 Ac.
SPATSIZI RIVER
Ross River
SPATSIZI PLATEAU WILDERNESS
PARK
1,668,020 Acres
KLAPPAN R.
Little Klappan River
STIKINE R.
SPATSIZI
DEASE LAKE
PARK
SMITHERS
PR.GEORGE
VANCOUVER
BC RAILWAY
ALIGNMENT
PARK BOUNDARY
SKEENA

Fig. 1.

2.

P. M. Monckton and occasional wealthy trophy hunters, the Gladys Lake area was rarely visited until in 1948 T. A. Walker, a hunting guide and outfitter, established a camp nearby at Cold Fish Lake (Figs. 1 and 8). The guiding operation has since changed hands several times and is presently run by H. Paish of Paish Ventures Ltd., Burnaby, B. C. The Gladys Lake area has also occasionally been used for guided hunts by other outfitters in the area. At present there are hunting/fishing camps at Hyland Post and on the Stikine River about 2 km below its confluence with the Spatsizi River. From about 1969 on, increasing numbers of non-guided resident hunters came via improved air access. In 1961, V. Geist began doctoral studies on the behavior of mountain sheep and goats, living in a small research cabin at Gladys Lake. Geist stayed in the area in 1961 and 1962, and returned for shorter stays in 1965. Accounts of his life at Gladys Lake can be found in Geist (1971, 1975). Other than brief surveys by a few other biologists, foresters, and geologists, and occasional horseback riders, Gladys Lake has received little human visitation except for the autumn hunting.

For over 20 years various individuals and groups had proposed that a major park or reserve be created in the Spatsizi area. In 1973, an ecological reserve over the Gladys Lake watershed was officially proposed by a group of scientists, and in 1974 they and other concerned people suggested that a much larger wilderness conservancy area be combined with the ecological reserve.

Considerable scientific and governmental analysis of the combination proposal ensued. Its resources were assessed, minor conflicts were resolved, and optimum boundaries determined. Finally, in late 1975, the Gladys Lake Ecological Reserve was established primarily to protect mountain sheep, mountain goats, their environment, and the opportunity to conduct scientific research on them. At about the same time, the surrounding Spatsizi Plateau

Wilderness Park was created. The wilderness park is intended to conserve the area's great wildlife, landscape, and recreational values.

PHYSIOGRAPHY AND GEOLOGY

Gladys Lake is situated at about 1275 m in the heart of the rugged Eaglenest Range, and is surrounded by mountain peaks rising to 2100-2500 m. Five major valleys radiate out from the lake (Fig. 2): Salix and upper Connector creeks head in glaciers; Castor (McMillan) and Landslide (Connors) creeks lead to passes; and lower Connector Creek drains Gladys Lake to Cold Fish Lake. There are also five main mountain blocks within the reserve: the Nation-Ghost-Guardian range; Sanctuary Ridge-Spatsizi Mountain; the Mount Will group, including Flower and Nival ridges and several unnamed icefield peaks; Fossil Flats-Festuca Ridge-McMillan Mountain; Moss Campion Mountain-Spermophilus Saddle. Mount Will (ca 2500 m) and Nation Peak (ca 2360 m) are the highest peaks in the area. The ecological reserve is entirely above 1200 m elevation.

The Eaglenest Range is part of the Skeena Mountains (Holland 1964). In the Gladys Lake area, these mountains have been carved in folded Triassic and Jurassic volcanic and sedimentary rocks. In the western part of the reserve these are partly in fault contact with siltstones, graywackes, and conglomerates of the Upper Jurassic-Lower Cretaceous Bowser assemblage (Geol. Surv. Can. Map 9-1957 and Map 214; Holland 1964; Welsh & Rigby 1971). For the most part, the peaks and high ridges are jagged and serrated due to alpine glaciation, and cirques are common on their north and east faces (Figs. 5, 6, 12, 13, 15, *inter alia*). However, there are areas of gently sloping uplands (e.g., Fossil Flats, Fig. 11) indicating that here at their northern boundary the Skeena Mountains pass by transition into the Spatsizi Plateau (Holland 1964).

The transition is striking between the Eaglenest Range of the Gladys Lake area and the Spatsizi Plateau to the north, with a broad valley of Cold Fish Lake separating the two realms (Figs. 4 and 8).

The Spatsizi Plateau occupies the Sustut basin (Eisbacher 1974) between Omineca and Cassiar mountains on the northeast and Skeena Mountains on the southwest. It is an area of wide, drift-filled valleys (Fig. 7) and open, gently rolling (but deeply indented) uplands or tablelands (Fig. 10). The plateau is underlain chiefly by sandstones, shales, and conglomerates. The rocks are mainly gently warped to flat lying. The major rivers within the wilderness park generally flow at between 1050 and 1225 m. The rolling surface of the tablelands ranges from 1800-2000 m.

The entire region was covered by glacial ice to a height of about 2100 m (Holland 1964). Upland surfaces were eroded and a veneer of drift deposited over most of the country. Late-stage cirque glaciation sculptured the higher peaks and ridges. There is a concentration of remnant ice around the Mount Will massif (Fig. 9).

Fossil localities are fairly common within the Spatsizi area (see Eisbacher 1974). Fossil Flats (Fig. 11) within the ecological reserve has a good exposure of (probably) Jurassic material.

CLIMATE

The Gladys Lake area has a moist, cold, continental climate. Summers are cool and moist, with frequent cloud cover. Geist (1971) recorded rain on 22 consecutive days starting on 1 August, 1962, and we logged 21 consecutive rainy days beginning 23 July, 1975. Snow and freezing temperatures can occur at any time, especially at higher elevations (Fig. 16). Temperature

maxima during the summer of 1975 (reputedly an unusually wet, cold summer) were generally 5-15° C.

Winters are long, cold, and cloudy, and Gladys Lake remains frozen for almost eight months of the year (Geist 1971). Snowfall is relatively heavy in the reserve, and appears to decrease towards the east. Walker (1960?) stated that a snowpack in the lower Spatsizi Valley was rarely more than 30-50 cm, and that the average maximum around Cold Fish Lake was about 125 cm. The Gladys Lake snowpack is probably around 150-200 cm.

Temperature and precipitation estimates for valley bottom locations in the Cold Fish Lake and Gladys Lake areas are given in Table 1. These data were kindly provided by R. D. Marsh, Climatology Division, Resource Analysis Unit, Environment and Land Use Committee Secretariat. As the available data-base was severely restricted, they attempt only to provide a broad estimate of the local climate in these areas.

Historical data were extracted from Atmospheric Environment Services "Monthly Summary" books for Cold Fish Lake. These data were utilized to establish a tenuous relationship to Dease Lake and Telegraph Creek climatological information. May to November temperature data are considered fairly reliable; December to April less so. Precipitation data could only be grossly estimated.

Normal temperatures at Gladys Lake were obtained through extrapolation from Cold Fish Lake data. The effect of the elevational difference between the two sites was minimized through application of a lapse rate value of 3.3° F/1000 feet. Estimates of expected minimum temperatures at Gladys Lake include the anticipated effects of cold air drainage from the surrounding mountains. Precipitation has not been given for Gladys Lake. However, personal experience indicates that, due to orographic effects, it is generally much cloudier and quite a bit wetter at Gladys Lake that at the hunting camp at the

TABLE I. Normal temperature and precipitation as estimated from Dease Lake and Telegraph Creek.

Cold Fish Lake

°F.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Annual
Mean Maximum	5.2	17.1	28.8	39.5	51.7	59.4	61.6	59.9	51.5	39.1	22.5	10.8	37.3
Mean Minimum	-12.5	-2.3	6.2	18.5	27.3	34.1	37.7	36.6	30.7	23.0	8.5	-4.4	17.0
Mean Mean	-3.7	7.4	17.5	29.0	39.5	46.8	49.7	48.3	41.1	31.1	15.5	3.2	27.1
Precipitation "	2.4	1.63	1.12	0.65	0.61	1.20	2.07	2.21	2.54	3.43	1.96	2.17	22.0"

Gladys Lake (Guestimated from Cold Fish Lake)

Mean Maximum	3.9	15.8	27.5	38.2	50.4	58.1	60.3	58.6	50.2	37.8	21.2	9.6	36.0
Mean Minimum	-16.8	-6.6	1.9	14.2	23.0	29.8	33.4	32.3	26.4	18.7	4.2	-8.7	12.7
Mean Mean	-6.5	4.6	14.7	26.2	36.7	44.0	46.9	45.5	38.3	28.3	12.7	0.5	24.3

northwest end of Cold Fish Lake.

Geist (1971) reported sudden, warm, violent chinook storms during the winter, with temperatures sometimes jumping from -40° C to 5° C in a few hours. These chinooks appear to be concentrated by the Mount Will massif and periodically funnel down the Gladys Lake valley, sweeping the surrounding mountainsides clean of snow.

SOILS

Soil development in the Gladys Lake reserve is generally not far advanced due to the recent glaciations and cold climate. The cold soil temperatures inhibit both the chemical and biological soil forming processes. Permafrost (Fig. 73) is discontinuous in the area (see Geol. Surv. Can. 1967). It occurs rarely at lower elevations in fine-textured soils beneath closed coniferous forest, and more commonly in the alpine, especially beneath wet tundra and organic soils on northern and eastern slopes.

Soils have developed on glacial till and thin colluvial deposits, with various degrees of water modification of the till along valley bottoms. Lithology is variable, with basalt, shales, sandstone, siltstone, mudstone and conglomerate all present. Parent material may be basic or acidic, but in general appears to be moderately calcareous. However, the sola are probably generally acid with pH increasing with depth.

Prevailing subalpine soils appear to be humo-ferric podzols and dystric brunisols, while alpine brunisols and lithic humisols and regosols predominate at high elevations. Gleyed regosols and organic soils are found in subalpine wetlands, with cumulic regosols on alluvial sites. High elevation wet tundra communities have cryic and lithic gleysols and organics. Shallow

chernozem-like soils are occasional on steep, grassy, south-facing slopes.

Pertinent studies on high elevation soils have been done by Nimlos and McConnell (1965), Retzer (1956), Sneddon et al. (1972), Knapik et al. (1973), Lord and Luckhurst (1974). Retzer (1965, 1974) presents valuable summaries.

PREVIOUS BIOLOGICAL RESEARCH

C. J. Guiget and A. F. Szczawinski of the British Columbia Provincial Museum conducted a biological survey in the central Spatsizi area for several weeks in 1959. V. Geist's sheep and goat studies starting in 1961 have been the major research effort to date in the Gladys Lake area. Geist's behavioural research was the first ever done on Stone's sheep. It is summarized in Geist (1971 and 1975). In 1969, scientists from Brigham Young University carried out a botanical and physiographic reconnaissance of the Spatsizi area, and did some work near Gladys Lake (Welsh and Rigby 1971). A brief biological survey of the Cold Fish Lake area by V. J. Krajina, K. Sumanik, R. G. McMinn, and T. G. Northcote preceded the original 1973 application for ecological reserve. Other than several wildlife survey flights done in the 1970's by provincial government biologists, there has been no other previous biological research in the Gladys Lake reserve.

METHODS

Vegetation

A rapid reconnaissance technique similar to that of Douglas (1974) was used. The Gladys Lake reserve encompasses a large area of extremely rugged, mountainous terrain that made adequate sampling coverage difficult. The

reconnaissance approach was especially valuable in that a larger number of stands were quantitatively sampled and a greater range of variability included than would have been possible using other methods.

Sample stands were selected that had relatively homogeneous populations of various combinations of species throughout the reserve. The term "stand" in this report refers to a specific example of vegetation that was sampled, a "community" or "community type" to a grouping of similar stands. The names of the community types are derived from the dominant species in one or more strata. Sampling was limited (as few as 4 stands) in rare community types, but was greater (as many as 26 stands) in widespread and variable types. A total of 319 stands was sampled.

Quantitative data were collected in each stand using a circular plot. Plot size was 15 m in diameter for forest stands, 7 m for shrub stands and most alpine tundra types, and 3 or even 1 m for tundra stands of small extent. Crown cover, using the methods and cover classes (0-5, 5-25, 25-50, 50-75, 75-95, 95-100%) of Daubenmire (1959, 1968) was estimated for overstory and intermediate trees, saplings, shrubs, all other vascular plants and terricolous lichens, mosses, and liverworts. The corresponding vegetation layers or strata were defined as: (A2) Main tree canopy, usually over 8 m high; (A3) Secondary tree canopy forming a definite layer below the main canopy; (B1) Tall shrubs and tree saplings, ususally between 2 m and 8 m high; (B2) Low shrubs and tree-regeneration, usually less than 2 m high; (C) All herbaceous plants and dwarf shrubs; (D) Cryptogams - lichens, mosses, and liverworts.

Midpoints of the six cover classes will be used later in calculating average per cent coverage of the taxa tallied within each plot. Similarly, the average per cent frequency will be calculated for all plant species. Saxicolous and corticolous lichens, mosses, and liverworts were recorded in each plot

using a broad abundance scale (rare, frequent, abundant). Additional rare species, that occurred outside the plots but within the stand, were also tallied. The aspect, percentage slope, elevation, landform, and other site characteristics of each plot were also recorded.

Prominence values will be calculated by multiplying cover by the square root of the frequency of each species of each plot. This index is considered to be a good estimate of the prominence of a species in a particular stand (Douglas 1974).

Taxonomic Considerations

For the most part, nomenclature, authorities, and taxonomy follow Welsh (1974) for vascular plants, Hale and Culberson (1970) for lichens, Crum et al. (1973) for mosses, and Schofield (1968) for hepatics. Hultén (1968) and a number of more specialized treatments were also consulted in vascular plant identification. Species names and authorities are in Appendices 2, 3, and 4.

A complete set of voucher specimens of vascular plants, mosses, and liverworts has been deposited in the Herbarium of the British Columbia Provincial Museum, and a complete set of lichen specimens is in the Herbarium of the University of British Columbia.

Soils

In each of the major plant communities one or more soil pits were established and the soil profile briefly described. Soil nomenclature is according to the Canadian System of Soil Classification (C.S.S.C., 1970) and Lord (1975).

Wildlife

Most of the ecological reserve was traversed on foot by the study team. They recorded all animal sightings, and as well made behavioural observations and noted mineral licks, game trails, and type and density of sign of big game (see Carswell 1975).

Where possible, observations of feeding behaviour were included. The occurrence and intensity of browsing and grazing, and the occurrence and density of scat was noted in each stand.

RESULTS AND DISCUSSION

Many of the study team's observations and findings have been reported by Carswell (1975). Included in his report are bird, mammal, and fish species lists, a record of wildlife sightings, maps locating important features such as mineral licks, major trails, outpost hunting camps, etc., and estimates of population sizes and habitat preferences of the major mammals present in the reserve. Additional results and discussion are presented in this report.

FLORA

Species of vascular plants, lichens, mosses, and liverworts collected by J. Pojar are listed in Appendices 1 to 3. A list of the collecting localities is in Appendix 4.

VEGETATION

The vegetation of the Gladys Lake Ecological Reserve falls within subalpine and alpine zones, or the spruce-willow-birch (SWB) and alpine tundra

(ATy) zones of Krajina (1969, 1975). The subalpine zone (see Douglas 1974 for a discussion of vegetation zonation) occurs along the lower valleys and slopes and is dominated by open *Picea glauca* (white spruce) and *Abies lasiocarpa* (subalpine fir) forests, and by dense thickets of medium to tall shrubs, mainly *Betula glandulosa* (dwarf birch) and *Salix* spp. (willows) (Figs. 21 and 22). There are also frequent aspen stands, grasslands, wetlands, and other shrub and herb types within the subalpine zone. The upper limit of the subalpine ranges from 1500 to 1700 m and above this is the alpine zone. Within the alpine zone there are dwarf shrub, heath, seepage, tundra, and fellfield community types. Widespread, zonal alpine types are (a) heath dominated by *Cassiope tetragona* (a white mountain heather), *Dryas integrifolia* (mountain avens), the dwarf willows *Salix reticulata* and *S. polaris*, and bryophytes, and (b) tundra dominated by the same dwarf willows, *Festuca altaica* (Altai fescue), the sedge *Carex microchaeta*, and lichens. Table II outlines the plant communities of the study area.

Previous botanical research in the Spatsizi area has been scanty. Szczawinski (1959) and Welsh and Rigby (1971) have done reconnaissance surveys of the flora and vegetation, but did not do quantitative plant community studies.

Pertinent studies have gone on recently in neighbouring regions. Anderson (1970) has done a vegetation and palynological study in the Atlin region of northwestern British Columbia. Luckhurst (1973) and Lord and Luckhurst (1974) have reported on the vegetation and soils of a Stone sheep study area (Nevis Creek) in the Rocky Mountain foothills of northeastern British Columbia. Kojima (1972, 1973) has studied phytogeocoenoses in the North Klondike River Valley, central Yukon Territory. Douglas (1974) has described the montane zone vegetation of the Alsek River region in the southwestern Yukon, while Hoefs,

TABLE II. Synopsis of the plant communities in the Gladys Lake ecological reserve.

Subalpine Vegetation

Forest community types.

(a) *Pinus contorta-Betula glandulosa*-cryptogam (lodgepole pine forest).

(b) *Populus tremuloides-Juniperus communis-Epilobium angustifolium-Festuca altaica-Hypnum revolutum* (aspen forest and scrub).

(c) *Populus balsamifera-Salix scouleriana-Epilobium angustifolium* (balsam poplar "pygmy forest").

(d) *Picea glauca*-feather moss (white spruce closed forest).

(e) *Picea glauca-Salix glauca-Betula glandulosa*-cryptogam (spruce-willow-birch open forest).

(f) *Abies lasiocarpa*-feather moss (subalpine fir closed forest).

(g) *Abies lasiocarpa-Betula glandulosa-Empetrum nigrum* (subalpine fir-birch-crowberry open forest and krummholz).

(h) *Abies lasiocarpa-Cassiope mertensiana-Rubus pedatus* (subalpine fir tree clumps and krummholz).

Shrub community types.

(a) *(Picea glauca)-Salix barclayi-Betula glandulosa-Carex aquatilis*-moss((white spruce)-willow-birch-sedge fens).

(b) *Salix scouleriana-Linnaea borealis-Festuca altaica* (Scouler's willow tall scrub).

(c) *Salix (glauca, barclayi, planifolia)-Festuca altaica-Rubus arcticus-Petasites frigidus-Aulacomnium palustre* (wet willow thickets).

(d) *Salix (alaxensis, barclayi, planifolia)-Epilobium latifolium-Drepanocladus uncinatus* (riparian willow thickets).

(e) *Salix glauca-Betula glandulosa-Festuca altaica* (willow-birch scrub).

(f) *Betula glandulosa-Festuca altaica*-cryptogam (dwarf birch scrub).

(g) *Juniperus communis-Arctostaphylos uva-ursi*-grass (dwarf juniper-bearberry grassy low scrub).

Herb community types.

(a) *Poa glauca-Carex supina-Potentilla pensylvanica-Artemisia borealis* (boreal steppe dry grassland).

(b) *Festuca altaica* (Altai fescue mesic grassland).

(c) *Festuca altaica-Luzula parviflora-Aconitum delphinifolium-Artemisia arctica-Senecio triangularis-Rumex acetosa* (lush grass-forb moist meadows)

(d) *Heracleum lanatum-Epilobium angustifolium-Thalictrum occidentale* (cow parsnip wet meadows).

(e) *Carex* (sedge) marshes and fens.

Talus-lichen-moss terrain unit.

Alpine Vegetation

Shrub community types.

(a) *Betula glandulosa-Artemisia arctica*-cryptogam (dwarf birch alpine scrub).

(b) *Salix barrattiana-Petasites frigidus-Tomenthypnum nitens* (wet alpine willow thickets).

Alpine tundra community types.

(a) *Cassiope mertensiana-Luetkea pectinata-Sibbaldia procumbens-Barbilophozia hatcheri* (snow-accumulation alpine heath).

(b) *Cassiope tetragona-Dryas integrifolia-Salix (reticulata, polaris)-Distichium capillaceum* (alpine heath).

(c) *Festuca altaica-Artemisia arctica-Polytrichum piliferum-Stereocaulon glareosum-Cetraria (cucullata, nivalis)* (fescue-lichen tundra).

(d) *Poa rupicola-Trisetum spicatum-Hierochloe alpina-Potentilla nivea* (zooclimax alpine grassland on goat/sheep "saddles").

(e) *Kobresia myosuroides*-lichen tundra.

(f) *Salix (polaris, reticulata)-Carex microchaeta-Polytrichum piliferum-Cetraria nivalis* (dwarf willow-sedge-grass-cryptogam tundra).

(g) *Dryas integrifolia-Oxytropis nigrescens-Silene acaulis*-lichen (cushion plant tundra).

(h) *Salix reticulata-Carex aquatilis*-moss (subhydric alpine seepage-fen).

(i) *Salix (polaris, reticulata)-Carex podocarpa-Petasites frigidus*-moss (alpine seepage/snowbed vegetation).

(j) *(Salix polaris-Ranunculus nivalis-Carex microchaeta)*-moss (moss-dominated alpine seepage/snowbed vegetation).

(k) alpine fellfield.

(l) alpine steepland vegetation.

Cowan, and Krajina (1976) have done a detailed study in the same area, on Sheep Mountain near Kluane Lake.

Geist et al. (1974) have briefly described a variety of plant communities found in the Wolf Lake area of the south central Yukon. Annas (1974) has reported briefly on vegetation and soil features of some steppe ecosystems of the southern Yukon.

The vegetation of the Gladys Lake reserve appears to be most similar to that described from the south central Yukon by Geist et al. (1974). There are also strong similarities with Nevis Creek, Atlin, and Alsek River communities, but the climate of these three areas is drier with less snowfall, and the soils appear to be more base-rich, than in the Gladys Lake area.

SUBALPINE VEGETATION OF THE GLADYS LAKE ECOLOGICAL RESERVE[1]

Forest Community Types[2]

Eight forest communities may be distinguished in the Gladys Lake area. There are six coniferous community types, one dominated by *Pinus contorta* (lodgepole pine), two by *Picea glauca*, and three by *Abies lasiocarpa*. The two deciduous types are dominated by either *Populus tremuloides* (trembling aspen) or *Populus balsamifera* (balsam poplar or cottonwood).

In general, the *Abies* types occur at higher elevations than the others, which are primarily valley bottom and lower slope communities. A general pattern apparent in the lower valleys of both ecological reserve and wilderness park is of intermittent to closed forest cover of *Picea, Populus,* and *Pinus* on the valley bottoms and lower slopes. Higher on the slopes *Abies*

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[1] Unless otherwise stated, the following information pertains only to the vegetation of the ecological reserve, although many statements and conclusions are of general application throughout the surrounding wilderness park.

[2] Appendix 5 lists the characteristic species of each plant community.

lasiocarpa dominates, especially on northern exposures, where it often forms nearly pure stands.

A typical Spatsizi feature is the treelessness of the bottoms of high passes and upper river valleys. The upper reaches of major streams such as the Stikine in the Tuaton Lake area (the "Stikine Prairie"), the Little Klappan, Ross, and Dawson rivers, and Buckinghorse and Kluayetz creeks all show this feature. A skirt of trees usually covers the lower and mid-slopes above the broad, treeless valley bottoms. In high valleys such as Kettlehole Pass (Fig. 37) and Sanctuary Pass in the ecological reserve, and in the vicinity of Buckinghorse and Klahowya lakes, the upper Ross and Dawson rivers, and upper Eaglenest and Tsetia creeks, the short skirt is primarily *Abies lasiocarpa* stands. In lower subalpine valleys (Fire Flats (Fig. 7), Stikine Prairie, Little Klappan, lower Ross) the skirt is longer and includes both *Picea glauca* and *Abies* stands.

(a) Pinus contorta-Betula glandulosa-cryptogam community (Fig. 25).

Pinus contorta var. *latifolia* (lodgepole pine) forest occurs in only one corner of the ecological reserve, near the outlet of Cold Fish Lake and bordering the first stretches of Mink Creek. Within the wilderness park it is a common type of coarse-textured, rapidly drained outwash, moraines, and alluvial terraces along the major river valleys. Soils are podzols or dystric brunisols. It is a forest type of the montane zone, but for the sake of simplicity is included here in the subalpine zone of the Gladys Lake reserve. Anderson (1970), Luckhurst (1973), and Geist et al. (1974) briefly described similar forests in their study areas.

The Gladys Lake pine stands are open, with trees occasionally reaching 20 m in height. Frequent *Picea glauca* in the canopy and subcanopy, and as saplings and seedlings, indicates the seral nature of this fire forest.

The shrub stratum is moderately to poorly developed. *Betula glandulosa* is prominent, and *Salix glauca* and *S. scouleriana* are fairly frequent.

Prominent in the moderately developed dwarf shrub/herb stratum are *Empetrum nigrum* (black crowberry), *Vaccinium vitis-idaea* (lingonberry), *Vaccinium caespitosum* (dwarf blueberry), *Festuca altaica*, and *Lupinus arcticus* (mountain lupine).

There is an abundant cryptogamic ground cover. Prominent mosses are *Pleurozium schreberi* and *Dicranum fuscescens*, and *Hylocomium splendens* and *Polytrichum juniperinum* are frequent. Lichens are common and abundant (Fig. 26) especially *Cladina mitis*, *C. rangiferina*, and *C. alpestris* (reindeer lichens), other Cladoniae *(Cladonia gracilis, C. uncialis, C. gonecha, C. chlorophaea, C. uncialis)* and the dog lichens *Peltigera aphthosa* and *P. malacea*.

Epiphytes are moderately abundant. Typical species, for *Pinus* forests as well as most other types within the reserve, are *Alectoria americana* (black beard lichen), *Cetraria pinastri*, *Hypogymnia austerodes*, *H. physodes*, *Parmelia sulcata*, *Parmeliopsis ambigua*, and *P. hyperopta*.

(b) Populus tremuloides-Juniperus communis-Epilobium angustifolium-Festuca altaica-Hypnum revolutum-Peltigera canina community.

Populus tremuloides stands are found frequently within the reserve on convex, south slopes of valley bottom moraines and eskers, and on steep, generally south-facing, colluvial, lower mountain slopes. In the Spatsizi area, aspen types are fairly common on similar submesic to dry sites along the major valleys, especially on the southwestern flanks of the Eaglenest Range along the lower Klappan River, and on south slopes along the lower Spatsizi and the Stikine west from Spruce Hill.

Open aspen forest (Figs. 27 and 28) with erect trees to 17 m tall is rare in the Gladys Lake area, occurring on moraines and eskers from the southwest

base of Sanctuary Ridge along Connector Creek to the outlet of Cold Fish Lake. These few forest stands (as well as the others in the park) belong more properly to the montane zone, but are grouped here with the subalpine scrub that is much more common in the reserve, and is very similar in species composition. In the open forest, shrubs are uncommon, the herb layer is well developed, and the cryptogamic layer sparse. Soils are shallow to moderately deep brunisols with dark surface horizons. Anderson (1970) and Douglas (1974) have described similar montane aspen communities in the Atlin and Alsek valleys, respectively.

Tall scrub or "pygmy forest" (Figs. 29 and 30) occurs to 1500 m on steep, dry, south- or southwest-facing colluvial slopes. Good examples of such scrub can be found all along the southern flanks of the Ghost Mountain-Sanctuary Mountain massif, from the mouth of Connector Creek to Red Canyon Creek. The pygmy forest consists of fairly dense stands of stunted, gnarled young *Populus tremuloides* with pole-size trunks. "Tree" height may be 2-7 m; DBH averages 7 cm, and tree age is probably less than 50 years. In the pygmy forest, the shrub and herb strata are both moderately developed, and the cryptogamic layer sparse. The shallow, dark-coloured soils are lithic brunisols or chernozem-like colluvial regosols. Annas (1974) and Lord and Luckhurst (1974) have described similar *Populus* communities.

Characteristic shrub species of both forest and scrub are *Salix scouleriana* (which occasionally reaches the canopy or subcanopy), *Shepherdia canadensis* (soapberry or soopolallie), *Rosa acicularis* (prickly rose), and *Viburnum edule* (squashberry or high bush cranberry). *Juniperus communis* (dwarf juniper), *Arctostaphylos uva-ursi* (bearberry), and *Linnaea borealis* (twinflower) are common dwarf or prostrate woody species. *Epilobium angustifolium* (fireweed), *Lupinus arcticus*, *Mertensia paniculata* (bluebells), *Arnica cordifolia* (heart-leaved arnica), *Fragaria virginiana* (strawberry), *Achillea millefolium* (yarrow), *Delphinium glaucum* (tall larkspur), *Gentianella propinqua* (an annual

gentian), *Festuca altaica*, and *Poa interior* and *P. glauca* (bluegrasses) are prominent in the herb stratum.

Hypnum revolutum, a moss that clothes the bases of aspen trunks, and *Peltigera canina* are the only prominent cryptogams. *Thuidium abietinum* and *Drepanocladus uncinatus* are also frequent tree-base mosses. *Tortula ruralis, Pleurozium schreberi,* and *Cladonia pyxidata* are common in some stands.

Epiphytes are sparse to frequent, with more coverage in more open stands. *Leptogium saturninum, Parmelia subaurifera,* and *Physcia* spp. are typical in addition to the species listed under *(a)*.

The *Populus* forest has a fire history. Seral stands on more mesic sites have *Picea glauca* slowly coming up underneath, but the pygmy forest has very little *Picea* invasion and appears to be a fire subclimax type. Aspen reproduction has been sporadic, judging from the variety of even-aged stands with variable seedling and sapling representation. In 1975, mature individuals were invariably sterile.

Snow cover beneath aspen is probably moderate to heavy, with drift accumulation. But melt-off is early, especially from the pygmy forest (cf. Geist et al. 1974; Lord and Luckhurst 1974).

(c) Populus balsamifera-Salix scouleriana-Epilobium angustifolium community.

Populus balsamifera (balsam poplar) pygmy forest occurs up to 1500 m on steep, colluvial, generally south-facing, lower mountain slopes. It is an uncommon type within the ecological reserve, and is probably infrequent in the park as well. It often occurs with aspen pygmy forest, but there are very few mixed stands. The poplars occupy moister sites than aspen, and in several stands some downslope seepage was evident. *Populus balsamifera* stands are often found on slightly concave slopes, and snow cover is probably heavier and longer-lasting than beneath *P. tremuloides*. Douglas (1974) has recognized

a somewhat similar poplar community, but Lord and Luckhurst (1974) and Hoefs, Cowan, and Krajina (1976) grouped aspen and poplar stands together in one community type.

The shrub stratum is poorly developed, with *Shepherdia canadensis*, *Rosa acicularis*, and *Viburnum edule* the common species.

The herb layer is lush and dominated by broad-leaved forbs. *Epilobium angustifolium*, *Arnica cordifolia*, *Delphinium glaucum*, *Fragaria virginiana*, *Mertensia paniculata*, *Heracleum lanatum* (cow parsnip), *Thalictrum occidentale* (meadow rue), *Geranium richardsonii* (white geranium) and *Lupinus arcticus* are prominent forbs. *Bromus richardsonii* (hairy brome) is the only common grass.

The cryptogamic layer is poorly developed or even lacking, and epiphytes are sparse.

In the Spatsizi area, well developed alluvial cottonwood (also *Populus balsamifera*)or cottonwood-spruce forest types occur only in the northwest corner on floodplain terraces of the Stikine and lower Klappan rivers.

(d) Picea glauca-feather moss community (Fig. 32).

Closed spruce forest is present within the reserve on some north- and east-facing lower slopes (particularly along the southwest side of Cold Fish Lake), and on a few stabilized alluvial terraces along major creeks. Such boreal forests are widespread and are the climax type in the montane zone of the Spatsizi area in general, but occur only in pockets in the subalpine zone. Roughly similar community types have been reported by Anderson (1970), Kojima (1972), Douglas (1974), Geist et al. (1974), and Lord and Luckhurst (1974).

The alluvial phase of this community, which is rare in the reserve, is probably common in the wilderness park in the lower major river valleys (Fig. 23). There it should be found on poorly drained alluvial flood plains with fine-textured (silty) parent material, and probably resembles the *Picea*

glauca-Ribes triste-Equisetum pratense-Drepanocladus uncinatus association of Kojima (1972).

Soils are deep and podzolic, or gleyed alluvial regosols. The soil is cool and moist, and permafrost is possible in fine-textured material.

The spruce-feather moss forest has a closed canopy and is moderately to densely stocked. Trees attain their best growth in the reserve in this type, with heights averaging 18-20 m and occasionally reaching 25 m. *Picea glauca* is the dominant tree species, and is reproducing in most of the stands of this climax type. Many of the spruce appear to be hydrid *Picea glauca* X *engelmannii*. Daubenmire's (1974) data do not agree with this observation, but G. W. Douglas (personal communication) has accumulated evidence pointing to a hybrid nature for many of our northwestern spruce. *Abies lasiocarpa* is frequently found in the overstory and as a sapling and seedling, especially in north slope spruce stands.

The shrub stratum is sparse or lacking.

The dwarf shrub/herb stratum is sparse to moderately developed and typically includes *Linnaea borealis*, *Cornus canadensis* (bunchberry or dwarf dogwood), *Arnica cordifolia*, and *Mertensia paniculata*. In the alluvial phase, horsetails *(Equistum arvense, E. pratense, E. scirpoides)* are more frequent, along with *Petasites frigidus* (coltsfoot).

The cryptogamic layer is very well developed and carpet-like. The feather mosses *Hylocomium splendens*, *Pleurozium schreberi*, and (to a lesser extent) *Ptilium crista-castrensis* form extensive wefts, and tufts of *Dicranum fuscescens*, *D. scoparium*, *Polytrichum juniperinum* and *Pogonatum alpinum* are common. *Drepanocladus uncinatus* is more abundant in the alluvial phase. *Barbilophozia lycopodioides* is a frequent liverwort. *Peltigera aphthosa* and *P. scabrosa* are common lichens.

Epiphytes are frequent to abundant, more so than in the open forest types. Common species include all those listed under *(a)*. *Usnea ? glabrescens* is frequent only in the spruce-feather moss community.

(e) Picea glauca-Salix glauca-Betula glandulosa-cryptogam community (Fig. 22).

Open upland spruce forest with abundant shrub cover is general throughout the reserve on valley bottoms and lower slopes up to about 1400 m. It is also one of the dominant vegetation types in the subalpine zone of the wilderness park. Krajina (1975) has termed the subalpine zone of northern British Columbia, the Yukon, and the Mackenzie District the spruce-willow-birch zone, in recognition of the zonal dominance of this general type of climax community. Similar communities have been described by Anderson (1970), Luckhurst (1973), and Douglas (1974).

The Gladys Lake spruce-willow-birch stands have an open canopy, with widely spaced trees usually less than 18 m tall. The *Picea* have a greater DBH and are shorter than in the spruce-feather moss closed forest. Spruce regeneration was present in nearly all of the stands sampled. All stands have evidence of past fire. Soils are humo-ferric podzols or dystric brunisols.

The shrub layer is moderately to well developed. *Salix glauca* and *Betula glandulosa* are the prominent species. Both are abundant in most stands, but the willow predominates on drier sites with southern aspects, while dwarf birch does so on colder, moister, northern slopes. In the latter situation, the plant cover can be characterized as a *Picea-Betula-Empetrum nigrum* phase. Douglas (1974) has given this phase community status in the Alsek Valley. However, in the Gladys Lake area, it appears to be merely an extreme phase linked by numerous intermediate stands to a *Picea-Salix* phase, all within the spruce-willow-birch community.

The sparse to moderately abundant dwarf shrub/herb layer typically

includes *Empetrum nigrum, Vaccinium vitis-idaea, Linnaea borealis, Festuca altaica, Lupinus arcticus, Mertensia paniculata, Epilobium angustifolium,* and *Pedicularis labradorica* (Labrador lousewort).

The cryptogamic stratum is well developed. Prominent mosses are *Pleurozium schreberi, Hylocomium splendens, Dicranum fuscescens,* and *Polytrichum juniperinum. Cladina mitis, C. rangiferina, Cladonia gracilis, C. phyllophora, C. cornuta, C. deformis, C. gonecha, C. uncialis,* and *Peltigera aphthosa, P. canina, P. malacea,* and *P. scabrosa* are common. Many of the open-grown spruce have very dense foliage "tents" that cast a litter shadow beneath them, the ground being densely covered with needles but with very few cryptogams.

(f) Abies lasiocarpa-feather moss community (Fig. 20).

Closed subalpine fir forest is local within the reserve, with best development on northern mid-slopes of Flower Ridge and Spermophilus Saddle. This type is more widespread in the southwestern section of the wilderness park where there seems to be a moister climate with greater snowfall. Snow accumulation is heavy and persistent in the subalpine fir forests. The relatively deep, podzolic soils are cold and moist, but without permafrost. Geist et al. (1974) briefly describe similar, nearly pure subalpine fir stands in the Wolf Lake area.

Abies lasiocarpa forms a closed canopy forest with moderately dense stocking. Tree growth is fairly good, with an average height of 16 m. *Abies* reproduction is extensive, both by layering and seedlings, in these climax stands.

The poorly developed shrub stratum has no prominent species other than reproducing subalpine fir. *Betula glandulosa* and *Ribes glandulosum* (skunk currant) occur fairly frequently.

Empetrum nigrum and *Cornus canadensis* are the only prominent species in the generally sparse dwarf shrub/herb stratum, but *Linnaea borealis*, *Mertensia paniculata*, *Vaccinium vitis-idaea*, and *Festuca altaica* may frequently be found.

The cryptogamic layer is very well developed, with a mean total cover of 80%. The feather mosses *Hylocomium splendens* and *Pleurozium schreberi* are prominent, along with *Dicranum fuscescens* and *Polytrichum juniperinum*. Additional common bryophytes are *Barbilophozia lycopodioides*, *Dicranum scoparium*, *Brachythecium asperrimum*, *Drepanocladus uncinatus*, and *Pogonatum alpinum*. Common lichens include *Peltigera aphthosa*, *P. scabrosa*, *P. malacea*, *Cladonia cornuta*, *C. gracilis*, *C. ecmocyna*, *C. deformis*, and *C. gonecha*.

Epiphytes are usually frequent to abundant and typically are *Cetraria pinastri*, *Hypogymnia austerodes*, and *Parmeliopsis ambigua*.

(g) Abies lasiocarpa-Betula glandulosa-Empetrum nigrum community (Fig. 37).

Open *Abies* forest and krummholz is a common type of steep, moist midslopes, with best development on northern exposures. Soils are moist to wet, cold, podzols. As *Picea-Betula-Salix* is the dominant forest community at lower elevations in the subalpine zone, so is *Abies-Betula-Empetrum* in the higher subalpine. This is true in the wilderness park as well as in the ecological reserve. The open forest grades into dwarfed clumps and eventually krummholz (Fig. 39) or shintangle on upper slopes. The treeline is thus gradual. Although the krummholz belt generally occurs at alpine elevations (1600+ m) its affinities are mainly with subalpine communities, and it will be included here in the subalpine zone. Luckhurst (1973) and Geist et al. (1974) have described similar fir-birch-crowberry communities.

The subalpine fir trees are widely spaced and poorly growing (10 m or less in height). *Abies* reproduction is frequent, but mainly by layering.

In the progression towards krummholz, the trees become stunted and assume the "flag" form, in which there is a dense, shrub-like thicket at the tree base, followed by a main stem snow-blasted and wind-desiccated free of foliage and most branches for a half metre or so. This bare "pole" is then topped by a sparse crown or "flag" of foliage. The height of the basal thicket indicates the prevailing winter snow depth on the site, which in the Gladys Lake area is about 1-1.5 m in this community type.

The shrub layer is moderately abundant to dense. *Betula glandulosa* is the prominent species, but *Salix glauca* and *Ledum groenlandicum* (Labrador tea) are abundant on wetter sites with gleyed podzols.

Prominent in the dwarf shrub/herb stratum are *Empetrum nigrum* and *Vaccinium vitis-idaea*. *Artemisia arctica* (arctic sage), *Cornus canadensis, Linnaea borealis, Lupinus arcticus, Mertensia paniculata, Pedicularis labradorica,* and *Festuca altaica* also may occur, and *Arctostaphylos rubra* (scarlet bearberry) may be abundant on wetter sites.

The cryptogamic layer is well developed (mean total cover of 75%) and diverse. Lichens are more prominent here than in the *Abies*-feather moss community. Important species include *Cladina alpestris, C. mitis, C. rangiferina; Cladonia cornuta, C. gracilis, C. chlorophaea, C. cenotea, C. coccifera, C. deformis, C. gonecha, C. amaurocraea, and C. uncialis; Peltigera aphthosa, P. scabrosa, P. malacea; Nephroma arcticum* (Fig. 38); *Lobaria linita;* and *Dactylina arctica*. *Hylocomium splendens, Pleurozium schreberi,* and *Dicranum* spp. are the prominent mosses.

Epiphytes are sparse to frequent, generally less abundant than in the *Abies*-feather moss forests. *Tholurna dissimilis* (Fig. 40) is an interesting lichen found occasionally here and in the following community on the poles and flags of stunted *Abies*. The Gladys Lake collections are to date the northernmost in North America for this rare lichen. The previous northernmost localities

were in the Smithers area.

(h) Abies lasiocarpa-Cassiope mertensiana-Rubus pedatus community.

This type of subalpine fir tree clump and krummholz community is local within the reserve, occurring on some upper valley bottoms and mid-slopes, especially in upper Castor Valley. Such areas appear to be heavier snowfall sites, presumably with a somewhat milder, moister mesoclimate. Soils are podzolic or minipodzolic. This fir-heather type is very common and characteristic in the coastal mountains of British Columbia. Its extent in the Spatsizi area is unknown, but in the cold, continental climate of the upper Stikine watershed, it must be at the limit of its dominant range.

Abies lasiocarpa forms dense, often stunted clumps in the tree clump-heath complex of the subalpine parkland, and krummholz on mid-slopes to 1700 m. Reproduction by seedlings and layering is abundant.

The shrub stratum is sparse in the forest clumps, but dense in krummholz. Stunted or regenerating *Abies* is dominant in this stratum. *Vaccinium membranaceum* (black huckleberry) is the only other common species, although *Sorbus sitchensis* (Sitka mountain ash) and *Ribes glandulosum* may also be found.

The dwarf shrub/herb layer is well developed and dominated by woody mats of *Cassiope mertensiana* (a white mountain heather) and *Empetrum nigrum*. *Rubus pedatus* (five-leaved bramble), *Linnaea borealis*, *Phyllodoce empetriformis* (red mountain heather), and *Vaccinium caespitosum* are also common woody species. Additional characteristic species include *Cornus canadensis*, *Sibbaldia procumbens*, *Lycopodium alpinum* and *L. annotinum* (clubmosses), *Hieracium gracile* (hawkweed), and *Juncus drummondii*.

The cryptogamic stratum is well developed, but lichens are much less abundant than in the *Abies-Betula-Empetrum* community. Prominent bryophytes are

Dicranum fuscescens, *D. scoparium*, *Hylocomium splendens*, and *Barbilophozia lycopodioides*. The lichens *Cladina mitis*, *C. alpestris*, and *Solorina crocea* are fairly frequent.

Epiphytes are generally sparse.

Shrub Community Types

There are seven shrub-dominated community types in the Gladys Lake reserve. Most of these appear to be climax or subclimax types. They range from fens to dry colluvial scrub.

(a) (Picea glauca)-Salix barclayi-Betula glandulosa-Carex aquatilis-moss community (Fig. 36).

Subalpine shrub fens occur commonly in the reserve in the valley bottoms in poorly drained abandoned channels and old oxbows within the meander plains of the major creeks. Fens have also developed in potholes in moraine fields and outwash and kame terraces, and on backswamps between mountain bases and natural levees along the streams. As well, fens occur along lake margins and areas swamped by beaver ponds. Shrub and forest fens are common in the park (primarily in the montane zone), and are exceptionally well developed along the lower Spatsizi River. This wetland type may be termed a moderately rich (weakly minerotrophic) soligenous/topogenous fen, following the classification of Sjörs(1963) and Heinselman (1963, 1970). That is to say, the fen waters are moderately rich in basic ions (and thus do not have low pH's), and the nutrients are fed in by water flowing from surrounding mineral soil and/or seeping down from higher ground. Soils are organics, humic gleysols, or gleyed podzols. Anderson (1970), Kojima (1972), and Douglas (1974) have reported somewhat similar fens from Atlin and the Yukon.

Trees are often lacking; if present, they are widely scattered,

stunted, and slow-growing. *Picea glauca* (most frequent) and *Pinus contorta* are the only tree species present in the Gladys Lake fens, and this appears to be the case in many of the park fens as well. However, *Picea mariana* (black spruce) should occur in some fens, especially at lower elevations and in lower nutrient situations.

The shrub stratum is moderately to well developed. *Salix barclayi, Betula glandulosa, Salix barrattiana, S. glauca,* and *Potentilla fruticosa* (shrubby cinquefoil) are prominent species.

A moderate to dense dwarf shrub/herb stratum is always present. *Carex aquatilis* is the most prominent species, followed by *Salix myrtillifolia* and *Empetrum nigrum*. Important associates are *Ledum groenlandicum, Arctostaphylos rubra, Oxycoccus microcarpus* (bog cranberry), *Rubus chamaemorus* (cloudberry), *Rubus arcticus* (pink-flowered arctic raspberry), *Equisetum arvense* (common horsetail), *Carex disperma, C. vaginata, C. media,* and *Arctagrostis latifolia* (polar water-grass).

The cryptogamic layer (mainly mosses) is usually well developed and markedly hummocky. Prominent species are *Aulacomnium palustre, Paludella squarrosa, Drepanocladus exannulatus, Sphagnum capillaceum, S. recurvum, Mnium venustum, Calliergon cordifolium,* and *Polytrichum strictum*. Also common are *Calliergon giganteum, Campylium stellatum, Cinclidium stygium, Dicranum undulatum, Drepanocladus revolvens, Sphagnum fuscum, S. warnstorfii, Bryum pallescens,* and *Hylocomium splendens*. *Peltigera aphthosa, P. scabrosa, Cladina impexa, Cladonia gonecha, C. deformis, C. chlorophaea, C. cyanipes, C. carneola,* and *Icmadophila ericetrorum* are frequent lichens.

(b) Salix scouleriana-Linnaea borealis-Festuca altaica community (Fig. 30).

Salix scouleriana forms a tall willow scrub on moderately to steeply sloping, mesic to dry, well drained colluvial or till slopes with shallow

brunisolic soils. It is best developed on southern exposures, and in the reserve ascends such slopes to 1460 m. It occurs fairly commonly on burned-over sites throughout the Spatsizi area, and is often associated with stands of pygmy aspen and poplar. Like these two types, the *Salix scouleriana* scrub probably has a moderate to heavy snowcover that melts off early in spring. Douglas (1974) describes a similar community in the Alsek region.

Clumps of *Salix scouleriana* to 7 m tall form a well developed tall shrub stratum. Lower shrubs are moderately abundant, with *Salix glauca* prominent, and *Betula glandulosa* and *Shepherdia canadensis* frequent associates. *Picea glauca* and *Populus balsamifera* invasion is infrequent.

The dwarf shrub/herb stratum is usually well developed. Prominent species are *Linnaea borealis, Epilobium angustifolium,* and *Festuca altaica.* Important associates are *Juniperus communis, Lupinus arcticus, Arnica cordifolia,* and *Mertensia paniculata.*

The cryptogamic layer is sparse to moderately abundant. Common species include *Thuidium abietinum, Pleurozium schreberi, Hylocomium splendens, Drepanocladus uncinatus, Hypnum revolutum, Peltigera canina, P. aphthosa,* and *Cladonia chlorophaea.*

Cetraria pinastri, Parmeliopsis ambigua, and *Leptogium saturninum* are the only common epiphytes.

(c) Salix (glauca, barclayi, planifolia)-Festuca altaica-Rubus arcticus-Petasites frigidus-Aulacomnium palustre community.

Medium-tall (1.5-3 m) willow thickets are common on wet sites in the valley bottoms on alluvial fans, meander plains (Fig. 31), lakesides, and depressions in till plains. Typical soils are rego and rego humic gleysols.

The shrub stratum is well developed, but variable in that tall shrubs may be lacking or abundant. *Salix glauca, S. barclayi,* and *S. planifolia* are

the prominent willows, and *Potentilla fruticosa* is common. *Betula glandulosa* is generally not an important species in this community.

The dwarf shrub/herb layer is rich in species and moderate to abundant in cover. Prominent species include *Festuca altaica, Luzula parviflora* (woodrush), *Poa pratensis, Petasites frigidus, Rubus arcticus, Epilobium angustifolium, Achillea millefolium, Aconitum delphinifolium* (monkshood), *Mertensia paniculata, Polemonium acutiflorum* (Jacob's ladder), *Stellaria monantha,* and *Senecio pauciflorus* (orange groundsel).

The moss layer is moderately developed and characteristically hummocky. Prominent species are *Aulacomnium palustre, Hylocomium splendens,* and *Peltigera aphthosa.* Important associates are *Polytrichum strictum, Drepanocladus uncinatus, Mnium venustum, Peltigera scabrosa* and *P. canina.* Other cryptogams that are locally common are *Brachythecium salebrosum, Climacium dendroides, Bryum pallescens, Tomenthypnum nitens, Blepharostoma trichophyllum, Marsupella sparsifolia, Cladonia cyanipes* and *C. gonecha.*

(d) Salix (alaxensis, barclayi, planifolia)-Epilobium latifolium-Drepanocladus uncinatus community (Figs. 31, 32, and 33).

