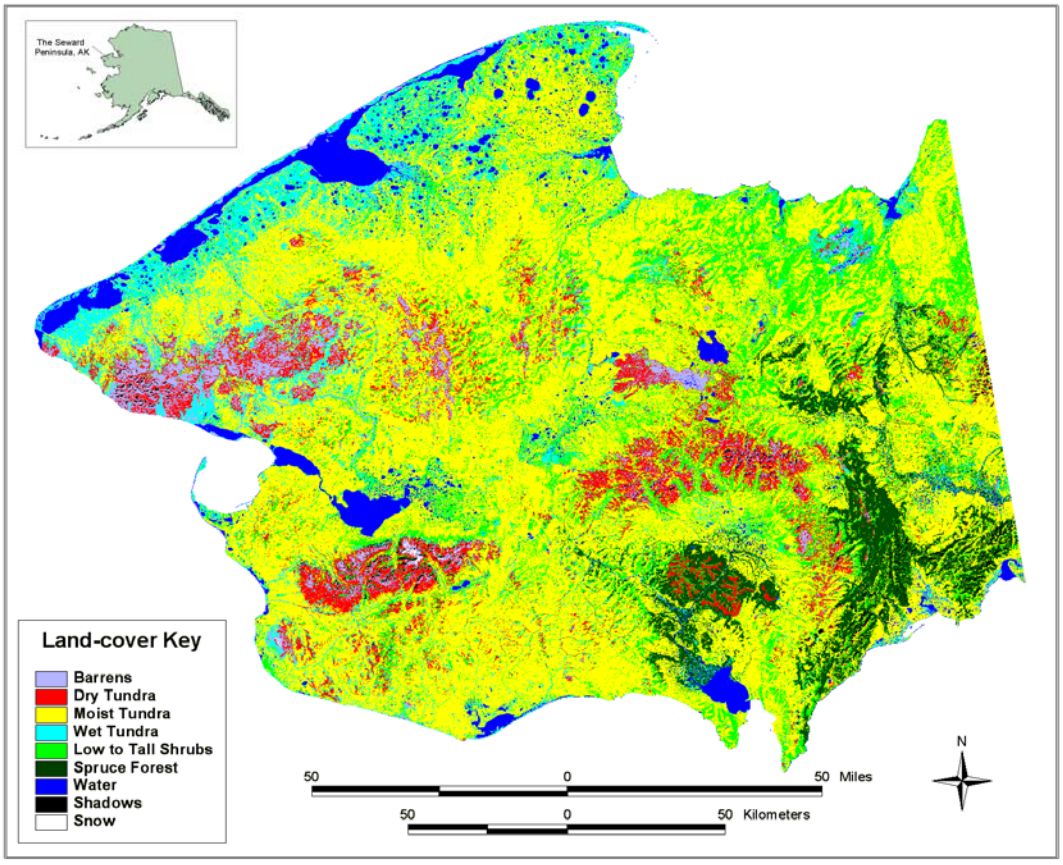
ATLAS Vegetation Studies: Seward Peninsula, Alaska, 2000



Vegetation, Soil, and Site Information, with Seward Vegetation Map

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ARCSS-ATLAS-AGC Data Report

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INTRODUCTION

This data report summarizes information that was collected as part of the NSF-sponsored Arctic Transitions in the Land-Atmosphere System (ATLAS) project called "Arctic Climate Change, Substrate, and Vegetation" (OPP-9908829). The goal of the project is to predict the consequences of climate change in the Arctic by examining present-day transitions. A wide variety of vegetation properties were measured across the climate gradient in northern Alaska and the Seward Peninsula, in areas of different geology and soils. This work is part of the larger ATLAS project, which is examining the transitions in the flux of energy, water, and trace gases along these same gradients. Other ATLAS investigators are collecting climate, soils, active layer, snow, hydrology, and flux information from many of the same sites described in this data report.

An initial reconnaissance of the Seward Peninsula was conducted in June 1998. Skip Walker took two airplane flights (Figure 1), and drove the roads to Council and Quartz Creek to help locate study plots.

This data report summarizes vegetation data that were collected in the vicinity of Council and Quartz Creek (Figures 2-5) during the period from June 26 to July 29, 2000. The data summarized here include the following:

Section I. Vegetation and site information from 100 x 100-m grids. A variety of data was collected from grid points of grids. Some of the grids were in homogeneous stands of vegetation that were considered representative of the regional climate or zonal vegetation**.** Other grids were in stands of vegetation that were regionally extensive or which were sites of flux measurements. Similar grids were established at 16 sites on the Arctic Slope. There are four grids in the Council vicinity (Figure 6 and 7) and three grids at Quartz Creek (Figures 3 and 8). The Council grids were sites where Terry Chapin's group measured fluxes of trace-gases and energy. The research grids in the Council vicinity are arranged along a conceptual toposequence (Figure 9). Only the starred grids (*) are part of this data report. The other sites are described by Catherine Copass (Copass et al., in prep.). The Quartz Creek grids are within a larger 1000 x 1000-m grid in the Mauze Creek drainage that was surveyed by Larry Hinzman. Flux measurements were made by Walt Oechel's group in nearby tundra sites at Quartz Creek. The grids were established in zonal vegetation and other vegetation types that locally cover large areas. The data from the grids include vegetation type (or species in forests) and microsite at each of the 121 grid points, and height of the vegetation, thickness of the moss layer, thickness of the soil organic horizons, phytomass and leaf-area index from a subset of grid points.

Section II. Plot data. Thirty-one vegetation plots were sampled from sites at Council, Quartz Creek, and along the roads between these locations. Some of these were in complexes of vegetation that contained up to three plant communities, so a total of 52 stands of vegetation (relevés) were sampled (Table 1). Relevés were located subjectively, to include representative plant community associations. In most cases the relevés were approximately 10x10 m, though the size was increased in

heterogeneous areas, and conformed to microsite variations. The relevé data include estimates of plant species cover, soil data, and site information. All the grids in section I contained at least one relevé .

Section III. Landsat MSS-derived map of the Seward Peninsula. A land-cover classification of the Seward Peninsular was prepared as part of a Research Experience for Undergraduates (REU) study conducted by Chris Thayer-Snyder. This map consists of 10 land-cover classes compatible with the MSS map of the North Slope created by Muller et al. (1999). The report includes ground truth data for sites identified on 1:60,000 CIR aerial photos, including 40 sites along the road along the Fox River to Council (Figure 6), 86 sites visited by helicopter around Council (Figure 6), 68 sites along the road between Nome and Quartz Creek (Figures 3, 4 and 5), and 79 sites visited by helicopter around Quartz Creek (Figures 3 and 4).

Section IV. Glacier Creek Forest Survey. This was an REU project by David Wirth. The objective was to compare the logged forest in the Council grid C1, with that of an old growth forest east of Council, in the Glacier Creek watershed (C9, Figure 6).

METHODS

All data in this report were collected 26 June to 29 July, 2000.

Vegetation Heterogeneity

At each grid, vegetation heterogeneity was sampled at 121 gridpoints, spaced every 10 meters (A1-K11).). In the Council forest grid (C1), and the shrub grid (C3) the point was described as either tree canopy, shrub canopy, or clearing; and the tree or shrub species at the point was noted. At the other grids, the vegetation type and the microsite type were noted at each point (Table 1).

Vegetation height

At each grid, the vegetation height was measured at 20 randomly chosen gridpoint. The depth of the live and dead nonvascular layer was measured, and the dominant species noted. The general height of the vascular vegetation was measured and the dominant species noted. The height of the microrelief was measured. These data are presented in Table 2.

Soil Description

At each grid, soil samples were collected. At the Council grids, random points were chosen along 6 rows. At the Quartz Creek grids, random points were chosen along each of the 11 rows (A-K). The organic horizons (Oi, Oe, and Oa) were measured and described (Table 3). Soils for analysis were collected in soil cans from the top of the B horizon. Samples were dried and weighed to calculate soil moisture (Table 4). Chemical and size composition were analyzed at the Palmer Experimental Laboratory (Table 5).

Leaf Area Index

Leaf area index (LAI) was measured at each of the grids using a LICOR LAI-2000 Plant Canopy Analyzer. An above-canopy reading (control) was followed by four below-canopy readings, taken above the moss layer along the axes of the grid at 1 m from the point. All measurements were taken facing away from the sun, and a sun screen was used to shade the sensor on sunny days. These measurements were repeated at 33 random points within each grid. A 90° field-of-view shield was used to prevent interference from the observers. LAI was calculated for each point, and mean LAI for each grid was calculated (Table 6).

Biomass

Biomass data for the Council grids can be obtained from Catharine Copass (Copass et al. *in prep*.). Clip harvests were collected for above ground biomass estimates at three Quartz Creek grids. At 10 random locations within in the grid, all above-ground biomass was clipped from a 20x50 cm area. In the shrub plot (QC3), the shrubs were sampled in a 1x1 m area, while the understory was sampled in 20x50 cm. The clip harvests were sorted by major plant functional type (moss, lichen, forb, horsetail, deciduous shrub, evergreen shrub, graminoid) in the field. All vascular plants were clipped at the top of the moss surface. Green stem bases below the moss surface were also included in the clip harvest. Mosses were clipped at the base of the green portion. The samples were frozen and returned to the UAF laboratory where they were further sorted into live and dead categories. Both shrub categories were divided into their foliar, reproductive, and stem components. Biomass samples were dried to constant weight at 50°C, and the dry weights were then used to estimate total g/m^2 for each grid and functional type with the grid (Table 7).

Relevé locations and plant communities

A total of 52 relevés were collected from the grids and other sites. Latitude, longitude, elevation, location descriptions and plant community descriptions of these relevés are found in Table 8.

Relevé environmental variables

A variety of environmental site data were collected from each relevé. Table 9 presents data on landforms, surficial geology, surficial geomorpholgy, microsites, site moisture, soil moisture, glacial geology, topographic position, soil unit, exposure to wind, estimated duration, animal and human disturbance, and stability. The data sheet for recording these variables, and their codes is included as Table 10.

Relevé cover data

Percent cover values for lifeforms were collected at all relevés (Table 11). Complete plant species composition data were obtained, using the Braun-Blanquet method (Table 12). Lichen and moss identifications were verified by scientists from the Komarov Botanical Institute. Mosses collected are listed in Table 13, and lichens in Table 14.

Relevé LAI

Leaf area index was measured at four Quartz Creek relevés. One above canopy and one below canopy measurement were taken at every 10 meters along a 100 m transect (Table 15).

Relevé soils data

Soils were described, and soil sample was collected at most relevés (Table 16). Samples were dried and weighed to calculate soil moisture (Table 17). Chemical and size composition were analyzed at the Palmer Experimental Laboratory (Table 18).

References

Copass, C.D., F.S Chapin III, A. D. McGuire, J. Beringer, D. A. Walker. *In prep*. Relationship of structural complexity to land surface exchange along a sequence of sites from arctic tundra to forest. University of Alaska Fairbanks, Ph.D. Thesis.

Muller, S.V., A.E. Racoviteanu and D. A. Walker. 1999. Landsat-MSS-derived land-cover map of northern Alaska: extrapolation methods and comparison with photo-interpreted and AVHRR derived maps. *International Journal of Remote Sensing*. 20:2921-2946.

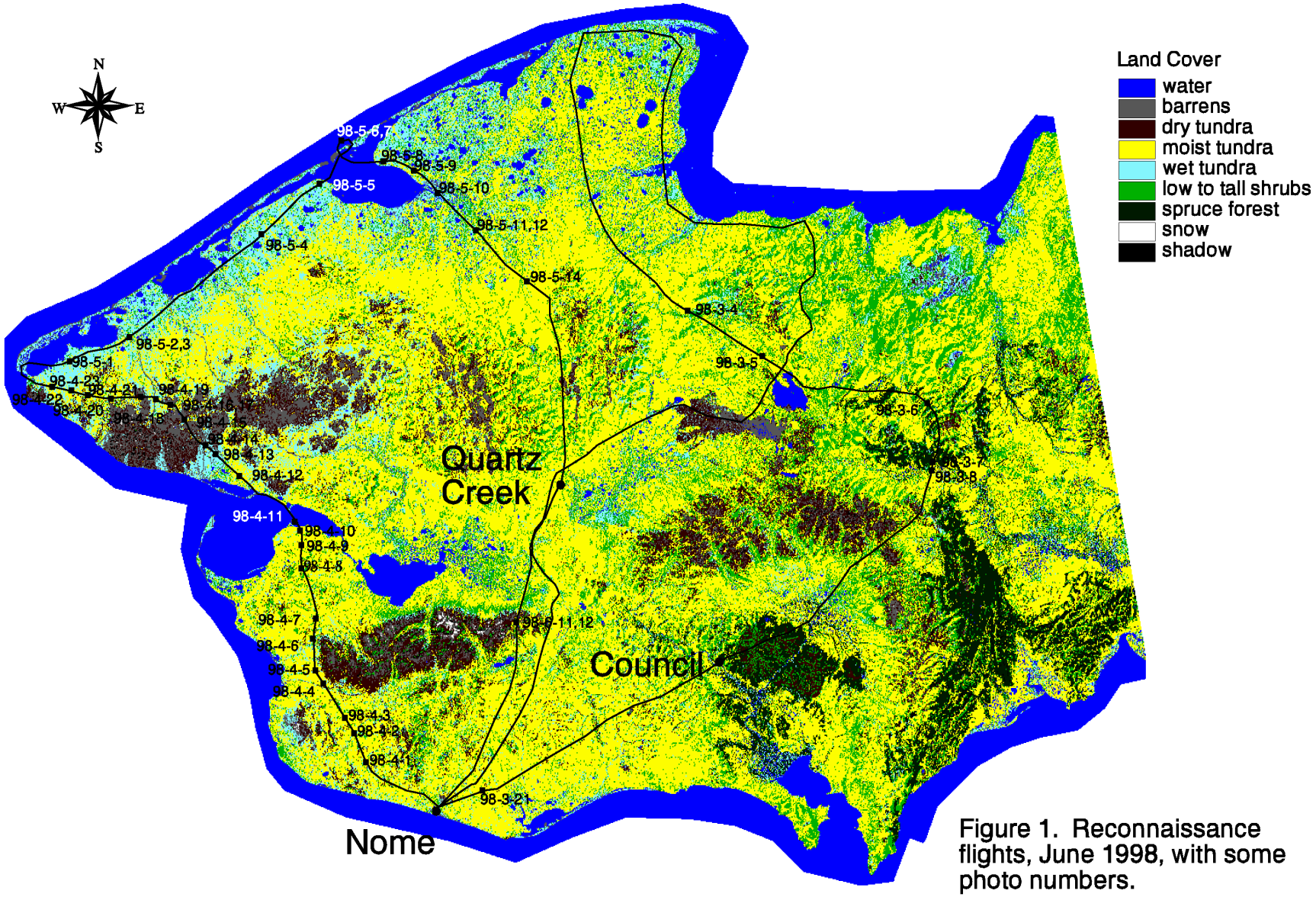

Figure 1. Reconnaissance flights, June 1998, with some photo numbers.

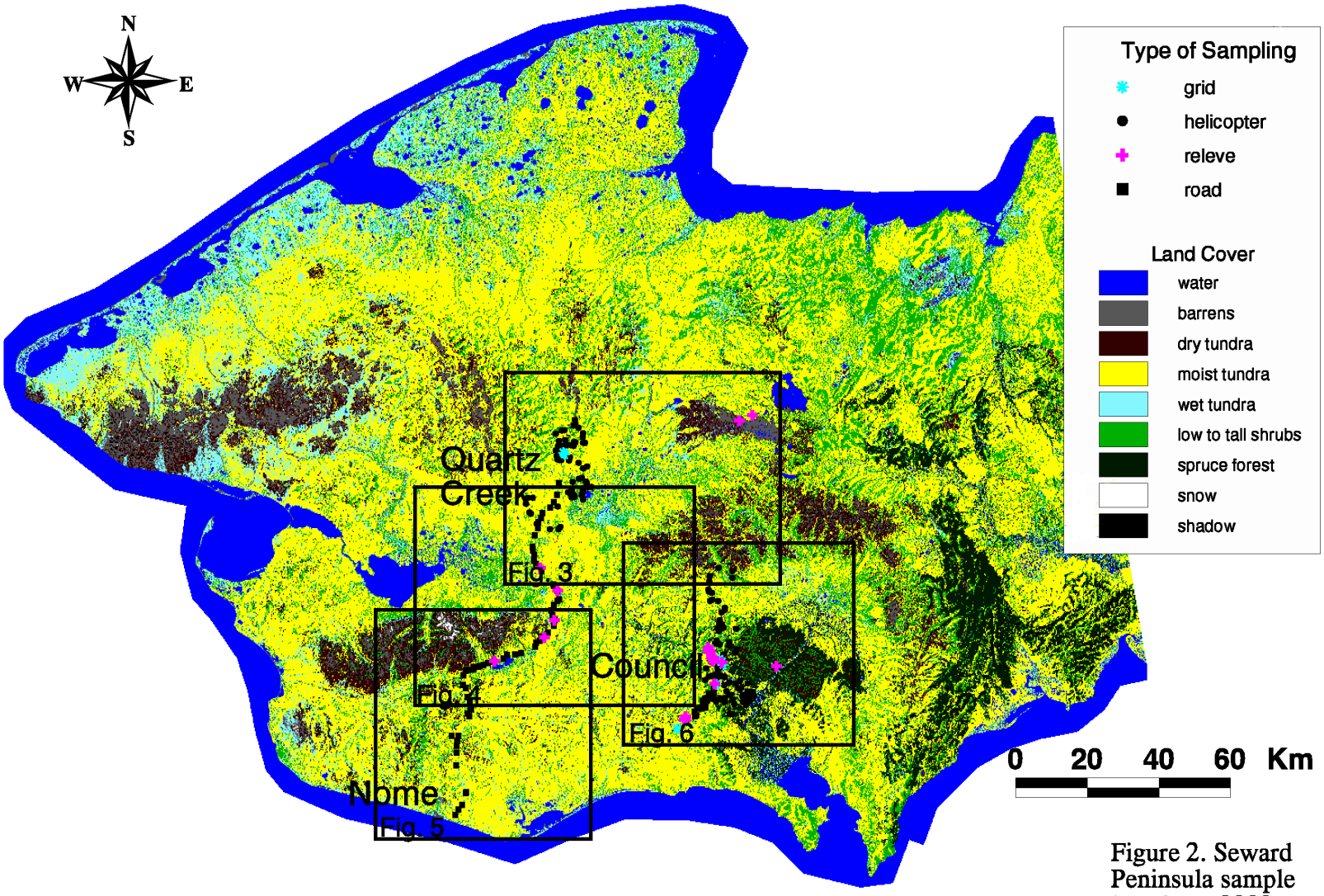

Figure 2. Seward Peninsula sample locations, 2000.

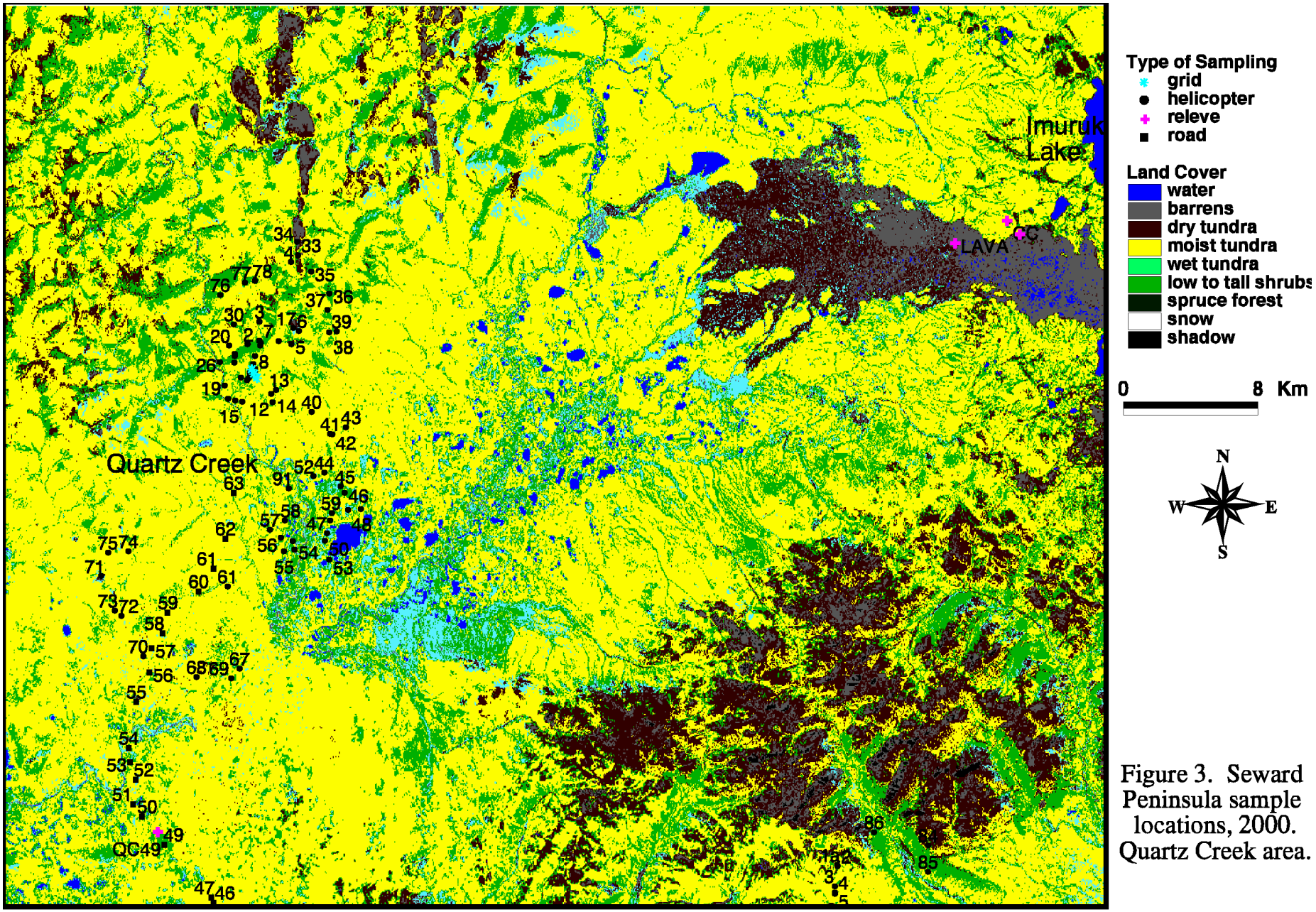

Figure 3. Seward Peninsula sample locations, 2000. Quartz Creek area.

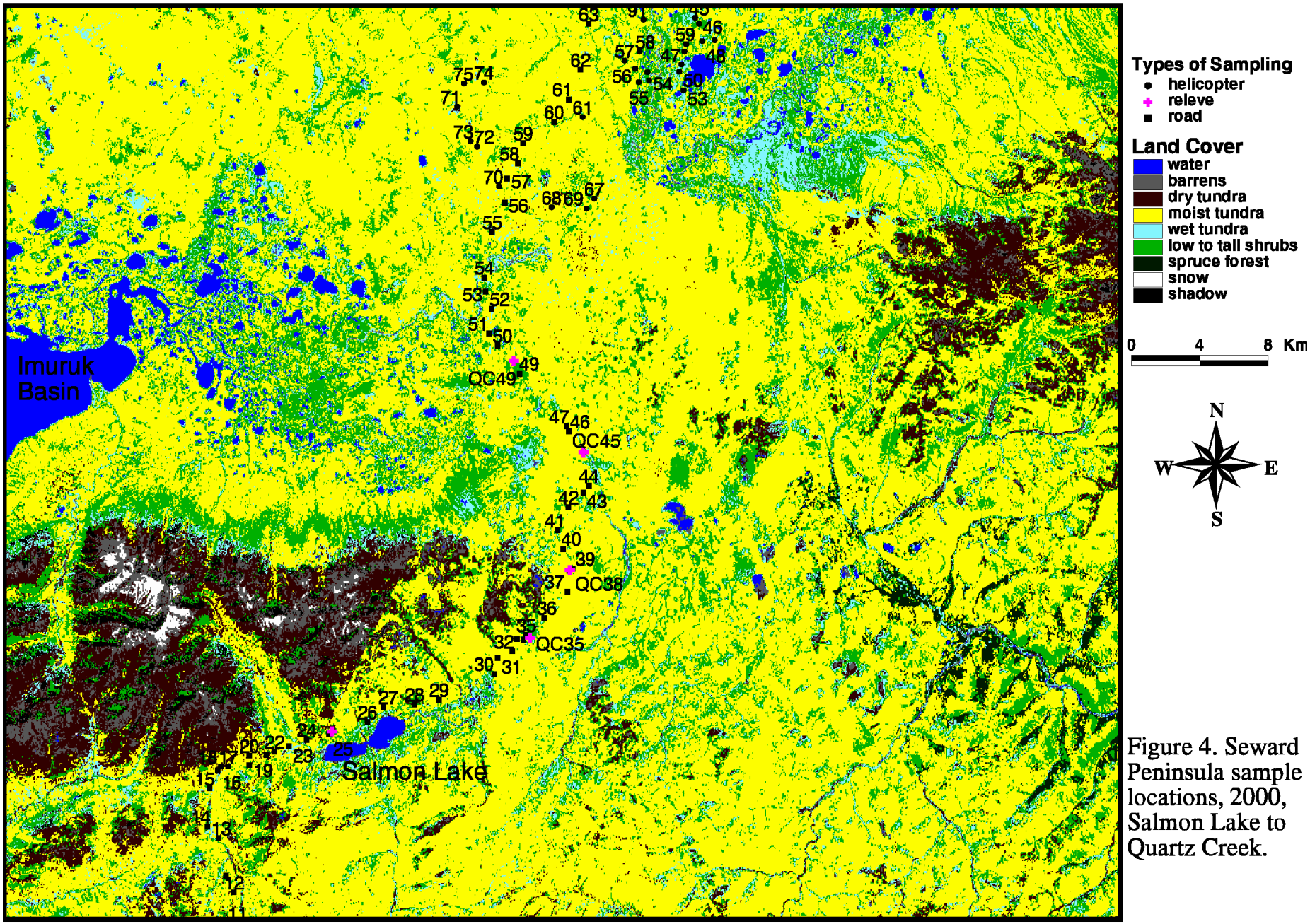

Figure 4. Seward Peninsula sample locations, 2000, Salmon Lake to Quartz Creek.

