VEGETATION AND UNGULATE HABITAT IN THE GLADYS LAKE ECOLOGICAL RESERVE, NORTHERN BRITISH COLUMBIA

by

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ABSTRACT

A rapid reconnaissance technique was used to sample subalpine and alpine vegetation in the Gladys Lake Ecological Reserve, upper Stikine River drainage, northern British Columbia. Twenty major subalpine community types and their habitats were described from 193 sample stands. Picea glauca and Abies lasiocarpa dominate the open forest and woodland that covers most of the lower subalpine elevations. Betula glandulosa and several species of Salix dominate the abundant shrub cover in the subalpine forests and as well form an extensive, medium-tall scrub that prevails higher in the subalpine zone. Festuca altaica steppe is the most common of the subalpine herb community types.

Thirteen major alpine community types and their habitats were described from 132 sample stands. A. lasiocarpa krummholz and a low scrub dominated by B. glandulosa and species of Salix are common at lower alpine elevations, but the majority of the alpine vegetation is tundra. F. altaica and Dryas integrifolia dominate relatively dry habitats with shallow snow cover. Cassiope tetragona, Dryas integrifolia, Salix polaris, and S. reticulata dominate or codominate mesic habitats with average to deep snow cover. S. polaris, S. reticulata, Cyperaceae, and mosses dominate wet, seepage/snowbed habitats, and lichen-dominated fellfield occurs at the highest, most exposed elevations.

One field season's data were sufficient to sample and describe the major types of vegetation and, in combination with previous and concurrent wildlife studies, qualitatively assess the importance of the vegetation types for ungulates. Of the total thirty-three plant community types described in the reserve, approximately 7, 7, 10, and 18 appear to be of major importance for mountain goats, mountain sheep, moose, and woodland caribou, respectively. This order reflects both a decline in feeding specialization from sheep to caribou, and an increasing trend in the quality and extent of physical habitat and vegetation suitable for the different ungulate species.

Most of the subalpine and alpine community types are closely related to those elsewhere in northern British Columbia and the southern Yukon, more so than to those in southern British Columbia and the southern Canadian Rocky Mountains. Vegetation - ungulate relationships of the reserve are typical for the interior plateaus and mountains of northern British Columbia and adjacent Yukon Territory.

Key Words: subalpine, alpine, vegetation, environment, ungulates, British Columbia.

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INTRODUCTION

The upper Stikine River drainage of northern British Columbia is a remote, mountainous region long renowned for its big game populations (Patterson 1966; Walker 1976). However, until recently the vegetation of the region has been virtually unstudied. Szczawinski (1959) collected plants and briefly surveyed the vegetation while on a biological survey of the Spatsizi Plateau by the British Columbia Provincial Museum. In the 1960's, V. Geist studied the behaviour of mountain sheep and goats at Gladys Lake, and accounts of his life and research there may be found in Geist (1971, 1975). Welsh and Rigby (1971) report on a botanical and physiographic reconnaissance of the region. Pertinent studies in nearby areas include Cathey (1974) to the west, Fenger (1982) to the north, and several unpublished, reconnaissance - level, vegetation and wildlife studies sponsored by B.C. Hydro (downstream) and mining companies (to the east).

The present study reports on fieldwork done by the author and assistant R. Carswell from June 19 to September 1, 1975, in the vicinity of Gladys Lake, upper Stikine River drainage (Fig. 1). The study was done to help select and describe a proposed ecological reserve in the area. The Gladys Lake Ecological Reserve was subsequently established in late 1975 (Krajina et al. 1978), as was the surrounding Spatsizi Plateau Wilderness Park (Fig. 1). Some controversy soon arose about trophy hunting in the park (hunting is not permitted in the ecological reserve). Concern over this problem and over various proposed hydroelectric and mining developments peripheral to the park has sparked several valuable wildlife studies in the area, mainly involving woodland caribou and the wolf - caribou - moose system (Bergerud and Butler 1978; Haber 1979; Hatler 1983; Boonstra and Sinclair 1984).

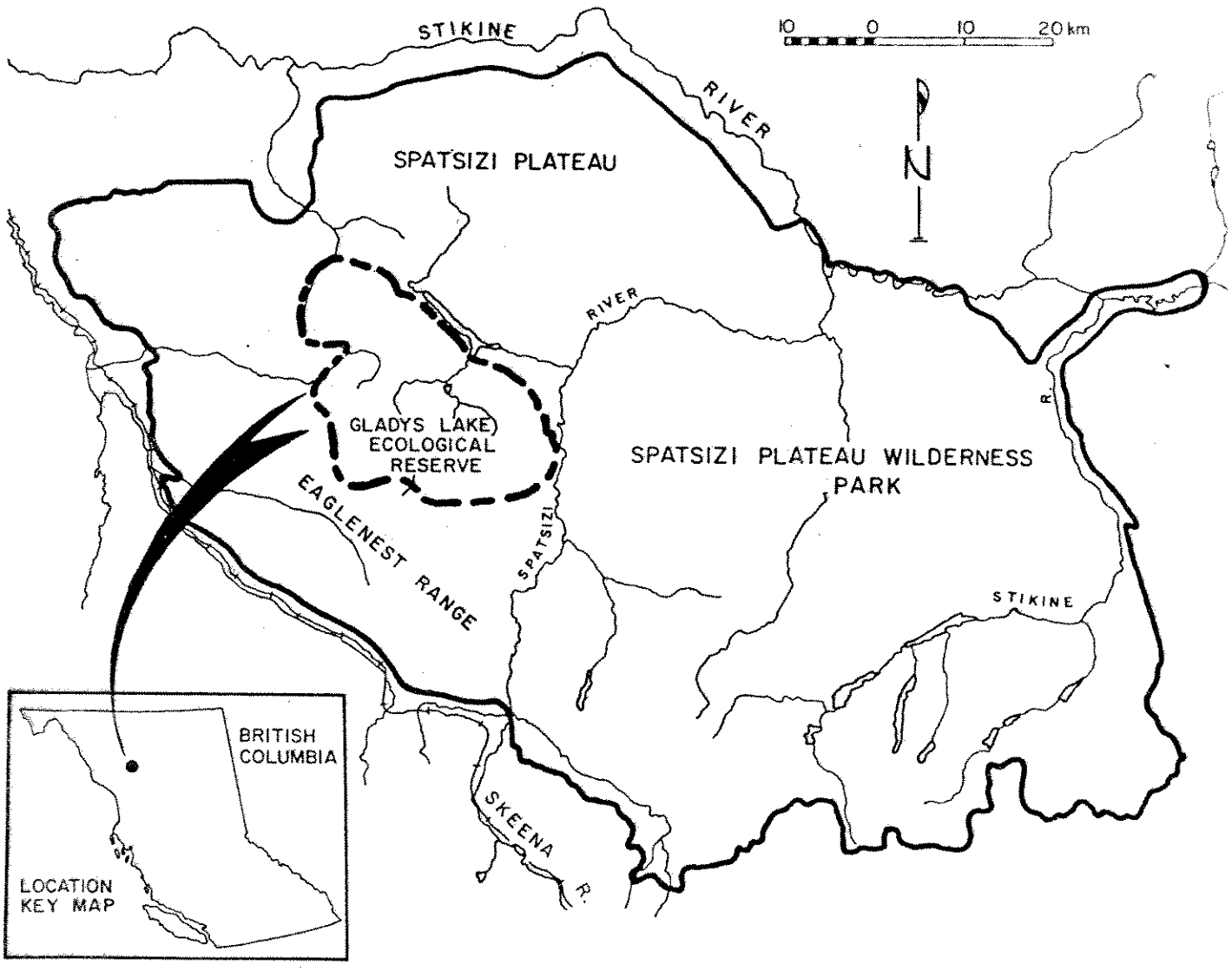

Figure 1. Gladys Lake Ecological Reserve and Spatsizi Plateau Wilderness Park, northern British Columbia.

STUDY AREA

The Gladys Lake Ecological Reserve is a 48,560 ha area in the upper Stikine region of north central British Columbia. Gladys Lake itself lies at 1275 m in the heart of the rugged Eaglenest Range, and is surrounded by peaks rising to 2100 - 2500 m. The ecological reserve is entirely above 1200 m elevation.

The Eaglenest Range is part of the Skeena Mountains (Holland 1976). 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; Welsh & Rigby 1971; Holland 1976; Eisbacher 1974; Souther et al. 1979). 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. However, there are areas of gently sloping uplands indicating that here at their northern boundary the Skeena Mountains pass by transition into the Spatsizi Plateau (Holland 1976). The transition is striking between the Eaglenest Range of the Gladys Lake area and the Spatsizi Plateau to the north, with the broad valley of Cold Fish Lake separating the two realms.

The entire region was covered by glacial ice to a height of about 2100 m (Holland 1976). 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 Mount Will.

The Gladys Lake area has a moist, cold, continental climate. Summers are cool and moist, with frequent cloud cover. Moist Pacific air from the west frequently causes sudden, often violent, local storms during summer. Winters are long, cold, and cloudy, and Gladys Lake remains frozen for almost eight months of the year (Geist 1971). A more stable air mass usually prevails in the winter, but cold spells may be broken by chinook winds. Snow and freezing temperatures can occur at any time.

There are no long-term meteorological data for the study area. The closest comparable long-term climate station is at Cassiar, 150 km to the

northwest. Based on 30-year (1951-1980) normals (Environment Canada 1980), Cassiar has a mean annual temperature of -3.2°C. Temperature averages above 10°C for just one month, below 0°C for seven months of the year. Total annual precipitation averages 700 mm, with 395 cm or 56% falling as snow.

Soil development in the Gladys Lake reserve is generally not far advanced, because of recent glaciation, cold climate, and periglacial processes. The processes of frost shattering, solifluction, nivation, and cryoturbation, as well as colluviation and snow avalanching, are all active, especially in the alpine zone. Permafrost is scattered and uncommon, but does occur in the alpine, especially beneath wet tundra and organic soils on northern and eastern slopes.

Soils have developed in glacial till, and in colluvial, fluvial, and glaciofluvial materials. Parent material may be basic or acidic, but sola are generally acid with pH increasing with depth. Lithology is variable, with basalt, shales, sandstone, siltstone, mudstone, and conglomerate all present (Alley and Young 1978; Souther et al. 1979).

Prevailing subalpine soils are Humo-Ferric Podzols and Dystric Brunisols. Gleyed Regosols, Humic Gleysols, and shallow Organics are found in subalpine wetlands, while fluvial soils are usually Regosols. Eutric or Melanic Brunisols are fairly common on steep, grassy, south-facing slopes. Regosols (Orthic and Humic) and Dystric Brunisols predominate in the alpine zone. Wet alpine habitats may have Humic Regosols, Humic Gleysols, or Organic soils, and Turbic Cryosols and Organic Cryosols also occur (Young and Alley 1978).

METHODS

3.1 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, less subjective 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 type" to a grouping of similar stands. The names of the community types were 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 325 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 communities 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 10 m high; (A3) Secondary tree canopy forming a definite layer below the main canopy; (B1) Tall shrubs and tree saplings, usually between 2 m and 8 m high; (B2) Low shrubs and tree regeneration, less than 2 m high; (C) All herbaceous plants and dwarf shrubs; (D) Cryptogams - lichens, mosses, and liverworts.

Midpoints of the six cover classes were used to calculate average per cent coverage of the taxa tallied within each plot. Similarly, average per cent frequency was 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 were calculated by multiplying cover by the square root of the frequency of each species of each community type. This index is considered to be a good estimate of the prominence of a species in a particular community type (Douglas 1974).

3.2 Taxonomic Considerations

For the most part, nomenclature, authorities, and taxonomy follow Taylor and MacBryde (1977, 1978) for vascular plants, Hale and Culberson (1970) for lichens, Ireland et al. (1980) for mosses, and Stotler and Crandall-Stotler (1977) for liverworts. Hulten (1968), Argus (1973), Welsh (1974), and several other more specialized treatments were consulted in vascular plant identification.

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.

3.3 Soils

In each of the major plant community types, one or more soil pits were established and the soil profile briefly described. Soil nomenclature is according to the Canadian System of Soil Classification (Canada Soil Survey Committee 1978).

3.4 Wildlife

Most of the ecological reserve was traversed on foot by the two-man study team. They recorded all animal sightings and included notes on ungulate behaviour, descriptions of mineral licks and game trails, and type and density of big game "sign" (see Carswell 1975). Observations relating to feeding were emphasized. The occurrence and intensity of browsing and grazing, and the occurrence and density of scats were noted in each stand. Ungulate taxonomy follows Banfield (1974).

4 RESULTS

The vegetation of the Gladys Lake Ecological Reserve falls within subalpine and alpine zones, or the subalpine Spruce - Willow - Birch (SWB) and Alpine Tundra (AT) biogeoclimatic zones of Krajina (1969, 1975). In the upper Stikine River region, lower elevations up to 950 - 1150 m are covered by

essentially continuous, white spruce (Picea glauca) - dominated forests that form a montane zone (cf. Douglas 1974) equivalent to the Boreal White and Black Spruce Zone (BWBS) of Krajina (1965, 1969). The study area is entirely above 1200 m, and has no true montane or boreal forest.

Within the ecological reserve, the SWB zone occupies the lower valleys and slopes and is dominated by open white spruce and subalpine fir (Abies lasiocarpa) forests, and (especially in the upper subalpine) by dense thickets of medium to tall (1 to 4 m high) deciduous shrubs, mainly Betula glandulosa and Salix spp. There are also frequent aspen (Populus tremuloides) stands, grasslands, wetlands, and other shrub and herb communities within the SWB.

The upper limit of the SWB ranges from 1450 to 1600 m and above this is the alpine zone or AT. Lower alpine elevations are dominated by low (up to 1 m) Betula - Salix shrubfields, herbaceous meadows, and krummholz. The upper AT has dwarf shrub, heath, grassland, seepage, snowbed, and fellfield community types, together commonly referred to as alpine tundra.

4.1 SUBALPINE VEGETATION OF THE GLADYS LAKE ECOLOGICAL RESERVE

4.1.1 Forest community types

Eight forest community types can be distinguished in the Gladys Lake area. There are six coniferous types, one dominated by lodgepole pine (Pinus contorta var. latifolia), two by white spruce, and three by subalpine fir. Trembling aspen and balsam poplar (Populus balsamifera) each dominate a deciduous forest type. Table 1 summarizes the species composition of these community types, while Table 2 presents selected environmental and community characteristics.

