VEGETATION COMMUNITIES WITHIN THE RANGE OF THE PORCUPINE CARIBOU HERD IN CANADA

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ABSTRACT

This report describes the vegetation communities located within the range of the Porcupine Caribou Herd in Canada. Within the winter range, 29 communities are described including 16 forest, six shrub, six graminoid and one forb community. These communities were sampled along the Dempster highway and a major vegetation shift was noted among physiographic regions along the highway.

Vegetation was also sampled during an investigation of the calving grounds of the herd. In the confined study area seven types were described including four shrub, two graminoid and one forb community.

The summer ecology of the herd was the focus of investigations from 1984 - 1986. Among the 20 communities described were seven scrub, 11 graminoid, one forb and one lichen type. Thematic Mapper satellite data was utilized to produce a vegetation map of the summer study area.

RÉSUMÉ

Le présent rapport décrit les communautés végétales se trouvant dans la territoire parcouru par la harde de caribous de la Porcupine, au Canada. Pour l'aire d'hivernage, nous décrivons 29 formations végétales : 16 forestières, 6 arbustives, six de graminoïdes at 1 de dicotylédones herbacées. Ces communautés végétales se trouvent le long de la route Dempster, et nous y avons constaté d'importantes variations des formations végétales entre régions physiographiques.

Nous avons également examiné la végétation durant une étude des aires de mise bas de la harde. Sur ce territoire restreint, nous avons répertorié 7 formations : 4 arbustives, 2 de graminoïdes et 1 de dicotylédones herbacées.

Les recherches menées de 1984 à 1986 étaient centrées sur l'écologie de la harde en été. Durant ces travaux, 20 communautés végétales ont été décrites : 7 arbustives, 11 de graminoïdes, 1 de dicotylédones herbacées et 1 de lichens. Des données satellitaires de capteur Thematic Mapper ont été utilisées pour la réalisation d'une carte de la végétation de l'aire étudiée en été.

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INTRODUCTION

The total home range of the Porcupine Caribou Herd is approximately 250,000 sq km within Alaska, Yukon and Northwest Territories (Figure 1) and, in the Yukon, includes virtually all the area north of Dawson. The vegetation complexes occurring in the region can be described within the context of biophysical units (Oswald and Senyk 1977; Wiken et al 1981) as they are primarily dictated by local physiography (Bostock 1965), glacial history (Hughes et al 1969) and climate (Wahl et al 1987).

From 1979 to 1986 the Canadian Wildlife Service conducted a number of studies on range use during winter (1979-82), spring (1979-81, 1983) and summer (1984-1986) by the Porcupine Caribou Herd (Russell et al 1992). A significant part of each of these studies was the documentation of vegetation communities. This report contains the detailed descriptions of the vegetation complexes within these seasonal ranges and serves as a companion document to Russell et al (1992).

Because the primary objective of each of these studies was not to describe the vegetation communities, our field methodology and the treatment of the data resulted in different levels of descriptive detail for each study.

WINTER

STUDY AREA

The study area encompassed the major wintering range of the Porcupine Caribou Herd within the Yukon Territory, an area bordered on the north by the Porcupine and Bell Rivers, and on the south by the south flank of the Ogilvie Mountains (app. 64 degrees N, Figure 2). Roughly half the area drains northeast into the Beaufort Sea via the Peel and Mackenzie Rivers, and the other half west into the Bering Sea via the Porcupine and Yukon Rivers.

Dawson and Old Crow are the only 2 Yukon communities bordering the winter range and only one all-season road, the Dempster Highway, transects the area (Figure 2), providing access to hunters from communities to the north and south. Since this study was initiated, the importance of the central and northern Richardson Mountains as key winter range has increased considerably. Unfortunately, we did not include this region in our original study area and suggest that more work needs to be conducted in that region.

Climate

The climate of the area is continental, with long cold winters and cool summers. Annual precipitation is low, varying from 200 mm in the low plains of the north to 750 mm in the southern mountains. The area is influenced to some extent by weather systems from both

Figure 1. Home range of the Porcupine caribou herd.

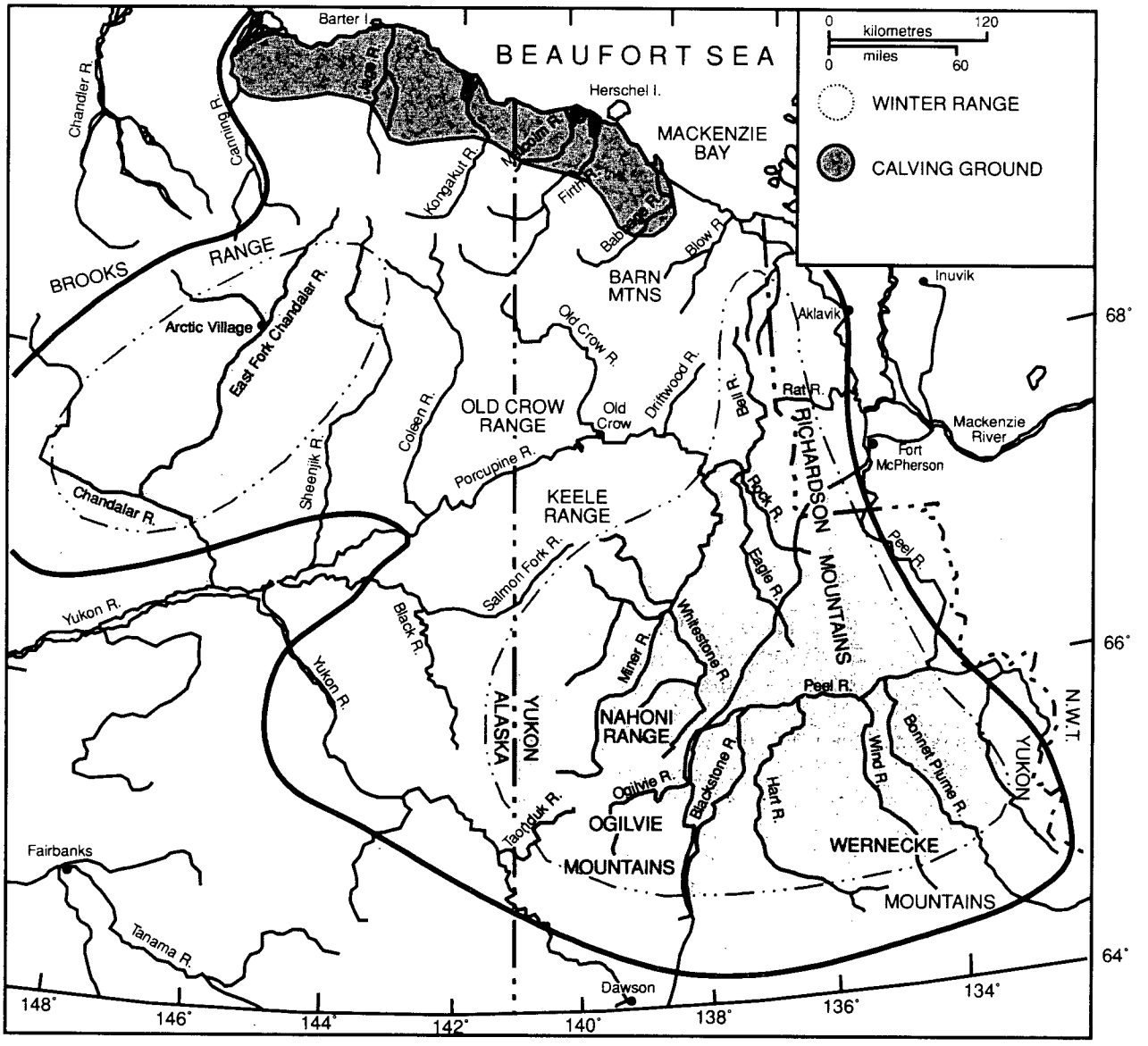
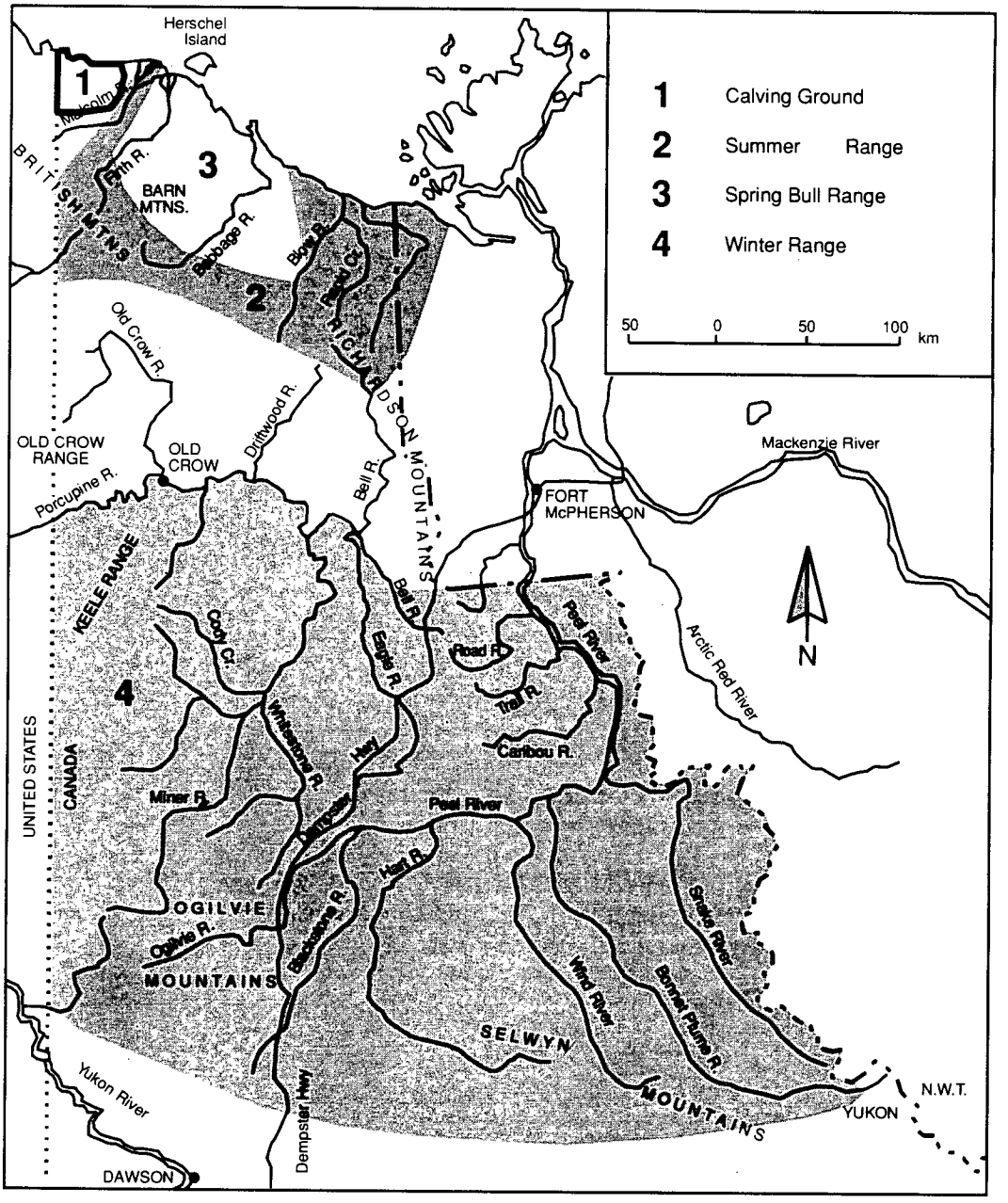


Figure 2. Study areas for the Porcupine caribou range analysis in Yukon.



the Pacific and Arctic Oceans -- Pacific air, either from the Gulf of Alaska or the Bering Sea, brings most of the precipitation, while Arctic air brings the extreme cold of winter. During the study, the mean monthly temperatures fell as low as -41.8 °C (January, 1982; Table 1). Pacific systems are more dominant in the south and Arctic systems dominate in the north.

Table 1. Mean daily temperatures at two locations along the Dempster Highway, 1979-82

		Temperature (deg C)					
Winter	Station	Nov	Dec	Jan	Feb	Mar	Apr
1979-8	Eagle Plains	-5.8	-20.5	-23.6	-14.7	-16.4	-11.3
	Ogilvie River	-11.2	-28.4	-31.7	-22.4	-19.1	-8.6
1980-81	Eagle Plains	-17.2	-25.0	-7.6	-20.2	-12.3	
	Ogilvie River	-19.2	-36.5	-14.2	-23.7	-15.1	-10.9
1981-82	Eagle Plains	-17.8	-18.4	-29.7	-23.0	-16.8	
	Ogilvie River	-21.6	-25.4	-41.8	-26.2	-22.8	

Terrain

Within the Yukon winter range of the Porcupine caribou herd lies all or part of three broad physiographic regions - the Richardson Mountains, Porcupine Plateau and Ogilvie Mountains (Bostock 1965).

The Richardson Mountains are characterized by moderate to steep slopes and rounded, north-south trending ridge crests, which rise 700 meters above the adjacent Porcupine Plateau. At their western edge the mountains become abruptly lower and appear to merge into the Porcupine Plateau (Terrain Analysis and Mapping Services Ltd. 1981).

The Porcupine Plateau includes the Embankment Hills, Peel Valley, Eagle Plain and the unnamed low rolling area which parallels the west flank of the Richardson Mountains. The latter area generally has a relief of 100 meters with some ridges rising up to 200 meters higher than the surrounding area. Rivers, arranged in a trellis pattern, cross this area as they flow westward from the Richardson Mountains. Only the Eagle River exhibits a flat-floored valley with terraced sides unlike the broad V-shaped

valleys of the other streams. To the south of the Eagle Plain, lies the 20 km wide, 200 meter deep flat-floored, steep-sided Peel Valley (Terrain Analysis and Mapping Services Ltd. 1981).

The Northern, Central and Southern Ogilvie Ranges and the Ogilvie and Taiga valleys comprise the Ogilvie Mountains. The Northern Ogilvie Ranges are a series of broad, steep-sided ridges. The Central Ogilvies consist of steep-sided, round topped east-west trending ridges that are transected by Engineer Creek. The Southern Ogilvies are the most rugged of all the mountain ranges in the area, with jagged crests and steep to precipitous flanked peaks, which rise 1000 meters above the broad, flat-floored valleys. The Klondike, Tombstone and Blackstone Rivers dissect the ranges completely (Terrain Analysis and Mapping Services Ltd. 1981).

Surficial geology

Most of the winter range, including the Porcupine Plateau, the northern part of the Ogilvie Mountains, the extreme western ridge of the Richardson Mountains, show no evidence of glaciation during the last ice age. On the Eagle Plains, fine texture clay silt overlay rubble material. In the Ogilvie Mountains a thinner coarser grained colluvium has evolved. Even though not glaciated most surficial deposits along watercourses are of glacial-fluvial origin. Along the Eagle and Whitestone Rivers, for example, terrace formation resulted from the damming of meltwater from the Laurentide Icefields.

The study area is located on the northern extremity of the discontinuous permafrost region of North America (Brown 1969). The location of this region is largely determined by mean annual temperature, however the mosaic of permafrost is largely influenced by such terrain features as relief, drainage, soil texture, vegetation and snow cover (Brown 1969). Permafrost-free areas include steep south facing slopes in the south, gravel deposits along most of the river valleys and in lakes.

Two features combine to produce a unique winter range among Canadian migratory herds - mountains and unglaciated terrain. The mountainous nature of the range results in dynamic weather conditions with distinct regional snow and wind patterns (Russell et al 1992). As well, the lack of extensive glaciofluvial deposits results in unique vegetation complexes and deeper more widespread permafrost, compared to more eastern winter ranges. Permafrost is speculated to have developed in the Pleistocene ice ages (Brown 1969). The lack of recent glacial influence over the majority of the winter range means that the processes of erosion and mass wasting are a longer phenomenon resulting in deep peat accumulations.

METHODS

We sampled sites along the Dempster Highway to define the

vegetation communities within the study area. These communities then formed the link required to assess lichen biomass and fire history in the region (Russell et al 1992). Colour aerial photographs (scale = 1:27,000) were interpreted into broad vegetation types based primarily on physiognomic criteria. One hundred and sixteen stands, dispersed within five physiographic regions along the Dempster Highway, were selected for field investigation.

During the summers of 1979 and 1980 field crews established a 100 m transect in the centre of each stand. Equidistantly along both sides of the transect 20 - 0.5x2m and five, 10x10m plots were established. At each of the smaller plots all species and their cover class were recorded as follows;

COVER CLASS	PERCENTAGE RANGE
1	<1
2	1-5
3	6-10
4	11-25
5	26-50
6	51-75
7	76-95
8	96-100

Similar cover values were recorded in the 10x10m plots for species grouped into the following physiognomic categories - trees (conifer and deciduous), tall, medium and low shrubs, graminoids, forbs, mosses (mesic and hydric), and lichens (fruticose and foliose).

An index of similarity was calculated for each plot pair using proportional similarity, PS, as outlined by Pielou (1977) and defined as

$$PS = 2 \sum_{v=1}^{s} \min \left[\frac{x_{iv}}{z}, \frac{x_{jv}}{z} \right]$$

where x represents the biomass of species v in plot i and j;
s is the total number of species in the two plots combined;
and

$$z = \sum_{v=1}^{s} (x_{iv} + x_{jv})$$

Clustering of the resultant proportional similarity matrix was conducted using a hierarchical agglomerative routine called completed linkage (Pielou 1977). Briefly, when a stand is joined to

a cluster using complete linkage its similarity to that cluster is equal to its similarity to the most dissimilar member within the cluster. When two clusters join the resultant similarity is that existing between the farthest pair of members.

RESULTS

After clustering, 29 community types were identified at a minimum similarity of 0.20. Using the classification scheme of Vierecke et al (1986), vegetation communities were classified to Level IV (Table 2). Generally vegetation communities (Level V) were named for dominant species in the major physiognomic layers, however, in some cases, species with high indicator value are listed. Appendix A summarizes the species and respective cover for each of these final 29 community types and Appendix B provides a summary of percent cover by range type.

Table 2. Vegetation communities along the Dempster Highway

LEVEL I	LEVEL II	LEVEL III	LEVEL IV[1]	LEVEL V	TypeCode	
Forest	Needleleaf Forest	Closed Needleleaf Forest	White spruce	Picea glauca/Lupinus/Pleurozium	6	Pg/L/P
				Picea glauca/Populus balsamifera/Rosa/Moss	26	Pg/Pb
		Open Needleleaf Forest	White spruce	Picea glauca/Vaccinium vitis-idaea/Stereocaulon	11	Pg/Vv/S
				Picea glauca/Rhododendron/Dryas	9	Pg/R/D
				Picea glauca/Salix reticulata/Dryas	5	Pg/Sr/D
				Picea glauca/Viburnum/Mertensia/Graminae	14	Pg/V/M
			Black spruce	Picea mariana/Alnus/Spirea	20	Pm/Al/Sp
				Picea mariana/Graminoids	12	Pm/Gr
		Needleleaf Woodland	White spruce	Picea glauca/Empetrum/Stereocaulon	22	Pg/Em/S
				Picea glauca/Shepherdia/Carex bigelowii	15	Pg/Sh/Cx
				Picea glauca/Equisetum scirpoides/Pleurozium	13	Pg/Eq/Pl
			Blackspruce	Picea mariana/Ledum/Sphagnum	21	Pm/L/Sp
				Picea mariana/Rubus chamaemorus	17	Pm/Rc
				Picea mariana/Eriophorum/Cladina	23	Pm/Er/Ci
				Picea mariana/Salix reticulata/Moss	29	Pm/Sr/Ms
				Picea mariana/Betula occidentalis/Cladonia	19	Pm/Bo/Cl
Scrub	Low Shrub Scrub	Open Low Shrub Scrub	Dwarf birch	Betula glandulosa/Salix/Petasites frigidum	2	Bg/Sx/Pf
				Betula glandulosa/Vaccinium vitis-idaea/ Saxifraga tricuspidata	7	Bg/Vv/Sa
				Betula glandulosa/Arctostaphylos alpina/ Hierchloe alpina	24	Bg/Ar/H
			Labrador tea	Ledum/Vaccinium uliginosum/Moss	27	Lp/Vu/Ms
				Ledum/Alnus crispa/Eriophorum	28	Lp/Al/Er
	Dwarf shrub Scrub	Closed Dwarf Shrub Scrub	Dryas tundra	Dryas/forb	25	D/Fb
Herbaceous	Graminoid Herbaceous	Mesic Graminoid Herbaceous	Tussock tundra	Eriophorum/Ledum/Shpagnum	1	Er/Lp/Sp
				Eriophorum/Betula/Sphagnum	4	Er/Bg/Sp
				Eriophorum/Picea mariana	16	Er/Pm
				Eriophorum/Picea mariana/Lichen	10	Er/Pm/Ln
				Carex bigelowii/Ledum/Sphagnum	8	Cx/Lp/Sp
				Carex bigelowii/Salix	3	Cx/Sx
	Forb Herbaceous	Mesic Forb Herbaceous	Horsetails	Equisetum silvaticum/Ledum	18	Eq/Lp

[1]- designation to Level IV follows Vierecke et al, 1986

Community descriptions

Forest communities

Needleleaf Forest

Closed Needleleaf Forest

These communities are characterized by relatively dense (>25%) white spruce stands located on level valley floors. The soils are generally silty clays to sandy clays underlain by gravel deposits which provides sufficient drainage to prevent permanent ice building in the soil. These communities are very localized and confined to the *Picea glauca/Lupinus/Pleurozium* community in southern and central sections of the Dempster and the *Picea glauca/Populus balsamifera/Rosa*/Moss community in the northern river valleys.

Picea glauca/Lupinus/Pleurozium (Pg/L/P) 1A1j

White spruce and occasionally balsam poplar dominate the overstorey. The poorly developed tall shrub layer is represented primarily by *Salix* species and *Potentilla fruticosa*, a good indicator species for this community. Dwarf shrubs are represented by *Empetrum nigrum, Vaccinum vitis-idaea* and *Arctostaphylos rubra*. The graminoid layer is poorly developed with a few *Graminae* individuals normally present. The forb component is moderately well developed with a good species diversity. *Equisetum scirpoides, Lupinus arcticum, Mertensia paniculata, Polygonum viviparum, Pyrola sp., Senecio lugens* and *Stellaria* are indicative of this community. Lichens are moderate to poorly developed in these typically old stands with *Cetraria cucullata, Cladina mitis, Cladonia sp.* and *Peltigera apthosa* contributing the majority of the cover. The moderate cover of moss is restricted to mesic species with *Pleurozium* dominating.

Picea glauca/Populus balsamifera/Rosa/Moss (Pg/Pb) 1A1j

This community is found in sheltered river valleys in the Richardson Mountains and foothills generally between 500 - 625 meters. White spruce and balsam poplar dominate the overstorey while the tall shrub component is well represented with *Rosa acicularis* and *Salix* species. Dwarf shrubs are poorly developed with *Pyrola secunda* the only species consistently present. Graminoids are poorly developed with *Arctogrostis podeoides* normally present. The forb component is moderately well developed with *Equisetum scirpoides, Polygonum viviparum, Anemone parviflora, Tofieldia coccinea, Aster sibiricus* and *Hedysarum alpinum* being good indicators of this community. Lichens are very poorly

developed with *Peltigera apthosa* being the only species consistently present. *Mnium, Hylocomium, Hypnum, Pleurozium* and other mesic mosses form an almost continuous mat of moss on these sites.

Open Needleleaf Forests

Four white spruce and two black spruce communities were classified as open needleleaf forests with the criteria that canopy cover is between 10 and 25%. These stands are found from the Blackstone River to the Eagle River area and generally on middle to lower moderately steep slopes. They are found in soils with a variety of textures from organics to rubble but are generally characterized by a deep active layer.

Picea glauca/Vaccinium vitis-idaea/Stereocaulon (Pg/Vv/S) 1A2f

These stands are found on poorly developed diamicton well drained soils in drier subxeric sites. This community has a moderately well developed shrub layer with tall shrubs being represented by *Ledum palustre, Betula glandulosa, Betula occidentalis* and dwarf shrubs being dominated by *Vaccinium vitis-idaea* but also including *Empetrum nigrum.*

Graminoids and forbs are essentially unrepresented in this community while the lichen layer is well developed and very diverse with *Cetraria cucculata, Cetraria islandica, Cetraria Richardsonii, Cetraria nivalis, Cladina alpestris, Cladina mitis, Cladina rangiferina, Cladonia sp., Peltigera apthosa* and *Stereocaulon alpinum* normally present. Mesic mosses generally have about 30 % ground cover in these stands.

Picea glauca/Rhododendron/Dryas (Pg/R/D) 1A2f

These stands are found primarily in the Ogilvie Valley region on middle slopes between 650 - 850 meters elevation. Stands are on moderately well drained mesic to submesic sites in rubbly to organic textured soils with a deep active layer. Typically these sites have moderate to sparse tall shrub, dense dwarf shrub and low lichen components. Indicative of these stands are *Dryas integrifolia, Rhododendron lapponicum, Potentilla fruticosa, Arctostaphylos rubra, Hedysarum alpinum, Carex scirpoides, Papaver Macounii, Androsace chamaejasme*, and *Anemone parviflora* ferns. Less indicative, but typical of these stands are *Picea glauca, Ledum palustre, Salix sp., Cetraria cucculata, Cetraria islandica, Cladina mitis, Cladonia sp., Peltigera apthosa* and mesic mosses.