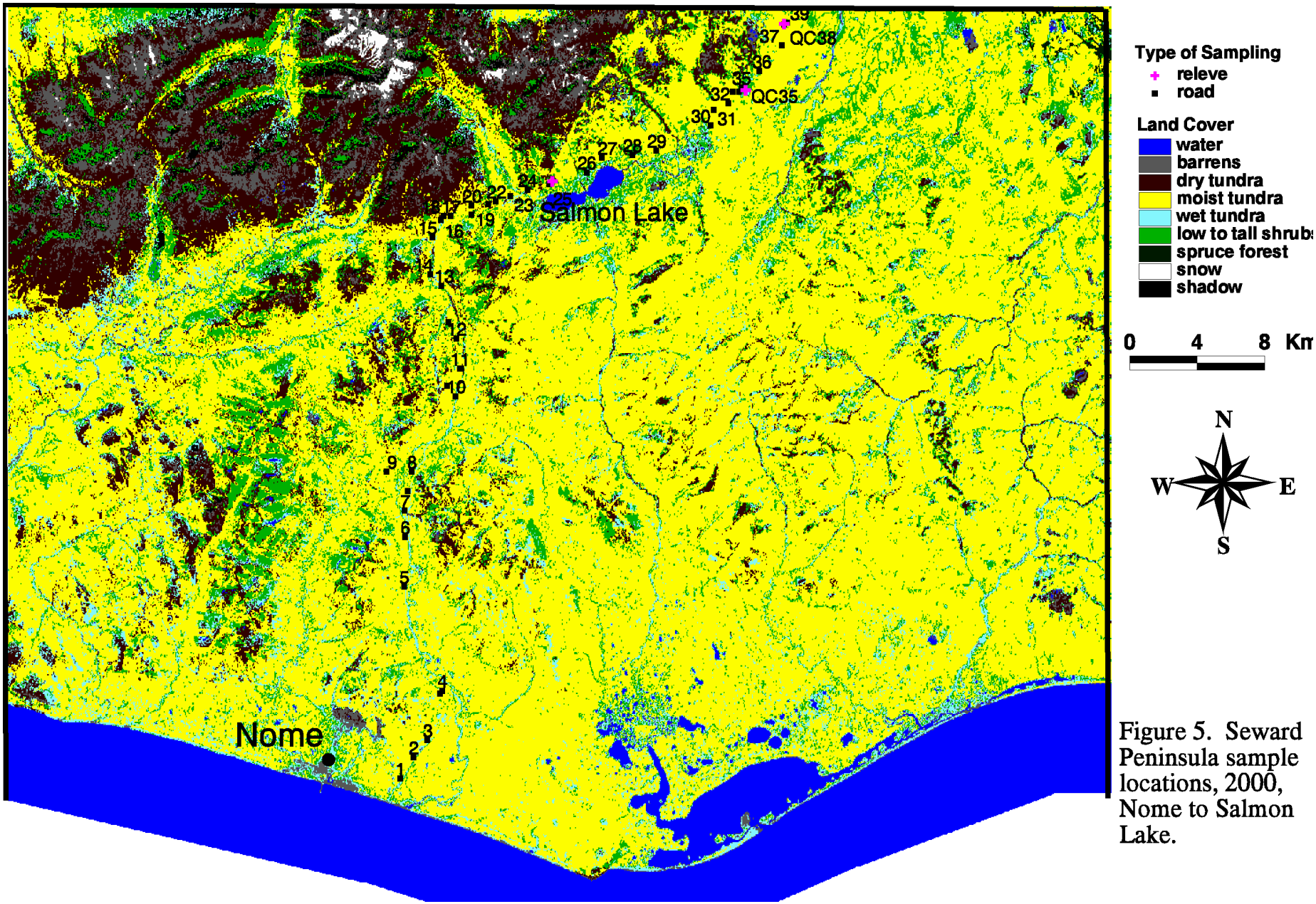

Figure 5. Seward Peninsula sample locations, 2000, Nome to Salmon Lake.

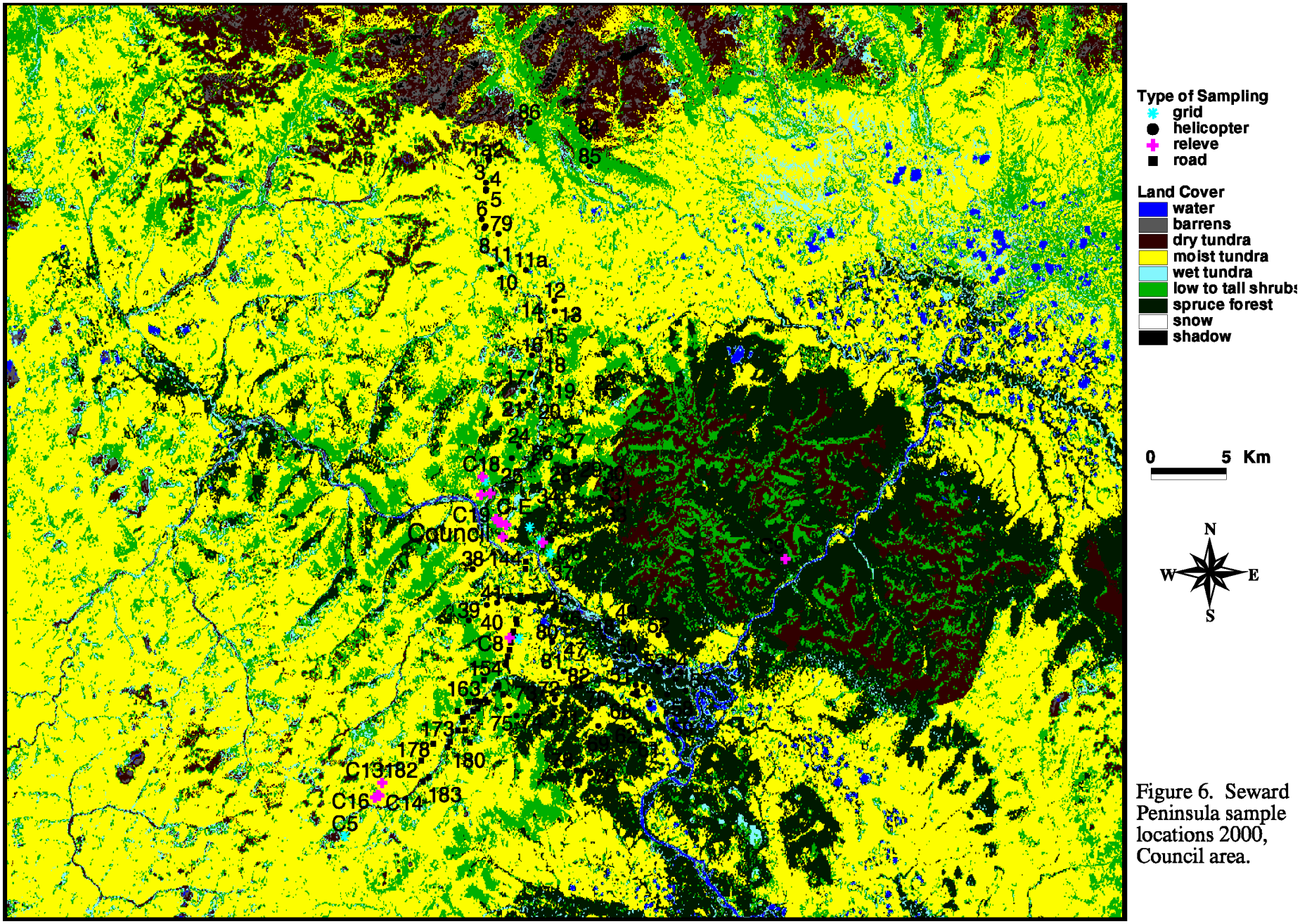

Figure 6. Seward Peninsula sample locations 2000, Council area.

Photo 03008 ALK CIR, August 1981, #2411, 1:60,000

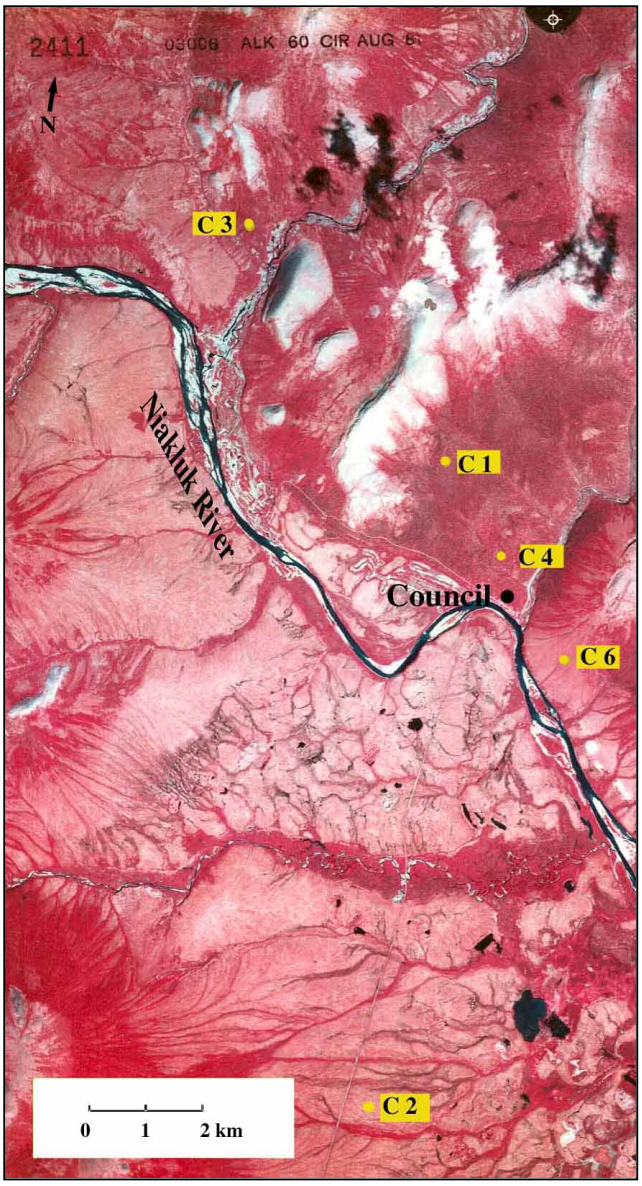

Figure 7a. Council Creek, Grid **C1, C 2, C 3, C 4, and C 6**. Grid **C 5** (see in photo below), is located southeast of these locations.

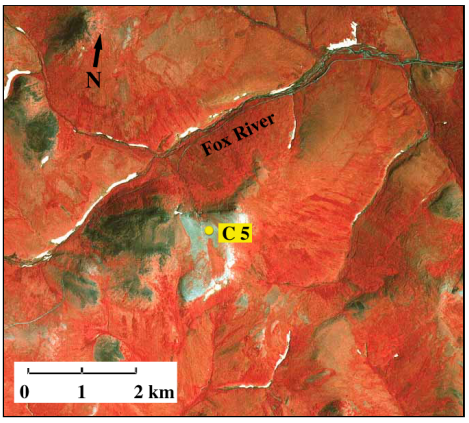

Photo NASA JSC 427, July 1980, Alaska CIR, # 08-072, 1:60,000

Figure 7b. Council Creek, **C 5.** Barren grid.

Photo NASA JSC 386, July 1978, Alaska CIR, # 13-098, 1:60,000

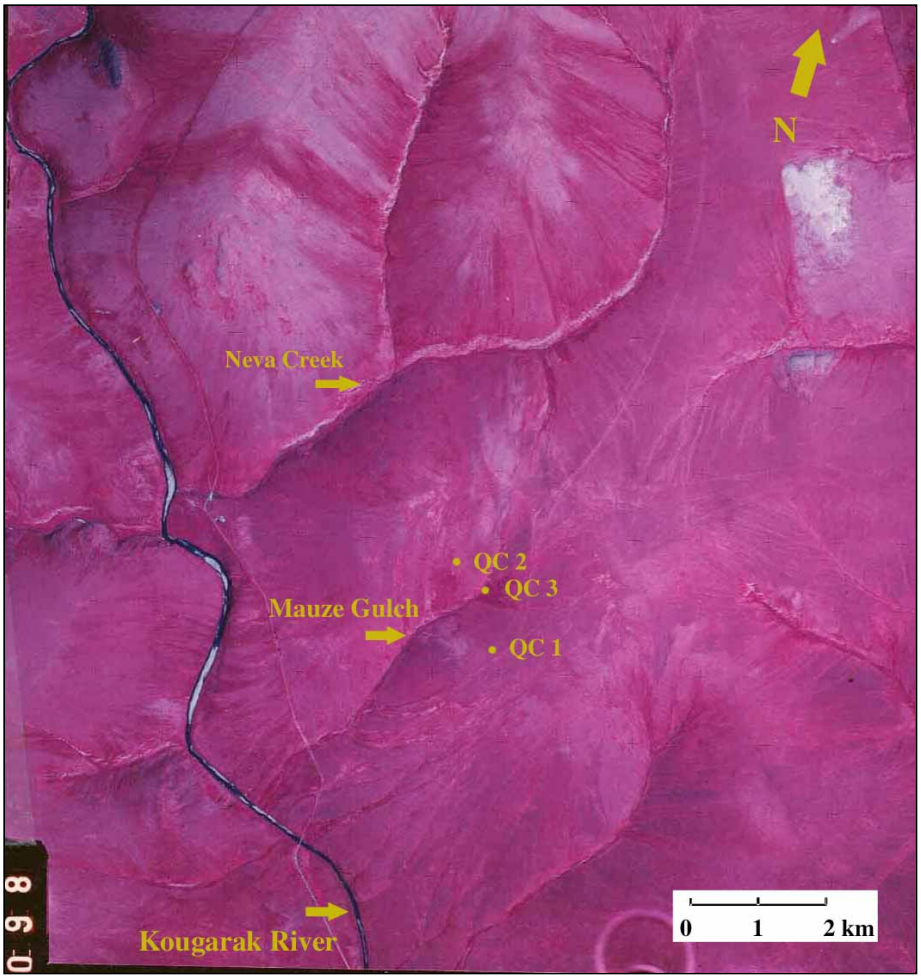

Figure 8. Quartz Creek Plots
Sites of QC 1, QC 2, and QC 3, northeast of Bendeleben Mountains.

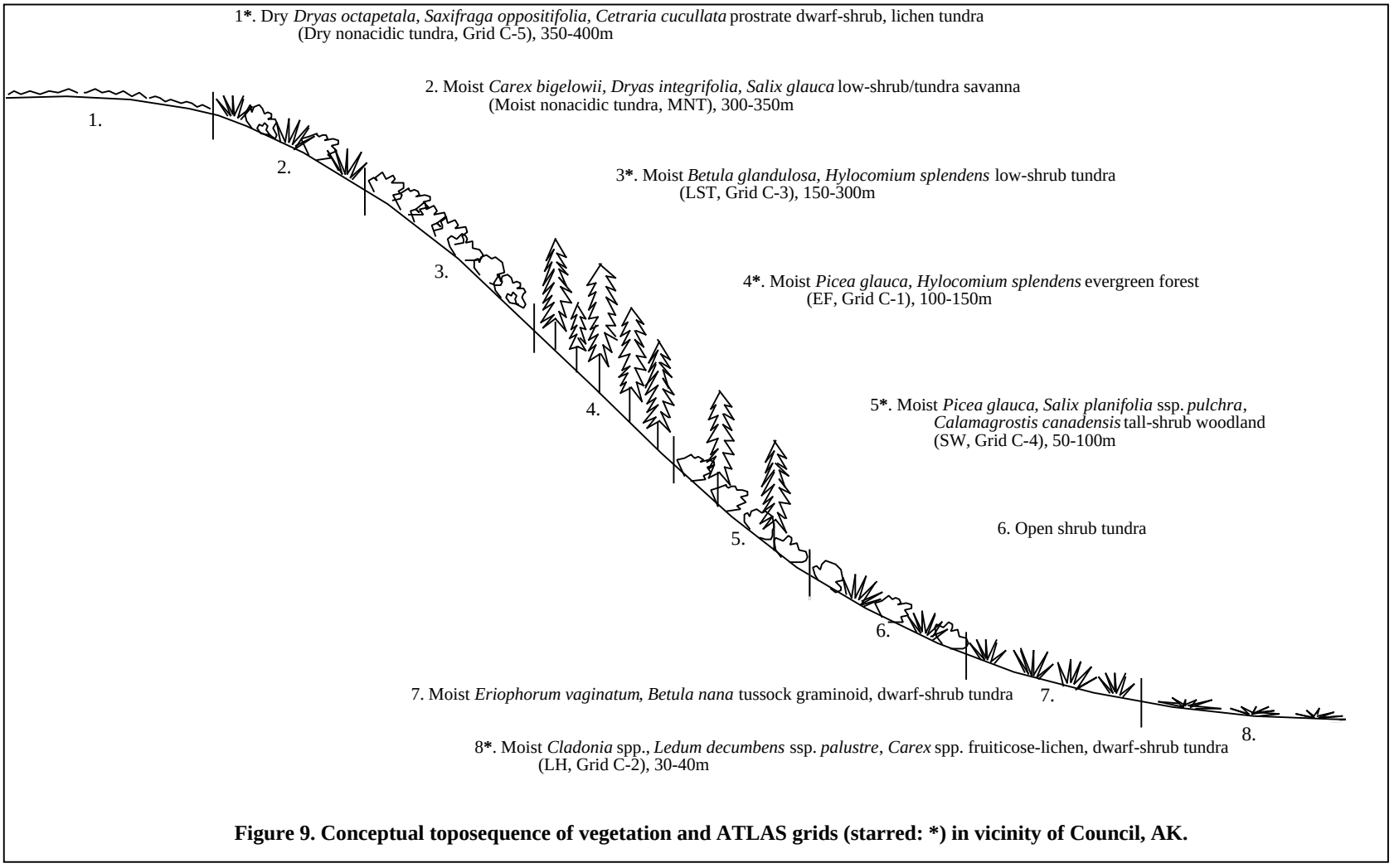

Figure 9. Conceptual toposequence of vegetation and ATLAS grids (starred: *) in vicinity of Council, AK.

Table 1. Vegetation heterogeneity at the gridpoints of the four Council grids, and three Quartz Creek grids

	C1 Forest		C2 Lichen tundra		C3 Shrub		C5 Barren		QC1 Tussock tundra		QC2 Striped tundra		QC3 Shrub
		Canopy A-tree, B-shrub, C-clearing	Veg.type A-Sphfus,Rubcha, Betnan,Leddec B-Cla spp.,Caraqu,Vaculi C-Eriang, Sph spp. Drep spp	Microsites A-mossy hummocks B-interhummocks C-wet depression	Veg.type A-shrub B-clearing		Veg.type A-open/patchy Dryoct,Oxybry B-continuous Dryoct,Oxybry	Microsites A-featureless B-patterned, sorted stone nets C-stripes		Microsite A-tussock B-intertussock	Microsite A-stripe B-interstripe C-nonsorted circle D-featureless E-solifluction lobe	Veg.Type A-Cladonia spp., Empnig lichen/prostrate dwarf shrub, B-Betnan,Vaculi,Carbig erect dwarf shrub/graminoid C-Salphl,Sphglo,Antfri D-Salpul,Salgla low shrub E-Carbig,Betnan,Equarv,Vaculi graminoid/dwarf shrub	Veg.type & microsite A-shrubs, B-clearings
Point	**Species**	**Canopy**	**Veg.type**	**Microsites**	**Veg.type**	**Species**	**Veg.type**	**Microsites**	**Veg. type**	**Microsite**	**Microsite**	**Veg.Type**	**Veg.type & microsite**
A1		C	B	B	A	Betgla/ Vaculi	A	C	tussock tundra	B	A	E	A
A2	Salpul	B	A	A	A	Betgla	A	C	tussock tundra	A	B	E	A
A3	Sallan	B	B	B	A	Betgla	A	C	tussock tundra	B	A	A	A
A4		C	B	B	A	Vaculi/ Betgla	A	C	tussock tundra	B	B	E	A
A5	Salpul	B	A	A	A	Penflo	A	C	tussock tundra	B	B	B	A
A6	Picgla	A	A	A	A	Betgla	A	C	tussock tundra	B	C	A	A
A7	Picgla	A	A	A	B	Arcrub	A	C	tussock tundra	A	D	D	B
A8	Picgla	A	A	A	A	Betgla	A	C	tussock tundra	A	B	B	A
A9		C	A	B	B		A	C	tussock tundra	A	D	B	A
A10	Salpul	B	A	A	B	Betgla	A	C	tussock tundra	A	D	B	A
A11	between Picgla	C	A	A	A	Salgla	A	C	tussock tundra	A	D	D	A
B1		C	A	A	A	Vaculi/ Betgla	A	A	tussock tundra	A	A	A	A
B2	Salpul	B	A	A	A	Betgla	A	A	tussock tundra	A	A	A	A
B3	Sallan	B	A	A	A	Vaculi/ Betgla	A	A	tussock tundra	A	B	B	A
B4	Salpul	B	C	C	A	Vaculi/ Betgla	A	C	tussock tundra	A	B	E	A
B5	Picgla	A	A	B	A	Betgla	A	C	tussock tundra	B	B	E	A
B6	Picgla	A	B	B	A	Betgla	A	C	tussock tundra	A	B	B	A
B7		C	A	A	B	Penflo	A	C	tussock tundra	A	D	B	A
B8	Picgla	A	A	A	A	Betgla	A	C	tussock tundra	B	D	B	A
B9	Salpul	B	A	B	A	Betgla/ Vaculi	A	C	tussock tundra	A	D	B	A
B10	Sallan	B	A	A	A	Penflo	A	C	tussock tundra	A	D	E	A
B11	Picgla	A	A	A	B		A	C	tussock tundra	A	D	B	A
C1	Picgla	A	A	A	A	Betgla	A	A	tussock tundra	B	C	C	A
C2	Salpul	B	B	B	A	Betgla	A	A	tussock tundra	B	B	B	A
C3		C	A	A	A	Vaculi/ Betgla	A	A	tussock tundra	B	B	B	A
C4		C	C	C	A	Vaculi/ Betgla	A	A	tussock tundra	B	B	B	B

Table 1. Vegetation heterogeneity (continued)

	C1 Forest		C2 Lichen tundra		C3 Shrub		C5 Barren		QC1 Tussock tundra		QC2 Striped tundra		QC3 Shrub
		Canopy A-tree, B-shrub, C-clearing	Veg.type A-Sphfus,Rubcha, Betnan,Leddec B-Cla spp.,Caraqu,Vaculi C-Eriang, Sph spp.,Drep.spp.	Microsites A-mossy hummocks B-interhummocks C-wet depression	Veg.type A-shrub B-clearing		Veg.type A-open/patchy Dryoct,Oxybry B-continuous Dryoct,Oxybry	Microsites A-featureless B-patterned, sorted stone nets C-stripes		Microsite A-tussock B-intertussock	Microsite A-stripe B-interstripe C-nonsorted circle D-featureless E-solifluction lobe	Veg.Type A-Cladonia spp., Empnig lichen/prostrate dwarf shrub B-Betnan,Vaculi,Carbig erect dwarf shrub/graminoid C-Salphl,Sphglo,Antfri D-Salpul,Salgla low shrub E-Carbig,Betnan,Equarv,Vaculi graminoid/dwarf shrub	Veg.type & microsite A-shrubs, B-clearings
Point	**Species**	**Canopy**	**Veg.type**	**Microsites**	**Veg.type**	**Species**	**Veg.type**	**Microsites**	**Veg. type**	**Microsite**	**Microsite**	**Veg.Type**	**Veg.type & microsite**
D1	Salix sp.	B	A	B	A	Betgla	A	A	tussock tundra	B	B	E	A
D2		C	C	C	A	Betgla/ Vaculi	A	A	tussock tundra	B	B	B	A
D3	Picgla	A	B	B	A	Vaculi/ Leddec	A	A	tussock tundra	B	B	D	A
D4		C	A	A	B	Vaculi	A	A	tussock tundra	B	A	A	A
D5	Salpul	B	C	C	A	Betgla	A	A	Carex lugens, tussock tundra	A	B	B	A
D6	Picgla	A	A	A	A	Betgla	A	A	tussock tundra	B	D	B	A
D7	Popbal	A	A	A	B		A	A	tussock tundra	B	D	B	A
D8	Sallan	B	A	A	A	Penflo/ Betgla	A	A	tussock tundra	B	D	B	A
D9	Salgla	B	B	B	B	Salret	A	A	tussock tundra	A	D	B	A
D10		C	A	A	A	Penflo	A	B	tussock tundra	A	D	B	A
D11		C	A	A	A	Betgla	A	A	Salix pulchra, tussock tundra	B	E	D	B
E1	Salpul	B	A	A	A	Salpul/ Betgla	A	B	tussock tundra	B	B	E	A
E2	Picgla	A	A	A	A	Vaculi/ Betgla	A	B	tussock tundra	B	B	E	A
E3	Picgla	A	A	A	A	Betgla	B	B	tussock tundra	B	B	B	A
E4	Picgla	A	B	B	A	Vaculi/ Betgla	A	B	tussock tundra	B	B	B	A
E5		C	A	A	A	Vaculi/ Salpul/ Betgla	A	B	tussock tundra	A	D	E	A
E6		C	A	A	A	Betgla	A	A	tussock tundra	A	B	D	B
E7		C	A	A	A	Salret/ Betgla	A	B	tussock tundra	B	D	B	A
E8		C	A	A	A	Betgla	A	B	tussock tundra	A	B	B	A
E9		C	A	A	A	Betgla	A	B	tussock tundra	A	D	B	A
E10	Salgla	B	B	B	B	Salpul	A	B	tussock tundra	B	D	B	A
E11		C	A	A	B	Salret	A	B	tussock tundra	B	E	D	A
F1		C	A	A	A	Betgla	A	B	tussock tundra	B	B	B	A