The subalpine fir types generally occur at higher elevations than the others, which represent primarily valley bottom and lower slope communities. A pattern apparent in the lower subalpine valleys of the ecological reserve and also in the upper Stikine region in general is of intermittent to closed forest cover of spruce, aspen, and pine on the valley bottom and lower slopes. Higher on the slopes subalpine fir dominates, especially on northern and estern exposures,

TABLE 1. Composition of plant community types in the subalpine zone of the Gladys Lake Ecological Reserve. Data are for prominence value indices[a]

Strata and species	PCB[b] (12)[c]	PTR (16)	PBA (4)	PHY (9)	PGB (6)	PSB (10)	AHY (8)	ABE (8)	SCA (19)	SAS (7)	SAL (7)	SGB (12)	SBE (6)	BEF (9)	JUA (13)	POG (9)	FES (17)	FEL (12)	HER (5)	CAR (4)
Overstory trees																				
Pinus contorta var. *latifolia*	510								T											
Picea glauca	10			620	317	331		1	52											
Populus tremuloides		553	T																	
Salix scouleriana		6	11																	
Populus balsamifera			472																	
Abies lasiocarpa							481	309												
Understory trees																				
Picea glauca	100	2		150	183	93			21											
Pinus contorta	17								T											
Abies lasiocarpa	6			20	3	6	179	197												
Populus tremuloides		180		2																
Salix scouleriana		20	4			16														
Populus balsamifera			145																	
Tree saplings/seedlings																				
Picea glauca	43	1		160	28	26			29	2	7	T	T							
Pinus contorta	9								2											
Abies lasiocarpa	6			47	15	11	372	365	T					1						
Populus tremuloides		152	3												4					
Populus balsamifera			203							1	1				T					
Tall shrubs																				
Salix scouleriana	7	18	16	1	2	25				684			17							
Salix glauca	2	2	3	16	8	44	T		7	4		83	49							
Betula glandulosa	T																			
Salix alaxensis											40									
Salix barclayi											30	5								
Salix planifolia											1	67								
Low shrubs																				
Betula glandulosa	216	3	3		532	184	25	317	105	100		8	459	841	5					
Salix glauca	59	1		25	67	178	1	31	37	93	1	254	408	28	1					
Ledum groenlandicum	T			5	5	6	1	1	42	9		T	17							
Shepherdia canadensis	31	16	1							24	1				12		T			
Rosa acicularis ssp. *sayi*		28	31	1						4					19	21				
Viburnum edule		10	16							7					T					
Ribes oxyacanthoides		4													1					
Salix scouleriana		1	3	1		T				15			5							
Potentilla fruticosa				1					20	1	4	44		1	28	7	1			

TABLE 1. Continued

Strata and species	PCB	PTR	PBA	PHY	PGB	PSB	AHY	ABE	SCA	SAS	SAL	SGB	SBE	BEF	JUA	POG	FES	FEL	HER	CAR
Salix barclayi				1	5			1	211		98	215								
Ribes glanculosum							20													
Salix barrattiana									40			55		8						
Salix alaxensis											190									
Salix planifolia									20		7	11								
Dwarf shrubs/herbs																				
Empetrum nigrum ssp. hermaphroditum	107	1		22	64	76	67	161	48	25		T	23	5						
Festuca altaica	100	238	43	17	79	116	16	18	2	118	4	179	161	140	141	14	602	355	62	
Vaccinium vitis-idaea ssp. minus	80	5		18	38	37	8	20	12	7			14	3	3	1	T			
Lupinus arcticus	73	86	117	29	61	102	16	20		63	38	T	42	27	3	1	29	57		
Vaccinium caespitosum	44	4		1	5	11	3	16		1			5	5			13	49		
Linnaea borealis	28	82	31	100	24	46	20	13		204		2	42	10	7					
Cornus canadensis	24	2		61	2	14	62	13		7		T	8							
Epilobium angustifolium	16	177	376	14	8	24	9	5	1	186	3	47	79	11	22	9	54	99	95	
Juniperus communis ssp. alpina	7	154	43		2	4				86			5		302	3	T			
Mertensia paniculata	7	54	87	42	24	45	13	9	1	53	1	40	46	14	1	6	20	23	18	
Pedicularis labradorica	7	10			17	18		13	6	1			2	6			T			
Achillea millefolium	5	25	25	2	14	14		1	T	19	30	58	8	7	17	22	10	8	25	
Arnica cordifolia	3	63	75	56	5	4	1	5		59	1	3	8	1	3			T		
Stellaria longipes var. altocaulis	3	T		1	2	2	1		T			16	2	5	T	14	10	11		
Arctostaphylos uva-ursi	2	63	3	1		23		1		14	1	T	2		365	42	4			
Galium boreale	T	4	60									3	5	1	T	1	7	1	11	
Fragaria virginiana		48	75	4						27	1	6	2		21	13	42	T		
Delphinium glaucum		29	75	2		4		1	T	29		30	40	T		13	34	13	90	
Saxifraga tricuspidata		15								1	1				93	75				
Gentianella propinqua		14	16			2				15	7	5	5		14	14	3	T	2	
Pyrola asarifolia		7	21		2		1	1	T	4			5	1						
Koeleria macrantha		6								1					43	47	4			
Solidago multiradiata var. scopulorum		6	6	1	2	4				7	7	8	2	3	14	4	31	T		
Poa glauca		5													60	410	28			
Agropyron trachycaulum s. lat		4									7	11			3	84	5		13	
Draba aurea		3										1	2		12	5	4	T		
Festuca saximontana		2									4	14		3	10	25	15			
Thalictrum occidentale		2	53								T						1	1	76	
Aconitum delphiniifolium		1	8							4	1	49	2	10		1	46	132	6	
Anemone multifida		1								1					10	9	T			

TABLE 1. Continued

Strata and species	PCB	PTR	PBA	PHY	PGB	PSB	AHY	ABE	SCA	SAS	SAL	SGB	SBE	BEF	JUA	POG	FES	FEL	HER	CAR
Androsace septentrionalis		T													4	18	1			
Castilleja unalaschensis		T				2				51	1				T		4	43	31	
Aquilegia formosa		T	31							1	T									
Trisetum spicatum s. lat.		T						1			10	7			10	41	10	3		
Heracleum sphondylium ssp. montanum			91								28							13	670	
Bromus richardsonii			71																13	
Geranium richardsonii			53							1								3	22	
Equisetum arvense			8	26		4		1	53		150	13	2					1	13	
Artemisia arctica			1		8	4	15	9		1		8	2	17		1	94	177		
Calamagrostis canadensis			1					1	4		8	2		28			1	10	66	6
Equisetum scirpoides				10	5	6	1	3	6			T	2					T		
Arctostaphylos rubra				7		14		11	29	1		2	2	4						
Astragalus alpinus				1							114	16					T			
Poa leptocoma				1				1			7	42					1	1		
Polemonium caeruleum ssp. villosum				1		2	6	1	4	1		28	2	7			11	19	23	
Rubus arcticus ssp. acaulis				1					11		1	58	5	1			T	28		
Petasites palmatus				1				1	11		7	52						3		
Salix myrtillifolia						T			89			14								
Carex media						T		1	3		1	18								
Luzula parviflora								3	2		30	27	2	5			20	106	6	
Carex aquatilis									188		13	6								180
Rubus chamaemorus									27											
Carex disperma									24											
Vaccinium microcarpum									17											
Carex vaginata									15											
Equisetum sylvaticum									10				2							
Arctagrostis latifolia var. arundinacea									8		57	10								
Sanguisorba canadensis ssp. latifolia									7		1	17					2	22	12	
Bistorta vivipara									5		1	22						1		
Equisetum variegatum									1		61									
Valeriana dioica ssp. sylvatica									1	1		11					T	3		
Senecio triangularis									1		1	T						82	49	
Ranunculus occidentalis									T								T	31		
Epilobium latifolium											161									
Artemisia tilesii s. lat.											107	2			1					
Poa alpina											53	23		1	T	1	5	3		

TABLE 1. Continued

Strata and species	PCB	PTR	PBA	PHY	PGB	PSB	AHY	ABE	SCA	SAS	SAL	SGB	SBE	BEF	JUA	POG	FES	FEL	HER	CAR
Juncus arcticus ssp. ater											44									
Parnassia kotzebuei											38	2								
Agrostis scabra											30	2			1					
Erigeron acris ssp. debilis											18	5			1		2	T		
Oxytropis campestris s. lat.											18	T			10	102	T			
Phleum alpinum var. commutatum											15	8					14	68	25	
Cerastium beeringianum											4	T			T	42	9	1		
Myosotis asiatica											1				T	61	7	72		
Veronica wormskjoldii											1	14					4	24		
Carex macloviana											1	7					15	3	6	
Senecio pauciflorus												25		T			2	3		
Potentilla diversifolia												9			T	7	57	43		
Rumex acetosa ssp. arifolius												T				1	9	87	11	
Carex podocarpa														1	T		27	120		
Artemisia campestris ssp. borealis															12	88	2			
Carex supina ssp. spaniocarpa															10	350	1			
Potentilla nivea															8	54				
Artemisia michauxiana															2	44				
Potentilla pensylvanica															T	69	2			
Poa cusickii s. lat.															T		41	13		
Penstemon procerus																10	T			
Valeriana sitchensis																		58	13	
Cirsium edule																			13	
Lupinus nootkatensis																			13	
Carex rostrata																				530
Carex saxatilis ssp. laxa																				28
Bryophytes																				
Pleurozium schreberi	183	12	2	128	100	110	102	63	5	24	1	7	57	64	2		4	2		
Dicranum fuscescens	110	5	2	70	25	35	46	30		3		6		2						
Polytrichum juniperinum	77	4		45	12	10	10						5	9			11	6		
Hylocomium splendens	74	6		216	80	106	331	93	15	50		31	125	101			T	5	T	
Ptilium crista-castrensis	6	2		11	7	T	5	2		1			10	3						
Pogonatum alpinum	4			13	10		10	2												
Dicranum acutifolium	2	2		15	15	5		35	T				7	19			4			
Hypnum revolutum		32	2							6										
Thuidium abietinum		12	1							15			2		1		20			
Tortula ruralis		8	4			1				3					8	17	7			
Drepanocladus uncinatus		7	7	12						7	15	25	1					2	T	

TABLE 1. Continued

Strata and species	PCB	PTR	PBA	PHY	PGB	PSB	AHY	ABE	SCA	SAS	SAL	SGB	SBE	BEF	JUA	POG	FES	FEL	HER	CAR
Dicranum scoparium	6			8			20													
Tomenthypnum nitens				1		1		4	136		14	7					2	4		
Barbilophozia lycopodioides				T			12	1												
Aulacomnium palustre				T					125		8	56		5				27		
Sphagnum spp.[a]									138			3								
Drepanocladus exannulatus									44											150
Plagiomnium ellipticum									20			2						3		
Paludella squarrosa									18		2	5								
Polytrichum strictum									14		1	10								
Calliergon cordifolium									12			2								
Calliergon giganteum									10											12
Campylium stellatum									10											
Hypnum lindbergii											23	T								
Lichens																				
Cladina mitis	183	4		36	91	85	12	83	15	11		15	33	45	T		15	1		
Cladina rangiferina	137	1		1	52	57	10	65	3	2			22	34			2			
Peltigera aphthosa	120	4		122	91	110	95	74	20	39	6	35	97	83	1		6	6		
Cladina alpestris	63			3	35	31	4	41		3		T	20	24						
Cladonia uncialis	56				23	11	2	1				T	7	3			T			
Peltigera malacea	51	7		37	77	48	28	22		3			22	3	2		2	T		
Cladonia gracilis	45	11		3	18	22	15	14	2	2		4	13	16				T		
Cladonia ecmocyna	35			2	25	15	25	57	8			10	11	14						
Cladonia cornuta	33	1		11	15	16	16	18	5	2		4	10	8	T		T			
Cladonia gonecha	30				10	4	6	13	6	T		1	5	2						
Cetraria islandica	23	1		1		6	2	T	T			3	1	7	3	T	3	T		
Nephroma arcticum	21			1	23	5	5	23	T				8	1			T			
Cetraria nivalis	18	T		3	2	8		1	T			T	1	2	5	T				
Cetraria cucullata	14	T		4	15	18	T	4		T		3	5	10	4	7	T			
Cladonia chlorophaea s. lat.	14	1	1	2	6	4	12	13	4	8		8	4	5	T	1	T			
Cladonia pyxidata	12	13	1		2	3	T	3		7	3	3	1	1	11	3	2			
Stereocaulon alpinum	7		T	3	6	12	1					7								
Cladonia deformis	T			T	5	T	10	13	1			2	1	1						
Cladonia pleurota	T	T		2	T	4	T	13	T			4	3				T			
Lobaria linita	T			3	2	4	T	10	T			5		7			4	1		
Peltigera canina s. lat.	T	28			1	1				18	22	8	3	T	17	7	3			
Peltigera scabrosa		T	1	58		26	17	13	7			12	22				1	3		
Stereocaulon paschale					1	8		5			12		1	4	1		3	T		

TABLE 1. Concluded

Strata and species	PCB	PTR	PBA	PHY	PGB	PSB	AHY	ABE	SCA	SAS	SAL	SGB	SBE	BEF	JUA	POG	FES	FEL	HER	CAR
Average cover (%)																				
Overstory trees	53	56	49	70	32	33	50	31	7											
Intermediate trees	13	20	18	13	18	14	21	20	3											
Tall shrubs and tree saplings	4	7	21	6	4	9	12	14	4	67	11	22	10							
Low shrubs	22	12	6	9	61	36	29	39	48	31	30	64	84	88						
Dwarf shrubs and herbs	45	87	97	26	28	34	21	28	54	71	56	51	28	37	91	89	105	113	135	82
Bryophytes and lichens	85	11	3	79	68	68	82	76	65	20	18	33	54	51	7	7	16	12	T	11
Bare ground	T	1			T	T				T	25				8	9	1			

[a]Only those species with a prominence value of 10 or more in at least one community type are listed; T (trace) indicates a prominence value of less than 0.5.

[b]Community type abbreviations: PCB, Pinus contorta - Betula glandulosa - Pleurozium schreberi; PTR, Populus tremuloides - Juniperus communis - Festuca altaica; PBA, Populus balsamifera - Epilobium angustifolium; PHY, Picea glauca - Hylocomium splendens; PGB, Picea glauca - Betula glandulosa - Salix glauca, Betula phase; PSB, Picea glauca - Betula glandulosa - Salix glauca, Salix phase; AHY, Abies lasiocarpa - Hylocomium splendens - Pleurozium schreberi; ABE, Abies lasiocarpa - Betula glandulosa - Empetrum nigrum; SCA, Salix barclayi - Betula glandulosa - Carex aquatilis - Aulacomnium palustre; SAS, Salix scouleriana; SAL, Salix alaxensis - Epilobium latifolium; SGB, Salix (glauca, barclayi) - Petasites palmatus; SBE, Salix glauca - Betula glandulosa - Festuca altaica; BEF, Betula glandulosa - Festuca altaica - Hylocomium splendens; JUA, Juniperus communis - Arctostaphylos uva-ursi; POG, Poa glauca - Carex supina; FES, Festuca altaica; FEL, Festuca altaica - Luzula parviflora; HER, Heracleum sphondylium; CAR, Carex rostrata - C. aquatilis.

[c]Number of stands sampled appears in parentheses.

[d]Sphagnum nemoreum, S. rubellum, S. fallax, S. fuscum, S. warnstorfii.

TABLE 2. Summary of environmental and community characteristics for subalpine plant community types, Gladys Lake Ecological Reserve

Community type	Relative abundance in reserve	Elevation range (m)	Slope (%) range and (mean)	Aspect	Snow release	Drainage	Moisture regime	Soil classification	Total no. species	Mean no. species	Mean cover (dominants[a]) (%)	Mean frequency (dominants[a]) (%)	Mean total plant cover (%)
Pinus contorta - *Betula glandulosa* - *Pleurozium schreberi*	X	1220-1250	0 - 10 (4)	Flat	Medium	Good - rapid	Subxeric -submesic	Humo-Ferric Podzols, Dystric Brunisols	58	30	31	100	222
Populus tremuloides *Juniperus communis* - *Festuca altaica*	XX	1220-1500	8 - 65 (30)	S, SW	Early	Moderate-rapid	Subxeric -mesic	Eutric & Melanic Brunisols, Regosols, Luvisols	82	26	42	94	193
Populus balsamifera - *Epilobium angustifolium*	X	1300-1500	15 - 50 (27)	S, SW	Early	Moderate - good	Mesic	Brunisols	45	24	62	100	194
Picea glauca - *Hylocomium splendens*	X	1220 1370	0 - 20 (6)	All	Medium - late	Moderate-imperfect	Mesic - subhygric	Podzols, Luvisols Regosols, Brunisols	65	27	55	100	203
Picea glauca - *Betula glandulosa* - *Salix glauca*, *Betula* phase	XXX	1220-1400	0 - 40 (18)	E, NE	Medium - late	Moderate - good	Mesic	Gray Luvisols, Dystric Brunisols, Humo-Ferric Podzols	56	31	38	100	211
Picea glauca - *Betula glandulosa* - *Salix glauca*, *Salix* phase	XXX	1220-1310	0 - 35 (15)	All	Medium	Moderate-good	Mesic - submesic	Gray Luvisols, Dystric Brunisols	83	35	30	90	194
Abies lasiocarpa - *Hylocomium splendens*	XX	1400-1550	3 - 55 (25)	N, NE	Very late	Moderate	Mesic	Humo-Ferric Podzols, Dystric Brunisols	61	23	43	100	215
Abies lasiocarpa - *Betula glandulosa* - *Empetrum nigrum*	XXX	1370-1575	0 - 3 (0)	N, E NW	Late	Moderate imperfect	Mesic - subhygric	Podzols, Gleysols	77	34	40	100	208
Salix barclayi - *Betula glandulosa* - *Carex aquatilis* - *Aulacomnium palustre*	XX	1220-1370	0 (0)	Flat	Medium	Very poor	Hygric - hydric	Organic, Humic Gleysols, Regosols	108	33	17	86	181