Picea glauca/Salix reticulata/Dryas (Pg/Sr/D) 1A2f

These stands are found primarily in the Blackstone River valley and floristic differences between this community and the *Picea glauca/Rhododendron/Dryas* community are due to the fact that these stands are found primarily at higher elevations, usually between 900 to 1150 meters. Soils are well drained, primarily rubbly textured and with a deep active layer. Stands are generally found on middle slopes under mesic to submesic moisture conditions. The tall shrub component is moderately well developed and normally represented by *Ledum palustre, Rhododendron lapponicum, Betula glandulosa* and *Salix* sp. The dwarf shrub layer is represented by *Arctostaphylos rubra, Vaccinum vitis-idaea, Andromeda polifolia* and *Salix reticulata*. On the drier, more open stands *Cassiope tetragona* and *Arctostaphylos uva ursi* will occur. Among the graminoids *Carex Bigelowii* and *C. scirpoides* usually are present. Most indicative of the forbs are *Anemone parviflora* and *Tofieldia coccinea*. Lichen are moderately well developed in these stands with *Cetraria cucullata, Cetraria islandica, Cetraria Richardsoni, Cladina rangiferina, C. mitis Cladonia* sp. and *Peltigera apthosa* normally occurring. Mesic mosses constitute about 40% of the ground cover in these stands.

Picea glauca/Viburnum/Mertensia/Graminae (Pg/V/M) 1A2f

This community was found only on lower slopes in the Ogilvie valley with soils that are generally moderate to poorly drained clay silts. The tree layer is represented by *Picea glauca* and *Betula papyrifera*. A dense tall shrub component is primarily made up of *Viburnum edule* and *Rosa acicularis* with *Ledum palustre, Alnus crispa* and *Rubus idaeus* also occurring. Dwarf shrubs include *Pyrola sp., Vaccinum vitis-idaea* and *Linnaea borealis*. Graminae species are very abundant. The most indicative forb species are *Mertensia paniculata, Aconitum delphiniflorium, Petasites frigidus* and *Polygonum alaskanum*. Lichen are almost absent in these stands with *Peltigera apthosa* being the sole representative. The dense shrub layer and subsequent litter fall also restrict the build up of a significant moss layer.

Picea mariana/Alnus/Spirea (Pm/Al/Sp) 1A2g

The stands, found only in the Eagle Plains region are usually found on moderate to poorly drained upper and middle slopes. Sites are generally mesic with clay silts being the predominant soil type on mid slopes and organic soils on upper slopes. These appear to be younger stands in which the active layer is still moderately deep (between 30 - 60cm). As well as *Picea mariana, Picea glauca* and *Betula papyrifera* can occur in the overstorey. Tall shrubs are moderately well developed and diverse with *Ledum palustre, Salix sp., Betula glandulosa, Vaccinium uliginosum, Alnus crispa* and *Rosa acicularis* normally occurring. Dwarf shrubs include *Empetrum*

nigrum, Vaccinium vitis-idaea and *Spirea Beauverdiana*. Graminoids are nearly absent from these stands. Lichen cover is moderate with *Cetraria cucullata, Cetraria islandica, Cladina mitis, Cladina rangiferina* and *Cladonia* sp usually found. The moss layer provides about 50% coverage being evenly divided between *Pleurozium* and *Sphagnum* species.

Picea mariana/Graminoids (Pm/Gr) 1A2g

This community is represented by many of the black spruce stands in the Ogilvie Valley and as such are usually found on middle slopes above typically poorly drained organic soils. Active layers, however are still moderately deep (between 20-40 cm). Tall and dwarf shrubs are poorly to moderately developed with no real indicative species. Normally found however are *Salix sp., Ledum palustre, Vaccinium uliginosum* and *Vaccinium vitis-idaea*. Graminoids are well represented covering about 15 to 20% of the ground and normally represented by *Eriophorum vaginatum, Carex Bigelowii* and *Graminae* sp. The tussock forming *Eriophorum* found under a tree canopy is indicative of the shallower active layer in this community than in the previously described communities. No forb species is consistently found on these sites. Lichen are moderately well represented by *Cetraria cucculata, Cetraria islandica, Cladina mitis, Cladina rangiferina, Cladonia sp.* and *Peltigera apthosa*. Mesic mosses dominate *Sphagnum* species on these sites.

Needleleaf woodland

Seven forest communities fall into the needleleaf woodland classification by virtue of having less then 10% evergreen cover. The sparse forest cover results for a variety of reasons - shallow active layer, treeline and shallow soils over bedrock or scree.

Picea glauca/Empetrum/Stereocaulon (Pg/Em/S) 1A3c

This community is found at crests and upper scree slopes under well drained xeric conditions. Sites were found only on the Eagle Plains at 600 to 650 meters elevation. Tall shrubs are essentially absent from this community while *Empetrum nigrum Spirea Beauverdiana, Vaccinum vitis-idaea* and *V. uliginosum* provide the only cover of dwarf shrubs. Some grass species occur sparsely in these sites and forb species are virtually absent. Approximately 75% of the ground cover is contributed by lichens with in order of abundance, *Stereocaulon alpinum, Cladonia sp., Cladina mitis, Peltigera apthosa, Cetraria culculata, Cetraria islandica, Cladina alpestris, Cladina rangiferina* and *Nephroma arcticum* being the major species. Moss cover is sparse to absent.

Picea glauca/Shepherdia/Carex Bigelowii (Pg/Sh/Cx) 1A3c

This community, found primarily in the transition between the Ogilvie Valley and the Eagle Plains, occurs on moderately well drained clay silt soils on valley floors or occasionally on organic middle slope soils. These sites are typically mesic with an active layer between 30 - 45 cm. Although *Picea glauca* is the most consistent tree species, *Picea mariana* and *Larix laricina* can occur as well. The tall shrub component normally includes *Salix sp., Ledum palustre, Rhododendron lapponicum* and *Shepherdia canadensis*. Dwarf shrubs are also well represented with *Arctostaphylos rubra, Empetrum nigrum, Vaccinium vitis-idaea* and *Vaccinum uliginosum* normally occurring. Since these sites are not as well drained as some of the previously described *Picea glauca* stands, sedges are an important component of the community with *Carex Bigelowei* and to a lesser extent *Eriophorum vaginatum* the most indicative species. Typical of the moderately developed forb layer is *Lupinus arcticum, Tofieldia coccinea* and *Petasites frigidus*. Less consistent but also found are *Anemone parviflora, Hedysarum alpinum* and *Mertensia paniculata*. Significant cover of *Equisetum scirpoides* is indicative of these sites. Although numerous lichen species normally occur, the lichen contribution to the total ground cover is generally small. Consistently found are *Cetraria cucullata, Cetraria islandica, Cladina mitis, Cladina rangiferina, Cladonia sp.* and *Peltigera apthosa*. Moss provides approximately 50% cover with *Pleurozium* and other mesic mosses being the major species.

Picea glauca/Equisetum scirpoides/Pleurozium (Pg/Eq/Pl)

This type was represented by a single stand sampled in the Ogilvie Valley. The site was a mesic valley floor community at 500 meters elevation. The active layer was moderately deep. The overstorey of *Picea glauca* was relatively sparse for a forest community. Shrubs were moderately well developed with a good species diversity including *Alnus crispa, Arctostaphylos rubra, Ledum palustre, Linnaea borealis, Pyrola asarifolia, Pyrola grandiflora, Rosa acicularis, Salix spp., Shepherdia canadensis, Vaccinium uliginosum, Vaccinium vitis-idaea* and *Viburnum edule*. Only a trace of *Graminae* spp. and no sedge species were located. Included among the forbs were *Amerorchis rotundifolia, Anemone parviflora, Gentiana glauca, Hedysarum alpinum, Lupinus arcticus, Mertensia paniculata, Moneses uniflora, Parnassia palustre* and *Pedicularis labradorica*. Lichens were poorly developed and were represented by *Cetraria cucullata, Cladina mitis, Cladina rangiferina, Cladonia* spp., and *Peltigera apthosa*. Horsetails were well developed on the site and were dominated by *Equisetum scirpoides* with *Equisetum fluviatile* occurring as well. About 75 % of the ground was covered by an almost continuous mat of *Pleurozium*.

Picea mariana/Ledum/Sphagnum (Pm/L/Sp) 1A3d

This community is found on a variety of sites on the Eagle Plains. Typically the sites tend to be moderately well to poorly drained with active layer depths of 20 - 50 cm. On the average, these sites are more poorly drained and as a consequence have shallower active layers then the previously described *Picea mariana/Alnus/Spirea* community. Floristic differences between the present community and the *Picea mariana/Alnus/Spirea* community reflect relative amounts of more permafarost tolerant species and to a lesser extent species present and absent. Of significance is the absence or low abundance of *Picea mariana, Alnus crispa, Rosa acicularis, Empetrum nigrum* and mesic mosses and the presence or higher abundance of *Ledum palustre, Betula glandulosa, Rubus chamaemorus, Oxycoccus microcarpa* and *Sphagnum* species.

Picea mariana/Rubus chamaemorus (Pm/Rc) 1A3d

This community differs from the *Picea mariana/Ledum/Sphagnum* community in that it is found only in the Ogilvie Valley region on typically poorer drained subhydric sites with shallower active layers and organic soils. Active layers vary from just under the moss mat to 25 cm. The tall shrub layer is moderately well developed with *Ledum palustre, Salix sp., Betula glandulosa. Empetrum nigrum* and *Vaccinum vitis-idaea* are the sole consistent representatives in the dwarf shrub layer. The forb layer is poorly represented with *Rubus chamaemorus, Oxyccocus microcarpa* and *Petasites frigidus* being the only species always present. Graminoids are poorly developed with *Eriophorum vaginatum* normally occurring. Lichens are moderately well developed and consistently present species include *Cetraria cucullata, Cetraria islandica, Cladina mitis, Cladina rangiferina, Cladonia sp.,* and *Peltigera apthosa*. The moss layer is equally represented by *Pleurozium* and *Sphagnum* species.

Picea mariana/Eriophorum/Cladina (Pm/Er/Ci) 1A3d

These stands found on the Eagle Plains, occur in a variety of sites from upper to lower slopes on primarily moderate to poorly drained clayey silts or organic soils. *Larix laricina* is commonly found with *Picea mariana* in the overstorey. *Ledum palustre* is the abundant tall shrub species with *Betula glandulosa* normally found in lesser amounts. Dwarf shrubs include *Empetrum nigrum, Vaccinium vitis idaea, Vaccinium uliginosum* and *Spirea Beauverdiana*. Tussock forming *Eriophorum vaginatum* is found in greatest abundance among forested stand in this community type. Most commonly found forbs

include *Oxycoccus microcarpa* and *Rubus chamaemorus*. *Equisetum silvaticum* achieves greatest expression in this community. The lichen layer has a high diversity of species and several species such as *Cladina alpestris* and *Cladina rangiferina* reach greatest abundance in these stands. Other lichen species normally found include *Cetraria cucullata, Cetraria islandica, Cetraria nivalis, Cladina mitis, Cladonia spp., Peltigera apthosa* and *Stereocaulon alpinum*. The moss layer is moderately well developed with mixed cover of mesic and hydric mosses.

Picea mariana/Salix reticulata/Moss (Pm/SR/Ms) 1A3d

These stands occur in poorly drained forested sites in the Richardson Mountains. Active layers vary between 20 and 50 cm in primarily organic soils. Frequently, *Picea glauca* and sometimes *Larix laricina* are found along with *Picea mariana* on these sites. *Ledum palustre, Betula glandulosa*, and *Salix* sp., comprise the tall shrub component. The dwarf shrubs are relatively well developed with *Empetrum nigrum, Salix reticulata, Vaccinium vitis-idaea* and *Vaccinium uliginosum* normally occurring. *Salix reticulata* is particularly indicative of these stands. Among the graminoids *Carex Bigelowii* and, less frequently, *Eriophorum vaginatum* contribute to moderately well developed layer. Forbs are consistently represented by indicative species such as *Andromeda polifolia, Pedicularis labradorica, Pedicularis sudetica* and *Saussurea angustifolia*. A variety of lichen species occur on these sites including *Cetraria cucullata, Cetraria islandica, Cetraria Richardsonii, Cladina alpestris, Cladina mitis, Cladina rangiferina, Cladonia sp., Dactylina alpina* and *Peltigera apthosa*. Over 80 % of the ground is covered by moss, primarily mesic moss species. *Equisetum scirpoides* is a commonly found horsetail on these sites.

Picea mariana/Betula occidentalis/Cladonia (Pm/Bo/Cl) 1A3d

Found primarily in the transition between the Ogilvie valley and the Eagle Plains, these stands normally occur on south facing slopes characterized by rubbly textured soils with deep active layers. These stands tend to be younger succession fire climax communities.

Normally the sparse overstorey is a mixture of *Picea mariana* and *Picea glauca*. The tall shrub component is almost exclusively *Ledum palustre, Betula glandulosa, Betula occidentalis, Salix sp.*, and *Rosa acicularis*. Dwarf shrubs are represented by *Empetrum nigrum, Vaccinum vitis-idaea, Vaccinium uliginosum* and *Spirea Beauverdiana*. Graminoids, forbs and horsetails are virtually absent from the stand in terms of cover with no species consistently present. Among the lichens *Cladonia* sp. and *Peltigera apthosa*

contribute the majority of the cover. The only other species normally present include *Stereocaulon alpinum* and *Peltigera apthosa*. *Cetraria* and *Cladina* sp. occur sporadically. These stands have characteristically poorly developed moss layers with *Pleurozium* sp. forming the major cover.

Shrub communities

Open low shrub scrub

Shrub communities were sampled in the North Fork Pass, Blackstone River and Richardson Mountain regions. Six community types were described and were characterized by shrub component with greater than 40 % cover and if trees were present the overstorey cover was less than two %.

Betula glandulosa/Salix/Petasites frigidus (Bg/Sx/Pf) 2C2a

These stands occur throughout the North Fork Pass region at elevations of 1000 - 1350 meters and with relatively gentle slopes. Soils are generally well drained rubble or clayey silt textured on mesic sites with a deep active layer. If present at all *Picea glauca* is very sparse and sporadic around treeline. The major shrub species in terms of abundance is *Betula glandulosa* and *Salix* sp. Also normally occurring are *Ledum palustre, Vaccinium uliginosum, Vaccinium vitis-idaea* and *Empetrum nigrum*. *Graminae* sp. are relatively absent on these sites. Among the forbs *Epilobium angustifolium, Mertensia paniculata* and *Petasites frigidus* typify this community. Lichens are consistently represented by *Cladina alpestris, Cladina mitis, Cladina rangiferina, Cladonia sp.* and *Peltigera apthosa*. Mesic Moss species, primarily *Pleurozium* average about 40 % cover.

Betula/Vaccinium vitis-idaea/Saxifraga (Bg/Vv/Sa) 2C2a

This community is found on steep mid-slope sites in the Blackstone River Valley. Stands have well drained rubbly textured soils, permafrost is absent and sites are typically subxeric to xeric. *Betula glandulosa* and *Vaccinium vitis-idaea* reach their greatest abundance in these stands. Additional shrub species include *Empetrum nigrum, Rosa acicularis* and *Ledum palustre*. Graminoids are virtually absent while among the forbs *Saxifraga tricuspidata* and *Epilobium angustifolium* typify the drier site condition. The lichen layer is well developed with a good species diversity that included *Cetraria cucullata, C. islandica, C. nivalis, C. Richardsoni, Cladina mitis, Cladina rangiferina, Cladonia sp., Peltigera apthosa* and *Stereocaulon alpinum*. Mesic mosses vary in abundance in these stands.

Betula/Arctostaphylos alpina/Hierchloe (Bg/Ar/H) 2C2a

This community is found throughout the Richardson Mountain section of the highway on ridge crests between 650-700 meters. These sites are subxeric to xeric with diamicton textured well drained soils. Major shrub species include *Betula glandulosa, Arctostaphylos alpina, Empetrum nigrum, Vaccinium uliginosum and Vaccinium vitis-idaea*. Among the graminoids *Hierchloe alpina* is the only consistently present species. Forbs are virtually absent with no species occurring in over 70 % of our sampled stands. Lichens are well developed and represented by *Cetraria cucullata, Cetraria islandica, Cetraria nivalis, Cetraria Richardsoni, Cladina mitis, Cladina rangiferina, Cladonia sp., Dactylina alpina, Stereocaulon alpinum* and *Thamnolia subuliformis*. Mosses are very sparse with *Dicranum* and *Polytrichum* species normally present.

Ledum palustre/Vaccinium uliginosum/Moss (Lp/Vu/Ms) 2C2j

These stands, located in the Richardson Mountain region, are normally found on moderate to poorly drained organic soils. Active layers are deeper than in sedge communities but shallower than the previously described shrub types. Shrubs are represented by *Ledum palustre, Betula glandulosa, Salix* spp., *Empetrum nigrum, Vaccinium vitis-idaea* and *Vaccinium uliginosum*.

Due to the shallow active layer, tussock sedges are predominant in most of the sites. *Eriophorum vaginatum* and *Carex Bigelowii* normally occur. No forb or horsetail species are found consistently throughout these stands. Lichens are well developed with *Cetraria cucullata, Cetraria islandica, Cetraria nivalis, Cladina mitis, Cladina rangiferina, Cladonia sp., Dactylina alpina, Peltigera apthosa, Stereocaulon alpina* and *Thamnolia subuliformis* normally present. A variety of moss generally occur in these stands including *Pleurozium, Sphagnum, Dicranum, Polytrichum, Hylocomium* and *Hypnum*.

Ledum palustre/Alnus crispa/Eriophorum vaginatum (Lp/Al/Er) 2C2j

Found in the Richardson Mountains, this type occurs on hygric and subhygric poorly drained sites. Active layers tend to be shallower than the *Ledum palustre/Vaccinium uliginosum*/moss type and unlike this previous type, these stands tend to be located on slopes in rolling terrain rather than on a level plain topography. If trees are present, they are usually limited to sporadic *Picea mariana* individuals. Among the shrub communities, *Ledum palustre* and *Alnus crispa* reach their greatest abundance in this type. Other shrubs include *Betula glandulosa, Empetrum nigrum, Vaccinium vitis-idaea, Vaccinium uliginosum* and *Andromeda polifolia*.

Eriophorum vaginatum also reaches its greatest abundance among the shrub types and along with *Carex Bigelowii* cover an average of 20 % of the ground. *Rubus chamaemorus* and *Pedicularis lapponicum* are the only consistent forbs present. Lichens are well represented by *Cetraria cucullata, Cetraria nivalis, Cetraria Richardsoni, Cladina mitis, Cladina rangiferina, Cladonia sp., Dactylina alpina, Peltigera apthosa, Stereocaulon alpinum* and *Thamnolia subuliformis*. Among the mosses, *Sphagnum* species form the majority of the cover, however other genera such as *Pleurozium, Dicranum, Polytrichum, Hylocomium* and *Hypnum* also occur.

Closed dwarf shrub scrub

Dryas integrifolia/forb (D/Fb) 2D1e

This type is found on drier well drained submesic to subxeric ridge communities in the Richardson Mountains. Soils tend to have a rubbly texture and active layers are very deep. *Dryas integrifolia* predominates on these sites. Other shrubs include *Cassiope tetragona, Rhododendron lapponicum, Vaccinium uliginosum, Salix reticulata* and taller *Salix* sp. Graminoids are restricted to a few *Carex scirpoides* and occasionally *Hierchloe alpina*. Forbs are well represented in these stands by *Astragalus sp., Parrya nudicaulis, Polygonum bistorta, Polygonum viviparum, Saussurea angustifolia, Tofieldia, Pedicularis Kanei* and *Pedicularis capitata*. Lichens are widespread and include *Alectoria ochroleuca, Cetraria cucullata, Cetraria nivalis, Cetraria richardsonii, Cladina mitis, Cladina rangiferina, Cladonia spp., Dactylina alpina, Peltigera apthosa, Stereocaulon alpinum* and *Thamnolia subuliformis*. Mesic mosses cover an average of 40 % of the ground.

Herbaceous communities

Mesic Graminoid Herbaceous

Cluster analysis separated six graminoid, essentially sedge communities. To be included in this range type communities had less than 40 % shrub cover, less than two % tree cover and greater than 15 % graminoid cover. These communities tended to be poorly drained in organic soils with shallow active layers. All communities occurred between the North Fork Pass region and the Ogilvie Valley region "Sedge-type" communities in the Richardson Mountains section normally had a sufficient shrub component to be included under the shrub types.

Where differences between some communities could not be attributed to significant species differences, then differences in the relative abundance of the major species were evident.

Eriophorum vaginatum/Ledum palustre/Sphagnum (Er/Lp/Sp) 3A2d

These stands were found in poorly drained valley floors in the North Fork Pass - Chapman Lake region between 950 and 1150 meters. Sites were primarily subhygric. *Ledum palustre* is the dominant shrub species with *Andromeda polifolia, Betula glandulosa* and *Vaccinium vitis-idaea* also occurring. *Eriophorum vaginatum* is the major sedge species with *Carex Bigeloweii* being codominant. Among the sedge communities, this type has the highest average lichen and moss cover. Lichens include *Cetraria cucullata, Cetraria nivalis, Cladina mitis, Cladina rangiferina, Cladonia sp., Dactylina alpina* and *Peltigera apthosa*. *Sphagnum* reaches its greatest abundance in this community with all mesic moss species being a relatively minor component.

Eriophorum vaginatum/Betula glandulosa/Sphagnum (Er/Bg/Sp) 3A2d

This community appears floristically similar to the previously described community, however in the present community *Betula glandulosa* is the major shrub species, *Eriophorum* is nearly twice as abundant and moss on the average contributes less to the ground cover. This community occurs on the open plains of the Chapman Lake/Blackstone River regions. Other shrub species occurring are *Andromeda polifolia, Ledum palustre* and *Vaccinium vitis-idaea*. Tussock forming sedges (*Eriophorum vaginatum* and *Carex Bigelowii*) cover approximately 35% of the ground. Only *Rubus chamaemorus* and *Pedicularis labradorica* are consistently found among the forbs. Lichens are represented by *Cetraria islandica, Cladina mitis, Cladina rangiferina, Cladina* sp. and *Peltigera apthosa*. Although mesic mosses contribute about 10% cover, *Sphagnum* is the dominant genera.

Eriophorum vaginatum/Picea mariana (Er/Pm) 3A2d

This type is found primarily in the transition between the Ogilvie valley and the Eagle Plains area between 500 to 800 meters. These sites tend to be found on hygric, poorly drained valley bottoms on organic and occasionally clayey silt substrates. Scattered stunted *Picea mariana* normally occur. Among the shrubs, *Ledum palustre, Betula glandulosa, Salix* sp., *Chamaedaphne calyculata, Vaccinium vitis-idaea* and *Vaccinium uliginosum* normally occur. *Eriophorum vaginatum* is by far the major sedge species. *Carex Bigelowii* is normally present but with limited abundance. Forbs reach their highest average abundance in this community and are represented by *Oxycoccus microcarpa, Rubus chamaemorus* and *Chrysosplenium tetrandrum*. Lichens include *Cetraria cucullata, Cetraria islandica, Cladina mitis, Cladina rangiferina, Cladonia* spp. and *Peltigera apthosa*. *Sphagnum* predominates the well developed moss layer.

Eriophorum vaginatum/Picea mariana/Lichen (Er/Pm/Ln) 3A2d

This type is found in the Ogilvie Valley on more mesic sites than the previously described communities. Shrub and lichens appear

more abundant and sedges less dominant. *Picea mariana* and occasionally *Larix laricina* are found. Shrubs include *Betula glandulosa, Salix sp., Ledum palustre, Empetrum nigrum, Vaccinium vitis-idaea* and *Vaccinium uliginosum*. The sedge layer includes *Eriophorum vaginatum* and *Carex Bigelowii*. Among the forbs *Rubus chamaemorus* and *Pedicularis labradorica* normally occur. Lichens are represented by *Cetraria cucullata, Cetraria islandica, Cetraria nivalis, Cladina mitis, Cladina rangiferina, Cladonia* sp., and *Peltigera apthosa*. Sphagnum species dominate the moss layer.

Carex Bigelowii/Ledum palustre/Sphagnum (Cx/Lp/Sp) 3A2d

This community is generally found on gentle lower slopes in the Blackstone River region between 870-900 meters. *Picea mariana* can be found as scattered stunted individuals in some sites. Among the shrubs *Ledum palustre* dominates with *Andromeda polifolia, Empetrum nigrum, Salix sp., Vaccinium uliginosum* and *Vaccinium vitis-idaea* also occurring. A variety of sedge species can occur in these sites however *Carex Bigelowii* is the most consistent. On wetter micro sites *Carex aquatilis* and *Eriophorum angustifolium* do occur. Forbs include *Oxycoccus microcarpa* and *Pinguicula villosa*. Among the lichens *Cetraria islandica, Cladina mitis, Cladina rangiferina, Cladonia* spp. and *Peltigera apthosa* normally are found. *Sphagnum* species dominates the moss layer.