Table 1. Vegetation heterogeneity (continued)

	C1 Forest		C2 Lichen tundra		C3 Shrub		C5 Barren		QC1 Tussock tundra		QC2 Striped tundra		QC3 Shrub
		Canopy A-tree, B-shrub, C-clearing	Veg.type A-Sphfus,Rubcha, Betnan,Leddec B-Cla spp.,Caraqu,Vaculi C-Eriang, Sph spp.,Drep.spp.	Microsites A-mossy hummocks B-interhummocks C-wet depression	Veg.type A-shrub B-clearing		Veg.type A-open/patchy Dryoct,Oxybry B-continuous Dryoct,Oxybry	Microsites A-featureless B-patterned, sorted stone nets C-stripes		Microsite A-tussock B-intertussock	Microsite A-stripe B-interstripe C-nonsorted circle D-featureless E-solifluction lobe	Veg.Type A-Cladonia spp., Empnig lichen/prostrate dwarf shrub B-Betnan,Vaculi,Carbig erect dwarf shrub/graminoid C-Salphl,Sphglo,Antfri D-Salpul,Salgla low shrub E-Carbig,Betnan,Equary,Vaculi graminoid/dwarf shrub	Veg.type & microsite A-shrubs, B-clearings
Point	**Species**	**Canopy**	**Veg.type**	**Microsites**	**Veg.type**	**Species**	**Veg.type**	**Microsites**	**Veg. type**	**Microsite**	**Microsite**	**Veg.Type**	**Veg.type & microsite**
F2	Picgla/ Betnan	A/B	A	A	A	Vaculi	A	B	tussock tundra	B	B	D	A- drainage, moose browsed
F3	Sallan	B	A	A	A	Salpul	B	B	tussock tundra	A	B	E	A
F4	Picgla	A	C	C	A	Vaculi/ Salpul	B	A	tussock tundra	A	A	A	A
F5	Picgla	A	A	A	A	Vaculi	B	A	tussock tundra	A	B	E	A
G5		C	A	A	A	Betgla	A	B	tussock tundra	A	B	E	A
G6	Salpul	B	A	A	A	Betgla	B	A	patch of Carex lugens tussock tundra	B	B	B	A
G7	Salgla	B	B	B	A	Betgla	B	B	tussock tundra	B	B	B	A
G8	Popbal	A	C	C	A	Betgla	A	B	tussock tundra	B	B	D	A
G9	Picgla	A	A	A	A	Betgla	A	C	tussock tundra	B	D	D	A
G10		C	A	A	A	Betgla	A	C	tussock tundra	B	D	B	A
G11	Salbra	B	A	A	B	Salret/ Arclat	A	C	tussock tundra	B	D	E	A
H1	Picgla	A	A	A	A	Salgla	A	B	tussock tundra	A	A	A	A
H2		C	A	A	A	Betgla	A	B	tussock tundra	B	B	E	A
H3	Salpul	B	B	B	A	Betgla	A	B	tussock tundra	B	A	A	A
H4	Picgla	A	B	B	A	Betgla	B	A	tussock tundra	B	A	A	A
H5	Popbal	A	A	A	A	Betgla/ Penflo	A	A	tussock tundra	B	A	A	A
H6	Picgla	A	B	B	A	Betgla/ Penflo	B	A	tussock tundra	B	A	A	A
H7	Salgla	B	A	A	A	Betgla	A	B	tussock tundra	B	D	B	A
H8		C	B	B	A	Betgla	A	B	tussock tundra	A	D	B	A
H9	Picgla	A	B	B	A	Betgla	A	B	tussock tundra	B	E	B	A
H10	Picgla	A	A	A	A	Betgla	A	C	tussock tundra	B	D	E	B
H11		C	B	B	B	Vaculi	A	C	tussock tundra	A	D	D	A
I 1	Salpul	B	A	A	A	Betgla	B	A	tussock tundra	B	A	E	A
I 2	Salpul	B	A	A	A	Betgla	A	B	tussock tundra	B	B	B	A

Table 1. Vegetation heterogeneity (continued)

	C1 Forest		C2 Lichen tundra		C3 Shrub		C5 Barren		QC1 Tussock tundra		QC2 Striped tundra		QC3 Shrub
		Canopy A-tree, B-shrub, C-clearing	Veg.type A-Sphfus,Rubcha, Betnan,Leddec B-Cla spp.,Caraqu,Vaculi C-Eriang, Sph spp.,Drep.spp.	Microsites A-mossy hummocks B-interhummocks C-wet depression	Veg.type A-shrub B-clearing		Veg.type A-open/patchy Dryoct,Oxybry B-continuous Dryoct,Oxybry	Microsites A-featureless B-patterned, sorted stone nets C-stripes		Microsite A-tussock B-intertussock	Microsite A-stripe B-interstripe C-nonsorted circle D-featureless E-solifluction lobe	Veg.Type A-Cladonia spp., Empnig lichen/prostrate dwarf shrub B-Betnan,Vaculi,Carbig erect dwarf shrub/graminoid C-Salphl,Sphglo,Antfri D-Salpul,Salgla low shrub E-Carbig,Betnan,Equarv,Vaculi graminoid/dwarf shrub	Veg.type & microsite A-shrubs, B-clearings
Point	**Species**	**Canopy**	**Veg.type**	**Microsites**	**Veg.type**	**Species**	**Veg.type**	**Microsites**	**Veg. type**	**Microsite**	**Microsite**	**Veg.Type**	**Veg.type & microsite**
I3		C	B	B	B	Vaculi	A	B	tussock tundra	B - dead Salpul	B	B	A
I4	Picgla	A	A	A	A	Betgla	B	B	tussock tundra	B	B	B	A
I5		C	B	B	A	Betgla	A	B	tussock tundra	A	B	B	A
I6	Picgla	A	B	B	A	Betgla	B	B	tussock tundra	B	B	B	A
I7		C	B	B	A	Betgla	A	B	tussock tundra	B	A	E	A
J6	Picgla	A	A	A	A	Betgla	A	B	tussock tundra	A	B	B	A
J7	Salpul	B	A	A	A	Betgla	A	B	tussock tundra	A	A	E	A
J8		C	B	B	A	Betgla	A	B	tussock tundra	B	B	E	A
J9		C	A	A	A	Betgla	A	C	tussock tundra	B	D	B	A
J10		C	C	C	A	Betgla	A	C	tussock tundra	A	D	E	A
J11	Picgla	A	A	A	A	Betgla	A	C	tussock tundra	B	D	D	A
K1	Salpul/ Salala	B	A	A	A	Betgla	B	A	tussock tundra	A	A	A	A
K2		C	B	B	A	Betgla	B	A	tussock tundra	B	B	B	A
K3	Picgla	A	A	A	A	Betgla	B	B	tussock tundra	A	B	B	A
K4	Picgla	A	A	A	A	Betgla	A	C	tussock tundra	A	E	D	A
K5		C	A	A	A	Salpul	A	C	tussock tundra	B	B	B	A
K6		C	B	B	A	Betgla	A	C	tussock tundra	B	B	E	A
K7	Picgla	A	C	C	A	Betgla/ Salpul	A	C	tussock tundra	A w/ Salpul	A	E	A
K8	Popbal	A	B	B	A	Betgla	A	B	tussock tundra	B	B	E	A
K9	Salpul	B	A	A	A	Betgla	A	B	tussock tundra	B	B	D	A
K10	Salpul	B	A	A	A	Betgla	A	C	tussock tundra	B	A	A	A
K11		C	A	A	A	Betgla	A	C	tussock tundra	A	D	D	A

Table 2. Vegetation height at gridpoints within 100 x 100 m grids

C1 Forest							C2 Lichen tundra						
Point	Moss depth (cm) green/nongreen	Moss species	Height of veg (cm)	Vascular species	Microrelief height (cm)		Point	Moss or lichen depth (cm) green/nongreen	Moss or lichen species	Height of veg (cm)	Vascular species	Microrelief height (cm)	
B2	4/2	Plesch	5	Empnig	5		B2	2/14	Sphag	5	Rubcha	20	
B4		litter	25	Carpod	5		B4	1/3	liverworts, Polstr	20	Betnan	25	
B6		litter	10	Carpod	22		B6	14/0	Claran	25	Vaculi	17	
B8	1/2	Hylspl	15	Empnig	38		B8	1/1	Ochfri	23	Caraqu	18	
B10	4/3	Hylspl	13	Empnig	12		B10	1/9	Sphag sp.	10	Rubcha	16	
D2	2/1	Plesch	7	Vacvit	23		D2	4/2	Sphfim	30	Caraqu	15	
D4	2/3	Hylspl	7	Rubarc	14		D4	1/19	Sphfus	15	Vaculi	17	
D6	3/5	Hylspl	10	Petfri	16		D6	12/0	Claarb	10	Leddec	16	
D8	6/6	Plesch	3	dead Empnig	24		D8	10/0	Claran	9	Leddec	25	
D10	<1/<1	Tomnit	11	Vaculi	12		D10	1/22	Sphfus	17	Betnan	20	
F2	2/1	Hylspl	11	Carpod	13		F2	1/19	Sphfus	15	Leddec	15	
F4	2/1	Hylspl	4	Empnig	6		F4	1/2	Sph sp.	20	Caraqu	25	
F6	4/1	Hylspl/Pticil	5	Salret	12		F6						
F8	1/1	Aulpal	3	Mercam	10		F8	15/0	Claran	15	Leddec	22	
F10	3/7	Aulpal	5	Carpod	9		F10	9/0	Claarb	14	Vaculi	15	
H2		wood	32	Equarv	16		H2	8/0	Claran	20	Caraqu	20	
H4	4/2	Hylspl/Aulpal	8	Empnig	23		H4	10/0	Claran	20	Caraqu	17	
H6	4/2	Plesch	16	Vaculi	36		H6	8/0	Claarb	20	Caraqu	18	
H8	3/2	Hylspl	7	Arcrub	14		H8	2/8	Sphfus	25	Caraqu	20	
H10		litter	17	Empnig	18		H10	1/19	Sphfus	15	Betnan	28	
J2		litter	13	Empnig	20		J2	1/23	Sphfus	12	Leddec	37	
J4		litter	11	Empnig	23		J4	3/5	Sph sp.	20	Betnan	18	
J6		litter	11	Vacvit	30		J6	15/0	Claran	18	Vaculi	25	
J8	5/2	Hylspl	21	Vaculi	30		J8	1/15	Sphfus	7	Vaculi	20	
J10	7/4	Plesch	0	no live vasc.	15		J10	2/13	Sphfus	20	Caraqu	25	

Table 2. Vegetation height (continued)

C3 Shrub						C5 7/12/00 Barren						QC1 Forest						
Point	Moss depth (cm) green/nongreen	Moss or lichen species	Height of veg (cm)	Vascular species	Microrelief height (cm)	Point	Moss depth (cm) green/nongreen	Moss species	Height of veg (cm)	Vascular species	Microrelief height (cm)	Point	Moss depth (cm) green/nongreen	Moss species	Height of veg (cm)	Vascular species	Microrelief height (cm)	
B2	1/3	Aulpal	20	Thaalp	40	B2			8	Hedmac	2	B2			32	Betnan	20	
B4	2/4	Hylspl	120	Salpul	30	B4			0	none	5	B4			33	Carbig	25	
B6	3/5	Hylspl	100	Betgla	15	B6			1	Saxopp	4	B6			30	Erivag	25	
B8	3/6	Hylspl	100	Vaculi	15	B8			0	none	2	B8			28	Vaculi	25	
B10	3/4	Hylspl	120	Salarc	10	B10			0	none	3	B10	1/12	Sphag	32	Leddec	20	
D2	3/5	Hylspl	135	Vaculi	20	D2			3	Dryoct	3	D2			25	Erivag	25	
D4	5/6	Hylspl	120	Vaculi	20	D4			2	Carrup	5	D4	2/3	Sphgir	15	Erivag	15	
D6	3/6	Hylspl	80	Carpod	15	D6			0	none	4	D6			32	Salpul	20	
D8	3/5	Hylspl	150	Penflo	20	D8			1	Dryoct	2	D8	2/1	liverwort	30	Carbig	30	
D10			140	Anepar	20	D10			0	none	4	D10			45	Erivag	35	
F2	4/6	Hylspl	115	Vaculi	10	F2			1	Andcha	4	F2	5/3	Sphgir	28	Erivag	20	
F4			100	Betgla	20	F4			5	Hedmac	6	F4			45	Erivag	25	
F6	5/3	Hylspl	15	Penflo	10	F6			2	Cettil	3	F6			32	Vaculi	20	
F8	0.5/1	Hylspl	15	Carsci	5	F8			2	Anenar	5	F8			27	Erivag	20	
F10			160	Salpul	10	F10			2	Dryoct	2	F10	2/2	Polstr	33	Carbig	30	
H2	4/6	Hylspl	60	Vaculi	30	H2			1	Senres	6	H2	2/1	Hylspl	30	Leddec	25	
H4	3/10	Hylspl/ Plesch	80	Vaculi	25	H4			2	Dryoct	3	H4			25	Leddec	20	
H6	3/8	Hylspl	120	Arcrub	20	H6			0	none	1	H6			30	Carbig	15	
H8	3/7	Hylspl	110	Valcap	10	H8			0	none	2	H8			30	Vaculi	15	
H10	3/6	Hylspl	120	Mercam	30	H10			4	Dryoct	2	H10			25	Carbig	17	
J2			115	Empnig	25	J2			4	Dryoct	2	J2			30	Vaculi	25	
J4	2/6	Hylspl	100	Empnig	25	J4			0	none	1	J4	1/1	liverwort	40	Erivag	30	
J6	1/2	Hylspl	100	Vaculi	15	J6			3	Potuni	2	J6			20	Erivag	15	
J8	2/4	Hylspl	85	Empnig	15	J8	.03/1	Bryum sp.	1	Perdac	5	J8	1/0	Dicr sp.	30	Erivag	20	
J10			110	Betgla	15	J10			0	none	0	J10			40	Erivag	30	

Table 2. Vegetation height (continued)

QC2 Stripes							QC3 Shrubs					
Point	Moss or lichen depth (cm) green/nongreen	Moss or lichen species	Height of veg (cm)	Vascular species	Microrelief height (cm)		Point	Moss depth (cm) green/nongreen	Moss species	Height of veg (cm)	Vascular species	Microrelief height (cm)
B2	1/0	Pelcan	5	Oxymay	15		B2		none	170	Salpul	30
B4	1/0	Pelapt	15	Carbig	20		B4	1/1	spindly feather	170	Salpul	15
B6	0		40	Erivag	30		B6		none	190	Salpul	40
B8	0		20	Betnan	15		B8		none	120	Salpul	20
B10	0		30	Salpul	20		B10	10/1		150	Lycann	20
D2			30	Salgla	25		D2	4/1	Tomnit	170	Salpul	12
D4	1/0	Cetisl	7	Pedkan	10		D4		none	170	Salpul	5
D6			35	Salpul	20		D6		none	140	Salpul	20
D8			30	Carbig	18		D8	6/2	Poljun	130	Salpul	20
D10			30	Vaculi	25		D10	2/+	Poljun	100	Salpul	13
F2	2/0	Dreunc	70	Salpul	20		F2	1/0	liverwort	90	Salpul	12
F4	2/0	Ochfri	5	Leddec	15		F4	2/1	liverwort	190	Salpul	40
F6	2/4	Sphang	25	Betnan	20		F6		none	150	Salpul	20
F8	1/1	Aultur	45	Betnan	15		F8		none	160	Salpul	30
F10	1/3	Polstr	65	Salpul	15		F10	5/2	Poljun	160	Salpul	25
H2	1/0	green cup Cladonia	9	Equarv	25		H2			180	Salpul	10
H4	2/3	Dicr sp.	8	Vaculi	20		H4			170	Salpul	5
H6	8/1	Cetarb	20	Carbig	20		H6	2/1	Poljun	110	Salpul	5
H8			18	Equarv	15		H8	1/+	spindly feather	130	Salpul	25
H10	3/3	Aulpal	30	Salgla	15		H10			130	Salpul	25
J2			35	Betnan	20		J2			175	Salpul	15
J4	+/0	Perdac	3	Rholap	10		J4			110	Salpul	10
J6			17	Vaculi	15		J6	1/+	spindly feather	130	Salpul	5
J8	4/6	Hylspl	25	Carbig	15		J8	1/+	spindly feather	150	Salpul	5
J10			20	Carbig	15		J10	1/1	Plesch	10	Carbig	25

Table 3. Grid organic soil horizon description

Grid	Date	Observers	Point	Oi	Oe	Oa	Total	Soil classification	Microsite	Collection	Notes
C1	7/13/00	SW,TR,AM,DW,CT	B10	4	3	10	17		beneath Sallan, gravelly	X, soil collected from top of B horizon	
			C5	4	8	29	41		beneath Picgla on a dead log		
			E10	8	4	18	30		beneath Salpul		
			G11	4	4	16	22		beneath Picgla on a dead log		
			I6	16	3	14	33		beneath Salix glauca on dead log		
			K3	3	5	3	11		beneath Picgla		
C2	7/11/00	SW,TR,AM,DW,CT	A10	12	6	10/pf	28	sphagnohemist	hummock (A)	X, all soil samples taken 2m N on grid point	
			C2	22	5/pf		27	sphagnofibrist	hummock (A)	X	
			E3	9	15	6/pf	30	sphagnohemist	hummock (A)	X	
			G4	21	18	5/pf	44	sphagnofibrist	hummock (A)	X	
			I10	26	6/pf		32	sphagnofibrist	hummock (A)	X	
			K2	19	9/pf		28	sphagnofibrist	hummock (A)	X	
C3	7/14/00	SW,TR,AM,DW,CT	A5	6	1	1	8	pergelic cryaquept	shrub	X	
			C3	6	3	2	11	pergelic cryaquept	shrub	X	
			E8	3	2	3	8	pergelic cryoquoll	shrub under Betgla	X	
			G6	6	2	3	11	pergelic cryaquept	shrub Betgla	X	
			I11	4	1	1	6	pergelic cryoquoll	shrub Betgla	X	
			K1	2	2	2	6	pergelic cryaquept	shrub Betgla	X	
C5	7/12/00	SW,TR,AM,DW,CT	no organic horizon								
QC1	7/23/00	SW,TR,AM,DW,CT	A4	5	12	10	27	histic pergelic cryaquept	intertussock	x top of B, grab sample	all soils are acidic
			B4	10	10	8	28	histic pergelic cryaquept	tussock	X grab sample	
			C7	1	0	15	16	histic pergelic cryaquept	intertussock	X B, grab sample	
			D1	1	4	20	25	histic pergelic cryaquept	intertussock	X Oa	
			E5	16	8	4	28	histic pergelic cryaquept	tussock	X B	
			F10	1	3	14	18	histic pergelic cryaquept	intertussock	X B	
			G4	17	0	13	30	histic pergelic cryaquept	margin of tussock	X Oa, grab sample	
			H6	6	0	6	12	pergelic cryaquept	tussock	X B	
			I9	1	0	15	16	histic pergelic cryaquept	Carlug tussock	X Oa	
			J6	2	0	22	24	histic pergelic cryaquept	intertussock	X Oa	
			K10	6	4 Oe/B		10	pergelic cryaquept	tussock	X	
QC2	7/22/00	SW,TR,AM,DW,CT	A1	2	0	0	2	ruptic pergelic cryaquept, acid	stripe	X	
			B4	3	2	0	5	pergelic cryaquept, acid	stripe	X	
			C7	4	1	6	11	pergelic cryaquept	interstripe	X	
			D1	1	1	0	2	ruptic pergelic cryaquept	stripe	X	
			E5	1	4	11	16	pergelic cryaquept, acid	featureless	X	
			F10	1	5	11	17	histic pergelic cryaquept, acid	interstripe	X	
			G4	1	0	4	5	pergelic cryumbrept >20cm A horiz.	interstripe	X	
			H6	4 (lichen)	0	3	7	pergelic cryaquept	stripe	X	
			I9	2	3	16	21	histic pergelic cryaquept, acid	featureless	X	
			J6	3	4	5	12	pergelic cryaquept, acid	interstripe	X	
			K10	3	3	0	6	pergelic cryaquept, acid	stripe-hummock	X	
QC3	7/26/00	SW,TR,AM,DW,CT	A4	3		2	5	pergelic cryaquept	shrub	X	
			B4	2	1		3	pergelic cryaquept	shrub	X	
			C7	3	3	2	8	pergelic cryaquept	shrub	X B	
			D1	2	1		3	pergelic cryaquept	shrub	X B	
			E5	2	2		4	pergelic cryaquept	shrub	X A & B	
			F10	1	1		2	pergelic cryaquept	shrub	X B	
			G4	1	2		3	pergelic cryaquept	shrub	X B	
			H6	1	2		3	pergelic cryaquept	shrub	X B	
			I9	1	2	1	4	pergelic cryaquept	shrub	X B	
			J6	1	2	1	4	pergelic cryaquept	shrub	X B	

Table 4. Grid soil moisture

Relevé	Sample #	Location	Wet Wt.	Dry Wt. (w/Tare)	Tare Wt.	Dry Wt.	Water Wt.	%Soil Moisture
C1	5	B10	137.3	47.7	13.1	34.6	89.6	2.6
	6	C5	165.9	62.6	13	49.6	103.3	2.1
	7	E10	140	48.1	12.1	36	91.9	2.6
	8	G11	141.3	48.1	10.6	37.5	93.2	2.5
	10	I6	144.2	42.6	11.4	31.2	101.6	3.3
	9	K3	204	101	12	89	103	1.2
C2	20	A10	136.6	38.4	15.4	23	98.2	4.3
	19	C2	85.3	25.2	13.2	12	60.1	5.0
	21	E3	119.1	28.5	12.7	15.8	90.6	5.7
	11	G4	114.2	38.8	10.5	28.3	75.4	2.7
	22	I10	91.9	28	13.2	14.8	63.9	4.3
	12	K1	117.9	27.1	11.3	15.8	90.8	5.7
C3	44	A5	154.5	93	0	93	61.5	0.7
	48	C3	172.6	82.4	0	82.4	90.2	1.1
	49	E8	142.6	30.1	0	30.1	112.5	3.7
	46	G6	121.3	46.6	0	46.6	74.7	1.6
	47	I11	123.7	41.6	0	41.6	82.1	2.0
	45	K1	146.1	49.5	0	49.5	96.6	2.0
QC1	61	A4	283.7	192	0	192	91.7	0.5
	62	B4	178.9	112.3	0	112.3	66.6	0.6
	63	C7	214.1	126.1	0	126.1	88	0.7
	64	D1	150.9	37.8	0	37.8	113.1	3.0
	65	E5	165.8	52.4	0	52.4	113.4	2.2
	66	F10	226.5	138.3	0	138.3	88.2	0.6
	67	G4	174.6	44.2	0	44.2	130.4	3.0
	68	H6	161	58.3	0	58.3	102.7	1.8
	69	I9	168.4	30.8	0	30.8	137.6	4.5
	73	J6	135.4	24.9	0	24.9	110.5	4.4
	74	K10	136.5	43.7	0	43.7	92.8	2.1
QC2	75	A1	394.1	317	0	317	77.1	0.2
	76	B4	324.5	257.7	0	257.7	66.8	0.3
	77	C7	238.1	114.5	0	114.5	123.6	1.1
	78	D1	338.6	274.2	0	274.2	64.4	0.2
	85	E5	429	120	0	120	309	2.6
	79	F10	267.6	59.9	0	59.9	207.7	3.5
	80	G4	187.9	51.3	0	51.3	136.6	2.7
	81	H6	226.6	155.6	0	155.6	71	0.5
	82	I9	402.5	83.6	0	83.6	318.9	3.8
	83	J6	289.9	226.7	0	226.7	63.2	0.3
	84	K10	344.1	270.7	0	270.7	73.4	0.3
QC3	86	A4	164.7	73.6	0	73.6	91.1	1.2
	87	B4	170.5	90.9	0	90.9	79.6	0.9
	88	C7	201.9	106	0	106	95.9	0.9
	89	D1	162.4	85.9	0	85.9	76.5	0.9
	90	E5	119	56.8	0	56.8	62.2	1.1
	91	F10	202	107.1	0	107.1	94.9	0.9
	92	G4	189.9	85.9	0	85.9	104	1.2
	93	H6	141.2	59.3	0	59.3	81.9	1.4
	94	I9	171.6	103	0	103	68.6	0.7
	95	J6	211.4	120.6	0	120.6	90.8	0.8