TABLE 2. Continued

Community type	Relative abundance in reserve	Elevation range (m)	Slope (%) range and (mean)	Aspect	Snow release	Drainage	Moisture regime	Soil classification	Total no. species	Mean no. species	Mean cover (dominants[a]) (%)	Mean frequency (dominants[a]) (%)	Mean total plant cover (%)
Salix scouleriana	XX	1300 1460	8 - 50 (32)	W, SW	Early	Moderate-good	Submesic - mesic	Brunisols	65	29	70	100	189
Salix alaxensis - Epilobium latifolium	X	1220-1500	0 - 25 (3)	Flat	Early	Imperfect	Hygric	Cumulic & Gleyed Regosols	108	30	22	100	115
Salix (glauca, barclayi) - Petasites palmatus	XXX	1220-1430	0 - 5 (1)	Flat (All)	Medium	Imperfect - poor	Subhygric - hygric	Rego & Humic Gleysols	127	42	22	86	170
Salix glauca - Betula glanoulosa - Festuca altaica	XXX	1300-1450	0 - 50 (23)	All	Medium	Moderate	Mesic	Brunisols, Humo-Ferric Podzols	68	27	37	100	177
Betula glandulosa - Festuca altaica - Hylocomium splendens	XXX	1300-1675	0 - 45 (12)	N, E, W	Late	Moderate - good	Mesic	Humo-Ferric Podzols, Dystric Brunisols	65	24	40	100	176
Juniperus communis - Arctostaphylos uva-ursi	X	1250-1630	15 - 60 (48)	S	Very early	Good - rapid	Xeric - subxeric	Brunisols, Regosols	85	27	34	95	98
Poa glauca - Carex supina	X	1495-1700	35 - 70 (51)	S	Snow-free	Good - rapid	Xeric - subxeric	Eutric & Melanic Brunisols	74	27	38	100	96
Festuca altaica	XX	1220-1700	0 - 70 (32)	S, W	Early-medium	Moderate - good	Submesic - mesic	Melanic & Sombric Brunisols	127	28	60	100	121
Festuca altaica - Luzula parviflora	X	1220-1675	0 - 25 (8)	E, N, SE	Late	Moderate -imperfect	Mesic - subhygric	Gleyed Brunisols, Humic Gleysols	93	26	24	96	125
Heracleum sphondylium	X	1400-1585	5 - 40 (13)	S, W	Late	Imperfect - poor	Subhygric - hygric	Gleyed Regosols & Rego Humic Gleysols	47	19	67	100	135
Carex rostrata - - C. aquatilis	X	1220-1370	0	Flat	Medium	Very poor	Subhygric - hydric	Organics, Humic Gleysols	30	8	44	67	93

[a] The one-few species used to name community type.

where it often forms pure stands. Higher in the subalpine zone, in passes and wide valleys subject to cold air drainage and ponding, valley bottoms are typically treeless and occupied by a mosaic of shrubfields, marshes, fens, and grassland. A skirt of forest occurs on lower and middle slopes, and shrubs and krummholz dominate above the intermediate forested belt.

(a) Pinus contorta - Betula glandulosa - Pleurozium schreberi.

Lodgepole pine forest occurs only in the northeastern corner of the ecological reserve, near the outlet of Cold Fish Lake. This community type has developed on Humo-Ferric Podzols and Dystric Brunisols over coarse textured, rapidly drained glaciofluvial outwash and alluvial terraces.

The pine stands are relatively open (total mean canopy cover of 62%), with trees occasionally reaching 18 m in height. The presence of charcoal in the soil profiles, and frequent spruce in the canopy, subcanopy, and as saplings and seedlings, indicate the seral nature of this forest type.

The shrub stratum is moderately to poorly developed, with a total mean cover of 20%. Betula glandulosa dominates, and Salix glauca, S. scouleriana, and Shepherdia canadensis are fairly frequent.

Prominent in the moderately developed dwarf shrub/herb stratum are Empetrum nigrum , Vaccinium vitis-idaea, V. caespitosum, Festuca altaica, and Lupinus arcticus.

The cryptogamic ground cover is well-developed. Prominent mosses are Pleurozium schreberi and Dicranum fuscescens; Hylocomium splendens and Polytrichum juniperinum are frequent. Lichens are common and abundant, especially Cladina mitis, C. rangiferina, C. alpestris, other Cladoniae (Cladonia gracilis, C. ecmocyna, C. uncialis, C. gonecha, C. chlorophaea), and Peltigera aphthosa and P. malacea.

Epiphytes are moderately abundant. Typical species, for pine forests as well as most other types within the reserve, are Alectoria

americana, Cetraria pinastri, Hypogymnia austerodes, H. physodes, Parmelia sulcata, Parmeliopsis ambigua, and P. hyperopta.

Lodgepole pine forests are fairly common in the SWB of the upper Stikine region, but are much more frequent and widespread at lower elevations in the BWBS, presumably because of greater frequency and extent of wildfires. Similar subalpine forests have been briefly described by Anderson (1970) in the Atlin area of northwestern British Columbia, by Luckhurst (1973) in the Rocky Mountain foothills of northeastern B.C., and by Geist et al. (1974) in the south central Yukon.

(b) Populus tremuloides - Juniperus communis - Festuca altaica.

Stands of trembling aspen occur frequently within the reserve on convex, south slopes of valley bottom moraines and glaciofluvial deposits, and on steep, colluvial, generally south-facing, lower mountain slopes. The aspen community type has two physiognomic phases, forest and scrub. Open forest with erect aspen trees to 15 m tall is rare in the Gladys Lake area, occurring on valley-bottom moraines, kames, and eskers in the northeast corner of the reserve. These few subalpine forest stands are related to those that occur commonly in the montane zone, but are grouped here with the subalpine scrub that is much more common in the SWB and is very similar in species composition. In the open forest phase, shrubs are uncommon, the herb layer is well-developed, and the cryptogamic layer sparse. Soils are shallow to moderately deep Brunisols with dark surface (Ah) horizons. Anderson (1970), Cathey (1974), Douglas (1974), Viereck (1975), and Orloci and Stanek (1979) have described similar aspen forests in the Atlin, Mt. Edziza, southwest Yukon, interior Alaska, and southern Yukon areas, respectively.

Tall scrub or "pygmy forest" of aspen occurs to 1500 m on steep, dry, south- or southwest-facing lower colluvial slopes in the Gladys Lake study area. The pygmy forest consists of fairly dense stands of

stunted, gnarled, young aspen with pole-sized trunks. "Tree" height is 2-7 m, DBH averages 7 cm, and tree age is apparently less than 50 years -- although older stands with thicker trees do occur. In the pygmy forest, the shrub and herb strata are both moderately developed, and the cryptogamic layer sparse. The shallow, dark-coloured soils are skeletal Brunisols or Chernozem-like, colluvial Regosols. Annas (1974) in the southern Yukon, Lord and Luckhurst (1974) in the northern Rocky Mountain foothills, and Viereck et al. (1983) in interior Alaska have described similar aspen communities.

Characteristic shrub species of both forest and scrub are Salix scouleriana (which occasionally reaches the canopy or subcanopy), Shepherdia canadensis, Rosa acicularis, and Viburnum edule. Juniperus communis, Arctostaphylos uva-ursi, and Linnaea borealis are common dwarf or prostrate woody species. Festuca altaica, Epilobium angustifolium, Lupinus arcticus, Mertensia paniculata, Arnica cordifolia, Fragaria virginiana, Achillea millefolium, Delphinium glaucum, and Poa interior and P. glauca 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, Brachythecium salebrosum, and Cladonia pyxidata are common in some stands.

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

The aspen forest has a fire history. Seral stands on more mesic sites have white spruce slowly coming up underneath, but the pygmy forest has very little spruce invasion and appears to be a pyroedaphic climax type.

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 - Epilobium angustifolium.

Balsam poplar "pygmy forest" occurs up to 1500 m on steep, colluvial, generally south-facing, mountain slopes. It is an uncommon community type within the ecological reserve and often occurs with aspen pygmy forest, but there are very few mixed stands. Balsam poplar occupies moister sites than does aspen, and in several stands some downslope seepage was evident. Balsam poplar stands are often found on slightly concave slopes, and snowpack is probably heavier and longer-lasting then beneath aspen. Douglas (1974) and Birks (1977) recognized somewhat similar balsam poplar community types, but Lord and Luckhurst (1974) and Hoefs et al. (1975) 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 sphondylium, Thalictrum occidentale, Geranium richardsonii, and Lupinus arcticus are prominent forbs. Bromus richardsonii is the only common grass. The cryptogamic layer is poorly developed or even lacking, and epiphytes are sparse.

In the upper Stikine region, well-developed alluvial balsam poplar or poplar - spruce forest types occur only in the montane or BWBS zone, on floodplain terraces of the Stikine and lower Klappan rivers.

(d) Picea glauca - Hylocomium splendens.

Closed white spruce forest is present within the reserve on some north- and east-facing lower slopes, and on a few older alluvial

terraces along major creeks. Soils are cold, moist, and generally deep, till-derived Podzols and Luvisols, or gleyed alluvial Regosols and Brunisols. Such forest types are widespread and represent climatic climax vegetation in the montane zone of the upper Stikine region, but occur only in pockets in the subalpine zone. Roughly similar community types have been reported by Anderson (1970), Kojima (1972), Cathey (1974), Douglas (1974), Geist et al. (1974), Lord and Luckhurst (1974), Viereck (1975), Orloci and Stanek (1979), and Viereck et al. (1983).

The alluvial phase of this community type, which is rare in the reserve, is common in the surrounding region in the lower major river valleys. It is found on poorly to moderately drained, alluvial flood plains with silty or fine sandy parent material, and resembles the Picea glauca - Ribes triste - Equisetum pratense - Drepanocladus uncinatus association of Kojima (1972).

The P. glauca - Hylocomium splendens forest has a closed canopy (mean cover of 70%) and is moderately to densely stocked. Trees attain their best growth in the reserve in this type, with heights averaging 17-20 m and occasionally reaching 25 m. White spruce is the dominant tree species, and is reproducing in most of the stands of this climax type. Subalpine fir is frequently found in the overstory and as a sapling and seedling, especially in north-slope 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, Arnica cordifolia, and Mertensia paniculata. In the alluvial phase of this community type, Equisetum spp. (E. arvense, E. pratense, E. scirpoides, E. sylvaticum) are more frequent, along with Petasites palmatus.

The cryptogamic layer is very well-developed and carpet-like. The feather mosses Hylocomium splendens, Pleurozium schreberi, and (to a much 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 P. glauca - H. splendens community type.

(e) Picea glauca - Betula glandulosa - Salix glauca.

Open forest and woodland[1] with abundant shrub cover is general on uplands 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 entire upper Stikine region. 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 (climatic climax) dominance of this general type of community. Similar communities have been described by Anderson (1970), Luckhurst (1973), Douglas (1974), Viereck (1975, 1979), and Viereck et al. (1983).

The Gladys Lake P. glauca - B. glandulosa - S. glauca stands have an open canopy (mean cover of 33%), with widely spaced trees usually less than 17 m tall. Mature spruce have a greater DBH and are shorter than in the P. glauca - Hylocomium splendens closed forest type. White spruce regeneration was present in nearly all of the stands sampled. All stands have evidence of past fire. Soils are Gray Luvisols, Dystric Brunisols, and Humo-Ferric Podzols.

The shrub layer is moderately to well-developed. Betula

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[1]Woodland: scattered trees, canopy coverage 10-25% (Fosberg 1967).

glandulosa and Salix glauca are the prominent species. Both are abundant in most stands, but B. glandulosa predominates on colder, moister, northern slopes, while S. glauca does so on drier sites with southern aspects. In the former situation, the plant cover can be characterized as a Picea - Betula phase. Douglas (1974) gave this phase community type status in the Alsek Valley. However, in the Gladys Lake area, it appears to be merely an extreme phase linked by intermediate stands to a Picea - Salix phase, all within the P. glauca - B. glandulosa - S. glauca community type.

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.

The cryptogamic stratum is well-developed. Prominent mosses are Pleurozium schreberi, Hylocomium splendens, Dicranum fuscescens, and Polytrichum juniperinum. Cladina mitis, C. rangiferina, C. ecmocyna, Cladonia gracilis, C. cornuta, C. deformis, C. gonecha, C. uncialis, Stereocaulon alpinum, 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 - Hylocomium splendens - Pleurozium schreberi.

Closed forest of subalpine fir is local within the reserve, with best development on a few northern mid-slopes. This community type is more widespread in the southwestern section of the wilderness park, where there seems to be a moister climate with greater snowfall. The relatively deep, podzolic or brunisolic soils are cold and moist, but without permafrost. Geist et al. (1974) briefly described similar, nearly pure subalpine fir stands in the south central Yukon.

Subalpine fir forms stands with patchy, incompletely closed canopies (mean total cover of 50%) and moderately dense stocking. Tree growth is poor, with an average height of 15 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 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. Additional common bryophytes are Barbilophozia lycopodioides, Dicranum scoparium, Brachythecium spp., Drepanocladus uncinatus, Polytrichum juniperinum, 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.

Open subalpine fir forest and woodland are common on steep, moist midslopes, with best development on northern exposures. Soils are moist to wet, cold, Podzols and Gleysols. As Picea - Betula - Salix is the dominant forest community type at lower elevations in the subalpine zone, so Abies - Betula - Empetrum is in the higher subalpine. The open forest and woodland grade into dwarfed clumps and eventually krummholz or "shintangle" on upper slopes. The treeline is thus gradual. The krummholz belt generally occurs at alpine elevations (1600+ m) and is included in the AT zone.

Luckhurst (1973), Cathey (1974), and Geist et al. (1974) have described similar Abies - Betula - Empetrum communities.

The trees are widely spaced and very poorly growing (10 m or less in height). Subalpine fir reproduction is common, 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 meter 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 are abundant on wetter sites with gleyed soils.

Prominent in the dwarf shrub/herb stratum are Empetrum nigrum and Vaccinium vitis-idaea. Artemisia arctica, Cornus canadensis, Linnaea borealis, Lupinus arcticus, Mertensia paniculata, Pedicularis labradorica, and Festuca altaica also occur, and Arctostaphylos rubra 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 - Hylocomium - Pleurozium community type. Important species include Cladina alpestris, C. mitis, C. rangiferina; Cladonia cornuta, C. gracilis, C. ecmocyna, C. chlorophaea, C. cenotea, C. coccifera, C. deformis, C. gonecha, C. crispata, and C. uncialis; Peltigera aphthosa, P. scabrosa, P. malacea; Nephroma arcticum, 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 Abies - Hylocomium - Pleurozium forests.

4.1.2 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 swamps and shrub fens to dry colluvial scrub (Tables 1 and 2).

(a) Salix barclayi - Betula glandulosa - Carex aquatilis - Aulacomnium palustre.

Subalpine shrubby wetlands 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. Swamps and fens have also developed in potholes in moraine fields, pitted outwash, and kame terraces, and as backswamps between mountain bases and natural levees along the streams. As well, wetlands occur along lake margins and in areas swamped by beaver ponds. Shrub and forest swamps 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 shrubby swamp or fen, following the classification of Sjörs (1963), Heinselman (1963, 1970), Zoltai et al. (1975), and Tarnocai (1980). That is to say, the wetland waters appear to be 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 seepage down from higher ground. Soils are organics, Humic Gleysols, and gleyed Regosols. Anderson (1970), Kojima (1972), Cathey (1974), and Douglas (1974) have reported somewhat similar wetlands. There are no true bogs in the ecological reserve.

Trees are often lacking; if present, they are widely scattered, stunted, and slow-growing. White spruce (most frequent) and lodgepole pine are the only tree species present in the Gladys Lake fens, and this appears to be the case in most of the wetlands of the

upper Stikine drainage. However, black spruce (Picea mariana) occurs in some swamps and bogs in the region, especially at lower elevations and in lower nutrient regimes.

The shrub stratum is moderately to well-developed. Salix barclayi, Betula glandulosa, Salix barrattiana, S. glauca, S. planifolia, and Potentilla fruticosa 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, Vaccinium microcarpum, Rubus chamaemorus, Rubus arcticus, Equisetum arvense, Carex disperma, C. vaginata, C. media, and Arctagrostis latifolia.

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

(b) Salix scouleriana.