Carex Bigelowii/Salix (Cx/Sx) 3A2d

Occurring between 1000 to 1100 meters elevation in the North Fork Pass, Chapman Lake area this type is found in generally wetter terrain occasionally under hydric conditions. *Salix* sp. typify these sites. Other shrubs include *Ledum palustre, Betula glandulosa* and *Vaccinium vitis-idaea*. Among the graminoids *Carex Bigelowii* is the dominant species and *Eriophorum angustifolium, Carex vaginata* and *Carex limnosa* can be found. Only an unidentified *Stellaria* species occurred consistently among the forbs. Lichens included *Cetraria cucullata, Cladina mitis, Cladina rangiferina, Cladonia* sp. and *Peltigera apthosa*. Mosses were less abundant in this community than other sedge communities with mesic species predominating over *Sphagnum*.

Mesic Forb Herbaceous

Equisetum silvaticum/Ledum palustre (Eq/Lp)

The only herbaceous non sedge community consisted of a single sampled stand in a recent burn. This stand on the Eagle Plain was found at 580 meters elevation on a well drained mid slope in a clayey silt soil. Shrubs included *Betula glandulosa, Empetrum nigrum, Ledum palustre, Rosa acicularis, Salix sp., Spirea Beauverdiana* and *Vaccinium vitis-idaea*. The poorly developed graminoid component was represented by *Graminae* sp. and *Eriophorum vaginatum*. Forbs included *Epilobium angustifolium, Polygonum*

alaskanum and *Rubus chamaemorus*. The dominant species at this site was *Equisetum silvaticum*, covering over 30 % of the ground. Lichens were absent except for the foliose, *Peltigera apthosa*. Mesic mosses were poorly developed and widely scattered.

DISCUSSION

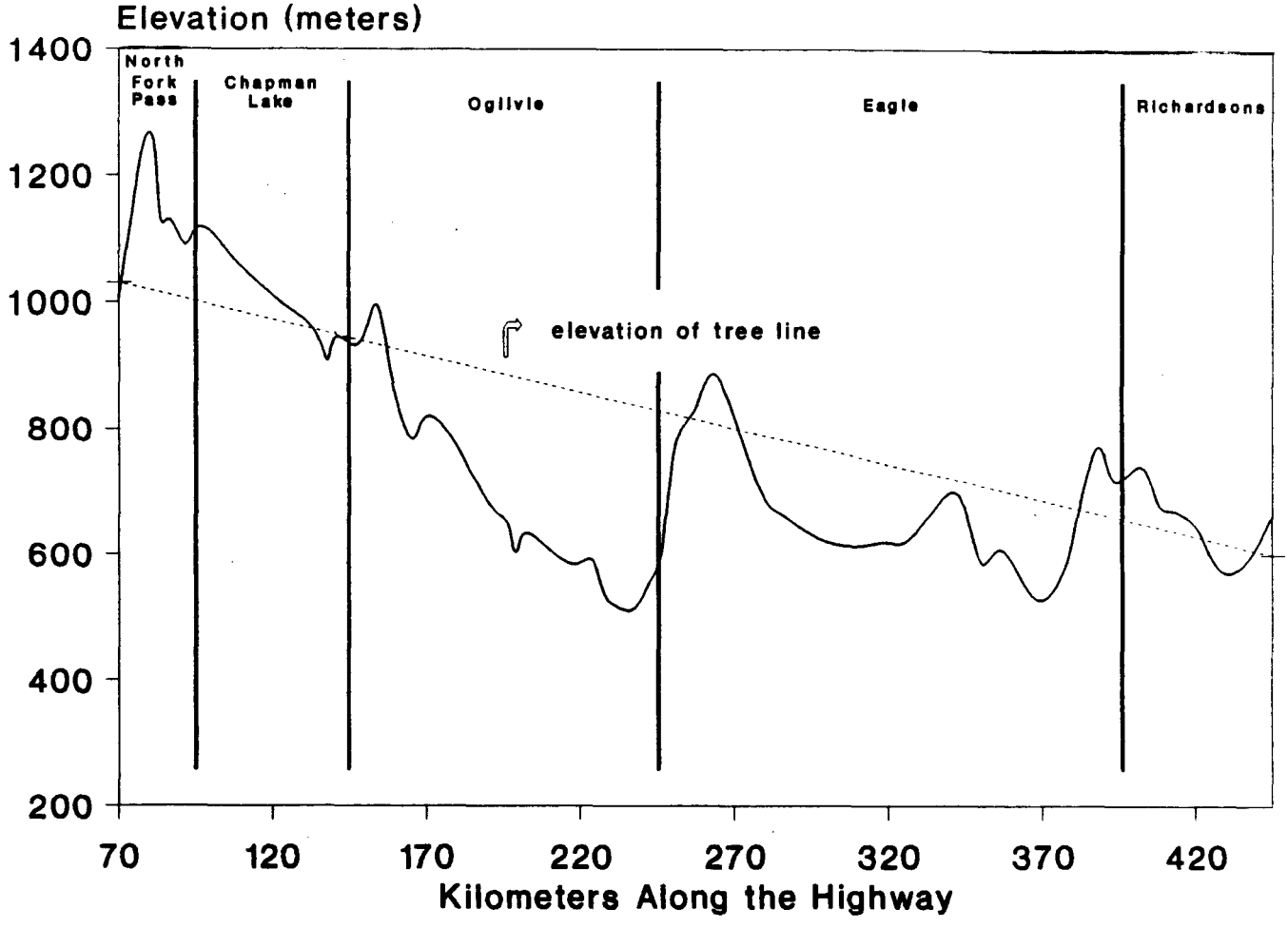
The regional pattern observed during our sampling largely reflects the route chosen for the construction of the Dempster Highway, essentially a transect through the winter range of the Porcupine caribou herd. The road climbs out of the headwaters of the North Klondike River in the south, through the North Fork Pass (1300 m) and descends through the headwaters of the Blackstone drainage in the Chapman Lake area to the Blackstone River (900 m). The road then follows the Blackstone River for about 20 km before cutting across Windy Pass to the Ogilvie drainage. The route follows Engineer Creek to its junction with the Ogilvie River to the Embankment Hills. Climbing up the Embankment Hills, the route proceeds northeastward along hilltops of the Eagle Plains for 120 km, crossing the Eagle River and then swinging northward along the foothills of the Richardson Mountains before entering the Northwest Territories (Figure 3).

Vegetation complexes in the North Fork Pass are dominated by subalpine shrub communities, primarily Bg/Sr/Pf and a dense riverine willow community. This latter community, not described in our survey, has been described by Stanek et al (1981) as a *Salix pulchra/Equisetum arvense/Calamagrostis canadensis* type, common along permafrost-free alluvial sites. Along collection sites at bases of slopes, tussock tundra (Er/Lp/Sp) forms, while wet sedge meadows (Cx/Sx) occur in depressions in wetter locations.

In the Chapman Lakes region, subalpine shrub communities (Bg/Vv/Sa) become reduced in distribution while tussock communities are more widespread. The wide extension of the Ogilvie Valley physiographic unit in this region results in many permafrost terrain features such as solifluction lobes, high and low centred polygons and pingos. At the base of hills and on tops and upper slopes of undulating terrain Er/Lp/Sp communities form. As drainage becomes poorer this type slowly intergrades with Er/Bg/Sp until in depressions Cx/Sx forms.

The Blackstone/Ogilvie Valley region produces a complicated pattern of habitats with its complex of plateaus, intermontane valleys, passes and trenches. Nearly one-half of the vegetation types described occur in this region. On poorly drained sites tussock tundra and wet sedge meadows form varying from Er/Pm/Ln and Er/Pm to Cx/Lp/Sp following a gradient from moderately poorly drained to poorly drained sites. Shrub tundra sites (Bg/Vv/S) are generally restricted to the southern portion of the Blackstone valley. Within the treed zone near treeline Pg/Sr/D stands occur, intergrading with Pg/R/D at lower elevations. Often on moist south facing slopes with substrates of shale origin, a Pm/Bo/Cl community develops. On some of the drier rubbly soiled lower slopes Pg/Vv/S communities occur, particularly evident on the upper portions of Engineer Creek. On lower north and northeast facing slopes and on moderate to poorly drained valley floor sites, old stands of Pg/L/P

Figure 3. Elevational profile of the Dempster Highway within the range of the Porcupine caribou herd.



and younger stands of Pg/V/M or Pg/Sh/Cx develop.

Forest communities predominate the vegetation of the Eagle Plains because, with the exception of the Embankment Hills, where some tussock tundra (Er/Lp/Sp) occurs, the area is characterized by low relief and elevation (450-600 m). On the restricted well drained sandy deposits, dense mats of lichen, primarily *Stereocaulon*, dominate the otherwise sparse understorey (Pg/Em/S). Depth to permafrost, decreasing as you descend down, results in a transition from a Pm/Ac/Sp community on upper slopes to Pm/Lp/Sp on mid slopes to Pm/Er/Ci on lower slopes. One recent burn sampled revealed an *Equisetum* dominated understorey (Eq/Lp).

Vegetation types located in the western Richardson foothills reflect a transition from the Porcupine Plateau to the Richardson Mountain physiographic units (Bostock 1948). No definable mesic graminoid communities were identified in this area due to the high shrub component. On poorer drained sections of the transition zone Lp/Ac/Er type occur slowly intergrading with Lp/Vu as drainage conditions improve. Dense white spruce stands (Pg/Pb) are restricted to the sheltered draws and alluvial gravels while on the slopes Pm/Sr/Ms sites merge with Bg/Ar/H near treeline. Alpine sites were primarily D/Fb.

The predominant winter range type associated with most Canadian migratory caribou herds is the spruce lichen woodlands (Hustich, 1957; Ahti, 1959; Fraser, 1956; Scotter, 1970; Miller, 1976; Kershaw, 1978). This type is virtually absent from our study area. Kershaw (1978) indicates that there is agreement among studies that:

1. The lichen woodland is largely dominated by *Cladina stellaris (alpestris)*.

2. It probably represents a long-term phase during the recovery sequence following fire.

3. It is restricted to dry sandy areas where the growth of associated trees is reduced to such an extent that the growth of the *Cladonia stellaris* is not limited by light competition.

Cladonia alpestris represents only 7% of the fruticose lichen biomass in our area (Russell et al 1992) and sandy habitats, in other studies primarily of glaciofluvial origin, are very restricted. A second lichen woodland, *Stereocaulon* woodland (Kershaw, 1978), is present in a few well drained crests and upper slopes on the Eagle Plains.

Our study area is comparable to the interior of Alaska with similar Cordillerian influences. Vegetation complexes appear

directly comparable to Vierecke et al (1986; Table 2).

SPRING

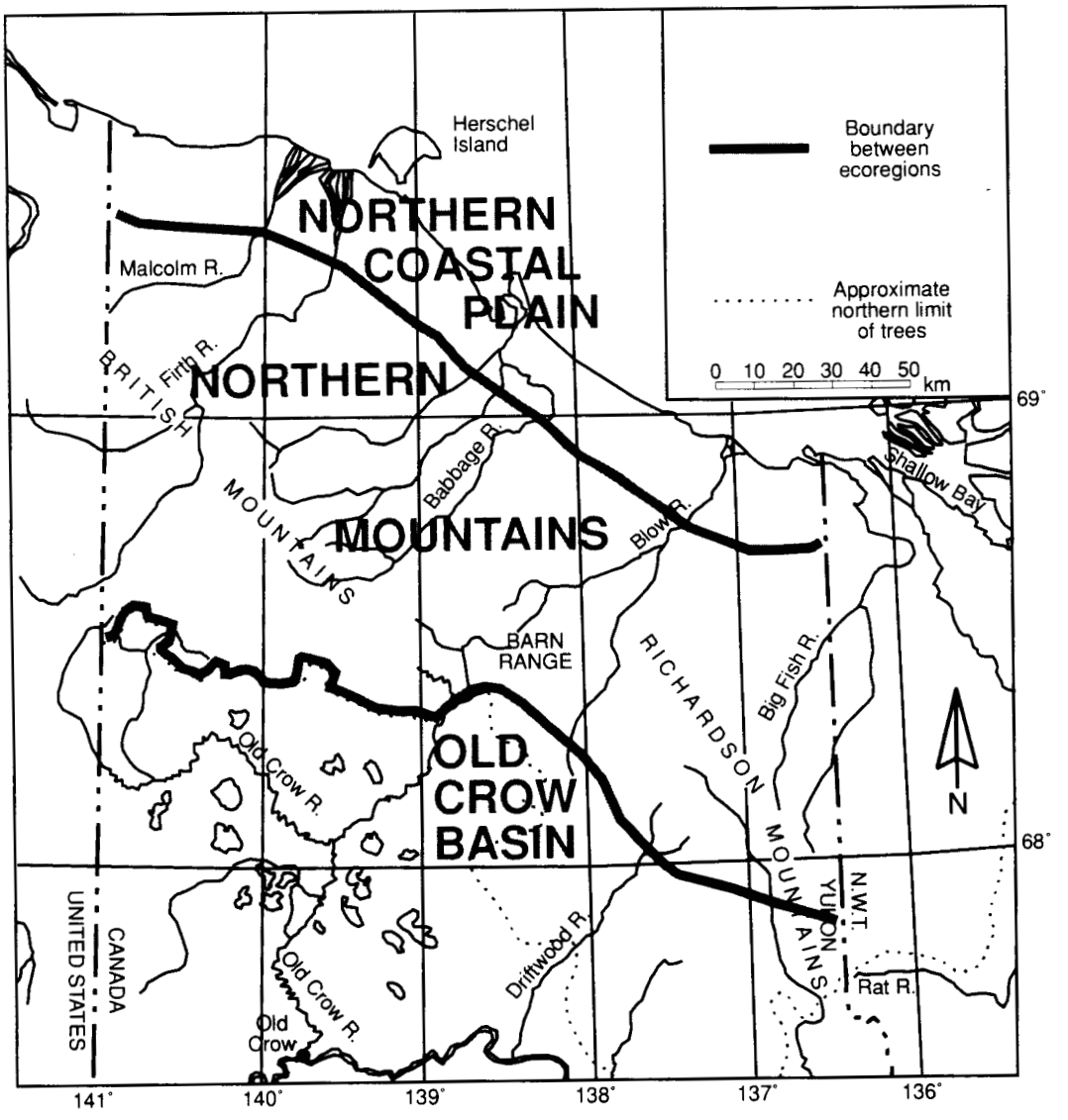
STUDY AREA

The study area (Figure 2) falls within the Northern Mountains and Coastal Plain Ecoregion, described by Oswald and Senyk (1977). Annual precipitation in the region varies from 250 and 380 mm on the Arctic Plateau and British Mountains and about 125 mm along the Arctic Coast (Oswald and Senyk, 1977). Mean annual temperature prevail between -10 to -11 °C with extremes moderated by the coastal influence compared to areas inland. The study area falls on the northern flank of interior mountains and as such is influenced by one of two maritime air masses that interact in the region. Pressure systems forming over the Gulf of Alaska frequently invade the area. However, because of the compact mountain barrier in Alaska, access to the northern Yukon is by sweeping along the coast. The second air mass is formed in the Beaufort Sea. This mass has a significant influence of the study area, but is barred from penetrating the interior by the mountain chain. The Beaufort Sea air mass introduces cold air to the region on its southerly coarse.

Within the Northern Mountains and Coastal Plain Ecoregion (Figure 4), Wiken et al (1981) describe two ecodistricts that overlap our study area, the Komakuk Plains and Malcolm River Ecodistricts. In common with the entire Coastal Plain Ecoregion, the Komokuk Plains are characterized by their low altitude and subdued relief, and their abrupt termination along the foothills in the vicinity of our Camp 2 location. To the west the Plains continue into Alaska, while eastward there is a sharp change of geomorphology onto the King Plains Ecodistrict. This marks the extreme westward extent of the Quaternary glaciation. The Komakuk Plains are an unglaciated landform, covered by extensive fans and braided deltas, with lowlying areas covered with a blanket of patterned organic materials underlain with marine sediments. Soils are generally poorly weathered throughout the plains, primarily as a function of shallow depths to permafrost and the presence of free water in the active layer for prolonged periods. These soils tend to be acidic and nutrient poor, but rich in undecomposed organic matter (Wiken et al 1981).

To the south of the Komakuk Plains lies the Malcolm River Ecodistrict a region of highly variable relief. The generally rounded mountains of this ecodistrict offer a variety of geomorphic features. Bedrock summits, talus and solifluction slopes, fans, residual deposits, cryoplanation terraces, rock and gravel river terraces, and gravel-bed headwater streams abound. The majority of this ecodistrict is colluvium which is all but devoid of vegetation. Organic pediments form in lower slopes above the broad coarse-textures floodplains (Wiken et al 1981).

Figure 4. Ecodistricts within the northern Yukon



METHODS

Eight range types were recognized from vegetational physiognomy and physiography as well as from published descriptions of the area (Hettinger et al 1973; Hettinger and Janz 1974). These range types were mapped for the study area using black and white aerial photography enlarged to 1:10,000 scale and verified by ground and helicopter reconnaissance. The composition of the vegetation in seven of the range types (*Salix* thickets were not sampled) was determined by estimating the cover of each plant species in 20 x 50 cm quadrats spaced at 5 m intervals along a 100 m transect located in the centre of a particular type. Twenty quadrats were sampled in most stands and 5 stands were sampled in each range type. In the two range types with the lowest vegetational cover, 40 quadrats were sampled per stand. Cover was estimated in nine classes: <1%, 1-5, 6-15, 16-25, 26-50, 51-75, 76-95, 95-99, >99%. Elevation, slope, aspect, topographic position, landform, and soil characteristics were recorded for each stand. Of the 35 stands sampled 15 were in Camp 1 area and 20 in Camp 2 area.

An index of similarity was calculated for each stand pair using proportional similarity as defined by Pielou (1977). Clustering of the resultant similarity matrix was conducted using a hierarchial agglomerative routine called complete linkage (Pielou 1977). The resultant clusters were then compared to our predetermined range type representatives to describe the composition of the range types and as a check on our ability to identify them in the field.

RESULTS

The plant communities on the study area were divided into eight range types which were consistently distinguishable through a spotting scope from up to 3 km away. The range types were dispersed throughout the study area as dictated by landform, slope, aspect, and drainage characteristics (Figure 5). The habitat types and their approximate classification according to Viereck and Dryness (1980) were: Tussock Meadow, 2C2c; Wet Sedge Meadow, 2A3a; Dwarf Shrub Heath, 2D2a and 2A4a; Alpine Barren, 2E1b; Alluvial Willow, 3a1a; Alluvial gravel 3B2a; Alluvial Heaths, 2D1c; In describing these range types, we refer to the profile transects (Figure 5) and the physiognomic composition of seven of the eight range types (Figure 6). The eighth type, alluvial willow, was not sampled and was conspicuous by the presence of tall willows. Willow thickets also were classified as this type even if they did not occur in alluvial deposits, such as willow thickets along drainages.

Sampling occurred at two camps during the study. Camp 1, located further into the foothills, contained a higher representation of drier upland types such as alpine barren and

Figure 5. Transect profiles of typical showing locations of typical range types in the calving grounds of the Porcupine Caribou Herd in the Yukon.

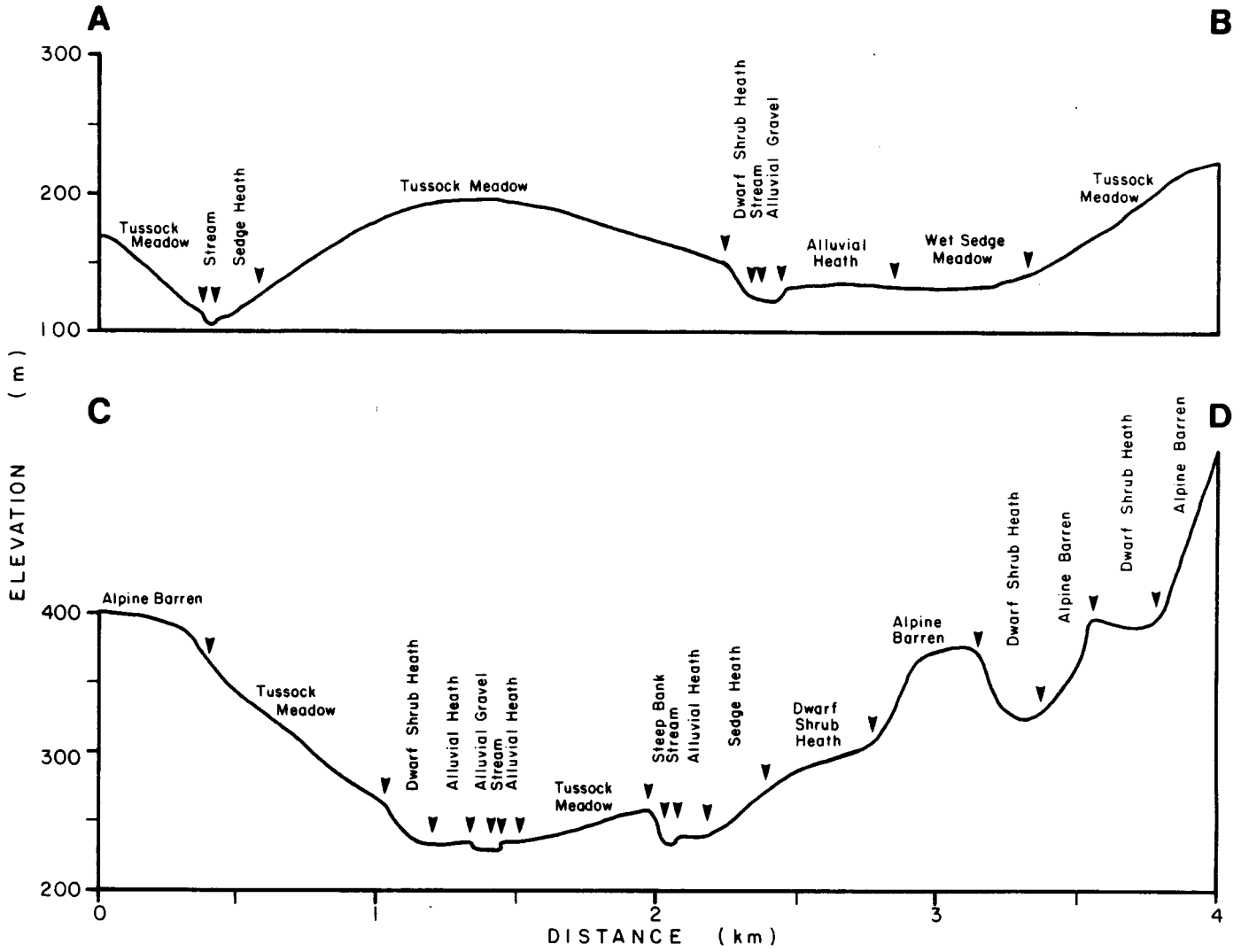
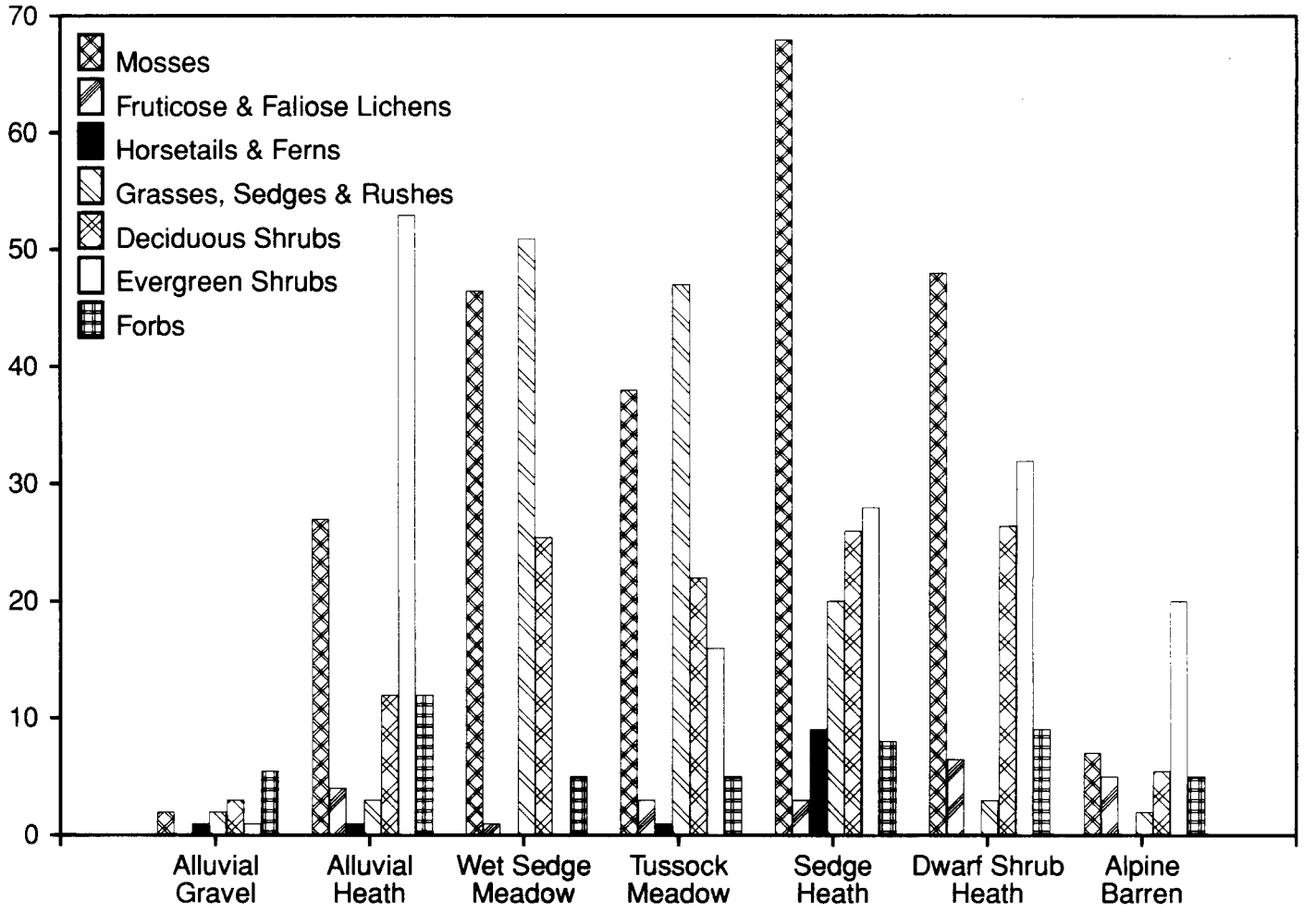


Figure 6. Physiognomic composition of the major range within the calving grounds of the Porcupine caribou Herd in the Yukon.



dwarf shrub heaths than was found in Camp 2, positioned in the area of transition between foothills and coastal plain (Table 3). In this latter location, alluvial communities reached a higher representation. The tussock meadow community was well represented in both areas and dominated overall (Table 3).