Table 5. Grid organic soil horizon analyses

Grid	Location	Sample #	pH	ppm P	ppm K	ppm Ca	ppm Mg	ppm Na	% Loss on Ignition	% Sand	% Silt	% Clay	% C	% N
C 1	B10	5	5.52	64	154	12008	280	48	65.45	na	na	na	32.61	1.82
	C5	6	5.19	13	66	6653	189	82	51.55	na	na	na	19.06	1.28
	E10	7	5.85	48	159	11910	296	49	61.78	na	na	na	33.19	1.91
	G11	8	5.40	39	89	10680	237	43	63.85	na	na	na	32.28	1.99
	K3	9	5.77	5	44	3192	84	58	22.01	na	na	na	7.73	0.57
	I6	10	5.36	60	234	11480	204	58	80.04	na	na	na	40.25	2.31
C2	G4	11	4.05	7	128	487	142	41	79.78	na	na	na	41.63	2.32
	K1	12	3.86	20	282	1436	544	70	93.26	na	na	na	43.75	1.64
	C2	19	3.67	64	352	1176	576	84	92.82	na	na	na	44.47	1.51
	A10	20	3.89	24	218	1166	426	96	91.84	na	na	na	43.57	1.54
	E3	21	3.88	10	196	1066	422	96	90.03	na	na	na	42.78	1.51
	I10	22	3.66	12	214	806	318	64	91.09	na	na	na	43.33	1.42
C 3	A5	44	5.14	10	126	1774	105	22	13.03	36.0	41.2	22.8	5.88	0.44
	K1	45	5.49	11	115	4893	161	32	30.29	na	na	na	13.21	0.86
	G6	46	5.86	7	112	5619	224	35	26.46	na	na	na	10.91	0.76
	I11	47	6.00	7	86	7650	192	32	34.64	na	na	na	14.86	0.94
	C3	48	5.54	11	117	3666	153	25	18.18	34.3	49.7	16.0	9.13	0.60
	E8	49	5.87	56	158	14446	366	88	70.43	na	na	na	33.82	2.10
QC1	A4	61	4.91	5	34	221	136	25	10.80	40.8	42.4	16.8	6.92	0.30
	B4	62	4.63	2	48	175	82	25	12.90	40.8	44.4	14.8	7.96	0.35
	C7	63	4.44	2	71	226	109	29	16.65	48.8	38.4	12.8	9.97	0.47
	D1	64	4.52	4	198	1202	436	82	62.51	na	na	na	27.92	1.20
	E5	65	4.42	36	226	580	252	82	67.19	na	na	na	27.08	1.40
	F10	66	4.61	5	42	231	107	27	14.62	28.8	58.4	12.8	7.97	0.39
	G4	67	4.61	2	194	931	374	55	51.76	na	na	na	24.26	1.06
	H6	68	4.66	4	146	651	309	52	40.59	na	na	na	18.36	0.92
	I9	69	4.52	4	328	1056	426	88	82.46	na	na	na	38.64	1.72
	J6	73	4.50	8	420	1696	704	104	88.85	na	na	na	41.64	1.51
	K10	74	4.21	26	186	990	406	86	76.73	na	na	na	39.50	1.66
QC2	A1	75	5.77	2	74	943	238	23	3.06	40.4	36.8	22.8	1.22	0.09
	B4	76	5.30	7	116	1065	281	23	7.10	46.4	36.8	16.8	1.95	0.11
	C7	77	5.01	41	57	1623	283	27	19.15	na	na	na	10.08	0.63
	D1	78	5.63	3	91	943	251	20	2.91	38.4	40.8	20.8	0.97	0.10
	F10	79	5.44	106	406	5824	764	116	79.24	na	na	na	38.15	2.10
	G4	80	4.73	56	198	4528	828	84	74.98	na	na	na	40.74	1.81
	H6	81	5.32	9	66	1254	270	17	8.70	na	na	na	5.49	0.32
	I9	82	5.89	40	548	5904	844	144	81.74	na	na	na	38.64	1.86
	J6	83	5.38	10	59	1314	247	31	8.52	50.4	38.8	10.8	4.13	0.31
	K10	84	5.29	1	61	656	139	13	3.09	42.8	40.4	16.8	1.17	0.10
	E5	85	5.56	30	262	4272	680	72	61.15	na	na	na	28.13	1.69
QC3	A4	86	6.41	7	75	3225	209	29	12.75	38.3	49.1	12.6	6.41	0.40
	B4	87	6.31	7	123	3207	242	31	11.86	16.8	68.4	14.8	4.57	0.34
	C7	88	5.56	3	51	1631	213	36	11.47	26.8	60.4	12.8	4.75	0.36
	D1	89	6.46	8	109	3739	169	25	13.53	na	na	na	4.73	0.29
	E5	90	4.77	8	149	633	185	34	17.30	na	na	na	7.88	0.52
	F10	91	4.30	3	84	290	112	31	2.86	na	na	na	5.49	0.34
	G4	92	4.67	11	157	514	196	40	17.45	na	na	na	6.61	0.47
	H6	93	4.50	16	144	541	199	32	25.41	na	na	na	12.32	0.87
	I9	94	4.70	3	61	434	150	30	7.38	37.2	47.6	15.2	3.12	0.22
	J6	95	4.83	4	101	586	177	32	10.26	na	na	na	4.73	0.31

Table 6. Grid leaf area index

C 5 grid point	LAI 7/13/2000	QC1 grid point	LAI 7/24/2000	QC2 grid point	LAI 7/23/2000	QC3 grid point	LAI 7/26/2000
A1	0.00	A1	2.76	K2	3.13	K11	3.95
A1	0.05	B2	3.08	I2	2.41	K10	4.42
B2	0.00	B4	2.51	I6	2.71	J9	3.36
B4	0.02	A4	3.45	J6	3.49	I9	2.07
A4	0.00	B8	0.83	J7	2.70	J8	4.19
B8	0.00	A10	2.19	J8	3.24	J6	3.22
A10	0.00	D10	4.20	I9	2.89	I6	3.35
1.0	0.19	C7	2.44	K10	2.03	I2	3.15
D10	0.04	C4	3.80	K11	2.82	K2	3.11
C7	0.02	C2	3.29	H10	1.99	G4	4.02
C4	0.00	D2	2.83	G7	2.03	H5	3.34
C2	0.03	D1	3.39	G6	3.83	H6	2.66
D2	0.08	E1	3.18	H6	1.65	G6	3.49
D1	0.00	F2	2.18	H5	1.17	G7	3.99
E1	0.02	F5	4.41	G4	2.11	H10	2.32
F2	0.08	E5	4.21	F2	4.55	F10	3.43
F5	0.00	E6	4.37	E1	1.70	E6	3.39
F5	0.09	F10	2.57	F5	1.27	E5	3.36
E5	0.00	H10	0.00	E5	2.16	F5	4.14
F10	0.00	H10	1.61	E6	3.49	F2	3.76
H10	0.00	G7	1.99	F10	3.53	E1	2.94
G7	0.24	G6	3.76	D10	3.54	D1	2.55
G6	0.00	H6	2.24	C7	2.72	D2	3.06
H6	0.06	H5	4.00	C4	2.73	C2	2.78
H5	0.02	G4	3.41	C2	2.20	C4	1.30
G4	0.03	I2	4.04	D2	2.93	B4	2.99
I2	0.02	K2	1.93	D1	2.96	B2	2.82
K2	0.13	J6	2.36	A1	1.69	A1	2.63
I6	0.03	L6	0.00	B2	0.28	A4	3.03
J6	0.00	I6	4.19	B4	0.84	E8	3.41
J7	0.00	J8	3.24	A4	3.47	A10	4.10
J8	0.05	I9	1.12	B8	2.43	D10	3.66
I9	0.02	J9	4.09	A10	2.46	**mean**	3.25
K10	0.03	K10	4.16	**mean**	2.52	**standard error ±**	0.12
K11	0.02	K11	2.24	**standard error ±**	0.16		
mean	0.04	**mean**	2.86				
standard error ±	0.01	**standard error ±**	0.20				

Table 7. Quartz Creek Grid Biomass (grams/0.1m ^{2})

QC1	location	moss	lichen	forb	horsetail	graminoid		shrub: folliage		shrub: stem		Litter	SUM (no litter)
						live	dead	live	dead	live	dead		
	A4	0.0	0.0	0.0	0.0	16.0	42.5	7.7	0.2	20.5	4.7	0.0	91.7
	B4	7.2	0.1	0.0	0.0	10.8	31.7	8.0	1.4	18.3	2.9	2.1	80.4
	D1	0.9	2.8	0.0	0.0	3.3	16.8	11.9	0.5	17.9	5.0	0.0	59.0
	F10	0.6	5.1	0.0	0.0	4.3	16.9	8.7	1.0	28.7	9.2	1.6	74.4
	H6	1.4	2.6	2.2	0.0	6.3	34.0	8.9	0.5	27.3	7.8	0.0	91.1
AVERAGE	J6	0.0	0.5	0.6	NA	4.4	8.5	17.4	0.5	41.4	6.0	0.1	79.3
793 g/m^2		1.7	1.8	0.5	0.0	7.5	25.1	10.4	0.7	25.7	5.9	0.6	79.3
	mean ± s.e.	1.7 ± 1.1	1.8 ± 0.8	0.5 ± 0.4	0.0	7.5 ± 2.0	25.1 ± 5.3	10.4 ± 1.5	0.7 ± 0.2	25.7 ± 3.7	5.9 ± 0.9	0.6 ± 0.4	79.3 ± 4.9

QC 2	location	moss	lichen	forb	horsetail	graminoid		shrub: folliage		shrub: stem		Litter	SUM (no litter)
						live	dead	live	dead	live	dead		
	A4	1.6	7.3	0.8	0.1	0.6	0.5	8.5	5.6	15.5	1.3	7.1	42.0
	B4	4.0	14.6	NA	0.0	2.3	6.1	7.7	3.0	6.1	3.4	1.1	47.3
	C7	0.2	3.5	0.0	0.8	4.0	5.6	16.2	3.7	43.5	6.2	0.0	83.7
	D1	1.9	13.5	0.0	0.0	5.2	5.5	6.9	8.8	9.5	2.1	1.7	53.5
	E5	1.5	10.8	0.0	0.2	2.1	3.5	12.8	0.8	30.9	5.8	2.7	68.3
	F10	0.2	4.2	0.5	3.5	0.9	1.9	20.8	1.4	36.2	12.9	1.1	82.5
	G4	0.5	38.8	1.1	0.0	0.5	0.8	2.4	3.9	6.4	4.9	2.1	59.2
	H6	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	H8	0.0	0.0	0.0	0.0	0.7	2.2	26.0	1.0	97.4	16.6	0.0	143.9
	I9	11.2	11.2	0.1	0.8	1.8	1.2	9.8	0.2	48.0	20.9	0.0	105.2
AVERAGE	J6	0.6	3.7	0.0	0.5	5.0	5.7	18.4	0.6	61.3	15.4	0.0	111.1
725 g/m^2		2.0	9.8	0.3	0.5	2.1	3.0	11.8	2.6	32.3	8.1	1.4	72.5
	mean ± s.e.	2.0 ± 1.0	9.8 ± 3.3	0.3 ± 0.1	0.5 ± 0.3	2.1 ± 0.6	3.0 ± 0.7	11.8 ±2.4	2.6 ± 0.8	32.4 ± 8.9	8.1 ± 2.1	1.4 ± 0.6	72.5 ± 11.8

QC 3*	location	moss	lichen	forb	horsetail	graminoid		shrub: folliage*		shrub: stem*		Litter	SUM (no litter)
						live	dead	live	dead	live	dead		
	A4	3.0	0.0	1.1	2.5	4.8	1.1	89.0	19.5	1050.0	395.0	0.0	167.9
	B4	1.9	0.2	2.4	3.0	0.8	1.6	0.0	0.0	0.1	0.0	1.2	10.0
	E5	2.2	2.2	2.5	0.0	0.4	0.2	0.2	0.2	0.0	0.0	0.0	7.8
	G4	2.4	0.0	9.0	1.1	5.8	4.6	95.0	23.8	2971.0	1661.5	0.5	498.0
	H6	8.3	1.4	0.0	0.6	1.0	1.2	0.1	0.0	0.0	0.0	2.3	12.6
AVERAGE	J6	1.7	0.0	1.8	1.4	0.0	0.0	136.0	21.4	2655.0	1410.4	0.0	427.2
1872 g/m^2		3.2	0.6	2.8	1.4	2.1	1.5	5.4	1.1	111.3	57.8	0.7	187.2
	mean ± s.e.	3.2 ± 1.0	0.6 ± 0.4	2.8 ± 1.3	1.4 ± 0.5	2.1 ± 1.0	1.5 ± 0.7	53.4 ± 24.7	10.8 ± 4.8	1112.7 ± 564.2	577.8 ± 311.1	0.7 ± 0.4	187.2 ± 91.0

*** QC 3 shrub data** = 1m^2, average & sum figures are converted to 1/10 m^2

Table 8. Releve locations and plant communities

Releve	Date	Latitude	Longitude	Elevation	Site		Description	Plant Community
C1	7/13/00	64.9077	163.6748	45m	Council, Seward Peninsula. Open white spruce/willow forest on gentle (3º) south-facing toe slope above Melsing Creek. Successional forest with even aged *Picea glauca* ~10-15 cm diameter. Undisturbed since logging 80 years ago.		forest	Moist *Picea glauca, Salix species, Vaccinium uliginosum* , *Hylocomium splendens,* evergreen tree, low-shrub forest
C2	7/11/00	64.8418	163.6930	43m	10 km west of Council, Seward Peninsula. Flat basins dissected by several small drainages. Interfluves - flat, hummocky with lichens, dwarf shrubs and sedges. Soils: pergelic sphagnohemist.	A	raised mossy hummocks	Moist *Rubus chamaemorus* , *Betula nana, Ledum decumbens, Sphagnum fuscum* erect dwarf-shrub, moss
						B	between hummocks	Moist *Cladonia arbusculoides, Cladonia rangiferina, Vaccinium uliginosum, Carex aquatilis* lichen, erect dwarf-shrub tundra
						C	wet depression	Wet *Eriophorum angustifolium, Sphagnum* spp. sedge, moss tundra
C3	7/14/00	64.9355	163.7357	86m	Ophir Creek, Council, Seward Peninsula. Shrubs on 5º slope, east side of creek. Dominated by *Betula glandulosa* and willows.	A	shrubby sites	Moist *Betula glandulosa, Salix glauca, Hylocomium splendens* low-shrub tundra
						B	clearings	Moist *Pentaphylloides floribunda, Vaccinium uliginosum, Festuca altaica, Hylocomium splendens, Salix reticulata* erect dwarf-shrub, graminoid tundra
C4	7/15/00	64.9074	163.6750	40m	Council, Seward Peninsula. Open woodland with low shrubs on hill above Melsing Creek. 2º slope to south.	A	shrub woodland	Moist *Salix pulchra, Betula glandulosa, Picea glauca* low-shrub woodland
						B	open clearings	Moist *Vaccinium uliginosum, Calamagrostis canadensis, Hylocomium splendens* low-shrub, graminoid, moss tundra
C5	7/12/00	64.7265	163.9407	356m	Between Solomon and Council, Seward Peninsula, 30 km west of Council. Small, low alpine knoll on top of limestone hill. Soil: pergelic cryochrept, on frost shattered limestone colluvium.	A	>50% cover	Dry *Dryas octopetala, Oxytropis bryophyla* prostrate dwarf-shrub, forb tundra
						B	< 50% cover, sorted stone nets	Dry *Dryas octopetala* barren complex
C6	7/19/00	64.8919	163.6470	113m	Blueberry Hill, Council, Seward Peninsula. Broad hillslope 1.5 km SE of Council. Shale derived colluvium, 10º slope to west.	A	moist interstripe areas dominated by dwarf shrubs	Moist *Betula nana, Ledum decumbens, Vaccinium uliginosum, Carex bigelowii, Sphagnum* species, dwarf shrub tundra
						B	stripes - lichens & dwarf shrubs	Moist *Cladonia* spp., *Empetrum nigrum* lichen dwarf-shrub tundra
C8	7/16/00	64.8423	163.7064	54m	10 km west of Council, Seward Peninsula,. 50 m northeast of Grid C1. Slight slope to SE, with shrubby drainages. Interfluve between small drainages. Soil: pergelic sphagnum fibrist	A	hummocks	Moist *Rubus chamaemorus, Empetrum nigrum, Vaccinium uliginosum, Sphagnum russowii* dwarf-shrub, moss tundra
						B	inter-hummocks	Moist *Cladonia* spp., *Carex aquatilis, Vaccinium uliginosum* lichen, sedge, dwarf-shrub tundra
C9	7/16/00	64.8852	163.3189	80m	Northeast side of Glacier Creek valley, 3/4 way down valley, and 2/3 of way down slope. 7º slope to southwest.		forest	Moist *Picea glauca, Vaccinium uliginosum, Empetrum nigrum* open conifer, low-shrub forest
C13	7/17/00	64.7577	163.8872	321m	Guy Rowe Creek, Seward Peninsula. Crest of rocky hill at east side of creek. 3º slope to south. Rocky torre area.		rocky alpine	Dry *Bryocaulon divergens, Umbillicaria proboscidea, Loiselurua procumbens, Ledum decumbens, Stereocaulon paschale, Arctous alpina* prostrate dwarf-shrub, lichen tundra

Table 8. Vegetation Communities (continued)

Releve	Date	Latitude	Longitude	Elevation	Site		Description	Plant Community
C14	7/17/00	64.7554	163.8874	246m	Guy Rowe Creek, Seward Peninsula. Hillsope below rocky outcrops, and above alders.	A	hillslope below rocky torres	Moist *Betula nana, Empetrum nigrens, Loiseluria procumbens, Stereocaulon tomentosum,* prostrate dwarf-shrub, lichen tundra
	7/17/00	64.7504	163.8907	179m		B	farther down hillslope, next to alders	Moist *Betula nana, Empetrum nigrens, Loiseluria procumbens, Stereocaulon tomentosum,* prostrate dwarf-shrub, lichen tundra
	7/17/00	64.7463	163.8989	150m		C	west bank of Guy Rowe Creek	Moist *Betula nana, Empetrum nigrens, Loiseluria procumbens, Stereocaulon tomentosum,* prostrate dwarf-shrub, lichen tundra
C15	7/17/00	64.7507	163.8938	174m	Guy Rowe Creek, Seward Peninsula. Dense alder shrub on slopes above east bank of creek. 4º south facing slope	A	dense tall shrub	Moist *Alnus crispa, Spirea beauvardiana, Calamagrostis canadensis* tall shrub tundra
						B	low-shrub graminoid meadow	Moist *Calamagrostis canadensis, Spirea beauvardiana, Salix pulchra* graminoid, low-shrub tundra
C16	7/17/00	64.7491	163.8977	133m	Guy Rowe Creek, Seward Peninsula. Low willow shrubs above east bank of creek. 5º S- facing slope.		low shrubs on rocky hillslope	Moist *Salix pulchra, Salix lanata low-shrub,* rock tundra
C17	7/17/00	64.9093	163.7076	223m	Council Mountain, Seward Peninsula. Near top of Council Mountain, 7º slope to south. 70% rocky limestone scree.		rocky scree	Dry *Dryas octopetala, Hedysarum mackenzii, Cetraria* spp., *Thamnolia subuliformis* prostrate dwarf-shrub, forb, lichen barren
C18	7/19/00	64.9383	163.7394	144m	Ophir Creek, Council, Seward Peninsula. Alders north of Ophir Creek, above grid plot C3. 2º slope to south.	A	alders	Moist *Alnus crispa* tall shrub
						B	openings	Moist *Salix glauca, Pentaphylloides floribunda, Calamagrostis canadensis* open low-shrub, graminoid, forb meadow
C19	7/19/00	64.9276	163.7418	76m	Ophir Creek, Council, Seward Peninsula. Shoulder of broad hillslope north of Ophir Creek. Slight slope to south.		tussock tundra	Moist *Eriophorum vaginatum, Rubus chamaemorus, Sphagnum* spp. dwarf-shrub, tussock tundra
BH1	7/19/00	7197595	563573	55m	Council, Seward Peninsula. North facing hill on south side of Melsing Creek, 3/4 km southeast of Council.		forest	Moist *Picea glauca, Betula glandulosa, Vaccinium uliginosum, Hylocomium splendens* low-shrub woodland
C-A	7/18/00	64.9021	163.7132	70m	Council Mountain, Seward Peninsula. Spruce forest above and below Ophir Creek Road, near Council Mountain trail		forest	Moist *Picea glauca, Salix lanata, Alnus crispa* open needleleaf forest
C-C	7/18/00	64.911	163.7189	150m	Council Mountain, Seward Peninsula. Southwest side of Council Mountain.		low-shrub	Moist *Betula glandulosa* , *Salix* spp. low-shrub tundra
C-D	7/18/00	64.911	163.714	220m	Council Mountain, Seward Peninsula. North side of Council Mountain, midslope. Probably snow accumulation area.		*Equisetum* areas	Moist *Equisetum arvense, Salix reticulata, Salix lanata, Tomenthypnum nitens* open low-shrub, dwarf-shrub, moss tundra
C-E	7/18/00	64.9129	163.7216	170m	Council Mountain, Seward Peninsula. Saddle between Council Mountain and north spur.		woodland	Moist *Picea glauca, Alnus crispa* , *Salix* spp. woodland, low-shrub tundra
C-H	7/18/00	64.9281	163.729	80m	Council Mountain, Seward Peninsula. North spur of Council Mountain, above Ophir Creek.		mountain side	Dry *Dryas integrifolia, Cetraria* spp. prostrate dwarf-shrub, lichen tundra
QC-1	7/23/00	65.4524	164.6248	248m	Quartz Creek, Seward Peninsula. Tussock tundra on slope of hill above Mauze Gulch, near headwaters. 4º west-facing slope.		tussock tundra	Moist *Eriophorum vaginatum, Ledum decumbens, Rubus chamaemorus, Sphagnum* spp. tussock graminoid, erect dwarf-shrub tundra

Table 8. Vegetation Communities (continued)

Releve	Date	Latitude	Longitude	Elevation	Site		Description	Plant Community
QC-2	7/22/00	65.4129	164.6337	250m	Quartz Creek, Seward Peninsula. Sorted stripe complex at the shoulder of the headwaters of Mauze Gulch. South facing hillside, 7º slope. Soils: histic pergelic cryaquept, with pergelic cryumbrept and pergelic cryorthent on frost features.	A	sorted stripe	Dry *Empetrum nigrum, Vaccinium uliginosum, Arctous alpina, Cladonia* spp. lichen, prostrate dwarf-shrub tundra
						B	interstripe	Moist *Betula nana, Salix pulchra, Carex bigelowii* erect dwarf-shrub tundra
						C	sorted circle	Dry *Loiseluria procumbens, Salix phlebophylla, Sphaerophorus fragilis, Bryocaulon divergens* lichen, prostrate dwarf-shrub barren
QC-3	7/25/00	65.4551	164.6290	221m	Quartz Creek, Seward Peninsula. Headwaters of Mauze Gulch. Low-shrubs in upper drainage, 5º slope to S. Soil: pergelic cryaquept.	A	low shrubs	Moist *Salix pulchra, Calamagrostis canadensis* low-shrub tundra
						B	clearings	Moist *Vaccinium uliginosum, Carex podocarpa, Solidago multiradiata, Hylocomium splendens* dwarf-shrub, graminoid meadow
CC	7/27/00	65.5479	163.4314	399m	Seward Peninsula lava flow southwest of Imiruk Lake. Cassiope Cone - cinder cone on northern edge of lava flow.	A	bottom of slope	Moist *Cassiope tetragona, Loiseluria procumbens, Vaccinium uliginosum, Cladonia* species, *Sphaerophorus globosus* prostrate dwarf-shrub, lichen tundra
						B	mid-slope	Moist *Cassiope tetragona, Loiseluria procumbens, Oxytropis bryophila, Hierochloe alpina, Cladonia* spp. prostrate dwarf-shrub, lichen tundra
						C	top of cone	Dry *Dryas octopetala, Beupleurum triradiatum, Potentilla uniflora* prostrate dwarf-shrub, forb, lichen tundra
LAVA	7/27/00	65.5341	163.5144	300m	Seward Peninsula lava flow, southwest of Imuruk Lake.	A	older brown lava rock	Dry *Lecidium* spp., *Stereocaulon vesuvianum* lichen barren
						B	younger black lava rock	Dry *Rhizocarpon geographicum, Umbillicaria proboscidea, Haematomma* spp. lichen barren
						C	finer-grained soil, vegetated	Moist *Loiseluria procumbens, Empetrum nigrum, Cladonia stellaris, Cetraria nivalis,* prostrate dwarf-shrub/lichen
QC25	7/29/00	64.9087	165.0687	211m	Kigluaik Mnts, Seward Peninsula. Tall alder stand and clearings north of Taylor Road, northeast of Salmon Lake. 7º slope, south facing.	A	alder stands	Moist *Alnus crispa* tall shrub
						B	clearings	Moist *Calamagrostis canadensis, Spirea beauvardiana, Senecio lugens* grass, forb meadow
QC35	7/29/00	64.9704	164.7593	146m	Kigluaik Mtns, Seward Peninsula. Flat river outwash plain. Soil: pergelic cryorthent.	A	vegetated	Dry *Betula nana, Loiseluria procumbens, Stereocaulon paschale* prostrate dwarf-shrub, lichen tundra
						B	more barren	Dry *Rhododendron camschatika, Loiseluria procumbens* dwarf-shrub, forb barren
QC38	7/28/00	65.0153	164.6971	279m	North of Kigluaik Mountains, Seward Peninsula. Top of hill, on northwest side of Taylor Road. Flat site with slight southern exposure. 10% frost scars. Soil: pergelic cryorthent.	A	inter frost scar	Dry *Empetrum nigrum, Loiseluria procumbens, Arctous alpina,* prostrate dwarf-shrub/lichen tundra
						B	frost scar	Dry *Dryas octopetala, Salix phelbophylla, Rhododendron camschatika,* prostrate dwarf-shrub/lichen barren
QC45	7/28/00	65.0932	164.6740	55m	Kigluaik Mtns, Seward Peninsula west of Taylor Road. Lichen tussock tundra on slight slope to NE. Soil: pergelic cryohemist dysic.		lichen tussock tundra	Moist *Eriophorum vaginatum* , *Cladonia* spp., *Sphagnum lenense* dwarf-shrub, lichen, tussock tundra
QC49	7/28/00	65.1539	164.7839	71m	Northern side of Kigluaik Mtns., Seward Peninsula. East side of Taylor Road, 20 miles south of Quartz Creek. 3º slope to west. Soil: histic pergelic cryaquept.		alder savannah, alders regularly spaced 2-3m apart, approx. 1m tall	Moist *Betula nana, Alnus crispa, Vaccinium uliginosum, Carex bigelowii* low-shrub, graminoid tundra

Table 9. Relevé characteristics (See Table 10 for codes)