Riparian willow thickets develop on fresh alluvium on active meander floodplains of low gradient streams (e.g., Connector Creek), and ascend for short distances on rubble along steep mountain creeks. The alluvial deposits are heterogeneous in size and texture and are well drained, although they are flooded in early summer, and the water table is high for most of the growing season. Soils are alluvial cumulic regosols and gleyed regosols. The successional vegetation is in several stages on such sites, depending on the age and stability of the substrate. Early stages have low or seedling shrubs, a moderately developed herb layer, sparse to moderate cryptogamic cover, and some bare ground. The most advanced stages have dense thickets or even small-tree-

sized stands of willows with white spruce seedlings and saplings, a moderately developed herb stratum, and a sparse to moderate cryptogamic layer.

Prominent shrubs are *Salix alaxensis* (Fig. 34), *S. barclayi*, and *S. planifolia*. *Epilobium latifolium* (broad-leaved willow herb), *Artemisia tilesii*, *Astragalus alpinus* (alpine milkvetch), *Equisetum arvense*, *E. variegatum*, *Parnassia kotzebuei* (small grass-of-Parnassus), *Lupinus arcticus*, *Arctogrostis latifolia*, *Poa alpina*, and *Juncus arcticus* are prominent in the herb stratum. Other characteristic herbs are *Arenaria dawsonensis*, *Barbarea orthoceras*, *Erigeron debilis*, *Oxytropis campestris*, *Carex aurea*, *Deschampsia caespitosa*, *Agrostis scabra*, and *Phleum alpinum*. Typical cryptogams include *Drepanocladus uncinatus*, *Hypnum lindbergii*, *Isopterygium pulchellum*, *Ceratodon purpureus*, *Bryum caespiticium*, *Distichium capillaceum*, *Rhacomitrium canescens*, *Preissia quadrata*, *Stereocaulon tomentosum*, *Cladonia pyxidata*, *C. chlorophaea* and *Peltigera canina*.

This community is similar to the *Salix alaxensis-Calamagrostis canadensis-Drepanocladus uncinatus* association of Kojima (1973).

Interestingly, there is no pioneer *Dryas drummondii* community in the Gladys Lake reserve. This type colonizes recent gravel outwash fans and stream terraces and is locally common in the nearby Cassiar area of B. C., and in the southwestern Yukon (Douglas 1974).

The dominant cover of the subalpine zone in the Gladys Lake reserve is a dense scrub of willows and dwarf birch 0.5 to 2.5 m high. At lower elevations it is mixed with the common spruce-willow-birch open forest community, but at middle and upper subalpine elevations the shrub cover becomes increasingly dominant. This scrub is climax vegetation in the Spatsizi area. Except in the lowermost subalpine, tree reproduction beneath the shrub cover is rare. As well, the shrub communities appear to be encroaching upon the subalpine

grassland throughout the region. Krajina (1975) suggests that the deciduous shrubs thrive in part because, even under cloudless skies, frost does not occur during the short summer nights. Similar shrub communities are common throughout northern British Columbia and the southern Yukon, and several have been described by Kojima (1973), Luckhurst (1973), Douglas (1974), and Krajina (1975).

(e) Salix glauca-Betula glandulosa-Festuca altaica community.

Willow-birch scrub is widespread (Fig. 21) on mesic to dry, well drained sites in the valley bottoms and on the lower slopes. Its occurrence is general except on cold, moist northern slopes. The brunisolic to minipodzolic soils have developed on well drained till, colluvium, or alluvium.

The shrub stratum is very well developed and generally 1-2 (3) m tall. *Salix glauca* and *Betula glandulosa* are co-dominants, and *Salix scouleriana* is a frequent associate.

The herb stratum is sparse to moderately developed. *Festuca altaica* is the prominent species. Import associates are *Epilobium angustifolium, Mertensia paniculata, Linnaea borealis,* and *Lupinus arcticus.*

The moss layer is moderately to well developed. *Pleurozium schreberi* and *Hylocomium splendens* are prominent mosses and *Dicranum acutifolium* is frequent. *Peltigera aphthosa* is the only prominent lichen, although various Cladoniae are frequent.

Epiphytes are generally sparse in the deciduous scrub. However, *Cetraria pinastri, Parmeliopsis ambigua, P. hyperopta,* and *Parmelia exasperatula* are fairly constant in both this and the following community.

(f) Betula glandulosa-Festuca altaica-cryptogam community (Figs. 14, 45 and 46).

Dwarf birch forms extensive thickets throughout the subalpine zone, but dominates most on mesic northern mid- and upper-slopes. This birch scrub

(commonly called "buckbrush" by locals) is widespread throughout the Spatsizi area, and northern British Columbia and the southern Yukon in general (cf. Kojima 1973; Douglas 1974; Lord and Luckhurst 1974; Krajina 1975). Typical soils are shallow, coarse minipodzols over moderately drained colluvium and till.

The shrub stratum is well developed, often covering 100%. It is overwhelmingly dominated by *Betula glandulosa*, usually 0.5-2 m tall. *Salix glauca* is a frequent associate, but never dominates in this community.

The herb stratum is usually fairly sparse, probably because of the dense birch cover. *Festuca altaica* is the only prominent species. *Empetrum nigrum, Artemisia arctica, Lupinus arcticus, Mertensia paniculata, Vaccinium vitis-idaea, Linnaea borealis,* and *Stellaria monantha* are common.

The cryptogamic layer is well developed. Prominent mosses are *Hylocomium splendens, Pleurozium schreberi, Dicranum acutifolium,* and *Polytrichum juniperinum.* Important lichens include *Cladina mitis, C. rangiferina, Peltigera aphthosa, Cladonia gracilis and C. deformis. Cetraria cucullata, C. islandica, Cladonia cornuta, C. gonecha, C. cenotea, C. coccifera, Peltigera malacea, Nephroma arcticum,* and *Lobaria linita* are fairly common.

On drier sites, the bryophytes tend to occur around the bases of the dwarf birch clumps, while the lichens and *Festuca altaica* abound in patches in the open between the clumps. On moister sites, dwarf birch forms a closer canopy, and the mosses form thick carpets beneath it. The Peltigeras and *Nephroma* increase in abundance on the moss carpets.

(g) Juniperus communis-Arctostaphylos uva-ursi-grass community (Fig. 48).

The dwarf juniper-bearberry-grass community is fairly common on dry, lower to middle elevation, colluvial slopes, stabilized talus, rocky ridge-crests, and moraine and esker faces. It is generally found on steep, often

convex, south slopes, at elevations of up to 1630 m. It is a seral type in the Gladys Lake reserve. It appears to be invading adjacent subalpine grassland, and at these elevations is itself succeeded (often very slowly) by aspen or poplar pygmy forests, or willow-birch scrub. Douglas (1974) describes a similar community in the Alsek Valley.

The well developed dwarf shrub/herb stratum is dominated by *Juniperus communis*, *Arctostaphylos uva-ursi*, and *Festuca altaica*. Stunted *Rosa acicularis* and *Potentilla fruticosa* are frequent shrubby associates. Other important herbaceous species include *Poa glauca*, *Koeleria nitida* (Junegrass), *Saxifraga tricuspidata* (prickly saxifrage), *Epilobium angustifolium*, *Achillea millefolium*, *Draba aurea*, *Gentiana propinqua*, *Sedum lanceolatum*, and *Anemone multifida*.

The cryptogamic layer is usually sparse. *Ceratodon purpureus*, *Tortula ruralis*, *Orthotrichum laevigatum*, *Peltigera canina*, and *Cladonia pyxidata* are fairly frequent, and all are typically xerophytic species.

Snow cover in this type is probably light and discontinuous, and periodically lacking. Soils are shallow (lithic brunisols) over colluvium.

Herb Community Types

Five subalpine herb communities are described in the Gladys Lake reserve. They are all pioneer or seral types and generally local in distribution. They occur on a variety of parent materials and range from dry steppe grassland to sedge fens.

(a) *Poa glauca-Carex supina-Potentilla pensylvanica-Artemisia borealis* community (Figs. 47 and 91).

This boreal steppe grassland is restricted to very steep (30^{o}), dry, south-facing, colluvial slopes, between about 1490 and 1770 m. The black,

chernozem-like soils are very shallow over colluvium, and this grassland type is largely snow-free in winter. Annas (1974) and Douglas (1974) have described similar steppe communities.

The well developed herb layer is dominated by grasses and sedges, most notably *Poa glauca* and *Carex supina*. *Agropyron caninum, Koeleria nitida, Festuca altaica, F. saximontana, Trisetum spicatum, Carex petasata, C. anthoxanthea,* and *C. obtusata* are additional important grasses and sedges. Prominent forbs are *Potentilla pensylvanica, Artemisia borealis,* and *Oxytropis campestris*. Common associates are *Potentilla nivea, Artemisia michauxiana, Cerastium beeringianum, Myosotis alpestris, Saxifraga tricuspidata,* and *Androsace septentrionalis*.

The cryptogamic stratum is sparse. *Tortula ruralis* is the most prominent species, while *Peltigera canina, Parmelia separata,* and *Physconia muscigena* are fairly frequent.

On some sites this grassland type appears to be an edaphic climax, but other sites are being invaded by shrubs such as *Rosa acicularis, Arctostaphylos uva-ursi, Potentilla fruticosa,* and *Juniperus communis*.

(b) Festuca altaica subalpine grassland community (Figs. 41 and 42).

Altai fescue grassland is widely distributed in the subalpine zone, usually below 1625 m, but occasionally ascending to 1850 m on south slopes. In the Gladys Lake reserve it occurs on mesic to dry sites on south faces of moraines, eskers, and alluvial terraces, on the bottom of rapidly drained frost pocket depressions in moraine fields, and on south-facing, lower and middle mountain slopes. It is of patchy occurrence in the reserve, forming extensive cover only in Kettlehole Pass (Figs. 18 and 45). In the park, much more extensive grassland coverage occurs in wide, drift-filled valleys such as Fire Flats (Fig. 7), the Stikine Prairie (Tuaton-Laslui lakes area), and the upper Ross River. Throughout the area, this seral grassland is being succeeded by

by the willow-birch-fescue, birch-fescue-cryptogam, and juniper-bearberry-grass shrub types.

This grassland type is conspicuously dominated by *Festuca altaica*, the fescue bunchgrass of the northern pastures of the Spatsizi region. The well developed herb stratum contains numerous species of other grasses and forbs. Prominent among them are *Festuca saximontana, Poa glauca, P. cusickii, Artemisia arctica,* and *Potentilla diversifolia*. Additional common herb species are *Aconitum delphinifolium, Delpninium glaucum, Epilobium angustifolium, Fragaria virginiana, Lupinus arcticus, Solidago multiradiata, Trisetum spicatum, Luzula parviflora, Carex podocarpa,* and *C. macloviana*.

The cryptogamic stratum is generally poorly developed. *Thuidium abietinum* is the only prominent species. On drier sites, the herb stratum thins out a bit, and moss and lichen cover increase. *Polytrichum juniperinum, Dicranum acutifolium, Tortula ruralis, Cladina mitis, Cetraria cucullata, C. islandica, Peltigera canina, P. aphthosa, Cladonia chlorophaea,* and *C. amaurocraea* may be locally common.

Soils are dark, well drained, and range from shallow and chernozem-like to deep, fine textured eutric brunisols. Snow accumulation is variable. Snow cover is probably light and discontinuous or lacking on steep, south-facing slopes, whereas moderate, continuous snow cover is probable in the broad upper valleys and frost pocket areas.

(c) *Festuca altaica-Luzula parviflora-Aconitum delphinifolium-Artemisia arctica-Senecio triangularis-Rumex acetosa* community (Fig. 43).

Lush grass-forb subalpine meadows are uncommon in the reserve. They are restricted to sites moister than those of the previous community, and reach best development on gentle lower slopes along broad ridges or the sides of wide valleys (e.g., Flower Ridge, vicinity of Bates Camp). Soils are deep

and moderately to poorly drained (gleyed brunisols and humic gleysols?). This is a seral or edaphic subclimax type, slowly being succeeded by wet willow thickets and dwarf birch scrub.

The herb stratum is very well developed, and consists of a lush and diverse mixture of grasses and forbs. Prominent species include *Festuca altaica, Luzula parviflora, Carex podocarpa, Phleum alpinum, Artemisia arctica, Aconitum delphinifolium, Rumex acetosa, Senecio triangularis, Rubus arcticus, Vaccinium caespitosum, Myosotis alpestris, Epilobium angustifolium,* and *Polemonium acutiflorum.* Common associates are *Castilleja unalaschcensis, Lupinus arcticus, Mertensia paniculata, Agoseris aurantiaca, Valeriana sitchensis, Veronica wormskjoldii,* and *Sanguisorba stipulata. Ranunculus occidentalis* and *Erigeron peregrinus* may be locally common.

The cryptogamic layer is generally sparse, but *Aulacomnium palustre* and *Peltigera aphthosa* are important on some sites.

Grass-forb moist subalpine meadows are much more common in the moister southwestern part of the park, as in the vicinity of Fire Flats and the Stikine Prairie. This is a common general community type in the coastal mountains further to the west. The coastal influence is indicated even in the Spatsizi area by the occurrence in these meadows of such species as *Fritillaria camschatcensis, Castilleja parviflora, Ranunculus occidentalis,* and *Viola langsdorfii.*

(d) Heracleum lanatum-Epilobium angustifolium-Thalictrum occidentale community (Fig. 44).

Lush cow parsnip meadows are uncommon and of small extent in the Gladys Lake reserve. They develop over coarse alluvium on convex, sloping deltaic fans at the bases of steep mountain creeks, and in concave lower slope seeps and snow accumulation areas. Soils are gleyed regosols or rego humic

gleysols fed by continuous downslope seepage on these hygric sites. Excellent examples of this type may be found at the south base of McMillan Mountain, at the mouth of Cow Parsnip Creek, and on the lower northeast flank of Flower Ridge.

The herb stratum is extremely well developed, but with fewer species than any of the previous community types. It is dominated by *Heracleum lanatum* (usually with cover values greater than 50%) and other broad-leaved forbs. Prominent forbs include *Epilobium angustifolium, Thalictrum occidentale* (western meadow rue), *Delphinium glaucum, Achillea millefolium, Mertensia paniculata,* and *Polemonium acutiflorum. Phleum alpinum, Calamagrostis canadensis* (bluejoint), and *Festuca altaica* are important grasses.

The cryptogamic layer is sparse or lacking. Species of *Bryum, Mnium* and *Drepanocladus* are occasional.

As with the grass-forb meadows, cow parsnip meadows have coastal affinities and increase in abundance toward the southwest of the park. *Cirsium edule, Epilobium luteum,* and *Lupinus nootkatensis* are three typically coastal species collected only at cow parsnip sites in the reserve.

(e) Carex marshes and fens community (Figs. 35 and 36).

Sedge-dominated wetlands are not common in the reserve. They have developed in poorly drained depressions in till fields, and are filling in kettlehole lakes, oxbows, backwaters, and beaver sloughs. Soils are organics, humic gleysols, and rego humic gleysols. Sedge marshes and fens are pioneer and seral vegetation types, succeeded by shrub and forest fen types. Sedge wetlands are very well developed on the meander plain of the lower Spatsizi River, especially its stretches along the eastern boundary of the Gladys Lake reserve (Fig. 23). They are fairly common throughout the park, but generally not very extensive.

The herb stratum is sparse to moderately developed in the marshes,

but better developed with more continuous cover in the fen type. Prominent sedges include *Carex aquatilis, C. rostrata,* and *C. saxatilis. Carex canescens, C. limosa, C. magellanica,* and cotton grasses *(Eriophorum angustifolium, E. callitrix, E. vaginatum)* are frequent associates. *Epilobium palustre, Chrysosplenium tetrandrum, Potentilla palustris, Callitriche verna, Hippuris vulgaris, Ranunculus hyperboreus, Calamagrostis canadensis, Arctagrostis latifolia,* and *Sparganium minimum* may be locally common.

The moss layer is generally poorly developed. *Drepanocladus exannulatus* and *Calliergon giganteum* are the only prominent species. *Cinclidium stygium, Drepanocladus revolvens, Calliergon cordifolium, Mnium venustum,* and *Bryum pallescens* may also occur.

Talus-Lichen-Moss Terrain Unit
(Figs. 49 and 50)

The only cryptogam-dominated vegetation type in the subalpine zone of the Gladys Lake reserve might be characterized the *(Dryopteris fragrans)*-lichen-moss community. However, this nowhere forms continuous, homogeneous cover, and it is actually a complex of several, very small-scale cryptogamic communities that would require different sampling methods to define. This terrain unit (as it is more properly termed) comprises pioneer vegetation on partially stabilized, south-facing talus and rubble slopes. It appears to be transitional to the *Juniperus communis-Arctostaphylos uva-ursi*-grass community. It is an uncommon type, occurring below 1460 m primarily beneath cliffs along the south faces of Guardian and Ghost mountains, and Alces Ridge.

There is a predominance of exposed rock, with little or no soil (organic matter slowly accumulates on ledges and flat boulders and in crevices). Xeric conditions predominate, but moist, shaded microhabitats honeycomb

such talus cones.

The herb stratum is sparse. There are no prominent species, but *Dryopteris fragrans* (fragrant shield-fern) (Fig. 50), *Cystopteris fragilis* (fragile fern), *Festuca saximontana, Saxifraga tricuspidata, Poa glauca,* and *Koeleria nitida* are fairly frequent.

The cryptogamic stratum is moderately to very well developed, with clumps of mosses and fruticose lichens, and numerous crustose lichens. Its composition is difficult to quantify because of the complex of microenvironments. However, prominent species include *Rhacomitrium lanuginosum, Cladina alpestris, C. mitis,Cetraria nivalis, Stereocaulon tomentosum, S. saxatile, S. glareosum, Cladonia uncialis, Rhizocarpon geographicum* agg., *Rhizocarpon badioatrum, Parmelia stygia, P. taractica, Lecidea granulosa, Actinogyra muehlenbergii, Umbilicaria hyperborea,* and *U. proboscoidea.* The cryptogamic flora is diverse. Additional common species are *Andreaea rupestris, Dicranum acutifolium, D. fragilifolium, Polytrichum piliferum, Pohlia cruda, Tortula ruralis, Rhacomitrium canescens, Thuidium abietinum, Chandonanthus setiformis, Cladina rangiferina, Cladonia amaurocraea, C. coccifera, C. gracilis, C. pyxidata, C. crispata, Cetraria cucullata, Alectoria ochroleuca, Sphaerophorus fragilis, Thamnolia vermicularis, Dactylina arctica, Parmelia omphalodes, P. infumata, P. saxatilis, Physconia muscigena, Umbilicaria vellea, Xanthoria elegans, Lepraria chlorina, Lecidea macrocarpa, Haemotomma lapponicum* (Fig. 52).

ALPINE VEGETATION OF THE GLADYS LAKE ECOLOGICAL RESERVE

Shrub Community Types

Shrub types are common at low to middle elevations (roughly 1675-1800 m) in the alpine zone of the Gladys Lake area. There are two basic types.

(a) Betula glandulosa-Artemisia arctica-cryptogam community (Figs. 54, 57 and 58).

Alpine birch thickets are common on mesic to moist, steep or gradual, upper colluvial slopes. They also occur on kame crests in some high, exposed passes, as in Danihue Pass. The podzolic soils are generally moist and shallow, with fairly thick humus layers. Floristically they are similar to subalpine birch thickets, but alpine species (especially of cryptogams) are more prominent. This type is similar to the *Betula glandulosa-Artemisia arctica-Hylocomium splendens* association of Kojima (1973).

The shrub stratum is moderately to well developed. *Betula glandulosa* is the prominent species. It is usually 1.0 m tall or less, much shorter than in the subalpine birch community. *Salix glauca, S. pulchra,* and *S. planifolia* are occasionally important associates.

The dwarf shrub/herb stratum is moderately abundant. Important species are *Artemisia arctica, Festuca altaica, Poa arctica, Lupinus arcticus,* and *Stellaria monantha.* Also present are *Empetrum nigrum, Vaccinium vitis-idaea, Salix arctica, Luzula parviflora, Petasites frigidus,* and *Senecio lugens.*

Prominent bryophytes in the well developed cryptogamic stratum are *Hylocomium splendens, Dicranum acutifolium, D. scoparium, Polytrichum juniperinum, P. strictum, Rhytidium rugosum,* and *Aulacomnium palustre.* Important lichens are *Peltigera aphthosa, Nephroma arcticum, Lobaria linita, Stereocaulon paschale, Dactylina arctica, Cladina alpestris, C. rangiferina, Cetraria cucullata, C. nivalis,* and *C. islandica.*

(b) Salix barrattiana-Petasites frigidus-Tomenthypnum nitens community (Fig. 59).

Salix barrattiana thickets are common on wet sites in the alpine valley bottoms, usually on gently sloping alluvial fans, at the base of long slopes, and within the meander plain of low gradient alpine streams. Soils that have developed on the fine to moderately coarse recent alluvium are cumulic regosols

or rego humic gleysols. The snow pack in this habitat is thick, but usually melts several weeks earlier than in typical snowbed areas. This community is similar to the Salicetum barrattianae of Hoefs, Cowan and Krajina (1976).

The dense low shrub layer (coverage often 100%) is dominated by *Salix barrattiana*, usually about 1 m tall. *Salix alaxensis* and *S. glauca* are occasional associates.

The herb layer is moderately developed. Prominent species are *Petasites frigidus*, *Rubus arcticus*, *Polemonium acutiflorum*, and *Mertensia paniculata*. Important associates are *Senecio lugens*, *S. triangularis*, *Delphinium glaucum*, *Artemisia arctica*, *Equisetum arvense*, *Pedicularis sudetica*, *Polygonum viviparum*, *Salix reticulata*, *Veronica wormskjoldii*, *Festuca altaica*, and *Luzula parviflora*. *Anemone richardsonii*, *Sanguisorba stipulata*, *Selaginella selaginoides*, *Carex podocarpa*, *Poa alpina*, and *Calamagrostis canadensis* may be locally common.

The cryptogamic stratum is moderately to well developed. *Tomenthypnum nitens* is the prominent species, while *Hylocomium splendens*, *Drepanocladus revolvens*, *Brachythecium plumosum*, *Mnium blyttii*, *Mnium venustum*, *Aulacomnium palustre*, and *Peltigera aphthosa* are important associates.

Salix planifolia and *S. pulchra* rarely form nearly pure stands on similar sites within the reserve. Except for the dominant shrub species, these willow stands are very similar to *Salix barrattiana* thickets.

Tundra Community Types

The dominant vegetation in the alpine zone of the Gladys Lake reserve is tundra - that is, vegetation consisting of short-stemmed perennial herbaceous plants, prostrate shrubs, bryophytes, and lichens (Billings 1974). The tundra vegetation includes two heath (dwarf evergreen shrub) communities, five

dwarf deciduous shrub-graminoid tundra types, three seepage types, a lichen fellfield type, and several additional plant assemblages characteristic of certain terrain units.

(a) Cassiope mertensiana-Luetkea pectinata-Sibbaldia procumbens-Barbilophozia hatcheri community (Fig. 39).

This heath type is uncommon and local in the reserve. It occurs on concave lee slopes with deep snow accumulation, generally at or just above treeline, often among tree islands and krummholz. The moist, turfy soils are alpine dystric brunisols or humic podzols. Similar heath communities are common and widespread throughout the Coast Range of B. C., and in the wetter southern interior ranges. Such heath vegetation is much more limited in the Spatsizi area, being restricted to protected, mesic to moist, snow-accumulation sites.

The dwarf shrub/herb stratum is very well developed. *Cassiope mertensiana, Luetkea pectinata* (partridge-foot) and *Sibbaldia procumbens* are the most prominent species. Important associates are *Phyllodoce empetriformis* (red mountain heather), *Empetrum nigrum, Artemisia arctica, Lycopodium alpinum* (alpine clubmoss), *Luzula parviflora, Juncus drummondii,* and *Hieracium gracile. Carex pyrenaica* may be locally abundant.

Prominent in the moderately developed cryptogamic layer are *Barbilophozia hatcheri, Orthocaulis floerkii, Dicranum scoparium, D. fuscescens,* and *Solorina crocea.* Also common are *Distichium capillaceum, Blepharostoma trichophyllum, Lobaria linita,* and *Cetraria islandica.*

(b) Cassiope tetragona-Dryas integrifolia-Salix (reticulata, polaris)-Distichium capillaceum community (Figs. 53 and 61).

Cassiope-Dryas-Salix heath is widespread throughout the Spatsizi area. It is the zonal community at low to moderate alpine elevations (up to ca 1850 m)

on steep to moderate slopes with moderate to deep, continuous, long-lasting snow cover. It attains best development on moist to mesic northern and eastern slopes. The cold, moist soils may be alpine dystric brunisols, regosols, or lithic and cryic humisols, gleysols, and organics. Seepage and solifluction are common, and ice lenses may be present in the subsoil. This heath type is very similar to the Salico (reticulatae)-Cassiopo (tetragonae)-Dryadetum integrifoliae described in Hoefs, Cowan and Krajina (1976).

The dwarf shrub/herb layer is well developed, generally covering 80-90%. Prominent species are all dwarf shrubs: *Cassiope tetragona, Dryas integrifolia* (mountain avens) (Fig. 62), *Salix reticulata,* and *S. polaris.* Other woody species frequently abundant are *Vaccinium uliginosum, V. vitis-idaea,* and *Salix arctica,* while *Arctostaphylos rubra* and *Ledum decumbens* are occasionally important. Common herbs are *Silene acaulis, Pedicularis capitata, Stellaria monantha, Polygonum viviparum, Carex microchaeta, C. podocarpa, Poa arctica,* and *Festuca altaica. Pedicularis langsdorfii, Arnica lessingii, Lupinus arcticus, Pyrola grandiflora, Draba longipes, Calamagrostis lapponica, Luzula confusa, L. tundricola,* and *L. arcuata* may be locally abundant.

The cryptogamic layer is moderately developed. Prominent species include *Distichium capillaceum, Hylocomium splendens, Dicranum acutifolium, Rhytidium rugosum,* and *Stereocaulon glareosum.* Important associates are *Blepharostoma trichophyllum, Barbilophozia hatcheri, Aulacomnium turgidum, Tomenthypnum nitens, Timmia austriaca, Thamnolia vermicularis, Dactylina arctica, Cetraria cucullata, C. islandica, C. nivalis, C. ~~subalpina~~ ericatorum, Lobaria linita, Peltigera aphthosa,* and *Lecidea* spp.

(c) Festuca altaica-Artemisia arctica-Polytrichum piliferum-Stereocaulon glareosum-Cetraria (cucullata, nivalis) community (Figs. 53, 54, 57, and 58).

Fescue-lichen tundra is fairly common on steep, generally south-facing

upper slopes (to 1900 m) and on exposed kame and moraine crests in high broad valleys. Sites are well drained, mesic to submesic, and with light, discontinuous winter snow cover. Soils are alpine eutric brunisols or chernozem-like, colluvial lithosols. This community is somewhat similar to the drier *Elymus innovatus-Festuca scabrella* type of Lord and Luckhurst (1974) and the wetter Artemisio (arcticae)-Salico (reticulatae)-Festucetum altaicae on Sheep Mountain (Hoefs, Cowan and Krajina 1976).

The herb stratum is well developed. *Festuca altaica* and *Artemisia arctica* are prominent species, and common associates include *Hierochloë alpina, Carex microchaeta, Luzula spicata, Antennaria monocephala, Campanula lasiocarpa, Gentiana glauca, Potentilla diversifolia, Polygonum viviparum,* and *Silene acaulis.*

The moderately to well developed cryptogamic stratum is dominated by *Polytrichum piliferum, Stereocaulon glareosum, Cetraria nivalis, C. cucullata,* and *Cladina alpestris.* Other important species are *Bryum angustirete, Cetraria islandica, Cladina mitis, C. rangiferina, Thamnolia vermicularis, Cladonia pleurota, C. coccifera, C. squamosa, C. pyxidata,* and *Dactylina arctica* (Fig. 55). *Cetraria richardsonii* (Fig. 56) was very abundant in a few plots on kame crests in Danihue Pass, but is otherwise a rare species in the reserve.

Exposed rock is common in this and the following four tundra communities, and is generally covered with lichens. Typical saxicolous species here are *Parmelia stygia, P. taractica, P. infumata, P. omphalodes, Cetraria hepatizon, Alectoria pubescens, Umbilicaria kraschenokovii, U. proboscoidea, Lecidea macrocarpa, Xanthoria elegans, Rhizocarpon geographicum* agg., *R. badioatrum, Collema undulatum, Stereocaulon saxatile,* and *Haemotomma lapponicum.*

(d) Poa rupicola-Trisetum spicatum-Hierochloë alpina-Potentilla nivea community (Fig. 84).

Scattered throughout the Gladys Lake reserve are goat/sheep "saddles".

These are grassy, convex clifftop, ridgecrest (Figs. 83, 84, and 85), or cave-mouth (Fig. 96) projections where goats and sheep feed, rest, and observe. Such sites are frequent (particularly on southern or western exposures), but very small and local. Their heterogeneous, zoo-climax tundra vegetation is heavily manured, lush, and dark green. These "saddles" are probably largely snow-free in winter. They are the first alpine community to green up in the spring, and are then easily recognized as bright green patches on the sere mountainsides.

The herb layer is very well developed (usually covering 100% or more) and consists of a thick sward of grasses, sedges, and forbs. Prominent species include *Poa rupicola, Trisetum spicatum, Hierochloë alpina, Carex supina, Potentilla nivea, P. uniflora, P. diversifolia,* and *Stellaria monantha.* Common associates are *Agropyron caninum* var. *latiglume, Carex albo-nigra, C. anthoxanthea, C. microchaeta, Poa alpina, Kobresia myosuroides, Festuca altaica, F. brachyphylla, Myosotis alpestris, Aconitum delphinifolium, Saxifraga tricuspidata, Taraxacum ceratophorum, Draba nemorosa, D. nivalis,* and *D. cinerea.*

The cryptogamic layer is poorly developed to lacking. However, *Bryum angustirete, Dicranum acutifolium, Polytrichum piliferum, Rhytidium rugosum, Cetraria nivalis,* and *Physconia muscigena* are fairly frequent.

(e) Kobresia myosuroides-lichen community (Fig. 107).

Kobresia tundra is a rare vegetation type found only on the most exposed, windswept, strongly convex, south- or west-facing ridgecrests (e.g., Kobresia Ridge, Ghost Pass, rimrocks of Lupus Ridge). Stone striping and patterned ground are common, and *Kobresia* appears to favour finer textured soil within the pattern. Soils beneath well developed *Kobresia* turf are alpine eutric brunisols, with dark Ah horizons. This community type is known to be snow-free during winter in Colorado (Marr 1967) and the southwestern Yukon (G. W. Douglas, personal communication).

There is usually some bare ground in *Kobresia* tundra, but the dwarf shrub/herb stratum is moderately to well developed. It is dominated by *Kobresia myosuroides*, a member of the sedge family. Other prominent species are *Hierochloë alpina*, *Carex microchaeta*, *Poa rupicola*, *Polygonum viviparum*, *Silene acaulis*, *Draba nivalis*, *Dryas integrifolia*, and *Salix polaris*. Also important are *Luzula spicata*, *Festuca brachyphylla*, *Oxytropis nigrescens*, *Potentilla uniflora*, and *Stellaria monantha*.

The cryptogamic stratum is moderately developed and lichen-dominated. Prominent species include *Bryum angustirete*, *Polytrichum piliferum*, *Dicranum acutifolium*, *Cetraria nivalis*, *C. cucullata*, *Lecidea* spp., *Thamnolia vermicularis*, *Alectoria ochroleuca*, *Cetraria nigricans*, *Cornicularia aculeata*, *Physconia muscigena*, and *Parmelia* cf. *tasmanica*.

(f) Salix (polaris, reticulata)-Carex microchaeta-Polytrichum piliferum-Cetraria nivalis community (Figs. 71, 106, and 108).

Dwarf willow-sedge-grass-cryptogam tundra is the widespread, zonal plant community at moderate to high alpine elevations in the Spatsizi area. This type usually occurs between 1900-2100 m, but descends to 1860 m in some large cirques. It is found in mesic to moist situations, on moderately sloping to flat topography, and on all aspects. It is especially widespread and well developed on the rolling alplands of the Spatsizi Plateau proper. Within the reserve it occurs on upper slopes and broad ridges, and in patches along narrow, serrated ridgecrests. It is best developed on rolling alpine areas such as Fossil Flats, Solifluction Ridge, and Sedge Saddle.

Soils are generally alpine dystric brunisols or regosols, but cryic and lithic gleysols and organics may occur in wet areas or over permafrost. Winter snow cover is probably light to moderate and continuous, and discontinuous permafrost is present. There are similarities between the dwarf willow tundra

described here and the moss-lichen-dwarf willow community of Lord and Luckhurst (1974) and the Seneciono (lugentis)-Salicetum polaris-reticulatae of Hoefs, Cowan and Krajina (1976).

The dwarf shrub/herb stratum is moderately to well developed and dominated by the dwarf willows *Salix polaris* and *S. reticulata* (Fig. 72). *S. polaris* predominates at higher elevations. Other prominent species include *Carex microchaeta*, the grasses *Hierochloë alpina*, *Festuca altaica*, *F. brachyphylla*, and *Poa arctica*, the tundra woodrush *Luzula tundricola*, and the forbs *Polygonum viviparum*, *Antennaria monocephala*, *Potentilla hyparctica*, *Silene acaulis* and *Stellaria monantha*. Frequent associates are *Campanula lasiocarpa* (Fig. 75), *Draba nivalis*, *D. lactea*, *D. fladnizensis*, *Pedicularis langsdorfii*, *Luzula spicata*, and *Calamgrostis lapponica*.

The cryptogamic layer is also moderately to well developed. Prominent species are *Polytrichum piliferum*, *Bryum angustirete*, *Cetraria nivalis*, *C. cucullata*, *Lecidea* spp., *Stereocaulon glareosum*, and *Thamnolia vermicularis*. Important associates include *Rhytidium rugosum*, *Distichium capillaceum*, *Ditrichum flexicaule*, *Cetraria islandica*, *Dactylina arctica*, *Alectoria ochroleuca*, and *Cladonia pyxidata*. Species such as *Rhacomitrium lanuginosum*, *Dicranum acutifolium*, *Conostomum tetragonum*, *Timmia austriaca*, *Dactylina ramulosa*, *Sphaerophorus fragilis*, *Cetraria delisei*, *C. ~~subalpina~~ ericetorum*, *Physconia-muscigena*, and *Cornicularia aculeata* also frequently occur.

(g) Dryas integrifolia-Oxytropis nigrescens-Silene acaulis-lichen community (Fig. 66).

Cushion plant tundra is common but local throughout on exposed, windswept, convex ridgecrests of every aspect, with best development on southern and western exposures. This is a high elevation tundra type, generally occurring above 1800 m. It is intermediate between *Kobresia* tundra and dwarf willow tundra.

There is much bare ground (20-30% of most plots), usually well-drained gravelly scree and rubble. Soils are regosols or lithic alpine brunisols. Stone striping is common. Snow cover is probably light and discontinuous or occasionally lacking, and the soils are deep-freezing. There are similarities between this type and the dryas-rough fescue community of Lord and Luckhurst (1974), and the Salico (reticulatae)-Sileno(acaulis)-Carico (scirpoideae)-Dryadetum integrifoliae and Oxytropo (viscidae)-Artemisio (hyperboreae)-Festuco (brachyphyllae)-Trisetetalia spicati of Hoefs, Cowan and Krajina (1976).

The dwarf shrub/herb layer is moderately developed and dominated by cushion-forming plants. Prominent species include *Dryas integrifolia, Oxytropis nigrescens, Silene acaulis* and *Potentilla uniflora* (Fig. 67), *Lupinus arcticus, Salix reticulata, Draba nivalis, Kobresia myosuroides, Carex microchaeta,* and *Hierochloë alpina.* Frequent or occasionally abundant species are *Polygonum viviparum, Arenaria rubella, Campanula uniflora, Draba lactea, D. fladnizensis, Salix polaris, Saxifraga tricuspidata, S. flagellaris* (Fig. 69), *Lychnis apetala, Lloydia serotina, Oxytropis huddelsonii* (Fig. 68), *Papaver radicatum* (Fig. 70), *Festuca altaica, F. brachyphylla, Poa rupicola, P. leptocoma, Calamagrostis purpurascens,* and *Carex nardina.*

The cryptogamic layer is also moderately developed and is dominated by lichens. Prominent species are *Cetraria nivalis, C. cucullata, C. tilesii, Lecidea* spp., *Thamnolia vermicularis, Alectoria ochroleuca, Cornicularia divergens,* and *C. aculeata.* Important associates are *Rhytidium rugosum, Polytrichum piliferum, Parmelia separata,* and *Cetraria nigricans.*

Seepage and snowbed vegetation.

Alpine seepage areas and snowbeds are common in the Gladys Lake reserve. Their vegetation is heterogeneous and forms several different communities. Only the three commonest types were sufficiently sampled to describe properly.

(h) Salix reticulata-Carex aquatilis-moss community (Fig. 60).

This is a fairly common low alpine, subhydric, seepage-fen type that rims kettlehole ponds and borders low gradient streams and rivulets in the broad alpine valleys such as Kettlehole Pass and Sanctuary Pass.

The dwarf shrub/herb stratum is very well developed and includes *Salix reticulata, Carex aquatilis,* and *Polygonum viviparum* as prominent species. Important associates are *Eriophorum callitrix, Scirpus caespitosus, Carex scirpoidea, Tofieldia pusilla, Sangiusorba stipulata, Equisetum variegatum* and *E. arvense.*

The cryptogam layer is moderately developed and dominated by mosses. *Tomenthypnum nitens, Aulacomnium palustre,* and *Drepanocladus uncinatus* are prominent. Common associates are *Calliergon cordifolium, Paludella squarrosa, Mnium blyttii, Plagiomnium rugicum, Brachythecium* spp., *Cinclidium stygium,* and *Sphagnum capillaceum.*

(i) Salix (polaris, reticulata)-Carex podocarpa-Petasites frigidus-moss community (Fig. 63).

This is the commonest middle to high alpine seepage/snowbed type. It occurs at the base of long slopes, in snowy cirque bottoms, around open seeps and flushes, along moderate gradient streams, and in snow accumulation basins. Discontinuous permafrost underlies these hygric sites, and the ground cover is continuous and hummocky. Soils are lithic and cryic gleysols and organics.

This community is somewhat similar to the Saxifraga (oppositifoliae)-Oxyrio (digynae)-Salicetum polaris and the Seneciono (lugentis)-Salicetum polaris-reticulatae described in Hoefs, Cowan and Krajina (1976).

The dwarf shrub/herb stratum is well to very well developed and quite variable in species composition. *Salix reticulata* and *S. polaris* are prominent shrubs, with *S. polaris* dominating at higher elevations. Prominent herbs are *Carex podocarpa, Petasites frigidus, Artemisia arctica, Ranunculus eschscholtzii* and *Anemone parviflora*. Common or locally abundant associates are *Anemone richardsonii, Arnica lessingii* (Fig. 64b), *Caltha leptosepala, Corydalis pauciflora* (Fig. 65), *Draba longipes, Epilobium alpinum, E. latifolium, Equisetum scirpoides, E. variegatum, Claytonia sarmentosa* (Fig. 64a), *Parnassia fimbriata, P. kotzebuei, Polemonium acutiflorum, Polygonum viviparum, Saxifraga lyallii, Senecio lugens, Tofieldia pusilla, Valeriana sitchensis, Veronica wormskjoldii, Carex lachenalii, C. scirpoidea, Calamagrostis lapponica, Juncus castaneus, J. triglumis, Luzula parviflora,* and *Poa alpina*.

The cryptogamic stratum is poorly to moderately developed. Common species include *Tomenthypnum nitens, Drepanocladus revolvens, Brachythecium plumosum, Aulacomnium palustre, Polytrichum strictum, P. longisetum, Cinclidium stygium, Calliergon* spp., *Meesia triquetra,* and *Paludella squarrosa*.

(j) (Salix polaris-Ranunculus nivalis-Carex microchaeta)-moss community

High alpine (generally 1900 m plus), mossy seepage/snowbed vegetation is common but never extensive. This type occurs in snow pockets on the high plateaux, rims gravelly flushes, and fringes melting permanent snowbanks. It is similar to the previous seepage type but differs in species composition and in the fact that the moss cover is dominant. Permafrost is also more common (Fig. 73).

The dwarf shrub/herb layer is moderately to poorly developed. Prominent species are *Salix polaris, Ranunculus nivalis,* and *Carex microchaeta*. Common associates are *Claytonia sarmentosa, Cardamine bellidifolia, Ranunculus pygmaeus, Saxifraga punctata, Carex podocarpa* and *Poa alpina*. *Corydalis pauciflora,*

Eutrema edwardsii, *Koenigia islandica*, *Juncus biglumis*, and *J. triglumis* may be locally abundant.

The cryptogamic layer is very well developed. Prominent species are all mosses: *Bryum cryophilum*, *B. weigelii*, *Drepanocladus revolvens*, *Pohlia wahlenbergii*, *Cinclidium stygium*, *Tomenthypnum nitens*, *Cratoneuron commutatum*, *Philonotis fontana*, *Mnium blyttii*, and *Brachythecium* spp. *Hygrohypnum* spp. and *Dermatocarpon fluviatile* are common submerged in running water.

An uncommon variant of this type might be termed the *Ranunculus sulphureus-Bryum cryophilum-Philonotis fontana* community. *R. sulphureus*, thought to be endemic to the Yukon Territory and eastern Alaska, is a new species for British Columbia.

(k) Alpine fellfield (Fig. 76).

Alpine fellfield is a terrain unit consisting of a large proportion of boulders with a sparse to moderate cover of lichens, mosses, and occasional cushion-form and graminoid vascular plants. It is common on mountain tops, the highest ridgecrests, etc., usually from 2000 m to the upper limit of vegetation. Fellfield typically occurs on horizontal and gently sloping terrain. There are extensive accumulations of felsenmeer or mountain top detritus. Patterned ground (boulder garlands, polygons - Fig. 74) and gelifraction (frost cracking, splitting, or riving) are typical phenomena. Soils are regosols (rawmark); the organic matter is removed by wind. The windswept, complex terrain is a mosaic of snow-free patches and accumulation pockets during much of the year. The pattern of snow accumulation is the major controlling factor in the distribution of plants within fellfield (see Barry and Van Wie 1974). On a microscale, several communities could be delineated, but for the purposes of this report alpine fellfield will be regarded as a single, complex unit.

Vascular plants and most mosses and fruticose lichens are restricted to protected depressions and crevices in the boulder field. The most common vascular species are *Cardamine bellidifolia, Draba alpina* (Fig. 77), *Silene acaulis, Saxifraga caespitosa, S. tricuspidata, S. oppositifolia, Potentilla hyparctica, Carex microchaeta, Poa leptocoma, Festuca brachyphylla,* and *Luzula arcuata.* Prominent cryptogams in depressions and crevices are *Rhacomitrium lanuginosum, Polytrichum piliferum, Dicranoweisia crispula, Cetraria delisei,* Lepraria neglecta Ochrolechia upsaliensis *~~C. subalpina~~, C. ericetrorum, C. nivalis, C. cucullata, C. tilesii* (Fig. 78), *C. islandica, C. commixta, Alectoria ochroleuca, Dactylina arctica, D. ramulosa,* Buella verruculosa *D. madreporiformis, Cornicularia aculeata, Parmelia omphalodes, P. infumata, P. separata, Thamnolia vermicularis, Actinogyra muehlenbergii, Umbilicaria vellea, U. virginis, Dermatocarpon moulinsii, Stereocaulon* spp., *Physconia muscigena, Cladonia crispata, Sphaerophorus fragilis, Solorina crocea,* among others. (rivulorum, botryosum, saxatile)

Prominent species on exposed rock are all lichens and nearly all crustose or closely foliose. *Alectoria pubescens* and *A. miniscula* are two common dwarf fruticose lichens. Other prominent species include *Parmelia stygia,* P. centrifuga *Cetraria hepatizon,* C. nigricans *Parmelia taractica, Hypogymnia subobscura, Umbilicaria proboscoidea, ~~U. kraschenninnikovii~~, U. deusta, U. torrefacta, U. cylindrica, U. hyperborea, Lecidea macrocarpa, Xanthoria elegans, Rhizocarpon geographicum* agg., R. chioneum *R. badioatrum, Haemotomma lapponicum,* and others. Sporastatia testudinea Peltusaria sp Lecanora spp

(l) Vegetation of moist alpine scree, wet ledges, rocky runnels, crevices, gullies, avalanche chutes, and talus slopes.

Such habitats are general at high elevations throughout the area on steep, actively eroding terrain. They often have 75% or more bare rock or rubble, and sparse vegetation cover. Soils, if present, are shallow regosols (rawmark).

The vascular flora is quite diverse, with many dwarfed, showy alpines.

Common species are: *Salix polaris, S. reticulata, Dryas integrifolia, Saxifraga caespitosa, S. cernua, S. adscendens, S. oppositifolia* (Fig. 79), *S. rivularis, S. nivalis, S. punctata, Potentilla uniflora, P. hyparctica, Erigeron humilis, E. purpuratus, Draba alpina, D. longipes, D. lactea, D. lonchocarpa, D. fladnizensis, D. nivalis, Cardamine bellidifolia, Crepis nana, Rununculus gelidus, R. pygmaeus, Cerastium beeringianum, Arenaria obtusiloba, Silene acaulis, Taraxacum ceratophorum, T. lyratum, Oxyria digyna, Campanula lasiocarpa, Antennaria monocephala, Senecio lugens, Anemone parviflora, Carex microchaeta, C. nardina, Luzula arcuata, L. tundricola, Poa alpina, P. leptocoma, P. arctica* and *Festuca brachyphylla.*

Cryptogams are also diverse. Virtually all of the species listed for alpine fellfield occur on one or more of these steepland habitats. Additional species are *Parmelia alpicola, Cetraria nigricans, Acarospora chlorophana, Pertusaria dactylina,* and *Andreaea rupestris,* among others.

WILDLIFE

Geist (1973) states that "Gladys Lake is a central focus of wintering mountain sheep, mountain goat, moose, and a large number of ptarmigan. From hundreds of square miles of surrounding territory, these animals concentrate around Gladys Lake, since it is here that a regime of favourable climates has created habitats suitable for their survival." Osborn caribou are also fairly common, but more so in the spring and summer than during winter. Black bear, grizzly bear, coyote and red fox are infrequent visitors, while wolves, lynx and wolverine may be seen or tracked regularly (at least in winter). Snowshoe hares, procupine, beaver, hoary marmots, groundsquirrels, red squirrels, least chipmunks, mice, voles, lemmings, and shrews are other common mammals. Spruce grouse and a few blue and ruffed grouse are present in the valley bottoms. Willow and white-tailed ptarmigan are common, while rock ptarmigan are infrequent. Non-game birds are also abundant. Carswell (1975) lists the mammals and birds known so far from the Gladys Lake reserve.

As Geist (1971) writes, the wildlife of the ecoreserve "is most conspicuous in winter when it crowds around the small lake, while the high valleys turn into a silent, snow-covered landscape". Thus, with only eleven weeks of midsummer residence, the 1975 study team was working at a considerable disadvantage. Consequently, the following discussion relies heavily on published information, personal communications, circumstantial evidence, and intelligent guesses.

Some Major Habitat Features and Plant-Animal Relationships

Mountain Goats

The Gladys Lake reserve, with its rugged mountains and frequent patches of alpine forage, provides good range for mountain goats (*Oreamnos americanus*). Mountain goats are food generalists but as specialized rock

climbers are quite restricted in habitat (Geist et al. 1974). The goats' preference for steep cliff terrain thus restricts their feeding to several plant communities found in and around the rugged mountain faces. Goats feed on graminoids and forbs in *Festuca altaica*-lichen, dwarf willow-sedge-grass-lichen, and *Kobresia*-lichen alpine tundra, in the *Poa glauca-Carex supina-Potentilla-Artemisia* and *Juniperus communis-Arctostaphylos uva-ursi*-grass communities, and in *Betula glandulosa* alpine scrub. They also feed on the upper reaches of *Festuca altaica* subalpine grassland and on the scattered vascular plants in the talus-lichen terrain unit. Geist (1971; et al. 1974) states that *Abies lasiocarpa* is a winter staple of mountain goats. Krummholz subalpine fir is present in abundance in and around all the good goat winter range in the reserve. Geist found that steep cliffs and subalpine fir remained goat favourites during winter at Gladys Lake even after chinooks had cleared the open grassy slopes of snow. Sheep preferred the cured forage on the grassy slopes. Goats therefore do not compete seriously for winter forage with sheep as long as there is an abundance of *Abies lasiocarpa* for the goats, and sheep are not forced to steep rock vegetation by crusted, icy snow on the lower open grassy slopes (Geist 1971, Geist et al. 1974).

The *Poa rupicola-Trisetum spicatum-Hierochloe alpina-Potentilla nivea* community is a local but important grass-forb type that occurs on goat/sheep "saddles" and slopes immediately below goat/sheep caves and bedding areas. "Saddles" afford feeding and resting areas with lush, well manured vegetation, excellent vantages, and nearby escape terrain (Figs. 83, 84, 85, 87, 88 and 92). Caves and other bedding depressions (Figs. 95 and 96) are common at the interface between cliff bases and the top of talus or scree cones. These sites provide shelter, resting space, nearby forage, and cool shade during hot spells. The 14 goat band on Festuca Ridge spent several midday hours in a very large, auditorium-like cave on the north face of McMillan Mountain on the warm sunny day of August 29, 1975.