Table 3. Percent coverage of range types on the calving grounds of the Porcupine Caribou Herd as determined from aerial photographs. Total area mapped (ha) in parenthesis.

	CAMP 1 (2563)	CAMP 2 (3964)	TOTAL (6527)
Alluvial gravel	2.8	4.1	3.6
Alluvial willow	0.8	2.6	1.9
Alluvial heath	3.7	15.4	10.8
Wet sedge meadow	1.4	8.0	5.4
Tussock meadow	32.5	53.3	45.2
Sedge heath	4.2	3.6	3.8
Dwarf shrub heath	13.4	4.6	8.1
Alpine barren	41.0	8.4	21.2

Alluvial gravel communities were sparsely vegetated, and primarily forbs and deciduous shrubs. This type was very restricted in distribution, occurring on gravelly deposits as a narrow strip adjacent the confined drainage channels near both camps. Moisture regime varied from hygric to submesic, depending on stream dynamics.

Alluvial heaths on valley floors at mesic to submesic sites with soils of varying textures. Among all types, this community was most dominated by evergreen heath vegetation with a moderate moss component and moderately well developed forb component. This type generally occurs on the drier terraces perched above the drainage channels and as such, was best represented by the less confined channels of camp 2.

Wet sedge meadows were located on organic soils at receiving sites at the bases of slopes. The terrain at these sites was generally flat or slightly rolling, poorly drained and generally of hygric to subhydric moisture regime. This community is characterized by a high graminoid and moss component and a well developed forb layer. The graminoid constituent was primarily non-tussock forming *Carex* and *Eriophorum* species. This type was best represented in the less

confined valley bottoms of the camp 2 location.

On the better drained and rolling uplands surrounding both camps the most widespread range type occurred, the tussock meadow. This type was generally found on organic subhydric to submesic sites on slopes up to 12%. Tussock forming *Eriophorum* dominates this community with the moss layer subdominating the total cover.

The sedge heath community had a limited distribution in the study area, generally upslope of the wet sedge meadow communities on west aspects, and often a transition to dwarf shrub heath. This type tends to be drier, better drained and occurring on steeper slopes than the tussock meadow community, hence the higher representation of heath species. The well developed moss layer, averaging 70% cover, and the moderately well developed graminoid layer, separates this type from the other heath types.

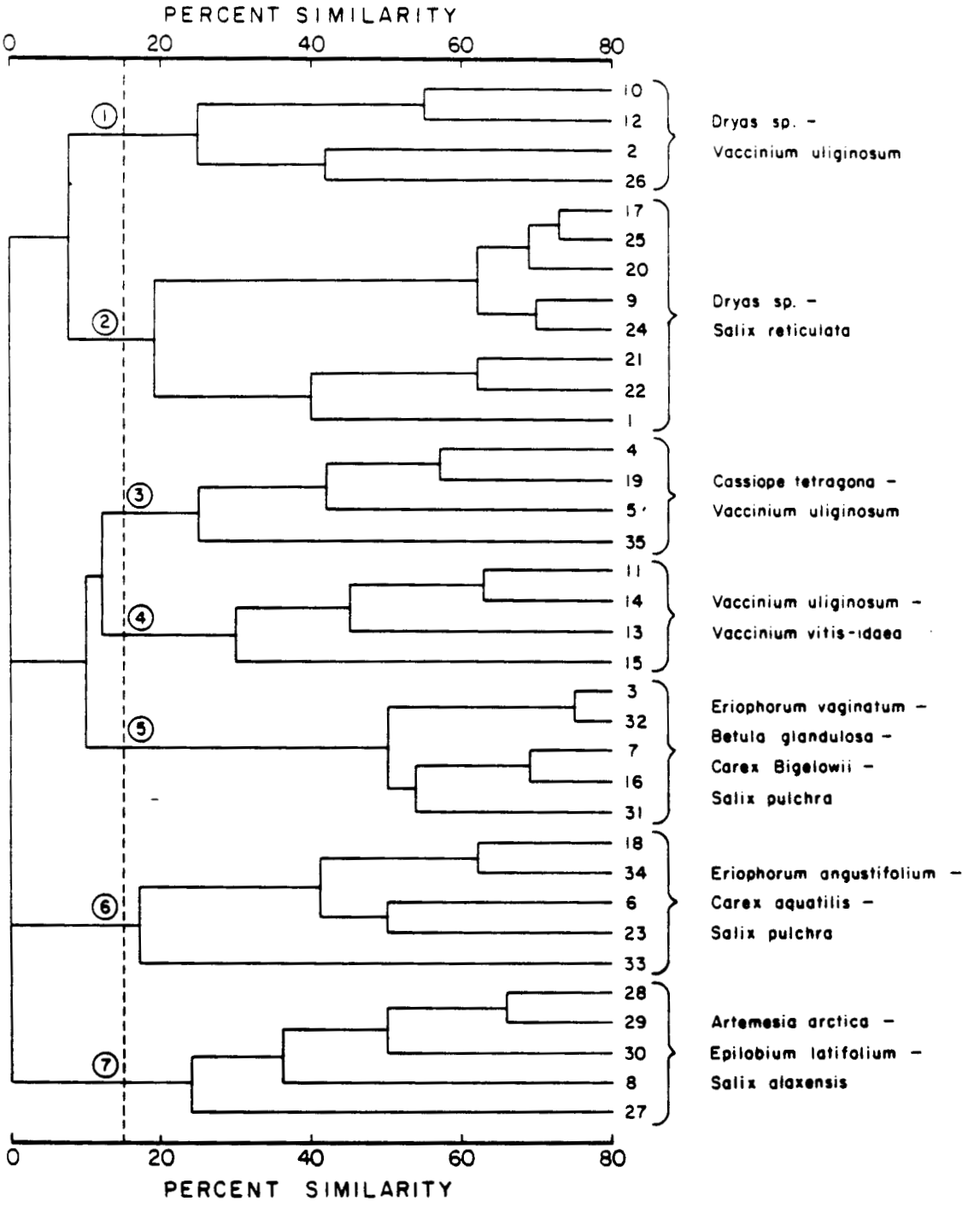
On drier and steeper slopes, but still with primarily clay or clay-silt substrates, the dwarf shrub heath range type predominates. This type was best represented on the more varied and steeper terrain associated with camp 1. Moisture regime on these sites varies from mesic to subxeric and the type can generally be found intermediate between meadows and barrens. Among the heath and meadow types, the dwarf shrub heaths contain the least cover of vascular vegetation with the moss, evergreen and deciduous shrubs predominating.

Alpine barrens were the predominant type in the camp 1 site. Containing approximately 30% cover of vascular vegetation, and primarily dominated by evergreen shrubs this type is found on moderately steep to steep gravelly slopes or higher elevation crests of hills with little or no soil development. Moisture ranges from subxeric to xeric.

Cluster analysis - Seven vegetation associations resulted from the cluster analysis of the 35 stands, sampled for vegetation composition, at a 15% level of similarity (Figure 7). The cophenetic correlation coefficient was 0.76 indicating that the dendogram is a good reflection of the similarity matrix. The clusters were considered to represent vegetation associations and were named from the prominence values (%cover x the square root of the frequency). The composition of the associations is given in Appendix C.

One of the objectives of sampling these stands was to provide a more detailed vegetation description of the range types we were assigning during our caribou observations. The resultant clusters generally reflect our unique range types. Four of the stands chosen to represent the alpine barren range type were identified as a *Dryas - Vaccinium* association while one of the stands was classified as a *Dryas - Salix* association. All five stands meant to represent the tussock meadow type were classified as a *Eriophorum*

Figure 7. Cluster analysis of the 35 stands sampled during a range study of the calving grounds of the Porcupine Caribou Herd in the Yukon.



- *Betula* association. Similarly all alluvial gravel types were classified as an *Artemisia-Epilobium* association. All five sedge-meadow stands were clustered into one association, *Eriophorum angustifolium - Carex*.

The remaining three associations and remaining three heath range types became mixed in the clustering analysis. Alluvial heaths are very recognizable due to its physiographic location but fell into *Dryas - Salix* and *Cassiope - Vaccinium* associations. Dwarf shrub heaths and sedge heaths can occur in similar physiographic locations and tend to intergrade, however we visually separated the two by the relative higher proportion of graminoids in the sedge heath range type (Figure 6). We recognize that dwarf shrub heaths are a complex of species and although visually appearing similar between types can have significantly different cover values for the dominant species.

SUMMER

STUDY AREA

This study on the summer ecology of the herd is limited to that portion of the summer range within northern Yukon (Figure 2). The climate in this area is characterized as "polar continental" in the extreme north and "subarctic continental" to the south (Wiken et al. 1981) with mean daily summer temperatures above 3°C and mean daily winter temperatures below 10°C. Precipitation is low at all times of the year.

Wiken et al (1981) defined 3 broad ecoregions in this area: the Northern Coastal Plain, the Northern Mountains and the Old Crow Basin (Figure 4). The Beaufort Sea and roughly the northern limit of tree line define the northern and southern limits, respectively, of the study area. The Northern Coastal Plain ecoregion stretches northward from the 150m elevation contour to the Beaufort Sea coast. Cold north winds often blow off the Beaufort ice pack resulting in cool summer temperatures. There are numerous lakes and ponds on the coastal plain, many are associated with thermokarst features. More lakes occur east of the Firth River as this area was glaciated. The predominant vegetative cover includes tundra communities: *Eriophorum vaginatum* tussocks, sedge meadows (in poorly drained areas), prostrate shrubs and herbaceous plants, and riparian willows (Wiken at al. 1981).

In the Northern Mountains ecoregion the British, Barn and Richardson Mountain ranges are separated by the large drainage basins of the Babbage and Blow Rivers. In each mountain range there are numerous valleys and occasional upland plateaus. Peaks in the British and Richardson Mountains reach an altitude of 1500m while the central Barn Mountains do not exceed 1100m. This region was unglaciated, so most mountain valleys tend to be narrow and "V" shaped. The area supports arctic and alpine tundra communities ranging from xeric to mesic. Vegetative cover is sparse or absent at high elevations. Riparian areas and wet slopes support dense shrub communities including *Salix glauca, S. pulchra, S. alaxensis, Betula glandulosa,* and *Alnus crispa*. Boreal forest extends northward into the mountainous region along river valleys and in a few isolated sites at low elevations. Summer temperatures are slightly warmer than on the coastal plain to the north, although cooler temperatures are still found at high elevations. Broad valleys to the south of these mountains merge with the Old Crow pediments which surround the Old Crow Basin (Wiken et al 1981).

The Old Crow Basin ecoregion has elements of both arctic tundra and boreal forest. The pediments in the northern sector of this region rise to 450m altitude and merge with the foothills of the Northern Mountains ecoregion. The southern sector consists of a huge wetland complex at approximately 300m altitude. The climate of this region is much warmer in summer than that of the

mountainous and coastal regions to the north.

The range types for northern Yukon have been, in large part, described previous section (Spring). The range types of interest in this study are: tussock meadow (mesic graminoid herbaceous), wet sedge meadow (wet graminoid herbaceous), dwarf shrub heath (open or closed dwarf shrub scrub), and alluvial willow (closed low shrub scrub). We refer to alpine barren, described in the spring section (open dwarf shrub scrub) as "sparsely vegetated" because it does occur at low elevation in the present study area. As well, we identified two additional habitat types: low shrub tundra, which is equivalent to open low shrub scrub (Viereck et al 1986), and sedge heath (mesic graminoid herbaceous of Viereck et al 1986).

METHODS

In the summer of 1986, vegetation plots were established within the study area. In preparation for this project we visually interpreted a LANDSAT Multispectral scanner (MSS) band 7 composite image (dated 05/07/83). Plots were allocated such that every type visually interpreted within each of the 23 ecodistricts (Wiken et al 1978) was sampled at least once. A total of 187 plots were established. At each site we recorded standard biophysical information (slope, elevation, moisture regime, etc.) as well as a list and corresponding cover percentage of each species encountered in each physiognomic level. We started in the middle of each stand, and walked in increasingly larger circles recording species until no new species were being recorded. In addition, 200 sites were visited where all but the detailed plant species data was recorded. It was our intention that these additional plots would provide a more widespread coverage for subsequent mapping, given the time available.

LANDSAT mapping

Landsat MSS digital data was acquired for Path/Row 66/12 (dated 05/07/83) from the Canadian Centre for Remote Sensing. The data, comprised of 4 MSS bands, was initially analyzed at the U.S. Geological Survey/EROS Field Office on the Interactive Digital Image Manipulation System (IDIMS). An unsupervised clustering technique (maximum likelihood algorithm) was used to develop statistical parameters by which the Landsat data were spectrally classified. The cluster statistics were then edited by pooling or deleting cluster classes which had a low probability of being separable from other cluster classes. These clusters were then evaluated based on data from the ground plots, and clusters representing similar land cover types were grouped. Each spectral class was identified as a vegetation cover type on the display monitor and labelled. Specifications for the classified scene were recorded on digital tape, which was then used to produce visual products in the form of colour transparencies and prints.

Analysis of vegetation plots

Initially, a percent similarity matrix between all pairs of plots was constructed. The percent similarity between any two plots was calculated as the sum of the minimum percent covers of all common plant species in the plots (Pielou 1977). When calculating the percent similarity between plots we ignored the cover values for moss species for two reasons: first, our field crews were not sufficiently trained to distinguish all moss species and secondly, the very high cover values for moss were felt to overly influence the clustering procedure. Using the SAS CLUSTER procedure (SAS Institute 1985), 20 distinct clusters were determined utilizing the AVERAGE (or UPGMA, unweighted pair group method using arithmetic averages) option. A dendogram was produced using the SAS TREE procedure. Summary statistics of vegetation (Appendix D) were generated for each final vegetation community.

RESULTS

A certain amount of subjectivity has been injected into the analysis to overcome the drawbacks of using a purely mathematical approach to classification. We identified three problems with the systematic approach:

1. communities with low vegetative cover, although floristically similar, were presented as unique clusters in the output,

2. since floristic diversity is extremely low among the major communities in the region, types that should be separate (for food quality/quantity available to caribou), were combined into a single cluster in the initial iteration.

3. types that were floristically unique, but for caribou, (and to the level of range type) could be considered one community, were presented as separate clusters.

The poorly vegetated areas, such as scree slopes, ridge tops and *Dryas* barrens were identified as unique clusters, primarily because there was so little vegetation that the percent similarity coefficient with any plot was low. Of the original 20 clusters, a significant number were attributed to subtle variations in similar vegetation communities. We have described these clusters as one type and merely point out the variations to expect.

Another application of subjectivity was applied to a number of "unique" clusters that were floristically similar, however were characterized by a moderate cover of *Eriophorum* and very low cover of other species. Again the cluster procedure could not recognize the floristic similarity of these stands due to the low between stand percent similarity.

Because so many of the original 20 clusters were characterized as poorly vegetated areas, much of the variation in community

structure was masked. In fact of the original 187 plots, 127 were classified as a single cluster. For the purpose of interpreting the vegetation communities as they pertain to caribou ecology, we required a finer distinction. As a result, the original 127 member cluster was reanalysed through three different iterations of 15, 8 and 6 clusters (Figure 8). In the final analysis, 20 vegetation communities were described. Communities were named by the species with the highest cover and frequency combined with a range type descriptor (eg. heath, meadow; Table 4).

Initial Classification

NO. OF STANDS	123	19	8	18	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CLUSTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
FINAL COMMUNITY	↓	16	17	6	18	4	7	4	20	4	4	20	20	3	20	20	7	7	7	19

First iteration

NO. OF STANDS	7	14	69	11	5	6	3	1	1	1	1	1	1	1	1
CLUSTER	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	1.11	1.12	1.13	1.14	1.15
FINAL COMMUNITY	11	2	↓	10	2	7	20	17	7	7	7	4	4	4	4

Second iteration

NO. OF STANDS	51	10	2	2	1	1	1	1
CLUSTER	1.3.1	1.3.2	1.3.3	1.3.4	1.3.5	1.3.6	1.3.7	1.3.8
FINAL COMMUNITY	↓	9	5	14	15	15	15	15

Third iteration

NO. OF STANDS	31	14	3	1	1	1
CLUSTER	1.3.1.1	1.3.1.2	1.3.1.3	1.3.1.4	1.3.1.5	1.3.1.6
FINAL COMMUNITY	12	13	8	15	15	15

Figure 8. Breakdown of clustering iterations to finalize 20 vegetation communities (Final communities refer to Table 4; ↓ indicates reclustered in next iteration).

Table 4. Vegetation communities on the summer range of the Porcupine Caribou Herd[1]

LEVEL I	LEVEL II	LEVEL III	LEVEL IV	LEVEL V
Scrub	Low shrub scrub	Closed low shrub scrub	Birch/willow	1. Betula/Salix dense shrub
				2. Salix/Betula dense shrub
			Alder	3. Alnus crispa thicket
		Open low shrub scrub	Mixed shrub	4. Arctostaphylos/Vacc. heath
			Tussock tun.	5. Ledum/Erio. tussock heath
	Dwarf shrub scrub	Open dwarf shrub scrub	Dryas lichen	6. Dryas heath barren
			Low birch	7. Betula heath barren
Graminoid herbaceous		Mesic graminoid	Tussock tun.	8. Erio./Carex/Dryas tussock heath
				9. Eriophorum/Betula tussock heath
				10. Carex/Vaccinium heath
				11. Carex/Salix shrub tundra
				12. Eriophorum/shrub tussock tundra
				13. Eriophorum/Vacc. tussock tundra
				14. Dense Eriophorum tussock tundra
				15. Sparse Eriophorum tussock tundra
			Sedge Dryas	16. Carex/Dryas sedge meadow
		Wet graminoid	Sedge/willow	17. Hydric Carex/Salix meadow
			Wet sedge	18. Erio. angust. sedge meadow
Forb herbaceous		Dry forb herb. Bryoid	Seral herbs	19. Lupinus meadow
			Frut. lichen	20. Lichen barrens

[1] -designation to level IV follows Vierecke et al, 1986

Community descriptions

The major headings refer to classification levels in Viereck et al (1986). Table 4 defines these categories in terms of physiognomic characteristics up to level IV while cluster descriptors are unique to this study.

Shrub communities

Closed low shrub scrub

Betula/Salix dense shrub (cluster 1.2)

Although this type has characteristically high *Betula* cover the biophysical characteristics of the type appear bimodal. The dry sites tend to be *Betula* heath types with a diminished importance of *Salix pulchra*. On the drier sites, *Betula* dominates seepage sites. *Salix* increases in abundance with increasing

moisture. Among all vegetation types, this type exhibits a moderate to high species diversity, with characteristically high cover of shrubs, forbs and fruticose lichens. The average *Betula* cover is over 40% in this type with *Salix pulchra, Ledum palustre, Vaccinium vitis-idaea, V. uliginosum* and *Empetrum nigrum* contributing to the overall high shrub cover. *Petasites frigidus* and *Polygonum bistorta* are the only consistently present forbs within the type, while *Carex Bigelowii* remains the only normally present graminoid species. *Cetraria cucullata* is the dominant lichen species. This type is very widespread with stand representations occurring from the coastal plain to the Old Crow Pediments.

Salix/Betula dense shrub (cluster 1.5)

This type is unique in its very high cover of *Salix pulchra* (55%). With a single exception in the Babbage region, this type appears confined to the Richardson Mountains and foothills. Among the sites sampled most could best be described as willow drainages and shrub slopes. This site appears to have similar biophysical attributes to the previously described *Betula/Salix* dense shrub type, however, in the present type of site conditions tend to favour *Salix* over *Betula*. These stands tend to have an overall low species diversity with the exception of the forb layer which is well developed with *Rubus chamaemorus, Petasites hyperboreus* and *Equisetum arvense*. Bryophytes reach high abundance in this type with *Pleurozium* and *Hylocomium* being the major contributors. Lichens are poorly developed under the typically hygric site conditions.

Alnus crispa thicket (cluster 14)

This type is only represented by one stand found south of Shingle Point on the coastal plain. This alder thicket community is quite restricted in the study area and appears distributed in an east-west band along the coastal foothills. An almost complete cover of medium to tall alder overshadow the exposed soil covered with leaf litter. *Vaccinium uliginosum* dominates the understorey along with *Betula glandulosa, Arctostaphylos rubra* and *Linnaea borealis*. The site is well drained with a deep active layer.

Open low shrub scrub

Arctostaphylos/Vaccinium heath (clusters 1.12-1.15, 6, 8, 10, 11)

This community, an aggregation of a number of unique clusters, can best be described as a dry heath community. Site conditions are generally subxeric but the community still maintains an almost complete vegetative cover with very little (less than 5%) bare soil or exposed rock. The species diversity of these stands, with their unique assemblages, resulted in the six stands being clustered separately, however a number of characteristic species and site characteristics set this type apart from the rest of the community

types. All but one of the stands were located in the Blow River/Richardson foothills region in the eastern portion of the study area. The low and ground shrub component tends to dominate the community with *Vaccinium uliginosum, Arctostaphylos rubra,* and *Salix* predominating. Graminoids are poor to moderately developed, restricted primarily to *Eriophorum vaginatum* or *Carex Bigelowii* with less than 20% cover. *Lupinus arcticus* is the most characteristic species in a well developed forb layer. The lichen component is well developed with *Stereocaulon alpina, Cetraria cucullata, C. Richardsoni, C. tilseii, Thamnolia subuliformis,* and *Dactylina arctica* normally present. Bryophyte cover varies considerably (5-80% range).

Ledum/Eriophorum tussock heath (cluster 1.3.3)

This type was found in the Old Crow Pediments and the Thomas Creek area and is characterized by slightly drier site conditions (than other *Eriophorum* types), a high ground shrub component and a very high species diversity. Among the ground shrubs, *Vaccinium vitis-idaea, Empetrum nigrum, Salix phlebophila,* and *Dryas* are the most indicative species. Although low in cover abundance, forbs are quite diverse with *Polygonum bistorta, Rubus chamaemorus, Oxytropis nigrescens* and *Rumex arctica* normally occurring. As drier site conditions prevail, lichens increase in importance. Like forbs the total cover of lichens could best be described as low to moderate, however the number of species represented is high. These include *Stereocaulon alpina, Cetraria cucullata, C. Richardsoni, Alectoria nigrescens,* and *Cladonia* species. Bryophytes are poorly developed in this type.

Closed dwarf scrub

Dryas heath barren (cluster 4)

This type has the highest ground shrub coverage among all the vegetation communities. *Dryas*, the predominant dwarf shrub, reaches an average coverage of 35% within this type, a high coverage considering that an average of 26% of the ground is rock. Dwarf shrubs which may be present include *Arctostaphylos rubra* and *Salix reticulata*. This type encompasses most *Dryas* dominated, dry (subxeric to xeric) stands varying from the more vegetated *Dryas* barrens to the drier, sparsely-vegetated heaths to the drier sedge heaths. On some of the subxeric, steeper slopes, heath plants increase in importance while lichen diversity flourishes on the more xeric sites. The major fruticose lichens are *Alectoria nigrescens, Thamnolia subuliformis, Dactylina arctica,* and *Stereocaulon alpina*. On the moister sites *Cladina mitis* and *Cladina rangiferina* increase in importance.