Salix scouleriana forms a tall willow scrub on moderately to steeply sloping, mesic to dry, well-drained colluvial or till slopes with 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 region, and is often associated with pygmy stands of aspen and balsam poplar. Like the two Populus types, the Salix scouleriana scrub probably has a

moderate to heavy snowcover that melts off early in spring. Douglas (1974) described a similar community type 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. White spruce and balsam poplar 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 most common epiphytes.

(c) Salix alaxensis - Epilobium latifolium.

Riparian willow thickets develop on fresh alluvium on active floodplains of low gradient streams 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 Cumulic and Gleyed Regosols. The vegetation is in different seral 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, S. barclayi, and S. planifolia. Epilobium latifolium, Artemisia tilesii, Astragalus alpinus, Equisetum arvense, E. variegatum, Parnassia kotzebuei, Lupinus arcticus, Arctogrostis latifolia, Poa alpina, and Juncus arcticus are prominent in the herb stratum. Other characteristic herbs are Minuartia dawsonensis, Barbarea orthoceras, Erigeron acris ssp. debilis, Oxytropis campestris, Carex aurea, Deschampsia cespitosa, 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 type is similar to the Salix alaxensis - Calamagrostis canadensis - Drepanocladus uncinatus association of Kojima (1973).

Interestingly, there are no pioneer Dryas drummondii communities 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 British Columbia, and in the southern Yukon (Douglas 1974; Orloci and Stanek 1979).

(d) Salix (glauca, barclayi) - Petasites palmatus.

Medium-tall (1.5-3 m) willow thickets are common on wet sites in the valley bottoms on alluvial fans, meander plains, 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 S. barrattiana and Potentilla fruticosa are common. Betula glandulosa is generally not an important species in this community type.

The dwarf shrub/herb layer is rich in species and moderate to abundant in cover. Prominent species include Festuca altaica, Luzula parviflora, Poa leptocoma, Petasites palmatus, Rubus arcticus, Epilobium angustifolium, Achillea millefolium, Aconitum delphiniifolium, Mertensia paniculata, Polemonium caeruleum, Stellaria longipes var. altocaulis, and Senecio pauciflorus.

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, Plagiomnium venustum, and Peltigera scabrosa. Other locally common cryptogams are Brachythecium salebrosum, Climacium dendroides, Bryum pallescens, Tomenthypnum nitens, Blepharostoma trichophyllum, Cladonia cyanipes, and C. gonecha.

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

The most extensive cover of the subalpine zone of the Gladys Lake reserve is a dense scrub of Betula glandulosa and Salix spp. 1 to 2.5 m high. At lower elevations, it is mixed with Picea - Betula - Salix open forest and woodland, but at middle and upper subalpine elevations the shrub cover becomes increasingly dominant, especially on mesic to dry, well-drained sites. This scrub is climax vegetation over much of the upper

Stikine region. Except in the lower subalpine, tree reproduction beneath the shrub cover is rare. As well, the shrub communities appear to be encroaching on 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), Cathey (1974), Douglas (1974), Krajina (1975), Birks (1977),

and Orloci and Stanek (1979).

Salix - Betula scrub is widespread on mesic to dry, well-drained sites in valley bottoms and on lower slopes. It occurs generally except on cold, moist, northern slopes. The brunisolic to podzolic 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. Important associates are Epilobium angustifolium, Mertensia paniculata, Linnaea borealis, and Lupinus arcticus.

The moss layer is moderately to well-developed. Hylocomium splendens and Pleurozium schreberi are prominent mosses and Dicranum acutifolium is frequent. Peltigera aphthosa is the only prominent lichen, although other Peltigeras and 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 type.

(f) Betula glandulosa - Festuca altaica - Hylocomium splendens.

Betula glandulosa forms extensive thickets throughout the subalpine zone, but dominates most on mesic to moist, northern, middle and upper slopes. This Betula scrub (commonly called "buckbrush" by locals) is widespread throughout the upper Stikine region, and northern British Columbia and the southern Yukon in general (cf. Kojima 1973; Cathey 1974; Douglas 1974; Lord and Luckhurst 1974; Krajina 1975). Typical soils are shallow, coarse textured Podzols over moderately drained colluvium and till.

The shrub stratum is well-developed, often covering 100%. It is overwhelmingly dominated by Betula glandulosa, usually 0.8-2 m tall. Salix glauca is a frequent associate, but never dominates in this community type.

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

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

On drier sites, the bryophytes tend to cluster around the bases of the B. glandulosa clumps, while the lichens and Festuca altaica abound in patches in the open between the clumps. On moister sites, B. glandulosa 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.

Juniperus communis - Arctostaphylos uva-ursi dwarf scrub is fairly common on dry, lower to middle elevation, colluvial slopes, stabilized talus, rocky ridge-crests, and kame and esker faces. It is generally found on steep south slopes, at elevations up to 1630 m. J. communis - A. uva-ursi appears to be invading adjacent subalpine grassland, and at these elevations is itself succeeded (often very slowly) by aspen or balsam poplar pygmy forests, or by Salix - Betula scrub. Douglas (1974) described a similar community type in the southwestern Yukon.

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 macrantha, Saxifraga tricuspidata, Epilobium angustifolium, Achillea millefolium, Draba aurea, Gentianella 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 Brunisols over coarse, well-drained colluvium or glaciofluvial materials.

4.1.3 Herb community types

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

(a) Poa glauca - Carex supina.

This subalpine steppe is restricted to very steep (ca 30°), dry, south-facing colluvial slopes, between about 1490 and 1770 m in the study area. The Eutric and Melanic Brunisols have well-developed, dark Ah horizons but otherwise are shallow over colluvium, and this grassland type is largely snow-free in winter. Annas (1974) and Douglas (1974) have described similar steppe community types.

The well-developed herb layer is dominated by grasses and sedges, most notably Poa glauca and Carex supina ssp. spaniocarpa. Agropyron trachycaulum, Koeleria macrantha, Festuca altaica, F. saximontana, Trisetum spicatum, Carex petasata, and C. obtusata are additional important grasses and sedges. Prominent forbs are Potentilla pensylvanica, Artemisia campestris ssp. borealis, and Oxytropis campestris. Common associates are Potentilla nivea, Artemisia michauxiana, Cerastium beeringianum, Myosotis asiatica,

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 a topoedaphic climax, but other sites are being invaded by shrubs such as Rosa acicularis, Arctostaphylos uva-ursi, Potentilla fruticosa, and Juniperus communis.

(b) Festuca altaica.

Festuca altaica steppe 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 glaciofluvial and fluvial landforms, in the bottom of rapidly drained frost-pocket depressions in moraine fields, and on south-facing, lower and middle colluvial slopes. F. altaica steppe is of patchy occurrence in the reserve, but occasionally forms extensive cover in larger areas of glaciofluvial deposits. In the upper Stikine region, much more extensive steppe occurs in wide, drift-filled valleys subject to cold air ponding. Throughout the region, some areas of steppe appear to form topoedaphic climax vegetation, whereas other grasslands are being invaded by shrubs.

This grassland type is conspicuously dominated by Festuca altaica, the widespread bunchgrass of the subalpine steppe of the region (Pojar 1982). 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 delphiniifolium, Delphinium 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 common 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. furcata may be locally common.

Soils are dark, well-drained, and range from shallow, marginal Chernozems to deep, loamy Sombric and Melanic 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.

Lush grass-forb subalpine meadows are uncommon in the reserve. They are restricted to sites moister than those of the previous community type, and reach best development on gentle, often north- or east-facing lower slopes along broad ridges or the sides of wide valleys. Soils are deep and moderately to poorly drained (Gleyed Brunisols and Humic Gleysols). These meadows appear to be seral or edaphic subclimax vegetation, slowly being succeeded by moist Salix thickets and Betula glandulosa 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 delphiniifolium, Rumex acetosa, Senecio triangularis, Rubus arcticus, Vaccinium caespitosum, Myosotis asiatica, Epilobium angustifolium, and Polemonium caeruleum. Common associates are Castilleja unalaschcensis, Lupinus arcticus, Mertensia paniculata, Agoseris aurantiaca, Valeriana sitchensis, Veronica wormskjoldii, and Sanguisorba canadensis ssp. latifolia. 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.

Moist F. altaica - forb subalpine meadows are much more common in the moister southwestern part of the upper Stikine region. This is a common community type in the mountains further to the west. A coastal influence is indicated even in the study area by the occurrence in these meadows of such species as Fritillaria camschatcensis, Castilleja parviflora, Ranunculus occidentalis, and Viola langsdorfii. The F. altaica - forb subalpine meadows are related to the forb-rich timberline meadows of central and southern British Columbia, but have major floristic differences (cf. Hamet-Ahti 1978).

(d) Heracleum sphondylium.

Lush Heracleum sphondylium meadows are uncommon and of small extent in the Gladys Lake reserve. They develop over coarse alluvium on convex, sloping, fluvial fans at the bases of steep mountain creeks, and in concave lower slope seepage and snow accumulation areas. Soils are Gleyed Regosols and Rego Humic Gleysols, fed by continuous downslope seepage through these hygric sites.

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

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

As with the F. altaica - forb meadows, H. spondylium meadows have some coastal affinities and increase in abundance toward the

southwest of the region. Cirsium edule, Epilobium luteum, and Lupinus nootkatensis are three typically coastal species collected only in H. sphondylium communities in the reserve.

(e) Carex (rostrata, aquatilis).

Carex-dominated wetlands are not common in the reserve. They have developed in poorly drained depressions in till fields, and are encroaching on kettlehole lakes, oxbows, backwaters, and beaver sloughs. Soils are organics, Humic Gleysols, and Rego Humic Gleysols. Carex marshes and fens are pioneer and seral vegetation types, succeeded by shrub and forest fen types. Carex 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. They are fairly common throughout the region, 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. paupercula, and Eriophorum angustifolium, E. callitrix, and 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 abundant.

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

4.1.4 Talus - lichen - moss terrain unit

The only cryptogam-dominated vegetation in the subalpine zone of the Gladys Lake reserve might be characterized as the (Dryopteris

fragrans) - lichen - moss community type. However, this nowhere forms continuous, homogeneous cover, and the vegetation 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) is uncommon and occurs below 1450 m. It comprises pioneer vegetation on partially stabilized, south-facing talus and rubble slopes. It appears to be transitional to Juniperus communis - Arctostaphylos uva-ursi communities. Similar communities have been described on recent lava in the nearby Mt. Edziza area by Cathey (1974).

There is a preponderance 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 the talus.

The herb stratum is sparse. There are no prominent species, but Dryopteris fragrans , Cystopteris fragilis, Festuca saximontana, Saxifraga tricuspidata, Poa glauca, and Koeleria macrantha 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, important species include Rhacomitrium lanuginosum, Cladina alpestris, C. mitis, Cetraria nivalis, Stereocaulon tomentosum, S. saxatile, S. paschale, Cladonia uncialis, Rhizocarpon geographicum agg., Rhizocarpon eupetraeum, Parmelia stygia, P. taractica, Lecidea spp., Actinogyra muehlenbergii, Umbilicaria hyperborea, and U. proboscidea. 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, Barbilophozia hatcheri, Ptilidium ciliare, Cladina rangiferina, Cladonia amaurocraea, C. coccifera, C. gracilis, C. pyxidata, C. crispata, Cetraria cucullata,

Alectoria ochroleuca, Sphaerophorus fragilis, Thamnolia subuliformis, Dactylina arctica, Parmelia omphalodes, P. infumata, P. saxatilis, Physconia muscigena, Umbilicaria vellea, Xanthoria elegans, Lepraria chlorina, Lecidea macrocarpa, Haemotomma lapponicum, and Lecanora spp.

4.2 Alpine Vegetation of the Gladys Lake Ecological Reserve

4.2.1 Shrub Community Types

Shrub types are common at low to middle elevations (roughly 1600-1800 m) of the alpine zone of the Gladys Lake reserve. There are three basic types (see Tables 3 and 4).

(a) Abies lasiocarpa - Cassiope mertensiana.

Subalpine fir tree clump and krummholz communities are local within the reserve, occurring on some upper valley bottoms and middle slopes, usually on colluvial materials. Such communities are much more common in the southwestern part of the region (cf. Welsh and Rigby 1971), an area of heavier snowfall. The A. lasiocarpa - C. mertensiana community type is very common and characteristic in the leeward coastal mountains of British Columbia. Subalpine fir forms dense, stunted clumps in the tree clump-heath complex at lower alpine elevations, and krummholz on mid-slopes to 1700 m. Reproduction by layering and seedlings is abundant. Soils are shallow and podzolic

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

The dwarf shrub/herb layer is well-developed and dominated by woody mats of Cassiope mertensiana and Empetrum nigrum. Rubus pedatus, Linnaea borealis, Phyllodoce empetriformis, Luetkea pectinata, and Vaccinium caespitosum are also common woody species. Additional characteristic

TABLE 3. Composition of plant community types in the alpine zone of the Gladys Lake Ecological Reserve. Data are for prominence value indices[a].

Strata and species	ALC[b] (5)[c]	BEH (7)	SAB (6)	CME (5)	CDI (18)	FEA (14)	PRU (13)	KOM (12)	SCM (26)	DRY (6)	SCA (6)	STO (11)	AFF (9)
Shrubs													
Abies lasiocarpa	850												
Vaccinium membranaceum	52												
Betula glandulosa	8	868	9		T								
Salix glauca		11	T										
Salix planifolia ssp. *pulchra*		9	10			1			T		17		
Salix barrattiana		8	912			T					5		
Salix commutata			10										
Dwarf shrubs/herbs													
Cassiope mertensiana	410			625									
Empetrum nigrum ssp. *hermaphroditum*	34	73		13	T								
Phyllodoce empetriformis	32			79									
Luetkea pectinata	20			98									
Lycopodium alpinum	15			18	T	15							
Juncus drummondii	12			31								2	
Hieracium gracile	10			18									
Artemisia arctica	8	70	48	85	6	153	6	T	6			32	
Sibbaldia procumbens	7	1		50		2					2	4	
Lupinus arcticus	5	24	5	4	27	9	T	14	T	100			
Luzula parviflora	3	1	13	18		T					5	10	
Aconitum delphiniifolium	2	1	5		T	1	21	T	T		11	15	
Gentiana glauca	2			12	T	11	T	T	T	T		T	
Vaccinium vitis-idaea ssp. *minus*	1	11		T	10	13	2	4		2	2		
Carex podocarpa	T		9	9	45	8	10		19		10	106	
Mertensia paniculata	T	11	67		T		22					T	
Poa arctica	T			2	11	14	2	7	16			10	
Stellaria longipes var. *altocaulis*	T	7	5		17	5	34	16	11	6		5	
Pyrola grandiflora	T				10				T				
Festuca altaica		80	49	18	23	408	30	4	25	12	6	4	
Epilobium angustifolium		13	2				9						
Vaccinium uliginosum		4		T	61	T		T		23	2		
Polemonium caeruleum ssp. *villosum*		1	66		3	1	T		T		2	15	
Salix reticulata		1	48		180	1	T	22	69	79	170	83	
Rubus arcticus ssp. *acaulis*		1	46								17	4	
Delphinium glaucum		1	38										
Senecio lugens		1	26		3		3	T	1		8	5	
Veronica wormskjoldii		1	13						T		2	8	
Bistorta vivipara		1	13	2	17	13	8	47	46	30	25	8	