Goats also utilize erosion sites (see under sheep) as rubbing and sandbathing areas (Figs. 89 and 90). Geist (1971) states that they dig in dry sandy soil and throw it over their flanks and haunches, impregnating their thick underwool with sand. He surmises that sandbathing is the major type of body surface care in mountain goats.

Stone Sheep[1]

The mountains around Gladys Lake provide small patches of prime Stone sheep (*Ovis dalli stonei*) habitat. Optimum conditions for thinhorn sheep prevail in relatively dry, well vegetated, sunny mountain ranges, with low winds during winter and strong temperature inversions (Geist 1971; Geist et al. 1974). Conditions in the Eaglenest Range are suboptimally moist, cloudy, and cool. Hence, there are a variety of small good sheep ranges rather than large areas of excellent range. In the ecological reserve, Ghost Mountain (Figs. 5 and 12) has the most important sheep winter range (Geist 1971). Other small winter ranges are on Sanctuary Mountain (Figs. 81 and 91), Alces Ridge, and McMillan Mountain (Fig. 82).

Goats and mountain sheep are often observed in the same general area. As specialized rock climbers, goats are restricted in habitat. Sheep, though accomplished mountaineers, are not the technical rock climbers that goats are, and they have more generalized habitat preferences. However, sheep have more specialized feeding habits than do goats. Sheep prefer plants such as grasses *(Festuca, Poa, Agropyron, Hierochloë alpina, Trisetum spicatum)*, sedges *(Carex, Kobresia)*, woodrushes *(Luzula)*, forbs *(Anemone, Potentilla, Achillea, Artemisia, Oxytropis, Myosotis)*, and dwarf shrubs such as *Salix* spp., *Dryas, Juniperus communis*, and *Arctostaphylos* (Geist 1971; Luckhurst 1973; Geist et al. 1974;

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[1] See Geist (1971, et al. 1974, 1975) for thorough discussions of mountain sheep ecology.

Hoefs 1974; Hoefs, Cowan and Krajina 1976). Such plants are common and abundant in the community types upon which the Gladys Lake sheep forage the most: *Festuca altaica*-lichen alpine tundra (Fig. 97), dwarf willow-sedge-grass-lichen tundra, cushion plant tundra, dwarf birch-fescue alpine scrub, and the *Juniperus communis-Arctostaphylos uva-ursi*-grass community.

Poa glauca-Carex supina-Potentilla-Artemisia boreal steppe grassland, *Kobresia*-lichen tundra, and exposed *Festuca*-lichen tundra form local but very important, mostly snow-free winter range. I found the first community type in the ecological reserve only on Ghost and Guardian Mountains and on open slopes beneath the Ochre Cliffs (Fig. 91). Similarly, Lord and Luckhurst (1974) and Hoefs, Cowan and Krajina (1976) found that nutritious, relatively high-yielding alpine grassland vegetation supplied most of the winter forage of sheep in the Nevis Creek area and on Sheep Mountain, respectively.

Sheep prefer crisp, fine-fibred vegetation and are delicate, deliberate feeders (Geist et al. 1974). They are fond of frost-cured grasses and forbs. In fairly wet areas (such as Eaglenest Range) they will also take coarser, lusher species such as *Heracleum lanatum, Senecio triangularis,* and *Epilobium angustifolium.* These plants are eaten mainly in fall, when the herbage is frozen and crisp-dried and ripe seed heads are available. Geist (1974) reported that both wintering goats and sheep sought these plants in the cow parsnip meadows at the south foot of McMillan Mountain. Similar vegetation occurs on alluvial fans at the base of creeks descending from Ghost, Guardian, and Sanctuary mountains, as well as from Nation Peak and other mountains in the reserve.

Sheep utilize feeding/resting/viewing saddles (Figs. 83 and 84), caves (Figs. 95 and 96), and bedding areas (Fig. 98) as much as do goats, and similarly forage on the associated *Poa rupicola-Trisetum-Hierochloë-Potentilla* vegetation. Erosion sites (Fig. 94) are favourite spots for sheep to rub off their winter coat during the spring molt. They vigorously rub their sides,

shoulders, and rears on the dirt walls of the sidehill craters (Geist, 1971). Geist also observed that group interactions such as frolicking, clashing, and displaying among rams are concentrated at erosion sites, ridgetops, and saddles.

Moose[1]

Geist (et al. 1974) summarizes key habitat requirements for moose (*Alces alces*): superabundant, high-quality summer forage, a rich mineral supply, cool summers, and soft snow below one meter in depth, combined with a relatively high density of winter browse. All of these requirements are fulfilled in the Gladys Lake reserve.

Geist (et al. 1974) characterizes a "moose river" as "a slow-running, annually flooding body which causes continuous stream erosion and sediment deposition as alluvial flats, and which fills the potholes and marshes annually with flood waters. In so doing it creates the required ecological conditions for dense willow flats to grow along the marshes and potholes as well as on its freshly deposited alluvium, exposed gravel bars, and islands. It causes aquatic vegetation - a summer forage of moose - to grow in the ponds. The predictable annual floods maintain these ecological conditions through repeated tearing up and redepositing of the rich, fertile alluvium and gravel, thus perpetuating the winter moose habitat."

The Spatsizi River (Figs. 3 and 23) is a prototypical moose river. On a smaller scale, Mink Creek and certain stretches of Connector (Figs. 31 and 32), Landslide, and Castor creeks also fit the description.

Winter moose habitats are fairly abundant in the Gladys Lake reserve. Habitat and food are found along creeks and around lakes with fringing willow thickets (i.e., wet willow and alluvial willow communities); in subalpine willow-sedge fens; in subalpine willow-birch scrub; in south- or southwest-facing

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[1] See Geist et al. (1974) and Bedard et al. (1975) for summaries of moose ecology.

aspen or poplar groves; and in south- or southwest-facing stands of spruce-willow-birch and subalpine fir-birch communities.

Willows are the preferred browse in early winter, but subalpine fir may also be used (Geist 1971; Geist et al. 1974). *Salix glauca* (the most abundant species), *S. barclayi*, *S. planifolia*, *S. alaxensis* (nearly always heavily browsed), *S. scouleriana*, and *S. myrtillifolia* are all browsed. *S. barrattiana* was very rarely browsed, however, perhaps because of its pungent oily-glandular stipules. *Betula glandulosa* also appears to be an infrequent choice of Gladys Lake moose, although Douglas (1974) includes it as a major moose browse species in the Alsek River region.

Geist (et al. 1974) also noticed that moose in the Wolf River region prefer south-facing slopes at moderately high elevations in early winter. They apparently avoid northern slopes and the shaded, cold air drainage troughs of valley bottoms at this time.

In late winter, snow depth, density, and hardness increase, and moose leave the open areas and concentrate on habitats with soft snow, particularly beneath closed canopy coniferous forest (Geist et al. 1974). They become less selective in foraging, and browse conifers and even beard lichens (*Alectoria* spp.) as well as the preferred willows. It is not known to what extent Spatsizi moose take conifers (*Abies lasiocarpa* and *Picea glauca*). Deciduous woody browse constituted the bulk of winter moose diet in Alaska, and spruce was rarely eaten (Cushwa and Coady 1976).

Other late-winter habitats occupied by moose are aspen/poplar pygmy forest and willow-birch scrub on steep, south-facing slopes with thin snow cover. According to Geist (et al. 1974), these habitats are unfavourable in that (1) they do not provide a radiation shield at night and thus animals lose more heat than under a dense coniferous canopy, and (2) they do not have the deep, fluffy snow that moose prefer for bedding.

Summering moose utilize many of the subalpine plant communities at

Gladys Lake. They prefer wetland vegetation, including sedge and willow fens as well as the aquatic vegetation of small lakes, and also browse on adjacent upland willow thickets. At higher elevations they favour *Abies lasiocarpa* types and nearby lush vegetation of the grass-forb moist meadows and cow parsnip meadows. Geist (1971) found that "in summer the moose live in the alpine fir thickets where their deep trails, soft droppings and beds in the lush herbaceous vegetation reveal their presence." The extensive birch-willow thickets in the subalpine are also utilized during summer and early fall.

Osborn Caribou[1]

The Spatsizi area is the heartland of Osborn caribou (*Rangifer tarandus osborni*) distribution, and this mountain caribou reaches its largest size and best development there. Osborn caribou reach their largest body size in wet, fairly cold mountains with moderate snowfall. Several features of such mountainous areas are essential for optimum caribou range.

(i) cirque glaciers and snowfields (Fig. 108).

These provide summer water and year-round adjacent green vegetation in the form of relatively productive alpine seepage/streambank/snowbed communities. They are areas where caribou can cool off and evade insect pests during summer (Fig. 109) and, by maintaining soil moisture downslope, play a role in reducing warble fly infestation.

(ii) extensive upland plateaux.

Mountain caribou in British Columbia are associated with rolling mountains and alpine tablelands, rather than with more rugged ranges (Edwards 1958). Such open, rolling, but deeply indented terrain in the Spatsizi area permits the development of an extensive mosaic of alpine tundra, shrub thickets, and associated open subalpine forest. The caribou's dependence on this vegetation

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[1] The following account is based largely on Geist et al. (1974), which see for an up-to-date summary of Osborn caribou ecology.

complex is discussed below. The broad upland ridges also provide escape terrain (mainly from wolves in summer) for these surprisingly fleet animals.

(iii) lakes and rivers.

Open lakes or even rivers with a hard snow surface serve as escape terrain for caribou in winter. Cold Fish Lake, Laslui Lake, and other smaller lakes in the Spatsizi such as Gladys, and the Stikine and Spatsizi rivers may provide good winter escape terrain. From these frozen water bodies the caribou can forage in the adjacent spruce-willow-birch vegetation.

(iv) calving grounds.

In spring, that is late April to June, mountain caribou females move up the water courses from the lowlands and disperse on the highest ridges for calving. After giving birth, they form small nursery groups that soon disappear from the ridges. These high ridges tend to lie within an inversion layer, so that they are relatively warmer and receive more sunshine than the valleys. The Gladys Lake reserve, and the Eaglenest Range as a whole, is an important caribou calving area. Geist (pers. comm.) states that every major ridge has female caribou on it at parturition time.

Other than good calving grounds, the Gladys Lake reserve does not provide much optimum caribou range. As Geist (1971) writes, "caribou are infrequent wanderers through the valleys." However, the Gladys Lake area, in combination with Cold Fish Lake, the Spatsizi and Stikine rivers, their valleys, and the Spatsizi Plateau, is an integral part of the biophysical complex that supports a substantial and high-quality Osborn caribou population.

Osborn caribou eat almost any plant at some time during the year. They are exceptionally mobile ungulates, and their opportunistic plant utilization is related to their opportunistic movements. Even in winter they may move from valley bottom to alpine ridge in a very short time, and their winter movements seem to be more unpredictable than those of mountain caribou in Wells Gray Park (Edwards and Ritcey 1959). The availability of favourable microha-

bitats or suitable escape terrain may also be more of a factor in food selection than the availability of forage. It is thus difficult to predict what, where, and when the caribou will eat. However, it is possible to make some comments about their food habits (cf. Edwards and Ritcey 1960).

Osborn caribou seem to prefer plants of moist habitats, and lush, wet vegetation to crisp, dry plants. The previously mentioned alpine seepage, snowbed, and streambank communities provide lush green forage that caribou can utilize while following the greening of vegetation upward as snow melt progresses. Plant communities along alpine creeks fed by glacier and snowfield meltwater in particular have an extended vegative period. Moist grass-forb subalpine meadows are also rich in lush herbage. Marsh, fen (Fig. 117), and riparian vegetation can supply year-round fodder for caribou -- as a source of high energy food from storage tissue in spring, as forage in summer and fall that aids fattening, or as "winter greens" beneath the protective snow blanket. As Geist (et al. 1974) points out, the preferred summer forage of caribou is virtually a list of the grasses, sedges, and forbs found in these hygric or subhygric communities.

Extensive birch-willow scrub provides deciduous foliage that forms the bulk of their summer forage. According to Geist (1973), Osborn caribou are the only ungulate to utilize the leaves of *Betula glandulosa*. Shrub thickets also have abundant reindeer lichens (*Cladina* spp.) and other Cladoniae, nutritious foliose lichens such as species of *Peltigera* and *Nephroma arcticum*, and *Festuca altaica* for bunchgrass forage plentiful in summer and green beneath the winter snow. Dwarf birch thickets on northern slopes are also utilized by caribou in mid-winter. Then, when the sun barely clears the horizon and the cold is most intense, the snow remains soft and the caribou may paw down to lichens and evergreen vascular plants such as *Empetrum nigrum*, *Ledum groenlandicum*, and *Vaccinium vitis-idaea*.

Closed coniferous forest is draped with abundant epiphytic beard

lichens (*Alectoria* spp.) that may make a substantial contribution to winter diet, especially in severe weather with frozen snow crusts (cf. Edwards and Ritcey 1960; Edwards, Soos, and Ritcey 1960; Scotter 1962; Miller 1974). Fruticose and foliose lichens are also fairly abundant at the base of trees and may be important particularly when (as is often the case) the snow blanket beneath the tree canopy is comparatively thin and soft. Spruce-willow-birch stands have as well a variety of grasses (especially *Festuca altaica*), sedges, dead horsetails (*Equisetum* spp.), and evergreen species such as *Empetrum nigrum* and *Vaccinium vitis-idaea* for winter forage. Horsetails are especially abundant in alluvial spruce stands. Furthermore, *Picea* and *Abies* communities are rich in mushrooms which (at least for reindeer) are nutritious late summer and fall food, and continued favourites long into winter when they are pawed out of the snow (Karaev 1961, as cited in Geist et al. 1974). Although currently not economically feasible, future logging in the mature spruce forest along the Stikine River on the northern boundary of the park could remove key caribou winter range. This stretch of unprotected land could prove to be a serious omission from the wilderness park.

Grassland vegetation on southern slopes with little snow also supplies winter-green graminoids, again especially if adjacent to good escape terrain. Lichen stands for early winter foraging are extensive in lodgepole pine forest, spruce-willow-birch open forest, and willow-birch scrub.

Alpine tundra communities such as *Festuca*-lichen and dwarf willow-sedge-grass-lichen types provide mostly graminoids (species of *Festuca, Poa, Calamagrostis, Carex, Luzula,* and *Hierochloe alpina*), dwarf shrubs (especially *Salix* spp.), and lichens. Lichens include many different species, especially of *Cetraria, Alectoria, Stereocaulon,* and *Thamnolia*, but not too much reindeer lichen (*Cladina* spp.), which is much more abundant at lower elevations and in more protected sites (e.g.,*Betula glandulosa* scrub).

It is difficult to assess the relative importance of tundra communities

for caribou food supply. Although low in productivity (Brink et al. 1972; Lord and Luckhurst 1974; Webber 1974) - much less so than wetter alpine vegetation - alpine tundra produces nutritious, very high-quality forage (Johnson et al. 1968; Klein 1970; Luckhurst 1973; Webber 1974). Furthermore, tundra vegetation is so extensive on the rolling alplands of the Spatsizi that its overall contribution to the caribou diet could be substantial. Certainly it is important forage at calving time, when the females and their young are on the high ridges and the tundra plants have just greened up and are adding new growth. It could also play a major role during the fall rut, when the Spatsizi caribou congregate on the broad alpine ridges and domes. At that time, the freshly cured tundra plants would be highest in protein, fats, and minerals. However, rutting caribou do not remain exclusively on tundra. They move up and down from the dwarf birch thickets, where feeding also takes place. The Spatsizi caribou reportedly often move to the high country in late winter when snow conditions permit (various pers. communications; cf. Edwards and Ritcey 1959). At such time, exposed tundra communities with little snow accumulation could provide graminoids, prostrate shrubs, and fruticose lichens.

Bears

Black bears (*Ursus americanus*) and grizzly bears (*Ursus arctos*) are infrequent visitors to the ecological reserve. Bear habitat in the reserve seems to be of unexceptional or poor quality. Hatler's (1967) study in Alaska indicated that wet meadows were important feeding habitats for black bears, and grizzlies often grub for food in the same type of meadows (Pearson 1972). At Gladys Lake, cow parsnip meadows (Figs. 44, 120 and 121) and lush, moist grass-forb subalpine meadows (Fig. 43) provide the sort of vegetation that bears rely on for much of their diet. Robust, juicy plants such as *Heracleum lanatum*, *Petasites frigidus*, and species of *Equisetum*, *Senecio*, *Pedicularis*, *Epilobium*, and grasses and sedges are abundant. However, the wet meadows, though fairly common, are of very small

extent in the reserve.

Berry crops for fattening are also sparse. *Empetrum nigrum* (black crowberry) and *Vaccinium vitis-idaea* (mountain cranberry, lingonberry) are common, but not abundant. Blueberries (*Vaccinium membranaceum* and *V. uliginosum*) are quite rare. *Shepherdia canadensis* (soapberry), an important bear food in the Yukon (Pearson 1972; Douglas 1974) is generally uncommon, and *Hedysarum alpinum*, favoured by grizzlies for its roots, is rare. Good forested floodplain with abundant *Equisetum*, *Petasites*, *Rosa* hips, and *Ribes* berries is preferred habitat for black bear, but is rare within the reserve.

Wet meadows and floodplain forests are more extensive, and berry crops more abundant, further south in the major river valleys of the wilderness park. Bear populations appear to be correspondingly higher in the southern half of the park (T. A. Walker, personal communication).

Beaver

Beaver *(Castor canadensis)* are common in the Gladys Lake reserve. Beaver activity was noted along Connector, Landslide, and Castor creeks, and around Gladys Lake (Fig. 123). Individuals that had built in Rosie and Castor lakes seemed to have abandoned the lakes or been killed. In both cases the surrounding lakeside aspen and willows had been harvested from the steep slopes to 50 m above the water (Fig. 122).

Aspen and *Salix scouleriana* are the favourite food and building material of the beavers. Where such stands have been exploited or not easily obtainable, the beavers turn to other willows, especially the larger species such as *Salix alaxensis* and *S. planifolia*.

Other Mammals

Arctic groundsquirrels *(Spermophilus undulatus plesius)* are present

throughout the reserve in suitable habitat on most open subalpine and alpine hillsides and well drained flatter sites. Hoary marmots (*Marmota caligata*) are also frequent in the alpine but more localized in distribution, with major congregations in Marmot Valley and upper Ungulate Valley, and a number of minor colonies elsewhere. They tend to place burrows in deep well-drained soil or rock clifts close to seepage areas, where lush green forage is amply provided. By their burrow building, both groundsquirrels and marmots play an important role in promoting soil development, especially in the alpine zone. By disturbing, exposing, and enriching mineral soil, they also create edaphic conditions that may not be found in adjacent communities, thus increasing the plant diversity of a region (Douglas 1974).

Snowshoe hares (*Lepus americanus*) in the Gladys Lake area eat various grasses, forbs, and willows. Coniferous foliage and deciduous tree branches and bark are used especially during peak population periods. The condition of spruce foliage and deciduous tree bark thus can provide a general estimate of hare density in an area. At high densities, hares could have significant local effects on subalpine vegetation.

Red squirrels (*Tamiasciurus hudsonicus*) are commonest in closed forest stands of *Picea glauca*. In Alberta, Kemp and Keith (1970) found a strong correlation between red squirrel population size and the production of white spruce cones. A similar correlation exists between the Douglas squirrel (*Tamiascurus douglasii*) and Douglas-fir (*Pseudotsuga menziesii*) in British Columbia (Smith 1970). Similar relationships probably exist in the boreal and subalpine spruce forests of the Spatsizi area, as they do in the Alsek River region (Douglas 1974).

Small mammals such as mice, shrews, voles, and lemmings undoubtedly exert a major influence on plant community structure and function. As a group and on the average, they probably consume more plant biomass than all other mammals combined, and of course play an important role in nutrient transfer and

cycling. However, we did not study the small mammal population in any detail, so cannot make any quantitative statements about plant-small mammal relationships.

Populations of the Large Mammal Species

The following information is taken from Walker (pers. comm.), Geist (1971 and pers. comm.), Carswell (1976), and recent aerial surveys by provincial biologists.

T. A. Walker was the hunting guide in the Spatsizi area for many years and has kindly lent us his records. His notes cover the years 1948-1959. In some years he spent little time in the Nations Peak-Gladys Lake area of the Ecological Reserve. While sometimes his observations ran from June to October, only August and September were consistently recorded. From the point of view of the present study, the years 1951-1954 contribute the most (Table 1). The distribution and number of Walker's observations were of course influenced by his regular routes of travel and his placement of hunting camps. Bate's Camp south of Nation Peak and McMillan Camp west of Mount Will were favourites within the Reserve and account for the many observations in these areas.

Geist (1971) concentrated his thorough study of Stone sheep and mountain goat in the mountains adjacent to Gladys Lake in 1961-62. It was this study more than any other factor which resulted in choosing the Gladys Lake watershed as a Reserve for sheep and goat.

Rod Carswell, a wildlife specialist, worked with Dr. Jim Pojar, plant ecologist, at Gladys Lake during the summer of 1975 and has written a useful report on the wildlife of the Reserve.

Biologists from the Provincial Parks Branch, Fish and Wildlife Branch, Ecological Reserves Unit and Zoology Department, University of British Columbia have participated in aerial surveys of ungulates in the Spatsizi area for the past few years. Sometimes these surveys have included parts of the Ecological Reserve. Never has a total count of the Reserve been attempted with the use of aircraft. The following counts have been used below: March 1973, February 1975, March (Cessna and Jet Ranger) and August 1976.

TABLE 1 - SUMMARY OF T.A. WALKER'S OBSERVATIONS IN THE ECOLOGICAL RESERVE, 1948-1959.

	Days in Reserve	Number of Occasions in Which Species Were Seen*				
		Sheep	Goat	Caribou	Moose	Grizzly Bear
Aug. 22-24 1948	2	1	1	0	0	0
Aug. 17-Sept. 8 1949	4	3	1	0	0	0
1950	0	0	0	0	0	0
June 23-Oct. 1 1951	23	23	9	13	5	3
Aug. 1-Sept. 18 1952	16	11	8	8	1	2
July 9-Sept. 8 1953	23	16	21	10	5	3
July 8-Sept. 19 1954	18	19	8	3	3	3
July 28-Sept. 4 1955	8	3	4	2	0	0
June 30-Sept. 29 1956	8	6	4	7	3	0
June 30-Sept. 30 1957	17	9	9	6	5	3
June 27-Sept. 10 1958	9	5	4	3	1	1
June 25-Oct. 1 1959	12	8	7	5	2	0

* or tracks in case of grizzly bear.

Stone sheep (*Ovis dalli stonei*)

Geist (1971) concluded that the movement of sheep is a rather complex matter; without knowing individuals accurate estimation of the population would be impossible because of the daily and seasonal movements.

Geist (*op. cit.* p. 25 and pers. comm.) determined that the sheep in his study area were most abundant in the spring, fewer in the fall, and fewest in mid-winter. He identified five wintering areas in October 1962: Ghost Mountain (38 ewes and lambs); Sanctuary Mountain was primarily a concentration area for rams in fall and spring, but rams and a few ewes and lambs (11 in October 1962) also wintered there. Lupine Hill (=Flower Ridge) and Cliff Mountain (=Rangifer Ridge) were roamed over by the same ewe band (9) and a few rams wintered on Cliff. A few rams also wintered on McMillan (up to 12) and Shady (=Alces Ridge) mountains.

Geist calculated the wintering population within 13 km (8 miles) of Gladys Lake to be 98 sheep (98 sheep in 512 km^2, 200 $miles^2$) and a sex ratio of rams to ewes of 88:100. Much of this area contained no sheep and other portions supported sheep which Geist did not include. For example, Geist (pers. comm., Sept. 11, 1975) mentions that there used to be 12-22 rams ($\bar{x}$ about 20) on Nation Peak June- October; Geist (pers. comm., Aug. 17, 1976) also mentions an occasional ewe appeared for a short time on Nation, perhaps spending the winter on Ghost Mountain; further that there were some rams and ewes southwest of Bate's Camp.

With so much movement of sheep it is impossible to arrive at an exact figure for the density of animals within the 13 km radius of Gladys - some would have spent only part of the year within this circumference. The total was likely over 100 rams, ewes, and young. Geist's data are summarized in Figure A.

Walker's records do not overlap Geist's chronologically and it is possible some populations Walker records were not present in Geist's time. However, since

Walker was concentrating on areas within what is now the Ecological Reserve which often differed from Geist's areas, it seems reasonable to add Walker's figures to Geist's to try to get a more complete picture of the population and movements of sheep in the area. Of course, Walker did not know the animals individually as did Geist, so repeat observations of the same band in different areas occurred. Walker's notes record 448 sheep in 79 herds of one or more individuals for a mean herd size of 5-6 (range 1-18). Figure B indicates where Walker saw bands of sheep during August and September, 1951-1959.

When comparing the two figures one cannot conclude any significant differences; the seasonal hunter and year around scientist had different objectives and often covered different ground. However, similarities are apparent and are significant. During the 1950's and early '60's rams favoured Nation Peak, Sanctuary Ridge and McMillan Camp while ewes preferred Ghost and Cliff Mountains in particular.

Carswell's inventory (1975) of the wildlife of the Reserve roughly covered the same area as Geist's 13 km radius area based on Gladys Lake. His counts are a testimony to the efficiency of the hunter during the last decade. The total number of individuals observed in the Reserve totalled 20 ewes, 16 yearlings and 6 rams. Sightings by other people give a total of 60-70 sheep as of August 30 (30-40 ewes, 15-20 immatures and 8 rams).

Carswell (op. cit.) records the distribution of sheep as follows: about 30 ewes and lambs in Airplane Valley (perhaps ranging southeast to Ghost Mountain), a band of 14 (ewes, lambs, 5 rams) on Spermophilus Saddle, and the rest on Sanctuary, Ovis, Rangifer, Oreamnos Ridges, Fossil Flats and occasionally Mount Will (Figure C).

Carswell concludes no ram bands existed in the Reserve in the summer of 1975 in spite of diligent searches on Nation Peak and Sanctuary Ridge. The closest ram bands were located on the west side of Cullivan Creek and at Marion Creek.

Flights over the last few years confirm that there are no ram bands

left in the Reserve (Figure D). An old ram (Class 4) was located on Sanctuary Ridge in March 1976.

Providing the Reserve is large enough to protect this species from hunters, ram bands should again appear within the Reserve in a few years.

Mountain Goat (Oreamnos americanus)

During his years in what is now Gladys Lake Ecological Reserve, T. A. Walker recorded 72 herds of 1 or more goat. The average herd size recorded is 3.5 (range 1-15). The favourite areas for goats were southwest of Coldfish Lake from Aeroplane Valley to Sanctuary Ridge extending further south to McMillan Camp (Figure E). Acute Ridge, Guardian (Lick) Mountain, Sanctuary and Festuca Ridges were particularly important. No goats were recorded in the preferred sheep areas of Nation Peak south towards Ungulate Valley. Nor were goats recorded in the southeast end of the Reserve probably because the area was visited by Walker only rarely; goats are known from this region which includes Spatsizi or Red Goat Mountain. It is impossible to estimate from Walker's figures the number of goats which formerly occupied the Reserve area.

Geist (1972) estimated there were about 30 goats in the Gladys Lake area in the early 1960's. Both Geist and Walker note the excellent mineral lick at the base of Guardian Mountain was primarily used by goats.

Geist (pers. comm. Aug. 19, 1976) writes:

> "There were some goats which could be seen on Cliff Mountain and Goat Hook, which apparently moved across to Mount Will and were also to be seen at MacMillan Camp. This was a small population, and it was not easy to identify how many animals we were dealing with here. There were always some goats on Nation Peak, but these could have been individuals who moved from Ghost Mountain to Nation Peak. There was a general influx of males to the mountains around Gladys Lake during the rutting season, and an exodus afterwards. Sanctuary Mountain, Ghost Mountain and Cliff Mountain held the nursery groups for this population."

Geist notes earlier (1964) that "the Ghost band in 1962 was made up of 5 females - 2 followed by kids and three yearlings - plus 2 2½-year-olds, one a female the other a male for a sum total of 12 goats. The Sanctuary band

was formed by 2 females - one followed by a kid and one by a yearling - for a total of 4 goats."

Carswell (1975) notes that only 3 goats were seen on Guardian Mountain during the summer of 1975 but there were still good populations from Festuca Ridge to Fossil Flats (14 and 12 recorded respectively), on Ochre Cliffs, and towards Spatsizi Mountain.

The aerial flights record only a few goats in the vicinity of Spatsizi Mountain, Mount Will, and Nation Peak.

From Geist's and Carswell's data it appears that the goat population of the Gladys Lake area has not been significantly altered in the last decade or so in spite of heavy hunting of sheep.

Osborn Caribou

Walker occasionally recorded caribou in almost any part of the Reserve though Airplane Valley, Bate's Camp area, Fossil Flats and Sanctuary Ridge and Valley were favourite spots.

Geist (1974) notes that caribou are infrequent wanderers through the valleys. He notes further (pers. comm., Aug. 19, 1976) that:

> "Around Bates Camp, one could frequently encounter caribou during the rutting season. The animals moved back and forth a lot and sometimes one could go for several days without seeing one, and then all of a sudden there would be a large number of bulls and cows in the vicinity. I also continued to see these animals right through the rut and early winter, as long as they were able to dig through the soft snow cover in the dwarf birch flats to feed, largely on lichen and sedges presumably. These animals cleared out during the season of hard snow, some time in March, and I did not see caribou until they reappeared again in spring to deliver their calves. During the peak of the calving season, there were mountain caribou on virtually all high points around Gladys Lake and along the valley of Connor Creek toward Nation Peak. During summer one met small nursery groups in a number of the cirques, and one could also find isolated large bulls staying in cirques feeding in dwarf birch fields in the valley bottoms, or resting on the cornices and snowfields at higher elevations. I do not know how many animals we were dealing with here, of course; these animals, the bulls, appeared to be distinct from those seen across Cold fish Lake on the Spatsizi Plateau itself. The bulls from the Spatsizi Plateau struck me on the few times I visited them as being animals

with much larger antlers on average. The caribou around Bates Camp tended to be somewhat scraggly-antlered, to say the very least.

Carswell (1975) concludes caribou are very fluid in their summer location, preferring alpine tundra over 5500 feet.

Recent aerial census have recorded no caribou.

There is no indication of population trends over the last two decades.

Moose (Alces alces gigas)

Walker occasionally saw moose in almost any lowland part of the Reserve. Geist (pers. comm., Aug. 19, 1976) reports:

> "The area around Gladys Lake, as well as the valley of Connor Creek and other tributary streams, are wintering sites for moose. The moose could, of course, be seen throughout the year, but particularly during early winter, while during late winter they were found on many of the moraine slopes and the higher slopes exposed to the southern sun. There were never very many animals in the valley, and I would assume that no more than about 30 moose occurred in the whole ecological reserve area. That is, however, no more than a guess, since I did not try to make any sort of census, which I think would have been impossible anyway because of the mobility of these large mammals.

Carswell (1975) made relatively few sightings of moose in the Reserve from June through August. These data are supported by the aerial counts; moose were occasionally seen in the valleys throughout the year.

Grizzly Bear (Ursus arctos)

Walker occasionally observed this species in the Reserve area (Table 1). Geist (1971) mentions grizzlys as infrequent visitors. Carswell (1975) only saw one set of tracks in his summer in the Reserve. None has been spotted in the aerial counts.

There is no doubt that the Ecological Reserve is not nearly large enough to support a family of this species.

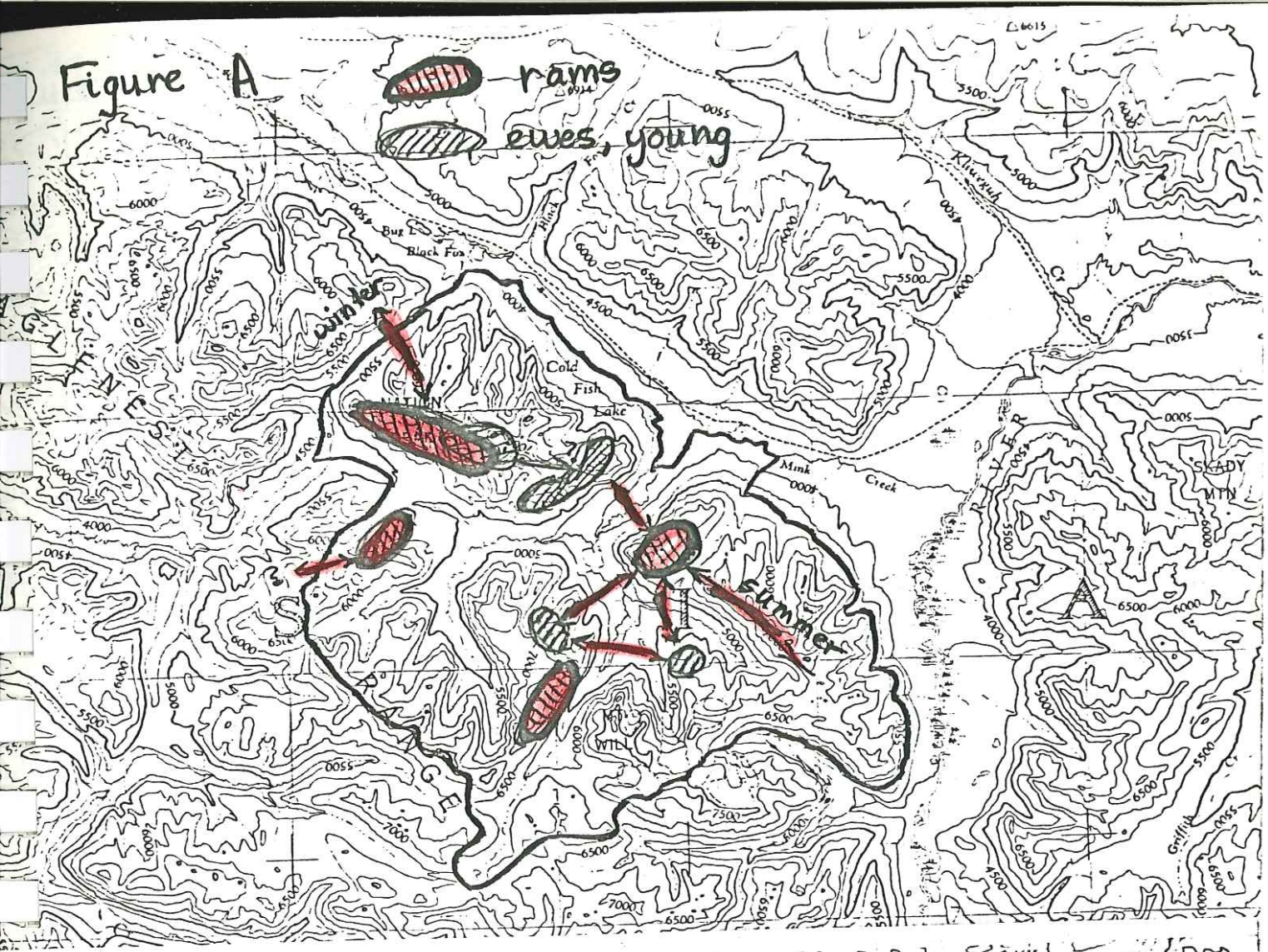
Figure A
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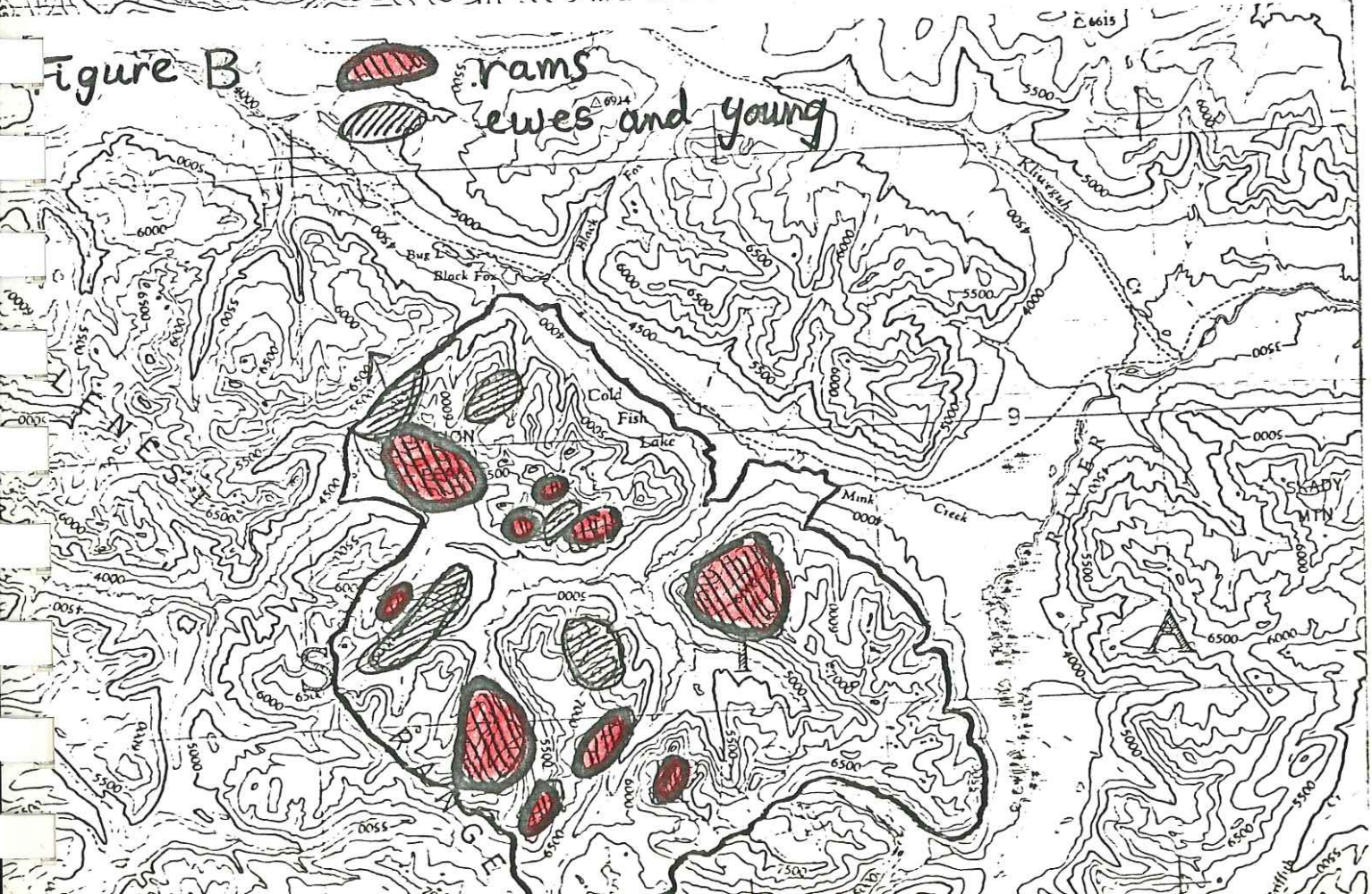
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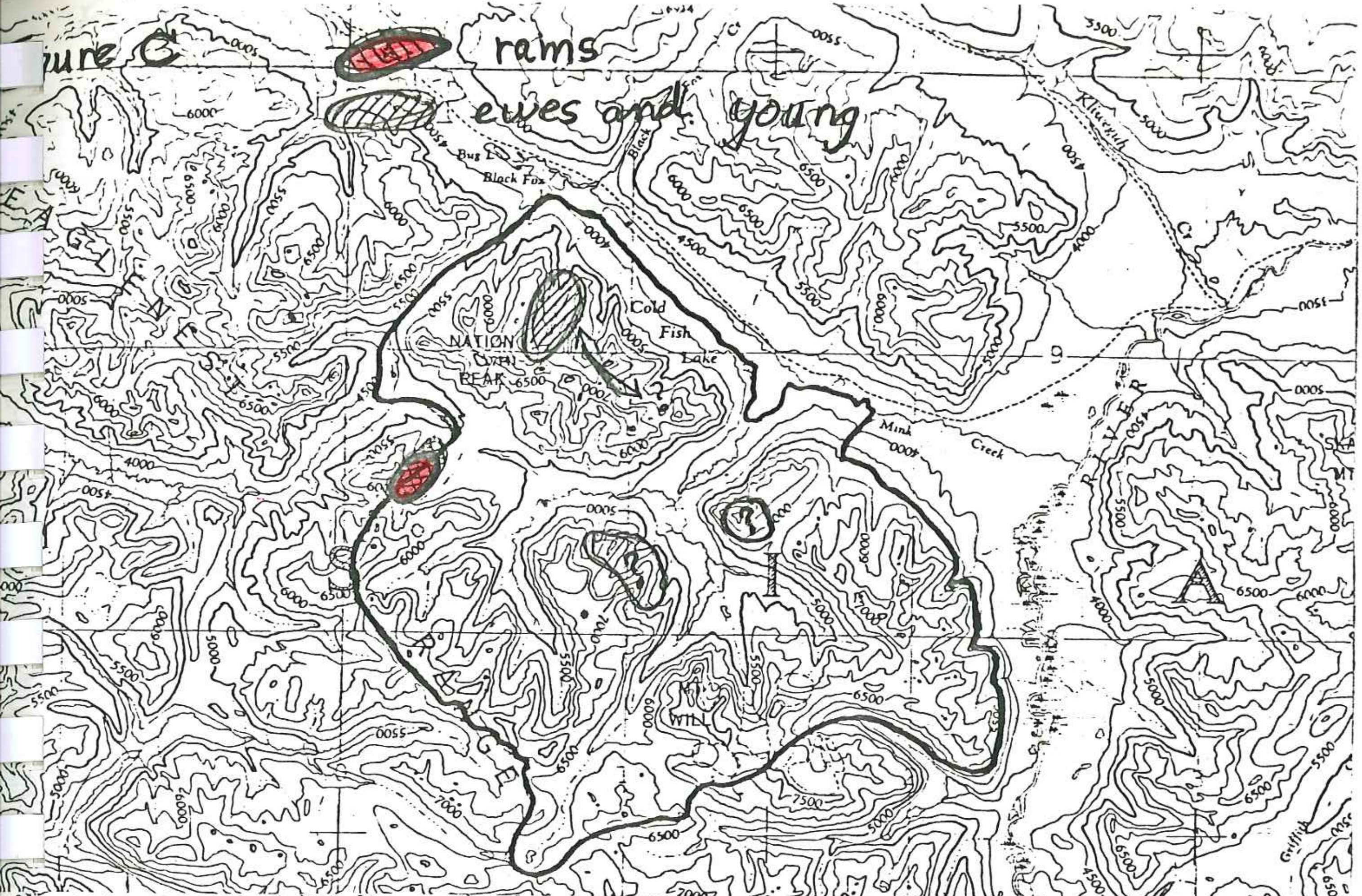

Figure C
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Figure D
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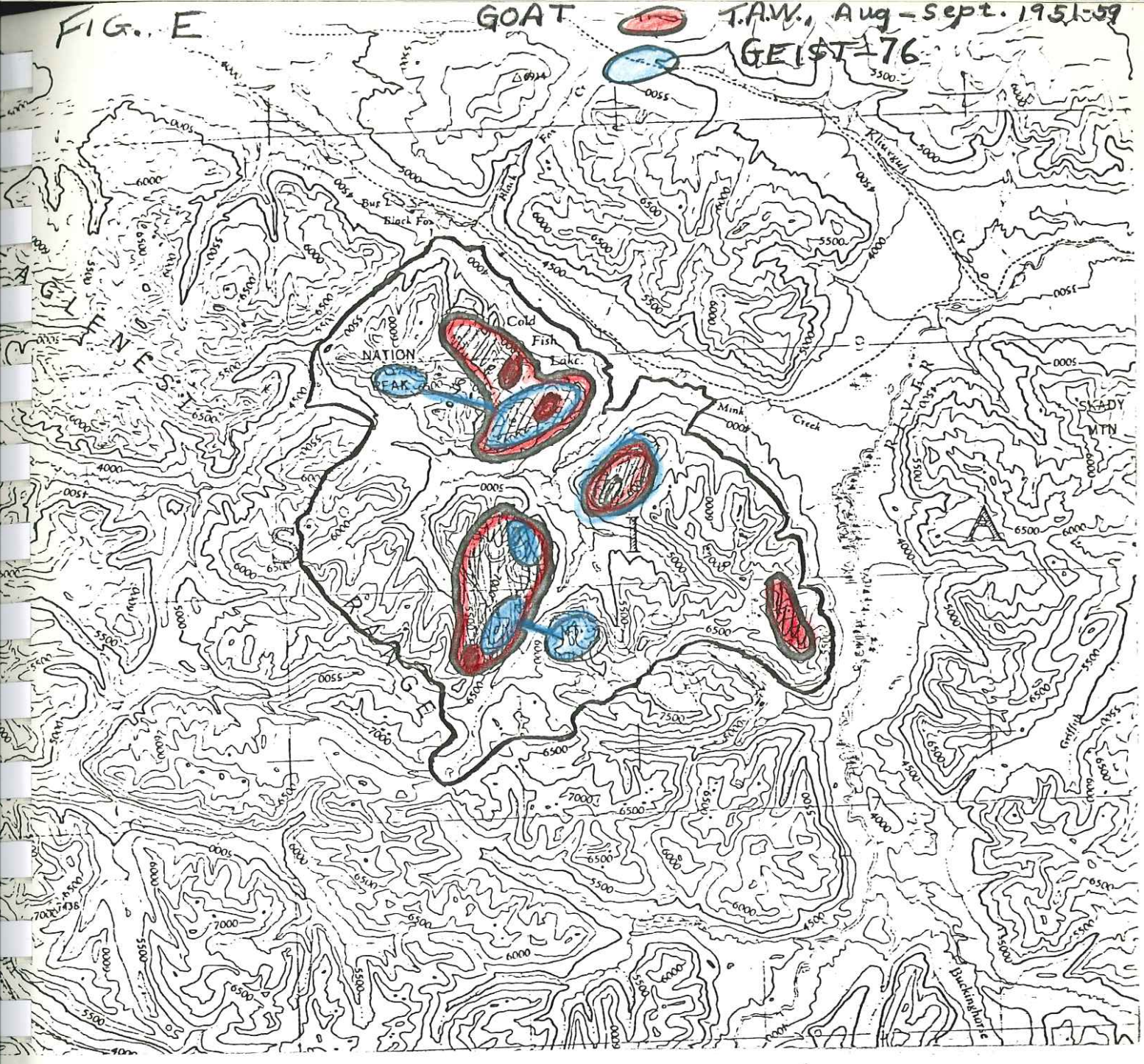
Black Fox
Cold
Fish
Lake
Mink
Creek

FIG. E


GOAT
T.A.W., Aug-Sept. 1951-59
GEIST-76
Cold
Fish
Lake
NATION
PEAK
Mink
Creek
SKADY
MTN
Black Fox
Buckinghorse

SUMMARY, CONCLUSIONS, and RECOMMENDATIONS

Flora

Roughly 370 species of vascular plants have so far been found in the Gladys Lake ecoreserve and surroundings. This is a comparatively rich flora for a glaciated, northern, subalpine-alpine area. More collecting, especially at lower elevations in the surrounding Spatsizi Wilderness Park, will yield additional species. However, the vascular flora of the Gladys Lake reserve was diligently collected and may now be assumed to be fairly complete.

Our lichen collection was also as thorough as time and access allowed. However, final determinations of many species have yet to be made. Crustose species especially need more collecting.

Only the commonest bryophytes were collected during this study. Therefore, mosses and liverworts still need thorough collection in the reserve.

Vegetation

The Gladys Lake reserve contains a substantial sample of subalpine and alpine vegetation typical of much of north central British Columbia. The subalpine spruce - willow - birch zone includes coniferous forest, deciduous forest, shrub, and herb community types. White spruce- and subalpine fir-dominated types represent climax forest vegetation in the reserve. There are also seral, post-fire forests dominated by lodgepole pine, aspen, or balsam poplar. Upland shrub thickets dominated by dwarf birch and/or willows are also climax in the SWB zone. Wetlands and alluvial sites support several seral shrub-dominated community types, as well as sedge marshes and fens. Subalpine grassland and forb meadows are common and also

appear to be seral types for the most part. However, on certain sites grassland forms an edaphic climax, with invasion by surround shrubs slow or lacking.

21 subalpine plant community types are described. The high vegetation diversity is due to the extremely variable topography, soils, microclimate, and frequency of disturbance by fire and geomorphological (mainly fluvial) processes. The same factors are responsible for the complex mosaic nature of the subalpine vegetative cover.

The alpine zone(AT) contains dwarf shrub, heath, seepage, tundra, and fellfield types, as well as much rock, snow, and ice. Most of the 14 described alpine types represent climax vegetation. Seral types are related to geomorphological processes such as avalanches, solifluction, gelifraction, etc. The alpine communities also form a mosaic, due in large part to patterns of snow accumulation.

Fauna

The Gladys Lake reserve provides essentially undisturbed habitat for a typical boreal-northern alplands fauna. There are resident populations of Stone sheep and mountain goat, as well as wintering moose and itinerant or calving Osborn caribou. Predators such as grizzly bear, black bear, wolf, coyote, red fox, wolverine, lynx, marten, and weasel are common in the general area, though most of these species are only visitors to the reserve. Snowshoe hares, porcupines, beaver, hoary marmots, Arctic groundsquirrels, red squirrels, least chipmunks, mice, voles, lemmings, and shrews are other common mammals. Common birds include grouse, ptarmigan, robin, slate-colored junco, Canada jay, shafted flicker, tree swallow, Wilson's warbler, fox, tree, and white-crowned sparrows, belted kingfisher, spotted sandpiper, rosy finch, Say's phoebe, golden-crowned sparrow, and golden eagle.