Relevé	Slope degrees	Thaw depth (cm) mean ± s.e.	Aspect	Elevation (m)	GPS (UTM 3)	Land form	Surf geol	Surf geom	Microsites	Site moist	Soil moist	Glacial geol	Topo. pos.	Soil units	Exposure	Snow	Disturb	Stability
C1	3	57.2 ± 3.3	SW	80	7198626N 562705W	1	6	11	none	6	5 @ 10cm	unglaciated	3	9?	1	4	3 - moose scat. Logged 80 yrs ago, undisturbed since	1
C2	0	A 21.8 ± 0.7 B 21.6 ± 0.6 C 43.5 ± 1.5	none	43	7191269N 0561995W	18 valley or basin	loess?	moss hummocks	A- moss hummock, B - inter-hummock C- depression	A- 6, B- 6, C- 8	A- 6, B- 6, C- 9	unglaciated	4	A- pergelic sphagnohemist, B- 7, C- 7	2	4	0	1
C3	5	A 44.6 ± 1.6 B 52.1 ± 3.4	SW	86	7201670N 559763W	1	6	11	A-shrubby areas, B- clearings	6	5	unglaciated	2	10	2	4	0	1
C4	2	N/A	SW	~40		1	6	11	moss hummocks	6	5	unglaciated	2		2	4	1	1
C5	0-2	N/A	none	356	7178197N 550465W	1	6, frost shattered limestone colluvium	11	A- areas w/ > 50% cover, B- area w/ < 50% cover	3	2	unglaciated	1	11	4	2	1 - Dall sheep scat	1
C6	10	A 41.7 ± 2.9	W	113	7196904N 564061W	1	6	8	A- 9 B- 8	A- 6, B- 5	A- 6, B- 4	unglaciated	2		2.4	4	1 - vole holes & trails	A- 3, B- 2 (frostscars & solifluction
C8	1	A 27.2 ± 1.6 B 32.7 ± 1.4 C 20.5 ± 1.0	SE	54	50 m NE of 7191316N 561360W	valley	7	2 to 25cm	A-3, B- 4	A- 7, B- 8	A- 5, B- 7	unglaciated	4	7 or Pergelic Sphagnum fibrist	2	4	2 - lemming holes, litter, and something was plucking the lichens	1
C9	7	64.5 ± 2.7	SW	81	7196529N 0579612W	1	6	11 w/ moss hummocks	none	6	5	unglaciated	2	9, acidic or nonacidic?	1	4	1 - rare scat	1
C13	3	N/A	S	350	64 45.462N 163 53.232W	1	rocky torre area	1, 15		3	3	unglaciated	1		4	3	1	3 - wind/frost
C14	5	N/A	S	A- 270 B-200 C-150	A-64 45.321N 163 53.244W, B- 64 45.026N 163 53.441W, C- 64 44.778N 163 53.932W	1	6	11		5	3	unglaciated	2		2	4	1 - caribou scat	1

Table 9. Relevé characteristics (continued)

Relevé	Slope degrees	Thaw depth (cm) mean ± s.e.	Aspect	Elevation (m)	GPS (UTM 3)	Land form	Surf geol	Surf geom	Microsites	Site moist	Soil moist	Glacial geol	Topo. pos.	Soil units	Exposure	Snow	Disturb	Stability
C15	4	A 37.9 ± 3.9 B 44.3 ± 3.8	S	190	64 45.040N 163 53.627W	1	6	11		5	3	unglaciated	2		1	5	1 - bear trails, scat	1
C16	5	39.9 ± 1.9	S	120	64 44.947N 163 53.859W	1	6	11	12	5	5	unglaciated	2		2	5	0	1
C17	7	N/A	S	230	64 54.560N 163 42.454W	2	6	8	12	3	2	unglaciated	2		4	3	0	3
C18	2	A 46.9 ± 1.7 B 57.6 ± 2.5	S	160	64 56.295N 163 44.366W	1	6	11	A- tall alder shrubs B- graminoid forb meadow	5	5	unglaciated	2		1	5	1	1
C19	1	34.5 ± 1.7	S	80	64 55.653N 163 44.509W	1	6	13, tussocks		5			1		3	4	0	1
BH1	15	46.7 ± 1.9	none	55	7197595N 563573W	1	6	11		6	5	unglaciated	2	1	1	5	1 - hare/porc., moose trails, human litter. Logged ~90 years ago.	1
C-A		N/A		70	64 54.124N 163 42.791W	1	6	11	12	5		unglaciated	2		1	4	1 - bear sign	1
C-C	4	N/A	SW		64 54.657N 163 43.132W	1	6	11	12	5		unglaciated	2		2	4	1 - animal trails	1
C-D		N/A	N	220	64 54.658N 163 42.889W	1	6	14	mossy hummocks, some frost scar/lichen stripes, some small drainages	6		unglaciated	2		2	4	4 - vole clippings	3
C-E		N/A	W	170	64 54.775N 163 43.297W	1	6	11	12	5		unglaciated	2		2	4	1 - some trails	1

Table 9. Relevé characteristics (continued)

Relevé	Slope degrees	Thaw depth (cm) mean ± s.e.	Aspect	Elevation (m)	GPS (UTM 3)	Landform	Surf geol	Surf geom	Microsites	Site moist	Soil moist	Glacial geol	Topo. pos.	Soil units	Exposure	Snow	Disturb	Stability
C-H	30	N/A	N	80	64 55.683N 163 43.740W	2	6	8		3		unglaciated	2		4	4	1	4
QC-1	4	34.8 ± 3.4	W	248	7258740N 0517393W	1	6	11		6	6	unglaciated	2	7	3	4	1 - vole runways	1
QC-2	7	A 24.3 ± 3.1 B 49.8 ± 4.8	S	250	7259335N 517005W	1	6	8	A- 8, B- 9, C- 1	A- 4, B- 6, C- 3	A- 3	unglaciated	1	A- 12, B- 7, C- 1	3	3	1 A - something has been pulling lichens out B- voles C- ptarmigan scat, caribou skull	A- 3, B- 3, C- 4
QC-3	0-10	A 66.2 ± 3.1 B 62.6 ± 3.3	S	221	7259035N 0517196W	1	5, 6	14	none	6	5	unglaciated	5 network at valley head	10	1	5	2 moose, ptarmigan, muskox, vole	3
CC	A-7, B-7, C-0-2	N/A	N	A-399	7270230N 0572450W	lava dome	lava	15		A- 5, B- 5, C- 3	A- 3, B- 3	unglaciated	A- 3, B- 2, C- 1		A- 3, B- 3, C- 4	A- 5, B- 5, C- 3	1	1
LAVA	0	N/A	none	300	7268601N 0568652W	lava flow	lava	15		A,B-2, C-5	A,B-no soil, C-4	unglaciated	4		3	4	1	1
QC25		N/A	S	211	7198091N 0496749W	1	6	11	A- shrub B- clearings	6	4	unknown	2		1	4	1 - shrew	1
QC35	0	N/A	none	146	7204985N 511363W	4	5	11	A - vegetated depressions, B- barren raised areas	A- 4, B- 3	3	2	4	1	4	3		1
QC38	1	45.8 ± 2.9	S	279	7210000N 514277W	1	6	11 (10% frost scars)	A- 2, B- 1	3		unglaciated	1		4	3	1	2
QC45	1	A 46.3 ± 2.4 B 38.1 ± 3.7	NE	55	7218690N 0515319W	1	6	11		7	7	unglaciated	2	17 - pergelic cryohemist dysic	2	4	0	1
QC49	3	A 61.1 ± 3.6 B 40.2 ±2.4	W	71	7225436N 510130W	1	6	11		5	7	unglaciated	2	histic pergelic cryaquept	2	4	1	1

Table 9. Relevé Site Characteristics

Site	Additional notes appearing on the data sheets
C1	Successional stand, logged 80 yrs. ago, undisturbed since.
C2	C2 is on a flat interfluve between 2 small streams that are about 0.5km apart. Lichen, dwarf-shrub tundra and lichen tussock tundra occurs on most of these surfaces. The site has 3 main microsites: A - moss hummocks dominated by *Sphagnum fuscum* and erect dwarf-shrubs, B- lichen tundra w/ a few dwarf shrubs and *Carex aquatilis* , and C- depressions dominated by *Eriophorum angustifolium* and a mix of mosses and a few dwarf shrubs.
C5	Relevé is between F4 F3 E4 E3 in a more continuously vegetated portion of the grid (50-75% cover). Much of the grid has patchy vegetation w/ 25-40% cover. The patchy areas have sorted stone nets w/ cells 1-2m across. Stone nets are inactive.
C6	The grid has a few widely scattered *Picea glauca* and *Alnus crispa* . There are several water tracks w/ denser *Salix pulchra* nearby. Plot A excludes some frost scars which cover about 3% of the plot.
BH1	Numerous small trees and seedlings, small dead trees, not as many stumps as C1
C-D	Mossy hummocks with patches of *Salix lanata* , lots of vole clipped areas.
QC-3	Site is in a creek drainage.

Table 10. Relevé environmental site factors form

Study Site: ***Site Description***

Relevé No.: _____ Date: _____ Recording personnel: _____ Weather: _____

Study area description: _____

Slope (deg): _____ Thaw depth (cm): A: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Aspect: _____ B: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Elevation: _____ C: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Record numbers for all microsites.

Landforms

1 Hills (including kames and moraines)
2 Talus slope
3 Colluvial basin
4 Glaciofluvial and other fluvial terraces
5 Marine terrace
6 Floodplains
7 Drained lakes and flat lake margins
8 Abandoned point bars and sloughs
9 Estuary
10 Lake or pond
11 Stream
12 Sea bluff
13 Lake bluff
14 Stream bluff
15 Sand dunes
16 Beach
17 Disturbed
18 _____
19 _____
20 _____
21 _____

Surficial Geology (Parent Material)

1 Glacial tills
2 Glaciofluvial deposits
3 Active alluvial sands
4 Active alluvial gravels
5 Stabilized alluvium (sands & gravels)
6 Undifferentiated hill slope colluvium
7 Basin colluvium and organic deposits
8 Drained lake or lacustrine organic deposits
9 Lake or pond organic, sand, or silt
10 Undifferentiated sands
11 Undifferentiated clay
12 Roads and gravel pads
13 _____
14 _____
15 _____
16 _____

Surficial Geomorphology

1 Frost scars
2 Wetland hummocks
3 Turf hummocks
4 Gelifluction features
5 Strangmoor or aligned hummocks
6 High- or flat-centered polygons
7 Mixed high- and low-centered polygons
8 Sorted and non-sorted stripes
9 Palsas
10 Thermokarst pits
11 Featureless or with less 20% frost scars
12 Well-developed hillslope water tracks and small streams > 50 cm deep
13 Poorly developed hillslope water tracks, < 50 cm deep
14 Gently rolling or irregular microrelief
15 Stoney surface
16 Lakes and ponds
17 Disturbed
18 _____
19 _____
20 _____
21 _____

Microsites

1 Frost-scar element
2 Inter-frost scar element
3 Strang or hummock
4 Flark, interstrang, or interhummock area
5 Polygon center
6 Polygon trough
7 Polygon rim
8 Stripe element
9 Inter-stripe element
10 Point bar (raised element)
11 Slough (wet element)
12 _____
13 _____
14 _____
15 _____

Site Moisture (modified from Komárková 1983)

1 Extremely xeric - almost no moisture; no plant growth
2 Very xeric - very little moisture; dry sand dunes
3 Xeric - little moisture; stabilized sand dunes, dry ridge tops
4 Subxeric - noticeable moisture; well-drained slopes, ridges
5 Subxeric to mesic - very noticeable moisture; flat to gently sloping
6 Mesic-moderate moisture; flat or shallow depressions
7 Mesic to subhygric - considerable moisture; depressions
8 Subhygric - very considerable moisture; saturated but with < 5% standing water < 10 cm deep
9 Hygric - much moisture; up to 100% of surface under water 10 to 50 cm deep; lake margins, shallow ponds, streams
10 Hydric - very much moisture; 100% of surface under water 50 to 150 cm deep; lakes, streams

Soil Moisture (from Komárková 1983)

1 Very dry - very little moisture; soil does not stick together
2 Dry - little moisture; soil somewhat sticks together
3 Damp - noticeable moisture; soil sticks together but crumbles
4 Damp to moist - very noticeable moisture; soil clumps
5 Moist - moderate moisture; soil binds but can be broken apart
6 Moist to wet - considerable moisture; soil binds and sticks to fingers
7 Wet - very considerable moisture; water drops can be squeezed out of soil
8 Very wet - much moisture can be squeezed out of soil
9 Saturated - very much moisture; water drips out of soil
10 Very saturated - extreme moisture; soil is more liquid than solid

Glacial Geology

1 Till
2 Outwash
3 Bedrock
4 _____
5 _____
6 _____
7 _____

Topographic Position

1 Hill crest or shoulder
2 Side slope
3 Footslope or toeslope
4 Flat
5 Drainage channel
6 Depression
7 Lake or pond

Other notes: _____

Soil Units

1 Pergelic Cryorthent, acid
2 Pergelic Cryopsamment
3 Pergelic Cryohemist, euic
4 Pergelic Cryosaprist, euic
5 Lithic Pergelic Cryosaprist
6 Pergelic Cryofibrist, euic
7 Histic Pergelic Cryaquept, acid
8 Histic Pergelic Cryaquept, nonacid
9 Pergelic Cryaquept, acid
10 Pergelic Cryaquept, nonacid
11 Pergelic Cryochrept
12 Pergelic Cryumbrept
13 Ruptic-Lithic Cryumbrept
14 Pergelic Cryaquoll
15 Histic Pergelic Cryaquoll
16 Pergelic Cryoboroll
17 _____
18 _____
19 _____
20 _____

Exposure Scale

1 Protected from winds
2 Moderate exposure to winds
3 Exposed to winds
4 Very exposed to winds

Estimated Snow Duration

1 Snow free all year
2 Snow free most of winter; some snow cover persistsafter storm but is blown free soon afterward
3 Snow free prior to melt out but with snow most of winter
4 Snow free immediately after melt out
5 Snow bank persists 1-2 weeks after melt out
6 Snow bank persists 3-4 weeks after melt out
7 Snow bank persists 4-8 weeks after melt out
8 Snow bank persists 8-12 weeks after melt out
9 Very short snow free period
10 Deep snow all year

Animal and Human Disturbance

0 No sign present
1 Some sign present; no disturbance
2 Minor disturbance or extensive sign
3 Moderate disturbance; small dens or light grazing
4 Major disturbance; multiple dens or noticeable trampling
5 Very major disturbance; very extensive tunneling or large pit

Stability

1 Stable
2 Subject to occasional disturbance
3 Subject to prolonged but slow disturbance such as solifluction
4 Annually disturbed
5 Disturbed more than once annually

Table 11. Lifeform percent cover values

Relevé	Trees	Tall shrubs	Low shrubs	Dwarf shrubs	Evergreen shrubs	Deciduous shrubs	Forbs	Graminoids	Lichens	Bryophytes	Rocks	Bare soil	Water	Frost scars	Total dead	Canopy height (cm)	Comments
C1	10		35	30	5	50	5	5	+	65	0	0	0	0	10	trees - 10m, low shrubs 1.5m, dwarf shrubs 30cm	
C2 A			0	45	5	40	0	5	25	90	0	0	0	0	5	30	
C2 B			0	10	+	10	0	3	75	5	0	0	0	0	1	15	
C2 C			0	1	0	1	0	20	0	60	0	0	0	0	20	25	
C3 A			85	25	+	85	5	5	+	50	0	0	0	0	5	120	
C3 B			20	30	2	50	3	5	10	65	0	+	0	0	2	20	
C4 A	7		90	0	0	90	+	2	+	+	0	0	0	0	40	150	
C4 B	0		30	10	10	30	+	25	2	50	0	+	0	0	10	20	
C5 A			0	60	60	+	5	3	5	1	15	5	0	0	5	2	
C5 B			0	20	20	+	5	+	1	0	80	5	0	25	3	2	
C6 A			+	80	25	55	0	15	+	30	0	0	0	+	5	30	
C6 B			+	25	15	10	0	5	60	+	+	0	0	70 (stable frost scars)	3	5	
C8 A			0	45	25	25	+	3	15	90	0	0	0	0	3	7	
C8 B			0	10	2	8	0	15	10	15	0	0	0	0	10	25	
C9	30		25	40	15	75	2	2	5	85	0	0	0	0	5	trees to 15m, ave 10m low shrub to 120cm, dwarf shrub to 30cm	
C13			0	65 (prostrate)	50	15	+	+	30	3	15	2	0	5	+	3	
C14 A			0	70	50	20	+	1	25	+	1	0	0	0	0	4	
C14 B			1	70	40	30	+	2	80	+	1	0	0	0	0	15	
C14 C			0	25	15	10	+	1	70	+	2	3	0	5	+	5	
C15 A		100	0	0	0	100	5	2	0	+	0	0	0	0	60	300	
C15 B		0	30	5	5	30	5	25	0	+	0	0	0	0	40	60	
C16			100	0	0	100	5	2	0	5	0	5	0	0	40	200	
C17			0	25 (prostrate)	25	0	2	+	3	+	70	5	0	0	2	2	
C18 A		100	0	0	0	100	+	+	0	1	0	0	0	0	85	300	
C18 B		0	75	5	+	80	5	2	+	10	0	0	0	0	5	100	
C19			0	35	10	25	+	20	20	30	0	+	+	0	10		
BH1	30		55	60	25	75	2	5	2	50	0	0	0	0	15	trees 5-8m, low shrubs 150cm, dwarf shrubs 25cm	
C-A	25		50	10	+	60	5	2	+	50	0	0	0	0	15	trees 8m, shrubs 2m	
C-C			90	10	2	90	2	+	+	25	0	0	0	0	30	150	

Table 11. Lifeform percent cover values (continued)

Relevé	Trees	Tall shrubs	Low shrubs	Dwarf shrubs	Evergreen shrubs	Deciduous shrubs	Forbs	Graminoids	Lichens	Bryophytes	Rocks	Bare soil	Water	Frost scars	Total dead	Canopy height (cm)	Comments
C-D			10	70	5	75	+	+	15	95	0	0	0	0	3 (up to 50% in some areas clipped by voles)	10	Equisetum - 25%
C-E			80	10	+	90	3	+	r	15	0	0	0	0	30	trees 8m, Alnus 3m, Salix 1.5m, clearings 20cm	
C-F			0	50	50	0	4	1	5	1	50	5	0	0	5	5	
C-H				35 (prostrate)	35	+	1	1	10	+	50	5	0	0	2	10	
QC-1			0	30	20	10	0	60	+	5	0	+	0	0	20	30	
QC-2 A			25	+	20	5	+	5	65	5	1	1	0	1	5	10	
QC-2 B			+	70	10	60	+	15	+	25	0	0	0	0	5	25	
QC-2 C			5	0	3	2	+	2	40	+	30	15	0	100	2	2	
QC-3 A			80	5	85	0	20	5	+	5	0	0	0	0	10	150	
QC-3 B			+	10	5	5	40	40	0	30	0	0	0	0	10	25	
CC A				50 (40 prostrate, 10 erect)	35	15	+	2	40	+	10	0	0	0	5	3	
CC B				75 (70 prostrate, 5 erect)	50	25	2	5	45	+	10	0	0	0	10	5	
CC C				30 (prostrate)	30	+	5	+	10	+	50	+	0	+	10	3	
LAVA A			0	0	0	0	0	0	80	6	100	0	0	0	0	+	
LAVA B			0	0	0	0	0	0	90	1	100	0	0	0	0	+	
LAVA C			0	30	25	5	+	+	45	r	20	5	0	0	5	3	
QC25 A		65	30	5	2	98	2	5	+	5	0	0	0	0	10 (litter under alders 45)	450	ferns +, Equisetum +
QC25 B		0	5	15	2	18	25	40	+	+	0	0	0	0	20	40	ferns 0, Equisetum +
QC35 A			0	45	30	15	+	+	35	+	5	+	0	10	5	3	microrelief - 5
QC35 B			0	15	10	5	+	0	35	+	80	5	0	15	2	2	microrelief - 3
QC38 A			0	45	20	25	+	+	55	+	15	5	0	10	1	3	microrelief - 5
QC38 B			0	5	2	3	+	0	20	+	70	5	0	100	+	2	microrelief - 10
QC45			0	25	12	12	+	30	30	25	0	+	+	+	7	20	15cm tussocks
QC49			70	10	10	70	+	10	+	2	0	0	0	0	10	low shrubs 50, alders 100	microrelief 30cm

Table 12 Relevé species

Plot names	C1	C2-A	C2-B	C2-C	C3-A	C3-B	C4-A	C4-B	C5-A	C5-B	C6-A	C6-B	C8-A	C8-B	C9	C13	C14-A	C14-B	C14-C	C15-A	C15-B	C16	C17	C18-A	C18-B	C19
Aconitum delphiniifolium s. delphiniif	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Alectoria nigricans	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.
Alectoria ochroleuca	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	r	.	.	.	.	.	.	+	.	.	.
Alnus viridis s. crispa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	5	.	.
Alopecurus borealis	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anastrophyllum minutum	.	.	r	r	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	r
Andromeda polifolia	r	+	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Androsace chamaejasme	r	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Anemone narcissiflora	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	.	+	.	.	.	+	.	.	.
Anemone parviflora	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
Anemone richardsonii	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Antennaria friesiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Arctagrostis latifolia	r	.	.	.	+	+	.	+	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Arctostaphylos alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	+	.	.	.	.	.	.	.
Arctostaphylos rubra	1	.	.	.	1	2	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Arnica alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	.	.	.
Arnica lessingii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia arctica	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Artemisia frigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Artemisia globularia	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Artemisia senjavinensis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asahinea chrysantha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Aster sibiricus	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Aulacomnium palustre	+	.	.	+	+	1	+	1	.	.	.	.	+	+	1	.	.	.	.	.	.	.	.	.	.	.
Aulacomnium turgidum	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+
Betula nana	+	2	+	+	3	2	2	+	.	.	2	1	1	.	2	.	3	3	2	.	1	.	.	.	1	1
Boykinia richardsonii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium reflexum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Braya glabella s. glabella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryocaulon divergens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.
Bryoria nitidula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Bryum pseudotriquetrum	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Bupleurum americanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Calamagrostis canadensis	.	.	.	r	.	.	1	2	.	.	.	+	.	.	1	.	.	.	.	1	2	1	.	+	+	.
Calamagrostis purpurascens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calamagrostis stricta s. inexpansa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calliergon stramineum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Caloplaca cerina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Calypogeja species	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campanula lasiocarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	.	.	.	.	.	.
Campanula uniflora	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Cardamine digitata	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine pratensis	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine purpurea	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex aquatilis	.	+	1	+	.	.	.	.	.	.	.	.	2	+	.	.	.	.	.	.	.	.	.	.	.	.
Carex bigelowii	+	.	.	.	.	+	.	1	+	.	2	+	.	.	.	+	+	1	1	.	.	.	.	.	.	+
Carex capillaris	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex lugens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex membranacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex misandra	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Carex nardina	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex podocarpa	1	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	+	.
Carex rupestris	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Carex scirpoidea	+	.	.	.	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex supina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Carex vaginata	r	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cassiope tetragona	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Castilleja caudata	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Castilleja elegans	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	.
Catoscopium nigritum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Cerastium beeringianum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Ceratodon purpureus	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cetraria aculeata	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Cetraria islandica	+	.	.	.	.	.	.	+	.	r	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
Cetraria kamczatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.
Cetraria laevigata	.	3	+	.	+	+	.	.	.	.	.	1	2	.	r	+	+	+	1	.	.	.	.	.	.	1
Cetraria nigricans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cetraria species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cetrariella delisei	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Chamaedaphne calyculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirriphyllum cirrosum	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladina arbuscula	+	+	3	.	+	+	.	.	.	.	+	3	+	2	1	1	1	1	2	.	.	.	.	.	.	1
Cladina mitis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladina rangiferina	.	+	3	.	r	1	.	+	.	.	+	2	+	2	1	.	.	.	.	.	.	.	.	.	.	.
Cladina stellaris	+	.	r	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Cladina stellaris v. aberrans	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	+	.	.	.	.	.	.	+
Cladina stygia	.	+	3	.	.	r	.	+	.	.	+	+	+	+	+	+	1	2	2	.	.	.	.	.	.	1
Cladonia acuminata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.
Cladonia amaurocraea	.	+	+	.	.	.	.	.	.	.	+	+	1	+	.	.	.	.	.	.	.	.	.	.	.	+
Cladonia bellidiflora	.	.	.	.	.	.	.	.	.	.	.	.	r	r	r	.	.	.	.	.	.	.	.	.	.	.
Cladonia cenotea	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia chlorophaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
Cladonia coccifera	.	.	r	.	.	.	.	.	.	.	.	.	+	.	.	r	r	.	+	.	.	.	.	.	.	+
Cladonia cornuta	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia crispata	.	.	+	.	.	.	.	+	.	.	.	.	1	+	r	.	.	.	.	.	.	.	.	.	.	.
Cladonia cyanipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 12 Relevé species (cont.)