TABLE 3. Continued

Strata and species	ALC[b]	BEH	SAB	CME	CDI	FEA	PRU	KOM	SCM	DRY	SCA	STO	AFF
Cassiope tetragona		1		2	210	T							
Campanula lasiocarpa		1			3	18	3	9	8	2			
Poa alpina		T	10		6	T	14	13	3	6	2	31	
Equisetum arvense			77	2							8	4	
Petasites nivalis			76								5	34	
Senecio triangularis			30								6	7	
Carex aquatilis			25								277		
Anemone richardsonii			18		T							5	
Anemone parviflora			17		13	1			2		5	35	
Sanguisorba canadensis ssp. latifolia			17								23	23	
Pedicularis sudetica			13									2	
Claytonia sarmentosa			5		T		3					57	
Epilobium anagallidifolium			5								2	10	
Equisetum variegatum			5								25	16	
Saxifraga lyallii			5		T							19	
Ranunculus eschscholtzii			2	9							2	71	
Epilobium latifolium			2	9								10	
Myosotis asiatica			2				14	2	T	2		T	
Pedicularis capitata			2		45			T	1	2	2	T	
Potentilla diversifolia			2			7	27				2	T	
Trisetum spicatum			2		T	1	59		T				
Salix polaris				22	77	25	6	55	197	22	2	117	7
Carex pyrenaica				14									
Dryas integrifolia					244	3	7	24	6	182	5	T	
Carex microchaeta					46	69	3	51	179	40		15	10
Silene acaulis					15	11	4	32	16	50			16
Antennaria monocephala					6	15	3	8	36	2		4	
Luzula confusa					5	7	3	7	10				
Kobresia myosuroides					5	T	19	380	2	113			
Saxifraga tricuspidata					2	3	10	10	3	6			12
Hierochloe alpina					T	40	60	58	29	18			
Calamagrostis lapponica					T	T			4		11	24	
Ranunculus nivalis					T				T		2	15	
Tofieldia pusilla					T						24		
Festuca brachyphylla					T	2	15	11	12	19			7
Carex scirpoidea					T		T				8	10	
Oxytropis nigrescens					T		T	20	T	62			2
Luzula spicata						22	6	14	9	6		T	
Potentilla hyparctica						3	7	7	12	8		T	8
Carex albonigra						1	43	14					

TABLE 3. Continued

Strata and species	ALC[b]	BEH	SAB	CME	CDI	FEA	PRU	KOM	SCM	DRY	SCA	STO	AFF
Draba nivalis						T	3	24	3	18			1
Potentilla uniflora						T	28	21	T	79			2
Carex bipartita						T	T		T		2	16	
Agropyron violaceum						T	53						
Poa rupicola							212	26	T	2			
Carex supina ssp. spaniocarpa							86	4					
Potentilla nivea							70	11	6				
Carex obtusata							17						
Calamagrostis purpurascens							16	4	16				
Potentilla hookerana							15						
Artemisia tilesii s. lat.							12					4	
Festuca saximontana							10						
Minuartia rubella							T	7	12				
Cardamine bellidifolia							T	T	1			5	10
Campanula uniflora								3	T	12			
Saxifraga cespitosa								T	T	3			13
Trichophorum cespitosum											55		
Eriophorum callitrix											28		
Eriophorum angustifolium											11		
Caltha leptosepala											7	67	
Parnassia fimbriata												22	
Bryophytes													
Hylocomium splendens	180	221	64		150	3	5		7		8	23	
Barbilophozia hatcheri	98	23		240	25		3		5				
Brachythecium spp.	33		12								18	40	
Barbilophozia floerkei	25			150								38	
Dicranum acutifolium	15	68	2	50	60	6	20	11	11	2		8	
Pleurozium schreberi	12	100		T	T								
Polytrichum juniperinum	12	39		8	8	36							
Dicranum fuscescens	12			25									
Drepanocladus uncinatus	12											55	
Blepharostoma trichophyllum	10			80	75		8						
Dicranum scoparium	5	15		100									
Ptilidium ciliare	2				2				3			3	10
Ptilium crista-castrensis	T	23											
Distichium capillaceum	T			58	165		20	2	5				
Bryum angustirete	T					49	3	44	45	12			
Rhytidium rugosum		19			97	12	17	14	33	38	8	17	
Aulacomnium palustre		4	24		8						180	72	

TABLE 3. Continued

Strata and species	ALC[b]	BEH	SAB	CME	COI	FEA	PRU	KOM	SCM	DRY	SCA	STO	AFF
Tomenthypnum nitens			163		7						300	164	
Drepanocladus revolvens			36						T		104	57	
Plagiomnium venustum			27								15		
Sphagnum spp.			15								162	11	
Calliergon stramineum			15								15		
Calliergon cordifolium			14								51	8	
Paludella squarrosa			7								87	71	
Mnium blyttii			7		T						51	21	
Philonotis fontana			T								18	30	
Rhacomitrium canescens				25	5	1							
Tortula ruralis					16	3	3	12	5	3			
Polytrichum piliferum					8	170	14	31	80	16			35
Aulacomnium turgidum					7				T			12	
Ditrichum flexicaule						2		5	10	3			
Rhacomitrium lanuginosum								21	12	4			50
Conostomum tetragonum									11				8
Polytrichum strictum									T		12	8	
Plagiomnium ellipticum											91		
Meesia triquetra											12		
Polytrichum longisetum											11		
Cinclidium stygium											8	25	
Bryum cryophilum												25	
Pohlia wahlenbergii												20	
Dicranoweisia crispula													15
Lichens													
Nephroma arcticum	35	26		2	2	3						8	
Solorina crocea	25	T		108	7	7			4				8
Peltigera aphthosa	15	110	15	5	22	3	2		4		2	T	
Cladonia gracilis	13	71		7		3							
earth crusts[d]	13			25	67	24	12	102	75	120			110
Stereocaulon paschale	8	8		20	90	145		5	73	6	5	T	11
Cladonia gonecha	5	19											
Peltigera scabrosa	5	15	10	19					T			12	
Lobaria linita	5	8		161	39	9			T				
Cladina mitis	2	57		5	22	92			T				
Cladonia uncialis	T	10		5		5							
Cladina alpestris		101			29	148			4	2			
Cladina rangiferina		68				44							
Peltigera malacea		23	2		2	9	T	T				10	

TABLE 3. Continued

Strata and species	ALC[b]	BEH	SAB	CME	CDI	FEA	PRU	KOM	SCM	DRY	SCA	STO	AFF
Cetraria cucullata		19			61	80	5	46	41	55			22
Dactylina arctica		19			53	21	2		14			T	8
Cetraria islandica		14	T	93	42	79	T		38	2			12
Cladonia pleurota		10		13	T	6							
Stereocaulon alpinum		5		19	8	50			15				
Cetraria nivalis		4			57	96	17	108	45	70			84
Thamnolia spp.					28	27	T	35	32	18			20
Cladonia pyxidata					4	13	1	3	6				
Cornicularia aculeata					4	T	T	14	8	12			15
Cetraria tilesii					4			3	T	31			25
Alectoria ochroleuca					2			16	10	12			38
Cetraria delisei					2				8				25
Cetraria ericetorum					2				2				10
Dactylina ramulosa					T	8	3	T	5				13
Cladonia coccifera						10							
Parmelia separata						T	21	T		10			12
Cornicularia divergens							36	3		5			20
Parmelia stygia							8	2		7			15
Alectoria nigricans							8						13
Pertusaria dactylina							2	T		3			15
Stereocaulon rivulorum							2						10
Umbilicaria proboscidea							1	6		8			45
Rhizocarpon geographicum agg.							T	2		7			40
Umbilicaria hyperborea							T	T		T			12
Alectoria minuscula							T			5			40
Sphaerophorus fragilis								1		4			10
Hypogymnia oroarctica								T					10
Parmelia centrifuga										3			12
Umbilicaria cylindrica										T			25
Lecanora spp.													35
Sporostatia testudinea													25
Stereocaulon saxatile													25
Parmelia omphalodes													18
Cetraria hepatizon													15
Xanthoria elegans													15
Parmelia infumata													12
Parmelia taractica													12

TABLE 3. Concluded

Strata and species	ALC[b]	BEH	SAB	CME	CDI	FEA	PRU	KOM	SCM	DRY	SCA	STO	AFF
Pertusaria spp.													12
Dermatocarpon moulinsii													10
Haemotomma lapponicum													10
Dactylina madreporiformis													10
Buellia verruculosa													10
Average cover (%)													
Stunted trees	85												
Low shrubs	7	93	93										
Dwarf shrubs and herbs	55	32	44	96	89	73	100	73	64	61	90	86	8
Bryophytes and lichens	40	59	44	28	45	56	11	45	46	35	43	38	58
Bare ground					3	1	3	9	9	25			45

[a]Only those species with a prominence value of 10 or more in at least one community type are listed; T (trace) indicates a prominence value of less than 0.5.

[b]Community type abbreviations: ACL, *Abies lasiocarpa* - *Cassiope mertensiana*; BEH, *Betula glandulosa* - *Hylocomium splendens*; SAB, *Salix barrattiana*; CME, *Cassiope mertensiana* - *Barbilophozia hatcheri*; CDI, *Cassiope tetragona* - *Dryas integrifolia*; FEA, *Festuca altaica* - *Artemisia arctica*; PRU, *Poa rupicola*; KOM, *Kobresia myosuroides*; SCM, *Salix polaris* - *S. reticulata* - *Carex microchaeta*; DRY, *Dryas integrifolia* - *Oxytropis nigrescens*; SCA, *Salix reticulata* - *Carex aquatilis*; STO, *Salix polaris* - *S. reticulata* - *Tomenthypnum nitens*; AFF, alpine fellfield.

[c]Number of stands sampled appears in parentheses.

[d]"Earth crusts" include *Lepraria neglecta*, *Ochrolechia upsaliensis*, *Lecanora* spp., *Lecidea* spp., *Psoroma hypnorum*, *Rinodina turfacea*, *Pannaria pezizoides*, *Caloplaca tiroliensis*, among others.

TABLE 4. Summary of environmental and community characteristics for alpine plant community types, Gladys Lake Ecological Reserve

Community type	Relative abundance in reserve	Elevation range (m)	Slope (%) range and (mean)	Aspect	Snow release	Drainage	Moisture regime	Soil classification	Total no. species	Mean no. species	Mean cover (dominants[a]) (%)	Mean frequency (dominants[a]) (%)	Mean total plant cover (%)
Abies lasiocarpa - *Cassiope mertensiana*	XX	1500-1750	5 - 65 (40)	N, E, W	Late	Moderate - rapid	Mesic - submesic	Humo-Ferric Podzols	55	21	63	100	187
Betula glandulosa - *Hylocomium splendens*	XXX	1500-1710	0 - 60 (22)	All	Late	Imperfect - good	Mesic - submesic	Podzols	61	22	51	93	184
Salix barrattiana	XX	1500-1710	2 - 25 (25)	All	Late	Poor	Hygric	Cumulic Regosols, Humic Gleysols	78	28	91	100	181
Cassiope mertensiana - *Barbilophozia hatcheri*	X	1500-1890	3 - 50 (21)	N, E, W	Very late	Moderate	Mesic	Dystric Brunisols Humic Regosols	60	23	43	100	124
Cassiope tetragona - *Dryas integrifolia*	XXX	1615-1920	3 - 55 (25)	N, E, NW	Late	Moderate -imperfect	Mesic - subhygric	Brunisols, Humic Regosols, Humic Gleysols, Cryosols	110	31	24	89	134
Festuca altaica - *Artemisia arctica*	XXX	1615-1900	0 - 45 (21)	S, W, E	Early-medium	Good - rapid	Submesic - mesic	Eutric & Melanic Brunisols	80	27	28	100	129
Poa rupicola	X	1500-2050	0 - 40 (8)	S, W	Snow-free	Good-rapid	Submesic	Eutric & Melanic Brunisols	102	25	23	85	111
Kobresia myosuroides	X	1710-2100	2 - 25 (7)	All	Snow-free	Good-rapid	Xeric - submesic	Eutric & Melanic Brunisols, Humic Regosols	85	31	38	100	118
Salix (*polaris*, *reticulata*) - *Carex microchaeta*	XXX	1550-2150	0 - 50 (7)	All	Medium	Moderate-imperfect	Mesic - subhygric	Dystric Brunisols Humic Regosols, Gleysols, Organics, Cryosols	105	28	16	87	110
Dryas integrifolia - *Oxytropis nigrescens*	XX	1750-2100	18 - 30 (25)	S, W	Very early	Good-rapid	Xeric - submesic	Regosols, Eutric Brunisols	65	30	13	80	96
Salix reticulata - *Carex aquatilis*	X	1500-1950	0 - 2 (25)	Flat	Late	Poor	Hygric-subhydric	Organics, Humic Gleysols	65	23	23	100	133
Salix (*polaris*, *reticulata*) - *Tomenthypnum nitens*	XX	1525-2100	2 - 15 (6)	All	Very late	Imperfect - poor	Hygric-subhydric	Humic Regosols, Cryosols	106	28	16	61	124

[a] The one-few species used to name the community type.

species include Cornus canadensis, Sibbaldia procumbens, Lycopodium alpinum, L. annotinum, Artemisia arctica, Hieracium gracile, Arnica latifolia, and Juncus drummondii.

The cryptogamic stratum is well-developed, but lichens are much less abundant than in the Abies - Betula - Empetrum community type of the subalpine zone. Prominent bryophytes are Dicranum spp., Hylocomium splendens, Barbilophozia lycopodioides, B. hatcheri, B. floerkei, Brachythecium spp., and Rhytidiopsis robusta. The lichens Nephroma arcticum, Cladina mitis, Peltigera aphthosa, and Solorina crocea are fairly frequent.

(b) Betula glandulosa - Hylocomium splendens.

Alpine B. glandulosa thickets are common on mesic to moist, steep or gradual, upper colluvial or morainal slopes. They also occur on kame crests in some high, exposed passes. The podzolic soils are generally moist and shallow, with fairly thick humus layers. Floristically the alpine scrub is similar to the subalpine B. glandulosa community type, 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), and has also been described by Cathey (1974), Ogilvie (1976), Birks (1977), and Buttrick (1977).

The shrub stratum is moderately to well-developed. Betula glandulosa is the prominent species. It is usually 1 m tall or less, much shorter than in the subalpine Betula community type. 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 longipes var. altocaulis. 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.

(c) Salix barrattiana.

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, or 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 snowpack in these habitats is thick, but usually melts several weeks earlier than in typical snowbed areas. This community type is similar to the Salicetum barrattianae of Hoefs et al. (1975) and to that described by several authors in the Canadian Rocky Mountains (see Ogilvie 1976), by Buttrick (1977) in the Atlin area, and by Selby (1980) in the Chilcotin Mountains of British Columbia.

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 Equisetum arvense, Petasites nivalis, Rubus arcticus, Polemonium caeruleum, and Mertensia paniculata. Important associates are Senecio lugens, S. triangularis, Delphinium glaucum, Artemisia arctica, Pedicularis sudetica, Bistorta vivipara, 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 spp., Mnium blyttii, Plagiomnium venustum, Aulacomnium palustre, and Peltigera aphthosa are important associates.

Salix planifolia occasionally forms nearly pure stands on similar sites within the reserve. Except for the dominant shrub species, the S. planifolia stands are very similar to Salix barrattiana thickets.

4.2.2 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 three heath (dwarf evergreen shrub) community types, three dwarf deciduous tundra types, three grassland types, a mossy seepage type, a lichen fellfield type, and several additional plant assemblages characteristic of certain terrain units (Tables 3 and 4).

(a) Cassiope mertensiana - Barbilophozia hatcheri.

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 Regosols. 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 upper Stikine region, being restricted to protected, mesic to moist, snow-accumulation sites. Similar community types have been described by Buttrick (1977), Douglas and Bliss (1977), and Hrapko and La Roi (1978).

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

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

(b) Cassiope tetragona - Dryas integrifolia.

Cassiope - Dryas heath is widespread throughout the Spatsizi area. It is the predominant community type 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 northern and eastern slopes with cold, mesic to moist soils (alpine Brunisols, Humic Regosols and Gleysols, or Turbic and Organic Cryosols). Seepage and solifluction are common, and ice lenses may be present in the subsoil. The hummocky terrain is due to Cassiope and Dryas clumps and frost-heaving. This heath type is very similar to the Salico (reticulatae) - Cassiopo (tetragonae) - Dryadetum integrifoliae described in Hoefs et al. (1975), and similar community types have been described by Birks (1977) and Hrapko and La Roi (1978).

The dwarf shrub/herb layer is well-developed, generally covering 80-90%. Prominent species are all dwarf shrubs: Cassiope tetragona, Dryas integrifolia, 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 longipes var. altocaulis, Bistorta vivipara, 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 Distichum capillaceum, Hylocomium splendens, Dicranum acutifolium, Rhytidium rugosum, and Stereocaulon paschale. Important associates are Blepharostoma trichophyllum, Barbilophozia hatcheri, Aulacomnium turgidum, Thamnolia subuliformis, Dactylina arctica, Cetraria cucullata, C. islandica, C. nivalis, Lobaria linita, Peltigera aphthosa, and Lecidea spp.

(c) Festuca altaica - Artemisia arctica.