The primary purpose of the ecological reserve is conservation of viable populations of Stone sheep and mountain goat. Unfortunately, heavy hunting pressure in recent years has depressed population levels of these species in the reserve, especially sheep. With the removal of hunting, these animals should increase and may attain pre-hunting numbers, providing behavioural patterns have not been overly disrupted.

Plant-Animal Relationships

Sheep and goats do most of their feeding on the vegetation of steep, rugged, mountain massifs. Grassy alpine tundra and subalpine grassland exposed on steep south-facing slopes provide winter range for both species. Goats also utilize subalpine fir tree clumps and krummholz during the winter. Alpine graminoids, forbs, and dwarf shrubs provide year-round forage for both species, as does the zooclimax grassy tundra that has developed on favoured feeding and resting areas. Lusher vegetation of moist habitats may also be eaten at times, especially in the fall when the plants are frost-cured and have ripe seeds.

Moose prefer wetland and aquatic vegetation and deciduous browse (particularly willows). At various times throughout the year they frequent sedge ponds and marshes, willow - sedge fens, wet meadows, alluvial thickets, subalpine willow - birch scrub, and aspen or poplar groves. They may also browse subalpine fir and spruce in a hard winter, and often bed down in closed coniferous forest in both winter and summer. Moose do not use alpine vegetation to any great extent.

Caribou may utilize virtually every type of plant community, both subalpine and alpine, at some time during the year. In general, they seem to

prefer vegetation of moist habitats, such as seepage, snowbed, riparian, marsh, fen, and wet meadow types. They forage as well on graminoids, forbs, and shrubs in subalpine grassland, birch - willow thickets, and alpine tundra. Especially in winter they also utilize the epidendric and/or terrestrial lichens abundant in community types such as mature spruce or subalpine fir forest, lodgepole pine stands, spruce - willow - birch open forest, willow - birch scrub, and some alpine tundra.

Grizzly and black bears tend to graze and grub in wet, lush subalpine meadows, and also forage in forested floodplain with preferred forbs and berries. Such habitat is not abundant in the reserve, and it is not a good area for studying bear ecology. There are much better areas in the surrounding park.

Beaver, groundsquirrels, marmots, snowshoe hares, squirrels, chipmunks, other smaller mammals, and herbivorous and granivorous birds all have important relationships with plants. However, information about these relationships is sketchy and much more study is needed.

Boundaries

As presently constituted, the Gladys Lake reserve should serve its primary purpose-----conservation of viable populations of mountain sheep and goats. Its value as a sheep and goat reserve could be enhanced by (1) including in the reserve all of the mountain system centred on the Mt. Will icefields; (2) extending the boundaries northwest to include Potentilla Ridge, Maternity Mountain, and the upper Cullivan Creek mineral lick. The latter extension would include an important maternity and rearing area for both sheep and caribou.

The scope of the reserve could be increased to include prime caribou habitat without creating a separate new reserve. An area encompassing the Marion Creek drainage, Hyland Post, and the ridge system between could be added to the existing reserve, connected by a corridor along the Spatsizi River. Not only would this provide typical Spatsizi caribou habitat (lacking in the Gladys Lake area) on the rolling alpine plateaux and in the broad forested valleys, but as well would include good sheep and goat populations along the plateaux rimrock, and first-class moose habitat on the meander plain of the Spatsizi River. Hyland Post could serve as an established, relatively accessible research base.

Problems of Disturbance

The Gladys Lake reserve is sufficiently large, remote, rugged, and infrequently visited that there is no immediate danger of disturbance----- as long as the visitors are aware of and obey the regulations. The main means of travel within the reserve should continue to be by foot. Horses could be based at Gladys Lake or at Bates Camp (see Fig. 131), but there is not enough feed for extended use without damage. A greater potential problem than overgrazing is that of overtrampling by horses. In certain areas, such as around traditional campsites, and in places where trails cross creeks or traverse wet terrain, the damage is conspicuous (Fig. 132). In sensitive alpine vegetation, severe and lasting damage may result (cf. Willard and Marr 1970, 1971).

Motorized vehicles are not allowed in ecological reserves, so destruction of alpine environments by tracked or wheeled vehicles should not be a problem at Gladys Lake (cf. Billings 1973; Ives 1974). Neither should it be in the Spatsizi wilderness park, as currently defined.

The impact of trampling by humans on foot should present no problem in the reserve or in a park so vast as Spatsizi. However, long term planning for the wilderness park must anticipate the inevitable increase in park visitors and the danger (however remote) of overtrampling in popular and sensitive alpine areas (cf. Willard & Marr 1970, 1971; Bell & Bliss 1973; Ives 1974). Scavenging for firewood and waste disposal could also become damaging at popular campsites.

Future Research

The Gladys Lake reserve offers superb opportunities for future scientific research, both within its boundaries and in combination with the surrounding wilderness park. It is an excellent area for studies of animal behaviour and population biology in a wilderness environment. Ungulate range capability could be assessed as non-hunted populations (hopefully) build up, and management techniques could be tested and applied. The role of fire in the maintenance and improvement of ungulate winter range needs more research, especially in these relatively wet northern alplands. Studies in bird and small mammal biology are badly needed and tend to be neglected in the emphasis on "game" species. Information about plant-animal relationships is largely qualitative and anecdotal, so any future studies on standing crop, biomass consumption, nutrient transfer, etc., will be most valuable.

The relatively rich flora and complex vegetation offer good opportunities for botanists and plant ecologists. The alpine flora and vegetation are especially interesting, and need more collecting and sampling.

It is already apparent that the Spatsizi is an area of range limits and extensions of typically more northern, arctic-alpine biota. It is also

an area of contact and mixing between northern interior, continental species and more coastal elements, particularly in the southwestern section of the park. Future biogeographic research is sure to be rewarding.

The frequent fossiliferous sediments and the occurrence of a variety of lakes, ponds, and peatlands indicate possibilities for valuable palaeo-biological and limnological research.

Study of soil-vegetation relationships, and soil classification and genesis is another potentially rich field. As well, the reserve provides ample and instructive examples of various aspects of geomorphology, glaciology, climatology, and hydrology.

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APPENDIX 1

PRELIMINARY LIST OF VASCULAR PLANTS FROM SPATSIZI PLATEAU WILDERNESS PARK

The following list mainly comprises species collected by J. Pojar in Spatsizi Plateau Wilderness Park during the summer of 1975. Most of this collection is from the Gladys Lake Ecological Reserve and close surroundings, in the heart of the Park. The list includes additional species mentioned by Szczawinski (1959) and Welsh and Rigby (1971), and a few collections made on the Plateau in 1973 and 1975 by V. J. Krajina. It does not include collections by Welsh et al. from outside Park boundaries. Thus, quite a number of species from the area to the south (Thutade Lake and vicinity) are excluded. Many of the excluded species are to be expected in the southern part of the Park, which needs thorough collection.

It should also be mentioned that the majority of the collections are from above 1200 metres. Many additional lower elevation species are to be expected in the park flora, especially from the major valley bottomlands and lower slopes.

Nomenclature for the most part follows that of Welsh (1974). Hultén (1968) and a number of more specialized treatments were consulted to a lesser extent. The first set of the Pojar collection has been deposited in the Herbarium of the British Columbia Provincial Museum, Victoria, and a second, incomplete set in the Herbarium of the University of British Columbia, Vancouver.

Rare species or species of taxonomic or distributional interest are indicated with an asterisk.

	COLLECTION SITE
OPHIOGLOSSACEAE	
Botrychium lunaria (L.) Swartz var. *lunaria*	92, 117, 165
POLYPODIACEAE	
Cryptogramma crispa (L.) R.Br. var. *acrostichoides* (R.Br.) C.B. Clarke	156
Cystopteris fragilis (L.) Bernh.	22
* *Dryopteris fragrans* (L.) Schott.	26
Polystichum lonchitis (L.) Roth	156
EQUISETACEAE	
Equisetum arvense L.	93, 204
" *pratense* Ehrh.	175, 204
" *scirpoides* Michx.	68, 115, 145
" *sylvaticum* L.	115
" *variegatum* Schleich.	72
LYCOPODIACEAE	
Lycopodium alpinum L.	21
" *annotinum* L.	137
" *clavatum* L.	173
" *complanatum* L.	103
" *selago* L.	69
SELAGINELLACEAE	
Selaginella selaginoides (L.) Link	201
* " *sibirica* (Milde) Hieron.	156
CUPRESSACEAE	
Juniperus communis L. var. *montana* Ait.	76
PINACEA	
Abies lasiocarpa (Hook.) Nutt.	113
Picea glauca (Moench) Voss	1, 93, 114
Picea ? glauca x *engelmannii*	162
Pinus contorta Dougl. var. *latifolia* Engelm.	196

	COLLECTION SITE
SPARGANIACEAE	
Sparganium minimum Fries	210
POTAMOGETONACEAE	
Potamogeton filiformis Pers.	217
JUNCACEAE	
Juncus arcticus Willd. var. *alaskanus* (Hult.) Welsh	91
" *biglumis* L.	118, 145
" *castaneus* J.E. Smith	91, 141
" *drummondii* E. Meyer	121
" *filiformis* L.	141
" *mertensianus* Bong.	233
" *triglumis* L. var. *albescens* Lange	91, 118, 145
Luzula arcuata (Wahl.) Wahl. var. *unalaschkensis* Buch.	85, 176
" *campestris* (L.) DC. var. *frigida* Buch.	119
" *confusa* Lindeb.	144
" *nivalis* (Laest.) Beurl.	149
" *parviflora* (Ehrh.) Desv.	98, 115
" *spicata* (L.) DC.	83, 101
" *tundricola* Gorodk.	111, 149, 176
" *wahlenbergii* Rupr.	145
CYPERACEAE	
Carex albo-nigra Mack.	61, 97, 123, 154, 168
" *anthoxanthea* Presl	32, 61
" *aquatilis* Wahl.	87, 90, 146, 151, 201, 217
" *atrata* L.	73, 94, 117, 129, 130
" *aurea* Nutt.	151, 217
" *brunnescens* (Pers.) Poir. ssp. *alaskana* Kalela	132
" *canescens* L.	115, 210, 217
" *capillaris* L.	129, 144
* " *concinna* R.Br.	184
" *eleusinoides* Turcz.	218
" *deflexa* Hornem.	92
" *dioica* L. ssp. *gynocrates* (Wormskj.) Hult.	230
" *disperma* Dewey	93, 116, 217
" *garberi* Fern. ssp. *bifaria* (Fern.) Hult.	217
" *lachenalii* Schkuhr	87, 108, 145, 197, 207
" *leptalea* Wahl.	142, 217
" *limosa* L.	217
" *loliacea* L.	142
" *macloviana* d'Urville	89, 92, 112
" *magellanica* Lam.	210

		COLLECTION SITE
	CYPERACEAE (Continued)	
	Carex media R.Br.	73, 94
	" *microchaeta* Holm	101, 105, 106, 109, 122, 176
	" *nardina* Fries	24, 167, 232
*	" *obtusata* Lilj.	186
	" *petasata* Dewey	117, 154
	" *phaeocephala* Piper	164, 229
	" *podocarpa* R.Br.	105, 109, 117, 130
	" *praticola* Rydb.	92
	" *pyrenaica* Wahl.	177, 216
	" *rossii* Boott	184
	" *rostrata* Stokes	218
	" *saxatilis* L. ssp. *laxa* (Trautv.) Kalela	206, 215, 218
	" *scirpoidea* Michx.	129
*	" *supina* Willd. ssp. *spaniocarpa* (Steud.) Hult.	48, 111
*	" *tenuiflora* Wahl.	217
	" *vaginata* Tausch.	138
	Eriophorum angustifolium Honck.	146
	" *brachyantherum* Trautv. and Mey.	118
	" *callitrix* Cham.	146
	" *vaginatum* L.	210
	Kobresia myosuroides (Vill.) Fiori and Paol.	83, 106, 123, 143
	Scirpus caespitosus L.	60
	GRAMINEAE	
*	*?Agropyron boreale* (Turcz.) Drobov	Krajina (1975)
	Agropyron caninum (L.) Beauv. var. *andinum* (Scribn. and Smith) Pease and Moore	92, 156
	" " " " var. *hornemannii* (Koch) Pease and Moore	32, 102, 117, 157
	" " " " var. *latiglume* (Scribn. and Smith) Pease and Moore	61, 111, 128, 166
	Agrostis scabra Willd.	91, 154
	Alopecurus aequalis Sobol.	218
	Arctagrostis latifolia (R.Br.) Griseb.	93, 151
	Bromus richardsonii Link	97, 192, 213
	Calamagrostis canadensis (Michx.) Beauv.	124, 189, 219
	" *lapponica* (Wahl.) Hartm.	76, 111, 144, 198
	" *purpurascens* R.Br.	107, 143
	Danthonia intermedia Vasey	157, 165
	Deschampsia caespitosa (L.) Beauv.	151
	Festuca altaica Trin.	185
	" *brachyphylla* Schult.	84, 111, 123
	" *rubra* L.	Szczawinski (1959)
	" *saximontana* Rydb.	76, 112
	Hierochloë alpina (Swartz) Roem. and Schult.	26, 42
	" *odorata* (L.) Beauv.	72, 89
	Koeleria nitida Nutt.	32, 92
	Phleum alpinum L.	112

		COLLECTION SITE
	GRAMINEAE (Continued)	
	Poa alpina L.	61, 141
	" *arctica* R.Br.	83, 87, 111, 144, 145, 157,
*	" *cusickii* Vasey var. *epilis* (Scribn.) C.L. Hitchc.	98, 130 183
	" *glauca* Vahl	32, 127, 165
*	" *interior* Rydb.	102
	" *leptocoma* Trin.	42, 174
	" *pratensis* L.	61, 112, 117, 153
*	" *rupicola* Nash	61, 111, 123, 205
	Stipa occidentalis Thurb. var. *minor* (Vasey) C.L. Hitchc.	229
	Trisetum spicatum (L.) Richter	72, 130
	LILIACEAE	
*	*Fritillaria camschatcensis* (L.) Ker-Gawl	89
R4	*Lloydia serotina* (L.) Wats.	42, 70
	Tofieldia pusilla (Michx.) Pers.	94, 144, 145
	Veratrum viride Ait.	201
	ORCHIDACEAE	
	Corallorhiza trifida Chat.	41
	Habenaria dilatata (Pursh) Hook.	90
	Listera cordata (L.) R.Br.	220
	SALICACEAE	
	Populus balsamifera L.	19
	" *tremuloides* Michx.	102
	Salix alaxensis (Anderss.) Coville var. *alaxensis*	13, 126
	" " " " var. *longistylis* (Rydb.) Schneid	38
	Salix arctica Pallas	21, 46
	" *barclayi* Anderss.	1, 27, 90, 138
	" *barrattiana* Hook.	16, 90, 145
	" *brachycarpa* Nutt. ssp. *brachycarpa*	202
	" *commutata* Bebb	88
	" *glauca* L.	16 a & b, 27, 219
	" *myrtillifolia* Anderss.	93, 94, 193, 221
	" *planifolia* Pursh ssp. *planifolia*	67, 74
	" *polaris* Wahl.	42, 127
R1 *	" *pulchra* Cham.	148
	" *raupii* Argus	74
	" *reticulata* L.	122
	" *scouleriana* Barratt	75
	BETULACEAE	
	Betula glandulosa Michx.	1

	COLLECTION SITE
SANTALACEAE	
Geocaulon lividum (Richards.) Fern.	102
POLYGONACEAE	
* *Koenigia islandica* L.	145, 197
Oxyria digyna (L.) Hill	16
* *Polygonum douglasii* Greene	156
" *viviparum* L.	73
Rumex acetosa L. ssp. *alpestris* (Scop.) A. Löve	43, 89
CHENOPODIACEAE	
Chenopodium capitatum (L.) Asch.	229
PORTULACACEAE	
* *Claytonia sarmentosa* C.A. Mey	3, 44
CARYOPHYLLACEAE	
* *Arenaria dawsonensis* Britt.	151
" *lateriflora* L.	97, 154
" *obtusiloba* (Rydb.) Fern.	98
" *rubella* (Wahl.) J.E. Smith	32, 143
" *sajanensis* Willd.	161, 197
Cerastium arvense L.	48
" *beeringianum* Cham. and Schlecht.	32, 72, 123, 157, 166
Lychnis apetala L.	65, 123
Sagina saginoides (L.) Britt.	197
Silene acaulis L.	33
Stellaria calycantha (Ledeb.) Bong.	99, 131, 145
" *laeta* Richards.	Szczawinski (1959)
" *longipes* Goldie var. *edwardsii*	92, 148
" *monantha* Hult.	14, 16, 42, 48, 51, 127
RANUNCULACEAE	
Aconitum delphinifolium DC.	34, 92
Anemone multifida Poir	25, 128
" *narcissiflora* L. var. *monantha* Schlecht.	Welsh & Rigby (1971)
" *parviflora* Michx.	4, 42
" *richardsonii* Hook.	39, 204
Aquilegia brevistyla Hook.	99
" *formosa* Fisch.	97
Caltha leptosepala DC.	13, 90

		COLLECTION SITE
	RANUNCULACEAE (Continued)	
	Delphinium glaucum Wats.	40
	Ranunculus eschscholtzii Schlecht.	12, 21, 44, 68
*	" *gelidus* Kar. & Kir.	36, 43
	" *hyperboreus* Rottb.	141, 218
	" *lapponicus* L.	93, 145
	" *nivalis* L.	12, 44, 207
	" *occidentalis* Nutt.	89, 121
R2	" *pygmaeus* Wahl.	62
R1 *	" *sulphureus* Soland.	145, Krajina (1973)
	Thalictrum alpinum L.	4, 77
	" *occidentale* Gray	171, 182
	PAPAVERACEAE	
R1	*Papaver alboroseum* Hult.	Welsh & Rigby (1971)
	" *radicatum* Rottb. (=*P.kluanense* D. Löve)	35, 70, 84, 203, 209
	FUMARIACEAE	
*	*Corydalis pauciflora* (Steph.) Pers.	12, 44
	CRUCIFERAE	
	Arabis divaricarpa A. Nels	25, 139, 191
	" *drummondii* Gray	1, 49, 130
	" *holboellii* Hornem.	92
*	" *lemmonii* S.Wats.	25
*	" *lyallii* Wats.	99
	" *lyrata* L.	16, 112, 124, 139
	Barbarea orthoceras Ledeb.	151
	Cardamine bellidifolia L.	63, 86
	" *oligosperma* Nutt.	153, 215
	" *pratensis* L.	153
*	*Draba alpina* L.	36, 53, 66
	" *aurea* Vahl	20, 32, 186
	" *borealis* DC.	92
R1	" *cinerea* Adams	61
R1 *	" *fladnizensis* Wulf.	35, 123, 187
	" *incerta* Payson	11, 33
R3	" *lactea* Adams	66, 123
	" *lanceolata* Royle (=*D. cana* Rydb.)	32, 61, 117
R1	" *lonchocarpa* Rydb. var. *thompsonii* (C.L. Hitchc.) Rollins	187
R3	" *longipes* Raup	12, 44, 122, 127
	" *nemorosa* L.	183
	" *nivalis* Lilj.	35, 62, 63, 66, 106, 143, 183
R3 *	*Eutrema edwardsii* R.Br.	86, 123, 145 187
	Thlaspi arvense L.	Welsh & Rigby (1971)

	COLLECTION SITE
CRASSULACEAE	
* *Sedum divergens* Wats.	37, 156
" *lanceolatum* Torr.	100, 107, 156
SAXIFRAGACEAE	
Chrysosplenium tetrandrum (Lund) Fries	109, 153
Mitella nuda L.	134
" *pentandra* Hook.	156
Parnassia fimbriata Konig	129
" *kotzebuei* Cham. & Schlecht.	16, 72
" *palustris* L.	199
Ribes glandulosum Grauer	131
" *hudsonianum* Richards.	27, 93
" *oxyacanthoides* L.	47
" *triste* Pallas	76, 204
Saxifraga adscendens L.	62, 120,187
" *caespitosa* L.	53, 64, 120
" *cernua* L.	42, 65, 66, 100
* " *exilis* Steph.	Krajina (1973)
* " *ferruginea* Graham	159
" *flagellaris* Willd.	70, 84
" *lyallii* Engler	99, 118
" *nivalis* L.	11, 23, 53
" *oppositifolia* L.	15, 22
" *punctata* L.	66, 81, 99, 145
" *rivularis* L.	66, 80, 120, 129
* " *serpyllifolia* Pursh	82, 147
" *tricuspidata* Rottb.	16, 76, 84, 111
ROSACEAE	
Amelanchier alnifolia (Nutt.) Nutt.	47, 107
Dryas integrifolia Vahl.	9, 21
Dryas octopetala L. var. *kamtschatica* (Juz.) Hult.	Welsh & Rigby (1971)
Fragaria virginiana Duchesne var. *glauca* Wats.	92
Geum macrophyllum Willd.	73
Luetkea pectinata (Pursh) Kuntze	158
Potentilla arguta Pursh	47
" *diversifolia* Lehm.	1, 89, 229
" *fruticosa* L.	47
" *hookeriana* Lehm.	32, 183
" *hyparctica* Malte	25, 29, 42
" *nivea* L.	24, 32
" " " var. *tomentosa* Nilsson-Ehle	61
" *norvegica* L. spp. *monspeliensis* (L.) Aschers & Graebn.	73
" *palustris* (L.) Scop.	217
" *pensylvanica* (L.)	32, 92, 229

	COLLECTION SITE
ROSACEAE (Continued)	
Potentilla uniflora Ledeb.	25
" *villosa* Pallas	25
Rosa acicularis Lindl.	47, 107
Rubus arcticus L.	2
" *chamaemorus* L.	93
" *idaeus* L.	76
" *pedatus* J.E. Smith	131
Sanguisorba stipulata Raf.	156
Sibbaldia procumbens L.	50
Sorbus scopulina Greene	156
LEGUMINOSAE	
Astragalus alpinus L.	16, 127
Hedysarum alpinum L.	144
Lupinus arcticus Wats.	1
* " *nootkatensis* Donn	88
Oxytropis campestris (L.) DC.	25, 72, 144
* " *huddelsonii* Porsild	33, 209
" *nigrescens* (Pallas) Fisch.	10, 33, 84, 123
GERANIACEAE	
* *Geranium erianthum* DC.	Welsh & Rigby (1971)
- also photographed in 1975 by Mrs. R. Fox, in vicinity of Buckinghorse Lake.	
Geranium richardsonii Fisch. & Trautv.	49, 97
EMPETRACEAE	
Empetrum nigrum L.	74
VIOLACEAE	
Viola adunca Smith	89
* " *langsdorfii* (Reg.) Fisch.	121
" *palustris* L.	217
ELEAGNACEAE	
Shepherdia canadensis (L.) Nutt.	102

	COLLECTION SITE
ONAGRACEAE	
Epilobium alpinum L. var. *alpinum*	99, 170
" " " var. *nutans* (Hornem.) Hook	99
" *angustifolium* L.	112
" *davuricum* Fisch.	145
" *latifolium* L.	72, 151
* " *luteum* Pursh.	214
" *palustre* L. var. *lapponicum* Wahl.	93, 152, 218
HALORAGACEAE	
Hippuris vulgaris L.	218
UMBELLIFERAE	
Heracleum lanatum Michx.	99
Osmorhiza depauperata Phil.	156
" *purpurea* (Coult. & Rose) Suksd.	99
CORNACEAE	
Cornus canadensis L.	140
PYROLACEAE	
Moneses uniflora L.	95, 140
Pyrola asarifolia Michx.	97, 107
" *grandiflora* Radius	26, 80, 109
" *minor* L.	95
" *secunda* L.	140, 185, 204
ERICACEAE	
Arctostaphylos rubra (Rehd. & Wilson) Fern.	74, 144
" *uva-ursi* (L.) Spreng.	103
Cassiope mertensiana (Bong.) D.Don	46, 125
" *tetragona* (L.) D.Don	9, 45
Kalmia microphylla (Hook.) Heller	55, 138
* *Ledum decumbens* (Ait.) Lodd.	231
" *groenlandicum* Oeder	54
Phyllodoce empetriformis (J.E. Smith) D.Don	46
" *glanduliflora* (Hook.) Coville	Welsh & Rigby (1971)
Oxycoccus microcarpus Turcz.	93
Vaccinium caespitosum Michx.	2, 74
" *membranaceum* Dougl.	172
" *uliginosum* L.	45, 74
" *vitis-idaea* L. ssp. *minus* (Lodd.) Hult.	76

	COLLECTION SITE
PRIMULACEAE	
Androsace septentrionalis L.	32
* *Douglasia gormanii* Constance	Krajina (1975)
Trientalis arctica Fisch.	77
GENTIANACEAE	
Gentiana glauca Pallas	52
" " " f. *chlorantha* Jordal	130
" *prostrata* Haenke	34
Gentianella amarella (L.) Borner	Welsh & Rigby (1971)
" *propinqua* (Richards.) Gillet	116
POLEMONIACEAE	
Polemonium acutiflorum Willd.	54
" *pulcherrimum* Hook.	89
BORAGINACEAE	
Hackelia deflexa (Wahl.) Opiz	192
Mertensia paniculata (Ait.) D.Don	112
Myosotis alpestris F.W. Schmidt	16, 61
SCROPHULARIACEAE	
* *Castilleja parviflora* Bong.	121, 190
" *unalaschcensis* (Cham. & Schlecht.) Malte	112
Mimulus guttatus DC.	170
Pedicularis capitata Adams	69
" *labradorica* Wirsing	74
" *langsdorfii* Fisch.	9
" *sudetica* Willd.	2, 42, 160
Penstemon procerus Dougl.	32
Veronica americana Schwein.	170
" *serpyllifolia* L. var. *humifusa* (Dickson) Vahl	Welsh & Rigby (1971)
" *wormskjoldii* Roem. & Schult.	73, 89, 99, 121
RUBIACEAE	
Galium boreale L.	155
" *trifidum* L.	218
" *triflorum* Michx.	156

	COLLECTION SITE
CAPRIFOLIACEAE	
Linnaea borealis L.	107
Viburnum edule (Michx.) Raf.	107
VALERIANACEAE	
Valeriana dioica L.	73
" *sitchensis* Bong.	88, 130
CAMPANULACEAE	
Campanula lasiocarpa Cham.	81, 85, 92, 100
" *uniflora* L.	84
COMPOSITAE	
Achillea millefolium L. ssp. *borealis* (Bong.) Breitung	112
" " " ssp. *lanulosa* (Nutt.) Piper	Welsh & Rigby (1971)
Agoseris aurantiaca (Hook.) Greene	89, 97, 98
" *glauca* (Pursh) Raf.	121, 191
Antennaria alpina (L.) Gaertn.	81, 123, 143
" *monocephala* DC.	9, 42
" *pulcherrima* Rydb.	151, 201
" *rosea* Greene	32, 92, 112
" *umbrinella* Rydb.	139
Arnica alpina (L.) Olin ssp. *attenuata* (Greene) Maguire var. *linearis* Hult.	156, 157, 165
" " " " var. *tomentosa* (Macoun) Cronq.	111, 164
" *chamissonis* Less. ssp. *chamissonis* var. *interior* Maguire	Szczawinski (1959)
" *cordifolia* Hook.	99
" *latifolia* Bong.	190
* " *lessingii* Greene	80, 118, 145
Artemisia arctica Less.	98, 183
" *campestris* L. var. *borealis* (Pall.) M.E.Peck	32, 48, 166
* " *michauxiana* Bess.	48, 166
" *tilesii* Ledeb.	99, 128, 154, 183, 229
* *Cirsium edule* Nutt.	192
" *foliosum* (Hook.) DC.	169
Crepis nana Richards. var. *nana*	100, 127
* " " " var. *lyratifolia* (Turcz.) Hult.	64, 100
Erigeron acris L. var. *debilis* Gray	61, 99, 100, 118, 218
" " " var. *elatus* (Hook.) Cronq.	151
" *compositus* Pursh var. *glabratus* Macoun	25, 32
" *grandiflorus* Hook.	65, 147, 188
" *humilis* Graham	36, 62, 74, 81, 99, 100, 187
" *lonchophyllus* Hook.	Welsh & Rigby (1971)
" *peregrinus* (Pursh) Greene ssp. *callianthemus* (Greene) Cronq.	208
* " *purpuratus* Greene	63, 123

	COLLECTION SITE
COMPOSITAE (Continued)	
Hieracium gracile Hook.	119, 158, 190
Petasites frigidus (L.) Fries var. *frigidus*	16, 204
" " " " var. *nivalis* (Greene)Cronq.	Szczawinski (1959)
" *palmatus* Ait.	195
" *sagittatus* (Banks) Gray	93
Senecio lugens Richards.	13, 54
" *pauciflorus* Pursh	71, 92
* " *sheldonensis* Porsild	155
" *triangularis* Hook.	99
Solidago multiradiata Ait.	92
Taraxacum ceratophorum (Ledeb.) DC.	61, 81, 111, 205
" *eriophorum* Rydb.	Welsh & Rigby (1971)
" *lyratum* (Ledeb.) DC.	85, 205

APPENDIX 2

LICHENS OF THE GLADYS LAKE ECOLOGICAL RESERVE AND ADJACENT PARTS OF THE SPATSIZI PLATEAU.*

	COLLECTION SITE
Acarospora chlorophana (Wahlenb. ex Ach.) Mass.	224, 227
Actinogyra muehlenbergii (Ach.) Schol.	
Alectoria americana Mot.	93
" *miniscula* Nyl.	
" *nigricans* (Ach.) Nyl.	
" *ochroleuca* (Hoffm.) Mass.	31, 53
" *tenuis* Dahl	
Baeomyces rufus (Huds.) Rebent.	225
Caloplaca tiroliensis Zahlbr.	168
Cetraria commixta (Nyl.) Th. Fr.	
" *cucullata* (Bell.) Ach.	139
" *delisei* (Bory ex Schaer.) Th. Fr.	31, 78, 179
" *ericetrorum* Opiz	31
" *hepatizon* (Ach.) Vain.	123, 135
" *islandica* (L.) Ach.	31, 56, 92, 137
" *nigricans* (Retz.) Nyl.	31, 58
" *nivalis* (L.) Ach.	56, 59, 76, 150
" *pinastri* (Scop.) S. Gray	93, 135
" *richardsonii* Hook.	29, 132
" *subalpina* Imsh.	78, 223
" *tilesii* Ach.	18, 53, 122, 227
Cladina alpestris (L.) Harm.	76
" *impexa* (Harm.) B. de Lesd.	
" *mitis* Sandst.	92
" *rangiferina* (L.) Harm.	103
Cladonia amaurocraea (Flörke) Schaer.	76, 139
" *cariosa* (Ach.) Spreng.	
" *carneola* (Fr.) Fr.	
" *cenotea* (Ach.) Schaer.	
" *chlorophaea* (Flörke) Spreng.	103, 105, 151
" *coccifera* (L.) Willd.	52, 103, 223
" *cornuta* (L.) Hoffm.	115, 131
" *crispata* (Ach.) Flot.	
" *cyanipes* (Somm.) Nyl.	
" *deformis* (L.) Hoffm.	115
" *ecmocyna* (Ach.) Nyl.	131
" *gonecha* (Ach.) Asah.	116, 131, 138
" *gracilis* (L.) Willd.	105, 116, 131

* This list is incomplete. Our collection contains many species yet to be determined.

	COLLECTION SITE
Cladonia grayi Merr. ex Sandst.	105
" *metacorallifera* Asah.	
" *parasitica* (Hoffm.) Hoffm.	135
" *phyllophora* Hoffm.	103
" *pleurota* (Florke) Schaer.	
" *pyxidata* (L.) Hoffm.	
" *squamosa* (Scop.) Hoffm.	
" *uncialis* (L.) Wigg.	76, 116
" *verticillata* (Hoffm.) Schaer.	
Collema undulatum Laur. ex Flot.	
Cornicularia aculeata (Schreb.) Ach.	31, 57, 58, 78, 143
" *divergens* Ach.	
Dactylina arctica (Hook.) Nyl.	6, 178
" *madreporiformis* (Wulf.) Tuck.	227
" *ramulosa* (Hook.) Tuck.	10, 17, 56, 226
Dermatocarpon fluviatile (G. Web.) Th. Fr.	
" *moulinsii* (Mont.) Zahlbr.	227
Haemotomma lapponicum Räs.	31
Hypogymnia austerodes (Nyl.) Räs.	102, 103, 135
" *enteromopha* (Ach.) Nyl.	
" *oroarctica* Krog. sp. nov.	179
" *physodes* (L.) Nyl.	
" *subobscura* (Vain.) Poelt.	179
Icmadophila ericetrorum (L.) Zahlbr.	138
Lecidea macrocarpa (D.C.) Steud. f. *oxydata*	78, 179
Lepraria chlorina (Ach.) Ach. ex Sm.	
Leptogium saturninum (Dicks.) Nyl.	102, 135
Nephroma arcticum (L.) Torss.	5
" *parile* (Ach.) Ach.	135
Pannaria pezizoides (G. Web.) Trev.	135, 168
Parmelia alpicola Th. Fr.	
" *exasperatula* Nyl.	135
" *infumata* Nyl.	
" *lineola* Berry	32
" *obsessa* Ach.	
" *omphalodes* (L.) Ach.	76
" *saxatilis* (L.) Ach.	185
" *separata* Th. Fr.	106, 143, 181
" *stygia* (L.) Ach.	179

	COLLECTION SITE
Parmelia subaurifera Nyl.	135
" *sulcata* Tayl.	102, 162, 163
" *taractica* Kremp.	76
" *tasmanica* Hook. f. & Tayl.	181
Parmeliopsis ambigua (Wulf.) Nyl.	135, 163
" *hyperopta* (Ach.) Arn.	
Peltigera aphthosa (L.) Willd.	5
" *canina* (L.) Willd.	93, 103, 122, 228
" *malacea* (Ach.) Funck	
" *scabrosa* Th. Fr.	
" *spuria* (Ach.) DC.	107, 150, 180
Physconia muscigena (Ach.) Poelt	76
Platismatia glauca (L.) Culb. & Culb.	
Rhizocarpon badioatrum (Flörke ex Spreng.) Th. Fr.	59
" *geographicum* (L.) DC. agg.	179, 227
Solorina crocea (L.) Ach.	58
" *octospora* Arn.	223
Sphaerophorus fragilis (L.) Pers.	17, 56, 76
Stereocaulon glareosum (Sav.) Magn.	
" *paschale* (L.) Hoffm.	
" *saxatilis* Magn.	57, 76
" *subalbicans* Lamb	59, 123, 179
" *tomentosum* Fr.	76, 103
Thamnolia subuliformis (Ehrh.) Culb.	18, 132
" *vermicularis* (Sw.) Schaer.	
Tholurna dissimilis (Norm.) Norm.	8, 131,190
Umbilicaria cylindrica (L.) Del.	31, 56, 57, 227
" *deusta* (L.) Baumg.	31
" *hyperborea* (Ach.) Ach.	179
" *krascheninnikovii* (Sav.) Zahlbr.	227
" *papulosa* (Ach.) Nyl.	
" *proboscoidea* (L.) Schrad.	31, 56, 179
" *torrefacta* (Lightf.) Schrad.	227
" *vellea* (L.) Ach.	76, 227
" *virginis* Schaer.	56, 57, 78
Usnea glabrescens (Nyl. ex Vain.) Vain.	103, 136
Xanthoria elegans (Link.) Th. Fr.	123
" *parietina* (L.) Th. Fr.	96

add:

Bacidia sphaeroides (Dicks.) Zahlbr.

Calicium viride Pers.

Letharia vulpina (L.) Hue

Lobaria linita (Ach.) Rabenh. 7

Ochrolechia upsaliensis (L.) Mass.

Parmelia centrifuga (L.) Ach.

Peltigera polydactyla (Neck.) Hoffm.
" *praetextata* (Florke) Vain.

Pertusaria dactylina (Ach.) Nyl.

Rhizocarpon geographicum (L) DC 179, 1066, 1354, 5342A, 5441, 5445, 5447, 5446, 5443, 5454, 5402, 5439, 5428, 5452

" *inarense* (Vain.) Vain 179A

" *intermedium* (Räs) 5442

" *lecanorinum* (Körb) And. 227a

" *macrosporum* Räs 5440, 5453, 5500

" *sphaerosporum* Räs 5401

" *superficiale* (Schaer.) Vain. 227

APPENDIX 3

BRYOPHYTES COLLECTED IN THE GLADYS LAKE ECOLOGICAL RESERVE

MUSCI

	COLLECTION SITE
Andreaea rupestris Hedw.	31,76
Aulacomnium palustre (Hedw.) Schwaegr.	93,108,122,123,129,133
" *turgidum* (Wahlenb.) Schwaegr.	78,122,144
Brachythecium albicans (Hedw.) B.S.G.	129
" *erythrorrhizon* B.S.G.	122
" *frigidum* (C. Muell.) Besch.	131
" *nelsonii* Grout	145
" *plumosum* (Hedw.) B.S.G.	122,145
" *salebrosum* (Web. & Mohr) B.S.G.	189
Bryum angustirete Kindb. ex Macoun	123,168
" *caespiticium* Hedw.	129,151
" *cryophilum* Mart.	78,86,145
" *pallescens* Schleich. ex Schwaegr.	122,152,189
" *pseudotriquetrum* (Hedw.) Gaertn., Meyer & Scherb.	110,145,151
" *weigelii* Spreng.	145
Calliergon cordifolium (Hedw.) Kindb.	93,145,217
" *giganteum* (Schimp.) Kindb.	93
" *stramineum* (Brid.) Kindb.	215
Campylium stellatum (Hedw.) C. Jens.	217
Ceratodon purpureus (Hedw.) Brid.	123,151,185
Cinclidium stygium Sw.	145,217
Climacium dendroides (Hedw.) Web. & Mohr	189
Conostomum tetragonum (Hedw.) Lindb.	31,123
Cratoneuron commutatum (Hedw.) Roth var. *falcatum* (Brid.) Moenk.	129
Dicranoweisia crispula (Hedw.) Lindb. ex Milde	78,211
Dicranum acutifolium (Lindb. & Arnell) C. Jens. ex Weinm.	78,92,103,108,123,129, 144,212
" *flagellare* Hedw.	168
" *fragilifolium* Lindb.	76
" *fuscescens* Turn.	178
" *scoparium* Hedw.	125,131
" *undulatum* Brid.	103,115

	COLLECTION SITE
Distichium capillaceum (Hedw.) B.S.G.	122,123,144,151
Ditrichum flexicaule (Schwaegr.) Hampe	123
Drepanocladus exannulatus (B.S.G.) Warnst.	138,152
" *revolvens* (Sw.) Warnst.	145,217
" *uncinatus* (Hedw.) Warnst.	108,135,145,178,189, 200,211,215
Encalypta rhaptocarpa Schwaegr.	123
Hygrohypnum ? luridum (Hedw.) Jenn.	122
Hylocomium splendens (Hedw.) B.S.G.	108,116,138,189
Hypnum lindbergii Mitt.	151
" *revolutum* (Mitt.) Lindb.	135
Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb.	151
Meesia triquetra (Richt.) Angstr.	145
Mnium blyttii B.S.G.	122,123,129
" *venustum* Mitt.	87,93,189
Orthotrichum laevigatum Zett.	135
Paludella squarrosa (Hedw.) Brid.	87,93,115,145,217
Philonotis fontana (Hedw.) Brid.	87,93,129,151
" " " " var. *caespitosa* (Jur.) Schimp.	189
Pleurozium schreberi (Brid.) Mitt.	178,192,200
Pogonatum alpinum (Hedw.) Roehl. var. *alpinum*	108
Pohlia cruda (Hedw.) Lindb.	76
" *elongata* Hedw.	197
" *nutans* (Hedw.) Lindb.	105
" *wahlenbergii* (Web. & Mohn) Andr.	129
Polytrichum juniperinum Hedw.	105,131
" *longisetum* Brid.	215
" *piliferum* Hedw.	31,76,144,179,212
" *strictum* Brid.	93,115,189
Pseudoleskeella tectorum (Funck ex Brid.) Kindb. ex Broth.	135
Ptilium crista-castrensis (Hedw.) De Not.	137
Rhacomitrium canescens (Hedw.) Brid.	78,122,151
" *lanuginosum* (Hedw.) Brid.	31,53,76,212
Rhizomnium pseudopunctatum (Bruch & Schimp.) Kop.	87

	COLLECTION SITE
Rhytidium rugosum (Hedw.) Kindb.	92,122,144,194
Sphagnum capillaceum (Weiss) Schrank var. *capillaceum*	93,115,138,145,217
" " " " " *tenellum* (Schimp.)Andr.	93,145
" *fuscum* (Schimp.) Klingrr.	115,217
" *recurvum* P.-Beauv.	115,217
" *warnstorfii* Russ.	93
Sphlachnum sphaericum Hedw.	134,219
Tetraplodon mnioides (Hedw.) B.S.G.	189
Thuidium abietinum (Hedw.) B.S.G.	92,135
Timmia austriaca Hedw.	122
Tomenthypnum nitens (Hedw.) Loeske	87,93,122,129,145,217
Tortula ruralis (Hedw.) Gaertn., Meyer, & Scherb.	92,122,135

HEPATICAE

Barbilophozia hatcheri (Evans) Loeske	53,122,137
" *lycopodioides* (Wallr.) Loeske	131,133,211,222
Blepharostoma trichophyllum (L.) Dumort.	122,189
Cephalozia ambigua Mass.	122
" *media* Lindb.	115
Chandonanthus setiformis (Ehrh.) Mitt.	76
Lophozia obtusa (Lindb.) Evans	108
Marsupella sparsifolia (Lindb.) Dumort.	189
Orthocaulis floerkii (Web. & Mohr.) Buch	125
" *quadrilobus* (Lindb.) Buch	189
Preissia quadrata (Scop.) Nees	151
Ptilidium ciliare (Web.) Hampe	103,109,144,212,222
" *pulcherrimum* (Web.) Hampe	137

APPENDIX 4

GLADYS LAKE ECOLOGICAL RESERVE COLLECTING SITES, 1975*

- June 25, 1975 -

(1) Vicinity U.B.C. cabin, Gladys Lake
alt. 1280 m
Picea glauca-Salix glauca-Betula glandulosa association

(2) Along trail from cabin up Landslide Creek
alt. 1370 m
Salix glauca-Betula glandulosa-Festuca altaica scrub

(3) Foot of N. slope of Oreamnos Ridge
alt. 1400 m
seepage site; in moss beneath willows, growing with *Anemone richardsonii* and *Equisetum scirpoides*

(4) Foot of N. slope of Oreamnos Ridge
alt. 1400 m
turfy *Festuca altaica* subalpine grassland

(5) Foot of N. slope of Ovis Ridge
alt. 1430 m
in moss on floor of *Abies lasiocarpa-(Picea glauca)* subalpine forest on N-facing slopes

(6) Kettlehole Pass
alt. 1675 m
in clumps of moss within *Festuca altaica* subalpine grassland

(7) Kettleholp Pass
alt. 1675 m
mossy edge of clump of stunted *Abies lasiocarpa*

(8) Kettlehole Pass
alt. 1675 m
on leading twigs and upper trunks of stunted *Abies lasiocarpa*

(9) Solifluction Ridge, NE. slopes
alt. 1850 m
Cassiope tetragona-Dryas integrifolia-Salix reticulata alpine heath

(10) Solifluction Ridge, NE. slopes
alt. 1850 m
solifluction lobes and frost boils within alpine heath

(11) Steep, SE-facing slopes of Solifluction Ridge, overlooking Phoebe Creek
alt. 1770 m
fine, moist soil and scree on edge of avalanche chute

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*For herbarium purposes, the latitude and longitude of all the collecting sites may be taken as that of Gladys Lake, viz. 57° 35'N; 128° 47'W (except for numbers 87-91).