Plot names	C1	C2-A	C2-B	C2-C	C3-A	C3-B	C4-A	C4-B	C5-A	C5-B	C6-A	C6-B	C8-A	C8-B	C9	C13	C14-A	C14-B	C14-C	C15-A	C15-B	C16	C17	C18-A	C18-B	C19
Cladonia deformis	.	+	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia ecmocyna	+	.	.	.	+	1	.	+	.	.	.	.	.	.	r	.	+	+	+	.	.	.	.	.	+	.
Cladonia furcata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia gracilis	.	+	+	.	.	+	.	.	.	.	.	+	+	1	.	.	.	.	.	.	.	.	.	.	.	+
Cladonia macrophylla	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia maxima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Cladonia metacorallifera	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	r
Cladonia nipponica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia phyllophora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Cladonia pyxidata	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia scabriuscula	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Cladonia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia squamosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Cladonia subfurcata	.	.	1	.	.	.	.	.	.	.	+	+	.	.	r	+	.	.	.	.	.	.	.	.	.	.
Cladonia sulphurina	.	+	+	.	.	.	.	.	.	.	.	.	r	r	r	.	.	.	.	.	.	.	.	.	.	+
Cladonia uncialis	.	.	+	.	.	+	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Claytonia sarmentosa	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Climacium dendroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Cornus suecica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Ctenidium species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Cystopteris montana	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylina arctica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylina beringica	.	.	.	.	.	+	.	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylina madreporiformis	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylina ramulosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Diapensia lapponica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.
Dichanthelium scoparium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum acutifolium	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Dicranum angustum	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum elongatum	.	1	+	+	.	.	.	.	.	.	+	+	+	.	r	+	.	.	.	.	.	.	.	.	.	+
Dicranum fuscescens v. fuscescens	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum groenlandicum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum majus	1	.	.	.	.	.	.	+	.	.	.	.	+	.	1	.	.	.	.	.	+	.	.	.	.	+
Dicranum spadiceum	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
Dicranum undulatum	.	.	.	.	.	.	r	r	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	1	.
Ditrichum flexicaule	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Dodecatheon frigidum	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
Doellingeria umbellata	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dryas integrifolia	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dryas octopetala	.	.	.	.	.	.	.	.	4	2	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.
Dryopteris expansa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Empetrum nigrum	1	1	+	.	+	+	+	2	.	.	1	2	2	.	3	+	2	1	2	.	+	.	.	.	+	+
Epilobium angustifolium	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Equisetum arvense	+	.	.	.	2	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	+	+	.
Equisetum pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Equisetum scirpoides	+	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
Equisetum sylvaticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Equisetum variegatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriophorum angustifolium	.	.	.	2	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriophorum vaginatum	.	+	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
Evernia divaricata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Festuca altaica	+	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca rubra	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	+	.	.	.	.	.	.	.	.	+	.
Flavocetraria cucullata	.	+	.	.	.	.	.	.	+	+	.	.	+	.	.	1	+	+	1	.	.	.	+	.	.	+
Flavocetraria nivalis	.	.	.	.	.	r	.	.	+	+	.	.	.	.	.	+	+	+	+	.	.	.	1	.	.	.
Galium boreale	+	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
Gentianella propinqua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.
Gymnocolea species	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hedysarum alpinum	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Hedysarum boreale s. mackenziei	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Hierochloe alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Huperzia selago v. selago	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hylocomiastrum pyrenaicum	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hylocomium splendens	3	.	.	.	3	4	+	3	.	.	r	.	.	.	2	.	.	.	.	.	+	.	.	+	1	.
Hypnum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypogymnia subobscura	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Icmadophila ericetorum	.	+	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+
Iris setosa	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lagotis glauca	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Lecanora epibryon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Lecanora species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecidea species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ledum palustre s. decumbens	.	1	+	.	r	r	.	1	.	.	2	1	1	1	.	2	2	2	1	.	+	.	.	.	.	+
Lesquerella arctica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Leucanthemum integrifolium	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Limprichtia revolvens	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linnaea borealis	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Lloydia serotina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Lobaria linita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.
Loiseleuria procumbens	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	2	.	2	.	.	.	.	.	.	.
Lophozia species	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.
Luzula arctica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula confusa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula multiflora	r	.	.	.	.	+	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Luzula parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycopodium annotinum	r	.	.	.	r	r	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.

Table 12 Relevé species (cont.)

Plot names	C1	C2-A	C2-B	C2-C	C3-A	C3-B	C4-A	C4-B	C5-A	C5-B	C6-A	C6-B	C8-A	C8-B	C9	C13	C14-A	C14-B	C14-C	C15-A	C15-B	C16	C17	C18-A	C18-B	C19
Lycopodium complanatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Marchantia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Masonhalea richardsonii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Megaspora verrucosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Mertensia paniculata	+	.	.	.	1	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.
Minuartia arctica	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Minuartia rossii	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mnium ambiguum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
Moehringia lateriflora	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	+	.
Moneses uniflora	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Myosotis asiatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nephroma arcticum	.	.	r	.	.	.	+	+	.	.	+	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.
Nephroma expallidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ochrolechia frigida	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	1	.	.	.	.	.	.	+	.	.	.
Ochrolechia upsaliensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Oncophorus wahlenbergii	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthilia secunda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Orthothecium species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis maydelliana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis mertensiana	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis nigrescens v. nigrescens	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.
Papaver macounii	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
Parmelia omphalodes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Parrya nudicaulis	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	+	.	r	.	.	.	+	.	.	.
Pedicularis capitata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis kanei	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	+	+	.	+	.	.	.	+	.	.	.
Pedicularis labradorica	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Pedicularis langsdorfii	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis sudetica	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis verticillata	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltigera aphthosa	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Peltigera hymenina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltigera leucophlebia	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	+	.
Peltigera malacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.
Peltigera scabrosa	.	r	.	.	.	.	.	.	.	.	1	+	.	+	.	.	.	+	.	.	.	.	.	.	.	+
Pentaphylloides floribunda	+	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	2	.
Pertusaria coriacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	r	.	.	.
Pertusaria dactylina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pertusaria panyrga	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	r	.	.	.
Petasites frigidus	r	.	.	.	r	.	+	+	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	.
Phlox sibirica	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Picea glauca	2	.	.	.	r	.	2	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Picea mariana	.	r	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pinguicula vulgaris	.	r	r	r	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiomnium ellipticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Plagiothecium berggrenianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiothecium denticulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.
Platanthera obtusata	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleurozium schreberi	3	+	.	.	.	.	r	r	.	.	1	.	1	+	3	.	.	.	.	.	.	.	.	.	.	+
Poa alpina	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
Poa arctica s. lanata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa glauca	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa pratensis	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa species	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Podistera species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pohlia nutans	.	+	.	+	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	+	.	.
Polemonium acutiflorum	+	.	.	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	+	.
Polygonum bistorta	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	+	.
Polygonum viviparum	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polytrichum commune	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	+	+	.	.	.	.	.
Polytrichum commune v. jensenii	.	+	.	+	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.
Polytrichum hyperboreum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polytrichum juniperinum	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Polytrichum piliferum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Polytrichum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polytrichum strictum	+	.	.	.	.	.	+	1	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.
Populus balsamifera	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla biflora	.	.	.	.	.	.	.	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla elegans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla nivea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla uniflora	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Pseudephebe pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptilidium species	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptilium crista	ml	.	.	.	.	+	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Pyrola grandiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Racomitrium lanuginosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhizocarpon species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhododendron lapponicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhytidiadelphus triquetrus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Rhododendron camtschaticu s. camtscha	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	1	+	.	+	.	.	.	.	.	.	.
Rhytidium rugosum	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ribes triste	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 12 Relevé species (cont.)

Plot names	C1	C2-A	C2-B	C2-C	C3-A	C3-B	C4-A	C4-B	C5-A	C5-B	C6-A	C6-B	C8-A	C8-B	C9	C13	C14-A	C14-B	C14-C	C15-A	C15-B	C16	C17	C18-A	C18-B	C19
Rinodina roscida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Rubus arcticus	1	.	.	.	.	.	+	1	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.
Rubus chamaemorus	.	3	1	.	.	.	.	.	.	.	2	.	2	+	.	.	.	.	.	.	.	.	.	.	.	2
Rumex acetosa	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex arcticus	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix alaxensis	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix arctica	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Salix brachycarpa	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix chamissonis	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix glauca	+	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Salix hastata	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Salix lanata	2	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	2	.
Salix ovalifolia v. cyclophylla	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix phlebophylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	1	.	.	.	.	.	.	.
Salix planifolia s. pulchra	+	.	.	r	1	.	3	.	.	.	1	.	.	.	3	.	r	+	+	.	1	3	.	.	.	.
Salix reticulata	1	.	.	.	2	1	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Salix species	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sanguisorba officinalis	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Sanionia uncinata	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.
Saussurea angustifolia	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Saxifraga bronchialis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga hieraciifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga hirculus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga nelsoniana	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Saxifraga oppositifolia	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Scapania species	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Sedum rosea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Selaginella rupestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Senecio atropurpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio conterminus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio cymbalaria	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Senecio lugens	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Silene acaulis	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Smelowskia calycina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Solidago multiradiata	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	r	.	+	+	.
Sphaerophorus fragilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphaerophorus globosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Sphagnum aongstroemii	.	.	.	r	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Sphagnum balticum	.	.	.	2	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	r
Sphagnum fimbriatum	.	r	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum girgensohnii	.	r	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum lenense	.	5	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	.	.	.	.	.	.	2
Sphagnum lindbergii	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum rubellum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum russowii	.	.	.	.	.	.	.	.	.	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum squarrosum	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Sphagnum warnstorfii	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Spiraea stevenii	r	.	.	.	.	.	.	.	.	.	+	.	.	.	1	+	r	+	.	2	2	.	.	.	.	.
Splachnum species	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria calycantha	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria dicranoides	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Stellaria longipes	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria longipes s. longipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stereocaulon alpinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stereocaulon paschale	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Stereocaulon tomentosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	.	.	.
Stereocaulon vesuvianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tetraplodon species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thalictrum alpinum	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	+	.
Thamnolia subuliformis	.	.	.	.	.	.	.	.	1	+	.	+	r	.	.	.	+	+	+	.	.	.	1	.	.	.
Thamnolia vermicularis	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Tofieldia coccinea	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.
Tomentypnum nitens	r	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortella tortuosa	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trientalis europaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.
Trisetum spicatum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tritomaria species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Umbilicaria hyperborea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Umbilicaria proboscidea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Umbilicaria rigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium oxycoccos	.	1	.	+	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+
Vaccinium uliginosum	2	2	2	+	2	2	.	3	.	.	2	1	2	1	2	+	3	3	2	.	1	+	.	.	1	1
Vaccinium vitis	s2	+	+	1	.	r	r	.	1	.	.	1	+	+	.	1	1	1	1	1	.	.	.	.	.	.
Valeriana capitata	+	.	.	.	1	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Veratrum album	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viburnum edule	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viola species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.
Vulpicida tilesii	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Warnstorfia fluitans	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Woodsia alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Woodsia X gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zigadenus elegans	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 12 Relevé species (cont.)

Plot names	BH1	C-A	C-C	C-D	C-E	C-F	C-H	QC-1	QC2-A	QC2-B	QC2-C	QC3-A	QC3-B	CC-A	CC-B	LAVA-A	LAVA-B	LAVA-C	QC25-A	QC25-B	QC35-A	QC35-B	QC38-A	QC38-B	QC45	QC49
Aconitum delphiniifoliu s. delphinii	+	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.
Alectoria nigricans	.	.	.	.	.	.	.	.	.	.	1	.	.	2	3	.	.	+	.	.	r	r	1	+	.	.
Alectoria ochroleuca	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	1	2	.	.	+	+	2	+	.	.
Alnus viridis s. crispa	.	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	2
Alopecurus borealis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anastrophyllum minutum	.	.	.	.	.	.	.	.	r	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	r	.
Andromeda polifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Androsace chamaejasme	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anemone narcissiflora	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Anemone parviflora	.	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Anemone richardsonii	.	.	+	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Antennaria friesiana	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.
Arctagrostis latifolia	.	.	.	.	.	.	.	.	+	+	1	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.
Arctostaphylos alpina	.	.	.	.	.	.	.	.	1	1	.	.	.	+	+	.	.	.	.	.	2	+	2	.	+	.
Arctostaphylos rubra	+	.	+	1	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Arnica alpina	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arnica lessingii	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia arctica	.	+	+	.	+	.	.	.	.	.	.	+	2	.	.	.	.	.	.	1	.	.	.	.	.	.
Artemisia frigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia globularia	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia senjavinensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asahinea chrysantha	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	+	+	+	+	.	.
Aster sibiricus	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aulacomnium palustre	2	.	1	1	.	.	.	1	.	+	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	+
Aulacomnium turgidum	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Betula nana	3	1	2	.	1	.	.	1	1	3	.	1	+	1	1	.	.	1	.	.	2	1	r	.	2	4
Boykinia richardsonii	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium reflexum	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	r	.	.	.	.	.	.	.
Braya glabella s. glabella	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryocaulon divergens	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	+	.	.	+	1	3	+	.	.
Bryoria nitidula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum pseudotriquetrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bupleurum americanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calamagrostis canadensis	+	.	+	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	2	2	.	.	.	.	.	.
Calamagrostis purpurascens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Calamagrostis stricta s. inexpansa	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calliergon stramineum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Caloplaca cerina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calypogeja species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campanula lasiocarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Campanula uniflora	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	r	r	+	+	.	.
Cardamine digitata	r	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine pratensis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine purpurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex aquatilis	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Carex bigelowii	.	.	.	+	.	.	.	1	1	2	+	.	.	1	1	.	.	.	.	.	+	.	+	.	+	2
Carex capillaris	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex lugens	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex membranacea	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex misandra	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex nardina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Carex podocarpa	1	+	.	.	+	.	.	.	.	.	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex rupestris	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex scirpoidea	.	+	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex supina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Carex vaginata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cassiope tetragona	.	.	.	+	+	.	+	.	+	.	+	.	.	1	+	.	.	+	.	.	.	.	.	.	.	.
Castilleja caudata	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Castilleja elegans	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catoscopium nigritum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium beeringianum	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Ceratodon purpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cetraria aculeata	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cetraria islandica	+	.	+	1	.	.	+	.	+	+	+	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.
Cetraria kamczatica	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	r	r	r	.	.	.
Cetraria laevigata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	+	+	+	+	.
Cetraria nigricans	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	+	.	.	.	1	.	1	.	.
Cetraria species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.
Cetrariella delisei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamaedaphne calyculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Cirriphyllum cirrosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladina arbuscula	+	.	.	.	.	.	.	.	3	+	+	.	.	2	1	.	.	1	.	.	.	.	.	.	3	+
Cladina mitis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Cladina rangiferina	+	.	+	+	.	.	.	.	2	+	+	.	.	2	+	.	.	1	.	.	+	+	r	r	.	.
Cladina stellaris	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	+	+	1	+	1	.
Cladina stellaris v. aberrans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladina stygia	+	.	+	.	.	.	.	+	r	.	.	.	.	.	.	.	.	r	.	.	r	r	.	.	2	+
Cladonia acuminata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia amaurocraea	+	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	r	.	.	.	.	+	.	+	.
Cladonia bellidiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia cenotea	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Cladonia chlorophaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia coccifera	+	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	r	r	+	.	.	+
Cladonia cornuta	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	+
Cladonia crispata	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.
Cladonia cyanipes	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 12 Relevé species (cont.)

Plot names	BH1	C-A	C-C	C-D	C-E	C-F	C-H	QC-1	QC2-A	QC2-B	QC2-C	QC3-A	QC3-B	CC-A	CC-B	LAVA-A	LAVA-B	LAVA-C	QC25-A	QC25-B	QC35-A	QC35-B	QC38-A	QC38-B	QC45	QC49
Cladonia deformis	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia ecmocyna	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.
Cladonia furcata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.
Cladonia gracilis	+	.	+	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Cladonia macrophylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia maxima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia metacorallifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia nipponica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	+	+	.	.
Cladonia phyllophora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia pyxidata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Cladonia scabriuscula	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia species	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia squamosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.
Cladonia subfurcata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	r	r	r	.
Cladonia sulphurina	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cladonia uncialis	.	.	.	.	.	.	.	.	2	.	.	.	.	+	+	.	.	.	.	.	+	.	+	.	.	.
Claytonia sarmentosa	+	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Climacium dendroides	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Cornus suecica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.
Ctenidium species	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cystopteris montana	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylina arctica	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Dactylina beringica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylina madreporiformis	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylina ramulosa	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diapensia lapponica	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	+	.	.	+	+	+	+	.	.
Dichanthelium scoparium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Dicranum acutifolium	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum angustum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum elongatum	.	1	.	.	.	.	.	1	r	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	r	+
Dicranum fuscescens v. fuscescen	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum groenlandicum	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Dicranum majus	2	.	.	.	.	.	.	.	r	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	+
Dicranum spadiceum	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.
Dicranum species	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum undulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ditrichum flexicaule	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dodecatheon frigidum	1	.	+	.	+	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Doellingeria umbellata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dryas integrifolia	.	.	.	1	+	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dryas octopetala	.	.	.	.	.	3	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	r	.	1	.	.
Dryopteris expansa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Empetrum nigrum	3	+	+	.	+	.	.	+	3	+	1	+	1	+	+	.	.	1	.	+	2	1	2	.	1	+
Epilobium angustifolium	+	.	.	r	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Equisetum arvense	+	+	+	3	+	.	.	.	+	1	+	+	+	.	.	.	.	.	+	1	.	.	.	.	.	1
Equisetum pratense	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Equisetum scirpoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Equisetum sylvaticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Equisetum variegatum	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriophorum angustifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriophorum vaginatum	.	.	.	.	.	.	.	4	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1
Evernia divaricata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca altaica	+	.	.	.	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca rubra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Flavocetraria cucullata	.	.	.	1	.	1	+	.	1	+	+	.	.	1	1	.	.	+	.	.	+	+	1	+	+	.
Flavocetraria nivalis	.	.	.	+	.	1	1	.	1	.	+	.	.	1	1	.	.	2	.	.	+	+	1	+	+	.
Galium boreale	+	+	.	.	+	.	.	.	.	.	.	1	+	.	.	.	.	.	+	+	.	.	.	.	.	.
Gentianella propinqua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gymnocolea species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hedysarum alpinum	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hedysarum boreale s. mackenziei	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hierochloe alpina	.	.	.	.	.	.	.	.	1	.	+	.	.	.	+	.	.	.	.	.	+	.	+	+	.	.
Huperzia selago v. selago	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hylocomiastrum pyrenaicum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.
Hylocomium splendens	3	2	+	2	.	.	.	.	.	+	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	+
Hypnum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Hypogymnia subobscura	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Icmadophila ericetorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.
Iris setosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lagotis glauca	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora epibryon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.	rim lichen
Lecidea species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	+	.	.	.	.	.	.	.	.	.
Ledum palustre s. decumbens	.	.	+	.	.	.	.	2	1	1	+	+	+	1	+	.	.	1	.	.	2	+	1	.	1	1
Lesquerella arctica	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucanthemum integrifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limprichtia revolvens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Linnaea borealis	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Lloydia serotina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
Lobaria linita	.	.	.	.	.	.	.	.	.	.	r	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Loiseleuria procumbens	.	.	.	.	.	.	.	.	+	.	1	.	.	3	2	.	.	2	.	.	1	2	2	+	.	.
Lophozia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula arctica	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula confusa	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.
Luzula multiflora	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
Luzula parviflora	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycopodium annotinum	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	+	.	.	.	.	.	.	.

Table 12 Relevé species (cont.)

Plot names	BH1	C-A	C-C	C-D	C-E	C-F	C-H	QC-1	QC2-A	QC2-B	QC2-C	QC3-A	QC3-B	CC-A	CC-B	LAVA-A	LAVA-B	LAVA-C	QC25-A	QC25-B	QC35-A	QC35-B	QC38-A	QC38-B	QC45	QC49
Lycopodium complanatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Marchantia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Masonhalea richardsonii	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Megaspora verrucosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mertensia paniculata	+	1	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Minuartia arctica	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	r	.	.	.	+	.	.	.	.
Minuartia rossii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mnium ambiguum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Moehringia lateriflora	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Moneses uniflora	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myosotis asiatica	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nephroma arcticum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Nephroma expallidum	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ochrolechia frigida	.	.	.	.	.	+	.	.	.	.	1	.	.	+	+	.	+	1	.	.	.	+	+	1	.	.
Ochrolechia upsaliensis	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oncophorus wahlenbergii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthilia secunda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orthothecium species	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis maydelliana	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis mertensiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxytropis nigrescens v. nigrescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	+	.	.
Papaver macounii	+	+	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Parmelia omphalodes	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.
Parrya nudicaulis	.	.	.	.	.	+	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis capitata	.	.	+	+	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis kanei	.	.	.	+	.	+	+	.	+	.	.	.	.	+	+	.	.	+	.	.	+	+	+	+	.	.
Pedicularis labradorica	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis langsdorfii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis sudetica	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pedicularis verticillata	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltigera aphthosa	+	.	+	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltigera hymenina	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltigera leucophlebia	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+
Peltigera malacea	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltigera scabrosa	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Pentaphylloides floribunda	1	1	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.
Pertusaria coriacea	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pertusaria dactylina	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pertusaria panyrga	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Petasites frigidus	.	.	+	.	+	.	.	.	+	+	+	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Phlox sibirica	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Picea glauca	3	2	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Picea mariana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pinguicula vulgaris	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiomnium ellipticum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiothecium berggrenianum	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiothecium denticulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Platanthera obtusata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleurozium schreberi	1	2	1	.	1	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.
Poa alpina	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa arctica s. lanata	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa glauca	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa pratensis	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Podistera species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Pohlia nutans	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Polemonium acutiflorum	+	.	+	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.
Polygonum bistorta	+	.	.	.	.	.	.	.	+	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Polygonum viviparum	.	.	.	r	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Polytrichum commune	.	.	.	.	.	.	.	1	.	.	.	1	+	.	.	.	.	.	+	+	.	.	.	.	.	.
Polytrichum commune v. jensenii	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.
Polytrichum hyperboreum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Polytrichum juniperinum	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Polytrichum piliferum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.
Polytrichum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Polytrichum strictum	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Populus balsamifera	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla biflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla elegans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Potentilla nivea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Potentilla uniflora	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudephebe pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.
Ptilidium species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptilium crista	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pyrola grandiflora	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Racomitrium lanuginosum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	2	1	1	.	.	1	+	.	.	.	.
Rhizocarpon species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.
Rhododendron lapponicum	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhytidiadelphus triquetrus	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhododendron camtschaticu s. camtscha	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	1	+	1	.	.
Rhytidium rugosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ribes triste	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 12 Relevé species (cont.)

Plot names	BH1	C-A	C-C	C-D	C-E	C-F	C-H	QC-1	QC2-A	QC2-B	QC2-C	QC3-A	QC3-B	CC-A	CC-B	LAVA-A	LAVA-B	LAVA-C	QC25-A	QC25-B	QC35-A	QC35-B	QC38-A	QC38-B	QC45	QC49
Rinodina roscida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus arcticus	1	+	+	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	+	1	.	.	.	.	.	.
Rubus chamaemorus	.	.	.	.	.	.	.	2	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+
Rumex acetosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex arcticus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix alaxensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix arctica	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix brachycarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix chamissonis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix glauca	1	2	2	.	3	.	.	.	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix hastata	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix lanata	+	1	+	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix ovalifolia v. cyclophylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix phlebophylla	.	.	.	.	.	.	.	.	+	.	1	.	.	+	+	.	.	+	.	.	+	+	.	1	.	.
Salix planifolia s. pulchra	2	.	2	.	.	.	.	+	.	2	.	5	+	+	.	.	.	.	.	1	.	.	.	.	.	+
Salix reticulata	+	+	+	3	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sanguisorba officinalis	r	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sanionia uncinata	.	+	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+
Saussurea angustifolia	+	.	.	+	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga bronchialis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Saxifraga hieraciifolia	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga hirculus	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Saxifraga nelsoniana	+	.	+	.	.	.	.	.	+	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	+
Saxifraga oppositifolia	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scapania species	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sedum rosea	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.
Selaginella rupestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio atropurpureus	.	.	.	r	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio conterminus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Senecio cymbalaria	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio lugens	.	+	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	+	.	1	.	.	.	.	.	.
Silene acaulis	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Smelowskia calycina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solidago multiradiata	+	+	.	+	+	.	.	.	.	.	.	+	2	.	.	.	.	.	.	+	.	.	.	.	.	.
Sphaerophorus fragilis	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphaerophorus globosus	.	.	.	.	.	.	.	.	.	.	r	.	.	1	1	.	.	+	.	.	+	+	+	+	.	.
Sphagnum aongstroemii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum balticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Sphagnum fimbriatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum girgensohnii	.	.	.	.	.	.	.	2	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Sphagnum lenense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Sphagnum lindbergii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum rubellum	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum russowii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum squarrosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sphagnum warnstorfii	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spiraea stevenii	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	2	3	.	.	.	.	.	.
Splachnum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria calycantha	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria dicranoides	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria longipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria longipes s. longipes	.	.	.	.	.	.	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria species	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stereocaulon alpinum	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stereocaulon paschale	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	3	+	1	.	.	.
Stereocaulon tomentosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stereocaulon vesuvianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.
Tetraplodon species	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Thalictrum alpinum	.	+	.	+	+	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thamnolia subuliformis	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	1	.	.	.	.
Thamnolia vermicularis	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	+	.	.	+	1	+	+	.	.
Tofieldia coccinea	.	.	.	.	+	+	1	.	.	.	+	.	.	.	+	.	.	+	.	.	.	.	.	+	.	.
Tomentypnum nitens	.	.	.	2	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tortella tortuosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trientalis europaea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.
Trisetum spicatum	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tritomaria species	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Umbilicaria hyperborea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.
Umbilicaria proboscidea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	4	.	.	.	.	.	.	.	.	.
Umbilicaria rigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Vaccinium oxycoccos	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium uliginosum	3	1	1	+	+	.	.	1	1	3	.	1	2	2	3	.	.	+	.	1	1	.	1	.	1	2
Vaccinium vitis	+	+	.	+	.	.	.	.	1	1	1	+	+	+	+	+	.	.	.	+	.	+	+	+	+	1
Valeriana capitata	+	+	+	+	+	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Veratrum album	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Viburnum edule	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viola species	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Vulpicida tilesii	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Warnstorfia fluitans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Woodsia alpina	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Woodsia X gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.
Zigadenus elegans	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 13. Moss, Liverwort and Hornwort Species List