Festuca - 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 have light, discontinuous winter snow cover. Soils are alpine Eutric and Melanic Brunisols. This community type has also been described by Buttrick (1978) and Selby (1980), and 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 of Hoefs et al. (1975). Raup (1934) and Welsh and Rigby (1971) mention similar vegetation.

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, Bistorta vivipara, and Silene acaulis.

The moderately to well-developed cryptogamic stratum is dominated by Polytrichum piliferum, Stereocaulon paschale, 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.

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. infumata, P. omphalodes, Cetraria hepatizon, Alectoria pubescens, Omphalodiscus kraschenninnikovii, Umbilicaria proboscidea, Lecidea macrocarpa, Xanthoria elegans, Rhizocarpon geographicum agg., R. badioatrum, Collema undulatum, Stereocaulon saxatile, and Haemotomma lapponicum.

(d) Poa rupicola.

Scattered throughout the Gladys Lake reserve are goat/sheep "saddles", convex grassy clifftop, ridgecrest, or cavemouth promontories where mountain goats (Oreamnos americanus) and Stone sheep (Ovis dalli stonei) 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 communities 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, Agropyron violaceum, Carex supina, Potentilla nivea, and Stellaria longipes var. altocaulis. Common associates are Carex albonigra, C. obtusata, C. microchaeta, Calamagrostis purpurascens, Poa alpina, Kobresia myosuroides, Festuca altaica, F. brachyphylla, Myosotis asiatica, Aconitum delphiniifolium, Saxifraga tricuspidata, Potentilla uniflora, P. diversifolia, 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.

Kobresia myosuroides tundra is a rare vegetation type in the study area, and is found only on the most exposed, windswept, strongly convex, south- or west-facing ridgecrests. 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 and Melanic Brunisols and Humic Regosols. This community type is known to be snow-free during winter in Colorado (Marr 1967) and the southwestern Yukon (G.W. Douglas, personal communication 1976). Clement and Fenger (1981 a&b) have identified the K. myosuroides community type in nearby areas of northern B.C.

There usually is some bare ground in Kobresia tundra, but the dwarf shrub/herb stratum is moderately to well-developed and dominated by Kobresia myosuroides. Other prominent species are Hierochloë alpina, Carex microchaeta, Poa rupicola, Bistorta vivipara, Silene acaulis, Draba nivalis, Dryas integrifolia, and Salix polaris. Also important are Luzula spicata, Festuca brachyphylla, Oxytropis nigrescens, Potentilla uniflora, and Stellaria longipes var. altocaulis.

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

(f) Salix (polaris, reticulata) - Carex microchaeta.

Salix - Carex - cryptogam tundra is the widespread, zonal plant community type at moderate to high alpine elevations in the upper Stikine region. This type usually occurs between 1900-2100 m, but descends to 1860 m in some large cirques. It is found in mesic to moist habitats, 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.

Soils are generally alpine Dystric Brunisols or Humic Regosols, but Gleysols, Organic soils, and Cryosols also occur. 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 type of Lord and Luckhurst (1974) and the Seneciono (lugentis) - Salicetum polaris - reticulatae of Hoefs et al. (1975).

The dwarf shrub/herb stratum is moderately to well-developed and dominated by the dwarf willows Salix polaris and S. reticulata (S. polaris predominates at the highest elevations) and the sedge Carex microchaeta. Other prominent species include Hierochloë alpina, Festuca altaica, F. brachyphylla, Poa arctica, Luzula confusa, and L. tundricola and the forbs Bistorta vivipara, Antennaria monocephala, Potentilla hyparctica, Silene acaulis, and Stellaria longipes var. altocaulis. Frequent associates are Campanula lasiocarpa, 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, Rhytidium rugosum, Cetraria nivalis, C. cucullata, C. islandica, Lecidea spp., Stereocaulon paschale, and Thamnolia subuliformis. Important associates include 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, Physconia muscigena, and Cornicularia aculeata also frequently occur.

(g) Dryas integrifolia - Oxytropis nigrescens.

Dryas tundra is common but local throughout on exposed, windswept, convex ridgecrests of every aspect, with best development on relatively dry southern and western exposures. This is a high elevation, cushion plant tundra type, generally occurring above 1800 m. It is intermediate between Kobresia tundra and dwarf willow tundra, both in floristics and in habitat conditions. There is much bare ground (20 - 30% of most plots), usually well-drained gravelly scree and rubble. Soils are Regosols or shallow 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), the Salico (reticulatae) - Sileno (acaulis) - Carico (scirpoideae) - Dryadetum integrifoliae and Oxytropo (viscidae) - Artemisio (hyperboreae) - Festuco (brachyphyllae) - Trisetetalia spicati of Hoefs et al. (1975), and the D. integrifolia tundra of Birks (1977).

The dwarf shrub/herb layer is moderately developed and dominated by cushion-forming plants. Prominent species include Dryas integrifolia, Oxytropis nigrescens, Silene acaulis, Potentilla uniflora, Lupinus arcticus, Salix reticulata, Draba nivalis, Kobresia myosuroides, Carex microchaeta, and Hierochloë alpina. Frequent or occasionally abundant species are Bistorta vivipara, Minuartia rubella, Campanula uniflora, Draba lactea, D. fladnizensis, Salix polaris, Saxifraga tricuspidata, S. flagellaris, Lloydia serotina, Oxytropis huddelsonii, Papaver radicatum, 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 subuliformis, 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 community types. Only the two commonest types were sufficiently sampled to describe properly (Tables 3 and 4).

(h) Salix reticulata - Carex aquatilis.

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.

The dwarf shrub/herb stratum is very well-developed and includes Salix reticulata, Carex aquatilis, and Bistorta vivipara as prominent species. Important associates are Eriophorum callitrix, Trichophorum cespitosum, Tofieldia pusilla, Sanguisorba canadensis ssp. latifolia, 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 ellipticum, Brachythecium spp., Cinclidium stygium, and Sphagnum nemoreum.

(i) Salix polaris - S. reticulata - Tomenthypnum nitens.

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 usually Humic Regosols or Cryosols.

This community type is somewhat similar to the Saxifraga (oppositifoliae) - Oxyrio (digynae) - Salicetum polaris and the Seneciono (lugentis) - Salicetum polaris - reticulatae described in Hoefs et al. (1975).

The dwarf shrub/herb stratum is well to very well developed and variable in species composition. Salix reticulata and S. polaris are prominent dwarf shrubs, with S. polaris dominating at higher elevations. Prominent herbs are Carex podocarpa, Petasites nivalis, Artemisia arctica, Ranunculus eschscholtzii, and Anemone parviflora. Common or locally abundant associates are Anemone richardsonii, Arnica lessingii, Caltha leptosepala, Corydalis pauciflora, Draba longipes, Epilobium anagallidifolium, E. latifolium, Equisetum scirpoides, E. variegatum, Claytonia sarmentosa, Parnassia fimbriata, P. kotzebuei, Polemonium caeruleum, Bistorta vivipara, Saxifraga lyallii, Senecio lugens, Tofieldia pusilla, Valeriana sitchensis, Veronica wormskjoldii, Carex bipartita, 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, D. uncinatus, Brachythecium plumosum, Aulacomnium palustre, A. turgidum, Polytrichum strictum, Cinclidium stygium, Calliergon spp., Meesia triquetra, and Paludella squarrosa.

(j) (Salix polaris) - moss

High alpine (generally 1900 m plus), mossy seepage/snowbed vegetation is common but never extensive. It occurs in snow pockets on the high plateaux, rims gravelly flushes, and fringes melting permanent snowbanks. This community type 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.

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.

(k) Alpine fellfield.

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) and gelifraction (frost cracking, splitting, or riving) are typical phenomena. Soils are Regosols (rawmark); much of 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 is regarded as a single, complex unit. Similar units have been described by Bryant and Scheinberg (1970), Birks (1977), Buttrick (1977), and Selby (1980).

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, 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, 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. infumata, P. separata, Thamnolia subuliformis, Actinogyra muehlenbergii, Umbilicaria vellea, Omphalodiscus virginis, Dermatocarpon moulinsii, Stereocaulon spp., Physconia muscigena, Cladonia crispata, Sphaerophorus fragilis, Solorina crocea, among others.

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, Cetraria hepatizon, Parmelia taractica, Hypogymnia subobscura, Umbilicaria proboscidea, U. deusta, U. torrefacta, U. cylindrica, U. hyperborea, Omphalodiscus krascheninnikovii, Lecidea macrocarpa, Xanthoria elegans, Rhizocarpon geographicum agg., R. badioatrum, Haemotomma lapponicum, and others.

(1) 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). Field notes only were taken in these habitats, so the vegetation is not summarized in Table 3.

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, 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, Minuartia obtusiloba, Silene acaulis, Taraxacum ceratophorum, T. lyratum, Oxyria digyna, Campanula lasiocarpa, Antennaria monocephala, Senecio lugens, Anemone parviflora, Carex microchaeta, C. nardina, Luzula arcuata, L. confusa, 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.

4.3 Major Habitat Features and Plant-Ungulate Relationships

The Gladys Lake Reserve supports resident populations of mountain goat (Oreamnos americanus) and Stone's sheep (Ovis dalli stonei). Gladys Lake itself is a focus of wintering populations of these ungulates. Moose (Alces alces) and woodland caribou (Rangifer tarandus caribou) are more or less transient in the reserve but are common, more so in the spring and

summer than during winter (Geist 1971; Carswell 1975; Hatler 1983).

4.3.1 Mountain Goat

The Gladys Lake reserve, with its rugged mountains and frequent patches of alpine forage, provides good range for mountain goats. 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 (Table 5). Goats feed on graminoids and forbs in Festuca altaica - lichen, Salix (polaris, reticulata) - Carex microchaeta, and Kobresia alpine tundra; in Poa glauca - Carex supina and Juniperus communis - Arctostaphylos uva-ursi communities; and in Betula glandulosa alpine scrub. They also feed in the upper reaches of Festuca altaica subalpine grassland and on the scattered vascular plants in the talus - lichen terrain unit. Geist (1971) 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

TABLE 5. Ungulate orientation[1] to plant community types of the Gladys Lake Ecological Reserve.

Community type	Mountain Goat R[2]	Mountain Goat F[3]	Stone's Sheep R	Stone's Sheep F	Moose R	Moose F	Woodland Caribou R	Woodland Caribou F
Subalpine zone								
Pinus contorta - Betula glandulosa - Pleurozium schreberi					+	+		+
Populus tremuloides - Juniperus communis - Festuca altaica			+	+	+	++		+
Populus balsamifera - Epilobium angustifolium					+	+		+
Picea glauca - Hylocomium splendens					+	+	+	++
Picea glauca - Betula glandulosa - Salix glauca, Betula phase					+	++	+	++
Picea glauca - Betula glandulosa - Salix glauca, Salix phase					++	++	+	++
Abies lasiocarpa - Hylocomium splendens			+		++	+	+	+
Abies lasiocarpa - Betula glandulosa - Empetrum nigrum			+		++	+	+	++
Salix barclayi - Betula glandulosa - Carex aquatilis - Aulacomnium palustre					+	++		++
Salix scouleriana					+	++		+
Salix alaxensis - Epilobium latifolium					++	++	+	+
Salix (glauca, barclayi) - Petasites palmatus					++	++	+	++
Salix glauca - Betula glandulosa - Festuca altaica			+	++	++	++	+	++
Betula glandulosa - Festuca altaica - Hylocomium splendens					+	+	++	++
Juniperus communis - Arctostaphylos uva-ursi				+				+
Poa glauca - Carex supina	++	++	++	++				+

TABLE 5. (cont'd).

Community type	Mountain Goat R[2]	Mountain Goat F[3]	Stone's Sheep R	Stone's Sheep F	Moose R	Moose F	Woodland Caribou R	Woodland Caribou F
Festuca altaica	+	+	+	+			+	++
Festuca altaica - Luzula parviflora						+		+
Heracleum sphondylium		+		+		+		+
Carex rostrata - C. aquatilis						+		++
Alpine zone								
Abies lasiocarpa - Cassiope mertensiana	+	++					+	+
Betula glandulosa - Hylocomium splendens		+		+		+	+	++
Salix barrattiana				+				+
Cassiope mertensiana - Barbilophozia hatcheri		+						
Cassiope tetragona - Dryas integrifolia	++	++	+	+			++	+
Festuca altaica - Artemisia arctica	++	++	++	++			+	++
Poa rupicola	++	++	++	++				
Kobresia myosuroides	++	++	+	++			+	+
Salix (polaris, reticulata) - Carex microchaeta	++	++	++	++			++	++
Dryas integrifolia - Oxytropis nigrescens	+	+	+	++			++	+
Salix reticulata - Carex aquatilis								++
Salix (polaris, reticulata) - Tomenthypnum nitens								++
Alpine fellfield		+	+	+			++	+

[1]Sources of information: Edwards and Ritcey (1960); Geist (1971); Luckhurst (1973); Geist et al. (1974); Hoefs (1974); Lord and Luckhurst (1974); Hoefs et al. (1975); Cushwa and Coady (1976); Bergerud and Butler (1978); Gill (1978); Hoefs and Cowan (1979); Hatler (1983); Boonstra and Sinclair (1984); author's data.

[2]R = reproduction, cover, rest, travel, etc. (++, primary; +, secondary).

[3]F = feeding (++, primary; +, secondary).

on the grassy slopes. At Gladys Lake, goats probably 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 community type is a local but important grass-forb type that occurs on "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. Caves and other bedding depressions are common nearby at the interface between cliff bases and grassy slopes. These sites provide shelter, resting space, nearby forage, and cool shade during hot spells.

Goats also utilize erosion sites as rubbing and sandbathing areas. 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.

4.3.2 Stone Sheep

The mountains around Gladys Lake provide small patches of prime stone sheep 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.

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 appear to have more

specialized feeding habits than do goats. Sheep prefer plants such as grasses (Festuca, Poa, Agropyron, Hierochloe 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; Hoefs 1974; Hoefs et al. 1975). Such plants are common and abundant in the community types upon which the Gladys Lake sheep forage the most (Table 5).

Poa glauca - Carex supina steppe, Kobresia tundra, and exposed Festuca tundra form local but very important, mostly snow-free winter range. Similarly, Lord and Luckhurst (1974) and Hoefs et al. (1975) 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 fond of frost-cured grasses and forbs (Geist et al. 1974). In fairly wet regions (such as Eaglenest Range) they will also take coarser, lusher species such as Heracleum sphondylium, 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 (1971) reported that both wintering goats and sheep sought these plants in the Heracleum meadows at the base of mountains in the reserve.

Sheep utilize feeding/resting/viewing saddles, caves, and bedding areas as much as do goats, and similarly forage on the associated Poa rupicola communities. Erosion sites 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.

4.3.3 Moose

Geist et al. (1974) summarize key habitat requirements for moose: 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) characterize 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 is a prototypical moose river. On a smaller scale, several creeks in the ecological reserve also fit the description.

Winter moose range is 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 Salix - Carex fens; in subalpine Salix - Betula scrub; in south- or southwest-facing aspen or poplar groves; and in south- or southwest-facing stands of spruce and subalpine fir

forest and woodland (Table 5).

Salix spp. 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. Although abundant, S. barattiana was very rarely browsed, 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 south central Yukon 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.

By late winter, most moose have left the reserve area for riparian habitats along the lower Spatsizi River (Hatler, personal communication 1984). The few that may remain around Gladys Lake leave the open areas and concentrate on habitats with soft snow, particularly beneath closed canopy coniferous forest. 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 (spruce and subalpine fir). Deciduous woody browse constitutes the bulk of winter moose diet in Alaska, and spruce is rarely eaten (Cushwa and Coady 1976).

Other late-winter habitats occupied by moose are aspen and poplar pygmy forest and Salix - Betula 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 subalpine fir communities and nearby lush vegetation of Festuca altaica - Luzula parviflora moist meadows and Heracleum sphondylium 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 Betula - Salix thickets in the subalpine are also utilized during summer and early fall.

4.3.4. Woodland Caribou

Caribou in the Spatsizi area belong to a northern ecotype of the subspecies, subsisting in winter largely upon terrestrial forage rather than arboreal lichens (Bergerud 1978; Hatler 1983). Such caribou attain their largest body size in wet, fairly cold mountains with moderate snowfall (Geist et al. 1974), and Spatsizi caribou are among the largest known (Hatler 1983). Several features of these mountainous areas are essential for optimum caribou range:

(i) cirque glaciers and snowfields

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.