Betula heath barren (clusters 1.6, 1.9-1.11, 7, 17, 18)

This type represents a typical heath barren without the

familiar *Dryas* dwarf shrub component. The characteristic lack of *Dryas* may simply reflect the patchy heterogenous nature of sparse heath communities or be indicative of real environmental parameters. Fruticose lichens enjoy a high abundance within this type (20%) with bedrock and scree accounting for close to 35% of the ground cover. Ground shrubs contribute the most to the physiognomic cover assemblage, with *Arctostaphylos rubra, Vaccinium vitis-idaea, Empetrum nigrum, Salix phlebophila,* and *Cassiope tetragona* normally present.

Herbaceous communities

Mesic graminoid

Eriophorum/Carex/Dryas tussock heath (cluster 1.3.1.3)

Only three stands of this type were sampled, however, its distribution was widespread. This community was located on gentle to moderately steep, mid slopes under mesic moisture conditions. The graminoid layer predominates, however, the species composition appears to approach a type of tussocky heath. *Dryas integrifolia* reaches its highest abundance within the type, thus ground shrubs are well represented compared to other communities. In addition to *Dryas*, and indicative of better drained site conditions, is the appearance of *Cassiope tetragona, Salix reticulata* and *Rhododendron lapponicum*. The diversity of forbs is relatively high in this type although their contribution to the total vegetative cover of the community is low. Good representatives of the forb layer include *Pedicularis labradorica*, and *Saussurea angustifolia*. Lichens are poorly represented while bryophytes reach moderate abundance with *Pleurozium* normally present.

Eriophorum/Betula tussock heath (cluster 1.3.2)

This type appeared indicative of the Babbage River region with 7 of 10 plots situated in the area. The type is found in a wider range of site conditions than most types with drier sites best described as sedge heaths and moister sites tending toward *Eriophorum* dominated low shrub tundra. The type, however, is characterized by a relatively high sedge component (*Eriophorum* dominated), a moderate to high low shrub component (*Betula* and *Salix* equally represented) and a moderate ground shrub component with *Vaccinium vitis-idaea, Empetrum nigrum* and *Arctostaphylos rubra* contributing. The moss layer is well represented by *Sphagnum* and *Pleurozium* species.

Carex/Vaccinium heath (cluster 1.4)

This community was characterized by mineralized soil types, typically found on, but not restricted to, patterned ground (eg. stripes, frost boils). Sites varied from mesic to subxeric moisture regimes and tended to be located on flat or gentle slopes. When

found on slopes the type appeared restricted to southerly aspects. In distribution, the community was primarily confined to the Old Crow Pediment region and could be distinguished by high ground shrubs (typical was *Arctostaphylos rubra, Vaccinium vitis-idaea, Dryas integrifolia*, and *Salix reticulata*, moderate to high graminoid (*Carex*) cover. Lichen and bryophyte species were moderately well developed.

Carex/Salix shrub tundra (cluster 1.1)

This community is characterized by a high abundance of low shrubs and graminoids. Generally found on gentle middle or lower slopes within the intermountain region of the study area. Tussock forming *Carex Bigelowii* reaches its greatest cover in the typical mesic to hygric site conditions. Among the shrubs, *Salix pulchra* is very abundant, with *Betula glandulosa, Vaccinium vitis-idaea* and *Empetrum nigrum* normally occurring. Forbs are poorly represented with only *Petasites frigidus*, and *Rubus chamaemorus* normally occurring. As well as *Carex, Eriophorum vaginatum* normally occurs, however the average cover value is less than 10%. *Sphagnum* and *Pleurozium* species cover about 50% of the ground.

Eriophorum/shrub tussock tundra (cluster 1.3.1.1)

Compared to the *Eriophorum/Vaccinium* tussock tundra (described next), this community has a lower coverage of *Eriophorum* (mean=43%) and a correspondingly higher percent cover of low and dwarf shrubs. This shift is presumably associated with an increase in the active layer as depicted under the typically drier moisture regimes (i.e. better drainage). The species composition of this community type is very similar to the next community described.

Eriophorum/Vaccinium tussock tundra (cluster 1.3.1.2)

This vegetation type occurs throughout the study area and probably represents the most abundant community. Occurring primarily on gentle mid-slopes, with relatively poor drainage and a shallow active layer, this type is the typical tussock tundra stereotype. *Eriophorum vaginatum* is by far the dominant plant species within the type averaging over 60% cover. Species diversity within the type is poor to moderate with *Carex Bigelowii* being the only other graminoid typical. Low shrubs are represented by *Betula glandulosa, Ledum palustre* and *Salix pulchra*. Dwarf shrubs have a relatively low abundance but species such as *Vaccinium vitis-idaea* and *Empetrum nigrum* are consistently found. *Rubus chamaemorus* is typical of the poorly developed forb layer. The bryophyte layer is variable in abundance with *Sphagnum* species dominating.

Dense *Eriophorum* tussock tundra (cluster 1.3.4)

This type is similar to the previously described type, with

the exception that it is characterized by a very high cover of *Eriophorum* (75%) and little else with the exception of *Sphagnum*. *Vaccinium uliginosum* and *Ledum* do occur in low abundance. Stands of the type were found only in the eastern portion of the study area in the Northern Richardsons and the Blow River valley. Sites were poorly drained, with an extremely shallow active layer.

Sparse *Eriophorum* tussock tundra (cluster 1.3.1.4-1.3.1.6, 1.3.5-1.3.8)

This "community" type was actually the combination of 8 unique clusters each represented by a single stand. We have combined the clusters into a single type because they are all characterized by a moderate *Eriophorum* cover with a relatively low cover of any other species. The stands are floristically very similar, however due to the low cover value for all but *Eriophorum*, the percent similarity coefficient among the stands was too low for the cluster procedure to join as one cluster. This type is found at lower elevations on gentle (less than 5%) slopes under poorly drained subhygric conditions. These conditions are typical of the lower Blow and Babbage River regions where all but one of the stands were located. Among the shrubs normally *Betula, Ledum, Vaccinium uliginosum* and *Salix pulchra* occur in small amounts (less than 7% total coverage). Bryophytes are generally well developed among these sites with *Pleurozium* and *Sphagnum* contributing the most. On some of the drier sites fruticose lichens, chiefly *Cetraria cucullata* can approach 10% cover, however lichens are typically poorly developed.

Carex/Dryas sedge meadow (cluster 2)

Characterized by high *Carex Bigelowii* this type encompasses all *Carex* dominated wet sedge meadows on moist, gently sloping sites and the moister, *Carex* dominated sedge heaths sites. Consistent among all the sites is a modest cover of *Dryas integrifolia*. Species diversity is relatively low among these stands with *Salix arctica* and *Salix reticulata* being the only other consistently present species. Forbs reach their highest diversity and abundance within this type on moderately sloping collection areas. These lush meadows contain a number of unique species to this type, such as *Dodecathon* spp., *Polemonium* spp. and *Oxyria* spp.

Wet graminoid

Hydric *Carex/Salix* meadow (cluster 1.8, 3)

Similar to the wet meadow stands in the previously described community type, this type differs in that the site conditions are typically wetter, varying between hygric and hydric sites on flat, poorly drained collection sites. A large portion of these meadows are bedrock controlled, perched at higher elevations throughout the

study area. This type boasts the lowest species diversity among all community types. Bryophyte species are moderately well developed with *Sphagnum* species dominating. Lichen coverage is almost nonexistent.

Eriophorum angustifolium sedge meadow (cluster 5)

Because our field efforts were not directed towards the wetter coastal plain region, where this community would be more typical, our sample is restricted to two stands. These stands were very wet, with standing water occurring in one of the sites. *Eriophorum angustifolium* dominated this type with an average cover value of 70% with a small amount of *Salix pulchra* sprinkled throughout the community. The only other vegetative cover of note is the almost complete mat of *Sphagnum* species.

Dry Forb Herbaceous

Lupinus meadow (cluster 20)

This type was represented by a single stand in the coastal foothills along the Babbage River. This lush type was found on flat terrain at 65 meters elevation under submesic site conditions. Forbs accounted for 40% of the ground cover with *Lupinus, Myosotis alpestris, Hedysarum* sp, *Arnica alpina*, and *Valeriana capitata* predominating. Among the moderately developed shrub layer, *Salix glauca* accounted for 30% cover with *Vaccinium uliginosum* also present. Bryophytes and lichens were poorly developed while graminoids were represented almost exclusively by grass species.

Bryoid types

Lichen barrens (clusters 1.7, 9, 12, 13, 15, 16, 17)

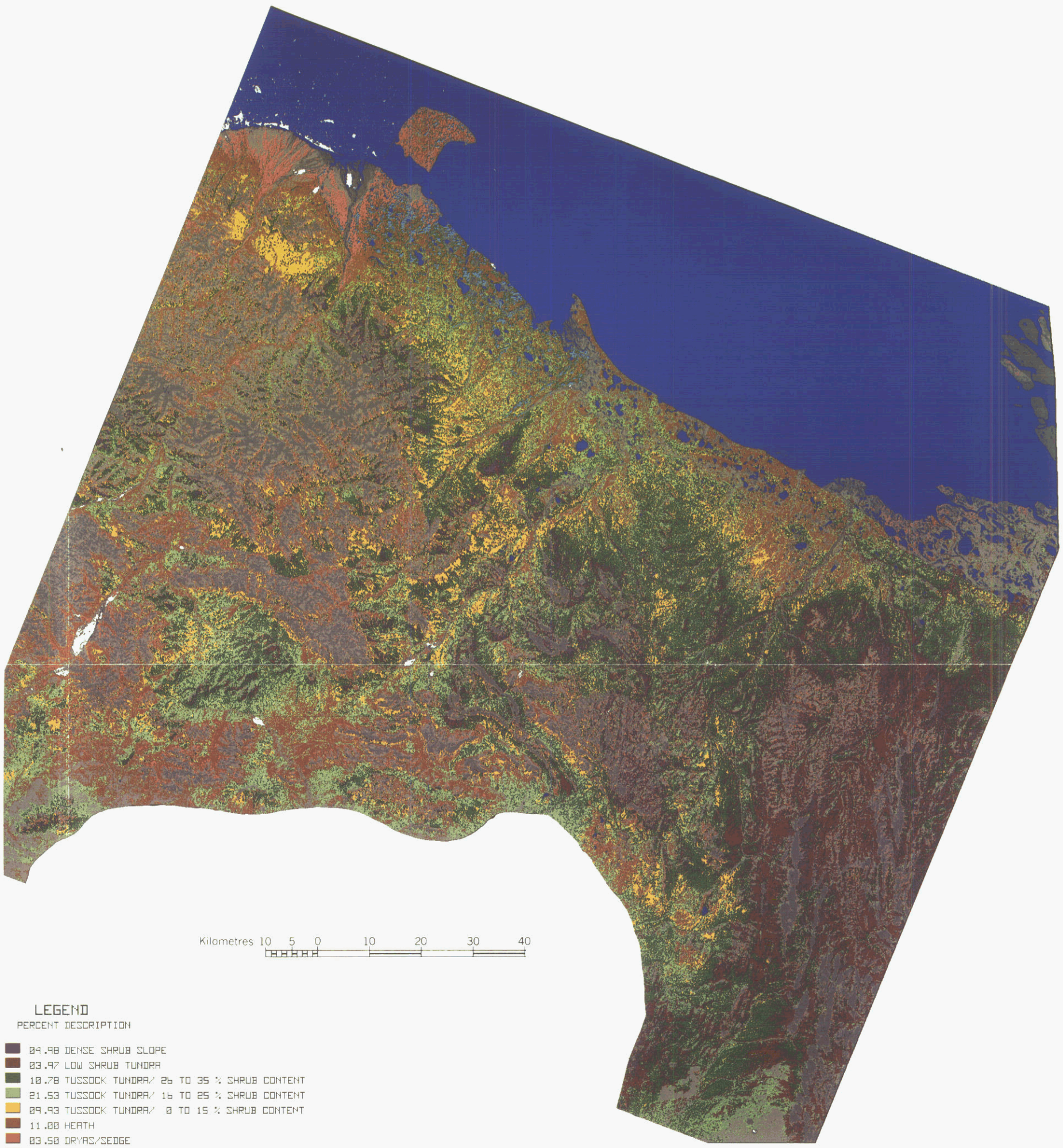
Six stands comprising 5 unique clusters have been combined into one type. This type is typically high in exposed bedrock or loose scree (mean cover is 60%). Lichens form the major physiognomic cover (20%). Most notable among the lichens is the presence of the crustose species *Rhizocarpon*. Ground shrubs occur in varying amounts with the most consistent shrubs being *Salix phlebophila* and *Vaccinium vitis-idaea*.

Satellite mapping

A total of 34 clusters were produced from analysis of the MSS data. Twelve of these were unvegetated and were classed as rock, water or ice. The remaining 13 were grouped to represent 9 vegetated land cover types ranging from sparsely vegetated to dense shrub cover (Figure 9). In most cases, the vegetated land cover types represent more than one of the community description types determined from the ground plot data (Table 5).

Figure 9. Vegetation map of the summer range of the Porcupine Caribou Herd in Yukon. Classified from Multispectral Scanner digital data (scene 5 July 1983).

SUMMER RANGE OF THE PORCUPINE CARIBOU HERD
NORTHERN YUKON - CANADA



Kilometres 10 5 0 10 20 30 40

LEGEND

PERCENT DESCRIPTION

- 04.98 DENSE SHRUB SLOPE
- 03.97 LOW SHRUB TUNDRA
- 10.78 TUSSOCK TUNDRA/ 26 TO 35 % SHRUB CONTENT
- 21.53 TUSSOCK TUNDRA/ 16 TO 25 % SHRUB CONTENT
- 09.93 TUSSOCK TUNDRA/ 0 TO 15 % SHRUB CONTENT
- 11.00 HEATH
- 03.50 DRYAS/SEDGE
- 22.20 LICHEN OR ALLUVIAL BARREN
- 08.35 UNVEGETATED
- 02.54 ICE
- ----- WATER *
- 01.21 WET

* WATER CLASS NOT INCLUDED IN PERCENTAGE ESTIMATES

THIS LAND COVER MAP WAS PRODUCED FROM LANDSAT MSS DATA DATED 5 JULY, 1983 (I.D. #1035420025; PATH/ROW 66/12). DATA PROCESSING AND MAP GENERATION WERE ACCOMPLISHED BY THE U.S. GEOLOGICAL SURVEY/ EROS - ALASKA FIELD OFFICE IN COOPERATION WITH THE CANADIAN WILDLIFE SERVICE, WHITEHORSE, YUKON.

It is interesting to note on the classified map that much of the British Mountains are sparsely vegetated or barren. Approximately 39% of this area is "rock" or "lichen or alluvial barren" while "dense shrub" and "low shrub tundra" is found in only 2.5% of the area. In contrast, the Richardson Mountains (including the foothills east of the Blow River valley) are only 24% "rock" or "lichen or alluvial barren" vs. 26% "dense shrub" and "low shrub tundra". The Barn Mountains have a higher percent cover of tussock tundra than the other 2 mountain ranges (Table 6).

Table 5. Linkage between vegetation communities derived from ground plots (Table 4) and final satellite classes (Figure 9).

Satellite class	Vegetation community
dense shrub slope	Betula/Salix dense shrub
	Salix/Betula dense shrub
	Alnus crispa thicket
low shrub tundra	Arctostaphylos/Vaccinium heath
tussock tundra (0-15% shrub)	Ledum/Eriophorum tussock heath
	dense Eriophorum tussock tundra
	sparse Eriophorum tussock tundra
tussock tundra (16-25% shrub)	Eriophorum/Carex/Dryas tussock heath
	Eriophorum/Vaccinium tussock heath
	Eriophorum/Betula tussock heath
tussock tundra (26-35% shrub)	Carex/Salix shrub tundra
	Eriophorum shrub tussock heath
heath	Carex/Vaccinium heath
Dryas/sedge	Carex/Dryas sedge meadow
Wet alluvial	Hydric Carex/Salix meadow
	Eriophorum angustifolium sedge meadow
Lichen or alluvial barren	Dryas heath barren
	Betula heath barren
	Lichen barrens
Unvegetated	Rock, scree, gravel
no class	Lupinus meadow

Table 6. Percent cover of land cover types found in each sub-region of mapped area.

	British Mts	Barn Mts	Richardson Mts	Coastal plain west	Coastal plain east
dense shrub slope	2.1	5.7	12.8	0.0	1.7
low shrub tundra	0.4	2.2	13.5	0.0	1.4
tussock tundra with 26 to 35% shrubs	12.4	12.6	6.7	3.4	10.6
tussock tundra with 16 to 25% shrubs	20.9	26.9	21.1	16.7	23.9
tussock tundra with 0 to 15% shrubs	7.2	17.0	17.0	0.9	9.5
heath	13.8	9.1	3.8	24.9	13.6
dryas / sedge	4.5	2.1	1.2	15.9	1.1
lichen / alluvial barren	29.3	18.9	17.6	20.6	19.3
rock	9.5	5.6	6.3	9.0	13.3
wet alluvial	0.0	0.0	0.0	8.6	5.4

DISCUSSION

To relate caribou use to vegetation plots, the degree of detail required within some range types, for example "sedge/shrub" dominated communities, was greater than the degree of detail required for other range types, such as "sparsely vegetated barrens". We attempted to remain as objective as possible in finalizing our community types and therefore chose a series of iterations within certain clusters until our preconceived level of detail among communities was realized.

All of the communities we described based on the vegetation plots were not represented as a unique class on the land cover map. We found that various stages of the mapping process more classes (i.e. more colours) are difficult to distinguish on one map. Also, we feel that the 9 vegetated land cover types which range from sparsely vegetated to densely vegetated adequately distinguish the types that are ecologically important to caribou on summer range.

Within the British Mountains subregion, the most extensive area with continuous vegetative cover is on the southeast edge, at the headwaters of the Babbage River and Muskeg and Timber Creeks. As stated earlier, caribou use this area more consistently than other parts of the British Mountains in July. Although much of the upland areas in the British mountains may offer relief from insect harassment, they are not in proximity to vegetated areas that could provide food for several thousand caribou.

The Richardson Mountains are interspersed with areas of very dense vegetation, and the western flank has extensive cover of dense shrub vegetation. This area has supported thousands of caribou from mid to late summer since distributions of caribou were first recorded in the early 1970's. In the Richardson Mountains, as in the southeast corner of the British Mountains, caribou can reduce exposure to insects by moving to higher elevation when insects are active, and moving down into valleys to feed when insect activity subsides. Other areas with extensive vegetative cover either have a low shrub content, or are not in close proximity to mountain slopes.

REFERENCES

Ahti, T. 1959. Studies of the caribou lichen stands of Newfoundland.Ann. Bot. Soc./ Vanamo 30(4):1-44.

Bostock, H. S. 1948. Physiography of the Canadian Cordillera, with special reference to the area north of the fifty-fifth parallel; Geol. Surv. Can., Mem. 247.

Brown R. J. E. 1969. Factors influencing discontinuous permafrost in Canada. in Pewe, T. L. ed. The periglacial environment. McGill-Queen's University Press, pp. 11-53.

Fraser, E. M. 1956. The lichen woodland of the Knob Lake area of Quebec/Labrador. McGill Sub-arctic Research Papers 1:3-28.

Hettinger, L., A. Janz, and R. W. Wein. 1973. Vegetation of the northern Yukon. Arctic Gas Biological Report Series. Volume One. 171p.

Hettinger, L. and A. Janz. 1974. Vegetation and soils of northeastern Alaska. Arctic Gas Biological Report Series: Volume 21: 207pp.

Hughes, O. L., R. B. Campbell, J. E. Muller and J. O. Wheeler. 1969. Glacial limits and flow patterns, Yukon Territory, south of 65 degrees north latitude. Dept. Energy, Mines and Resources, Geol. Surv. Canada. Paper 68-34.

Hustich, I. 1957. On the phytogeography of the subarctic Hudson Bay Lowland. Acta. Geogr. 16:1-48.

Kershaw, K. A. 1978. The role of lichens in boreal tundra transition areas. The Bryologist 81(2):294-306.

Markon, C. J. 1986. Arctic National Wildife Refuge land cover mapping project users guide. 14 p. (mimeo).

Miller, D. R. 1976. Biology of the Kaminuriak population of barren-ground caribou. Part 3. Taiga winter range relationships and diet. Can. Wildl. Report Series 36:42 p.

Oswald, E. T. and J. P. Senyk. 1977. Eco-regions of the Yukon Territory. Canadian Forestry Service, Fisheries and Environment Canada. BC-X-164. 115p.

Pielou, E. C. 1977. Mathematical ecology. John Wiley and Sons, Toronto. 385 p.

Russell, D, A. Martell and W. Nixon. 1992. The range ecology of the Porcupine Caribou Herd in Canada. Rangifer Special Issue xx:

Scotter, G. W. 1970. Wildfires in relation to the habitat of barren-ground caribou in the taiga of northern Canada. Ann. Proc. Tall Timbers Conf. 10:85-106.

Stanek, W., K. Alexander and C. S. Simmons. 1981. Reconnaisance of vegetation and soils along the Dempster Highway, Yukon Territory. I. Vegetation types. Canadian Forestry Service Report BC-X-217. 32 p.

Terrain Analysis and Mapping Services, Ltd. 1981. Geologic interpretations and evaluations of the Dempster Highway area. Report to Canada-Yukon Subsidary Agreement on Renewable Resource Information and Tourist Industry Development. 78 p.

Vierecke, L. A., C. T. Dyrness and A. R. Batten. 1986. 1986 Revision of the preliminary classification for vegetation of Alaska.

Wahl, H. E., D. B. Fraser, R. C. Harvey and J. B. Maxwell. 1987. Climate of Yukon. Climatological Studies. Number 40. Environment Canada. Atmospheric Environment Service. 323 p.

Wiken, E.B., D.M. Welch, G.R. Ironside, and D.G. Taylor. 1981. The Northern Yukon: an ecological land survey. Ecological land classification series, No. 6. Lands Directorate, Environment Canada. Ottawa, Ontario. 197pp.

Appendix A. Vegetation composition of winter range community types. Numbered community types refer to Table 2.