Mosses

Aulacomnium palustre (Hedw.) Schwaegr.
Aulacomnium turgidum (Wahlenb.) Schwaegr.
Brachythecium reflexum (Starke in Web.et Mohr) Schimp.
Brachythecium species
Bryum pseudotriquetrum (Hedw.) Gaertn. et al.
Bryum species
Calliergon giganteum (Schimp.) Kindb.
Calliergon species
Calliergon stramineum (Brid.) Kindb.
Catoscopium nigritum (Hedw.) Brid.
Ceratodon purpureus (Hedw.) Brid.
Cirriphyllum cirrosum (Schwaegr. in Schultes) Grout
Climacium dendroides (Hedw.) Web. et Mohr.
Ctenidium procerrimum (Mol.) Lindb. (=*Pseudostereodon procerrimus*)
Dicranum acutifolium (Lindb. et H.Arnell) C.Jens.
Dicranum angustum Lindb.
Dicranum bergeri Bland. in Starke
Dicranum congestum Brid.
Dicranum elongatum Schleich. ex Schwaegr.
Dicranum fuscescens Turn.
Dicranum groenlandicum Brid
Dicranum majus Sm.
Dicranum scoparium Hedw.
Dicranum spadiceum Zett.
Ditrichum flexicaule (Schwaegr.) Hampe
Hylocomiastrum pyrenaicum (Spruce) Fleisch. in Broth., Schwaegr.
Hylocomium splendens (Hedw.) Schimp. in B.S.G.
Hypnum bambergeri Schimp.
Hypnum holmenii Ando
Hypnum plicatulum (Lindb.) Jaeg.
Limprichtia revolvens (Sw.) Loeske (=*Drepanocladus revolvens*)
Mnium ambiguum H.Muell.
Oncophorus wahlenbergii Brid.
Paludella squarrosa (Hedw.) Brid.
Plagiomnium ellipticum (Brid.) T.Kop.
Plagiothecium berggrenianum Frisvoll
Plagiothecium denticulatum (Hedw.) B.S.G.
Pleurozium schreberi (Brid.) Mitt.
Pogonatum urnigerum (Hedw.) P.Beauv.
Pohlia nutans (Hedw.) Lindb.
Pohlia wahlenbergii (Web. et Mohr) Andrews in Grout,
Pohlia species
Polytrichum commune Hedw.
Polytrichum hyperboreum R.Br.
Polytrichum jensenii Hag.
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Polytrichum strictum Brid.
Ptilidium ciliare (L.) Hampe
Ptilium crista-castrensis (Hedw.) De Not.
Racomitrium lanuginosum (Hedw.) Brid.
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidium rugosum (Hedw.) Kindb.
Sanionia uncinata (Hedw.) Loeske (=*Drepanocladus uncinatus*).
Sphagnum aongstroemii C.Hartm.
Sphagnum balticum (Russ.) Russ. ex C.Jens.,
Sphagnum fimbriatum Wils. in Wils. et Hook.f.
Sphagnum girgensohnii Russ.
Sphagnum lenense H. Lindb. in Pohle
Sphagnum lindbergii Schimp. ex Lindb.
Sphagnum rubellum Wils.
Sphagnum russowii Warnst.
Sphagnum squarrosum Crome
Sphagnum warnstorfii Russ.
Tomentypnum nitens (Hedw.) Loeske
Tortella tortuosa (Hedw.) Limpr.
Warnstorfia fluitans (Hedw.) Loeske (=*Drepanocladus fluitans*)

Liverworts and Hornworts

Calypogeia species
Gymnocolea inflata (huds.) Dum.
Lophozia ventricosa (Dicks.) Dum.
Marchantia polymorpha L.(Nees) Burgeff=*M. aquatica*
Orthocaulis binsteadii (Kaal) Buch (= *Barbilophozia binsteadii*)
Scapania paludicola Loeske et K. Muell.
Sphenolobus minutus (Schreb.) Berggr.=*Anastophyllum minutum*
Tetralophozia setiformis (Ehrh.) Schljak. (= *Chandonanthus setiformis*)
Tritomaria quinquedentata (Huds.)Buch

Species identified by Komarov Institute, St. Petersburg, Russia

Table 14. Lichen Species List

Agyrophora rigida (Du Rietz) Llano
Alectoria nigricans (Ach.)
Alectoria ochroleuca Hoffm.) Massal.
Asahinea chrysantha (Tuck.) Culb &Culb
Balomyces rufus *
Bistera species *
Bryocaulon divergens (Ach.) Kaernef.
Bryoria nitidula (Th. Fr.) Brodo & D. Hawksw.
Caloplaca cerina (Ehrh. ex Hedwig) Th. Fr.
Caloplaca tiroliensis Zahlbr.
Catapyrenium cinereum (Pers.) Koerber.
Cetraria aculeata (Schreber) Fr.
Cetraria andrejevii Oxner
Cetraria commixta (Nyl.) Th. Fr.
Cetraria cucullata (Bellardi) Ach.
Cetraria delisei (Bory ex Schaerer) Nyl.
Cetraria islandica (L.) Ach.
Cetraria kamczatica savicz
Cetraria laevigata Rass.
Cetraria nigricans Nyl. (Kaernefelt 1979)
Cetraria nivalis (L.) Ach.
Cladina aberrans (des Abb.) Hale & Culb.
Cladina arbuscula (Wallr.) Hale & Culb.
Cladina mitis (Sandst.) Hustich
Cladina rangifera (L.) Nyl.
Cladina stellaris (Opiz) Brodo
Cladina stygia (Fr.) Ahti (Ahti 1984; Ahti & Hyvoenen 1985)
Cladonia cenotea (Ach.) Schaerer
Cladonia cf *cabriuscula* *
Cladonia cf. *acuminata* (Ach) Norrlin
Cladonia alaskana A. Evans
Cladonia amaurocraea (Floerke) Schaerer
Cladonia bellidiflora (Ach.) Schaerer
Cladonia chlorophaea (Floerke *ex* Sommerf.) Sprengel
Cladonia coccifera (L.) Willd.
Cladonia cornuta (L.) Hoffm.
Cladonia crispata (Ach.) Flotow
Cladonia cf. *metacorallifera* Asah.
Cladonia cyanipes (Sommerf.) Nyl.
Cladonia deformis (L.) Hoffm.
Cladonia ecmocyna Leighton
Cladonia fimbriata (L.) Fr.
Cladonia gracilis (L.) Willd.
Cladonia macrophylla (Schaerer) Stenh.
Cladonia maxima (Asah.) Ahti (Ahti 1980)
Cladonia nipponica Asah.
Cladonia pocillum (Ach.) O. Rich
Cladonia pyxidata (L.) Hoffm.
Cladonia species Hill *ex* Browne
Cladonia squamosa (Scop.) Hoffm.
Cladonia subfurcata (Nyl.) Arnold
Cladonia sulphurina (Michaux) Fr.
Cladonia thomsonii Ahti (Ahti 1978; Thomson 1979)
Cladonia uncialis (L.) Weber *ex* Wigg.
Dactylina arctica (Richardson) Nyl. (Thomson 1984)
Dactylina beringica Bird & Thomson (Thomson 1979)
Dactylina madreporiformis (Ach.) Tuck.
Dactylina ramulosa (Hook.) Tuck
Evernia divaricata (L.) Ach.
Evernia perfragilis Llano
Hypogymnia subobscura (Vainio) Poelt
Icmadophila ericetorum (L.) Zahlbr.
Lecanora epibryon (Ach.) Ach.
Lecidea ramulosa Th. Fr.
Leptogium gelatinosum (With.) Laundon
Lobaria linita (Ach.) Rabenh.
Lopadium pezizoideum (Ach.) Koerber
Masonhalea richardsonii (hook.) Kaernef.
Megaspora verrucosa *
Mycobilimbia lobulata *
Nephroma arcticum (L.) Torss.
Nephroma expallidum (Nyl.) Nyl.
Ochrolechia frigida (Swartz) Lynge
Ochrolechia upsalienses (L.) Massal.

Table 14. Lichen Species List (continued)

Pannaria pezizoides (Weber) Trevisan
Parmelia omphalodes (L.) Ach.
Parmelia omphalodes ssp. *glacialis* Skult (Skult 1985)
Peltigera apthosa (L.) Willd.
Peltigera leucophlebia (Nyl.) Gyelnik
Peltigera malacea (Ach.) Funck
Peltigera polydactyla (Necker) Hoffm.
Peltigera scabrosa Th. Fr.
Peltigera species
Pertusaria panyrga (Ach.) Massal.
Pertusaria bryontha (Ach.) Nyl.
Pertusaria coriacea (Th. Fr.) Th. Fr.
Pertusaria dactylina
Peziza species*
Polyblastia gelatinosa (Ach.) Th. Fr. (Ahti *et al*. 1973)
Polyblastia sendtneri Krempelh. (Thomson 1979)
Polyblastia species Massal.
Pseudophebe pubescens (L.) M. Choisy
Rinodina turfacea (Wahlenb.) Koerber)
Rinodina roscida (Sommerf.) Arnold
Solorina bispora (Nyl.)
Solorina saccata (L.) Ach.
Sphaerophorus globosus (Huds.) Vainio
Spharophorus fragilis (L.) Pers.
Stereocaulon alpinum (Laurer *ex* Funck (Lamb 1977)
Stereocaulon paschale (L.) Hoffm.
Stereocaulon tomentosum Fr.
Stereocaulon vesuvianum Pers.
Thamnolia subuliformis (Ehrh.) Culb.
Thamnolia vermicularis (Swartz) Ach. *ex* Schaerer)
Umbilicaria hyperborea (Ach.) Hoffm.
Umbilicaria proboscidea (L.) Schrader
*Vulpicida tilesii**

*** no authors found in:**

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Lichen identification by Mikail Zhurbenko, Komarov Institute, St. Petersburg, Russia.

Table 15. Relevé leaf area index

QC35 grid point	LAI 7/29/2000	QC38 grid point	LAI 7/28/2000	QC45 grid point	LAI 7/28/2000	QC49 grid point	LAI 7/28/2000
100	0.27	100	0.00	100	0.52	0	4.91
90	0.04	90	0.02	90	1.70	0	1.22
80	0.09	80	0.02	80	0.05	0	3.23
70	1.27	70	0.00	70	0.30	0	6.38
60	0.03	60	0.12	60	1.48	0	2.69
50	0.12	50	0.24	50	0.16	0	5.36
40	0.04	40	0.09	40	0.03	0	5.38
30	0.51	30	0.02	30	0.04	0	2.13
20	0.00	20	0.11	20	2.82	0	0.79
10	0.52	10	0.00	10	1.21	0	1.77
mean	0.29		0.06		0.83		3.39
standard error ±	0.13		0.02		0.28		0.60

Table 16. Soil descriptions (by Skip Walker)

Relevé	Date	Soil classification	Depth	Horizon	Color	Structure	Gravel	Consistency	Texture	Boundaries	Collected	Notes
C1	7/13/00		0-8	O e	7.5 yr 3/2 dark brown	1 pl	0			c s	X	loose organic layer composed of fine to med. fine roots & mosses
	7/13/00		8-20	A	7.5 yr 2/0 black	1 f gr	0	ss ps	SL	a w	X	smooth, many very fine roots
	7/13/00		20-31	A/B	mix of A color & 5yr 3/3 dark reddish brown	1 m abk	0	ss ps	SL	a w	X	occasional fine roots in B
	7/13/00		31-40	2B	10yr 3/3 dark brown	m m abk (breaking to a moderate fine granular)	0	s p	CL		X	streaks of brownish orange mottles - large 5yr 4/4 reddish-brown; occasional fine roots.
C2-A	7/11/00		0-13	Oi	brown		0			c s	X	includes 3cm live moss, loose dead *Sphagnum* bases
	7/11/00		13-25	Oe	dark brown						X	composed of root fibers and sedge bases
C2-B	7/11/00		0-8	Oi	whitish		0			a s	x	lichens - Claran & Claarb
	7/11/00		8-24	1Oe	dark reddish brown		0			a s	x	mix of fine roots, sedge parts, *Sphagnum* and other mosses
	7/11/00		24-27	2Oe	yellowish brown		0			a s	x	frozen sedge & fine roots & moss pieces
C2-C	7/11/00	pergelic cryaquept	0-8	Oe	very dark brown		0			a w	x	
	7/11/00		8-36	Bw	greyish brown	m	0	s p	CL			many medium mottles that are orange-ish, permafrost base

Table 16. Soil descriptions (continued)

Relevé	Date	Soil classification	Depth	Horizon	Color	Structure	Gravel	Consistency	Texture	Boundaries	Collected	Notes
C3-B	7/14/00	pergelic cryaquept	0-9	Oi	reddish brown	loose moss	0			a s		loose mat of *Hylspl*
	7/14/00		9-11	Oe	very dark blackish brown	1 pl	0			a s		tight fibrous mat of very fine roots & moss
	7/14/00		11-13	Oa	very dark blackish brown	1 pl	0	ss ps	SiL	a s		parent material - colluvium (silt rich)
	7/14/00		13-18	A	dark brown	m gr	0	ss ps	SiL	c w	x	
	7/14/00		18-40	B	brown	1 m gr sbk	<10	s p	L			
C4-B	7/15/00		0-5	Oi						g w		been raining for 2 1/2 days, hole fills with water
	7/15/00		5-7	Oe						d w		
	7/15/00		7-9	Oa						g s		
	7/15/00		9-15	A						c s	x	
	7/15/00			B/C							x	mineral, has rocks, very clayey, sticky, no sand
C5-A	7/12/00	pergelic cryaquept/ pergelic cryoboroll?	0-10	A	7.5YR 2.5/2 v.dk brown	1 f gr	10	ss ps	SiL	c l	x	organic rich horizon beneath patches of Dryas, many very fine roots
	7/12/00		10-25	C	7.5YR 2/2 dk.brown	1 f gr	25	ss ps	SiL		x	dark brown, few fine roots. Parent material - limestone
C6-A	7/19/00	Sphagnum fibrist	0-23	Oi	7.5 YR 6/6 reddish yellow		0			a s	X	collected 5cm from surface, loose mat of *Sphagnum*
	7/19/00		23-43	A/O	10 YR 1.5/2 dark black	1 m sbk	<10	ss ps	SiL		X	mix of mineral & organic (very fine roots, sedge stems & leaves), gravel up to ~1cm diam.

Table 16 Soil descriptions (continued)

Relevé	Date	Soil classification	Depth	Horizon	Color	Structure	Gravel	Consistency	Texture	Boundaries	Collected	Notes
C6-B	7/19/00		0-10	O			0			a s		mat of *Clad* .spp.
	7/19/00		10-14	A	10 YR 2/2 very dark brown	1 m sbk	10	s p	L	c w	X	organic rich layer below lichens w/ many fine and very fine roots
	7/19/00		14+	Bw	10 YR 4/1 dark grey	m	>75	s p	L			very gravely colluvium, parent material - shale derived colluvium
C8	7/16/00		0-9	Oi						a s		mat of Sphagnum russowii
	7/16/00		10-20	Oe						a s		partially decomposed *Sphagnum russowii*
	7/16/00		20-30 (frozen)	2Oe							X	fine sedge roots and stems, some mineral material, 5% silt
C9	7/16/00	pergelic cryaquept	0-3	Oi						a s		loose mat of Pleurozium
	7/16/00		3-7	Oe	very dark brown					a s		organic, many roots, fine & large, 5% silt
	7/16/00		7-20	B	brown with many medium dark-brown mottles	m m gr	0	ss ps	L		X (top of B)	few fine roots
C13	7/17/00		0-1	Oi								lichen mat
	7/17/00		1-2	Oe								roots
	7/17/00		2-5	Oa								decomposed litter & mineral soil
	7/17/00		5-8	A								small rocks w/ some organic
	7/17/00		8-18	B								w/ small rocks, ~ no organic

Table 16. Soil descriptions (continued)

Relevé	Date	Soil classification	Depth	Horizon	Color	Structure	Gravel	Consistency	Texture	Boundaries	Collected	Notes
C14	7/17/00		0-3	Oi								lichen/*Empetrum* roots, dark
	7/17/00		3-5	Oe								fibrous, fine & coarse roots
	7/17/00		5-8	Oa								fine roots, organic detritus
	7/17/00		8-11	A							X	less roots, dark finely decomposed soil
	7/17/00		11-13 (rock)	B								rocks
C15	7/17/00		0-1	Oi								Calcan litter
	7/17/00		1-2	Oe								fine roots & organic
	7/17/00		2-4	Oa	dark brown							fine roots & organic
	7/17/00		4-8	A	gray-brown						x	
	7/17/00		>8	C	gray with brown mottles							some clay
C16	7/17/00		0-2	Oi	dark gray-brown							thin alder litter layer
	7/17/00		2-5	Oe	dark gray-brown							decomposed leaves, some roots
	7/17/00		5-11	Oa	dark gray-brown							fewer roots
	7/17/00		>11	B	grey-bown w/ brown mottles						X	mostly mineral, some large some fine roots
C17	7/18/00		0-1	C								soil/rock slabs on surface
	7/18/00		>1	C							X	soil/gravel mix

Table 16. Soil descriptions (continued)

Relevé	Date	Soil classification	Depth	Horizon	Color	Structure	Gravel	Consistency	Texture	Boundaries	Collected	Notes
C18	7/19/00		0-4	Oa	dark reddish brown						x	some detritus & fine roots
	7/19/00		>4	C	grey						x	unsorted varied rocks
C19	7/19/00		0-18	Oi	light orange-brown							compacted *Sphagnum lenense*
	7/19/00		18-27 (frozen)	Oe	dark reddish brown						x	fine roots and decomposing Sphagnum
BH1	7/19/00		0-3	Oa								
	7/19/00		3-20	B							x	
QC1	7/23/00	histic pergelic cryaquept	0-2	Oi						a w		loose mat of *Polytrichum* & litter
	7/23/00		2-10	Oe	7.5 YR 3/2 dark brown					a w		tight mass of sedge leaves & roots
	7/23/00		10-15	Oa	7.5 YR 2/2 very dark brown	2 m sbk		so po	Si	c w		10% silt, base of Oa is a layer of carbon
	7/23/00		15-35	B	10YR 3/2 very dark greyish brown	2 m pl	<10 fine gravel	s p	CL			many fine roots
QC2-A	7/22/00		0-6	Oi						a w		loose mat of *Dicranum* & *Cladonia*
	7/22/00		6-10	Oa	7.5 YR 2/1 very dark brown			ss ps	Si	c w		decomposed roots, many very fine roots
	7/22/00		10-19	A	7.5 YR 2/0 black	1 m sbk	0	ss ps	SiL	a w	x	a lot of fine & very fine roots
	7/22/00		>19	B	10 YR 3.5/2 dark grayish brown	2 m sbk	50	s p	CL		x	many stones up to 10-15cm, some mottling w/ color of 10YR 4/4 dark yellowish brown

Table 16. Soil descriptions (continued)

Relevé	Date	Soil classification	Depth	Horizon	Color	Structure	Gravel	Consistency	Texture	Boundaries	Collected	Notes
QC3-B	7/26/00	pergelic cryaquept	0-2	Oi						c s		loose mat of *Aulpal* and litter
	7/26/00		2-7	Oe	7.5 YR 2/2 very dark brown					c s		fibrous mat of grass and sedge roots and bases
	7/26/00		7-10	Oa	7.5 YR 2.5/2 very dark brown					c s		same as Oe, with 5% silt
	7/26/00		>10	B	10YR 3.5/3 dark brown	m m pl	<10 fine	s p	CL		X top of B	fine roots, mottles concentrated around patches of organic matter
	7/26/00			patches in B	10YR 5/1.5 greyish-brown	m m sbk						
	7/26/00			many large mottles in B	10YR 4/4 dark yellowish-brown	1 m gr						
QC25	7/29/00	alfisol	0-4	Oi						a w		alder leaves
	7/29/00		4-24	A	10 YR 2/2 very dark brown	loose mat of organic mixed with mineral		so po	Si	c w	x	very porous, fine roots & bits of wood & other plant parts
	7/29/00		24-40+	B	10 YR 2.5/2 very dark greyish brown		m m sbk	ss po	SiL		x	
QC35	7/29/00	pergelic cryorthent?	0-2	Oi						a s		mostly live & dead *Stereocaulon paschala*
	7/29/00		2-6	A or Oa	7.5 YR 2.5/2 very dark brown	weak m sbk	<2	so po	Si?	c s	X top of A, may have some B	very fine roots, 10-15% mineral
	7/29/00		6-40	B	10 YR 3.5/4 dark yellowish brown	weak m sbk	10 fine gravel	ss sp, sandy	SL, very fine			

Table 16. Soil descriptions (continued)

Relevé	Date	Soil classification	Depth	Horizon	Color	Structure	Gravel	Consistency	Texture	Boundaries	Collected	Notes
QC38	7/28/00	pergelic cryorthent	0-4	Oi						a s		loose mat of dead *Claunc*
	7/28/00		4-10	A or Oa	7.5 YR 2.5/2 very dark brown	weak m sbk	5 fine gravel	ss sp	SiL	a s	x - grab sample	
	7/28/00		10-40	1B	10 YR 4/3 dark brown	loose	85					
	7/28/00			1B	7.5 YR 3/2 dark brown							organic mixed in 1B layer
	7/28/00		40+	2B	10 YR 4/3 dark brown	m m sbk	20	s p	CL			
QC45	7/28/00	pergelic cryohemist ?	0-8	Oi	7.5 YR 5/4 brown					c s		loose mat of *Sphaang*
	7/28/00		8-25	Oe	7.5 YR 2/2 very dark brown					g s		moderately decomposed layer of *Sphagnum* and sedge leaves, stems & fine roots
	7/28/00		25-28+ (frost)	Oa	7.5 YR 2.5/2 very dark brown							well decomposed layer of compacted *Sphagnum* peat
QC49	7/28/00	histic pergelic cryaquept	1-10	Oi	10 YR 6/6 brownish yellow (predominant)					a w		loose mat of *Sphgir*
	7/28/00		10-19	Oe	7.5 YR 2/2 very dark brown					c w		sedge bases and leaves, fine roots, partially decomposed
	7/28/00		19-31	Oa	7.5 yr 3/2 dark brown					a w		nearly fully decomposed organic horizon w/ very many fine roots
	7/28/00		31-33+ (frost)	B	10 YR 4/1 dark grey	massive	30	s p	SCL		x - grab sample	

Table 17. Relevé soil moisture

Relevé	Sample #	Horizon	Wet Wt.	Dry Wt. (w/Tare)	Tare Wt.	Dry Wt.	Water Wt.	%Soil Moisture
C1	1	Oe	64.7	31.1	12.3	18.8	33.6	1.8
	2	A	124.8	45	13.7	31.3	79.8	2.5
	3	A/B	178.1	82.7	12.9	69.8	95.4	1.4
	4	2B	320.3	259.5	12	247.5	60.8	0.2
C2A	13	Oe	99.8	28.2	10.8	17.4	71.6	4.1
	14	Oi	39.1	18.9	12.1	6.8	20.2	3.0
C2B	15	1Oe	85.3	28.6	15.8	12.8	56.7	4.4
	16	2Oe	126.9	26.4	12.3	14.1	100.5	7.1
C2C	17	Oe	109.4	27	12.6	14.4	82.4	5.7
	18	Bw	278.4	199.1	12.1	187	79.3	0.4
C3	25	A	164.6	51.2	0	51.2	113.4	2.2
C4	26	Oa	170.1	29.7	0	29.7	140.4	4.7
	27	C	373.3	291.9	0	291.9	81.4	0.3
C5	23	A	142.4	105.2	13.6	91.6	37.2	0.4
	24	C	227.8	187.2	11	176.2	40.6	0.2
C6A	28	Oi	37	5.5	0	5.5	31.5	5.7
	29	A/O	58	30.2	0	30.2	27.8	0.9
C6B		O						
	31	A		75.1		N/A	N/A	N/A
		B						
C8	33	2Oe	127	11.5	0	11.5	115.5	10.0
C9	34	B	230.8	97.3	0	97.3	133.5	1.4
C13	35	A	228.1	160.6	0	160.6	67.5	0.4
C14	36	A	224	67.4	0	67.4	156.6	2.3
C15	37	A	198.4	111.8	0	111.8	86.6	0.8
C16	38	B	203.8	108.1	0	108.1	95.7	0.9
C17	39	C	224	188	0	188	36	0.2
C18	40	Oa	84.7	32.4	0	32.4	52.3	1.6
	41	C	208.4	172.3	0	172.3	36.1	0.2
C19	42	Oe	132.2	18.5	0	18.5	113.7	6.1
BH1	43	B	147.6	68.9	0	68.9	78.7	1.1
QC1	50	B	203.1	99.3	0	99.3	103.8	1.0
QC2A	51	A	112.2	27.5	0	27.5	84.7	3.1
	52	B	246	183.1	0	183.1	62.9	0.3
QC2B	53	Oa	162.9	36.3	0	36.3	126.6	3.5
QC2C	54	B	192.1	162.2	0	162.2	29.9	0.2
QC25	55	A	84.8	34.7	0	34.7	50.1	1.4
	56	B	164.2	93.6	0	93.6	70.6	0.8
QC35	57	A	174.8	128.5	0	128.5	46.3	0.4
QC38	58		273.1	203.5	0	203.5	69.6	0.3
QC45	59		146.7	21.1	0	21.1	125.6	6.0
QC49	60		259.7	200.7	0	200.7	59	0.3
CC	70	A	247.5	59.5	0	59.5	188	3.2
	71	B	175.1	67.7	0	67.7	107.4	1.6
LAVA-C	72		140.5	65.9	0	65.9	74.6	1.1
QC3	97	B	247.3	172.2	0	172.2	75.1	0.4