(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 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 rivers with a hard snow surface serve as escape terrain for caribou in winter. 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.

The Gladys Lake reserve is used by caribou primarily in summer. Geist (personal communication 1973) states that every major ridge there has female caribou on it at parturition time, and Hatler (personal communication 1984) has documented females with calves there in each of four summers involving radio-tracking studies. Other than good calving grounds, the Gladys Lake reserve does not provide much optimum caribou range. However, in combination with the large lakes, rivers, valleys, and alpine plateaux of the surrounding upper Stikine drainage, the reserve is an integral part of the biophysical complex that supports a substantial and high-quality caribou population.

Woodland caribou eat almost any plant at some time during the year. They are exceptionally mobile ungulates, and their

opportunistic foraging (see Table 5) 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 microhabitats 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).

Woodland caribou seem to prefer plants of moist habitats, and lush, wet vegetation to crisp, dry plants. 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 vegetative period. Moist grass-forb subalpine meadows are also rich in lush herbage. Marsh, fen 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) point out, the preferred summer forage of caribou is virtually a list of the grasses, sedges, and forbs found in these wet communities.

Extensive Betula - Salix scrub provides deciduous foliage that forms the bulk of their summer forage. According to Geist (personal communication 1973), 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. Betula 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 et al. 1960; Scotter 1962; Miller 1974) -- although this has yet to be documented in the Spatsizi area (Hatler, personal communication 1984). 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 (Geist et al. 1974).

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 altaica - Artemisia arctica and Salix (polaris, reticulata) - Carex microchaeta 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 - much less so than wetter alpine vegetation - alpine tundra produces nutritious, very high-quality forage (Johnson et al. 1968; Brink et al. 1972; Luckhurst 1973; Lord and Luckhurst 1974; Webber 1974). Furthermore, tundra vegetation is so extensive on the rolling alplands of the upper Stikine region that its overall contribution to the caribou diet could be substantial. Certainly it is important forage at calving time, when many of 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 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 caribou often move to the high country in late winter when snow conditions demand (Hatler 1983). At such times, exposed tundra communities with little snow accumulation could provide graminoids, prostrate shrubs, and fruticose lichens.

5 DISCUSSION

The vegetation and plant - ungulate relationships of the Gladys Lake Ecological Reserve are typical for the interior plateaus and mountains of northern British Columbia and adjacent Yukon Territory. Similar vegetation has been described from northwestern (Anderson 1970; Cathey 1974; Buttrick 1977, 1978; Clement and Fenger 1981 a&b; Fenger 1982) and northeastern (Luckhurst 1973; Lord and Luckhurst 1974) B.C., and also from the southern

Yukon (Kojima 1973; Douglas 1974; Geist et al. 1974; Hoefs et al. 1975; Birks 1977; Oswald and Senyk 1977; Orloci and Stanek 1979). Similar vegetation - ungulate systems have been described by Geist et al. (1974), LaResche and Bishop (1974), Lord and Luckhurst (1974), Hoefs et al. (1975), Bergerud (1978), Gill (1978), and Hoefs and Cowan (1979).

The Gladys Lake environment is representative of fairly wet, cool, moderate-snowfall areas of the northern Canadian Cordillera. Regional differences are primarily related to variations in climate, secondarily to differences in physiography and bedrock geology. The environmental differences tend to be expressed in the relative abundance and distribution of plant community types, in the patterns of vegetation in the landscape -- the floristics are fairly uniform. These differences also influence ungulate populations. For example, the drier, sunnier, lower-snowfall mountains of the southwestern Yukon have more extensive, dry, grassy and scrub vegetation and hence more range for mountain sheep than do the mountains of the upper Stikine region (Geist 1971).

Table 5 shows that use of the twenty subalpine and thirteen alpine community types varies markedly among the four ungulate species of the Gladys Lake reserve. The assessments of "ungulate orientation" to vegetation are qualitative and partly rely on circumstantial evidence, but some trends are obvious. Of the total 33 community types described, approximately 7, 7, 10, and 18 appear to be of major importance for goats, sheep, moose, and caribou, respectively. Goats and sheep use mostly alpine terrain and vegetation; their habitat use overlaps but the goats seem to be food generalists and terrain specialists, whereas the sheep have more specialized feeding habitats but do not necessarily stay as close to cliffs as the goats do (Geist 1971; Geist et al. 1974). Moose use mostly subalpine ecosystems, and range fairly generally through the subalpine environment except during the winter. Caribou are the most mobile and opportunistic species, use both subalpine and alpine environments, and are least restricted by winter conditions (Geist et al. 1974; Bergerud and Butler 1978; Hatler 1983). Hence, the patterns of Table 5 reflect a decline in feeding specialization from sheep to caribou, and a

decrease in terrain specificity from goats to caribou. Table 5 also reflects the biophysical make-up of the reserve. The goat and sheep areas are small and local, but there is abundant, excellent moose habitat and much good caribou habitat.

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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, several 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 meters. Many additional lower elevation species are to be expected in the park flora, especially from the major valley bottomlands and lower slopes.

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.

PTERIDOPHYTA

ADIANTACEAE

Cryptogramma crispa (L.) R.Br. ssp. acrostichoides (R.Br.) Hult.

ASPLENIACEAE

Cystopteris fragilis (L.) Bernh.
*Dryopteris fragrans (L.) Schott
Polystichum lonchitis (L.) Roth

EQUISETACEAE

Equisetum arvense L.
E. pratense Ehrh.
E. scirpoides Michx.
E. sylvaticum L.
E. variegatum Schliech.

LYCOPODIACEAE

Huperzia selago (L.) Bernh.
Lycopodium alpinum L.
L. annotinum L.
L. clavatum L.
L. complanatum L.

OPHIOGLOSSACEAE

Botrychium lunaria (L.) Swartz

SELAGINELLACEAE

Selaginella selaginoides (L.) Link
*S. sibirica (Milde) Hieron.

PINOPHYTA

CUPRESSACEAE

Juniperus communis L. ssp. alpina (Neilreich) Celakovsky

PINACEAE

Abies lasiocarpa (Hook.) Nutt.
Picea glauca (Moench) Voss
Pinus contorta Dougl. var. latifolia Engelm.

MAGNOLIOPHYTA - DICOTYLEDONAE

APIACEAE

Heracleum sphondylium L. ssp. montanum (Gaud.) Briq.
Osmorhiza depauperata Phil.
O. purpurea (Coult. & Rose) Suksd.

ASTERACEAE

Achillea millefollium L. s. lat.
Agoseris aurantiaca (Hook.) Greene
A. glauca (Pursh) Raf. var. dasycephala (T. & G.) Jepson
Antennaria alpina (L.) Gaertn. s. lat.
A. microphylla Rydb.
Antennaria monocephala DC.
A. pulcherrima Rydb.
A. umbrinella Rydb.
Arnica alpina (L.) Olin ssp. angustifolia (Vahl) Maguire
A. alpina (L.) Olin ssp. tomentosa (Macoum) Cronq.
A. amplexicaulis Nutt.
A. chamissonis Less.
A. cordifolia Hook.
A. latifolia Bong.
*A. lessingii Greene
A. mollis Hook.
Artemisia arctica Less.
A. campestris L. ssp. borealis (Pall.) Hall & Clements
*A. michauxiana Bess.
A. tilesii Ledeb. s. lat.
*Cirsium edule Nutt.
C. foliosum (Hook.) DC.
Crepis nana Richards.
Erigeron acris L. ssp. debilis (Gray) Piper
E. compositus Pursh var. glabratus Macoun
E. elatus (Hook.) Greene
E. grandiflorus Hook.
E. humilis Graham
E. lonchophyllus Hook.
E. peregrinus (Pursh) Greene ssp. callianthemus (Greene) Cronq.
*E. purpuratus Greene
Hieracium gracile Hook.
Petasites frigidus (L.) Fries
P. nivalis Greene
P. palmatus (Ait.) Gray
P. sagittatus (Banks) Gray
Senecio lugens Richards.
S. pauciflorus Pursh
*S. sheldonensis Porsild
S. triangularis Hook.

Solidago multiradiata Ait. var. scopulorum Gray
Taraxacum ceratophorum (Ledeb.) DC.
T. lyratum (Ledeb.) DC.

BETULACEAE
Betula glandulosa Michx.

BORAGINACEAE
Hackelia deflexa (Wahl.) Opiz ssp. americana (Gray) Hult.
Mertensia paniculata (Ait.) G. Don
Myosotis asiatica (Vestergren) Schischkin & Sergievskaja

BRASSICACEAE
Arabis divaricarpa A. Nels.
A. drummondii Gray
A. holboellii Hornem. s. lat.
*A. lemmonii S. Wats
Arabis lyallii S. Wats.
A. lyrata L. ssp. kamchatica (Fisch.) Hult.
Barbarea orthoceras Ledeb.
Cardamine bellidifolia L.
C. oligosperma Nutt.
C. pratensis L. ssp. angustifolia (Hook.) Schulz
*Draba alpina L.
D. aurea Vahl.
D. borealis DC.
D. cana Rydb.
D. cinerea Adams
*D. fladnizensis Wulf.
D. incerta Payson
D. lactea Adams
D. lonchocarpa Rydb. var. thompsonii (C.L. Hitchc.) Rollins
D. longipes Raup
D. nemorosa L.
D. nivalis Lilj.
*Eutrema edwardsii R.Br.

CALLITRICHACEAE
Callitriche palustris L.

CAMPANULACEAE
Campanula lasiocarpa Cham.
C. uniflora L.

CAPRIFOLIACEAE
Linnaea borealis L. s. lat.
Viburnum edule (Michx.) Raf.

CARYOPHYLLACEAE

Cerastium arvense L.
C. beeringianum Cham. & Schlecht.
Minuartia biflora (L.) Schinz & Thell.
*M. dawsonensis (Britt.) House
M. obtusiloba (Rybd.) House
M. rubella (Wahl.) Hiern
Moehringia lateriflora (L.) Fenzl
Sagina saginoides (L.) Karst.
Silene acaulis (L.) Jacq.
S. uralensis (Rupr.) Bocq. ssp. attenuata (Farr) McNeill
Stellaria calycantha (Ledeb.) Bong. s. lat.
S. longipes Goldie var. altocaulis (Hult.) C.L. Hitchc.
S. longipes Goldie var. laeta (J. Richards.) S. Wats.
S. longipes Goldie var. longipes

CHENOPODIACEAE

Chenopodium capitatum (L.) Asch.

CORNACEAE

Cornus canadensis L.

CRASSULACEAE

*Sedum divergens Wats.
S. lanceolatum Torr.

ELEAGNACEAE

Shepherdia canadensis (L.) Nutt.

EMPETRACEAE

Empetrum nigrum L. s. lat

ERICACEAE

Arctostaphylos rubra (Rehd. & Wilson) Fern.
A. uva-ursi (L.) Spreng. s. lat.
Cassiope mertensiana (Bong.) G. Don
C. tetragona (L.) D. Don s. lat.
Kalmia microphylla (Hook.) Heller
*Ledum palustre L. ssp. decumbens (Ait.) Hult.
L. groenlandicum Oeder
Phyllodoce empetriformis (J.E. Smith) D. Don
P. glanduliflora (Hook.) Coville
Vaccinium caespitosum Michx.
V. membranaceum Dougl.
V. microcarpum (Turcz.) Schmalhausen
V. uliginosum L. ssp. alpinum (Bigelow) Hult.
V. vitis-idaea L. ssp. minus (Lodd.) Hult.

FABACEAE

Astragalus alpinus L.
Hedysarum alpinum L. spp. americanum (Michx.) Fedtsch.
H. boreale Nutt. s. lat.
Lupinus arcticus Wats. s. lat.
*L. nootkatensis Donn s. lat.
Oxytropis campestris (L.) DC. s. lat.
*O. huddelsonii Porsild
O. nigrescens (Pall.) Fisch. s. lat.

FUMARIACEAE

Corydalis pauciflora (Steph.) Pers.

GENTIANACEAE

Gentiana glauca Pall.
G. prostrata Haenke
Gentianella amarella (L.) Borner ssp. acuta (Michx.) Gillett
[Welsh & Rigby (1971)]
G. propinqua (Richards.) Gillett

GERANIACEAE

Geranium erianthum DC.
G. richardsonii Fisch. & Trautv.

GROSSULARIACEAE

Ribes glaudulosum Grauer
R. hudsonianum Richards
R. oxyacanthoides L.
R. triste Pall.

HIPPURIDACEAE

Hippuris vulgaris L.

ONAGRACEAE

Epilobium anagallidifolium Lamarck
E. angustifolium L.
E. davuricum Fisch.
E. hornemannii Reich.
E. latifolium L.
*E. luteum Pursh
E. palustre L.

PAPAVERACEAE

Papaver alboroseum Hult. [Welsh & Rigby (1971)]
P. kluanense D. Love

PARNASSIACEAE
Parnassia fimbriata Konig
P. kotzebuei Cham. & Schlecht
P. palustris L.

POLEMONIACEAE
Polemonium caeruleum L. ssp. villosum (Rudolph) Brand
P. pulcherrimum Hook.

POLYGONACEAE
Bistorta vivipara (L.) S.F. Gray
*Koenigia islandica L.
Oxyria digyna (L.) Hill
*Polygonum douglasii Greene s. lat.
Rumex acetosa L. ssp. arifolium (All.) Blytt & Dahl

PORTULACACEAE
Claytonia sarmentosa C.A. Mey.

PRIMULACEAE
Androsace septentrionalis L. s. lat.
*Douglasia gormanii Constance
Trientalis europaea L. ssp. arctica (Fisch.) Hult.

PYROLACEAE
Moneses uniflora (L.) Gray
Orthilia secunda (L.) House s. lat.
Pyrola asarifolia Michx.
P. grandiflora Radius
P. minor L.

RANUNCULACEAE
Aconitum delphiniifolium DC.
Anemone multifida Poir.
A. narcissiflora L. ssp. interior Hult. [Welsh & Rigby (1971)]
A. parviflora Michx.
A. richardsonii Hook.
Aquilegia brevistyla Hook.
A. formosa Fisch.
Caltha leptosepala DC.
Delphinium glaucum Wats.
Ranunculus cooleyae Vasey & Rose
R. eschscholtzii Schlecht.
*R. grayi Britt.
R. hyperboreus Rottb.
R. lapponicus L.
R. nivalis L.
R. occidentalis Nutt.

R. pygmaeus Wahl.
*R. sulphureus Soland.
Thalictrum alpinum L.
T. occidentale Gray

ROSACEAE

Amelanchier alnifolia (Nutt.) Nutt. s. lat.
Dryas integrifolia Vahl
D. octopetala L. ssp. alaskensis (Pors.) Hult. [Welsh & Rigby (1971)]
Fragaria virginiana Duchesne ssp. glauca (S. Wats.) Staudt
Geum macrophyllum Willd.
Luetkea pectinata (Pursh) Kuntze
Potentilla arguta Pursh ssp. convallaria (Rydb.) Keck
P. diversifolia Lehm.
P. fruticosa L. ssp. floribunda (Pursh) Elkington
P. hookerana Lehm.
P. hyparctica Malte
P. nivea L.
P. norvegica L.
P. palustris (L.) Scop.
P. pensylvanica L.
P. uniflora Ledeb.
P. villosa Pall.
Rosa acicularis Lindl. ssp. sayi (Schwein.) W.H. Lewis
Rubus arcticus L. ssp. acaulis (Michx.) Focke
R. chamaemorus L.
R. ideaus L. ssp. melanolasius (Dieck) Focke
R. pedatus J.E. Smith
Sanguisorba canadensis L. ssp. latifolia (Hook.) Calder & Taylor
Sibbaldia procumbens L.
Sorbus scopulina Greene

RUBIACEAE

Galium boreale L.
G. trifidum L.
G. triflorum Michx.

SALICACEAE

Populus balsamifera L.
P. tremuloides Michx.
Salix alaxensis (Anderss.) Coville
S. alaxensis (Anderss.) Coville var. longistylis (Rydb.) Schneid.
S. arctica Pall.
S. barclayi Anderss.
S. barrattiana Hook.
S. brachycarpa Nutt.
S. commutata Bebb.
S. glauca L. s. lat.