(12) Kettlehole Pass
alt. 1675 m
patches of turfy subalpine seepage within *Festuca altaica* grassland

(13) Kettlehole Pass
alt. 1586 m
bank of small tributary of Kettlehole Creek

(14) Along Landslide Creek, near mouth of Kettlehole Creek
alt. 1400 m
sandy-gravelly floodplain flats

(15) Solifluction Ridge, NE. slopes
alt. 1770 m
fine moist soil in solifluction lobe

(16) Mouth of Oreamnos Creek
alt. 1400 m
sandy-gravelly alluvial fan with thickets of *Salix barrattiana* and *S. barclayi*

- June 26, 1975 -

(17) Ghost Pass, between Ghost and Guardian Mountains
alt. 1980 m
in dwarf willow-grass-sedge-lichen alpine tundra, and among moss polsters on shallow soil over talus blocks

(18) Ghost Pass, between Ghost and Guardian Mountains
alt. 1920 m
alpine scree and talus slope

(19) Forget-Me-Not Ridge, S. face of Ghost Mountain
alt. 1460 m
pygmy poplar grove, on very steep colluvial slope

(20) Forget-Me-Not Ridge, S. face of Shost Mountain
alt. 1370 m
pygmy aspen grove, on very steep colluvial slope

(21) Steep NE-facing side of gulch leading up to Ghost Pass
alt. 1850 m
Cassiope-Dryas-Salix alpine heath

(22) Steep NE-facing side of gulch leading up to Ghost Pass
alt. 1770 m
wet crevices, niches and ledges in cliffs

(23) Forget-Me-Not Ridge, S. face of Ghost Mountain
alt. 1460 m
thin soil over rock outcropping beside a game trail in *Juniperus communis-Arctostaphylos uva-ursi*-grass association

(24) Forget-Me-Not Ridge, S. face of Ghost Mountain
alt. 1590 m
fine, shallow soil over rock outcrops and ledges along ridge crest

(25) Forget-Me-Not Ridge, S. face of Ghost Mountain
alt. 1525 m
gravelly ridges and outcrops within subalpine *Festuca altaica* grassland

(26) S. slopes of Guardian Mountain
alt. 1525 m
large, partially stabilized talus slope

(27) Vicinity of U.B.C. cabin, Gladys Lake
alt. 1280 m
swampy alluvial willow thickets near mouth of Landslide Creek

- June 28, 1975 -

(29) Danihue Pass, between the valleys of Eaglenest Creek and Cold Fish Lake
alt. 1675 m
on soil and among grasses and moss, *Festuca altaica*-lichen alpine tundra

(30) Danihue Pass, between the valleys of Eaglenest Creek and Cold Fish Lake
alt. 1675 m
on rocks, and binding sand, gravel and small pebbles; fjeldmark alpine tundra along moraine crest

- June 30, 1975 -

(28) Vicinity of Rainbow Cabin, near SE. end of Cold Fish Lake
alt. 1190 m
on NE. face of huge (5x5 m) boulder; in lodgepole pine forest

(31) Wheatear Ridge, Spatsizi Plateau
alt. 2075 m
dwarf willow-grass-sedge-lichen alpine tundra, on broad, windswept ridge

(32) Oxytropis Ridge, NE. of Rainbow Cabin
alt. 1525 m
Poa glauca-Carex supina-Artemisia spp. boreal steppe grassland, on steep, S-facing hillsides

(33) Oxytropis Ridge, NE. of Rainbow Cabin
alt. 1850-2075 m
Cassiope-Dryas-Salix alpine heath

(34) Oxytropis Ridge, NE. of Rainbow Cabin
alt. 1585 m
subalpine *Festuca altaica* grassland, on steep, S-facing slopes

(35) Oxytropis Ridge, NE. of Rainbow Cabin
alt. 1980 m
dwarf willow-grass-sedge-lichen alpine tundra, just below the ridge crest

(36) Wheatear Ridge, Spatsizi Plateau
alt. 2090 m
moist scree and fine gravel in windswept saddle on rim of broad cirque

- July 2, 1975 -

(37) Kettlehole Pass
alt. 1585 m
sand and gravel, dry alluvial fan from creek draining S. face of Nation Peak

(38) Vicinity of U.B.C. cabin, near mouth of Landslide Creek
alt. 1280 m
streambank willow thickets

- July 3, 1975 -

(39) Vicinity of U.B.C. cabin, near outlet of Gladys Lake
alt. 1250 m
white spruce-willow fen bordering the lake

(40) Old trail along E. side of Gladys Lake
alt. 1280 m
Festuca altaica subalpine grassland on S. faces of moraines

(41) Along game trail on NE. side of Salix Creek, below the W. entrance to Sanctuary Pass
alt. 1370 m
subhygric *Picea glauca-Salix glauca* forest type; growing in moss over humus

(42) Sanctuary Ridge
alt. 2075 m
dwarf willow-grass-sedge-lichen alpine tundra

(43) Sanctuary Ridge, SE-facing slopes above the E. entrance to Sanctuary Pass
alt. 1710 m
subalpine *Festuca altaica* grassland

(44) Sanctuary Pass
alt. 1650 m
mossy, alpine seepage and streambank vegetation, along and at the mouth of a small creek draining the snowfields of Sanctuary Ridge

(45) Sanctuary Ridge, E-facing slope just below the ridge crest
alt. 1950 m
Empetrum nigrum-Salix reticulata-Vaccinium uliginosum alpine heath

(46) Sanctuary Ridge, SE-facing slopes above the E. entrance to Sanctuary Pass
alt. 1675 m
Cassiope mertensiana-Empetrum nigrum-Phyllodoce empetriformis subalpine heath

(47) SW-facing lower slopes of Ochre Cliffs, Sanctuary Ridge
alt. 1370 m
pygmy aspen-(poplar)-*Salix scouleriana* forest, over steep, stabilized talus slope

(48) Ochre Cliffs, above confluence of Salix and Connector Creeks
alt. 1615 m
Poa glauca-Carex supina-Artemisia spp. boreal steppe grassland, on very steep S- and SW-facing colluvial slopes

(49) SSW-facing slopes below the W. entrance to Sanctuary Pass
alt. 1525 m
mesic *Festuca altaica* subalpine grassland

(50) Sanctuary Pass, on the valley floor
alt. 1675 m
snowpatch vegetation in lee of ridges

(51) Sanctuary Pass, on valley floor
alt. 1615 m
crevices in large, isolated boulder

(52) Sanctuary Pass
alt. 1675 m
Festuca altaica-lichen alpine tundra

(53) Summit crest of Sanctuary Ridge
alt. 2225 m
alpine scree; crevices in boulder fellfield

- July 4, 1975 -

(54) Vicinity of U.B.C. cabin, Gladys Lake
alt. 1280 m
Picea glauca-Salix glauca-Betula glandulosa association

(55) Kettlehole Pass
alt. 1615 m
alpine willow-sedge-moss fen

(56) Sanctuary Ridge, near the summit
alt. 2165 m
alpine fellfield

- July 6, 1975 -

(57) Eyrie Ridge, Marmot Mountain
alt. 1860 m
solifluction stripes below ridge crest

- July 5, 1975 -

(58) Summit ridge of Cornicularia Peak
alt. 2315 m
broken rock/lichen tundra (alpine fellfield)

(59) Summit ridge of Ghost Mountain
alt. 2350 m
broken rock/lichen tundra (alpine fellfield)

(60) Kettlehole Pass
alt. 1615 m
peaty, raised rim of small, shallow kettlehole pond

(61) Forget-Me-Not Ridge, S. face Ghost Mountain
alt. 1710 m
lush, well-manured grass-forb sward on a sheep/goat "saddle" (resting and feeding area)

(62) Ghost Mountain, S. face
alt. 2075 m
fine moist scree beneath cliffs

(63) Umbilicaria Ridge
alt. 2200 m
moist, shaded crevices between large blocks of talus, just beneath the ridge crest

(64) Ghost Mountain, S. face
alt. 2225 m
talus slope below summit cliffs

(65) Forget-Me-Not Ridge
alt. 1770 m
dry, exposed, grassy ridge above a sheep lick

(66) Ghost Mountain, S. face
alt. 2225 m
wet ledges, drip faces, crevices, and mossy runnels; base of summit cliffs

- July 6, 1975 -

(67) Marmot Valley
alt. 1850 m
alpine willow thickets in large, snowy cirque at head of Marmot Creek

(68) Marmot Valley
alt. 1770 m
mossy alpine seepage areas along upper Marmot Creek

(69) Solifluction Ridge, NE. slope
alt. 1740 m
Cassiope-Dryas-Salix alpine heath

(70) Solifluction Ridge, along the ridge crest
alt. 2075 m
dwarf willow-grass-sedge-lichen alpine tundra

(71) Kettlehole Pass
alt. 1525 m
mesic *Festuca altaica* subalpine grassland

- July 7, 1975 -

(72) Landslide Creek, vicinity of U.B.C. cabin
alt. 1280 m
creekbank mud and silt over sand and gravel

- July 8, 1975 -

(73) Vicinity of U.B.C. cabin
alt. 1280 m
Salix glauca-Betula glandulosa-Festuca altaica association

(74) Vicinity of U.B.C. cabin
alt. 1280 m
peaty shores of Gladys Lake, and adjacent willow fen

(75) Lower slopes of Landslide Ridge, S. face of Ghost Mountain
alt. 1370 m
Willow (*Salix scouleriana, S. glauca*) thickets and aspen groves on S-facing slopes

- July 11, 1975 -

(87) Fire Flats, near the headwaters of Kluayetz Creek
57° 12' N; 128° 33' W.
alt. 1220 m
subalpine sedge fen

(88) Fire Flats
alt. 1250 m
(subhygric) white spruce-willow-lupine-cow parsnip association, on alluvial fan at base of mountainside

(89) Fire Flats
alt. 1220 m
(subhygric) *Festuca altaica*-forb subalpine meadow

(90) Fire Flats
alt. 1220 m
subalpine willow-sedge fen

(91) Head of Tuaton Lake, at debouchment of Stikine River
57° 16' N; 128° 05' W.
alt. 1280 m
alluvial willow thickets and lake edge gravel bars and mud flats

- July 13, 1975 -

(92) N. end of Gladys Lake, E. of Connector Creek
alt. 1250 m
Festuca altaica subalpine grassland

(93) @ 6.3 km NE. of Gladys Lake, along E. side of Connector Creek
alt. 1190 m
white spruce-willow-sedge-moss fen, bordering a beaver pond

(94) Along the trail between Gladys and Cold Fish Lakes, @ 5 km NE. of Gladys
alt. 1205 m
willow-sedge swamp

(95) Along the trail between Gladys and Cold Fish Lakes, @ 3.2 km NE. of Gladys
alt. 1250 m
white spruce-moss forest type

(96) Along the trail between Gladys and Cold Fish Lakes, @ 5 km NE. of Gladys
alt. 1220 m
aspen forest along esker crest

(76) Landslide at base of Landslide Ridge
alt. 1400 m
large boulders and talus blocks at toe of the slide

(77) S. bank of Landslide Creek, just above its canyon and opposite the landslide
alt. 1340 m
creekbank willow (*Salix barclayi, S. glauca*) fen

- July 9, 1975 -

(78) Fossil Flats, SW. of Gladys Lake
alt. 2195 m
alpine fellfield along the gentle ridge crest

(79) Ovis Ridge
alt. 2045 m
wet cliffs and ledges on N. face beneath the hoodoos

(80) NE. slope of Ovis Ridge
alt. 1830 m
Cassiope-Vaccinium-Betula alpine heath

(81) W. end of Ovis Ridge, as it rises to Fossil Flats
alt. 2100 m
moist scree, talus, and wet ledges beneath the rimrock of Fossil Flats

(82) Col between Fossil Flats and Rangifer Ridge
alt. 2170 m
fine, dry ridgecrest gravel

(83) Ovis Ridge
alt. 1980 m
sheep/goat "saddle" (feeding and resting place) along the ridge crest

- July 10, 1975 -

(84) Potentilla Ridge, between Danihue Pass and the headwaters of Cullivan Creek
alt. 1980 m
dwarf willow-grass-sedge-lichen alpine tundra

(85) Spatsizi (Red Goat) Mountain
alt. 1980 m
rocky, jagged ridgecrest

(86) NW. slope of Potentilla Ridge
alt. 1830 m
mossy bank of alpine rivulet, fed by seepage

- July 14, 1975 -

(97) Columbine Ridge, SW-most ridge of Ghost Mountain
alt. 1465 m
pygmy poplar forest on steep S-facing slopes above Landslide Creek

(98) Columbine Ridge
alt. 1740 m
Festuca altaica subalpine grassland on S-facing slope

(99) Gorge between Landslide and Forget-Me-Not Ridges, S. face of Ghost Mountain
alt. 1525 m
streambank ledges, boulders and rubble

(100) Landslide Ridge
alt. 1770 m
scree slopes below cliffs

(101) Columbine Ridge
alt. 1830 m
Festuca altaica-lichen alpine tundra

- July 15, 1975 -

(102) Just N. of U.B.C. cabin, across Landslide Creek
alt. 1280 m
aspen forest on S-facing slope of esker

(103) Along W. side of Connector Creek, @ 0.2 km NE. of U.B.C. cabin
alt. 1280 m
Picea glauca-Salix glauca-Betula glandulosa-Festuca altaica-lichen association

- July 16, 1975 -

(104) Ptarmigan Ridge, Guardian Mountain
alt. 1525 m
dead leading branches and twigs of stunted *Abies lasiocarpa*

(105) Ptarmigan Ridge
alt. 1830 m
Festuca altaica-lichen alpine tundra

(106) Ghost Pass, between Ghost and Guardian Mountains
alt. 1950 m
Kobresia-lichen alpine tundra, on exposed hillock

(107) SE. face of Ptarmigan Ridge
alt. 1280 m
pygmy aspen forest on steep, S-facing, stabilized talus slope

(108) NE. face of Raptor Ridge, Guardian Mountain
alt. 1950 m
alpine seepage area (snow flush)

(109) NE. face of Raptor Ridge
alt. 1830 m
lush grass-forb sward, sheep/goat "saddle"

(110) Ghost Poss
alt. 1890 m
alpine seepage and creekbank vegetation, bordering rivulets fed by melting snowbanks

(111) Ptarmigan Ridge, SE. face
alt. 1770 m
goat/sheep "saddle"

- July 18, 1975 -

(112) Vicinity of U.B.C. cabin, Gladys Lake
alt. 1280 m
Salix glauca-Betula glandulosa-Festuca altaica association

(113) @0.6 km NE. of U.B.C. cabin, along the trail up Landslide Creek
alt. 1340 m
Abies lasiocarpa-Betula glandulosa-Empetrum nigrum association

(114) @ 0.4 km NE. of U.B.C. cabin
alt. 1300 m
white spruce-willow-dwarf birch association

(115) @ 0.4 km NE. of U.B.C. cabin
alt. 1300 m
(hygric) white spruce-willow-sedge-moss swamp

(116) @ 0.6 km NE. of U.B.C. cabin, along the trail up Landslide Creek
alt. 1300 m
Salix glauca, scouleriana-Betula glandulosa-Festuca altaica association

(117) E. entrance to Kettlehole Pass
alt. 1460 m
(mesic) *Festuca altaica* subalpine grassland

(118) Kettlehole Pass
alt. 1560 m
peaty margins and islands of turf around and in a gravelly-muddy seepage area.

- July 19, 1976 -

(119) Kettlehole Pass
alt. 1645 m
Festuca altaica subalpine grassland, on steep s-facing moraine slopes

(120) NE. slopes, Solifluction Ridge
alt. 1980 m
ridgecrest scree and broken rock

(121) Kettlehole Pass
alt. 1645 m
mesic-subhygric, lush *Festuca altaica*-forb subalpine meadows

(122) NE. face, Solifluction Ridge
alt. 1770 m
Cassiope-Dryas-Salix reticulata alpine heath

(123) Solifluction Ridge
alt. 2045 m
dwarf willow-grass-sedge-lichen alpine alpine on the broad ridgecrest

(124) Marmot Valley
alt. 1645 m
dwarf birch scrub on E-facing valley sides

(125) NE. slopes, Solifluction Ridge
alt. 1675 m
Cassiope mertensiana-Phyllodoce empetriformis-Lycopodium alpinum
subalpine heath

(126) Marmot Valley
alt. 1675 m
streamside *Salix barrattiana* thickets

(127) Marmot Valley, E. side
alt. 1830 m
scree slope beneath cliffs

(128) E. slopes of Spermophilus Saddle, above Marmot Valley
alt. 1675 m
sandy, gravelly banks of gully cut by snowmelt stream

(129) E. slopes of Spermophilus Saddle, above Marmot Valley
alt. 1710 m
mossy alpine seepage area, near a sheep lick

(130) Vicinity of Bates Camp, Kettlehole Pass
alt. 1585 m
mesic *Festuca altaica* subalpine grassland

(131) Vicinity of Bates Camp, Kettlehole Pass
alt. 1585 m
clumps of *Abies lasiocarpa*

(132) Kettlehole Pass
alt. 1615 m
Festuca altaica-lichen alpine tundra on kame crest

(133) Kettlehole Pass, near mouth of Marmot Creek
alt. 1585 m
Salix barrattiana alluvial willow thicket

- July 22, 1975 -

(134) Vicinity of old Gladys Lake camp, SE. corner of lake
alt. 1250 m
willow-sedge fen

(135) Lower SW. slopes of Sanctuary Ridge, above Gladys Lake camp
alt. 1340 m
aspen forest on steep colluvial slopes

(136) @ 1 km N. of U.B.C. cabin
alt. 1310 m
white spruce-moss forest type

- July 24, 1975 -

(137) Vicinity of head of Mink Creek, @ 9 km NE. of Gladys Lake
alt. 1220 m
Pinus contorta-Betula glandulosa-moss-lichen association

(138) Vicinity of head of Mink Creek, @ 9 km NE. of Gladys Lake
alt. 1250 m
white spruce-dwarf birch-willow-sedge fen

(139) Along the trail between Gladys Lake and Mink Creek, 2 km NE. of the lake
alt. 1280 m
Festuca altaica subalpine grassland

(140) Along the trail to Mink Creek, 5.5 km NE. of Gladys Lake
alt. 1220 m
Picea glauca-Salix glauca-Betula glandulosa association

(141) Along the trail to Mink Creek, 4.5 km NE. of Gladys Lake
alt. 1250 m
Picea glauca-Salix glauca seepage-fen

(142) Along the trail to Mink Creek, 7 km NE. of Gladys Lake
alt. 1220 m
mossy, muddy banks of rivulet crossing the trail

- July 25, 1975 -

(143) Maternity Mountain; between the 2 forks of upper Cullivan Creek
alt. 1770 m
Kobresia-lichen alpine tundra on exposed, windswept ridge

(144) Maternity Mountain
alt. 1710 m
subhygric alpine heath, above the sheep lick

(145) Maternity Mountain
alt. 1770 m
alpine seepage area

(146) Maternity Mountain
alt. 1710 m
alpine *Carex-Eriophorum* fen

(147) Maternity Mountain
alt. 1710 m
dry, gravelly solifluction ridge above sheep lick

(148) Maternity Mountain
alt. 1770 m
dwarf willow-grass-sedge-lichen alpine tundra and dwarf birch and willow thickets

(149) Maternity Mountain
alt. 1860 m
dwarf willow-grass-sedge-lichen alpine tundra

(150) @ 0.6 km NE. of U.B.C. cabin, across Landslide Creek
alt. 1280 m
Picea glauca-Betula glandulosa association

- July 26, 1975 -

(151) 3 km downstream of Gladys Lake, along Connector Creek
alt. 1250 m
gravelly-sandy-muddy alluvial sites on the active floodplain

(152) 3 km downstream of Gladys Lake, along Connector Creek
alt. 1250 m
willow-sedge fen

(153) 3 km downstream of Gladys Lake, along Connector Creek
alt. 1250 m
alluvial willow thicket

- July 27, 1975 -

(154) S. slopes of Alces Ridge, opposite Mount Will
alt. 1465 m
Juniperus communis-Arctostaphylos uva-ursi-grass association on stabilized talus slope

(155) Along Castor Creek, at the foot of Stark Cirque, Mount Will
alt. 1375 m
rubbly creekbank

(156) S. slopes of Alces Ridge, opposite Mount Will
alt. 1515 m
rocky-gravelly ravine, edged with clumps of stunted *Abies lasiocarpa*

(157) S. slopes of Alces Ridge, opposite Mount Will
alt. 1675 m
steep, grassy ridges below sheep and goat cliffs

(158) SE-facing slopes leading up to lip of Ursus Cirque
alt. 1830 m
Cassiope mertensiana-Pyllodoce empetriformis-Empetrum nigrum
alpine heath

(159) S. slopes of Alces Ridge, opposite Mount Will
alt. 1830 m
fine, moist scree on steep sides of rocky, snow-choked gully

(160) Ursus Cirque
alt. 1890 m
dwarf willow-sedge alpine seepage area

(161) Ursus Cirque, just below Ursus Pass
alt. 2045 m
fine, moist scree below rimrocks

- July 28, 1975 -

(162) 2 km S. of U.B.C. cabin, foot of Rangifer Ridge, above Gladys Lake
alt. 1315 m
Picea glauca-Betula glandulosa association on NE. slopes

(163) Vicinity of U.B.C. cabin, just across Landslide Creek
alt. 1280 m
alluvial *Picea glauca*-moss forest type

- July 29, 1975 -

(164) Beneath NW. face of Ochre Cliffs, W. end of Sanctuary Ridge
alt. 1675 m
gravelly saddle fanning out from base of the cliffs

(165) SW. face of Ochre Cliffs
alt. 1735 m
Festuca altaica subalpine grassland, along side of sheep/goat "saddle"

(166) SW. face of Ochre Cliffs
alt. 1615 m
Poa glauca-Carex supina-Artemisia spp. boreal steppe grassland on very steep, S-facing colluvial slopes

(167) SW. face of Ochre Cliffs
alt. 1770 m
ledges along steep-rocky avalanche chute

(168) NW. face of Ochre Cliffs
alt. 1710 m
Kobresia-lichen alpine tundra on exposed, wind-swept sheep/goat "saddle"

- July 30, 1975 -

(169) Salix Creek, at foot of slope leading up to Sanctuary Pass; @ 4 km SE. of Gladys Lake
alt. 1370 m
mesic subalpine grass-forb meadow

(170) Salix Creek, at foot of slope leading up to Sanctuary Pass; @ 4 km SE. of Gladys Lake
alt. 1370 m
mossy seepage and moss-covered rocks along rivulets

(171) Mouth of Cow Parsnip Creek, @ 7.5 km SE. of Gladys Lake
alt. 1465 m
hygric cow parsnip meadow on alluvial fan

(172) NE. end of Haemotomma Ridge, above Salix Creek
alt. 1585 m
edge of *Abies lasiocarpa* clump in subalpine parkland

(173) NE. end of Haemotomma Ridge, above Salix Creek
alt. 1675 m
alpine heath

(174) Flower Ridge, which ascends S. from Gladys Lake between Mère and Austere glaciers
alt. 2195 m
moist scree along the ridge crest

(175) Valley of Salix Creek, 3 km SE. of Gladys Lake
alt. 1320 m
white spruce-moss alluvial forest type

(176) Haemotomma Ridge
alt. 1980 m
dwarf willow-grass-sedge-lichen alpine tundra

(177) Haemotomma Ridge
alt. 1830 m
soil pockets in snow accumulation areas with boulder field

(178) Flower Ridge, gradual N-facing slope
alt. 1525 m
Abies lasiocarpa-moss subalpine forest type

(179) Haemotomma Ridge
alt. 2075 m
alpine fellfield

(180) NW. base of Ochre Cliffs
alt. 1310 m
Salix scouleriana "forest"on steep, colluvial slopes

(181) Flower Ridge
alt. 2100 m
Kobresia-lichen alpine tundra on the ridge crest

- August 1, 1975 -

(182) Lower slopes, Forget-Me-Not Ridge, S. face Ghost Mountain
alt. 1465 m
pygmy poplar forest

(183) Midslope, Forget-Me-Not Ridge
alt. 1710 m
sheep/goat "saddle"

(184) Lower slopes, Forget-Me-Not Ridge
alt. 1525 m
Juniperus communis-Arctostaphylos uva-ursi-grass association

(185) Lower slopes, Forget-Me-Not Ridge
alt. 1430 m
pygmy aspen forest

(186) Midslopes, Forget-Me-Not Ridge
alt. 1800 m
Poa glauca-Carex supina-Artemisia spp. association

(187) S. face of Ghost Mountain
alt. 2015 m
wet ledges and moist scree at foot of summit cliffs

(188) Upper Forget-Me-Not Ridge
alt. 1890 m
Kobresia-lichen alpine tundra on windswept ridge crest

- August 2, 1975 -

(189) S. end of Gladys Lake, delta of Connector Creek
alt. 1250 m
alluvial willow fen

- August 3, 1975 -

(190) SW. slopes of Fissile Ridge, overlooking valley of Salix Creek
alt. 1645 m
Cassiope mertensiana-Phyllodoce empetriformis-Luetkea pectinata
alpine heath

(191) Along Salix Creek, vicinity of mouth of Cow Parsnip Creek
alt. 1465 m
mesic *Festuca altaica* subalpine grassland

(192) Above Salix Creek, slopes leading up to W. entrance of Sanctuary Pass
alt. 1435 m
hygric cow parsnip meadows in seepage areas

(193) Above Salix Creek, slopes leading up to W. entrance of Sanctuary Pass
alt. 1400 m
white spruce-willow seepage fen

(194) W. entrance to Sanctuary Pass
alt. 1645 m
mosaic of *Betula glandulosa* scrub and *Festuca altaica*-lichen alpine tundra

- August 4, 1975 -

(195) Vicinity of mouth of Connector Creek, at Cold Fish Lake
alt. 1250 m
white spruce-willow-dwarf birch-sedge fen

(196) Vicinity of head of Mink Creek, outlet of Cold Fish Lake
alt. 1190 m
lodgepole pine forest

- August 6, 1975 -

(197) Danihue Pass
alt. 1675 m
muddy areas where trail crosses alpine rivulets

- August 8, 1975 -

(198) Spatsizi Plateau, above headwaters of Black Fox Creek
alt. 1860 m
dwarf willow-grass-sedge-lichen alpine tundra

- August 9, 1975 -

(199) Vicinity of mouth of Black Fox Creek
alt. 1190 m
alluvial willow thickets

(200) Lower Airplane Valley, above mouth of Black Fox Creek
alt. 1250 m
white spruce-subalpine fir-moss forest type

- August 11, 1975 -

(201) Marmot Valley
alt. 1650 m
Salix reticulata-sedge-moss alpine seepage

(202) Kettlehole Pass
alt. 1620 m
willow clump in subalpine grassland

(203) Solifluction Ridge
alt. 2045 m
dwarf willow-grass-sedge-lichen alpine tundra

- August 14, 1975 -

(204) Along Landslide Creek, @ 0.3 km NW. of U.B.C. cabin
alt. 1280 m
alluvial white spruce-moss forest type

- August 15, 1975 -

(205) Wolverine Ridge; rimrocks at head of S. fork of Marion Creek, Spatsizi Plateau
alt. 2010 m
gravelly scree along cliff edge

(206) Lupus Ridge; E-W ridge between 2 forks of upper Marion Creek, Spatsizi Plateau
alt. 1980 m
sedge marsh on edge of shallow alpine pond

(207) Lupus Ridge; E-W ridge between 2 forks of upper Marion Creek, Spatsizi Plateau
alt. 1980 m
alpine seepage area

(208) Purple Daisy Ridge, above Cache Creek camp, Spatsizi Plateau
alt. 1710 m
mesic *Festuca altaica* subalpine grassland

- August 16, 1975 -

(209) Wheatear Ridge
alt. 2075 m
fjeldmark vegetation on gravelly, windswept ridge

(210) Along old Indian trail up Kliweguh Creek, @ 4 km NW. of Cache Creek camp
alt. 1525 m
small subalpine pool

(211) Wheatear Ridge
alt. 2045 m
in crevices between boulders in alpine fellfield

(212) Wolverine Ridge
alt. 2010 m
dwarf willow-grass-sedge-lichen alpine tundra

- August 19, 1975 -

(213) Slopes leading up to W. entrance to Santuary Pass
alt. 1525 m
mesic *Festuca altaica* subalpine grassland

(214) Slopes leading up to W. entrance to Sanctuary Pass
alt. 1525 m
lush subalpine meadow in seepage area

(215) Sanctuary Pass
alt. 1645 m
sedge-forb-moss alpine fen

(216) Sanctuary Pass
alt. 1710 m
snow bed area surrounded by *Cassiope mertensiana-Sibbaldia procumbens-Lycopodium alpinum* alpine heath

- August 20, 1975 -

(217) Between mouth of Connector Creek and head of Mink Creek
alt. 1250 m
mucky pond margins and adjacent white spruce-willow-dwarf birch-sedge fen

(218) S. end of Gladys Lake, near mouth of Alces Creek
alt. 1250 m
sedge marsh and shallow-water deltaic mudflats

- August 22, 1975 -

(219) @ 4 km NE. of U.B.C. cabin, between Connector Creek and lower slopes of Ghost Mountain
alt. 1250 m
willow-sedge-moss fen

(220) Vicinity of U.B.C. cabin, just across Landslide Creek
alt. 1280 m
white spruce-willow fen

(221) @ 4 km NE. of U.B.C. cabin, between Connector Creek and lower slopes of Ghost Mountain
alt. 1280 m
Salix glauca-barclayi subhygric willow thicket

(222) @ 4 km NE. of U.B.C. cabin, between Connector Creek and lower slopes of Ghost Mountain
alt. 1280 m
white spruce-moss forest type

- August 25, 1975 -

(223) NE. flank of Ovis Ridge
alt. 1800 m
alpine heath

(224) Crest of Ovis Ridge
alt. 1985 m
rocky ridge, cliffs and talus

(225) NE. flank of Ovis Ridge
alt. 1585 m
Abies lasiocarpa-Betula glandulosa-Empetrum nigrum subalpine forest type

- August 26, 1975 -

(226) N. face of Mount Will, beneath Stark Cirque
alt. 1525 m
talus slope

(227) Mount Will
alt. 2400-2530 m
summit ridge and cliffs

- August 28, 1975 -

(228) SW-facing steep slopes below Ochre Cliffs, above old Gladys Lake camp
alt. 1370 m
Juniperus communis-Arctostaphylos uva-ursi-grass association

(229) Ochre Cliffs, directly above Gladys Lake camp
alt. 1525 m
sheep cave and grassy, well-manured berm at its mouth

(230) @ 4 km SE. of Gladys Lake, on bench above and on NE. side of Salix Creek
alt. 1400 m
willow-sedge-moss fen

- August 29, 1975 -

(231) NE. flank of Rangifer Ridge
alt. 1675 m
alpine heath

(232) Crest of Rangifer Ridge
alt. 2200 m
cliff ledge

(233) Castor Creek valley, vicinity of MacMillan Camp
alt. 1585 m
hygric subalpine seepage meadow, on alluvial fan

- August 31, 1975 -

(234) Castor Creek valley, vicinity of Castor Lake
alt. 1370 m
caribou leg bone, in dwarf birch scrub

APPENDIX 5

CHARACTERISTIC SPECIES OF THE GLADYS LAKE PLANT COMMUNITIES

Subalpine Vegetation

Forest community types.

(a) *Pinus contorta-Betula glandulosa*-cryptogam.
Pinus contorta, Picea glauca
Betula glandulosa, Salix glauca
Empetrum nigrum, Vaccinium vitis-idaea, V. caespitosum
Festuca altaica, Lupinus arcticus
Pleurozium schreberi, Dicranum fuscescens, Hylocomium splendens
Polytrichum juniperinum
Cladina mitis, C. rangiferina, C. alpestris, Cladonia gracilis, C. uncialis, C. gonecha, C. chlorophaea, C. uncialis, Peltigera aphthosa, P. malacea, Cetraria islandica
Alectoria americana, Cetraria pinastri, Hypogymnia austerodes, H. physodes, Parmelia sulcata, Parmeliopsis ambigua, P. hyperopta

(b) *Populus tremuloides-Juniperus communis-Epilobium angustifolium-Festuca altaica-Hypnum revolutum.*
Populus tremuloides, Salix scouleriana
Shepherdia canadensis, Rosa acicularis, Viburnum edule
Juniperus communis, Arctostaphylos uva-ursi, Linnaea borealis
Epilobium angustifolium, Lupinus arcticus, Mertensia paniculata, Arnica cordifolia, Fragaria virginiana, Achillea millefolium, Delphinium glaucum, Gentianella propinqua, Festuca altaica, Poa interior, P. glauca
Hypnum revolutum, Thuidium abietinum, Drepanocladus uncinatus, Tortula ruralis, Pleurozium schreberi
Peltigera canina, P. spuria, Cladonia chlorophaea, C. pyxidata
Cetraria pinastri, Parmeliopsis ambigua, P. hyperopta
Parmelia subaurifera, Leptogium saturninum, Physcia spp., *Hypogymnia austerodes*

(c) *Populus balsamifera-Salix scouleriana-Epilobium angustifolium.*
Populus balsamifera, Salix scouleriana
Rosa acicularis, Shepherdia canadensis, Viburnum edule
Epilobium angustifolium, Arnica cordifolia, Delphinium glaucum, Fragaria virginiana, Mertensia paniculata, Heracleum lanatum, Thalictrum occidentale, Geranium richardsonii, Lupinus arcticus, Bromus richardsonii

(d) *Picea glauca*-feather moss.
Picea glauca
(Abies lasiocarpa)

Linnaea borealis, Cornus canadensis, Arnica cordifolia, Mertensia paniculata, (Equisetum arvense, E. pratense, E. scirpoides, Petasites frigidus)
Hylocomium splendens, Pleurozium schreberi, Ptilium crista-castrensis, Dicranum fuscescens, D. scoparium, Polytrichum juniperinum, Pogonatum alpinum, Drepanocladus uncinatus, Barbilophozia lycopodioides
Peltigera aphthosa, P. scabrosa, Cladonia gracilis
Alectoria americana, Cetraria pinastri, Hypogymnia austerodes, H. physodes, Parmeliopsis ambigua, Parmelia sulcata, Usnea ? glabrescens

(e) *Picea glauca-Salix glauca-Betula glandulosa*-cryptogam.
Picea glauca, (Abies lasiocarpa)
Salix glauca, Betula glandulosa
Empetrum nigrum, Vaccinium vitis-idaea, Linnaea borealis
Festuca altaica, Lupinus arcticus, Mertensia paniculata, Epilobium angustifolium, Pedicularis labradorica
Pleurozium schreberi, Hylocomium splendens, Dicranum fuscescens, D. acutifolium, Polytrichum juniperinum, Ptilidium ciliare
Cladina mitis, C. rangiferina, Cladonia gracilis, C. cornuta, C. uncialis, C. amaurocraea, C. phyllophora, C. deformis, C. gonecha, C. coccifera, Peltigera aphthosa, P. canina, P. malacea, P. scabrosa, Stereocaulon tomentosum, S. paschale, Cetraria islandica
Alectoria americana, Cetraria pinastri, Hypogymnia austerodes, Parmeliopsis ambigua, Parmelia sulcata, Xanthoria parietina

(f) *Abies lasiocarpa*-feather moss.
Abies lasiocarpa
(Betula glandulosa, Ribes glandulosum)
Empetrum nigrum, Vaccinium vitis-idaea
Cornus canadensis, Mertensia paniculata, Festuca altaica
Hylocomium splendens, Pleurozium schreberi, Dicranum fuscescens, D. scoparium, Polytrichum juniperinum, Pogonatum alpinum, Brachythecium asperrimum, Drepanocladus uncinatus, Barbilophozia lycopodioides
Peltigera aphthosa, P. scabrosa, P. malacea, Cladonia gracilis, C. cornuta, C. ecmocyna, C. deformis, C. gonecha
Cetraria pinastri, Parmeliopsis ambigua, Hypogymnia austerodes, Alectoria americana

(g) *Abies lasiocarpa-Betula glandulosa-Empetrum nigrum.*
Abies lasiocarpa
Betula glandulosa, (Salix glauca, Ledum groenlandicum)
Empetrum nigrum, Vaccinium vitis-idaea, (Linnaea borealis, Arctostaphylos rubra)
Artemisia arctica, Cornus canadensis, Lupinus arcticus, Mertensia paniculata, Pedicularis labradorica, Festuca altaica
Hylocomium splendens, Pleurozium schreberi, Dicranum acutifolium, D. fuscescens
Cladina mitis, C. rangiferina, C. alpestris, Cladonia gracilis, C. cornuta, C. chlorophaea, C. coccifera, C. deformis, C. gonecha,

C. amaurocraea, C. uncialis, C. cenotea, Peltigera aphthosa, P. scabrosa, P. malacea, Nephroma arcticum, Lobaria linita, Dactylina arctica
Cetraria pinastri, Hypogymnia austerodes, Parmeliopsis ambigua

(h) *Abies lasiocarpa-Cassiope mertensiana-Rubus pedatus.*
Abies lasiocarpa
Vaccinium membranaceum, (Ribes glandulosum, Sorbus sitchensis)
Cassiope mertensiana, Empetrum nigrum, Linnaea borealis, Vaccinium caespitosum, Phyllodoce empetriformis
Rubus pedatus, Cornus canadensis, Sibbaldia procumbens
Lycopodium alpinum, L. annotinum, Hieracium gracile, Juncus drummondii
Dicranum fuscescens, D. scoparium, Hylocomium splendens, Orthocaulis floerkii, Barbilophozia lycopodioides
Cladina mitis, C. alpestris, Solorina crocea

Shrub community types.

(a) *(Picea glauca)-Salix barclayi-Betula glandulosa-Carex aquatilis*-moss.
(Picea glauca)
Salix barclayi, S. barrattiana, S. glauca, Betula glandulosa, Potentilla fruticosa
Salix myrtillifolia, Ledum groenlandicum, Empetrum nigrum, Arctostaphylos rubra, Oxycoccus microcarpus
Rubus chamaemorus, R. arcticus, Equisetum arvense
Carex aquatilis, C. disperma, (C. vaginata, C. media)
Arctagrostis latifolia, (Petasites frigidus, P. sagittatus, Pedicularis sudetica, Epilobium palustre)
Aulacomnium palustre, Paludella squarrosa, Drepanocladus exannulatus, Sphagnum capillaceum, S. recurvum, Plagiomnium venustum, Calliergon cordifolium, Polytrichum strictum, Calliergon giganteum, Campylium stellatum, Cinclidium stygium, Dicranum undulatum, Drepanocladus revolvens, Sphagnum fuscum, S. warnstorfii, Bryum pallescens, Hylocomium splendens
Peltigera aphthosa, P. scabrosa, Cladina impexa, Cladonia gonecha, C. deformis, C. chlorophaea, C. cyanipes, C. carneola, Icmadophila ericetrorum

(b) *Salix scouleriana-Linnaea borealis-Festuca altaica.*
Salix scouleriana
Salix glauca, Betula glandulosa, Shepherdia canadensis
Linnaea borealis, Juniperus communis
Epilobium angustifolium, Lupinus arcticus, Arnica cordifolia, Mertensia paniculata, Festuca altaica
Thuidium abietinum, Pleurozium schreberi, Hylocomium splendens, Drepanocladus uncinatus, Hypnum revolutum, Peltigera canina, P. aphthosa, Cladonia chlorophaea
Cetraria pinastri, Parmeliopsis ambigua, Leptogium saturninum

(c) *Salix (glauca, barclayi, planifolia)-Festuca altaica-Rubus arcticus-Petasites frigidus-Aulacomnium palustre.*
Salix glauca, S. barclayi, S. planifolia, Potentilla fruticosa
Festuca altaica, Luzula parviflora, Poa pratensis, Petasites frigidus, Rubus arcticus, Epilobium angustifolium, Achillea millefolium, Aconitum delphinifolium, Mertensia paniculata, Polemonium acutiflorum, Stellaria monantha, Senecio pauciflorus, S. lugens, Pedicularis sudetica, Polygonum viviparum, Delphinium glaucum, Carex macloviana, Phleum alpinum, Sanguisorba stipulata
Aulacomnium palustre, Hylocomium splendens, Polytrichum strictum, Drepanocladus uncinatus, Plagiomnium venustum, Brachythecium salebrosum, Bryum pallescens, Climacium dendroides, Tomenthypnum nitens, Blepharostoma trichophyllum, Marsupella sparsifolia
Cladonia cyanipes, C. gonecha, Peltigera aphthosa, Lobaria linita

(d) *Salix (alaxensis, barclayi, planifolia)- Epilobium latifolium-Drepanocladus uncinatus.*
Salix alaxensis, S. barclayi, S. planifolia, (Potentilla fruticosa)
Epilobium latifolium, Artemisia tilesii, Astragalus alpinus, Equisetum arvense, E. variegatum, Parnassia kotzebuei, Lupinus arcticus, Arctagrostis latifolia, Poa alpina, Juncus arcticus, Deschampsia caespitosa, Erigeron debilis, Oxytropis campestris, Agostis scabra, Phleum alpinum
Drepanocladus uncinatus, Hypnum lindbergii, Isopterygium pulchellum, Bryum caespiticium, Distichium capillaceum, Rhacomitrium canescens, Preissia quadrata, Ceratodon purpureus
Stereocaulon tomentosum, S. paschale, Cladonia pyxidata, C. chlorophaea, Peltigera canina

(e) *Salix glauca-Betula glandulosa-Festuca altaica.*
Salix glauca, Betula glandulosa, (Salix scouleriana)
Festuca altaica, Epilobium angustifolium, Mertensia paniculata, Linnaea borealis, Lupinus arcticus, Vaccinium caespitosum
Pleurozium schreberi, Hylocomium splendens, Dicranum acutifolium
Peltigera aphthosa, P. malacea, P. canina, Cladina mitis, C. rangiferina, Cladonia gracilis, C. deformis, C. gonecha, C. chlorophaea, C. cornuta, C. coccifera

(f) *Betula glandulosa-Festuca altaica*-cryptogam.
Betula glandulosa, (Salix glauca)
Empetrum nigrum, Vaccinium vitis-idaea, Linnaea borealis
Artemisia arctica, Lupinus arcticus, Mertensia paniculata, Stellaria monantha, Festuca altaica, (Calamagrostis canadensis)
Hylocomium splendens, Pleurozium schreberi, Dicranum acutifolium, Polytrichum juniperinum
Cladina mitis, C. rangiferina, Peltigera aphthosa, P. malacea, Cladonia gracilis, C. deformis, C. gonecha, C. cornuta, C. coccifera, C. cenotea, Cetraria cucullata, C. islandica, Nephroma arcticum, Lobaria linita

(g) *Juniperus communis-Arctostaphylos uva-ursi*-grass.
Juniperus communis, Arctostaphylos uva-ursi, Rosa acicularis, Potentilla fruticosa

Festuca altaica, F. saximontana, Poa glauca, Koeleria nitida, (Agropyron caninum, Trisetum spicatum)
Saxifraga tricuspidata, Epilobium angustifolium, Achillea millefolium, Draba aurea, Gentiana propinqua, Sedum lanceolatum, Anemone multifida, Antennaria rosea, Erigeron compositus, Oxytropis campestris
Ceratodon purpureus, Tortula ruralis, Orthotrichum laevigatum, Polytrichum norvegicum, Peltigera canina, Cladonia pyxidata, (Cornicularia aculeata, Cetraria cucullata, Peltigera spuria)

Herb community types.

(a) *Poa glauca-Carex supina-Potentilla pensylvanica-Artemisia borealis.*
Poa glauca, Agropyron caninum, Koeleria nitida, Festuca altaica, F. saximontana, Trisetum spicatum, Carex supina, C. anthoxanthea, C. petasata, C. obtusata, C. praticola
Potentilla pensylvanica, P. nivea, P. hookeriana, Artemisia borealis, A. michauxiana, Oxytropis campestris, Cerastium beeringianum, Myosotis alpestris, Saxifraga tricuspidata, Androsace septentrionalis
Tortula ruralis
Peltigera canina, Physconia muscigena, Parmelia separata

(b) *Festuca altaica* subalpine grassland.
Festuca altaica, F. saximontana, Poa glauca, P. cusickii, Phleum alpinum, Trisetum spicatum, Luzula parviflora, Carex macloviana, C. podocarpa, Artemisia arctica, Potentilla diversifolia, Aconitum delphinifolium, Delphinium glaucum, Epilobium angustifolium, Fragaria virginiana, Lupinus arcticus, Solidago multiradiata, Myosotis alpestris, Achillea millefolium, Rumex acetosa, (Draba aurea, Gentiana propinqua, Stellaria monantha, Botrychium lunaria)
Thuidium abietinum, Polytrichum juniperinum, Dicranum acutifolium, Tortula ruralis, Cladina mitis, Cetraria cucullata, C. islandica, Peltigera canina, P. aphthosa, Cladonia chlorophaea, C. amaurocraea, Stereocaulon paschale

(c) *Festuca altaica-Luzula parviflora-Aconitum delphinifolium-Artemisia arctica-Senecio triangularis-Rumex acetosa.*
Festuca altaica, Luzula parviflora, Carex podocarpa, Phleum alpinum, Aconitum delphinifolium, Artemisia arctica, Senecio triangularis, Rumex acetosa, Rubus arcticus, Vaccinium caespitosum, Myosotis alpestris, Epilogium angustifolium, Polemonium acutiflorum, Castilleja unalaschcensis, Lupinus arcticus, Mertensia paniculata, Agoseris aurantiaca, Valeriana sitchensis, V. dioica, Veronica wormskjoldii, Sanguisorba stipulata, Potentilla diversifolia, Ranunculus occidentalis, Erigeron peregrinus, Thalictrum occidentale
Aulacomnium palustre, Peltigera aphthosa

(d) *Heracleum lanatum-Epilobium angustifolium-Thalictrum occidentale.*
Heracleum lanatum, Epilobium angustifolium, Thalictrum occidentale, Delphinium glaucum, Achillea millefolium, Mertensia peniculata, Polemonium acutiflorum, Phleum alpinum, Calamagrostis canadensis, Festuca altaica, Bromus richardsonii

Drepanocladus uncinatus, Rhizomnium pseudopunctatum

(e) Carex marshes and fens.
Carex aquatilis, C. rostrata, C. saxatilis, C. canescens, C. limosa, C. magellanica, Eriophorum angustifolium, E. callitrix, E. vaginatum, Epilobium palustre, Chrysosplenium tetrandrum, Potentilla palustris, Hippuris vulgaris, Callitriche verna, Ranunculus hyperboreus, Calamagrostis canadensis, Arctagrostis latifolia, Sparganium minimum Drepanocladus exannulatus, Calliergon giganteum, Cinclidium stygium, Drepanocladus revolvens, Calliergon cordifolium, Plagiomnium venustum, Bryum pallescens

Talus-lichen-moss terrain unit.
Rhacomitrium lanuginosum, R. canescens, Andreaea rupestris, Dicranum acutifolium, D. fragilifolium, Polytrichum piliferum, Pohlia cruda, Tortula ruralis, Thuidium abietinum, Chandonanthus setiformis Cladina alpestris, C. mitis, C. rangiferina, Cladonia amaurocraea, C. coccifera, C. gracilis, C. pyxidata, C. crispata, C. uncialis, Cetraria nivalis, C. cucullata, Stereocaulon tomentosum, S. saxatile, S. glareosum, Rhizocarpon geographicum, R. badioatrum, Parmelia stygia, P. taractica, P. omphalodes, P. infumata, P. saxatilis, Lecidea granulosa, L. macrocarpa, Actinogyra muehlenbergii, Umbilicaria hyperborea, U. proboscoides, U. vellea, Alectoria ochroleuca, Sphaerophorus fragilis, Thamnolia vermicularis, Dactylina arctica, Physconia muscigena, Xanthoria elegans, Lepraria chlorina, Haemotomma lapponicum Dryopteris fragrans, Cystopteris fragilis, Festuca saximontana, Poa glauca, Koeleria nitida, Saxifraga tricuspidata

Alpine Vegetation

Shrub community types.

(a) *Betula glandulosa-Artemisia arctica*-cryptogam.
Betula glandulosa, (Salix glauca, S. pulchra, S. planifolia) Empetrum nigrum, Vaccinium vitis-idaea, Salix arctica Artemisia arctica, Petasites frigidus, Senecio lugens, Stellaria monantha, S. longipes, Lupinus arcticus, Festuca altaica, Poa arctica, Luzula parviflora, Calamagrostis canadensis Hylocomium splendens, Dicranum acutifolium, D. scoparium, Polytrichum juniperinum, Rhytidium rugosum, Aulacomnium palustre, Peltigera aphthosa, Nephroma arcticum, Lobaria linita, Stereocaulon paschale, Dactylina arctica, Cladina alpestris, C. rangiferina, Cetraria cucullata, C. nivalis, C. islandica

(b) *Salix barrattiana-Petasites frigidus-Tomenthypnum nitens.*
Salix barrattiana, S. planifolia, S. pulchra, (S. alaxensis, S. glauca) Petasites frigidus, Rubus arcticus, Polemonium acutiflorum, Mertensia paniculata, Senecio lugens, S. triangularis, Delphinium glaucum, Artemisia arctica, Equisetum arvense, Pedicularis sudetica, Polygonum

viviparum, Salix reticulata, Veronica wormskjoldii, Anemone richardsonii, A. parviflora, Sanguisorba stipulata, Selaginella selaginoides, Carex podocarpa, Poa alpina, Calamagrostis canadensis
Tomenthypnum nitens, Hylocomium splendens, Drepanocladus revolvens, Brachythecium plumosum, Mnium blyttii, Plagiomnium venustum, Aulacomnium palustre
Peltigera aphthosa, P. scabrosa

Tundra community types.