VEGETATION COMPOSITION OF NEEDLEEAF FOREST STANDS

	CLOSED NEEDLELEAF		OPEN NEEDLELEAF		
COMMUNITY TYPE	26	14	12	15	29
Larix laricina	-	-	-	2.6±2.63 (33)	trace
Picea glauca	43.9±9.65 (100)	10.1±0.00 (100)	-	2.9±1.51 (100)	3.1±1.86 (50)
Picea mariana	-	-	14.2±3.29 (100)	1.1±1.13 (33)	3.4±2.47 (75)
TOTAL CONIFEROUS	43.9±9.65 (100)	10.1±0.00 (100)	14.2±3.29 (100)	6.7±2.38 (100)	6.6±3.34 (100)
Betula papyrifera	-	5.0±0.00 (100)	-	-	trace
Populus balsamifera	11.8±5.75 (100)	-	-	-	-
TOTAL TREES DECIDUOUS	11.8±5.75 (100)	5.0±0.00 (100)	-	-	0.1±0.13 (25)
Ledum palustre	trace	trace	5.6±1.91 (100)	2.3±0.22 (100)	3.8±1.15 (100)
Rhododendron lapponicum	-	-	1.1±0.56 (50)	trace	-
TOTAL TALL SHRUBS EVERGREEN	0.3±0.30 (50)	0.4±0.00 (100)	7.6±1.44 (100)	3.2±0.38 (100)	3.8±1.15 (100)
Alnus crispa	-	1.4±0.00 (100)	trace	trace	2.9±2.38 (50)
Betula galndulosa	trace	-	1.6±1.27 (67)	trace	5.9±2.33 (75)
Betula occidentalis	-	-	-	-	-
Ribes triste	-	-	-	-	-
Rosa acicularis	16.4±16.0 (100)	10.5±0.00 (100)	trace	trace	-
Rubus idaeus	-	1.9±0.00 (100)	-	-	-
Salix sp.	16.1±14.1 (100)	-	1.2±0.32 (83)	1.5±0.26 (100)	7.5±0.85 (100)
Viburnum edule	-	17.5±0.00 (100)	-	-	-
TOTAL TALL SHRUBS DECIDUOUS	32.8±1.6 (100)	31.3±0.00 (100)	3.9±1.29 (100)	3.8±1.68 (100)	16.4±3.57 (100)
Arctostaphylos uva-ursi	-	-	trace	-	-
Cassiope tetragona	trace	-	trace	-	1.8±1.15 (50)
Dryas spp.	-	-	3.2±2.02 (50)	-	trace
Empetrum nigrum	trace	-	trace	1.2±0.69 (67)	4.1±1.49 (100)
Linnaea borealis	2.35±2.35 (50)	3.2±0.00 (100)	-	trace	trace
Salix reticulata	trace	-	trace	-	4.0±1.88 (100)
Vaccinium vitis-idaea	trace	13.4±0.00 (100)	6.8±3.29 (100)	trace	3.9±0.89 (100)
TOTAL DWARF SHRUB EVERGREEN	3.6±1.95 (100)	3.2±0.49 (100)	16.7±0.00 (100)	trace	14.4±3.75 (100)
Arctostaphylos alpina	-	-	-	trace	1.1±0.97 (50)
Arctostaphylos rubra	1.3±1.3 (50)	-	1.9±0.83 (67)	9.8±1.45 (100)	2.8±1.83 (50)
Spiraea Beauverdiana	-	-	trace	-	-
Vaccinium uliginosum	trace	-	1.2±0.36 (84)	3.8±2.56 (100)	8.0±1.35 (100)
TOTAL DWARF SHRUB DECIDUOUS	1.6±1.56 (50)	-	3.9±0.82 (100)	13.6±2.71 (100)	11.9±2.2 (100)

Appenidx A (cont). VEGETATION COMPOSITION OF NEEDLEEAF FOREST STANDS

COMMUNITY TYPE	CLOSED NEEDLELEAF 26	14	12	OPEN NEEDLELEAF 15	29
Eriophorum vaginatum	-	-	3.3±2.1 (83)	trace	5.8±3.34 (50)
Gram spp.	-	23.8±0.00 (100)	2.4±1.63 (50)	trace	trace
Tricholophorum caespitosum	-	-	2.3±2.32 (17)	-	-
Carex Bigelowii	trace	-	7.7±3.38 (67)	5.4±1.19 (100)	7.7±4.2 (75)
Carex scirpoides	-	-	-	-	trace
Carex rotundata	-	-	-	-	-
Arctagrostis latifolia	1.4±1.4 (50)	-	-	-	-
TOTAL GRAMINOIDS	3.?±?.00 (100)	23.8±0.00 (100)	-	6.5±1.11 (100)	15.5±5.9 (100)
(cont)					
Anemone parvifora	1.4±0.80 (100)	-	trace	trace	trace
Hedysarum alpinum	2.9±0.70 (100)	-	trace	trace	-
Lupinus arcticum	-	-	-	1.1±1.00 (100)	-
Mertensia paniculata	-	2.3±0.00 (100)	trace	trace	-
Petasites frigidus	-	trace	trace	trace	trace
Senecio fuscatus	-	-	-	-	2.1±1.23 (50)
Aster sibiricus	1.8±1.35 (100)	-	-	-	-
TOTAL FORBS	8.5±2.6 (100)	2.9±0.00 (100)	3.9±0.88 (100)	3.4±1.3 (100)	7.5±2.3 (100)
Cetraria cucullata	trace	-	trace	trace	1.2±0.69 (75)
Cetraria islandica	-	-	trace	trace	2.6±1.29 (100)
Cladina mitis	-	-	4.3±1.55 (100)	0.8±0.33 (100)	trace
Cladina rangerferina	-	-	4.0±2.27 (100)	trace	2.2±1.39 (75)
Cladina spp.	trace	-	1.0±0.29 (100)	trace	trace
Nephroma arcticum	-	-	trace	-	trace
Peltigera aphthosa	1.6±1.45 (100)	1.0±0.00 (100)	1.1±0.49 (100)	trace	2.8±1.23 (100)
Sterocaulon alpinum	-	-	trace	-	trace
TOTAL LICHEN	1.6±1.55 (100)	1.0±0.00 (100)	12.2±3.64 (100)	3.1±0.95 (100)	10.8±2.97 (100)
Mineum sp.	4.6±4.6 (50)	-	-	trace	trace
Moss sp.	62.8±2.65 (100)	4.5±0.00 (100)	24.0±3.9 (100)	37.3±7.21 (100)	41.7±12.40 (100)
Pleurozium spp.	trace	10.6±0.00 (100)	9.4±1.44 (100)	14.8±8.11 (100)	5.8±2.87 (100)
Spagnum spp.	-	5.1±0.00 (100)	5.5±2.29 (83)	trace	5.9±4.93 (50)
Dicanum spp.	trace	-	-	-	10.4±8.75 (100)
Hylocomium palustre	29.0±28.85 (100)	-	-	-	16.6±9.62 (75)
Hypnum spp.	17.3±17.30 (50)	-	-	-	trace
TOTAL MOSS	114.2±9.80 (100)	20.2±0.00 (100)	38.9±5.83 (100)	52.9±7.21 (100)	82.0±20.44 (100)
Equisetum scirpoides	2.6±1.20 (100)	-	trace	5.4±3.21 (100)	4.4±3.69 (75)
Equisetum pretense	1.5±0.30 (50)	-	-	-	trace
TOTAL OTHER	4.3±0.75 (100)	-	0.9±0.26 (100)	6.2±2.72 (100)	5.4±3.73 (75)

Appendix A (cont). VEGETATION COMPOSITION OF NEEDLELEAF FOREST STAND

NEEDLELEAF WOODLAND

COMMUNITY TYPE	5	6	9	11	17
Larix laricina	-	-	-	-	trace
Picea glauca	3.6±2.03 (60)	4.0±0.00 (100)	5.2±2.58 (100)	4.6±2.05 (100)	-
Picea mariana	trace	-	-	-	10.4±1.92 (100)
TOTAL CONIFEROUS	4.1±1.81 (100)	4.0±0.00 (100)	5.2±2.58 (100)	4.6±2.05 (100)	10.8±1.62 (100)
Betula papyrifera	-	-	-	-	-
Populus balsamifera	trace	1.15±1.15 (50)	-	-	-
TOTAL TREES DECIDUOUS	0.02±0.02 (50)	1.15±1.15 (50)	-	-	-
Ledum palustre	1.6±0.67 (100)	trace	1.7±0.80 (100)	3.6±2.25 (100)	11.6±2.05 (100)
Rhododendron lapponicum	trace	-	1.6±0.55 (100)	-	trace
TOTAL TALL SHRUBS EVERGREEN	1.9±0.67 (100)	0.45±0.45 (50)	3.4±0.77 (100)	3.6±2.25 (100)	11.6±2.05 (100)
Alnus crispa	-	-	trace	trace	1.1±0.76 (50)
Betula glandulosa	1.7±1.12 (80)	trace	trace	5.1±1.5 (100)	3.6±1.09 (100)
Betula occidentalis	-	-	-	1.3±0.05 (100)	trace
Ribes triste	-	-	-	-	-
Rosa acicularis	trace	1.3±1.3 (50)	-	trace	trace
Rubus idaeus	-	-	-	-	-
Salix sp.	2.4±1.37 (100)	5.2±0.55 (100)	1.6±1.34 (100)	-	1.3±0.36 (100)
Viburnum edule	-	-	-	-	-
TOTAL TALL SHRUBS DECIDUOUS	4.9±2.14 (100)	7.6±0.25 (100)	3.4±1.22 (100)	6.8±2.0 (100)	6.6±1.61 (100)
Arctostaphylos uva-ursi	trace	-	2.1±2.07 (33)	-	-
Cassiope tetragona	2.0±2.17 (40)	-	trace	-	-
Dryas spp.	4.0±1.82 (100)	trace	16.0±3.09 (100)	-	-
Empetrum nigrum	trace	trace	-	2.6±1.7(100)	trace
Linnaea borealis	-	-	-	-	-
Salix reticulata	1.1±0.69 (80)	trace	-	-	trace
Vaccinium vitis-idaea	trace	4.4±4.1 (100)	trace	15.6±9.85 (100)	6.7±0.82 (100)
TOTAL DWARF SHRUB EVERGREEN	10.4±2.97 (100)	5.3±4.2 (100)	18.6±2.98 (100)	18.3±8.15 (100)	7.3±0.89 (100)
Arctostaphylos alpina	-	-	-	-	
Arctostaphylos rubra	4.0±1.19 (100)	2.2±2.05 (100)	7.0±1.13 (100)	-	trace
Spiraea Beauverdiana	-	-	-	trace	trace
Vaccinium uliginosum	trace	-	2.5±1.65 (66)	trace	1.2±0.61 (67)
TOTAL DWARF SHRUB DECIDUOUS	4.9±1.54 (100)	2.2±2.05 (100)	9.5±2.75 (100)	0.4±0.40 (30)	1.8±0.63 (100)

Appendix A (cont). VEGETATION COMPOSITION OF NEEDLELEAF FOREST STAND

NEEDLELEAF WOODLAND

COMMUNITY TYPE	5	6	9	11	17
Eriophorum vaginatum	trace	-	-	-	1.5±0.30 (100)
Gram spp.	trace	1.6±0.25 (100)	trace	trace	trace
Tricholophorum caespitosum	-	-	-	-	-
Carex Bigelowii	2.3±1.35 (60)	-	trace	-	7.3±5.35 (33)
Carex scirpoides	1.4±0.68 (60)	-	4.1±0.73 (100)	-	-
Carex rotundata	-	-	-	-	-
Arctagrostis latifolia	-	-	-	-	-
TOTAL GRAMINOIDES	4.6±1.31 (100)	1.8±0.10 (100)	5.9±0.75 (100)	0.3±0.05 (100)	9.5±5.33 (100)
Anemone parvifora	trace	-	trace	-	trace
Hedysarum alpinum	trace	trace	1.2±0.84 (100)	-	-
Lupinus arcticum	trace	2.6±1.25 (100)	trace	-	-
Mertensia paniculata	trace	trace	trace	-	-
Petasites frigidus	trace	trace	trace	-	trace
Rubus chaemaemorus	-	-	-	trace	6.1±1.90 (100)
Senecio fuscatus	-	-	-	-	-
Aster sibiricus	-	-	-	-	-
TOTAL FORBS	2.9±0.53 (100)	4.2±1.9 (100)	4.4±1.65 (100)	0.1±0.1 (50)	8.8±1.48 (100)
Cetraria cucullata	trace	trace	trace	trace	trace
Cetraria islandica	trace	trace	2.27±0.58 (100)	trace	2.05±0.32 (100)
Cladina alpestris	trace	2.4±2.4 (50)	-	trace	1.02±0.83 (73)
Cladina mitis	3.4±0.52 (100)	trace	trace	2.3±1.35 (100)	4.4±1.07 (100)
Cladina rangerferina	trace	2.4±2.4 (50)	trace	trace	5.5 2.15 (100)
Cladina spp.	trace	trace	trace	2.2±0.45 (100)	1.6±0.41 (100)
Nephroma arcticum	-	-	-	-	trace
Peltigera aphthosa	trace	3.1±0.45 (100)	trace	1.0±0.00 (100)	trace
Stereocaulon alpinum	trace	trace	-	17.8±7.8 (100)	-
TOTAL LICHEN	8.8±1.34 (100)	10.2±7.00 (100)	4.4±0.43 (100)	26.8±10.8 (100)	15.8±2.78 (100)
Minium sp.	-	-	-	-	-
Moss sp.	22.5±4.48 (100)	2.4±0.35 (100)	32.6±12.36 (100)	2.6±1.35 (100)	6.1±1.98 (100)
Pleurozium sp.	18.1±7.23 (100)	61.6±7.85 (100)	3.8±2.02 (100)	-	20.8±6.98 (100)
Spagnum spp.	1.1±0.49 (60)	-	-	-	20.1±4.34 (100)
Dicranum spp.	-	-	-	-	-
Hyocomium palustre	-	-	-	-	-
Hypnum spp.	-	-	-	-	-
TOTAL MOSS	41.6±7.99 (100)	63.9±8.20 (100)	36.4±10.60 (100)	2.6±1.35 (100)	46.9±6.91 (100)
Equisetum arvense	trace	trace	1.4±1.38 (67)	-	-
Equisetum scirpoides	1.3±1.10 (60)	trace	1.2±1.09 (67)	-	trace
Equisetum silvaticum	-	-	-	-	trace
Equisetum pretense	-	-	-	-	-
TOTAL OTHER	2.3±1.30 (80)	0.6±0.30 (100)	2.8±2.45 (100)	0.05±0.05 (50)	0.3±0.24 (50)

Appendix A. (cont)

COMMUNITY TYPE	19	20	21	22	23
Larix laricina	-	-	-	-	1.3±0.85 (46)
Picea glauca	2.2±1.99 (67)	2.4±2.35 (17)	-	2.4±0.00 (100)	-
Picea mariana	3.7±1.13 (100)	10.6±2.58 (83)	-	8.5±1.88 (100)	-
TOTAL CONIFEROUS	5.9±1.22 (100)	12.4±1.48 (100)	9.5±2.13 (89)	2.4±0.00 (100)	9.8±1.64 (100)
Betula papyrifera	-	trace	-	-	trace
Populus balsamifera	-	-	-	-	-
TOTAL TREES DECIDUOUS	-	0.90±0.61 (33)	-	-	0.01 ±0.01 (50)
Ledum palustre	3.6±1.09 (100)	7.7±1.24 (100)	14.1±1.27 (100)	-	13.2±2.03 (100)
Rhododendron lapponicum	-	-	trace	-	-
TOTAL TALL SHRUBS EVERGREEN	3.6±1.09 (100)	7.7±1.24 (100)	1.41±1.27 (100)	-	13.2±2.03 (100)
Alnus crispa	1.8±1.8 (33)	7.6±6.9 (100)	2.7±1.35 (78)	-	1.3±0.91 (36)
Betula galndulosa	9.4±1.89 (100)	2.9±0.8 (83)	5.3±0.93 (100)	-	3.7±0.88 (100)
Betula occidentalis	6.9±2.05 (100)	trace	trace	-	trace
Ribes triste	trace	1.6±1.62 (33)	-	-	-
Rosa acicularis	3.2±0.42 (100)	1.6±0.73 (100)	trace	-	trace
Rubus idaeus	-	-	-	-	-
Salix sp.	trace	trace	1.6±0.79 (78)	trace	trace
Viburnum edule	-	-	-	-	-
TOTAL TALL SHRUBS DECIDUOUS	22.1±1.9 (100)	15.5±9.51 (100)	10.39±9.51 (100)	0.3±0.00 (100)	6.4±1.16 (100)
Arctostaphylos uva-ursi	-	-	-	-	-
Cassiope tetragona	-	-	trace	-	-
Dryas spp.	-	-	-	-	-
Empetrum nigrum	trace	1.2±0.52 (83)	1.5±1.26 (56)	5.3±0.00 (100)	3.4±1.22 (91)
Linnaea borealis	trace	-	-	-	-
Salix reticulata	-	-	-	-	trace
Vaccinium vitis-idaea	11.8±2.2 (100)	9.3±1.85 (100)	11.6±1.84 (100)	1.7±0.00 (100)	8.8±1.28 (100)
TOTAL DWARF SHRUB EVERGREEN	12.8±1.76 (100)	10.5±1.9 (100)	13.2±1.91 (100)	7.0±0.00 (100)	12.3±1.73 (100)
Arctostaphylos alpina	trace	-	trace	-	trace
Arctostaphylos rubra	-	trace	-	-	-
Spiraea Beauverdiana	trace	1.2±0.77 (100)	1.0±0.29 (78)	trace	trace
Vaccinium uliginosum	trace	trace	trace	6.6±0.00 (100)	2.1±0.65 (82)
TOTAL DWARF SHRUB DECIDUOUS	1.8±0.72 (100)	1.6±0.73 (100)	1.6±0.61 (100)	7.1±0.00 (100)	3.2±0.92 (100)
Eriophorum vaginatum	-	trace	trace	-	10.6±3.2 (91)
Gram spp.	trace	1.0±0.33 (100)	1.5±0.33 (89)	trace	trace
Tricholophorum caespitosum	-	-	-	-	-
Carex Bigelowii	-	-	-	-	-
Carex scirpoides	-	-	-	-	-
Carex rotundata	-	-	2.4±2.37 (11)	-	-
Arctagrostis latifolia	-	-	-	-	-
TOTAL GRAMINOIDES	1.0±0.31 (100)	1.1±0.40 (100)	4.9±3.12 (100)	0.1±0.00 (100)	11.2±3.29 (100)

Appendix A (cont).

COMMUNITY TYPE	19	20	21	22	23
Anemone parviflora	-	-	-	-	-
Hedysarum alpinum	-	-	-	-	-
Lupinus arcticum	-	-	-	-	trace
Mertensia paniculata	-	-	-	-	-
Petasites frigidus	trace	3.0±0.91 (89)	2.6±0.64 (89)	-	trace
Rubus chaemaemorus	trace	3.1±0.74 (100)	5.1±1.65 (100)	-	4.9±1.81 (100)
Senecio fuscatus	-	-	-	-	-
Aster sibiricus	-	-	-	-	-
TOTAL FORBS	0.6±0.41 (67)	6.4±0.92 (100)	8.0±1.42 (100)	0.1±0.00 (100)	6.6±2.01 (100)
Cetraria cucullata	trace	trace	trace	trace	trace
Cetraria islandica	trace	trace	trace	trace	1.5±0.35 (100)
Cladina alpestris	5.6±3.35 (67)	1.08±0.78 (67)	trace	trace	5.76±2.42 (100)
Cladina mitis	1.3±0.75 (67)	2.1±0.80 (100)	2.3±0.58 (100)	7.1±0.00 (100)	5.5±0.99 (100)
Cladina rangerferina	2.1±1.06 (67)	3.9±1.19 (100)	3.2±0.97 (89)	trace	9.3±1.89 (100)
Cladina spp.	9.0±7.45 (100)	1.0±0.21 (100)	1.3±0.21 (100)	30.0±0.00 (1000	3.3±0.53 (100)
Nephroma arcticum	trace	trace	1.0±0.56 (56)	trace	trace
Peltigera aphthosa	5.9±0.74 (100)	1.7±0.57 (100)	4.1±0.94 (100)	4.8±0.00 (100)	3.0±0.64 (91)
Stereocaulon alpinum	1.9±1.73 (100)	trace	trace	32.5±0.00 (100)	4.6±2.35 (91)
TOTAL LICHEN	26.7±4.81 (100)	11.3±2.53 (100)	14.3±1.59 (100)	76.7±0.00 (100)	35.7±5.94 (100)
Minium sp.	-	trace	trace	-	trace
Moss sp.	3.2±0.65 (100)	2.7±0.53 (100)	6.9±1.45 (100)	3.1±0.00 (100)	11.3±2.33 (100)
Pleurozium spp.	14.1±11.4 (100)	32.6±3.89 (100)	13.8±3.97 (100)	-	3.1±1.18 (100)
Spagnum spp.	trace	14.6±2.29 (100)	22.5±6.26 (100)	-	12.3±3.42 (100)
Dicranum spp.	-	-	trace	-	2.8±0.86 (91)
Hyocomium palustre	-	-	trace	-	trace
Hypnum spp.	-	-	-	-	trace
TOTAL MOSS	17.6±10.64 (100)	49.9±5.17 (100)	43.6±4.67 (100)	3.1±0.00 (100)	31.4±5.42 (100)
Equisetum arvense	-	-	-	-	-
Equisetum scirpoides	-	-	-	-	-
Equisetum silvaticum	trace	trace	1.02±0.39 (67)	-	1.2±0.39 (82)
Equisetum pretense	-	-	-	-	-
TOTAL OTHER	0.1±0.13 (33)	0.3±0.17 (50)	1.08±0.41 (67)	0.6±0.00 (100)	1.3±0.40 (91)
***** *****	-	-	-	-	trace
TOTAL UNKNOWN	-	-	-	-	0.7±0.40 (55)

Appendix A. (cont) VEGETATION COMPOSITION OF MESIC GRAMINOID/HERBACEOUS STANDS

	1	3	4	8	10	16
Picea mariana				trace	1.8±1.73 (75)	1.96±1.06 (80)
TOTAL TREES CONIFEROUS				0.16±0.12 (67)	1.9±1.69 (100)	2.38±1.39 (80)
Ledum palustre	10.55±1.97 (100)	3.9±1.99 (100)	4.5±1.25 (100)	11.2±2.08 (100)	11.8±2.28 (100)	12.5±3.67 (100)
TOTAL TALL SHRUBS EVERGREEN	10.55±1.97 (100)	3.9±1.99 (100)	4.6±1.20 (100)	11.2±2.05 (100)	11.8±2.28 (100)	12.5±3.65 (100)
Betula glandulosa	4.2±0.59 (100)	8.42±3.60 (100)	8.2±4.60 (100)	5.4±1.14 (100)	8.1±2.29 (100)	5.18±1.72 (100)
Salix sp.		5.42±2.88 (100)	1.9±0.06 (50)	0.9±0.06 (100)	2.0±1.33 (75)	1.47±0.87 (80)
TOTAL TALL SHRUBS DECIDUOUS	4.2±0.59 (100)	13.86±5.01 (100)	11.05±1.75 (100)	7.0±0.57 (100)	10.9±3.23 (100)	6.96±2.43 (100)
Empetrum nigrm	trace	2.0±1.87 (60)		1.4±0.12 (100)	2.4±0.72 (100)	2.0±1.87 (60)
Salix reticulata		1.3±1.29 (40)	trace	trace		
Vaccinimum vitis-idaea	2.2±0.29 (100)	2.4±0.82 (100)	2.2±0.50 (100)	5.0±1.47 (100)	7.7±1.82 (100)	4.9±3.19 (100)
TOTAL DWARF SHRUB EVERGREEN	2.5±0.35 (100)	6.3±2.48 (100)	3.5±0.80 (100)	6.6±1.33 (100)	10.4±2.62 (100)	6.9±5.06 (100)
Arctostraphylos alpina					1.6±1.05 (50)	trace
Vaccinimum uliginosum	trace	trace	trace	3.2±0.66 (100)	2.9±1.54 (100)	1.6±0.64 (80)
TOTAL DWARF SHRUB DECIDUOUS	0.02±0.02 (25)	1.2±0.66 (80)	0.4±0.4 (50)	3.9±1.28 (100)	4.6±2.09 (100)	2.4±1.17 (80)
Eriophorum vaginatum	17.3±2.09 (100)	2.3±0.93 (80)	33.9±3.45 (100)	5.5±3.36 (67)	10.6±4.12 (75)	27.3±4.14 (100)
Triglochin spp.				2.9±2.9 (33)		
Carex aquatilis				1.4±1.37 (33)		
Carex bigelowii	2.3±1.14 (100)	18.0±2.96 (100)	2.6±2.55 (100)	4.5±0.17 (100)	8.2±7.33 (50)	3.7±2.19 (80)
Carex vaginata		2.3±2.24 (20)				
Carex limosa		1.0±1.00 (20)				
Eriophorum angustifolium		1.2±1.16 (20)		1.03±1.03 (33)		
TOTAL GRAMINOIDS	19.5±1.04 (100)	26.4±4.31 (100)	37.2±5.5 (100)	15.4±3.40 (100)	18.9±7.60 (100)	31.1±5.70 (100)
Andromeda polifolia	trace	trace	trace	1.2±0.22 (100)	trace	trace
Rubus arcticus				1.2±1.17 (33)		
Rubus chamaemorus	2.5±0.72 (100)	0.2±0.14 (40)	1.3±1.00 (100)	0.2±0.15 (67)	2.9±2.17 (100)	3.6±2.07 (100)
TOTAL FORBS	3.1±0.68 (100)	2.4±0.60 (100)	2.9±0.05 (100)	4.1±1.16 (100)	4.6±2.74 (100)	5.1±2.35 (100)
Cetraria cucullata	2.8±0.82 (100)	0.9±0.21 (100)	2.5±2.55 (50)	2.2±1.11 (67)	2.1±0.58 (100)	1.1±0.29 (100)
Cetraria islandica	trace	trace	trace	1.0±0.29 (100)	trace	trace
Cladina mitis	3.9±2.39 (100)	trace	2.6±1.60 (100)	1.8±0.07 (100)	1.4±0.23 (100)	1.4±0.26 (100)
Cladina rangiferina	1.3±0.41 (100)	trace	trace	1.1±0.28 (100)	1.2±0.19 (100)	1.1±0.36 (100)
Cladina sp.	1.7±0.33 (100)	1.6±0.50 (100)	1.2±1.00 (100)	1.0±0.22 (100)	1.5±0.29 (100)	trace
Peltigera apthosa	trace	1.5±0.75 (80)	trace	trace	3.0±1.78 (75)	1.1±0.52 (100)
TOTAL LICHENS	10.7±3.56 (100)	6.1±1.33 (100)	7.9±4.15 (100)	7.7±1.69 (100)	10.3±1.47 (100)	6.3±1.00 (100)
Moss sp.	8.2±3.72 (100)	14.1±5.72 (100)	5.6±3.45 (100)	9.5±2.43 (100)	15.3±8.25 (100)	7.8±2.08 (100)
Pleurosium sp.		5.6±1.97 (80)	6.2±6.15 (50)	2.2±1.10 (100)	1.4±0.81 (75)	1.2±0.71 (80)
Shagnum spp.	46.6±8.36 (100)	10.8±3.65 (100)	33.4±25.7 (100)	29.3±2.86 (100)	25.9±16.45 (100)	29.7±7.59 (100)
TOTAL MOSS	54.7±5.01 (100)	20.5±4.61 (100)	45.2±16.1 (100)	40.9±1.62 (100)	42.8±10.99 (100)	38.7±6.39 (100)
TOTAL OTHER	0.04±0.02 (40)	0.2±0.15 (50)				0.02±0.02 (20)