S. myrtillifolia Anderss.
S. planifolia Pursh
S. planifolia Pursh ssp. pulchra (Cham.) Argus
S. polaris Wahl.
*S. raupii Argus
S. reticulata L.
S. scouleriana Barratt

SANTALACEAE
Geocaulon lividum (Richards.) Fern.

SAXIFRAGACEAE
Chrysosplenium tetrandrum (Lund) Fries
Mitella nuda L.
M. pentandra Hook.
Saxifraga adscendens L. ssp. oregonensis (Raf.) Bacigalupi
S. cernua L.
S. cespitosa L. s. lat.
S. ferruginea Graham
S. flagellaris Stern. & Willd. ssp. setigera (Pursh) Tolmatchev
S. lyallii Engler ssp. hultenii (Calder & Savile) Calder & Taylor
S. nelsoniana Don s. lat.
S. nivalis L.
S. oppositifolia L.
*S. radiata Small
S. rivularis L. var. flexuosa (Stern.) Engl. & Irmsch.
*S. serpyllifolia Pursh
S. tricuspidata Rottb.

SCROPHULARIACEAE
*Castilleja parviflora Bong.
C. unalaschensis (Cham. & Schlecht.) Malte
Mimulus guttatus DC.
Pedicularis capitata Adams
P. labradorica Wirsing
P. langsdorfii Fisch. ssp. arctica (R. Br.) Pennell
P. sudetica Willd. ssp. interior (Hult.) Hult.
Penstemon procerus Dougl.
Rhinanthus minor L.
Veronica americana Schwein.
V. serpyllifolia L. ssp. humifusa (Dickson) Syme
[Welsh & Rigby (1971)]
V. wormskjoldii Roem. & Schult.

VALERIANACEAE
Valeriana dioica L. ssp. sylvatica (Soland.) Mey.
V. sitchensis Bong.

VIOLACEAE

Viola adunca J.E. Smith
V. langsdorfii (Reg.) Fisch.
V. palustris L.

MAGNOLIOPHYTA - MONOCOTYLEDONAE

CYPERACEAE

Carex albonigra Mack.
C. aquatilis Wahl.
C. aurea Nutt.
C. bipartita Bellardi
C. brunnescens (Pers.) Poir. ssp. alaskana Kalela
C. canescens L.
C. capillaris L.
C. concinna R. Br.
C. deflexa Hornem.
C. dioica L. ssp. gynocrates (Wormskj.) Hult.
C. disperma Dewey
C. enanderi Hult.
C. garberi Fern. ssp. bifaria (Fern.) Hult.
C. heteroneura W. Boott var. epapillosa (Mack.) Hermann
C. leptalea Wahl.
C. limosa L.
C. loliacea L.
C. macloviana d'Urv.
C. media R. Br.
C. microchaeta Holm
C. nardina Fries
*C. obtusata Lilj.
C. paupercula Michx.
C. petasata Dewey
C. phaeocephala Piper
C. podocarpa R. Br.
C. praticola Rydb.
C. pyrenaica Wahl. s. lat.
C. rossii F. Boott
C. rostrata Stokes
C. saxatilis L. ssp. laxa (Trautv.) Kalela
C. scirpoidea Michx. s. lat.
*C. supina Willd. ssp. spaniocarpa (Steud.) Hult.
C. tenuiflora Wahl.
C. vaginata Tausch
Eriophorum angustifolium Honck. s. lat.
E. brachyantherum Trautv. & Mey.
E. callitrix Cham.

E. vaginatum L.
Kobresia myosuroides (Vill.) Fiori & Paol.
Trichophorum cespitosum (L.) Hartm.

JUNCACEAE

Juncus arcticus Willd. ssp. alaskanus Hult.
J. biglumis L.
J. castaneus J.E. Smith
J. drummondii E. Meyer
J. filiformis L.
J. mertensianus Bong.
J. triglumis L.
*Luzula arctica Blytt
L. arctica Blytt. ssp. latifolia (Kjellm.) Porsild
L. arcuata (Wahl.) Sw. ssp. unalaschkensis (Buch.) Hult.
*L. confusa Lindeb.
L. multiflora (Retz.) Lej. ssp. multiflora var. frigida (Buch.) Samuelsson
L. parviflora (Ehrh.) Desv.
L. spicata (L.) DC.
L. wahlenbergii Rupr.

LILIACEAE

*Fritillaria camschatcensis (L.) Ker-Gawl.
Lloydia serotina (L.) Reich.
Tofieldia pusilla (Michx.) Pers.
Veratrum viride Ait. ssp. eschscholtzii (Gray) Love & Love

ORCHIDACEAE

Corallorhiza trifida Chat.
Listera cordata (L.) R. Br.
Platanthera dilatata (Pursh) Lindl. s. lat.

POACEAE

Agropyron trachycaulum (Link) Malte s. lat.
A. violaceum (Hornem.) Lange
Agrostis scabra Willd.
Alopecurus aequalis Sobol.
Arctagrostis latifolia (R. Br.) Griseb. var. arundinacea (Trin.) Griseb.
Bromus richardsonii Link
Calamagrostis canadensis (Michx.) Beauv.
C. lapponica (Wahl.) Hartm. var. nearctica Porsild
C. purpurascens R. Br.
Danthonia californica Boland.
Deschampsia cespitosa (L.) Beauv.
Festuca altaica Trin.
F. brachyphylla Schult.

F. rubra L. ssp. richardsonii (Hook.) Hult.
F. saximontana Rydb.
Hierochloe alpina (Sw.) Roem. & Schult.
H. odorata (L.) Beauv. ssp. hirta Schrank
Koeleria macrantha (Ledeb.) Schult.
Phleum alpinum L. var. commutatum (Gaudin) Griseb.
Poa alpina L.
P. arctica R. Br. s. lat.
P. cusickii Vaseyi var. epilis (Scribn.) C.L. Hitchc.
P. glauca Vahl.
*P. interior Rydb.
P. leptocoma Trin.
*P. rupicola Nash
Stipa occidentalis Thurb. var. minor (Vasey) C.L. Hitchc.
Trisetum spicatum (L.) Richter s. lat.

POTAMOGETONACEAE
Potamogeton filiformis Pers.

SPARGANIACEAE
Sparganium minimum (Hartm.) Wallr.

APPENDIX 2

Lichens of the Gladys Lake Ecological Reserve
and Adjacent Parts of the Spatsizi Plateau*

Acarospora chlorophana (Wahlenb. ex Ach.) Mass.

Actinogyra muehlenbergii (Ach.) Schol.

Alectoria americana Mot.
" minuscula Nyl.
" nigricans (Ach.) Nyl.
" pubescens (L.) R.H. Howe
" ochroleuca (Hoffm.) Mass.
" tenuis Dahl

Bacidia sphaeroides (Dicks.) Zahlbr.

Baeomyces rufus (Huds.) Rebent.

Buellia verruculosa (Sm.) Mudd

Calicium viride Pers.

Caloplaca tiroliensis Zahlbr.

Cetraria commixta (Nyl.) Th. Fr.
" cucullata (Bell.) Ach.
" delisei (Bory ex Schaer.) Th. Fr.
" ericetrorum Opiz
" hepatizon (Ach.) Vain.
" islandica (L.) Ach.
" nigricans (Retz.) Nyl.
" nivalis (L.) Ach.
" pinastri (Scop.) S. Gray
" richardsonii Hook.
" subalpina Imsh.
" tilesii Ach.

Cladina alpestris (L.) Harm.
" impexa (Harm.) B. de Lesd.
" mitis (Sandst.) Hale & W. Culb.
" rangiferina (L.) Harm.

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

Cladonia amaurocraea (Florke) Schaer.
" cariosa (Ach.) Spreng.
" carneola (Fr.) Fr.
" cenotea (Ach.) Schaer.
" chlorophaea (Florke ex Somm.) Spreng.
" coccifera (L.) Willd.
" cornuta (Ach.) Hoffm.
" crispata (Ach.) Flot.
" cyanipes (Somm.) Nyl.
" deformis (L.) Hoffm.
" ecmocyna (Ach.) Nyl.
" gonecha (Ach.) Asah.
" gracilis (L.) Willd.
" grayi Merr. ex Sandst.
" metacorallifera Asah.
" parasitica (Hoffm.) Hoffm.
" phyllophora Hoffm.
" pleurota (Florke) Schaer.
" pyxidata (L.) Hoffm.
" squamosa (Scop.) Hoffm.
" uncialis (L.) Wigg.
" verticillata (Hoffm.) Schaer.

Collema undulatum Laur. ex Flot.

Cornicularia aculaeta (Schreb.) Ach.
" divergens Ach.

Dactylina arctica (Hook.) Nyl.
" madreporiformis (Wulf.) Tuck.
" ramulosa (Hook.) Tuck.

Dermatocarpon fluviatile (G. Web.) Th. Fr.
" moulinsii (Mont.) Zahlbr.

Haemotomma lapponicum Ras.

Hypogymnia austerodes (Nyl.) Ras.
" enteromopha (Ach.) Nyl.
" oroarctica Krog. sp. nov.
" physodes (L.) W. Wats.

Icmadophila ericetrorum (L.) Zahlbr.

Lecanora spp.

Lecidea macrocarpa (D.C.) Steud. f. oxydata

Lepraria chlorina (Ach.) Ach. ex Sm.
" neglecta (Nyl.) Lett.

Leptogium saturninum (Dicks.) Nyl.
Letharia vulpina (L.) Hue

Lobaria linita (Ach.) Rabenh.

Nephroma arcticum (L.) Torss.
" parile (Ach.) Ach.

Ochrolechia upsaliensis (L.) Mass.

Omphalodiscus krascheninnikovii (Sav.) Schol.
" virginis (Schaer.) Schol.

Pannaria pezizoides (G. Web.) Trev.

Parmelia alpicola Th. Fr.
" centrifuga (L.) Ach.
" exasperatula Nyl.
" infumata Nyl.
" lineola Berry
" obsessa Ach.
" omphalodes (L.) Ach.
" saxatilis (L.) Ach.
" separata Th. Fr.
" stygia (L.) Ach.
" subaurifera Nyl.
" sulcata Tayl.
" taractica Kremp.

Parmeliopsis ambigua (Wulf.) Nyl.
" hyperopta (Ach.) Arn.

Peltigera aphthosa (L.) Willd.
" canina (L.) Willd.
" malacea (Ach.) Funck
" polydactyla (Neck. ex Somm.) Hoffm.
" praetextata (Forke) Vain.
" scabrosa Th. Fr.
" spuria (Ach.) DC.

Pertusaria dactylina (Ach.) Nyl.

Physconia muscigena (Ach.) Poelt

Platismatia glauca (L.) Culb. & Culb.

Rhizocarpon badioatrum (Florke ex Spreng.) Th. Fr.
" chioneum (Norm.) Th. Fr.
" geographicum (L.) DC. agg.
" inarense (Vain.) Vain.
" intermedium Degel.
" lecanorinum (Korb) And.
" macrosporum Ras.
" sphaerosporum Ras.
" superficiale (Schaer.) Vain.
Solorina crocea (L.) Ach.
" octospora Arn.

Sphaerophorus fragilis (L.) Pers.

Sporostatia testudinea (Ach.) Mass.

Stereocaulon alpinum Laur.
" botryosum Ach.
" grande (Magn.) Magn.
" paschale (L.) Hoffm.
" rivulorum Magn.
" saxatilis Magn.
" tomentosum Fr.

Thamnolia subuliformis (Ehrh.) W. Culb.
" vermicularis (Sw.) Ach. ex Schaer.

Tholurna dissimilis (Norm.) Norm.

Umbilicaria cylindrica (L.) Del.
" deusta (L.) Baumg.
" hyperborea (Ach.) Ach.
" papulosa (Ach.) Nyl.
" proboscidea (L.) Schrad.
" torrefecta (Lightf.) Schrad.
" vellea (L.) Ach.

Usnea glabrescens (Nyl. ex Vain.) Vain.

Xanthoria elegans (Link) Th. Fr.
" parietina (L.) Th. Fr.

APPENDIX 3

Bryophytes Collected in the Gladys Lake Ecological Reserve

MUSCI

Andreaea rupestris Hedw.

Aulacomnium palustre (Hedw.) Schwaegr.
" turgidum (Wahlenb.) Schwaegr.

Brachythecium albicans (Hedw.) B.S.G.
" erythrorrhizon B.S.G.
" frigidum (C. Muell.) Besch.
" nelsonii Grout
" plumosum (Hedw.) B.S.G.
" salebrosum (Web. & Mohr) B.S.G.

Bryum angustirete Kindb. ex Macoun
" caespiticium Hedw.
" cryophilum Mart.
" pallescens Schleich. ex Schwaegr.
" pseudotriquetrum (Hedw.) Gaertn., Meyer, & Scherb.
" weigelii Spreng.

Calliergon cordifolium (Hedw.) Kindb.
" giganteum (Schimp.) Kindb.
" stramineum (Brid.) Kindb.

Campylium stellatum (Hedw.) C. Jens.

Ceratodon purpureus (Hedw.) Brid.

Cinclidium stygium Sw.

Climacium dendroides (Hedw.) Web. & Mohr

Conostomum tetragonum (Hedw.) Lindb.

Cratoneuron commutatum (Hedw.) Roth var. falcatum (Brid.) Moenk.

Dicranoweisia crispula (Hedw.) Lindb. ex Milde

Dicranum acutifolium (Lindb. & Arnell) C. Jens. ex Weinm.
" flagellare Hedw.
" fragilifolium Lindb.
" fuscescens Turn.
" scoparium Hedw.
" undulatum Brid.

Distichium capillaceum (Hedw.) B.S.G.

Ditrichum flexicaule (Schwaegr.) Hampe

Drepanocladus exannulatus (B.S.G.) Warnst.
" revolvens (Sw.) Warnst.
" uncinatus (Hedw.) Warnst.

Encalypta rhaptocarpa Schwaegr.

Hygrohypnum luridum (Hedw.) Jenn.

Hylocomium splendens (Hedw.) B.S.G.

Hypnum lindbergii Mitt.
" revolutum (Mitt.) Lindb.

Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb.

Meesia triquetra (Richt.) Angstr.

Mnium blyttii B.S.G.

Orthotrichum laevigatum Zett.

Paludella squarrosa (Hedw.) Brid.

Philonotis fontana (Hedw.) Brid.
" " " " var. caespitosa (Jur.) Schimp.

Plagiomnium ellipticum (Brid.) Kop.
" venustum (Mitt.) Kop.

Pleurozium schreberi (Brid.) Mitt.

Pogonatum alpinum (Hedw.) Roehl.

Pohlia cruda (Hedw.) Lindb.
" elongata Hedw.
" nutans (Hedw.) Lindb.
" wahlenbergii (Web. & Mohr) Andr.

Polytrichum juniperinum Hedw.
" longisetum Brid.
" piliferum Hedw.
" strictum Brid.

Pseudoleskeella tectorum (Funck ex Brid.) Kindb. ex Broth.

Ptilium crista-castrensis (Hedw.) De Not.

Rhacomitrium canescens (Hedw.) Brid.
" lanuginosum (Hedw.) Brid.

Rhizomnium pseudopunctatum (Bruch & Schimp.) Kop.

Rhytidium rugosum (Hedw.) Kindb.

Sphagnum fallax (Klinggr.) Klinggr.
" fuscum (Schimp.) Klinggr.
: nemoreum Scop.
" rubellum Wils.
" warnstorfii Russ.

Sphlachnum sphaericum Hedw.

Tetraplodon mnioides (Hedw.) B.S.G.

Thuidium abietinum (Hedw.) B.S.G.

Timmia austriaca Hedw.

Tomenthypnum vitens (Hedw.) Loeske

Tortula ruralis (Hedw.) Gaertn., Meyer, & Scherb.

HEPATICAE

Barbilophozia floerkei (Web. & Mohr.) Loeske
" hatcheri (Evans) Loeske
" lycopodioides (Wallr.) Loeske
" quadriloba (Lindb.) Loeske

Blepharostoma trichophyllum (L.) Dum.

Cephalozia ambigua Mass.
" media Lindb.

Chandonanthus setiformis (Ehrh.) Lindb.

Lophozia obtusa (Lindb.) Evans

Marsupella sparsifolia (Lindb.) Dum.

Preissia quadrata (Scop.) Nees

Ptilidium ciliare (L.) Hampe
" pulcherrimum (L.) Hampe