(a) *Cassiope mertensiana-Luetkea pectinata-Sibbaldia procumbens-Barbilophozia hatcheri.*
Cassiope mertensiana, Luetkea pectinata, Sibbaldia procumbens, Phyllodoce empetriformis, Empetrum nigrum, Lycopodium alpinum, Artemisia arctica, Hieracium gracile, Luzula parviflora, Juncus drummondii, Carex pyrenaica
Barbilophozia hatcheri, Orthocaulis floerkii, Dicranum scoparium, D. fuscescens, Distichium capillaceum, Blepharostoma trichophyllum
Solorina crocea, Lobaria linita, Cetraria islandica

(b) *Cassiope tetragona-Dryas integrifolia-Salix (reticulata, polaris),-Distichium capillaceum.*
Cassiope tetragona, Dryas integrifolia, Salix reticulata, S. polaris, Vaccinium uliginosum, V. vitis-idaea, Salix arctica, (Arctostaphylos rubra, Ledum decumbens)
Silene acaulis, Pedicularis capitata, Stellaria monantha, Polygonum viviparum, Pedicularis langsdorfii, Arnica lessingii, Lupinus arcticus, Pyrola grandiflora, Draba longipes, Carex microchaeta, C. podocarpa, Poa arctica, Festuca altaica, Calamagrostis lapponica, Luzula confusa, L. tundricola, L. arcuata
Distichium capillaceum, Hylocomium splendens, Dicranum acutifolium, Rhytidium rugosum, Aulacomnium turgidum, Tomenthypnum nitens, Timmia austriaca, Polytrichum piliferum, Blepharostoma trichophyllum, Barbilophozia hatcheri
Stereocaulon glareosum, Thamnolia vermicularis, Dactylina arctica, Cetraria cucullata, C. islandica, C. nivalis, C. subalpina, Lobaria linita, Peltigera aphthosa, Lecidea spp., *Caloplaca tiroliensis*

(c) *Festuca altaica-Artemisia arctica-Polytrichum piliferum-Stereocaulon glareosum-Cetraria (cucullata, nivalis).*
Festuca altaica, Hierochloe alpina, Poa arctica, Carex microchaeta, Luzula spicata, Artemisia arctica, Antennaria monocephala, Campanula lasiocarpa, Aconitum delphinifolium, Gentiana glauca, Potentilla diversifolia, Polygonum viviparum, Silene acaulis, Pedicularis langsdorfii
Polytrichum piliferum, P. norvegicum, Bryum angustirete
Dicranum acutifolium
Stereocaulon glareosum, Cetraria nivalis, C. cucullata, C. islandica, Cladina alpestris, (C. mitis, C. rangiferina), Thamnolia vermicularis, Dactylina arctica, Cladonia coccifera, C. pleurota, C. pyxidata, C. squamosa, C. uncialis, Cetraria richardsonii

(d) *Poa rupicola-Trisetum spicatum-Hierochloe alpina-Potentilla nivea.*
Poa rupicola, P. alpina, (P. arctica), Trisetum spicatum, Hierochloe alpina, Agropyron caninum var. *latiglume, Festuca altaica, F. brachyphylla, Carex supina, C. albo-nigra, C. anthoxanthea, C. microchaeta, Kobresia myosuroides, Potentilla nivea, P. uniflora, P. diversifolia, Stellaria monantha, Myosotis alpestris, Aconitum delphinifolium, Saxifraga tricuspidata, Artemisia arctica, Taraxacum ceratophorum, Draba nemorosa, D. nivalis, D. cinerea*
Bryum angustirete, Dicranum acutifolium, Polytrichum piliferum, Rhytidium rugosum, Cetraria nivalis, Physconia muscigena

(e) *Kobresia myosuroides*-lichen.
Kobresia myosuroides, Carex microchaeta, C. albo-nigra, Hierochloe alpina, Poa rupicola, Festuca brachyphylla, Luzula spicata, Polygonum viviparum, Silene acaulis, Draba nivalis, Dryas integrifolia, Oxytropis nigrescens, Potentilla uniflora, Stellaria monantha, Salix polaris, Antennaria alpina, Campanula lasiocarpa
Bryum angustirete, Polytrichum piliferum, Dicranum acutifolium
Cetraria nivalis, C. cucullata, Lecidea spp., *Thamnolia vermicularis, Alectoria ochroleuca, Cetraria nigricans, Cornicularia aculeata, Physconia muscigena, Parmelia tasmanica*

(f) *Salix (polaris, reticulata)-Carex microchaeta-Polytrichum piliferum-Cetraria nivalis.*
Salix polaris, S. reticulata, (Dryas integrifolia), Carex microchaeta, Hierochloe alpina, Festuca altaica, F. brachyphylla, Poa arctica, Calamagrostis lapponica, Luzula tundricola, L. nivalis, L. spicata, Polygonum viviparum, Antennaria monocephala, Potentilla hyparctica, Silene acaulis, Stellaria monantha, Campanula lasiocarpa, Draba navalis, D. lactea, D. fladnizensis, Pedicularis langsdorfii, Saxifraga nivalis
Polytrichum piliferum, Bryum angustirete, Rhytidium rugosum, Distichium capillaceum, Ditrichum flexicaule, Rhacomitrium lanuginosum, Dicranum acutifolium, Conostomum tetragonum, Timmia austriaca
Cetraria nivalis, C. cucullata, C. islandica, C. delisei, C. subalpina, Lecidea spp., *Stereocaulon glareosum, Thamnolia vermicularis, Dactylina arctica, D. ramulosa, Sphaerophorus fragilis, Alectoria ochroleuca, Cladonia pyxidata, Cornicularia aculeata, Physconia muscigena*

(g) *Dryas integrifolia-Oxytropis nigrescens-Silene acaulis*-lichen.
Dryas integrifolia, Oxytropis nigrescens, Silene acaulis, Potentilla uniflora, Lupinus arcticus, Draba nivalis, D. lactea, D. fladnizensis, Salix reticulata, S. polaris, Polygonum viviparum, Arenaria rubella, Campanula uniflora, Saxifraga tricuspidata, S. flagellaris, Lychnis apetala, Lloydia serotina, Oxytropis huddelsonii, Papaver radicatum, Kobresia myosuroides, Carex microchaeta, C. nardina, Hierochloe alpina, Festuca altaica, F. brachyphylla, Poa rupicola, P. leptocoma, Calamagrostis purpurascens
Rhytidium rugosum, Polytrichum piliferum, Bryum angustirete
Cetraria nivalis, C. cucullata, C. tilesii, C. nigricans, Lecidea spp., *Thamnolia vermicularis, Alectoria ochroleuca, Cornicularia aculeata, C. divergens, Parmelia separata*

(h) *Salix reticulata-Carex aquatilis*-moss.
Salix reticulata
Carex aquatilis, C. scirpoidea, C. saxatilis, Eriophorum callitrix, Scirpus caespitosus, Tofieldia pusilla, Sanguisorba stipulata, Equisetum arvense, Polygonum viviparum
Tomenthypnum nitens, Aulacomnium palustre, Drepanocladus uncinatus, Calliergon cordifolium, Paludella squarrosa, Mnium blyttii, Plagiomnium rugicum, Brachythecium spp., *Cinclidium stygium, Sphagnum capillaceum*

(i) *Salix (polaris, reticulata)-Carex podocarpa-Petasites frigidus*-moss.
Salix polaris, S. reticulata
Carex podocarpa, C. lachenalii, C. scirpoidea, Calamagrostis lapponica, Poa alpina, Juncus castaneus, J. triglumis, J. biglumis, Luzula parviflora
Petasites frigidus, Artemisia arctica, Ranunculus eschscholtzii, R. nivalis, Anemone parviflora, A. richardsonii, Caltha leptosepala, Arnica lessingii, Corydalis pauciflora, Claytonia sarmentosa, Draba longipes, Epilobium alpinum, E. latifolium, Equisetum scirpoides, E. variegatum, Parnassia fimbriata, P. kotzebuei, Polemonium acutiflorum, Polygonum viviparum, Saxifraga lyallii, Senecio lugens, Tofieldia pusilla, Valeriana sitchensis, Veronica wormskjoldii
Tomenthypnum nitens, Drepanocladus revolvens, Brachythecium plumosum, Aulacomnium palustre, Polytrichum strictum, P. longisetum, Cinclidium stygium, Calliergon spp., *Meesia triquetra, Paludella squarrosa*

(j) *(Salix polaris-Ranunculus nivalis-Carex microchaeta)*-moss.
Bryum cryophilum, B. weigelii, Drepanocladus revolvens, Pohlia wahlenbergii, Cinclidium stygium, Tomenthypnum nitens, Cratoneuron commutatum, Philonotis fontana, Mnium blyttii, Brachythecium spp., *Hygrohypnum* spp., *(Dermatocarpon fluviatile)*
Salix polaris
Ranunculus nivalis, R. pygmaeus, R. sulphureus, Claytonia sarmentosa, Cardamine bellidifolia, Saxifraga punctata, S. lyallii, Corydalis pauciflora, Eutrema edwardsii, Oxyria digyna, Petasites frigidus, Draba longipes, (Koenigia islandica)
Carex microchaeta, C. podocarpa, Juncus biglumis, J. triglumis, Poa alpina

(k) Alpine fellfield.
Rhacomitrium lanuginosum, Polytrichum piliferum, Andreaea rupestris, Dicranoweisia crispula, Ptilidium ciliare
Cetraria delisei, C. subalpina, C. ericetrorum, C. nivalis, C. cucullata, C. tilesii, C. islandica, C. commixta, Alectoria ochroleuca, Dactylina arctica, D. ramulosa, D. madreporiformis, Cornicularia aculeata, Parmelia omphalodes, P. separata, P. infumata, P. taractica, Thamnolia vermicularis, Actinogyra muehlenbergii, Umbilicaria vellea, U. virginis, Dermatocarpon moulinsii, Stereocaulon spp., *Physconia muscigena, Cladonia crispata, Sphaerophorus fragilis, Solorina crocea, Alectoria*

pubescens, A. miniscula, Parmelia stygia, Cetraria hepatizon, Hypogymnia subobscura, Umbilicaria proboscoidea, U. krascheninnikovii. U. deusta, U. torrefacta, U. cylindrica, U. hyperborea, Lecidea macrocarpa, Xanthoria elegans, Rhizocarpon geographicum agg., *R. badioatrum, Haemotomma lapponicum*
Cardamine bellidifolia, Draba alpina, Silene acaulis, Saxifraga caespitosa, S. tricuspidata, S. oppositifolia, Potentilla hyparctica, Carex microchaeta, Poa leptocoma, Festuca brachyphylla, Luzula arcuata,

(l) Vegetation of alpine steeplands.
Salix polaris, S. reticulata, Dryas integrifolia
Saxifraga caespitosa, S. cernua, S. adscendens, S. oppositifolia, S. rivularis, S. nivalis, S. punctata, Potentilla uniflora, P. hyparctica, Erigeron humilis, E. purpuratus, Draba alpina, D. longipes, D. lactea, D. lonchocarpa, D. fladnizensis, D. nivalis, Cardamine bellidifolia, Crepis nana, Ranunculus gelidus, R. pygmaeus, Cerastium beeringianum, Arenaria obtusiloba, Silene acaulis, Taraxacum ceratophorum, T. lyratum, Oxyria digyna, Campanula lasiocarpa, Antennaria monocephala, Senecio lugens, Anemone parviflora, Carex microchaeta, C. nardina, Luzula arcuata, L. tundricola, Poa alpina, P. leptocoma, P. arctica, Festuca brachyphylla
- cryptogams much as in *(k)*, with additionally: *Parmelia alpicola, Cetraria nigricans, Acarospora chlorophana, Pertusaria dactylina, Andreaea rupestris*

APPENDIX 6

PRACTICAL NOTES AND SUGGESTIONS FOR FUTURE RESEARCHERS

The following comments pertain to travel on foot, which is and should remain the main way of getting around in the ecological reserve.

Carry a stout staff or ice axe for general bushwhacking and mountain scrambling, and especially for fording streams. Some rope and a pair of old sneakers or running shoes also come in handy in stream crossings. These crossings can be very dangerous, especially with a full packsack and at high water time in early summer.

See the maps accompanying Carswell's 1975 report for the location of the major trails within the reserve. I will not elaborate on them here.

The northeast-facing slopes above Cold Fish Lake are most easily reached by boat from the lake. There is an intermittent trail along the lake's southwestern shore, but the terrain is often boggy and brushy.

Ascend Guardian (Lick) Mountain via Ptarmigan Ridge. The southwestern base of Ptarmigan Ridge can be reached by a variable trail from the Gladys Lake cabin along the north side of Connector Creek. For the most part this trail keeps to the edge of the creek's meander plain, which is usually too wet to travel. Guardian Mountain can also be climbed through a notch from Ghost Pass, but the rock and scree are dangerously steep and loose. To get around Raptor Ridge, cliffs on its northwest face must be skirted.

Cloudbowl Valley is pleasant, and offers access to Flatiron Peak and Acute Ridge. Umbilicaria Ridge and Ghost Mountain can also be gained from the valley, but it is much safer and easier to approach them from the south.

Ghost Pass is reached via the gully draining southeast from it, after substantial bushwhacking at lower elevations. The gully is virtually dry in

early summer. However, it carries a late summer freshet fed underground by Ghost Tarn, which is frozen until August.

The quickest route to Ghost Mountain follows directly up Forget-Me-Not Ridge and then a traverse where appropriate across the steep south face of the mountain to the saddle between Landslide Ridge and Carmine Valley. A short scramble up and thence northeast along an easy ridge to the summit.

The traverse from Ghost Mountain to Cornicularia Peak along Umbilicaria Ridge is exhilarating and instructive, but strenuous. The ridge is serrated and interrupted by several nasty cliffs and gendarmes, and the rock is extremely rotten. Traverses of Cetraria Ridge, Nation Peak, and Alectoria Ridge are also possible, with the same reservations. When in doubt follow the game trails. Flatiron Peak, Spumoni Ridge, and Purple Saxifrage Ridge did not appear to be safely accessible from this high ridge system. However, it is probably possible to do these crossovers from the opposite direction (i.e., climbing up, rather than down). In any case, ropes should be used.

Kettlehole Pass is a superb area. Bates Camp is a good base to work from (there are water, tent frames, a corral, a limited amount of firewood, hunters in season, and garbage of course), but there are several other good spots for a base camp. Hoodoo Valley (very nice), Hierochloe Peak, Marmot Peak, Solifluction Ridge, and Spermophilus Saddle are all easily accessible from Kettlehole Pass. Nation Peak may be easily climbed (in reasonable weather) from the pass via its southeastern ridge. Marmot Peak is best approached from the east along Solifluction Ridge and then in a loop from the south.

The trail through Danihue Pass is well defined. Very interesting country around Maternity Mountain, Potentilla Ridge, and upper Cullivan Creek may be attained by striking out straight up the mountainside from Danihue Pass to a saddle at the head of Maternity Creek. Sphinx Cirque is imposing but not

too interesting biologically.

It is possible to hike with a full pack from Gladys Lake to the lodge at Cold Fish Lake in one full day. The preferred route is via Kettlehole and Danihue passes, but the route down Connector Creek and up the northeast side of Cold Fish Lake is probably quicker.

A side trail from Kettlehole Pass crosses the northeastern foot of Solifluction Ridge and drops down to Landslide (Connors) Creek near its confluence with Phoebe Creek. There are routes up Phoebe, Rosy Finch, and Shintangle creeks, but none are easy going. A game trail continues along upper Landslide creek through Ungulate Valley, but it is intermittent, wet, and brushy.

The high ridge system between Moss Campion Mountain and Marmot Peak can be traversed with care but is a stiff hike from any reasonable base camp within the reserve. These boundary peaks and divides would perhaps be best explored from the south, using Waterfall Camp as a base.

From Gladys Lake, Fossil Flats should be approached via Rangifer Ridge (Cliff Mountain). Follow the game trails at high elevations. Oreamnos Ridge provides a reasonable approach along the ridge west of Oreamnos Creek. Another approach is via Castor (McMillan) Creek, diagonally up to Ursus Cirque, thence to Ursus Pass. Kobresia Ridge offers a pleasant crossing from the pass to the Flats. Fossil Flats and Ovis Ridge are separated by cliffs that require dangerous free climbing or artificial aid. Alces Ridge (Shady Mountain) is an indirect and much too difficult route.

Billygoat Notch is a broad, pleasant ridgewalk from Ursus Pass along Festuca Ridge. McMillan Mountain blocks further progress southwest.

McMillan Camp is a good base for exploring the upper Castor Creek drainage. There is a horse trail to the height of land near Brimful Lake, and beyond. Beverly Lake, Weathermaker Glacier, and other glaciers and peaks to

the south can be reached from the camp.

Ursus Cirque and the south slopes of Festuca and Alces ridges are all approachable from Castor Creek Valley.

Mount Will can be climbed fairly easily from the southwest, along Dwarf Willow Ridge. The final 300 m are unpleasant talus and scree, and the summit cliffs can be tricky, but in good weather the climb is quite enjoyable. It is possible to ascend Mount Will from the Gladys Lake cabin and return in one long day. Stark Cirque and Grim Ridge should be avoided. The icefields and peaks south from Mount Will are also for mountaineers only.

The trail along Castor Creek from below Stark Cirque to McMillan Camp may be difficult to follow, in part because of recent beaver activity along that stretch.

There is an intermittent trail from Gladys Lake up Connector Creek to Rosie Lake, and it carries on to the snout of the Mère Glacier. A team equipped for glacier travel could hike up the glacier to the divide. An alternative route is to ascend gentle Flower Ridge from the north and ridge hike to Austere Glacier and beyond.

The southeastern corner of the ecoreserve can be profitably explored from an old base camp in Salix Valley near the foot of Rust Bluff. Nival Ridge is a reasonable traverse. However, the terrain around Spatsizi Mountain is extremely rugged and makes for slow going. In fact, the whole ridge system from Sanctuary Pass southeast to Spatsizi Mountain is serrated, with tiring and often dangerous ups and downs, and very rotten rocks. We did not explore the side valleys dropping down to the Spatsizi River.

There is an intermittent trail along most of the length of Salix Creek, and a sidehill route paralleling this at about 1700-1800 m on the southwest flanks of Thamnolia and Fissile ridges.

Sanctuary Pass is another very attractive and interesting alpine valley. It is possible to scale the Ochre Cliffs and climb to the summit of Sanctuary Ridge directly from Gladys Lake. But it is easier and more instructive to come up from the northeastern end of Sanctuary Pass, gain the spine of Sanctuary Ridge, and then follow the ridge southwest to its summit. The Ochre Cliffs are girdled by a very interesting game trail that contours around the cliffs at about 1750 m.

Mink Creek is best forded just at the outlet of Cold Fish Lake, where a lagoon narrows and the current quickens. This is the standard horse crossing as well. Normal water is waist deep, and not dangerously fast. At high water, this crossing must be swum or rafted. A boat here would be most useful.

Wheatear Ridge may be fairly quickly gained from Rainbow Cabin via the Kestrel Crags and Oxytropis Ridge. Once on top, there are numerous routes to follow. Rainbow Cabin is dry, spacious, and has a stove - or at least it did in 1975.

To get to upper Marion Creek from Gladys Lake, it is best to go up over the top of Rainbow Mountain or Wheatear Ridge to Kliweguh Creek and Cache Creek Camp. From this camp a trail goes up Purple Daisy Ridge, over the divide, and down into the Marion Creek drainage.

Fig. 3. View from Spatsizi (Red Goat) Mountain northwest over the meandering Spatsizi River to the Spatsizi Plateau in the distance. The river was in flood here in early July, 1975.

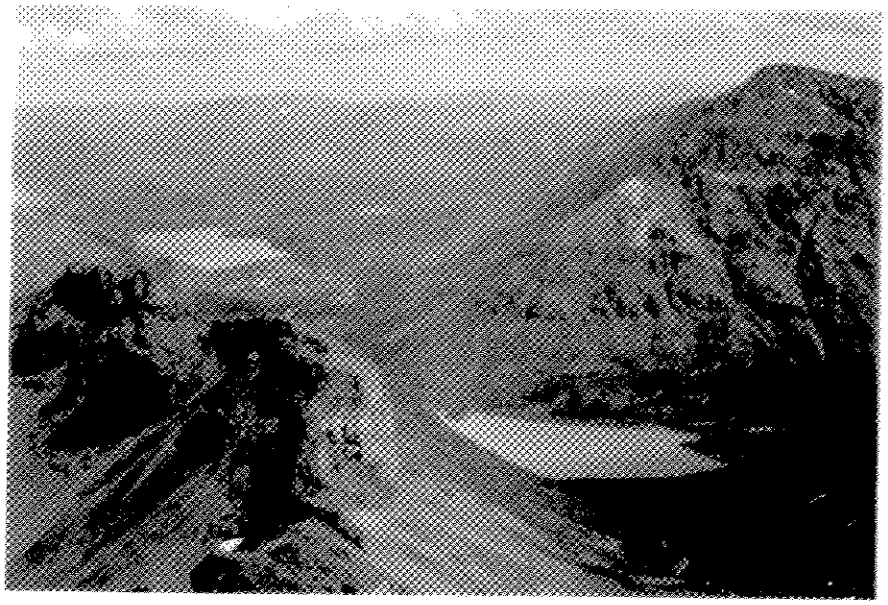


Fig. 4. View northwest from Fossil Flats over Gladys Lake and Cold Fish Lake to the Spatsizi Plateau. Ovis Ridge is in the left foreground, and the Ochre Cliffs and Sanctuary Ridge rise from the west shore of Gladys Lake.

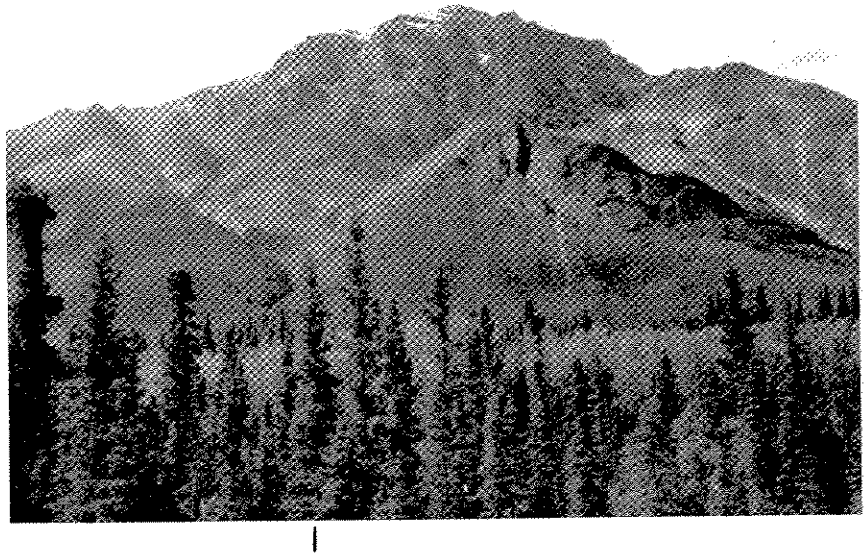


Fig. 5. The south face of Ghost Mountain (2320 m high) from near Gladys Lake. Ghost Mountain has small patches of prime mountain sheep habitat, and provides the most important sheep winter range in the ecological reserve.

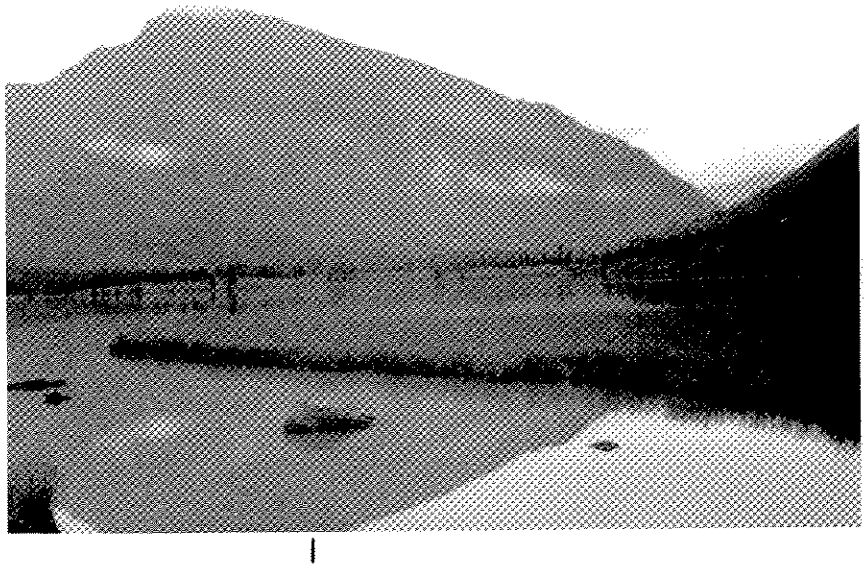


Fig. 6. Guardian (Lick) Mountain from the south end of Gladys Lake. Note the sedge fen in foreground.

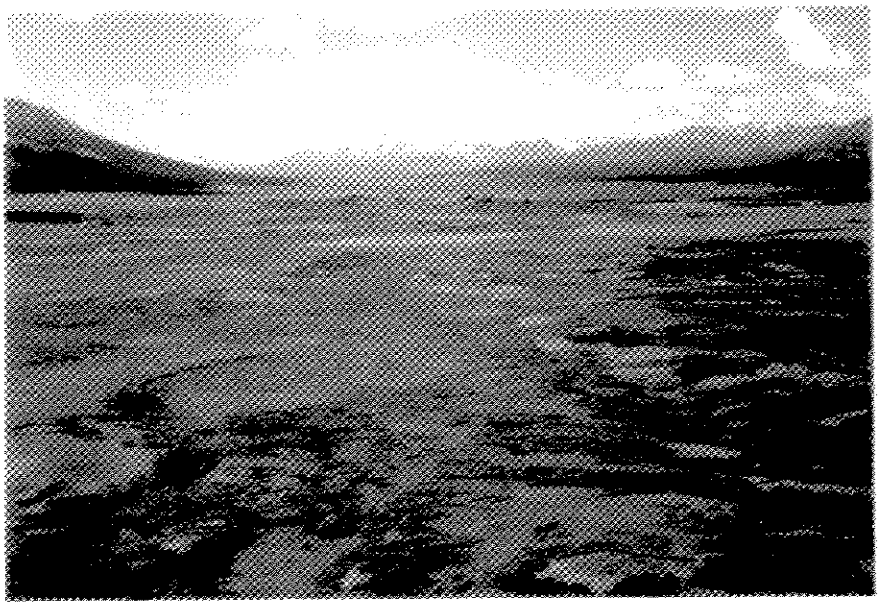


Fig. 7. Fire Flats, in the southwestern corner of Spatsizi Plateau Wilderness Park. Such broad, till-filled, treeless valleys are typical of the Spatsizi area. The vegetation of the valley floor (ca 1225 m) is a mosaic of willow and dwarf birch thickets, *Festuca altaica* subalpine grassland, and willow-sedge fens.

Fig. 8. View from hunting camp southeast down Cold Fish Lake. The boundary of the ecological reserve runs along the eastern shore of the lake. The prominent ridge in centre background is Raptor Ridge of Guardian (Lick) Mountain.

Fig. 9. Mère Glacier, part of the Mount Will icefield along the southern boundary of the ecological reserve. The high point is an unnamed 2400 m peak southeast of Mount Will.

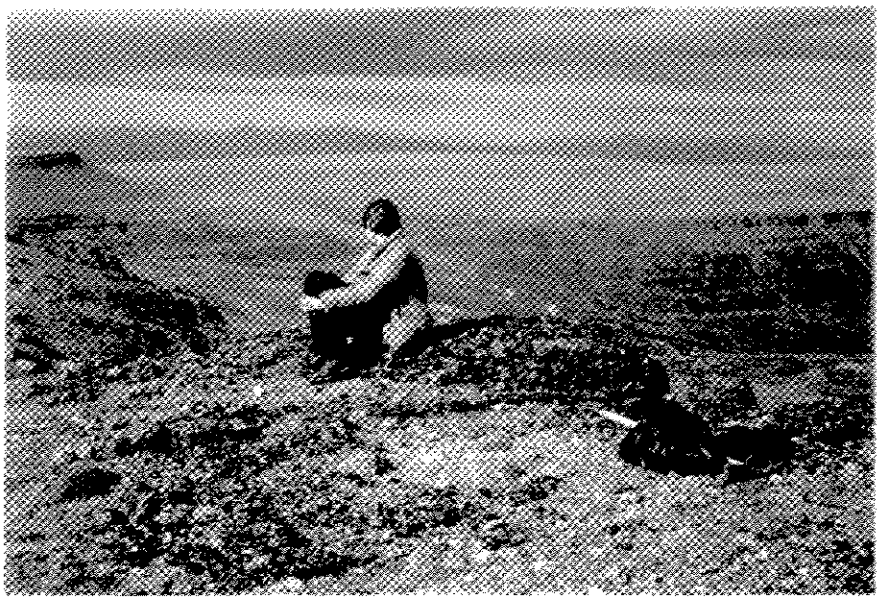


Fig. 10. Rimrock and rolling alplands (2000 m) on Lupus Ridge, Spatsizi Plateau, near the headwaters of Marion Creek.

Fig. 11. Fossil Flats from Draba Peak. Alpine fellfield and a thin skiff of dwarf willow tundra cover this broad 2200 m high ridge. Scattered Osborn caribou were sighted here fairly frequently in summer 1975.

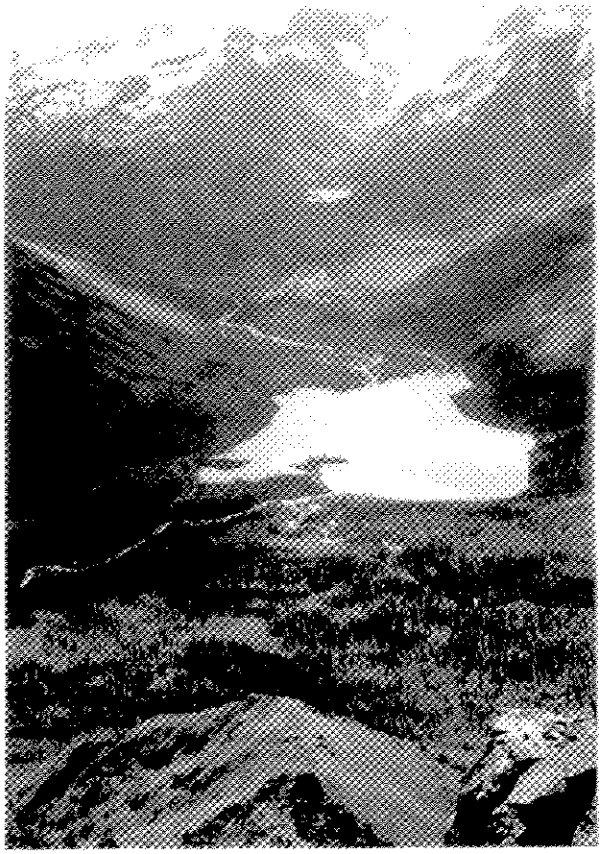


Fig. 12. Gladys Lake from the summit of Ghost Mountain. Rosie Lake and Mère Glacier in the distance. Note grassy sheep range on south-facing Forget-Me-Not Ridge in foreground.

Fig. 13. Sphinx Cirque and the Nation Peak massif from Danihue Pass, late June, 1975. Note the pronounced kettle-kame topography in foreground. The snow-filled basins melt out to kettlehole ponds.

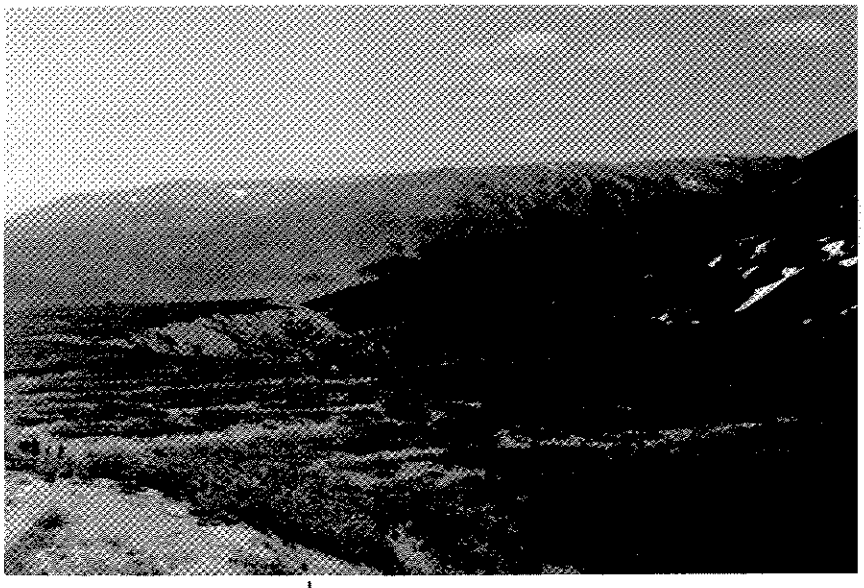


Fig. 14. Northeast from Danihue Pass (1650 m) to the Spatsizi Plateau. The kame terraces are covered with dwarf birch thickets.

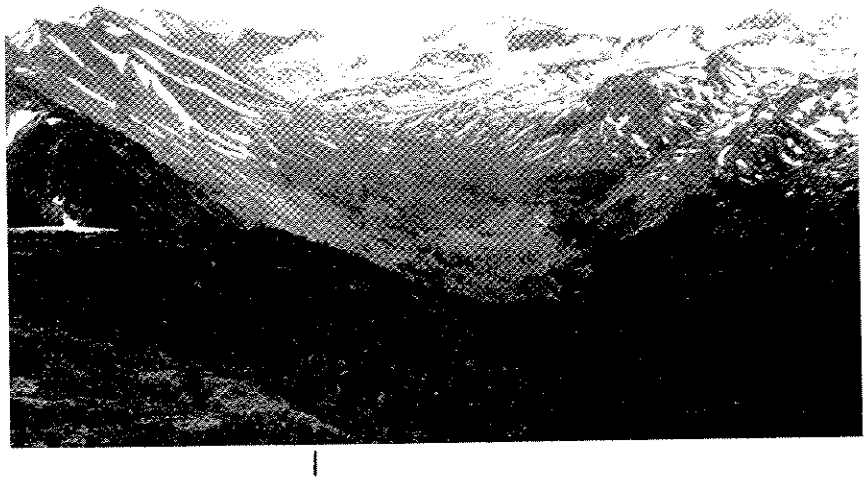


Fig. 15. Upper Salix Creek and Nival Ridge in the southeastern section of the ecological reserve, from the summit of Sanctuary Ridge. The distant ridges all crest at 2100-2200 m.

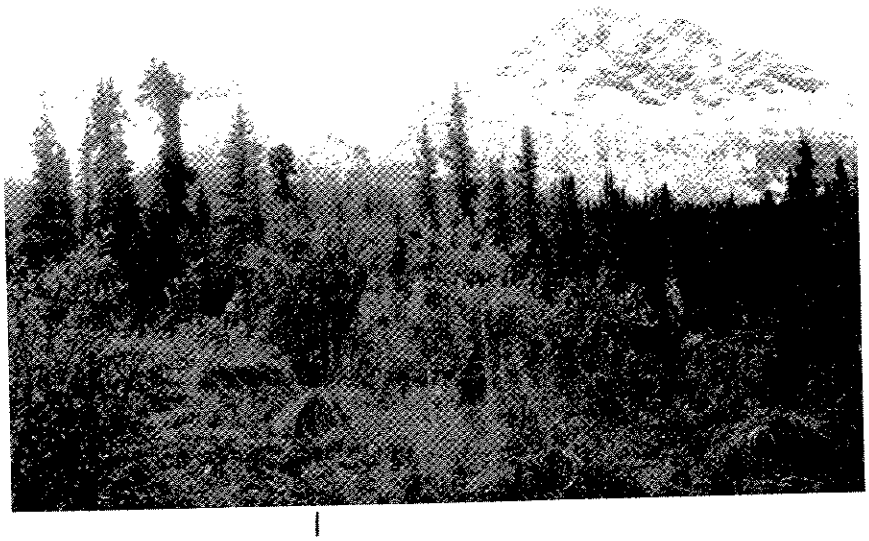


Fig. 16. Fresh snow down to 1300 m on Ghost Mountain, July 28, 1975.

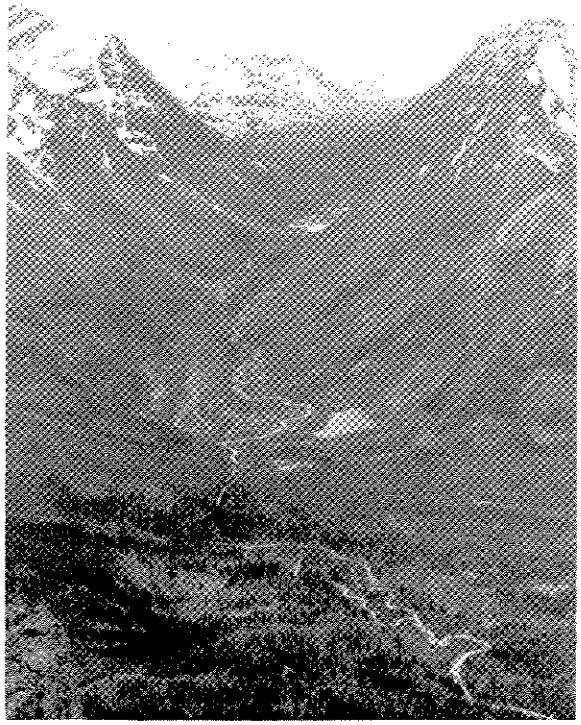


Fig. 17. Southwest from Sanctuary Ridge up Castor Creek valley. Castor Lake lies at the foot of Alces Ridge (on the right).

Fig. 18. Nation Peak (2350 m) from Kettlehole Pass (1600 m), July 1, 1975. Note seepage/streambank vegetation in foreground, light patches of *Festuca altaica* grassland, darker thickets of dwarf birch, and skirt of *Abies lasiocarpa* on the lower flanks of the mountain.

Fig. 19. Snowy Marmot Peak and Solifluction Ridge (on left) from Kettlehole Pass, July 1, 1975.

Fig. 20. View southwest down upper Eaglenest Creek from the base of Nation Peak.

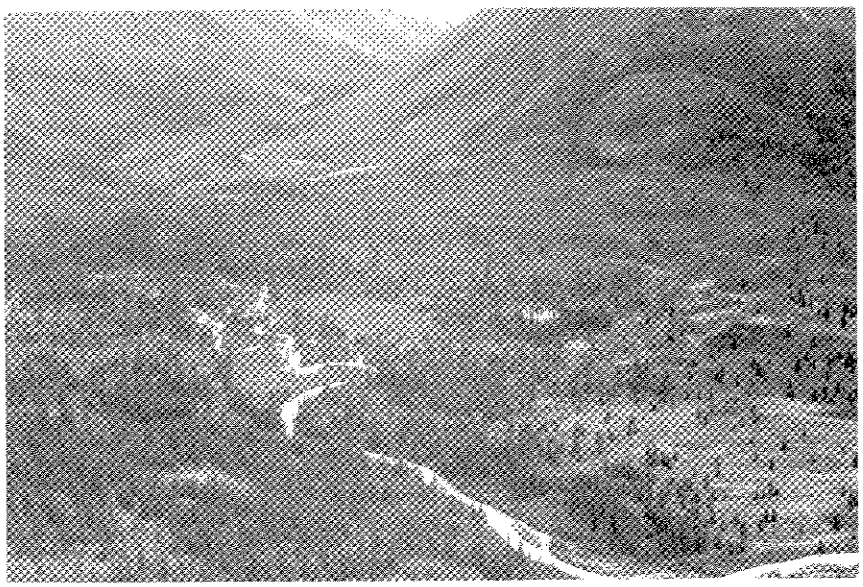


Fig. 21. Typical subalpine vegetation along Connector Creek south of Gladys Lake - the spruce-willow-birch zone (SWB).

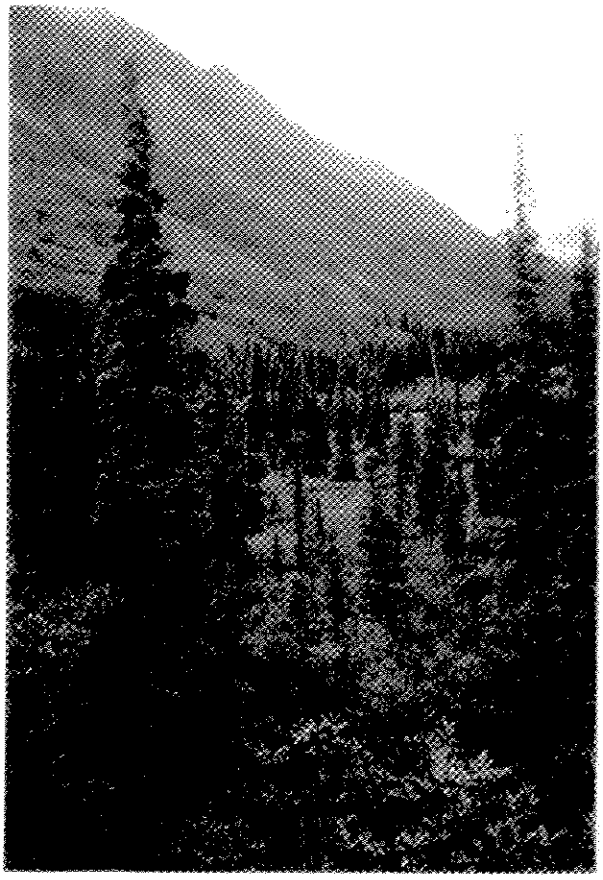


Fig. 22. *Picea glauca-Salix glauca-Betula glandulosa*-cryptogam community in the valley of lower Connector Creek. East flank of Guardian (Lick) Mountain in the background.

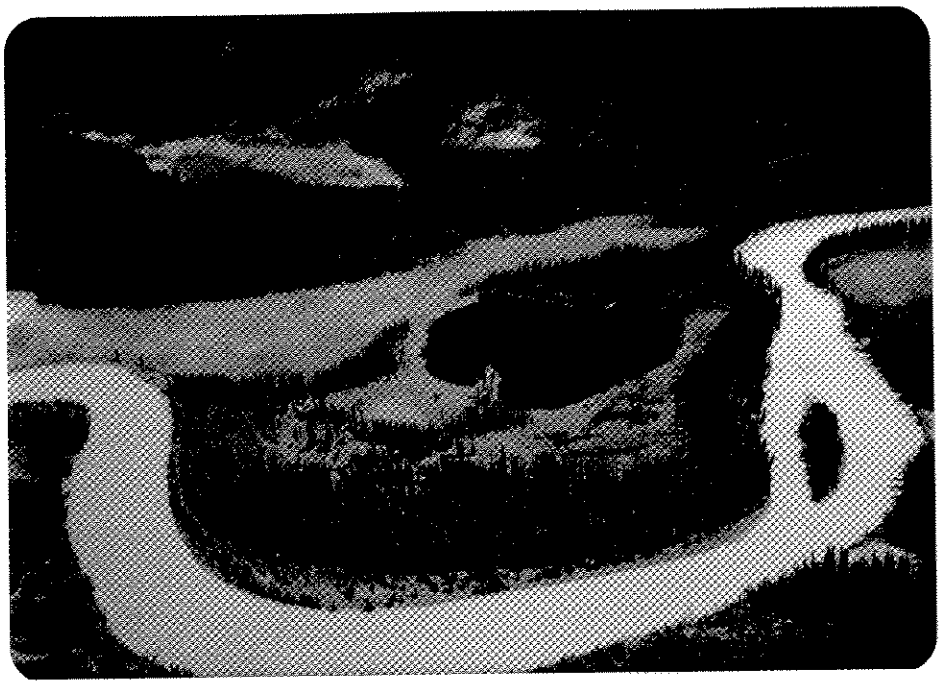


Fig. 23. An oxbow lake and the meandering Spatsizi - an excellent moose river - east of the Gladys Lake reserve. Note alluvial *Picea glauca* forest and *Carex* fen. July 8, 1975.

Fig. 24. *Splachnum luteum*, a coprophilous moss growing here on moose dung in a willow-sedge fen.

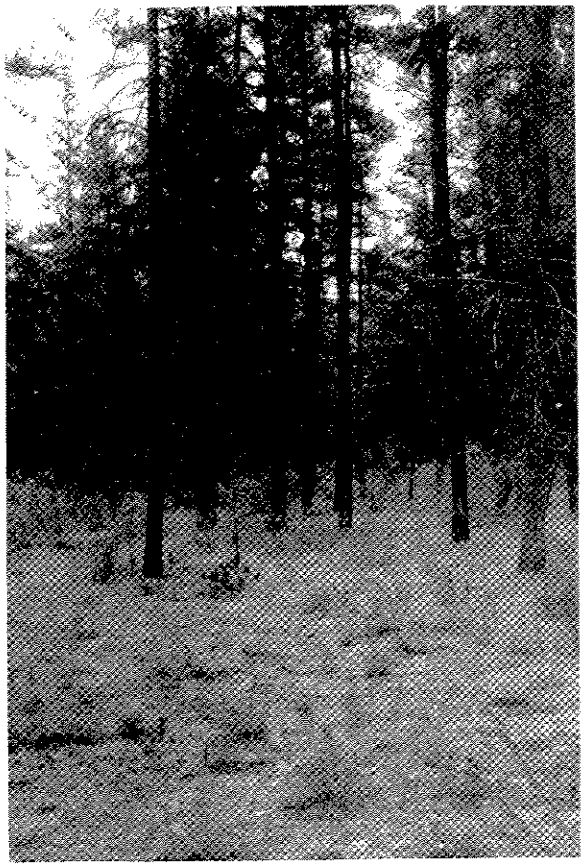


Fig. 25. *Pinus contorta-Betula glandulosa*-cryptogam community near the outlet of Cold Fish Lake.

Fig. 26. Species of *Cladonia* are common in lodgepole pine forest.

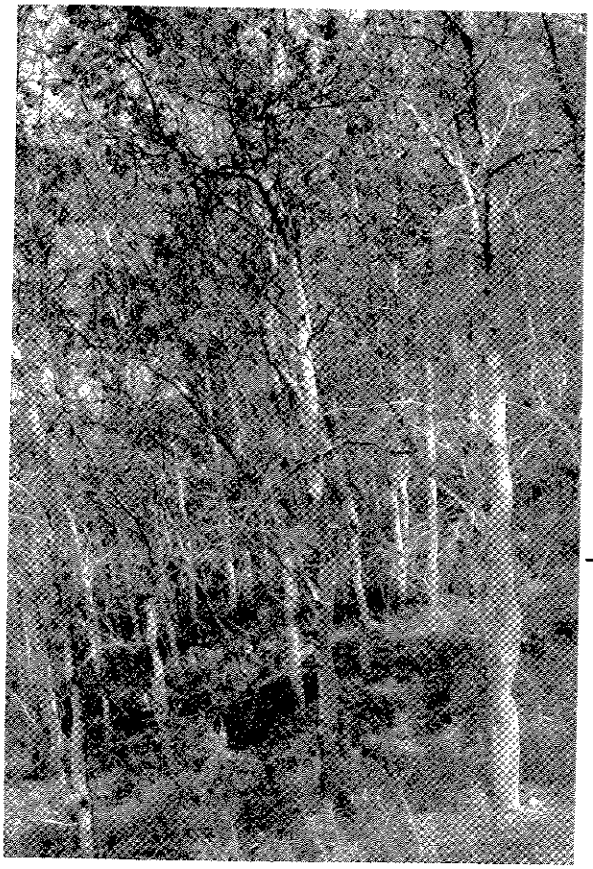


Fig. 27 & 28. *Populus tremuloides* stands above Gladys Lake at the base of Ochre Cliffs. *Juniperus communis*, *Epilobium angustifolium*, and *Festuca altaica* are evident in the dwarf shrub/herb stratum.

Fig. 29. *Populus tremuloides* "pygmy forest" on south facing slopes above the *Picea glauca*-feather moss community. The aspen here are about 3 m high. *Juniperus communis* is the dominant ground cover.

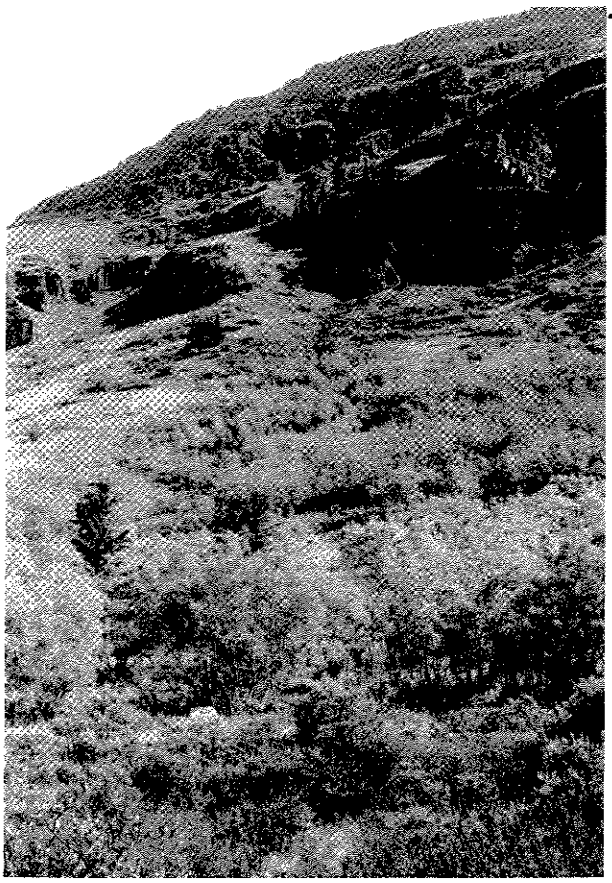


Fig. 30. *Salix scouleriana* tall willow scrub and (above) *Populus tremuloides* "pygmy forest" on southwest slope at base of Ochre Cliffs.

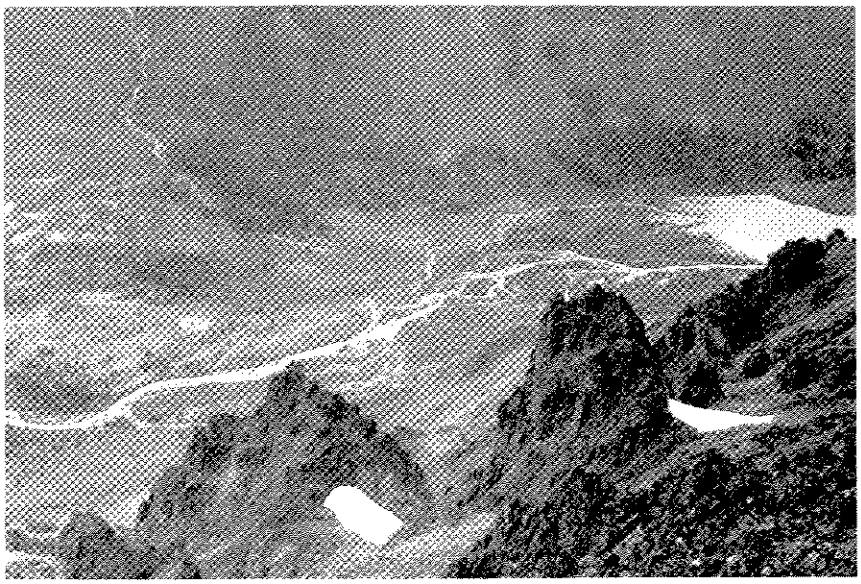


Fig. 31. Connector Creek and its delta on Gladys Lake, from the Ochre Cliffs. Various willow communities dominate the meander plain. Connector Creek is also a good moose stream, but on a much smaller scale than the Spatsizi River.

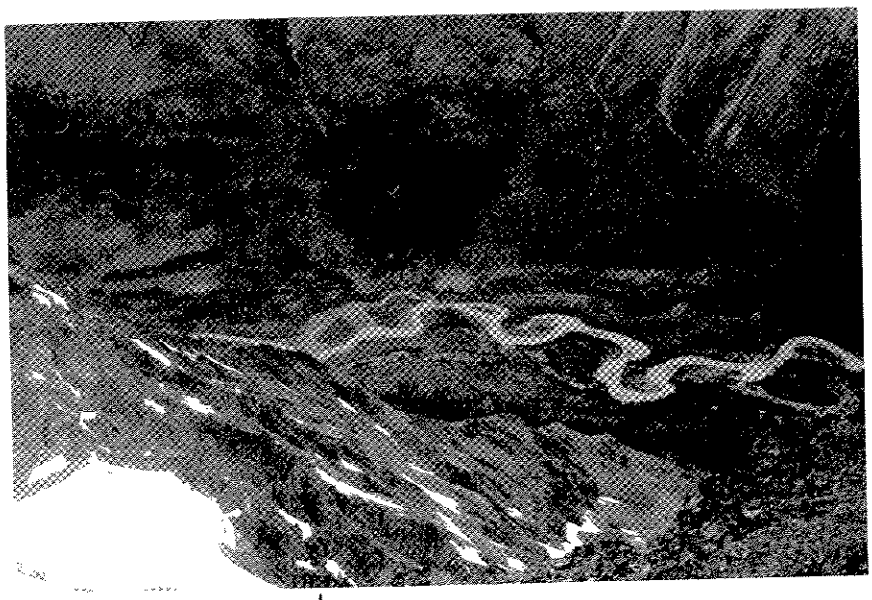


Fig. 32. Connector Creek below Gladys Lake, from Sanctuary Ridge. Note the wedge of *Picea glauca*-feather moss closed forest in the upper centre of the photograph.

Fig. 33. Fresh alluvium and various stages in the riparian willow thicket community along Connector Creek.

Fig. 34. Tree-size *Salix alaxensis* in riparian willow thicket along Castor Creek, below McMillan Camp. *S. alaxensis* is almost invariably heavily browsed by moose.