Appendix A. (cont). VEGETATION COMPOSITION OF LOW SHRUB SCRUB

	2	7	24	25	27	28
Picea glauca	1.2±1.16 (33)	1.9±1.9 (50)			1.4±1.00 (50)	trace
Picea mariana					trace	2.0±1.24 (50)
TOTAL TREES CONIFEROUS	1.2±1.16 (33)	1.9±1.9 (50)			1.5±1.00 (63)	2.2±1.13 (75)
Ledum palustre	3.3±1.87 (83)	4.2±1.8 (100)	4.4±4.45 (50)	trace	9.0±0.83 (100)	15.2±3.29 (100)
Rhododendron lapponicum	trace			1.2±0.54 (75)	trace	
TOTAL TALL SHRUBS EVERGREEN	3.3±1.86 (83)	4.7±2.3 (100)	4.4±4.45 (50)	1.4±0.53 (75)	9.0±0.84 (100)	15.2±3.29 (100)
Alnus crispa					3.1±2.38 (25)	10.0±1.53 (100)
Betula glandulosa	17.2±3.28 (17)	28.6±5.8 (100)	14.6±1.4 (100)	trace	5.2±1.36 (100)	10.6±3.65 (100)
Betula occidentalis	1.9±1.97 (17)	8.2±8.25 (50)			trace	
Salix spp.	16.4±2.65 (100)	1.2±1.25 (50)	trace	8.3±2.51 (100)	1.4±0.44 (88)	1.0±0.62 (50)
TOTAL TALL SHRUBS DECIDUOUS	36.4±4.03 (100)	38.6±13.15 (100)	14.7±1.3 (100)	8.83±2.9 (100)	10.2±3.38 (100)	21.7±3.81 (100)
Cassiope tetragona				4.8±1.56 (100)	trace	trace
Dryas spp.	trace			27.4±7.33 (100)		
Empetrum nigrum	3.4±1.52 (83)	3.6±3.4 (100)	8.4±1.7 (100)	trace	2.2±0.39 (100)	2.6±1.26 (100)
Salix reticulata	2.3±1.51 (33)			3.4±1.39 (100)	trace	
Vaccinimum vitis-idaea	2.4±1.57 (100)	11.4±2.2 (100)	3.8±0.2 (100)	trace	5.2±0.57 (100)	9.4±1.83 (100)
TOTAL DWARF SHRUBS EVERGREEN	8.2±2.38 (100)	15.2±1.00 (100)	12.2±1.6 (100)	35.6±6.65 (100)	8.2±0.74 (100)	12.1±2.91 (100)
Arctostaphylos alpina		trace	6.0±1.5 (100)	trace	trace	2.8±2.16 (50)
Arctostaphylos rubra	2.3±2.01 (50)	trace	trace	1.3±1.29 (50)	2.0±1.19 (50)	trace
Spiraea Beauverdiana					1.1±1.08 (13)	trace
Vaccinimum uliginosum	1.8±0.85 (84)	2.9±2.9 (50)	1.0±0.7 (100)	2.6±0.86 (100)	10.8±2.77 (100)	4.7±2.48 (75)
Salix arctica			1.3±1.30 (50)	trace		
TOTAL DWARF SHRUBS DECIDUOUS	4.1±2.21 (83)	3.2±3.25 (50)	9.2±3.0 (100)	4.6±1.78 (100)	14.6±3.99 (100)	8.0±4.26 (100)
Eriophorum vaginatum					22.8±6.85 (50)	14.5±4.44 (100)
Graminae spp.	4.8±1.39 (100)	1.0±0.95 (100)		trace	trace	trace
Carex Bigelowii	trace		trace	1.2±1.04 (50)	4.6±2.74 (50)	3.8±1.84 (75)
Eriophorum angustifolium					4.6±4.61 (13)	
Carex rotundata			6.2±6.20 (50)		trace	4.08±4.08 (25)
Hierchloe alpina			1.6±0.3 (100)	trace	trace	
TOTAL GRAMINOIDS	6.1±1.70 (100)	1.0±0.95 (100)	8.8±6.7 (100)	4.4±0.79 (100)	22.0±8.92 (100)	22.5±7.41 (100)
Artemesia arctica	2.3±1.14 (50)					
Mertensia paniculata	1.6±0.73 (83)	trace				
Petasites frigidum	5.5±4.95 (100)	trace	trace		trace	trace
Polemonium acutiflorum	1.6±1.35 (67)					
Polygonum bistorta	1.0±1.35 (67)			trace	trace	trace
Rubus chamaemorus	trace				2.0±0.99 (50)	4.7±1.65 (100)
Saxifraga tricuspidata		1.4±1.25 (100)		trace	trace	
Oxytropis maydelliana				1.2±1.2 (25)		
Astragalus spp.	trace			1.1±0.37 (75)		
TOTAL FORBS	17.7±8.53 (100)	2.4±2.05 (100)	1.4±0.2 (100)	8.7±1.48 (100)	5.1±0.99 (100)	6.9±1.46 (100)

Appendix A (cont) VEGETATION COMPOSITION OF LOW SHRUB SCRUB (cont)

	2	7	24	25	27	28
Alectoria ochroleuca	-	-	2.0±0.05 (100)	trace	trace	trace
Cetraria cucullata	-	trace	4.1±1.25 (100)	4.9±1.58 (100)	1.7±0.56 (100)	1.7±0.65 (100)
Cetraria islandica	trace	trace	1.2±0.35 (100)	1.6±0.25 (100)	1.8±0.46 (100)	1.2±.034 (100)
Cetraria nivalis	trace	trace	1.4±0.35 (100)	trace	trace	trace
Cetraria richardsoni	trace	trace	1.0±0.45 (100)	1.9±1.38 (100)	trace	trace
Cladina alpestris	1.0±0.43 (83)	trace	trace	-	trace	trace
Cladina mitis	1.5±0.57 (83)	1.3±0.50 (100)	1.9±0.35 (100)	0.08±0.02 (75)	2.6±0.83 (100)	1.3±0.31 (100)
Cladina rangerferina	1.6±0.70 (83)	1.4±0.60 (100)	2.3±0.70 (100)	trace	3.9±1.20 (100)	3.7±1.49 (100)
Cladina spp.	trace	1.6±1.00 (100)	1.7±0.90 (100)	0.2±0.05 (100)	1.2±0.24 (100)	0.9±0.23 (100)
Peltigera apthosa	4.2±1.67 (100)	2.3±1.60 (100)	trace	1.8±0.79 (100)	4.3±1.59 (100)	trace
Sterocaulon alpinum	trace	1.2±0.95 (100)	trace	trace	-	-
Crustose lichen	-	-	-	4.2±3.50 (50)	-	-
TOTAL LICHENS	10.5±3.5 (100)	9.4±0.55 (100)	17.8±0.70 (100)	17.6±4.31 (100)	17.7±3.30 (100)	11.2±2.89 (100)
Moss sp.	12.1±4.16 (100)	20.1±17.9 (100)	2.2±2.25 (50)	30.9±16.04 (100)	18.3±3.9 (100)	7.2±5.26 (50)
Pleurosium spp.	27.8±5.58 (100)	-	trace	trace	1.9±0.78 (88)	1.0±0.42 (100)
Shagnum spp.	trace	-	-	-	6.6±2.81 (75)	14.5±3.84 (100)
Dicranum spp.	-	-	1.8±1.70 (100)	2.8±0.73 (100)	2.2±0.70 (100)	2.8±1.18 (100)
Polytrichum spp.	-	-	1.2±1.15 (100)	-	trace	trace
Hylocomium palu	-	-	trace	6.5±3.24 (75)	5.8±3.47 (75)	5.2±3.24 (100)
TOTAL MOSS	40.8±4.11 (100)	20.1±1.79 (100)	5.4±1.60 (100)	40.8±17.6 (100)	35.4±6.14 (100)	31.5±6.0 (100)
TOTAL OTHER	0.8±0.36 (100)	0.05±0.05 (50)	-	0.02±0.02 (25)	0.7±0.57 (25)	0.7±0.64 (50)
***** *****	-	-	trace	1.8±1.56 (50)	2.8±0.68 (88)	2.9±2.57 (75)
TOTAL UNKNOWN	-	-	0.8±0.75 (50)	2.0±1.49 (75)	2.8±0.68 (88)	2.9±2.57 (75)

Appendix A (cont). VEGETATION COMPOSITION OF MESIC FORB HERBACEOUS

	13	18
Picea glauca	1.9±0.00 (100)	
TOTAL TREES CONIFEROUS	1.9±0.00 (100)	0.1±0.00 (100)
Ledum palustre	trace	12.8±0.00 (100)
TOTAL TALL SHRUBS EVERGREEN	0.1±0.00 (100)	12.8±0.00 (100)
Alnus crispa	4.3±0.00 (100)	
Rosa acicularis	trace	3.6±0.00 (100)
TOTAL TALL SHRUBS DECIDUOUS	5.3±0.00 (100)	3.8±0.00 (100)
Pyrola grandiflora	2.1±0.00 (100)	
Vaccinimum vitis-idaea	trace	1.7±0.00 (100)
TOTAL DWARF SHRUBS EVERGREEN	3.2±0.00 (100)	1.9±0.00 (100)
Arctostaphylos rubra	3.1±0.00 (100)	
Spireae Beauverdiana		3.9±0.00 (100)
TOTAL DWARF SHRUBS DECIDUOUS	3.3±0.00 (100)	3.9±0.00 (100)
Eriophorum vaginatum		1.1±0.00 (100)
Graminae spp.	trace	4.1±0.00 (100)
TOTAL GRAMINOIDS	0.1±0.00 (100)	5.2±0.00 (100)
Epilobium angustifolium		1.1±0.00 (100)
Petasites frigidus		2.0±0.00 (100)
TOTAL FORBS	2.0±0.00 (100)	4.0±0.00 (100)
Peltigera apthosa	1.9±0.00 (100)	trace
TOTAL LICHENS	2.6±0.00 (100)	0.4±0.00 (100)
Moss spp.	2.9±0.00 (100)	5.2±0.00 (100)
Pleurosium spp.	74.5±0.00 (100)	
TOTAL MOSS	77.5±0.00 (100)	5.2±0.00 (100)
Equisetum fluviatile	1.7±0.00 (100)	
Equisetum scirpoides	9.9±0.00 (100)	
Equisetum silvatium		33.4±0.00 (100)
TOTAL OTHER	11.5±0.00 (100)	33.4±0.00 (100)

Appendix B. Percent cover* by physiognomic levels for range type on the winter range of the Porcupine Caribou herd.

	TREES		TALL SHRUBS		DWARF SHRUBS						
	Coniferous	Deciduous	Evergreen	Deciduous	Evergreen	Deciduous	Graminoids	Forbs	Lichens	Moss	Other**
FOREST											
Closed Needleleaf	34.0 (28-40)	4.3 (4.0-4.5)	0.4 (.45-.3)	20.2 (7.6-32.8)	4.5 (3.6-5.3)	1.9 (1.6-2.2)	2.5 (1.8-3.1)	6.4 (4.2-8.5)	5.9 (1.6-10.2)	89.1 (63.9-114.2)	2.5 (0.6-4.6)
Open Needleleaf	12.3 (10-15)	0.4 (0-15)	4.1 (1.9-7.7)	10.8 (3.4-31.3)	14.5 (10.4-18.6)	3.4 (0-9.5)	8.7 (0.1-23.8)	3.4 (0.1-6.4)	15.7 (1-26.8)	31.6 (2.6-49.9)	1.1 (0-2.8)
Needleleaf Woodland	7.1 (5-9)	0.03 (0-0.2)	6.2 (0-14.1)	8.9 (0.5-22.1)	9.1 (3.2-14.4)	6.6 (1.6-13.6)	6.1 (0.1-15.5)	4.6 (0.1-8.8)	23.3 (2.6-76.7)	44.4 (17.6-82.0)	3.3 (0.1-11.6)
SHRUB											
Open Lowshrub Scrub	1.1 (0-4)	_	7.3 (3.3-15.2)	24.3 (10.2-38.6)	11.2 (9.3-15.2)	7.8 (3.2-14.6)	12.1 (1-22.5)	6.7 (1.4-17.7)	13.3 (9.4-17.8)	26.6 (5.4-3.54)	0.5 (.1-.8)
Closed Dwarf Shrub	_	_	1.4	8.8	35.6	4.6	4.4	8.7	17.4	40.8	0.02
HERBACEOUS											
Mesic Graminoid Herbaceous	0.5 (0-1.1)	_	9.1 (3.9-12.5)	8.9 (4.2-13.9)	6.1 (2.5-10.4)	2.1 (.02-4.6)	24.8 (15.4-37.2)	3.7 (2.4-5.1)	8.2 (6.1-10.7)	42.1 (30.5-54.7)	0.04 (0-0.2)
Mesic Forb Herbaceous	0.1	_	12.8	3.8	1.9	3.9	5.2	4.0	0.4	5.2	33.4

* Average - mean of means of communities
** Includes horsetails, ferns, liverworts, clubmoss

Appendix C. Vegetational composition (% cover and frequency) of the plant associations found on the study area.

Species	Dryas sp. V. uliginosum	Dryas sp. S. reticulata	C. tetragona V. uliginosum	V. uliginosum V. vitis-idaea	E. vaginatum B. glandulosa C. Bigelowii	E. angustifolium C. aquatilis S. pulchra	A. arctica E. latifolium S. alaxensis
	$\bar{x} \pm SE$ (f)	$\bar{x} \pm SE$ (f)	$\bar{x} \pm SE$ (f)	$\bar{x} \pm SE$ (f)	$\bar{x} \pm SE$ (f)	$\bar{x} \pm SE$ (f)	$\bar{x} \pm SE$ (f)
Mesic moss	4.76 ± 2.1 (52)	37.11 ± 9.53 (91)	64.94 ± 7.13 (100)	31.45 ± 9.42 (84)	28.39 ± 8.51 (69)	20.21 ± 6.72 (57)	1.91 ± 1.76 (17)
Hydric moss	—	—	—	12.24 ± 8.66 (30)	10.21 ± 6.76 (29)	26.31 ± 8.22 (54)	0.02 ± 0.02 (2)
Total moss	4.76	37.11	64.94	43.69	38.60	46.52	1.93
Alectoria nigricans	1.50 ± 0.68 (78)	0.11 ± 0.05 (22)	0.07 ± 0.04 (15)	0.17 ± 0.13 (15)	—	—	—
Alectoria ochroleuca	0.50 ± 0.08 (75)	0.12 ± 0.05 (25)	0.20 ± 0.07 (28)	0.02 ± 0.01 (3)	0.01 ± 0.01 (1)	—	—
Cetraria cucullata	0.30 ± 0.10 (35)	0.53 ± 0.20 (61)	1.16 ± 0.67 (76)	0.84 ± 0.30 (74)	0.28 ± 0.06 (33)	0.01 ± 0.01 (2)	—
Cetraria islandica	0.17 ± 0.10 (28)	0.17 ± 0.04 (45)	0.27 ± 0.06 (28)	0.06 ± 0.03 (5)	0.23 ± 0.18 (9)	tr (1)	—
Cetraria nivalis	0.47 ± 0.32 (54)	0.47 ± 0.20 (48)	0.14 ± 0.07 (20)	0.04 ± 0.02 (8)	0.01 ± 0.01 (3)	—	0.01 ± 0.01 (1)
Masonhalea Richardsonii	0.26 ± 0.16 (19)	0.08 ± 0.03 (9)	0.27 ± 0.05 (38)	0.53 ± 0.16 (26)	0.01 ± 0.01 (1)	—	—
Cetraria tilesii	tr (1)	0.13 ± 0.07 (16)	0.03 ± 0.02 (6)	—	—	—	—
Cladina rangiferina	0.22 ± 0.18 (23)	—	0.35 ± 0.12 (21)	0.75 ± 0.34 (51)	0.04 ± 0.03 (3)	—	—
Dactylina arctica	0.01 ± 0.01 (3)	0.18 ± 0.08 (26)	0.55 ± 0.11 (41)	0.25 ± 0.10 (38)	0.18 ± 0.07 (26)	tr (1)	—
Nephroma expallidum	0.37 ± 0.28 (30)	0.20 ± 0.20 (15)	0.67 ± 0.49 (21)	0.13 ± 0.08 (8)	tr (1)	—	—
Peltigera aphthosa	0.10 ± 0.09 (7)	tr (1)	1.32 ± 0.99 (24)	0.57 ± 0.30 (26)	1.30 ± 0.44 (45)	0.77 ± 0.70 (14)	—
Stereocaulon paschale	0.56 ± 0.35 (33)	0.02 ± 0.02 (4)	0.09 ± 0.06 (10)	0.92 ± 0.87 (28)	—	—	—
Thamnolia vermicularis	0.36 ± 0.14 (53)	0.78 ± 0.34 (66)	0.46 ± 0.16 (58)	0.32 ± 0.09 (66)	0.09 ± 0.03 (13)	—	—
Miscellaneous lichens	0.23 ± 0.20 (23)	0.27 ± 0.19 (16)	tr (1)	0.01 ± 0.01 (3)	0.06 ± 0.06 (12)	—	—
Total lichens	5.05	3.06	5.58	4.61	2.21	0.78	0.01
Equisetum variegatum	—	0.60 ± 0.37 (19)	tr (1)	—	—	tr (1)	0.23 ± 0.18 (5)
Equisetum scirpoides	—	tr (2)	0.01 ± 0.01 (3)	—	0.29 ± 0.29 (5)	—	0.25 ± 0.10 (3)
Equisetum arvense	—	3.77 ± 2.45 (31)	tr (1)	3.06 ± 3.06 (25)	0.36 ± 0.36 (7)	0.05 ± 0.05 (3)	—
Cystopteris fragilis	tr (1)	—	—	—	—	—	—
Woodsia alpina	—	tr (1)	—	—	—	—	—
Total ferns & horsetails*	tr	4.37	0.01	3.06	0.65	0.05	0.48
Hierochloe alpina	0.08 ± 0.08 (10)	0.09 ± 0.09 (4)	0.26 ± 0.18 (25)	0.08 ± 0.08 (4)	—	0.09 ± 0.09 (1)	—
Arctagrostis latifolia	—	0.36 ± 0.27 (18)	0.65 ± 0.65 (5)	0.18 ± 0.11 (11)	0.27 ± 0.17 (15)	0.18 ± 0.13 (15)	0.02 ± 0.02 (2)
Trisetum spicatum	—	—	—	—	—	—	0.06 ± 0.06 (4)
Poa arctica	0.03 ± 0.03 (2)	—	—	—	0.04 ± 0.04 (8)	0.03 ± 0.03 (1)	—
Poa glauca	0.02 ± 0.02 (1)	—	—	0.04 ± 0.04 (1)	—	—	—
Festuca altaica	—	0.02 ± 0.02 (1)	—	—	—	—	—
Festuca brachyphylla	0.02 ± 0.02 (1)	—	—	—	—	—	—
Festuca rubra	—	—	—	—	—	—	0.40 ± 0.40 (6)
Eriophorum angustifolium	—	1.16 ± 0.79 (19)	0.10 ± 0.10 (1)	0.33 ± 0.33 (3)	1.39 ± 0.92 (10)	23.12 ± 6.38 (77)	—
Eriophorum vaginatum	—	—	—	1.24 ± 0.77 (4)	34.59 ± 4.61 (81)	9.50 ± 4.29 (39)	—
Carex capitata	—	0.02 ± 0.02 (1)	—	—	—	—	—
Carex scirpoidea	0.34 ± 0.34 (16)	1.32 ± 0.55 (28)	0.31 ± 0.31 (11)	—	—	tr (1)	—
Carex rupestris	0.18 ± 0.18 (7)	0.14 ± 0.12 (6)	—	0.09 ± 0.09 (6)	—	—	—
Carex Bigelowii	—	1.25 ± 0.73 (19)	4.62 ± 3.66 (44)	9.11 ± 6.01 (46)	10.13 ± 4.23 (49)	2.75 ± 1.82 (26)	—
Carex lugens	—	0.33 ± 0.71 (7)	—	—	—	—	—
Carex aquatilis	—	0.24 ± 0.23 (4)	—	—	—	15.67 ± 8.74 (60)	—
Carex vaginata	—	0.18 ± 0.12 (3)	0.41 ± 0.41 (6)	—	—	—	—
Carex atrofusca	—	0.39 ± 0.39 (5)	—	—	—	—	—
Carex misandra	—	0.26 ± 0.18 (13)	0.33 ± 0.33 (3)	—	—	0.02 ± 0.02 (2)	—
Carex capillaris	—	0.13 ± 0.08 (8)	0.04 ± 0.04 (1)	—	—	—	—
Carex membranacea	—	0.40 ± 0.40 (1)	—	—	—	—	—
Carex sp.	—	0.09 ± 0.07 (6)	0.14 ± 0.14 (8)	—	tr (1)	—	—

Appendix C. continued

Species	Dryas sp. V. uliginosum $\bar{x} \pm SE$ (f)	Dryas sp. S. reticulata $\bar{x} \pm SE$ (f)	C. tetragona V. uliginosum $\bar{x} \pm SE$ (f)	V. uliginosum V. vitis idaea $\bar{x} \pm SE$ (f)	E. vaginatum B. glandulosa C. bigelowii $\bar{x} \pm SE$ (f)	E. angustifolium C. aquatilis S. pulchra $\bar{x} \pm SE$ (f)	A. arctica E. latifolium S. alaxensis $\bar{x} \pm SE$ (f)
Juncus triglumis	—	—	—	—	0.04 ± 0.04 (3)	—	—
Juncus biglumis	—	0.07 ± 0.07 (5)	—	—	—	—	—
Luzula arctica	—	0.02 ± 0.02 (1)	—	—	—	—	—
Luzula confusa	—	—	tr (1)	—	—	—	—
Luzula multiflora	—	—	0.14 ± 0.14 (3)	—	—	—	—
Luzula sp.	—	0.05 ± 0.03 (3)	—	—	0.03 ± 0.03 (1)	—	—
Unknown graminae	—	0.05 ± 0.03 (3)	0.05 ± 0.05 (10)	0.23 ± 0.13 (8)	—	—	0.53 ± 0.39 (7)
Total graminoids	0.67	6.57	7.05	11.30	46.49	51.36	1.01
Salix phlebophylla	0.37 ± 0.12 (8)	0.61 ± 0.51 (14)	0.16 ± 0.16 (8)	0.45 ± 0.29 (9)	—	—	—
Salix arctica	—	2.36 ± 1.68 (22)	—	—	tr (1)	—	—
Salix glauca	—	0.37 ± 0.35 (3)	—	0.33 ± 0.33 (3)	0.26 ± 0.26 (3)	1.53 ± 1.27 (8)	0.40 ± 0.40 (3)
Salix chamissonis	—	—	4.28 ± 4.28 (23)	0.10 ± 0.10 (1)	0.03 ± 0.03 (1)	0.40 ± 0.25 (3)	—
Salix lanata	—	0.02 ± 0.02 (1)	—	—	—	—	—
Salix alaxensis	—	—	—	—	—	—	1.79 ±0.70 (11)
Salix pulchra	—	0.11 ± 0.07 (3)	1.28 ± 1.28 (5)	4.43 ± 2.92 (29)	8.72 ± 1.04 (61)	14.06 ± 4.72 (72)	—
Betula glandulosa	0.48 ± 0.48 (1)	—	3.59 ± 2.14 (19)	8.25 ± 1.84 (50)	8.71 ± 2.09 (74)	6.26 ± 2.89 (53)	—
Vaccinium uliginosum	4.79 ± 2.15 (14)	4.88 ± 2.92 (33)	9.61 ± 2.67 (71)	18.05 ± 3.85 (80)	3.21 ± 0.24 (44)	1.81 ± 0.55 (24)	0.09 ± 0.09 (1)
Arctostaphylos alpina	0.99 ± 0.27 (8)	—	0.21 ± 0.20 (5)	6.42 ± 2.09 (40)	0.03 ± 0.03 (1)	—	—
Arctostaphylos rubra	—	3.68 ± 1.11 (32)	0.23 ± 0.23 (1)	—	0.29 ± 0.21 (5)	—	0.01 ± 0.01 (1)
Total deciduous shrubs	6.63	12.03	19.36	38.03	21.25	24.06	2.29
Salix reticulata	—	6.09 ± 1.57 (68)	3.09 ± 0.93 (59)	0.31 ± 0.18 (6)	2.66 ± 0.92 (37)	2.78 ± 2.35 (24)	0.09 ± 0.09 (1)
Empetrum nigrum	0.13 ± 0.11 (1)	—	1.25 ± 0.64 (9)	10.23 ± 3.41 (51)	1.75 ± 1.57 (19)	—	—
Ledum palustre	0.05 ± 0.05 (2)	—	0.27 ± 0.09 (15)	5.85 ± 1.93 (59)	3.56 ± 1.51 (61)	0.03 ± 0.03 (2)	—
Rhododendron lapponicum	—	1.83 ± 0.72 (31)	0.08 ± 0.08 (5)	0.04 ± 0.04 (1)	0.07 ± 0.04 (3)	—	—
Cassiope tetragona	0.41 ± 0.41 (2)	1.58 ± 0.51 (22)	13.73 ± 3.36 (84)	2.99 ± 1.63 (24)	2.56 ± 1.51 (28)	0.04 ± 0.04 (2)	—
Andromeda polifolia	—	—	0.04 ± 0.04 (1)	0.41 ± 0.32 (8)	0.11 ± 0.11 (10)	0.63 ± 0.39 (11)	—
Vaccinium vitis-idaea	0.23 ± 0.12 (6)	—	1.38 ± 0.41 (23)	10.47 ± 2.23 (69)	2.80 ± 1.99 (43)	0.09 ± 0.08 (2)	—
Dryas integrifolia	10.20 ± 4.34 (43)	38.51 ± 7.22 (96)	6.17 ± 2.49 (65)	0.24 ± 0.10 (4)	2.07 ± 1.03 (26)	0.63 ± 0.27 (14)	0.34 ± 0.34 (2)
Diapensia lapponica	—	—	—	0.48 ± 0.48 (1)	—	—	—
Total evergreen shrubs	11.02	48.01	26.01	31.02	11.95	4.17	0.43
Total shrubs	17.65	60.04	45.37	69.05	36.83	28.26	2.72
Tofieldia coccinea	—	0.27 ± 0.21 (12)	0.04 ± 0.04 (1)	—	—	—	—
Tofieldia pusilla	—	0.31 ± 0.27 (26)	0.13 ± 0.13 (14)	—	tr (1)	0.03 ± 0.03 (2)	—
Tofieldia sp.	—	0.24 ± 0.24 (10)	0.26 ± 0.26 (14)	—	—	—	—
Polygonum bistorta	tr (1)	0.06 ± 0.10 (10)	0.80 ± 0.56 (25)	1.49 ± 0.69 (35)	0.80 ± 0.25 (32)	0.06 ± 0.05 (7)	tr (1)
Polygonum viviparum	tr (1)	0.15 ± 0.06 (24)	—	0.04 ± 0.04 (1)	tr (2)	0.03 ± 0.03 (4)	—
Stellaria edwardsii	—	—	0.12 ± 0.12 (5)	0.06 ± 0.04 (11)	0.05 ± 0.03 (6)	0.01 ± 0.01 (3)	0.02 ± 0.02 (2)
Sagina intermedia	tr (1)	0.10 ± 0.04 (7)	—	—	—	—	0.03 ± 0.03 (1)
Minuartia sp.	0.30 ± 0.16 (8)	0.15 ± 0.07 (12)	0.11 ± 0.11 (3)	tr (1)	—	—	0.01 ± 0.01 (1)
Silene acaulis	0.02 ± 0.02 (3)	0.32 ± 0.06 (11)	0.14 ± 0.14 (4)	—	—	—	0.05 ± 0.05 (1)
Melandrium apetalum	—	0.03 ± 0.02 (3)	—	—	—	—	—
Dianthus repens	0.14 ± 0.14 (2)	—	—	—	—	—	—
Anemone parviflora	0.11 ± 0.11 (1)	0.08 ± 0.04 (6)	0.05 ± 0.05 (1)	—	—	—	tr (1)
Anemone Drummondii	0.20 ± 0.08 (7)	tr (1)	—	—	—	—	—
Thalictrum alpinum	—	0.13 ± 0.06 (19)	—	—	—	—	—
Papaver Macounii	—	0.06 ± 0.06 (3)	0.12 ± 0.12 (6)	0.10 ± 0.10 (1)	—	—	—
Eutrema Edwardsii	—	0.05 ± 0.03 (3)	—	—	—	—	—
Cardamine bellidifolia	—	—	tr (1)	—	—	—	—
Cardamine hyperborea	—	0.03 ± 0.03 (2)	0.01 ± 0.01 (3)	0.01 ± 0.01 (3)	—	—	—
Draba macrocarpa	—	0.02 ± 0.02 (1)	—	—	—	—	—
Draba longipes	—	—	0.04 ± 0.04 (1)	—	—	—	—