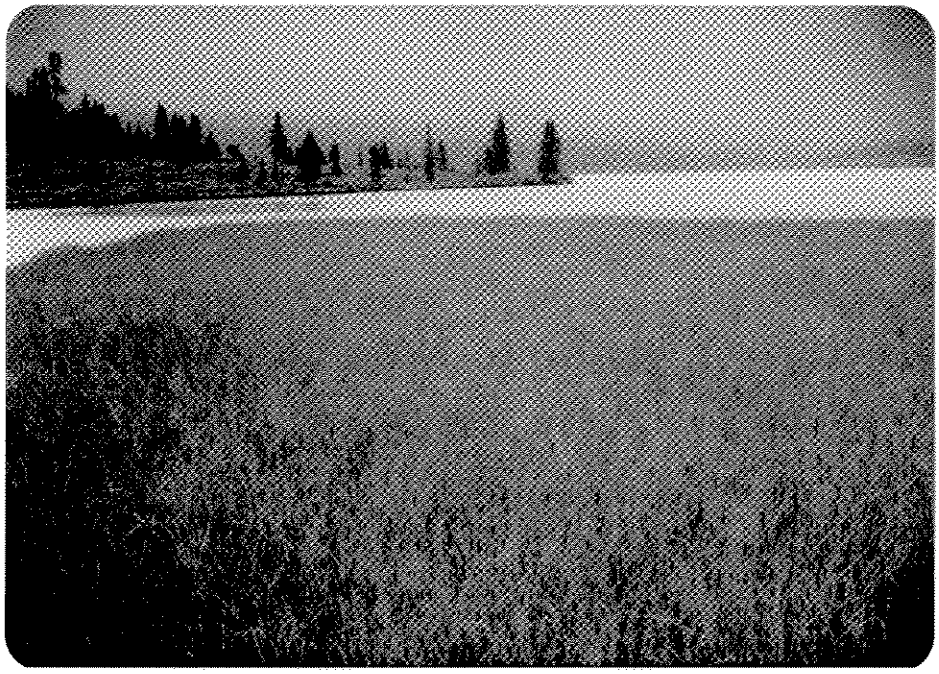


Fig. 35. *Carex (saxatilis, rostrata)* fen colonizing muddy flats at south end of Gladys Lake.

Fig. 36. A lens of *Carex aquatilis-Drepanocladus exannulatus* fen within the *(Picea glauca)-Salix barclayi-Betula glandulosa-Carex aquatilis*-moss fen type, along lower Connector Creek.

Fig. 37. View south from summit of Nation Peak over Kettlehole Pass and Bates Camp to Spermophilus Sadde, Aug. 13, 1975. Note the *Abies lasiocarpa* stands on the lower slopes (1550-1700 m) of the Saddle.

Fig. 38. Large patch of the foliose lichen *Nephroma arcticum* in the *Abies lasiocarpa-Betula glandulosa-Empetrum nigrum* community.

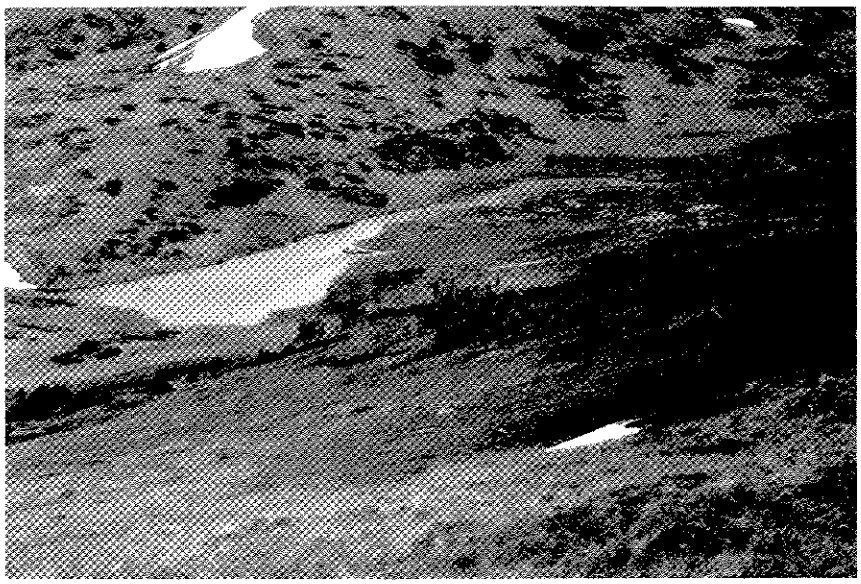


Fig. 39. Looking south over the northeast end of Sanctuary Pass. Note the *Abies lasiocarpa* krummholz running across the centre of the photograph. A patch of *Cassiope mertensiana* alpine heath occurs in the snow accumulation zone in the lee of the *Abies*.

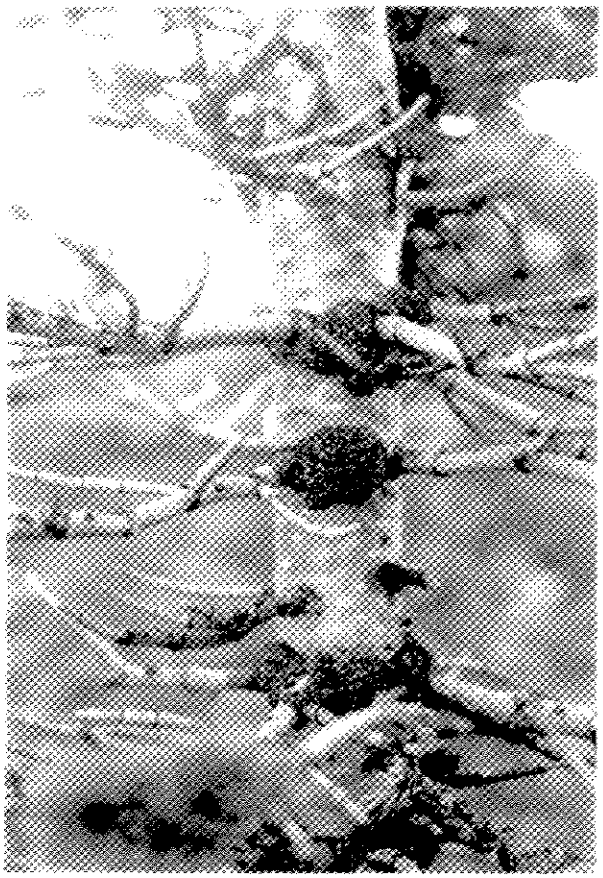


Fig. 40. Cushions of *Tholurna dissimilis*, a rare lichen, on the wind- and snow-blasted pole of an *Abies lasiocarpa* "flag" tree.

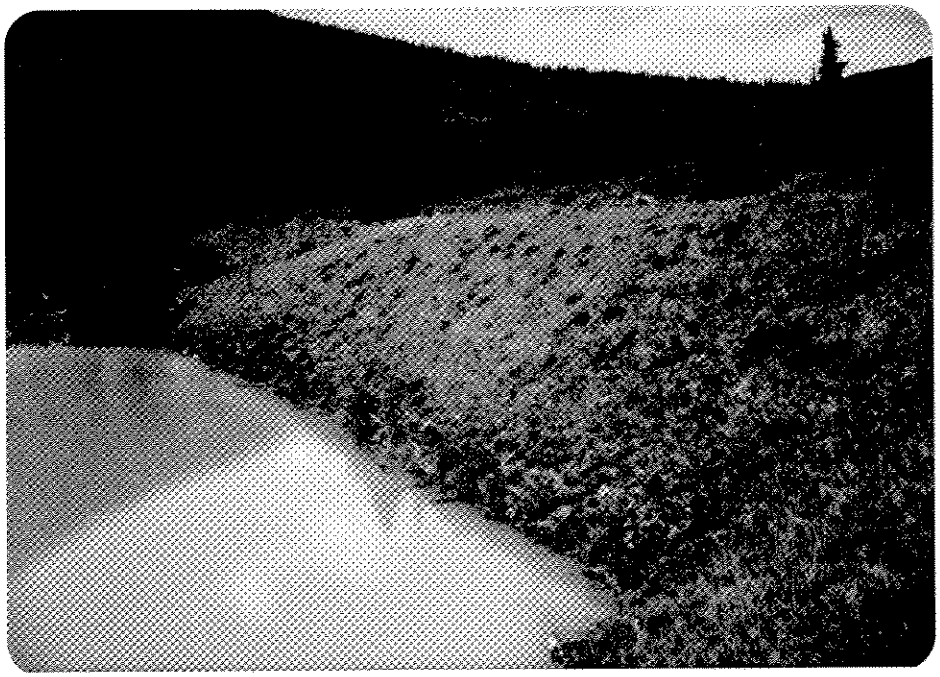


Fig. 41. Submesic *Festuca altaica* subalpine grassland on south-facing embankment of moraine damming Gladys Lake.

Fig. 42. Productive, mesic *Festuca altaica* subalpine grassland in Fire Flats.

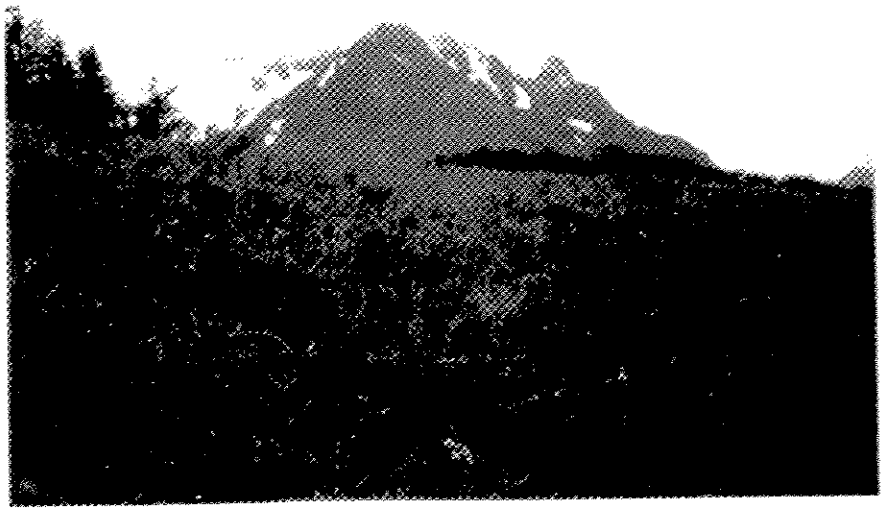


Fig. 43. Lush grass-forb subalpine meadow at 1600 m on Flower Ridge. Mount Will looms beyond. Discernible in this photograph are *Festuca altaica*, *Aconitum delphinifolium*, *Rumex acetosa*, and *Senecio triangularis*.

Fig. 44. *Heracleum lanatum-Epilobium angustifolium-Thalictrum occidentale* community on alluvial fan of Cow Parsnip Creek.

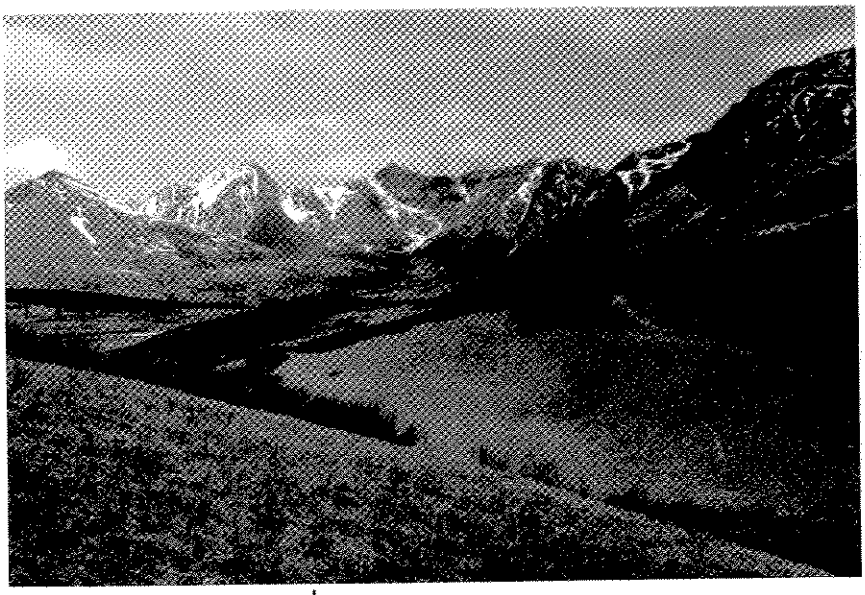


Fig. 45. *Festuca altaica* subalpine grassland and *Betula glandulosa* thickets on kames in Kettlehole Pass - looking west.

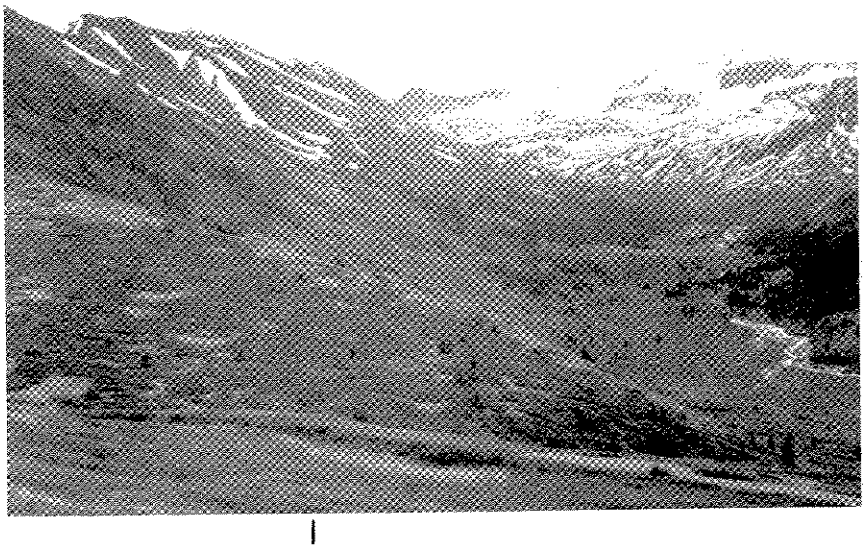


Fig. 46. Extensive dwarf birch thickets at the western entrance to Sanctuary Pass, and extensive willow thickets below in the valley of Salix Creek.

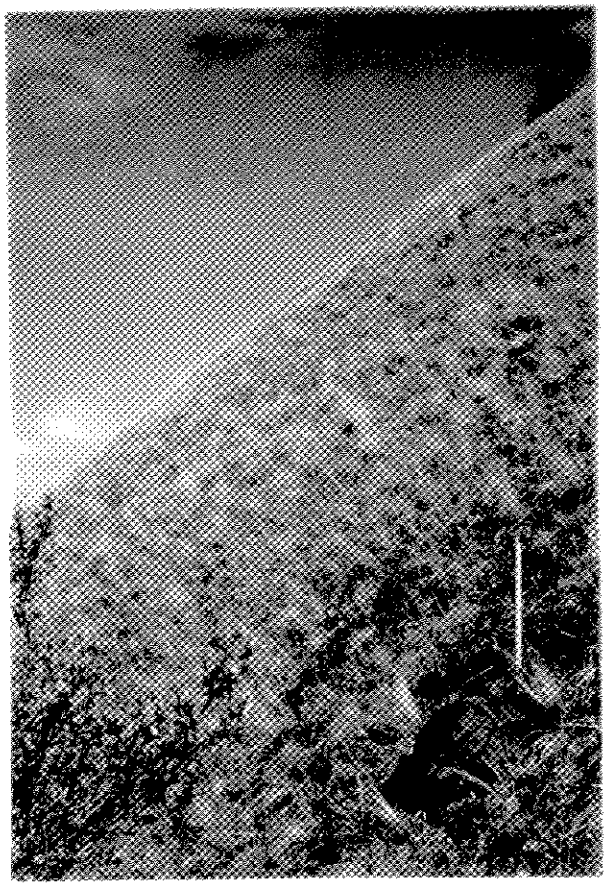


Fig. 47. *Poa glauca-Carex supina-Potentilla pensylvanica-Artemisia borealis* community at 1500 m on steep, convex, south-facing slope along Oxytropis Ridge.

Fig. 48. *Juniperus communis-Arctostaphylos uva-ursi*-grass community on stabilized colluvium at the toe of the landslide from the south face of Ghost Mountain.

Fig. 49. Talus-lichen-moss terrain unit at 1400 m below Alces Ridge, opposite Mount Will.

Fig. 50. Abundant cryptogams in the talus-lichen-moss terrain unit on the landslide at the foot of Ghost Mountain. *Cladina alpestris* is prominent, and other discernible species are *Stereocaulon saxatilis*, *Umbilicaria* spp., *Parmelia stygia*, *Rhacomitrium canescens* and *R. lanuginosum*.

Fig. 51. *Dryopteris fragrans* in the talus-lichen-moss terrain unit. This fern is along the southern margin of its range in the Spatsizi area.

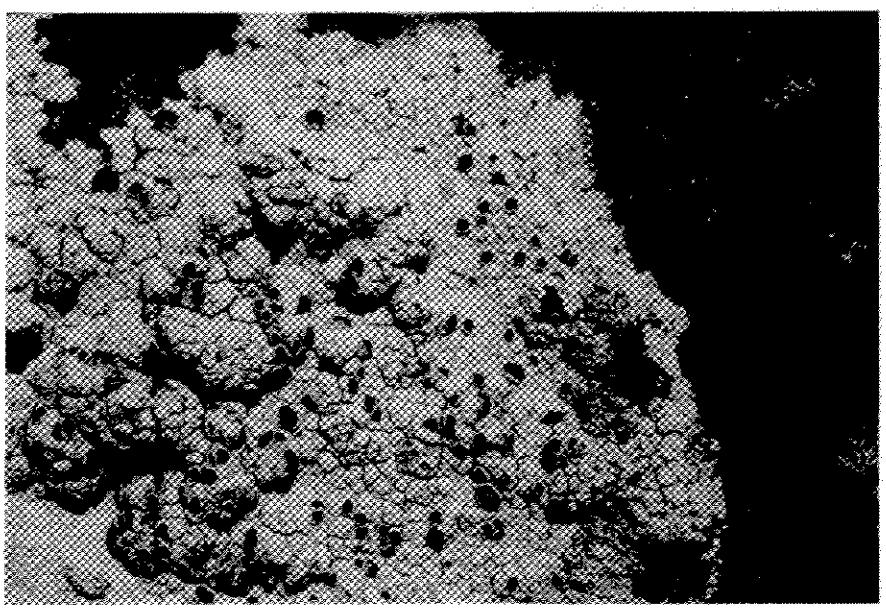


Fig. 52. *Haemotomma lapponicum* on rock in the talus-lichen-moss terrain unit.

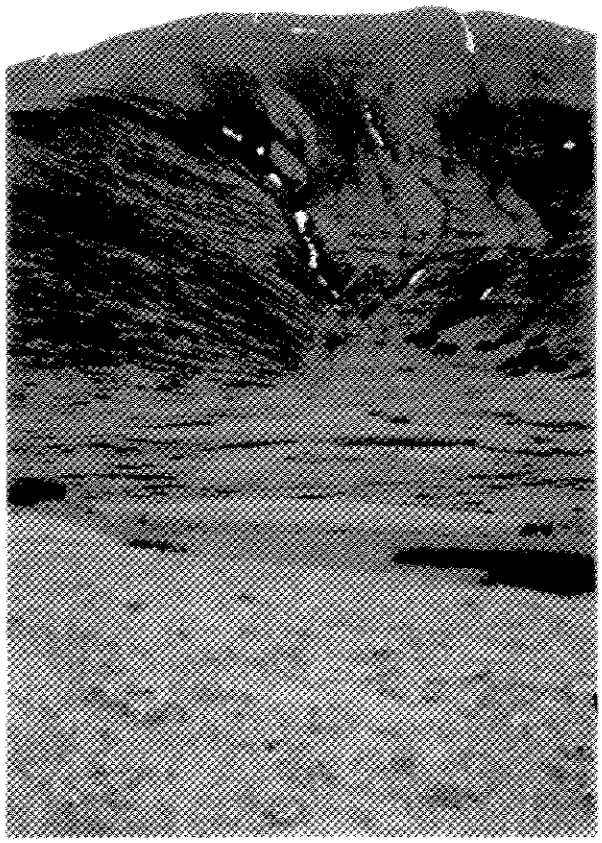


Fig. 53. The north face of Solifluction Ridge from Kettlehole Pass. *Festuca altaica*-lichen alpine tundra is in the foreground, the *Salix barrattiana* community is the bluish green patch in the middle, and *Cassiope tetragona-Dryas integrifolia-Salix reticulata* alpine heath is the brownish green vegetation on the slopes at the upper left.

Fig. 54. Mosaic of *Betula glandulosa* scrub and *Festuca altaica*-lichen alpine tundra at the western entrance to Sanctuary Pass. Fissile and Thamnolia ridges run off to the south.

Fig. 55. *Dactylina arctica*, an unusual lichen common in *Festuca altaica*--lichen alpine tundra.

Fig. 56. *Cetraria richardsonii*, a showy fruticose lichen rare in the ecological reserve, is shown here from *Festuca altaica*-lichen tundra.

Fig. 57. Alpine dome (1850 m) welling up from vast expanse of *Betula glandulosa* scrub on the Spatsizi Plateau, near the headwaters of Black Fox Creek. Fescue-lichen and dwarf willow tundra cover the top of the dome.

Fig. 58. Aerial view of Spatsizi Plateau mosaic of light-coloured fescue-lichen tundra, dark dwarf birch scrub, and yellow-green seepage vegetation.

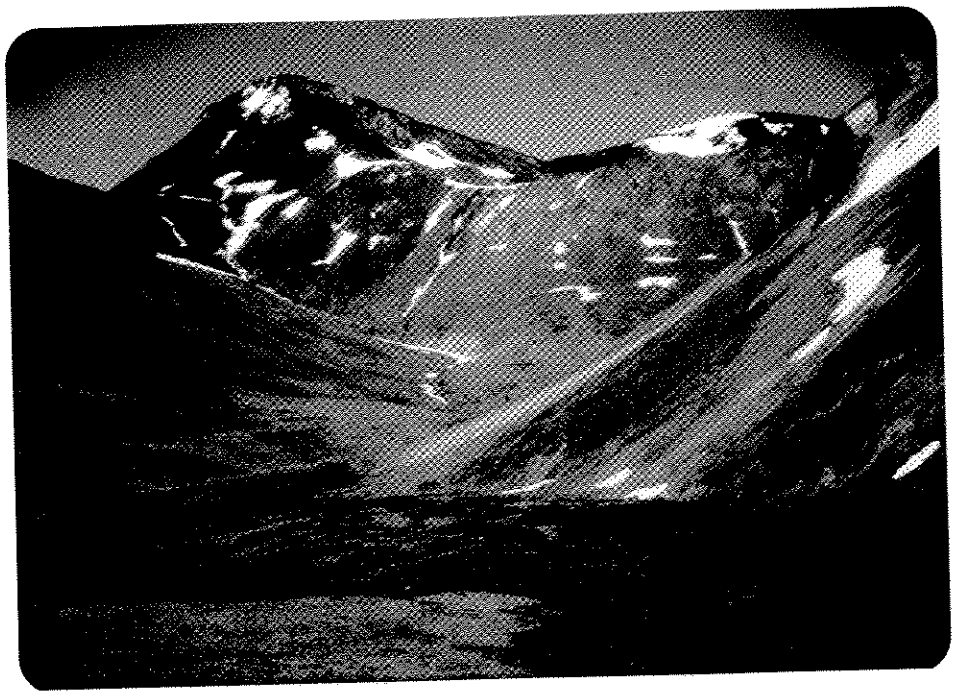


Fig. 59. Hoodoo Valley, dominated by 2300 m Cornicularia Peak. The dark vegetation in the foreground is wet *Salix barrattiana* thickets and dwarf willow-sedge-moss seepage vegetation.

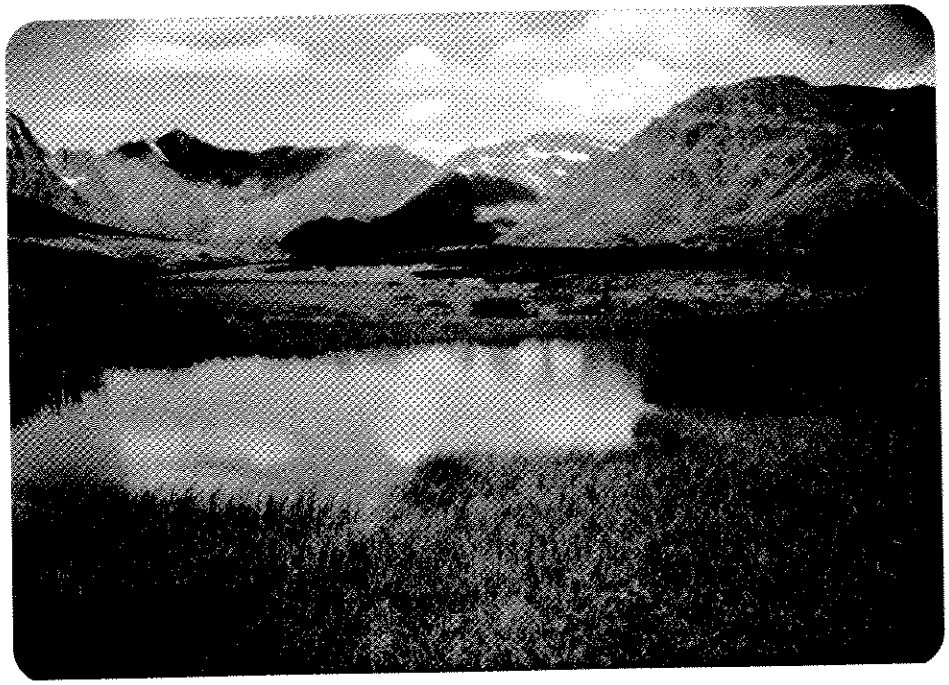


Fig. 60. Shallow pond in Kettlehole Pass rimmed by the *Salix reticulata-Carex aquatilis*-moss community, with *C. aquatilis* and *Eriophorum callitrix* colonizing the water's edge.

Fig. 61. *Cassiope tetragona-Dryas integrifolia-Salix (reticulata, polaris)-Distichium capillaceum* alpine heath on the northeast flank of Rangifer Ridge. *Cassiope tetragona* in flower.

Fig. 62. *Dryas integrifolia* in bloom.

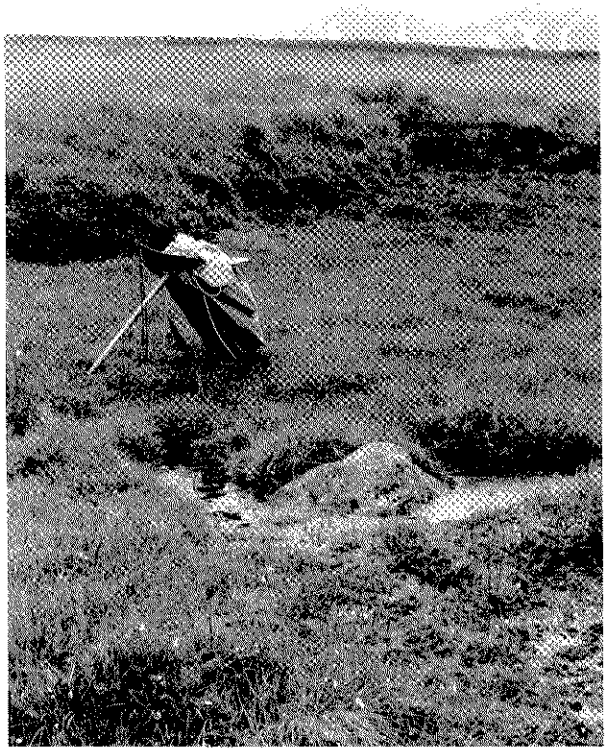


Fig. 63. Turfy alpine seepage vegetation on Maternity Mountain, dominated by *Carex podocarpa*, *C. lachenalii*, *Artemisia arctica*, and *Ranunculus eschscholtzii*. *Ranunculus sulphureus* was also seen.

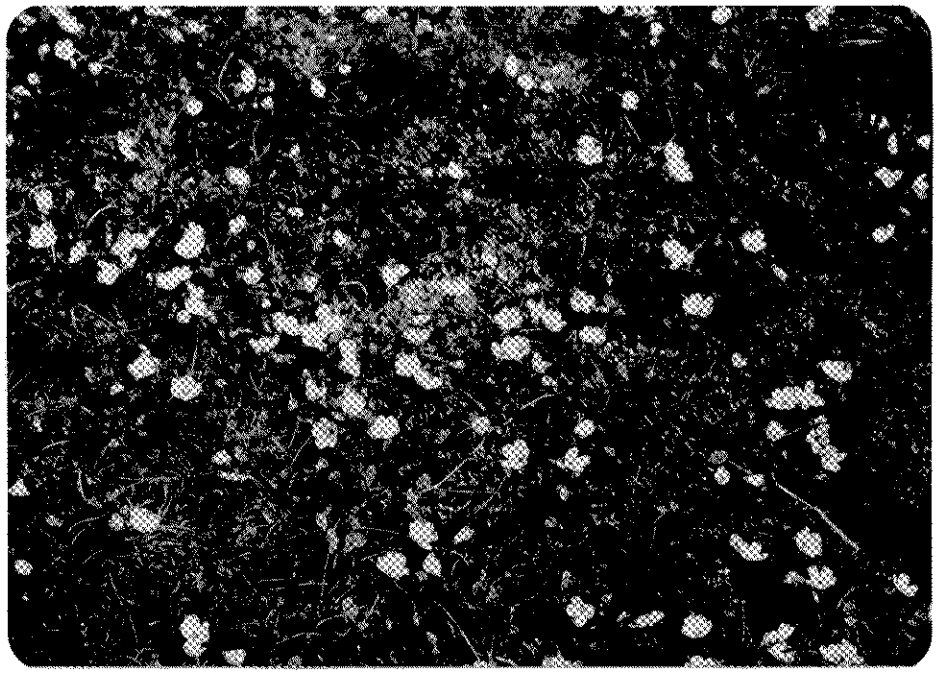


Fig. 64a.

Claytonia sarmentosa with *Tomenthypnum nitens* and *Hylocomium splendens* in an alpine seepage area.

Fig. 64b.

Arnica lessingii and *Oxyria digyna* in an alpine seepage area.

Fig. 65. *Corydalis pauciflora* in an alpine seepage area.

Fig. 66. Cushion plant tundra (*Dryas integrifolia-Oxytropis nigrescens-Silene acaulis*-lichen community) on Potentilla Ridge.

Fig. 67. *Potentilla uniflora* and *Silene acaulis* in cushion plant tundra.

Fig. 68. *Oxytropis huddelsonii*, a new species for British Columbia, in cushion plant tundra.

Fig. 69. *Saxifraga flagellaris* in cushion plant tundra.

Fig. 70. *Popaver radicatum* in cushion plant tundra. This arctic poppy is at the southern limit of its range in the Spatsizi area.

Fig. 71. *Salix (polaris, reticulata)-Carex microchaeta-Polytrichum piliferum-Cetraria nivalis* alpine tundra at 2000 m on Wolverine Ridge, Spatsizi Plateau. Note small human figure at far right centre

Fig. 72. The same, Aug. 15, 1975, with the already yellow leaves of *Salix reticulata* standing out.

Fig. 73. Permafrost underlying mossy seepage area in Marmot Cirque. Species of *Pohlia*, *Bryum*, and *Philonotis fontana* are among the mosses.

Fig. 74. Patterned ground in a wet depression at 2000 m on Lupus Ridge, Spatsizi Ridge.

Fig. 75. *Campanula lasiocarpa* in dwarf willow alpine tundra.

Fig. 76. Alpine fellfield at 2300 m on summit plateau of Ghost Mountain.

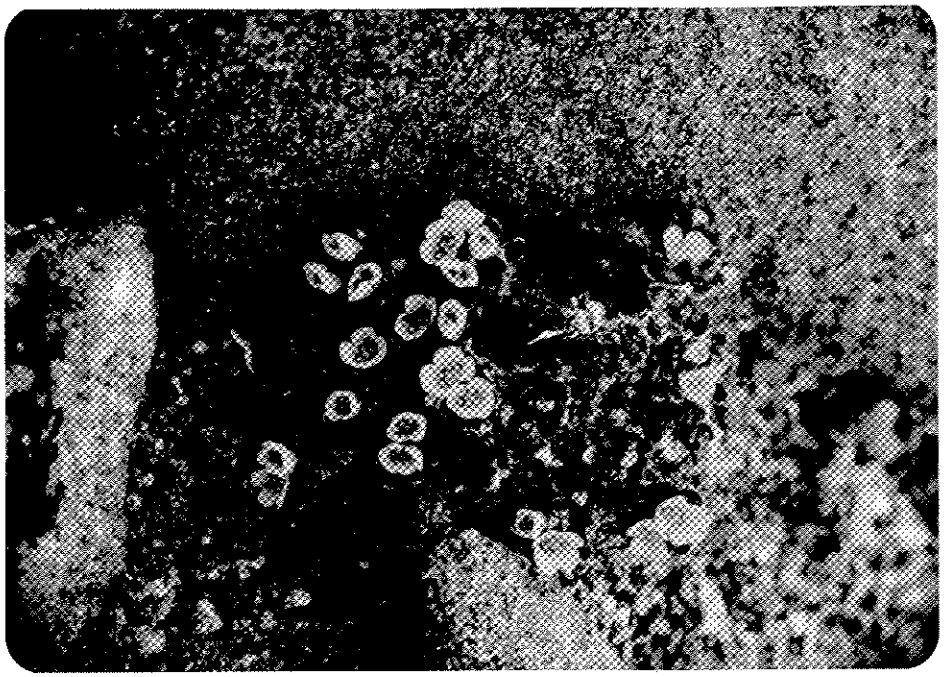


Fig. 77. *Draba alpina*, wedged between rocks in alpine fellfield.

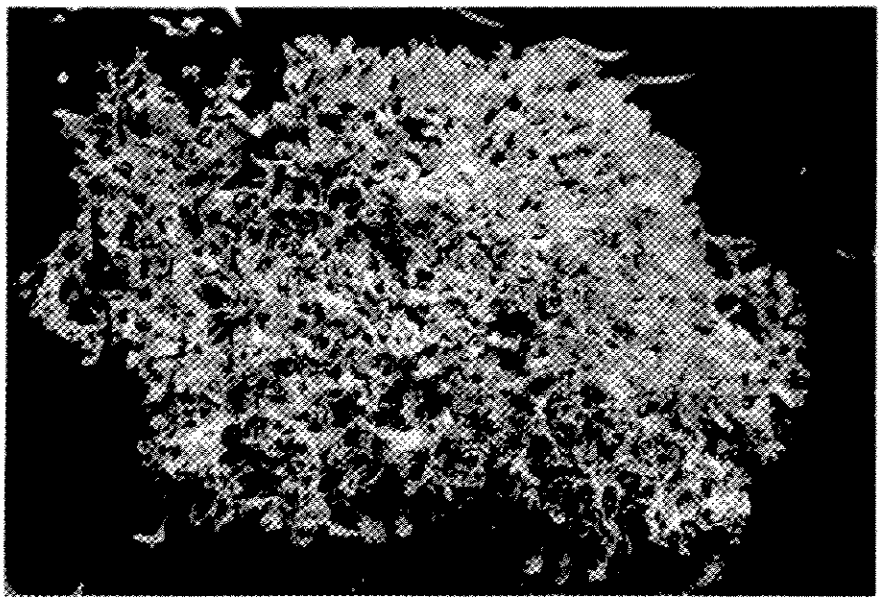


Fig. 78. *Cetraria tilesii*, a calcicolous fruticose lichen, from alpine fellfield on Fossil Flats.

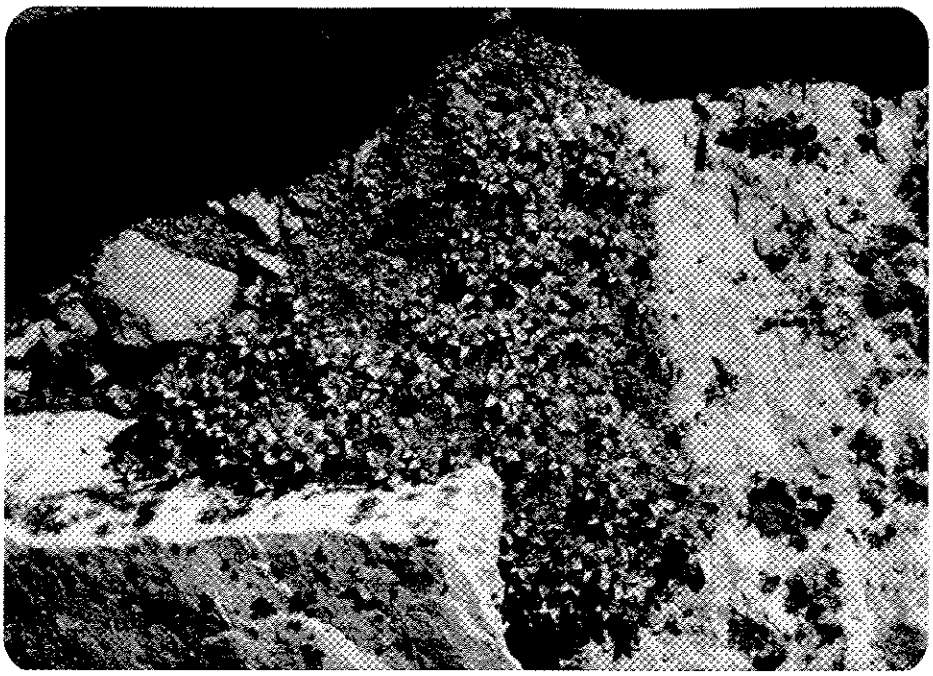


Fig. 79. *Saxifraga oppositifolia* in cliff crevice, Ghost Mountain.

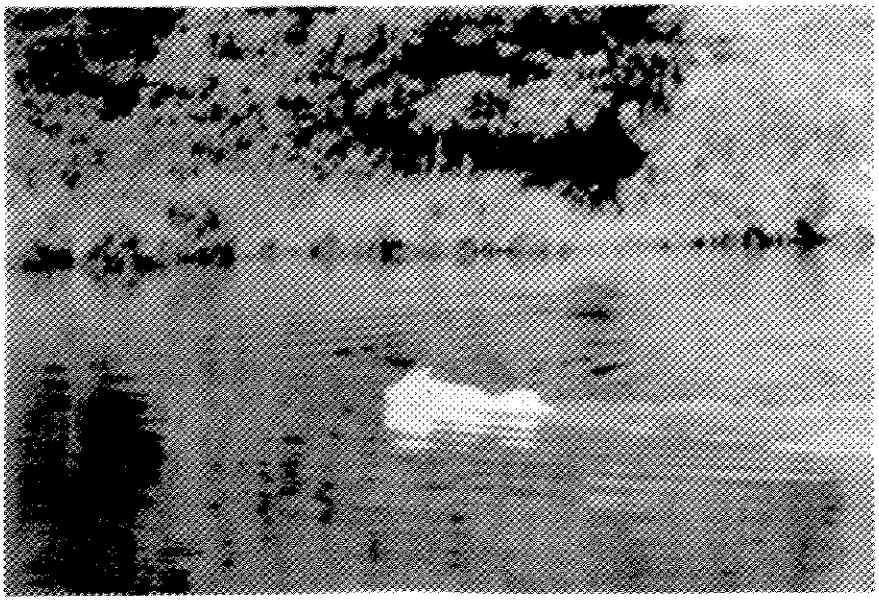


Fig. 80. Female goat swimming Mink Creek, late August, 1975. It had descended from Spatsizi Plateau and was heading toward Sanctuary Ridge.

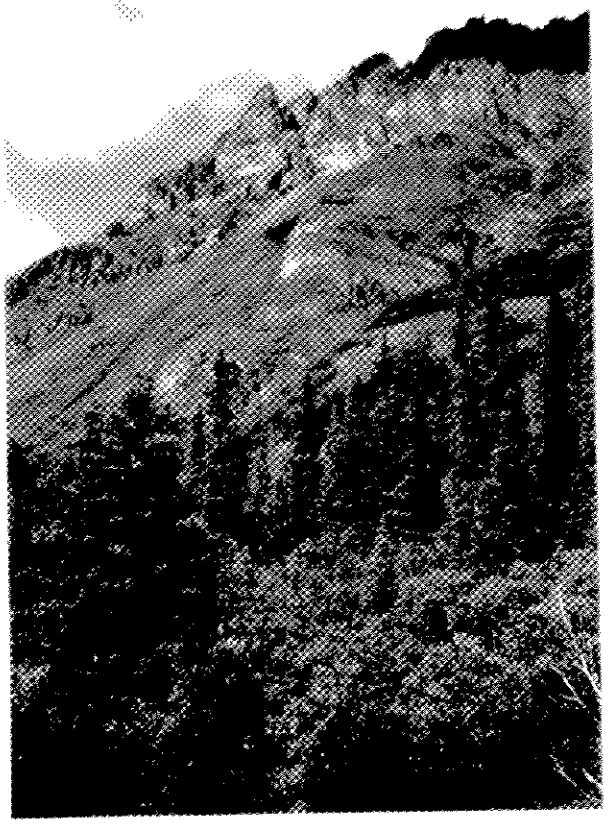


Fig. 81. Sheep and goat range on southwest-facing slopes of Sanctuary Ridge, below the Ochre Cliffs.

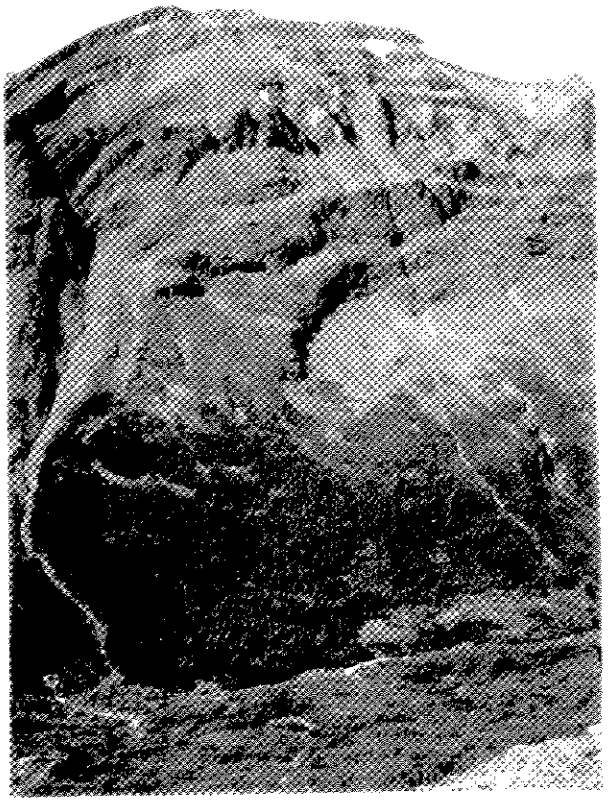


Fig. 82. Sheep and goat range on south face of Festuca Ridge, near McMillan Mountain.

Fig. 83. Sheep/goat "saddle" (feeding, resting, and viewing area) near summit of Sanctuary Ridge, overlooking Sanctuary Pass. Note the extensive view available from this small knob.

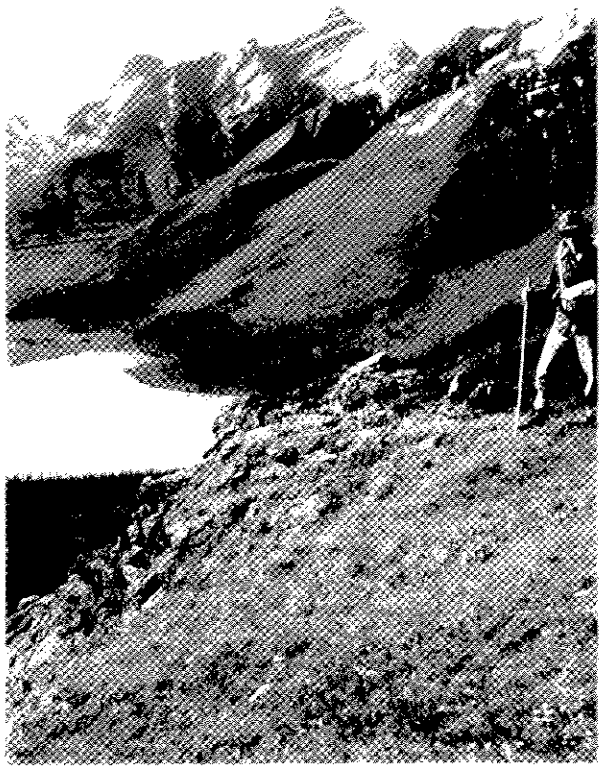


Fig. 84. Sheep/goat "saddle" on Forget-Me-Not Ridge, Ghost Mountain. Gladys Lake and Mount Will in the distance Saddle vegetation belongs to the *Poa rupicola-Trisetum spicatum-Hierochloe alpina-Potentilla nivea* community type.

Fig. 85. Abundant scat on sheep/goat saddle, Ovis Ridge.

Fig. 86. 13 mountain goats (8 females, 5 immatures) on the western flank of Fossil Flats, July 10, 1975.

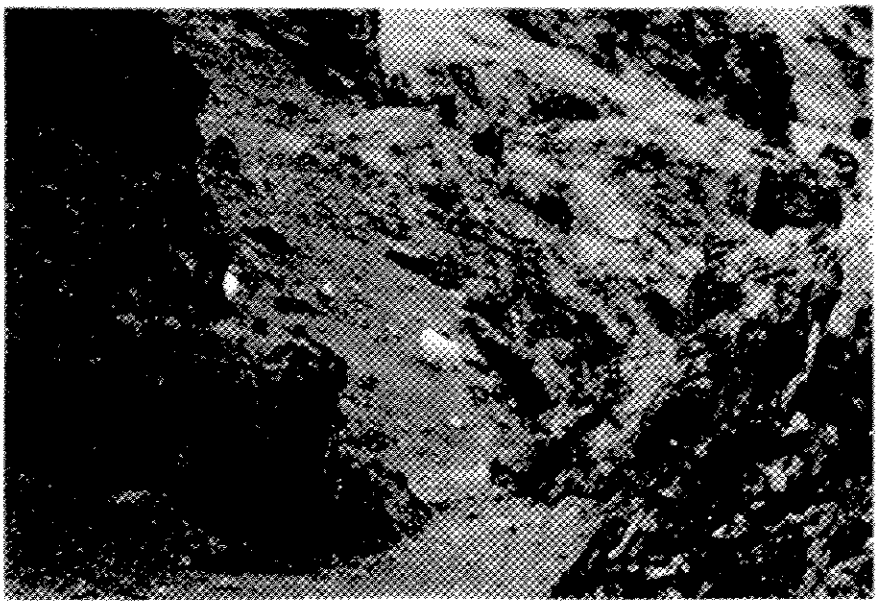


Fig. 87. Lone billygoat among the Ochre Cliffs.

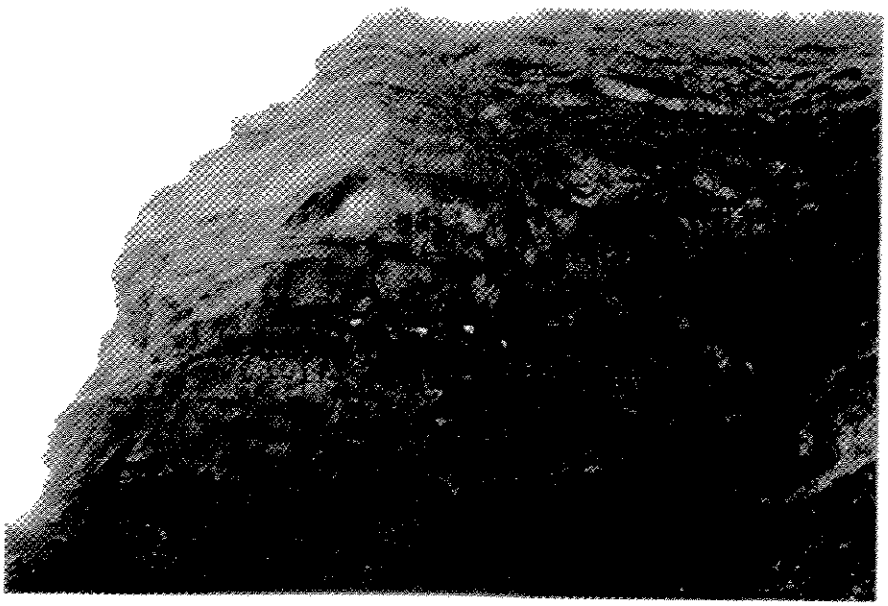


Fig. 88. Four goats on prototypical escape terrain in the Eaglenest Range. Photograph W. G. Hazelwood.

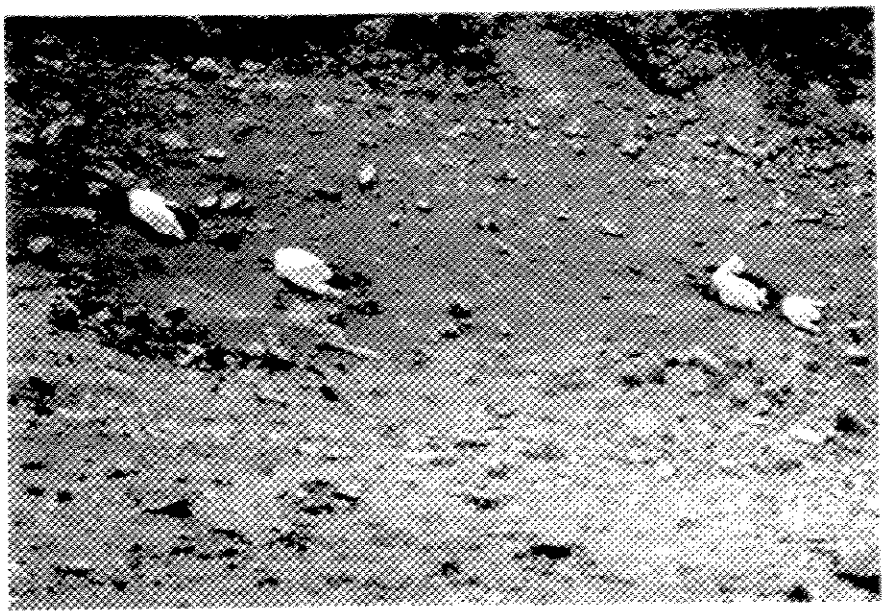


Fig. 89. Goats bedding in gravelly scree on Festuca Ridge. Such scree is cool and moist beneath the dry surface. The temperature was relatively high (19°C) on this day.

Fig. 90. Goat erosion site on Ghost Mountain. Note the fleece rubbed off against the exposed sod.

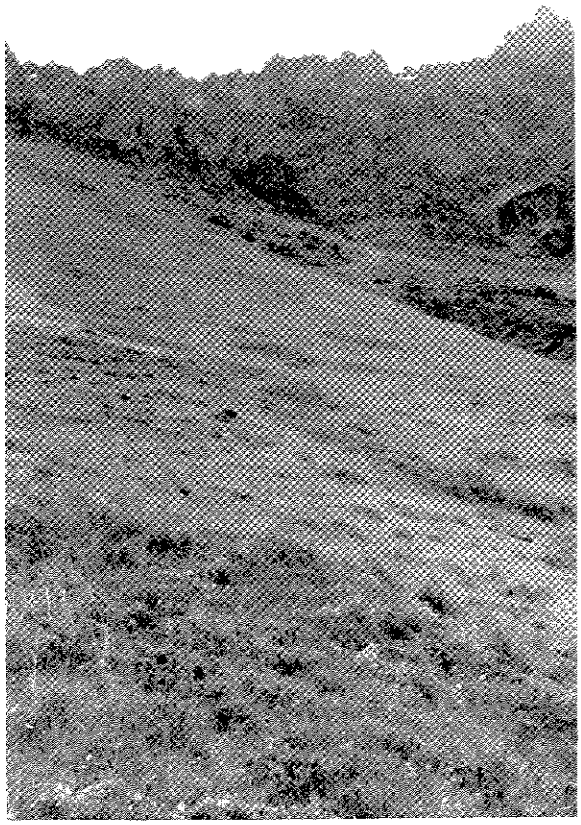


Fig. 91. Good sheep winter range (*Poa glauca-Carex supina-Potentilla pensylvanica-Artemisia borealis* community) on SSW-facing slope beneath the Ochre Cliffs, Sanctuary Ridge.

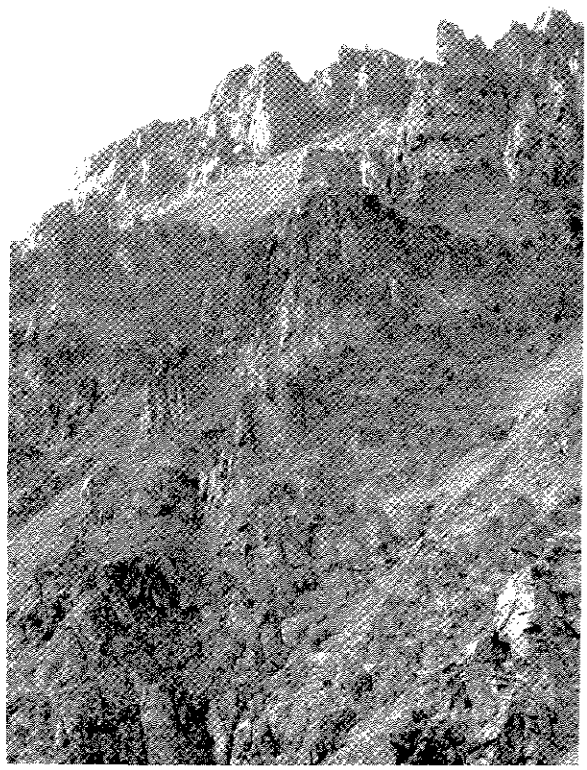


Fig. 92. The Ochre Cliffs provide excellent escape terrain for mountain sheep and goats.

Fig. 93. Stone sheep ewe and lamb calmly "escaping" from observer on Ochre Cliffs. Flower Ridge in the distance on right.

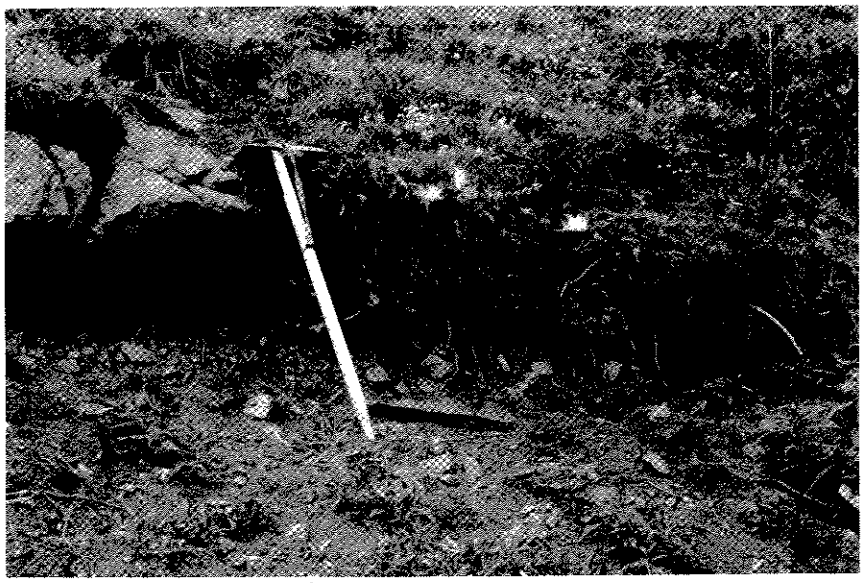


Fig. 94. Sheep erosion site or rub crater on grassy slopes beneath the Ochre Cliffs.

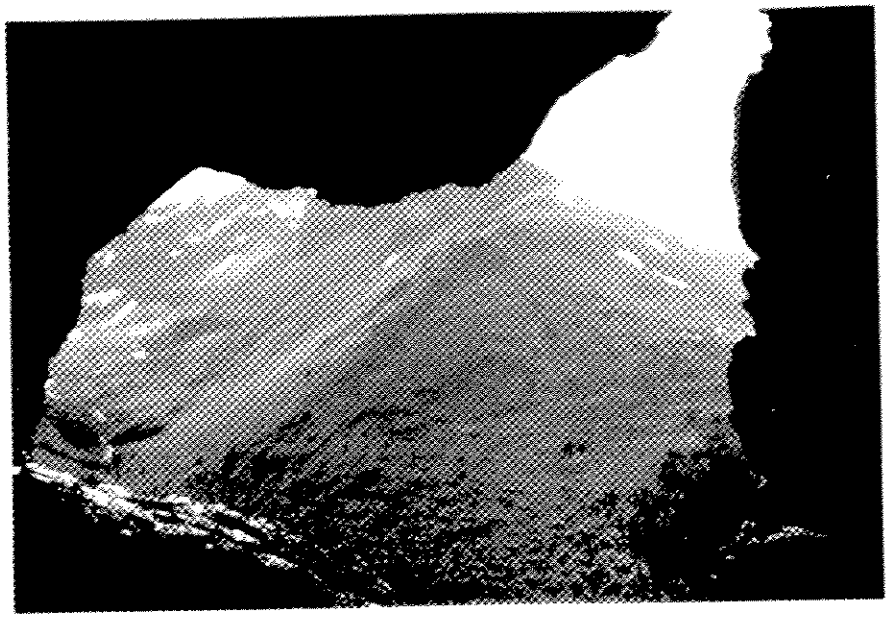


Fig. 95. Sheep and goat cave in the Ochre Cliffs.

Fig. 96. Another cave at the base of the Ochre Cliffs. According to Geist (1971), this cave was used by rams for winter shelter.

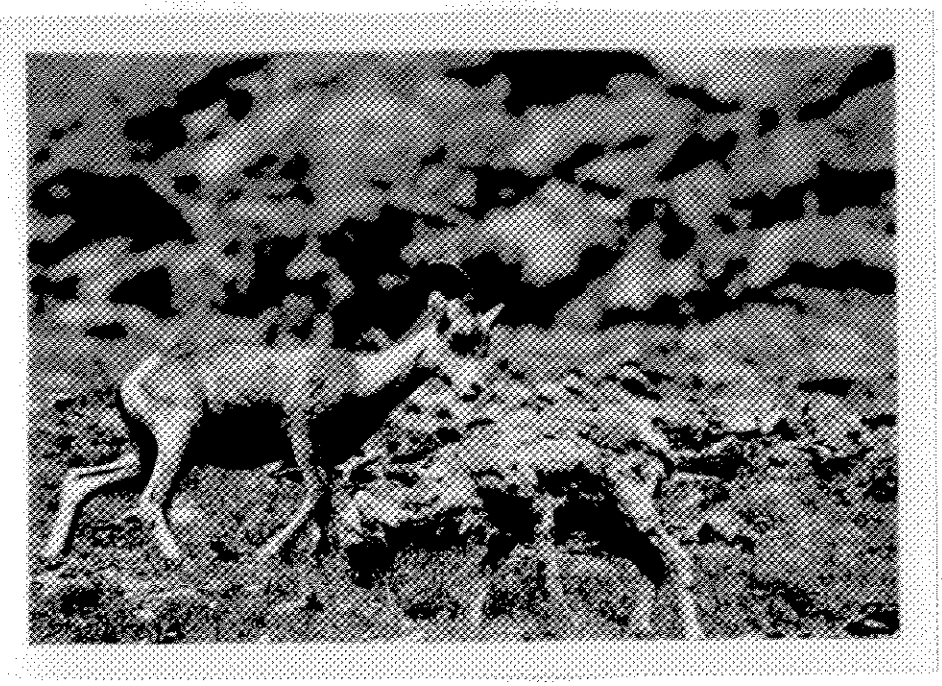


Fig. 97. Stone sheep ewe and lamb grazing. *Potentilla* sp. *(diversifolia?)* in bloom. Photograph J. B. Foster.

Fig. 98. Sheep at rest in the Eaglenest Range. The location is typical - the interface between a cliff and the accreting colluvial slope beneath. Photograph J. B. Foster.

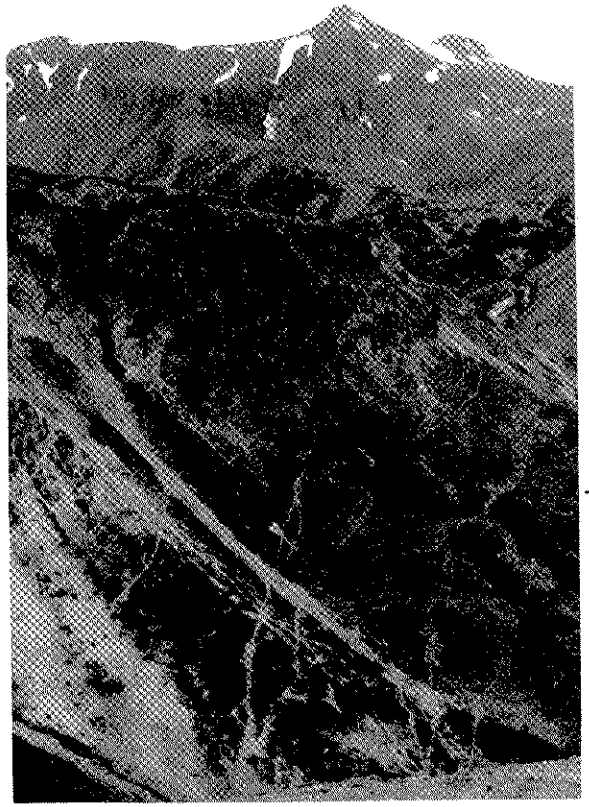
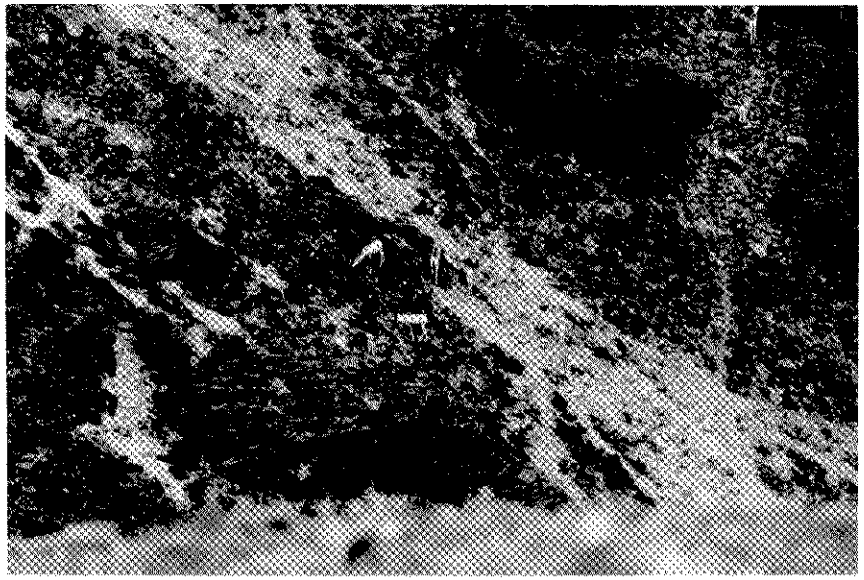


Fig. 99. Tracks leading down to sheep mineral lick above upper Cullivan Creek, western slopes of Maternity Mountain. The centre of the lick is in the gully at the lower left of the photograph.



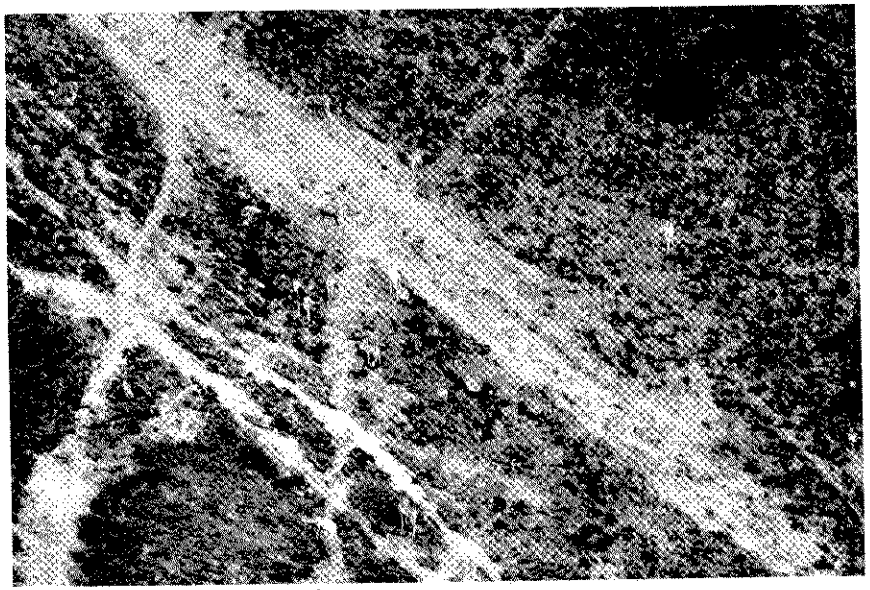


Fig. 100 & 101.

Stone sheep near the lick. 15 ewes and 9 immatures were in this band. There were more than 60 sheep sighted in the vicinity on July 25, 1975.

Fig. 102. Muddy mineral lick on lower slopes of Spermophilus Saddle, northwest side of Marmot Valley.

Fig. 103. Stone sheep lamb at the lick, July 19, 1975.

Fig. 104. Ewe and young ram at the lick, July 19, 1975.

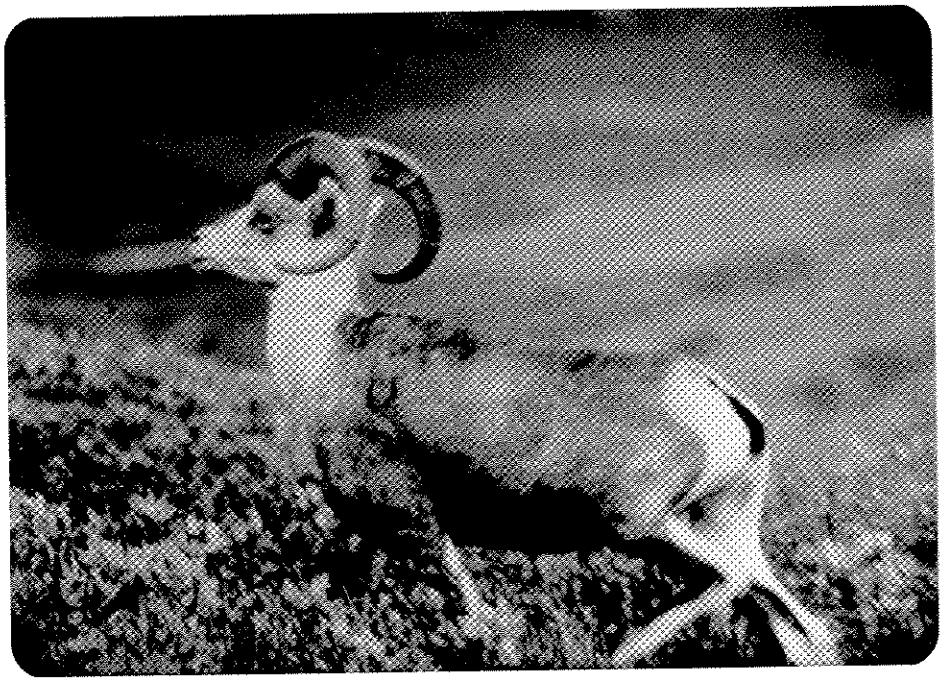


Fig. 105. Young ram at the lick. Composition of this band was six young males, five females, and one immature.

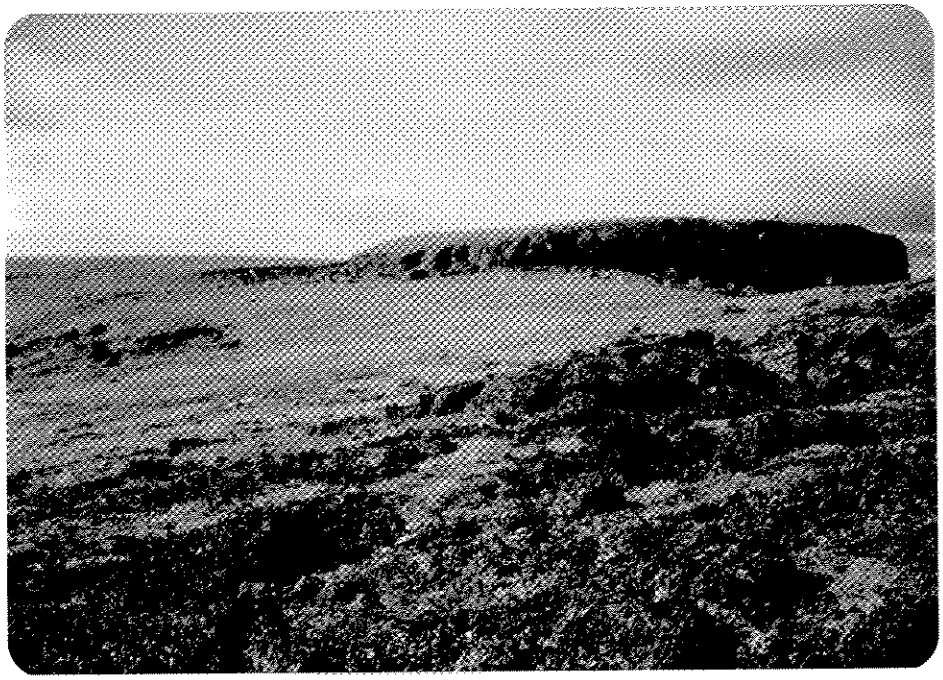


Fig. 106. Band of ca 50 female and immature sheep on Wolverine Ridge, Spatsizi Plateau, Aug. 15, 1975. Vegetation is mainly *Salix (polaris, reticulata)-Carex microchaeta-Polytrichum piliferum-Cetraria nivalis* alpine tundra.

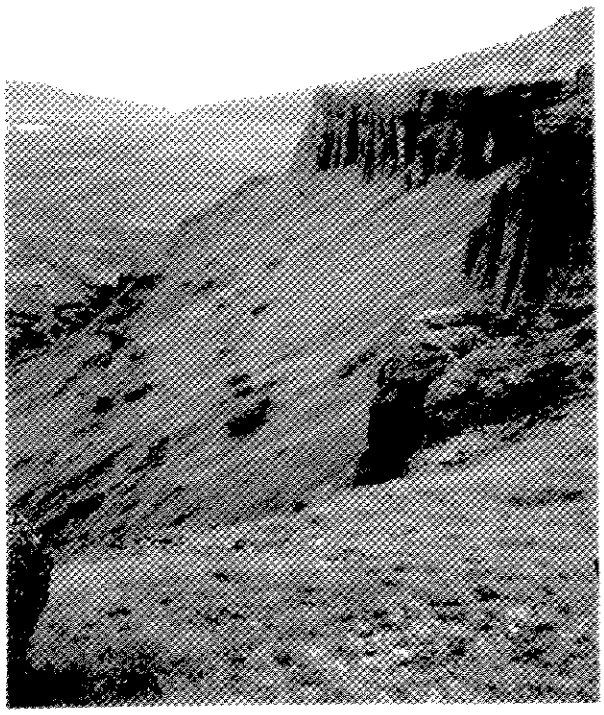


Fig. 107. South-facing rimrock and excellent sheep habitat, Lupus Ridge, upper Marion Creek, Spatsizi Plateau. *Kobresia*-lichen alpine tundra in foreground.

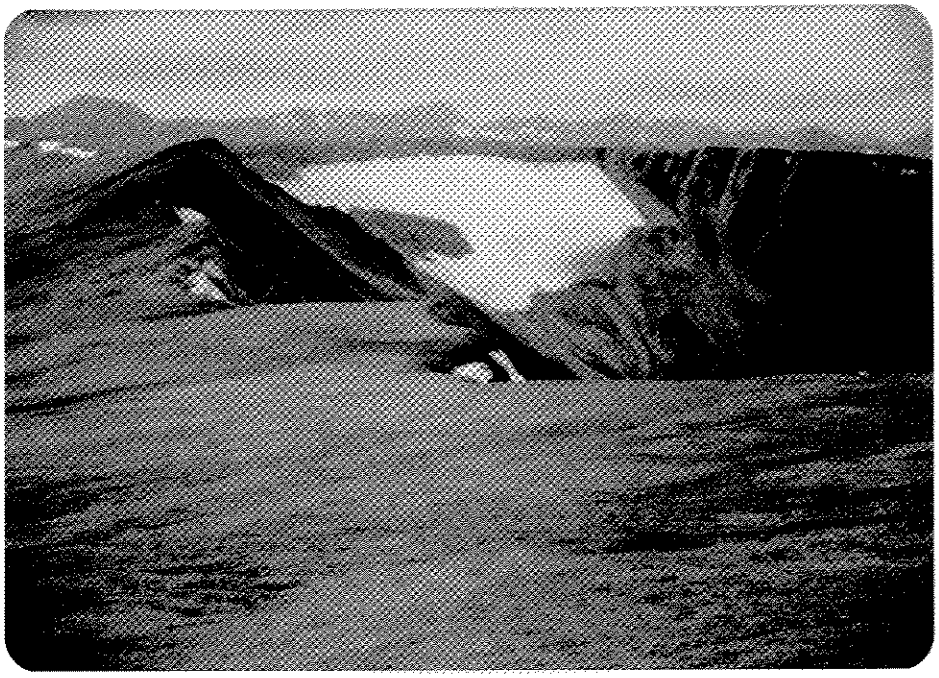


Fig. 108. Wheatear Ridge, Spatsizi Plateau, Aug. 16, 1975. Excellent Osborn caribou range with rolling alpine tundra and permanent cirque snowfield nearby.

Fig. 109. Small band of Osborn caribou cooling off and evading insects on cirque snowfield, Spatsizi Plateau. It was the warm,sunny day of July 10, 1975.

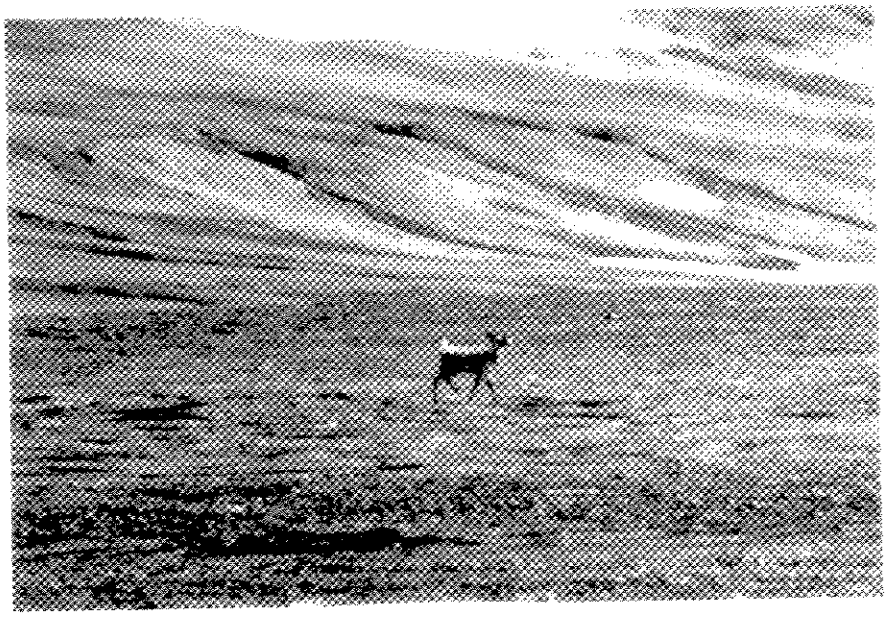


Fig. 110. Caribou cow on Fossil Flats.

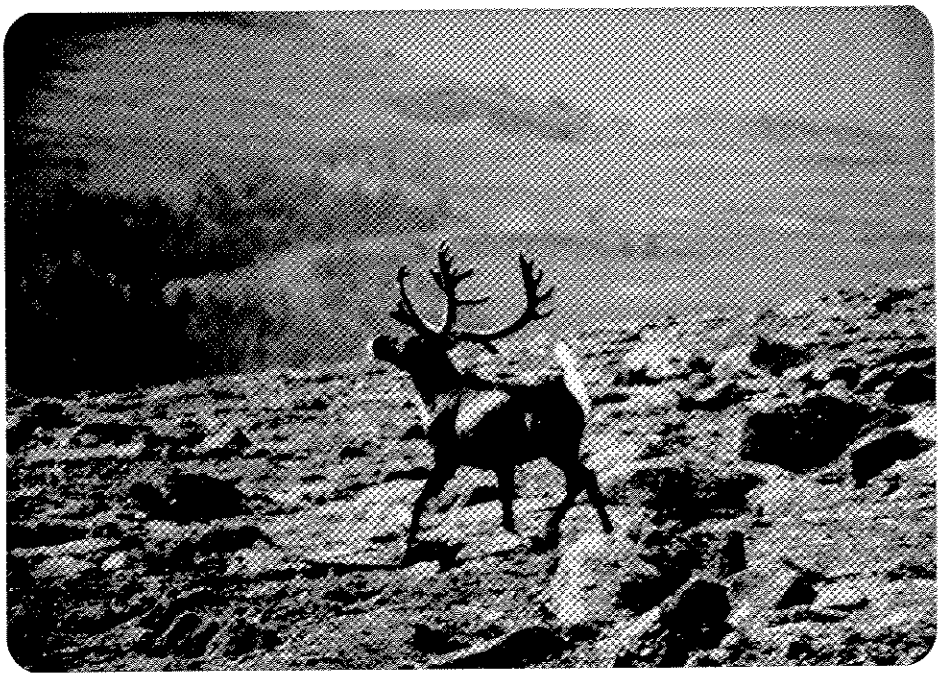


Fig. 111. Bull caribou, alarmed and trotting away, on Wolverine Ridge, Spatsizi Plateau.

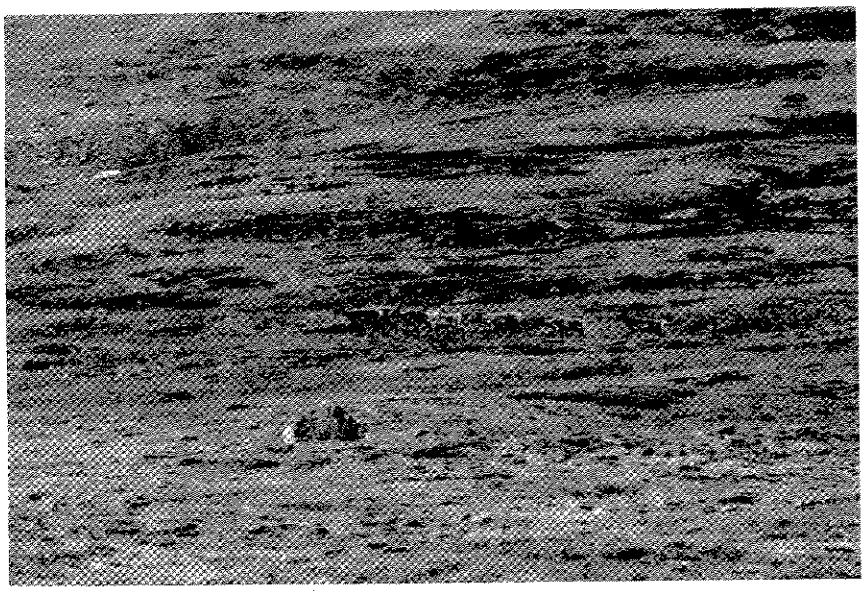


Fig. 112. Caribou band (one male, six females) on Maternity Mountain, July 25, 1975.

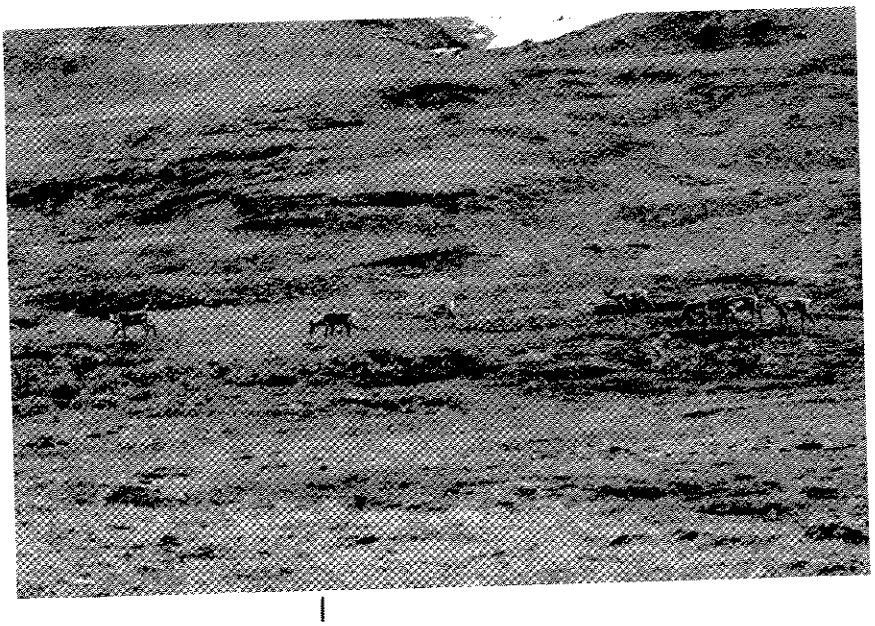


Fig. 113. The male leads.

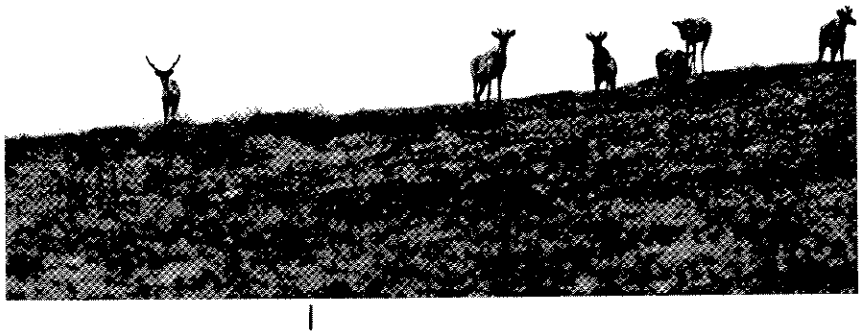


Fig. 114. The caribou have seen the observer. The male stands aloof from the females.

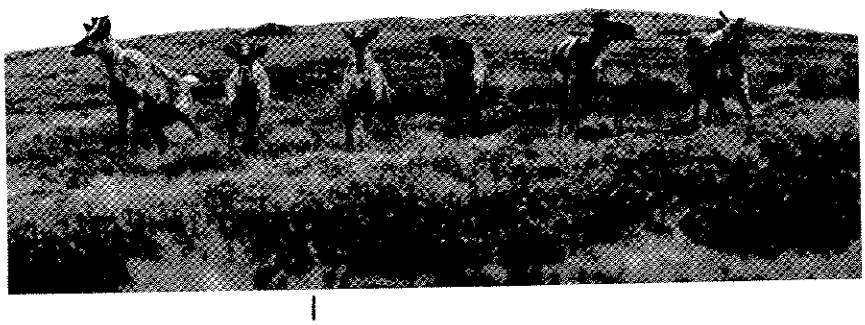


Fig. 115. Inquisitive females approach closely while the male stands his distance, out of the frame.

Fig. 116. Fire Flats, near the junction of Kluayetz and McCumber creeks.

Fig. 117. Band of young bull caribou at Fire Flats, July 11, 1975. The animals were feeding in a willow-sedge fen, apparently on the lush green sedges and other wetland forbs. Surprisingly, there were few mosquitoes or flies here on this date. Photograph J. B. Foster.

Fig. 118. Caribou "rub" boulder on Maternity Mountain. Note path worn in front of the boulder.

Fig. 119. Sapling *Pinus contorta* used as "rub" tree by moose, near head of Mink Creek.

Fig. 120 & 121. Black bear in lush cow parsnip meadow, along Castor Creek below Mount Will.

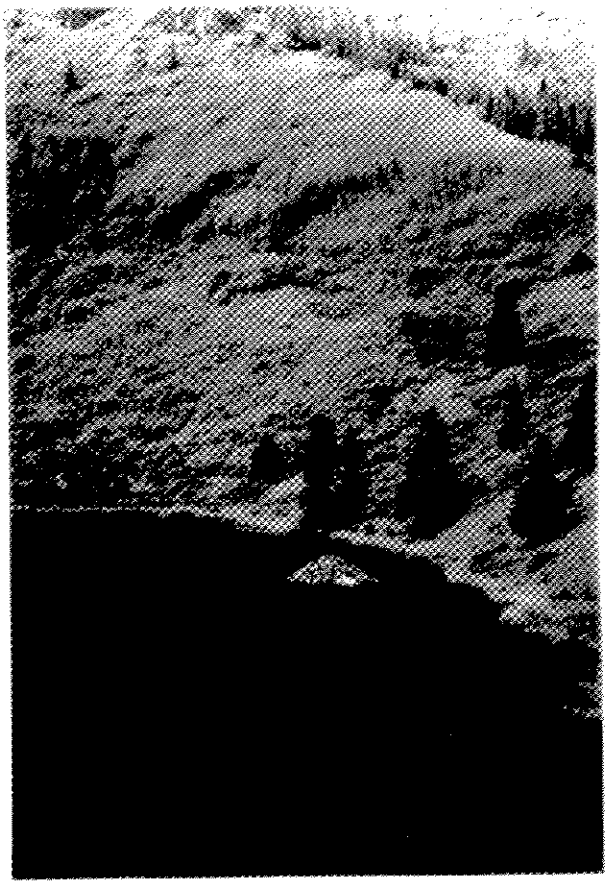


Fig. 122. Abandoned beaver lodge in Castor Lake. Note how *Populus tremuloides* and *Salix scouleriana* have been harvested from the steep slopes to 50 m above the lake.

Fig. 123. Active beaver lodge on shore of Gladys Lake, near the mouth of Rangifer Creek.

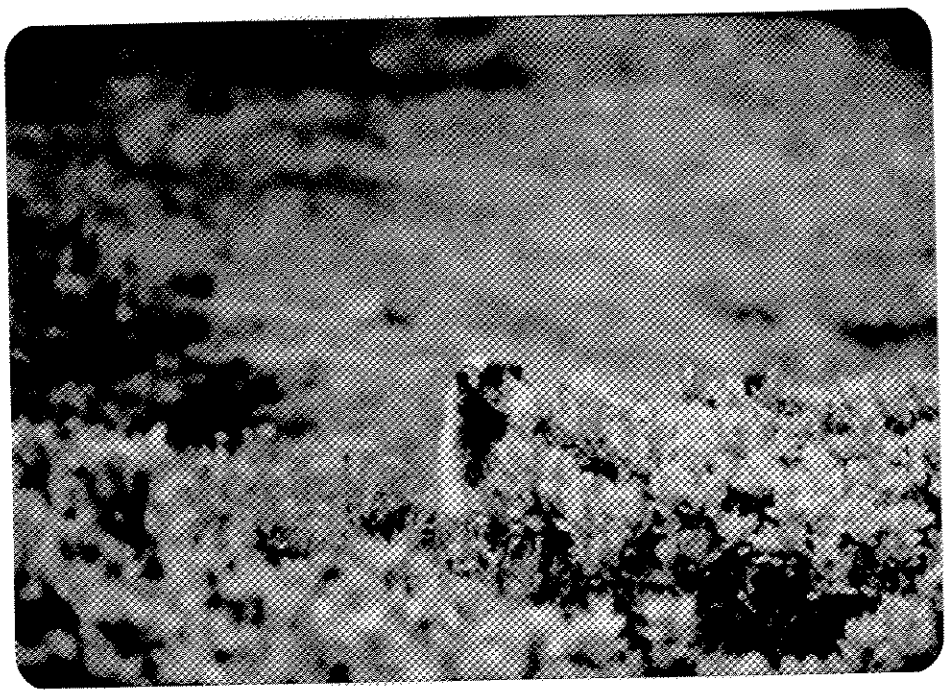


Fig. 124. Hoary marmot or whistler near burrow in Marmot Valley.

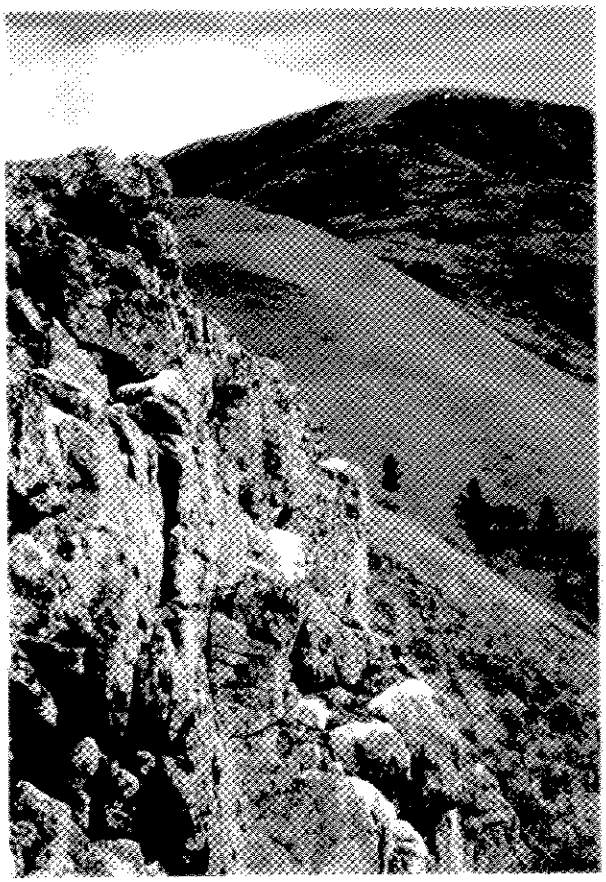


Fig. 125. Excretal deposits (probably from packrats) and the bright orange, nitrophilous, crustose lichen *Xanthoria elegans*. Kestrel Crags, Oxytropis Ridge.

Fig. 126. Say's Phoebe near nest on Ochre Cliffs. Three pairs nested here.

Fig. 127.

Willow ptarmigan in *Festuca altaica* sub-alpine grassland, Kettlehole Pass.

Fig. 128.

Common loons on Cold Fish Lake. These birds were rarely observed durin the summer at Gladys Lake.

Fig. 129. Fishing at the mouth of the Stikine River on Tuaton Lake. *Epilobium latifolium* in bloom in the foreground.

Fig. 130. Average size rainbow trout taken from Mink Creek.

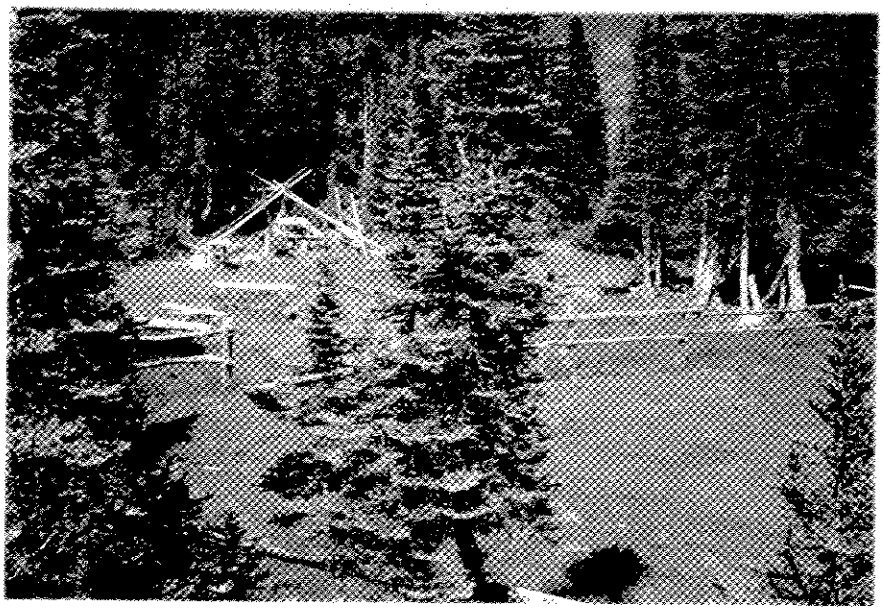


Fig. 131. Bates Camp in Kettlehole Pass.

Fig. 132. Excessive trampling by horses has damaged wet meadow vegetation near Bates Camp.

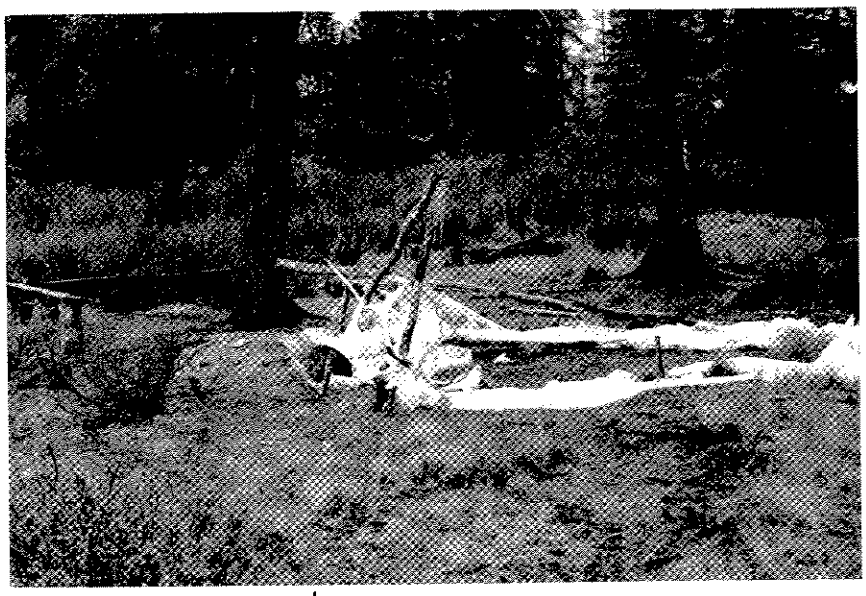


Fig. 133. Garbage at hunting and geological exploration camp on Cold Fish Lake.

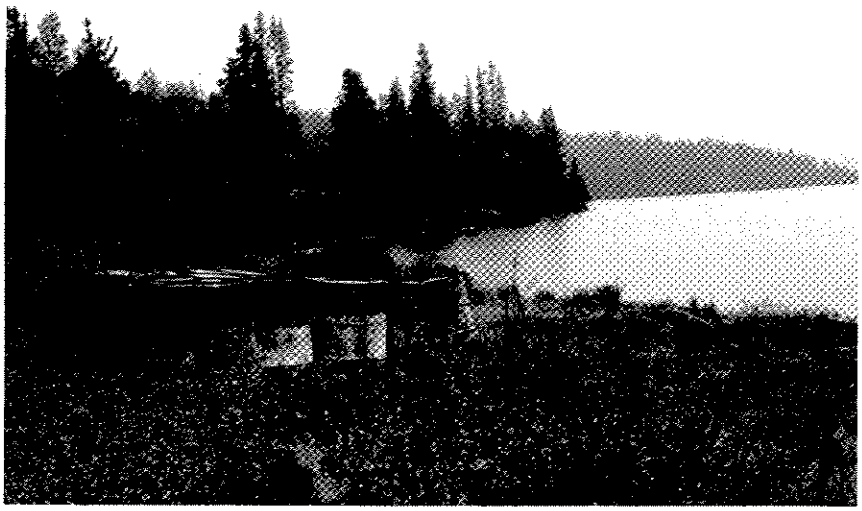


Fig. 134. Empty oil drums left behind at geological exploration camp, Cold Fish Lake.

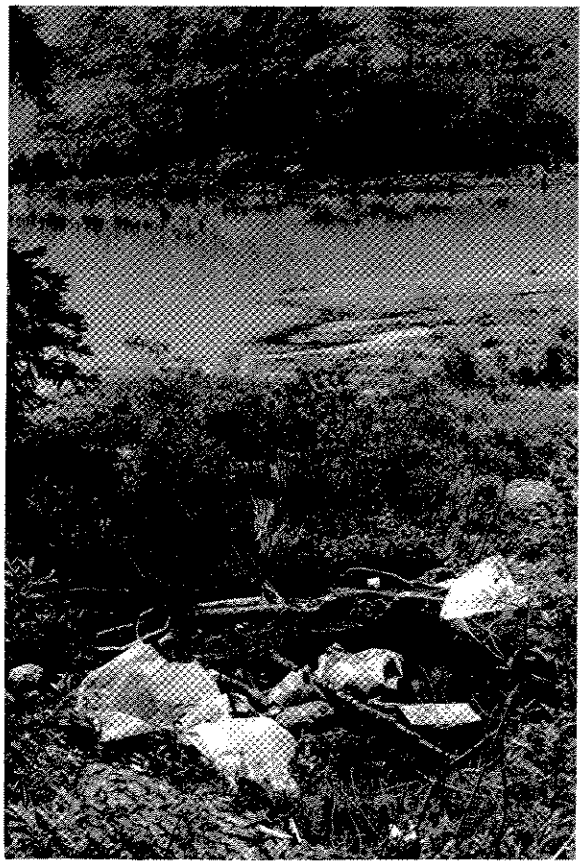


Fig. 135. Hunters' garbage at Gladys Lake.

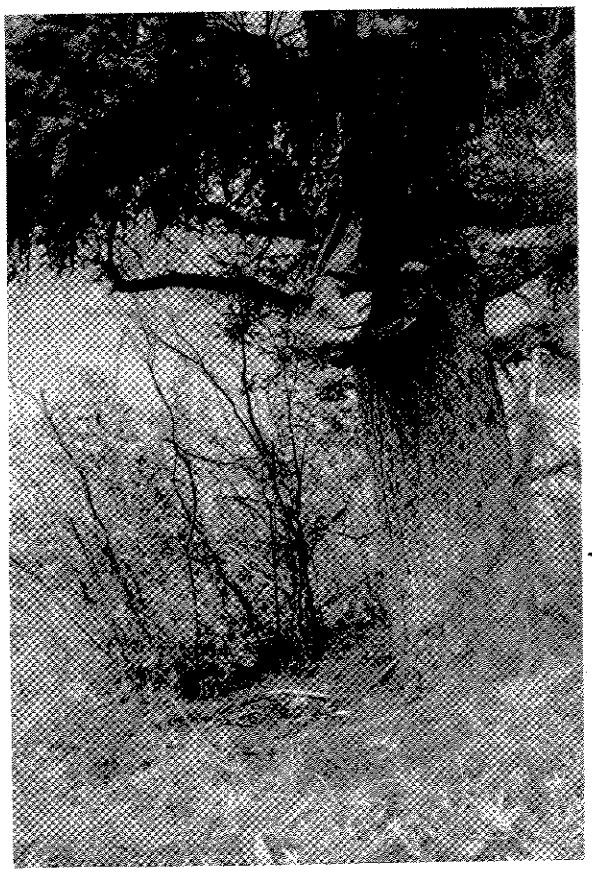


Fig. 136 & 137. Illegal artifical salt lick strung up in a spruce tree near Gladys Lake by unscrupulous hunters.