Appendix C. concluded

Species	Dryas sp. V. uliginosum $\bar{x} \pm SE$ (f)	Dryas sp. S. reticulata $\bar{x} \pm SE$ (f)	C. tetragona V. uliginosum $\bar{x} \pm SE$ (f)	V. uliginosum V. vitis idaea $\bar{x} \pm SE$ (f)	E. vaginatum B. glandulosa C. bigelowii $\bar{x} \pm SE$ (f)	E. angustifolium C. aquatilis S. pulchra $\bar{x} \pm SE$ (f)	A. arctica E. latifolium S. alaxensis $\bar{x} \pm SE$ (f)
Smelowskia calycina	0.09 ± 0.02 (8)	—	—	—	—	—	—
Erysimum inconspicuum	—	tr (1)	—	—	—	—	—
Parrya nudicaulis	—	0.21 ± 0.09 (9)	0.29 ± 0.24 (9)	0.43 ± 0.42 (3)	0.04 ± 0.04 (3)	—	—
Boykinia Richardsonii	—	0.18 ± 0.18 (4)	1.03 ± 0.97 (8)	—	0.34 ± 0.34 (4)	—	—
Saxifraga oppositifolia	—	0.09 ± 0.07 (6)	—	—	—	—	—
Saxifraga Eschscholtzii	0.07 ± 0.05 (3)	—	—	—	—	—	—
Saxifraga bronchialis	0.51 ± 0.18 (16)	tr (1)	0.45 ± 0.34 (10)	0.15 ± 0.13 (5)	—	—	—
Saxifraga tricuspidata	0.25 ± 0.16 (6)	—	—	tr (1)	—	—	—
Saxifraga punctata	—	0.02 ± 0.02 (1)	0.20 ± 0.11 (14)	0.23 ± 0.18 (9)	0.29 ± 0.18 (11)	—	—
Saxifraga cernua	—	—	0.04 ± 0.04 (1)	—	—	—	—
Saxifraga davurica	—	—	0.08 ± 0.08 (3)	—	—	—	—
Saxifraga reflexa	0.03 ± 0.02 (4)	—	0.01 ± 0.01 (1)	tr (1)	—	—	—
Rubus chamaemorus	—	—	—	0.66 ± 0.66 (13)	0.58 ± 0.32 (11)	0.54 ± 0.27 (18)	—
Potentilla biflora	—	0.34 ± 0.27	—	—	—	—	—
Potentilla vahliana	0.16 ± 0.12 (7)	0.03 ± 0.03 (2)	—	—	—	—	—
Geum glaciale	—	—	0.93 ± 0.88 (4)	—	—	—	—
Lupinus arcticus	0.59 ± 0.34 (9)	1.81 ± 0.58 (22)	3.46 ± 1.55 (29)	1.53 ± 0.88 (11)	0.26 ± 0.26 (2)	—	—
Astragalus umbellatus	—	0.30 ± 0.17 (17)	—	—	—	—	—
Astragalus alpinus	—	—	—	—	—	—	0.10 ± 0.03 (5)
Oxytropis Maydelliana	—	0.33 ± 0.15 (14)	0.08 ± 0.08 (5)	—	—	—	0.01 ± 0.01 (1)
Oxytropis arctica	—	0.26 ± 0.21 (7)	—	—	—	—	0.24 ± 0.19 (3)
Oxytropis nigrescens	0.14 ± 0.14 (1)	0.80 ± 0.33 (26)	0.05 ± 0.05 (4)	—	—	—	0.01 ± 0.01 (1)
Oxytropis borealis	—	0.05 ± 0.05 (1)	—	—	—	—	0.06 ± 0.06 (2)
Hedysarum Mackenzii	—	0.22 ± 0.15 (8)	—	—	—	—	0.06 ± 0.06 (2)
Hedysarum alpinum	—	0.02 ± 0.02 (1)	—	—	—	—	0.04 ± 0.04 (1)
Epilobium latifolium	—	—	—	—	—	—	1.27 ± 0.59 (22)
Bupleurum triradiatum	tr (2)	—	—	0.04 ± 0.04 (1)	—	—	—
Pyrola grandiflora	—	tr (1)	0.62 ± 0.50 (14)	0.20 ± 0.10 (9)	1.43 ± 0.49 (43)	1.09 ± 0.46 (34)	—
Pyrola secunda	—	—	—	—	0.14 ± 0.05 (25)	0.04 ± 0.04 (3)	—
Douglasia ochotensis	0.16 ± 0.11 (8)	—	—	—	—	—	—
Androsace chamaejasme	0.10 ± 0.10 (8)	0.03 ± 0.02 (3)	—	—	—	—	—
Dodecatheon frigidum	—	—	0.05 ± 0.05 (1)	—	—	—	—
Phlox sibirica	0.03 ± 0.02 (3)	0.04 ± 0.04 (1)	—	—	—	—	—
Eritrichium aretioides	tr (1)	—	—	—	—	—	—
Lagotis glauca	—	—	0.04 ± 0.04 (1)	—	tr (1)	—	—
Pedicularis lapponica	—	—	—	—	0.12 ± 0.12 (4)	—	—
Pedicularis labradorica	—	—	—	0.04 ± 0.04 (1)	0.03 ± 0.03 (1)	—	—
Pedicularis Langsdorffii	—	0.04 ± 0.03 (4)	—	—	—	—	—
Pedicularis sudetica	—	0.13 ± 0.09 (6)	—	0.04 ± 0.04 (1)	—	2.60 ± 0.18 (7)	—
Pedicularis capitata	0.15 ± 0.12 (13)	0.30 ± 0.09 (24)	0.19 ± 0.11 (6)	0.18 ± 0.18 (5)	0.05 ± 0.04 (5)	0.04 ± 0.03 (2)	—
Pedicularis Oederi	—	0.18 ± 0.18 (7)	—	—	—	—	—
Pedicularis Kanei	0.03 ± 0.03 (3)	0.20 ± 0.07 (13)	0.10 ± 0.10 (9)	0.04 ± 0.04 (1)	—	—	—
Aster sibiricus	—	—	—	—	—	—	0.02 ± 0.02 (1)
Erigeron eriocephalus	—	—	—	—	—	—	0.12 ± 0.12 (3)
Antennaria sp.	0.22 ± 0.20 (10)	0.07 ± 0.04 (8)	—	—	—	—	—
Artemisia arctica	—	—	0.80 ± 0.80 (9)	—	—	—	3.65 ± 0.61 (30)
Artemisia furcata	0.05 ± 0.05 (1)	—	—	—	—	—	—
Petasites frigidus	—	—	0.34 ± 0.22 (13)	1.59 ± 1.30 (24)	0.58 ± 0.36 (8)	0.29 ± 0.18 (13)	—
Arnica alpina	0.01 ± 0.01 (2)	—	—	—	—	—	—
Senecio atropurpureus	—	0.06 ± 0.05 (22)	0.01 ± 0.01 (1)	—	tr (1)	—	—
Senecio resedifolius	0.04 ± 0.04 (1)	0.12 ± 0.06 (18)	—	—	0.04 ± 0.04 (2)	—	0.01 ± 0.01 (1)
Saussurea angustifolia	—	0.13 ± 0.07 (5)	0.37 ± 0.22 (11)	0.54 ± 0.40 (8)	0.07 ± 0.04 (2)	—	—
Crepis nana	—	—	—	—	—	—	0.16 ± 0.06 (10)
Total forbs	3.40	7.96	10.97	7.37	4.82	4.73	5.86
Total vascular cover	21.72	78.94	63.40	90.78	88.79	84.40	10.07
Total vegetative cover	31.53	119.11	133.92	139.08	129.60	131.70	12.01

Appendix D. Vegetational composition (% cover and frequency) of shrub associations found on the summer range of the Porcupine Caribou Herd.

Species	Betula/Salix dense shrub	Salix/Betula dense shrub	Alnus thicket	Arctostaphylos Vaccinium heath	Ledum/Eriop. tussock heath	Dryas heath barren	Betula heath barren
moss (unid)	35.6 (92)	42.0 (100)	10.0 (100)	16.8 (100)	12.5 (100)	15.9 (77)	7.9 (90)
Pleurozium sp.	6.2 (21)	35.0 (80)	-	1.9 (25)	10.0 (50)	1.7 (22)	1.1 (27)
Sphagnum sp.	18.6 (50)	-	-	10.6 (25)	-	-	1.4 (27)
Total Mosses	43.4	70.0	10.0	19.9	17.5	12.6	7.8
Alectoria nigrescens	-	-	-	-	-	3.5 (27)	2.1 (72)
Cetraria cucullata	-	-	-	4.3 (75)	1.5 (100)	2.6 (88)	3.0 (100)
Cetraria nivalis	-	-	-	1.7 (50)	1.0 (50)	1.4 (44)	1.0 (54)
Cetraria Richardsoni	-	-	-	-	-	-	1.0 (54)
Cladina rangiferina	1.6 (21)	-	-	-	-	-	-
Cladonia sp.	-	-	-	-	1.5 (50)	-	-
Peltigera apthosa	-	-	-	-	1.0 (100)	-	-
Stereocaulon alpina	1.0 (21)	-	-	3.0 (75)	2.0 (100)	2.0 (55)	5.1 (90)
Thamnolia subuliformis	-	-	-	1.2 (62)	-	1.1 (77)	-
Total lichens	0.5	-	-	7.1	5.8	5.8	10.2
Equisetum arvense	-	2.0 (60)	-	3.8 (12)	-	1.0 (16)	-
Equisetum sp.	-	-	-	-	-	2.9 (22)	-
Total horsetails	-	2.0	-	0.5	-	0.8	-
Carex Bigeloweii	3.1 (50)	1.0 (20)	-	5.1 (50)	6.0 (100)	2.3 (38)	1.0 (27)
Carex (unid)	3.2 (21)	2.0 (20)	-	2.1 (50)	-	9.1 (44)	-
Eriophorum angustifolium	1.1 (28)	-	-	-	-	-	-
Eriophorum vaginatum	1.1 (35)	6.0 (40)	-	4.0 (37)	17.5 (100)	-	-
Graminae (unid)	1.3 (50)	7.6 (80)	5.0 (100)	1.7 (62)	-	2.0 (61)	1.8 (63)
Total graminoids	3.6	9.1	5.0	6.1	23.5	6.1	1.4
Alnus crispa	-	-	70.0 (100)	-	-	-	-
Arctostaphylos rubra	1.0 (28)	-	5.0 (100)	8.1 (87)	-	4.7 (61)	7.7 (72)
Betula glandulosa	43.5 (100)	14.0 (100)	10.0 (100)	6.6 (62)	15.0 (100)	1.0 (22)	14.4 (100)
Cassiope tetragona	1.2 (35)	-	-	3.1 (50)	-	3.2 (44)	2.6 (54)
Dryas integrifolia	-	-	-	3.3 (37)	-	35.2 (100)	2.8 (54)
Empetrum nigrum	6.0 (64)	2.0 (20)	-	1.6 (37)	5.0 (100)	-	3.2 (63)
Ledum palustre	10.9 (85)	-	2.0 (100)	2.1 (37)	20.0 (100)	-	7.5 (90)
Linnaea borealis	-	-	5.0 (100)	-	-	-	-
Picea glauca	-	5.0 (20)	-	3.1 (12)	-	-	-
Rhododendron lapponica	-	-	-	1.5 (25)	-	-	-
Ribes sp.	-	-	2.0 (100)	-	-	-	-
Salix arctica	-	-	-	1.0 (25)	-	2.0 (50)	-
Salix glauca	1.4 (21)	2.0 (20)	-	3.1 (50)	-	-	-
Salix phlebophylla	1.0 (28)	-	-	-	1.0 (50)	4.7 (33)	5.1 (90)
Salix pulchra	15.1 (92)	56.0 (100)	-	-	7.5 (50)	-	3.1 (27)
Salix reticulata	-	-	-	1.3 (12)	-	2.5 (55)	-
Spirea Beauverdiana	-	5.0 (60)	2.0 (100)	-	-	-	-
Vaccinium uliginosum	7.1 (78)	5.0 (40)	25.0 (100)	10.3 (75)	3.0 (100)	-	6.0 (100)
Vaccinium vitis-idaea	17.1 (78)	4.4 (60)	2.0 (100)	6.5 (37)	10.5 (100)	-	4.1 (81)
Total trees and shrubs	90.6	79.4	123.0	28.1	57.8	43.6	46.4
Hedysarum Mackenzieii	-	-	-	1.3 (12)	-	1.0 (33)	-
Lupinus arctica	-	-	-	2.1 (62)	-	2.3 (55)	2.0 (36)
Oxytropis nigrescens	-	-	-	-	-	1.9 (61)	-
Pedicularis lapponica	-	-	-	1.1 (25)	-	-	-
Petasites frigidus	2.9 (71)	-	-	-	-	-	-
Petasites hyperboreus	-	6.6 (60)	-	-	-	-	-
Polygonum bistorta	-	-	-	-	3.0 (100)	-	-
Pyrola asarifolia	-	-	2.0 (100)	-	-	-	-
Rubus chaemamorus	4.8 (42)	3.6 (80)	-	-	3.5 (50)	-	-
Saxifraga punctinata	-	-	2.0 (100)	-	-	-	-
Valariana capitata	-	1.0 (20)	-	-	-	-	-
Total forbs	4.1	7.0	4.0	1.7	4.8	2.8	0.7

Appendix D. Vegetational composition (% cover and frequency) of graminoid associations found on the summer range of the Porcupine Caribou Herd.

Species	Eriophorum Carex/Dryas tussock heath	Erioph./ Betula tussock hth.	Carex/Vacc. heath	Carex/Salix shrub tundra	Erioph./ shrub tuss. tund.	Erio./ Vaccinium tuss. tund.	dense Erio. tussock tundra
moss (unid)	40.0 (100)	17.6 (100)	28.6 (100)	8.2 (50)	18.7 (85)	10.5 (70)	21.0 (100)
Pleurozium sp.	7.0 (66)	8.7 (70)	15.4 (54)	11.7 (50)	7.2 (50)	4.0 (51)	-
Sphagnum sp.	-	32.0 (90)	5.9 (27)	36.2 (87)	18.5 (71)	22.9 (83)	22.9 (50)
Total Mosses	44.6	52.5	38.3	41.4	32.6	28.4	32.5
Cetraria cuculata	1.0 (100)	-	1.6 (100)	-	-	-	1.0 (100)
Cladonia sp.	-	-	-	-	-	-	1.0 (100)
Nephroma arctica	-	-	1.0 (18)	-	-	-	-
Peltigera apthosa	1.0 (67)	-	-	-	-	-	-
Stereocaulon alpina	-	-	-	-	-	-	1.0 (100)
Total lichens	1.7	-	1.8	-	-	-	3.0
Equisetum sp.	1.3 (67)	-	-	-	-	-	
Total horsetails	0.9	-	-	-	-	-	
Carex Bigeloweii	21.6 (100)	14.1 (100)	30.7 (100)	41.2 (100)	1.6 (35)	5.7 (77)	-
Carex (unid)	-	-	1.3 (18)	-	2.8 (7)	-	-
Eriophorum angustifolium	-	-	-	1.8 (50)	-	-	-
Eriophorum vaginatum	53.3 (100)	26.0 (100)	4.5 (72)	5.5 (100)	42.5 (100)	62.2 (100)	75.0 (100)
Graminae (unid)	4.6 (100)	-	2.3 (54)	-	-	-	-
Total graminoids	78.5	40.1	35.4	47.5	43.3	66.6	75.0
Alnus crispa	-	-	-	-	1.0 (7)	-	-
Arctostaphylos rubra	3.3 (33)	2.9 (50)	5.7 (90)	-	-	-	-
Betula glandulosa	5.0 (66)	16.8 (100)	10.4 (100)	18.0 (100)	19.6 (100)	8.4 (96)	1.5 (100)
Cassiope tetragona	3.6 (100)	1.5 (40)	1.9 (36)	-	1.5 (35)	-	-
Dryas integrifolia	18.3 (100)	1.3 (30)	3.7 (72)	-	-	-	-
Empetrum nigrum	1.7 (33)	4.1 (80)	4.6 (72)	-	3.6 (78)	1.8 (54)	-
Ledum palustre	2.3 (66)	8.4 (90)	5.3 (81)	1.3 (75)	12.0 (92)	10.8 (93)	2.0 (100)
Picea glauca	3.3 (33)	-	1.0 (18)	-	-	-	-
Rhododendron lapponica	2.0 (67)	-	-	-	-	-	-
Salix arctica	2.3 (67)	-	-	-	-	-	-
Salix glauca	3.3 (66)	1.0 (20)	7.5 (81)	-	2.3 (21)	-	-
Salix phlebophylla	-	-	1.6 (36)	-	-	-	-
Salix pulchra	2.0 (67)	16.5 (100)	5.1 (90)	26.8 (100)	8.1 (100)	4.0 (80)	-
Salix reticulata	3.3 (66)	1.1 (50)	1.0 (54)	-	-	-	-
Vaccinium uliginosum	8.0 (100)	10.9 (100)	14.8 (100)	2.3 (38)	5.1 (85)	2.7 (64)	2.5 (100)
Vaccinium vitis-idaea	2.3 (67)	5.6 (90)	4.0 (81)	1.7 (75)	8.0 (100)	6.9 (100)	1.0 (50)
Total trees and shrubs	47.6	63.3	56.5	47.9	55.0	30.9	7.5
Petasites frigidus	-	2.0 (90)	1.0 (54)	2.8 (62)	1.0 (57)	-	-
Polygonum bistorta	1.0 (67)	-	1.0 (63)	-	-	-	-
Rubus chaemamorus	-	1.3 (40)	-	2.0 (87)	1.9 (42)	2.6 (80)	-
Saussurea angustifolium	-	-	1.6 (72)	-	-	-	-
Senecio sp.	-	-	-	1.3 (13)	-	-	-
Total forbs	0.7	2.3	2.3	3.6	1.4	2.1	-

Appendix D. Vegetational composition (% cover and frequency) of vegetaion associations found on the summer range of the Porcupine Caribou Herd.

	GRAMINOID				FORB	LICHEN
Species	sparse Erioph. tuss.tund.	Carex/ Dryas sdge mead.	hydric Carex/Salix meadow	Erioph. angust. sedge mead.	Lupinus meadow	Lichen barrens
moss (unid)	8.7 (71)	32.6 (90)	35.0 (88)	1.0 (50)	20.0 (100)	4.2 (60)
Pleurozium sp.	3.8 (42)	5.2 (30)	3.3 (22)	-	-	3.0 (10)
Sphagnum sp.	37.8 (71)	11.5 (25)	13.7 (44)	75.0 (100)	-	-
Total Mosses	34.6	33.8	37.6	75.5	20.0	2.8
Alectoria nigrescens	-	-	-	-	-	1.4 (40)
Cetraria cucullata	1.0 (100)	-	-	-	-	1.1 (90)
Rhizocarpa sp.	-	-	-	-	-	3.5 (20)
Total lichens	1.0	-	-	-	-	2.3
Equisetum sp.	-	5.4 (40)	-	-	10.0 (100)	-
Total horsetails	-	2.2	-	-	10.0	-
Carex Bigeloweii	4.7 (85)	47.9 (95)	-	24.0 (50)	1.0 (100)	3.4 (50)
Carex (unid)	-	1.2 (10)	62.2 (100)	-	-	2.6 (30)
Eriophorum angustifolium	-	1.5 (25)	5.1 (22)	68.5 (100)	2.0 (100)	-
Eriophorum vaginatum	40.7 (100)	6.1 (55)	2.8 (44)	-	-	-
Graminae (unid)	-	2.0 (50)	2.2 (11)	-	30.0 (100)	1.4 (40)
Total graminoids	44.7	50.4	64.8	80.5	33.0	3.0
Arctostaphylos rubra	2.8 (57)	1.6 (35)	1.3 (22)	-	-	1.0 (40)
Betula glandulosa	4.7 (100)	1.0 (30)	-	-	10.0 (100)	4.0 (50)
Cassiope tetragona	-	1.2 (30)	-	-	-	2.9 (50)
Dryas integrifolia	-	13.0 (85)	2.8 (55)	-	1.0 (100)	4.0 (60)
Empetrum nigrum	1.8 (57)	-	-	-	-	2.8 (50)
Ledum palustre	5.8 (100)	-	-	-	-	2.7 (60)
Salix arctica	-	7.7 (80)	5.5 (55)	2.5 (50)	-	-
Salix glauca	-	-	-	-	30.0 (100)	-
Salix phlebophylla	-	-	-	-	-	5.9 (60)
Salix pulchra	2.5 (71)	-	8.2 (66)	2.0 (100)	-	3.8 (40)
Salix reticulata	-	6.5 (70)	1.1 (22)	-	10.0 (100)	-
Vaccinium uliginosum	5.7 (100)	-	-	-	5.0 (100)	6.8 (70)
Vaccinium vitis-idaea	2.8 (100)	-	-	-	-	2.5 (50)
Total trees and shrubs	23.4	23.0	10.5	3.3	56.0	20.3
Arnica Lessiingii	-	-	1.1 (11)	-	-	-
Arnica alpina	-	-	-	-	1.0 (100)	-
Crucifera sp.	-	-	-	-	-	6.0 (20)
Hedysarum Mackenzieii	-	-	-	-	5.0 (100)	-
Lupinus arctica	-	-	-	-	30.0 (100)	-
Myosotis alpestris	-	-	-	-	1.0 (100)	-
Pedicularis capitata	-	-	-	-	1.0 (100)	-
Pedicularis sp.	-	-	-	-	1.0 (100)	-
Petasites frigidus	-	1.1 (35)	1.2 (22)	-	-	-
Polygonum bistorta	-	-	1.3 (44)	-	-	-
Potentilla biflora	-	-	-	-	1.0 (100)	-
Pyrola asarifolia	-	-	-	-	1.0 (100)	-
Rubus chaemamorus	2.8 (57)	-	-	-	-	-
Senecio sp.	-	-	-	-	1.0 (100)	-
Stellaria sp.	-	-	-	-	1.0 (100)	-
Valariana capitata	-	-	-	-	1.0 (100)	-
Total forbs	1.6	0.4	1.0	-	44.0	1.2