Table 18. Relevé soil analysis by horizon

Relevé	horizon	Sample #	pH	P	K	Ca	Mg	Na	% Loss on	%	%	%	%	%
				ppm	ppm	ppm	ppm	ppm	Ignition	Sand	Silt	Clay	C	N
C 1	Oe	1	4.68	134	782	6924	334	72	89.61	na	na	na	44.02	2.16
	A	2	5.38	44	221	10380	226	73	74.63	na	na	na	36.66	2.42
	A/B	3	5.74	5	42	6933	82	74	34.09	na	na	na	13.95	0.98
	2B	4	5.93	3	34	2528	43	25	3.30	36.8	39.2	24.0	1.40	0.15
C2A	Oe	13	3.76	20	196	936	400	68	92.83	na	na	na	44.24	1.64
	Oi	14	3.68	72	612	948	792	104	98.90	na	na	na	45.86	1.01
C2B	1Oe	15	3.70	34	332	1096	658	70	94.75	na	na	na	44.43	1.29
	2Oe	16	3.90	44	156	1896	788	100	96.22	na	na	na	44.78	1.26
C2C	Oe	17	3.97	16	568	692	316	116	71.03	na	na	na	32.33	1.51
	Bw	18	4.06	4	29	209	55	39	7.53	20.8	47.2	32.0	3.31	0.13
C 3	A	25	5.78	9	97	7107	222	28	40.95	na	na	na	18.95	1.32
C 4	Oa	26	6.50	48	216	14718	188	48	64.33	na	na	na	34.38	2.27
	C	27	8.09	1	59	6407	47	11	2.63	42.0	35.6	22.4	1.97	0.10
C 5	A	23	7.05	54	64	9738	102	8	26.87	na	na	na	14.79	1.07
	C	24	7.76	7	35	9113	57	5	8.89	50.8	37.2	12.0	6.10	0.52
C6A	Oi	28	3.72	68	576	1660	636	88	95.08	na	na	na	46.76	1.05
	A/O	29	4.12	70	206	1646	342	58	84.29	na	na	na	42.25	2.00
C6B	A	31	4.01	31	111	287	100	10	22.58	na	na	na	13.26	0.55
C8	2Oe	33	3.94	50	232	1102	436	110	94.45	na	na	na	47.33	1.75
C9	B	34	4.58	8	70	272	46	23	12.39	32.0	57.6	10.4	4.82	0.35
C13	A	35	4.36	5	39	41	18	5	6.55	48.0	39.6	12.4	3.20	0.23
C14	A	36	4.97	17	113	2485	371	26	37.13	na	na	na	24.34	1.17
C15	A	37	4.64	5	18	97	19	14	9.14	44.0	43.6	12.4	3.87	0.29
C16	B	38	5.73	10	24	1276	165	17	9.60	40.0	51.2	8.8	3.84	0.34
C17	C	39	8.12	4	20	5047	35	4	3.03	76.0	15.2	8.8	7.21	0.25
C18	Oa	40	5.38	58	150	10964	172	36	65.08	na	na	na	31.13	2.27
	C	41	6.05	3	18	2020	31	9	3.96	56.0	29.2	14.8	2.57	0.26
C19	Oe	42	3.85	4	152	1260	300	92	84.17	na	na	na	38.10	1.54
BH1	B	43	5.34	14	110	2532	104	38	24.69	na	na	na	10.49	0.73
QC1	B	50	4.62	3	45	475	106	21	22.55	na	na	na	13.24	0.60
QC2A	A	51	4.00	88	596	3630	696	64	90.32	na	na	na	44.54	1.52
	B	52	5.10	5	47	576	91	18	5.41	42.8	38.8	18.4	3.30	0.20
QC2B	Oa	53	5.28	102	402	6552	1054	76	87.16	na	na	na	42.22	1.88
QC2C	B	54	5.15	9	63	905	177	23	5.07	53.5	28.5	18.0	2.65	0.17
QC3	B	97	5.05	4	38	857	132	17	6.30	51.2	35.6	13.2	4.40	0.34
QC25	A	55	3.77	70	188	1902	264	14	48.32	na	na	na	23.30	1.49
	B	56	4.55	10	59	269	33	12	13.04	50.8	44.8	4.4	6.40	0.51
QC35	A	57	4.17	12	99	128	62	7	16.49	na	na	na	11.80	0.42
QC38		58	4.30	34	140	339	85	13	22.35	na	na	na	16.31	0.69
QC45		59	4.04	24	312	1724	700	68	88.96	na	na	na	40.70	1.28
QC49		60	5.41	3	47	1195	366	38	6.36	50.8	30.8	18.4	4.32	0.21
CC	A	70	4.34	32	318	1124	416	44	76.24	na	na	na	38.79	1.51
CC	B	71	5.17	7	209	883	296	30	39.72	na	na	na	19.70	0.94
LAVA-C		72	5.19	2	90	300	83	63	23.80	na	na	na	8.75	0.35

C 1: Council, Seward Peninsula. Open white spruce forest on gentle (3º) south-facing toe slope above Melsing Creek. Undisturbed since logging 80 years ago. Moist *Picea glauca*, *Salix* species, *Vaccinium uliginosum*, *Hylocomium splendens*, evergreen tree/low shrub.

C 3: Ophir Creek, Council, Seward Peninsula. Shrubs on hillside above creek. 5º slope to southwest. Relevé A: shrubby sites. Moist *Betula glandulosa, Salix glauca, Hylocomium splendens*. Relevé B: clearings. Moist *Pentaphylloides floribunda, Vaccinium uliginosum, Festuca altaica, Hylocomium splendens, Salix reticulata.*

C 2: 5 miles west of Council, Seward Peninsula. Flat basin dissected by several small drainages. Soils: pergelic spagnohemist . Relevé A: raised mossy hummocks. Moist *Rubus chamaemorus, Betula nana, Ledum decumbens, Sphagnum fuscum*, erect dwarf shrub/moss. Relevé B : between hummocks. Mois*t Cladonia arbusculoides, Cladonia rangiferina, Vaccinium uliginosum, Carex aquatilis,* lichen/erect dwarf-shrub tundra. Relevé C : wet depression. Wet *Eriophorum angustifolium, Sphagnum* species, sedge tundra.

C 5: Hilltop between Solomon and Council, Seward Peninsula. Soil: pergelic cryochrept, on frost shattered limestone colluvium. Relevé **A**: >50% *Dryas* cover. Dry *Dryas octopetala, Oxytropis bryophyla,* prostrate dwarf-shrub/forb tundra. Relevé **B**: < 50% cover, sorted stone nets. Dry *Dryas octopetala,* barren complex.

C 6: Blueberry Hill, Council, Seward Peninsula. Broad hillslope on shale derived colluvium. 10º slope to west. Relevé **A**.: moist *Betula nana, Ledum decumbens, Vaccinium uliginosum, Carex bigelowii, Sphagnum* species, dwarf shrub tundra. Relevé **B**.: moist *Cladonia* species, *Empetrum nigrum*, tundra

C 8: 10 km west of Council, Seward Peninsula. Slight slope to southeast, with shrubby drainages. Soil: pergelic sphagnum fibrist. Relevé **A**.: moist *Rubus chamaemorus, Empetrum nigrum, Vaccinium uliginosum, Sphagnum russowii.* Relevé **B**.: moist *Cladonia* species, *Carex aquatilis, Vaccinium uliginosum*

C 9: Glacier Creek, Seward Peninsula. Open old growth white spruce forest. Part way down hill, 7º slope to SW. Soil: pergelic cryaquept. Moist *Picea glauca, Vaccinium uliginosum, Empetrum nigrum.* Open forest/low shrub.

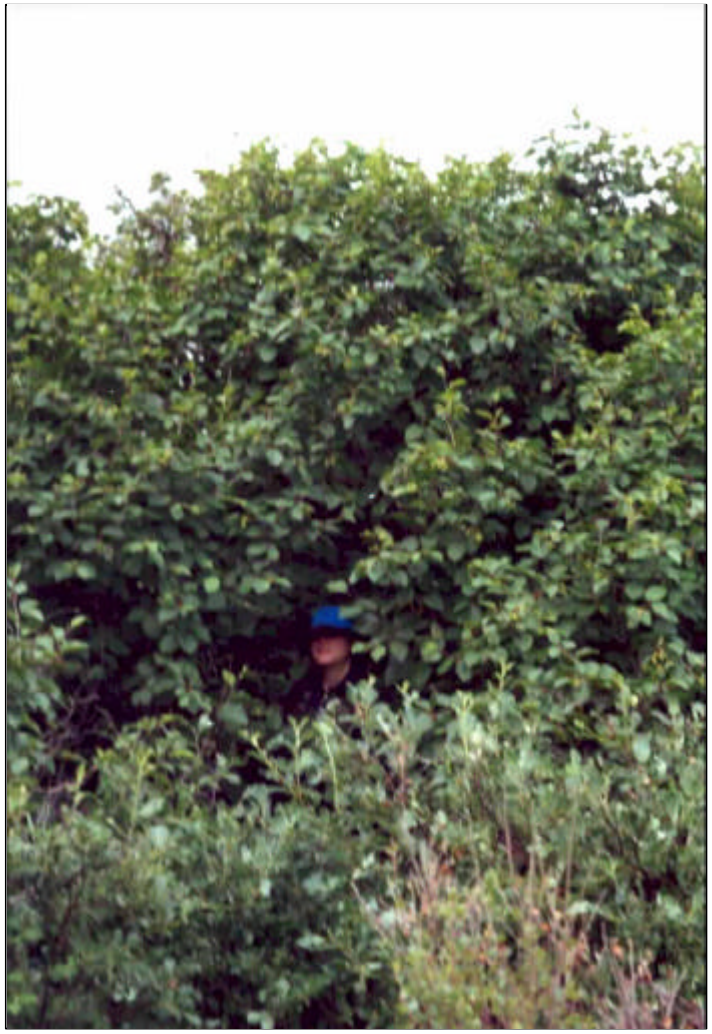
C 13: Crest of hill at head of Guy Rowe Creek, Seward Peninsula. Rocky torre area. 3º slope to south. Relevé **A:**.dry *Bryocaulon divergens, Umbillicaria proboscidea, Loiseluria procumbens, Ledum decumbens, Stereocaulon paschala, Arctous alpina*, prostrate dwarf-shrub/lichen.

C 14: Slope above Guy Rowe Creek, Seward Peninsula, 5º south facing slope. Moist *Betula nana*, *Empetrum nigrens, Loiseluria procumbens, Stereocaulon tomentosum*, prostrate dwarf-shrub/lichen.

C 15: Dense alder shrub on slopes above Guy Rowe Creek, Seward Peninsula, 4º south facing slope. Relevé **A**: moist *Alnus crispa, Spirea beauvardiana, Calamagrostis canadensis.* Relevé **B**: moist *Calamagrostis canadensis, Spirea beauvardiana, Salix pulchra.*

C 16: Low willow shrubs on banks above Guy Rowe Creek, Seward Peninsula, 5ºsouth facing slope. Moist *Salix pulchra, Salix lanata*, rock.

C 17: Council Mountain, Seward Peninsula. 70% rocky limestone scree, 7º slope to south. Dry *Dryas octopetala, Hedysarum mackenzii, Cetraria* species, *Thamnolia subuliformis*



C 18: Ophir Creek, Council, Seward Peninsula. Patchy alder stands above grid C 3, 4º slope to the south. Relevé **A**: moist *Alnus crispa*, tall shrub. Relevé **B**: moist *Salix glauca, Pentaphylloides floribunda, Calamagrostis canadensis*, open low shrub/graminoid/forb meadow.

C 19: Ophir Creek, Council, Seward Peninsula. Shoulder of broad hill above creek. Slight slope to south. Moist *Eriophorum vaginatum, Rubus chamaemorus, Sphagnum* species, dwarf shrub tussock tundra.

C-D: Equisetum areas, midslope on N side of Council Mtn., probably hold snow. Moist *Equisetum arvense, Salix reticulata, Salix lanata, Tomentypnum nitens*, open low-shrub, dwarf-shrub, moss.

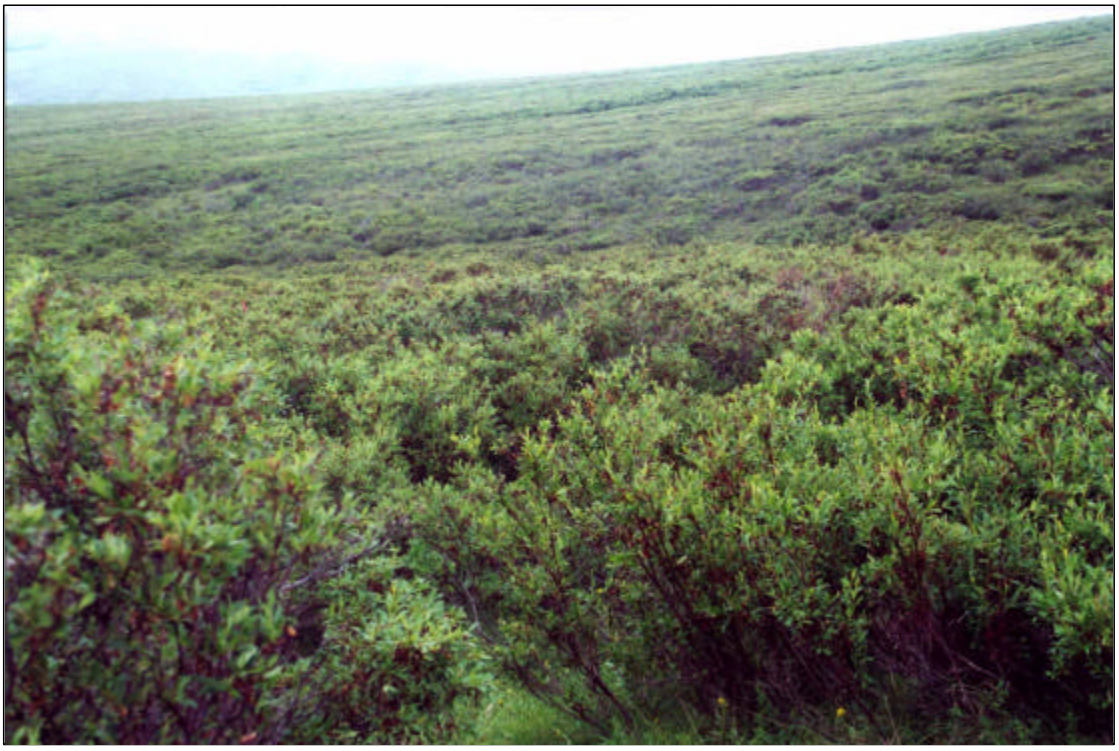
C-E: Council Mountain, Seward Peninsula. 70% rocky limestone scree, 7º slope to south. Moist *Betula glandulosa, Salix* species, low shrub tundra.

Blueberry Hill. Moist *Picea glauca, Betula glandulosa, Vaccinium uliginosum, Hylocomium splendens,* shrub woodland.

Cassiope Cone. Cone on northern side of Seward Peninsula lava flow. Bottom of slope, 7º slope, facing north.

QC 1: Tussock tundra on shoulder of hill above Mauze Creek, Seward Peninsula. 4º west-facing slope. Moist *Eriophorum vaginatum, Ledum decumbens, Rubus chamaemorus, Sphagnum* species, tussock graminoid/erect dwarf-shrub.

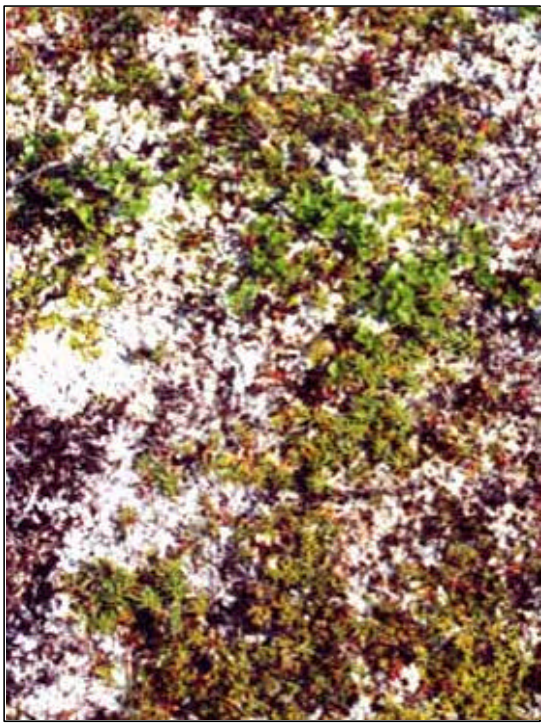
QC 2:. Mauze Creek, Seward Peninsula. Moist erect dwarf shrub tundra with frost features: stripe and scars. South facing hillside, 7º slope. Soils: histic pergelic cryaquept, with pergelic cryumbrept and pergelic cryorthent on frost features. Relevé **A**: Dry *Empetrum nigrum, Vaccinium uliginosum, Arctous alpina, Cladonia* species lichen/prostrate dwarf-shrub tundra. Relevé **B**: Moist *Betula nana, Salix pulchra, Carex bigelowii,* erect dwarf shrub tundra. Relevé **C:** dry *Loiseluria procumbens, Salix phlebophylla, Sphaerophorus fragilis, Bryocaulon divergens,* lichen/prostrate dwarf shrub barren.

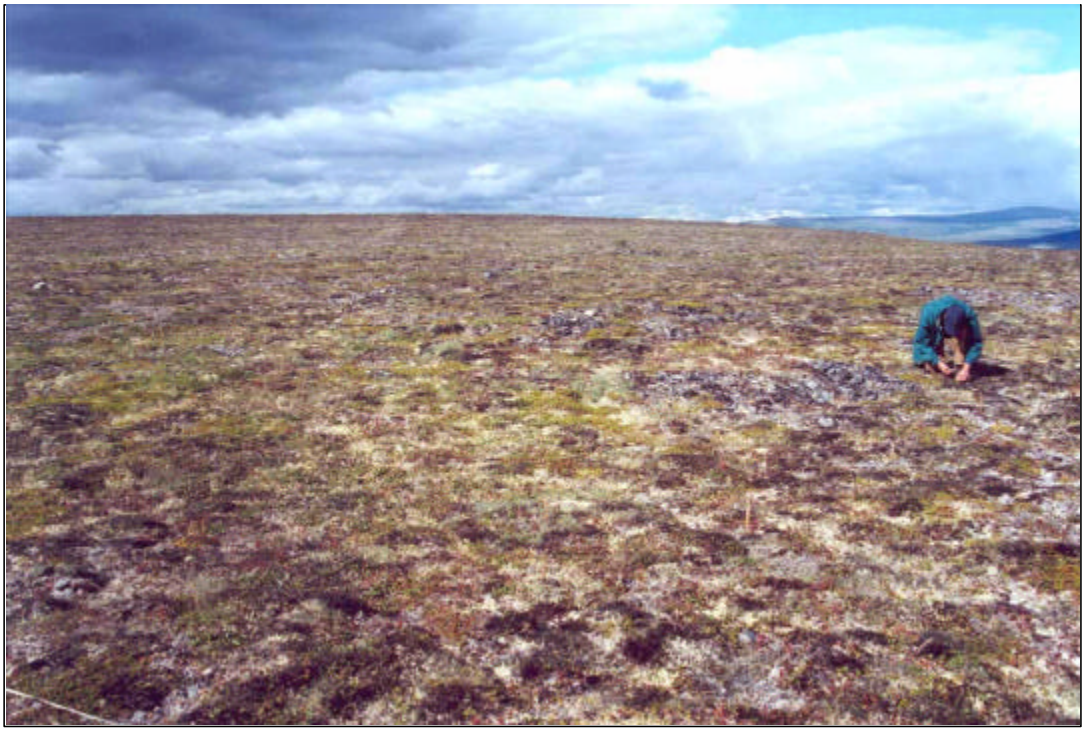


QC 3: Mauze Creek, Seward Peninsula. Low shrubs in upper drainage, 5º slope to S. Soil: pergelic cryaquept. Relevé **A**: moist *Salix pulchra, Calamagrostis canadensis,* low shrub tundra. Relevé **B**: moist *Vaccinium uliginosum, Carex podocarpa, Solidago multiradiata, Hylocomium splendens,* dwarf shrub/graminoid meadow.

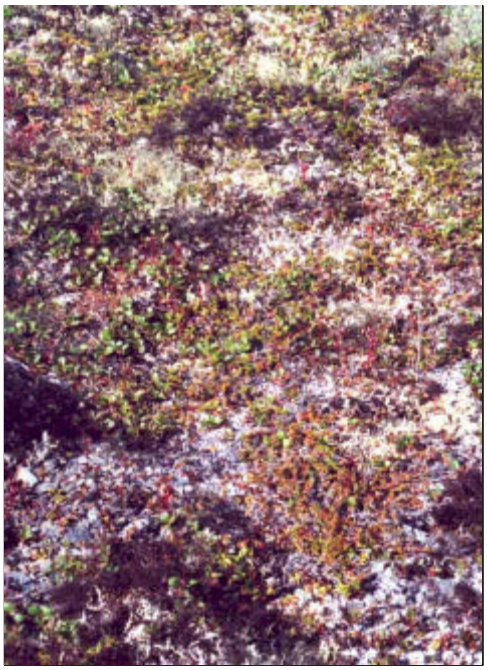
QC 25: Tall alder stand above Kougarak Road, Kigluaik Mnts, Seward Peninsula. 7º slope, south facing. Subplot **A**: moist *Alnus crispa*, tall shrub. Subplot **B**: moist *Calamagrostis canadensis, Spirea beauvardiana, Senecio lugens*, grass/forb meadow.

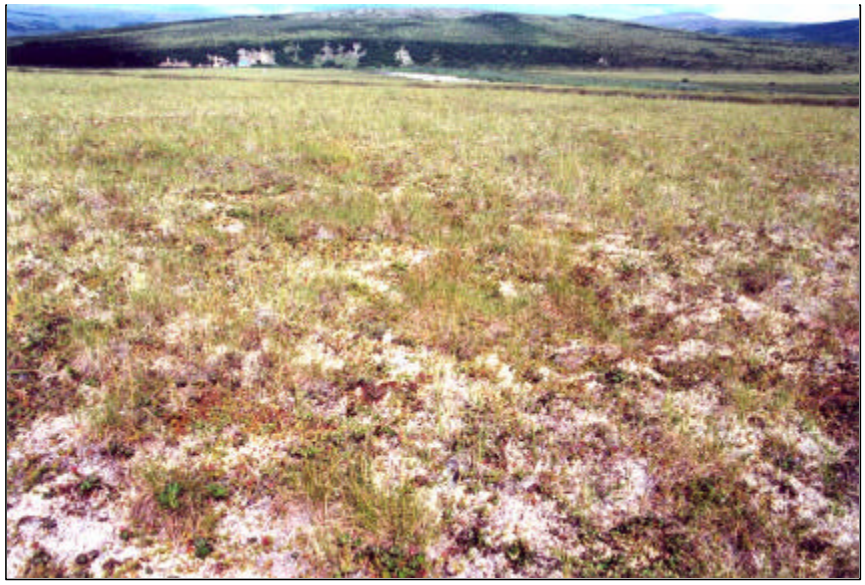
QC 35: Flat river outwash plain in Kigluaik Mtns, Seward Peninsula. Soil: pergelic cryorthent. Subplot **A**: dry *Betula nana, Loiseluria procumbens*, *Stereocaulon pascala, prostrate* shrub lichen. Subplot **B:**. dry *Rhododendron camschatika, Loiseluria procumbens,* barren.





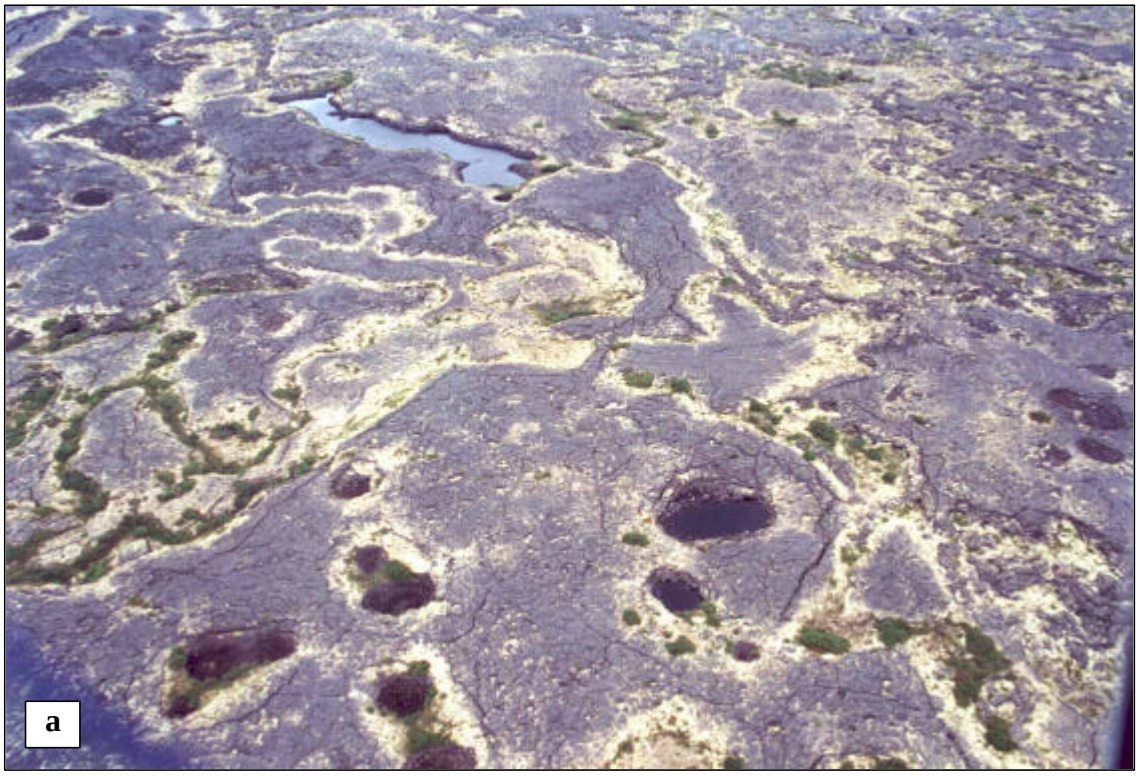
QC-38. Kigluaik Mnts, Seward Peninsula. Flat site with slight southern exposure. 10% frost scars. Soil: pergelic cryorthent. **A**. Dry Empetrum nigrum, Loiseluria procumbens, Arctous alpina, prostrate dwarf-shrub/lichen tundra. **B**. Dry Dryas octopetala, Salix phelbophylla, Rhododendron camschatika, prostrate dwarf-shrub/lichen barren



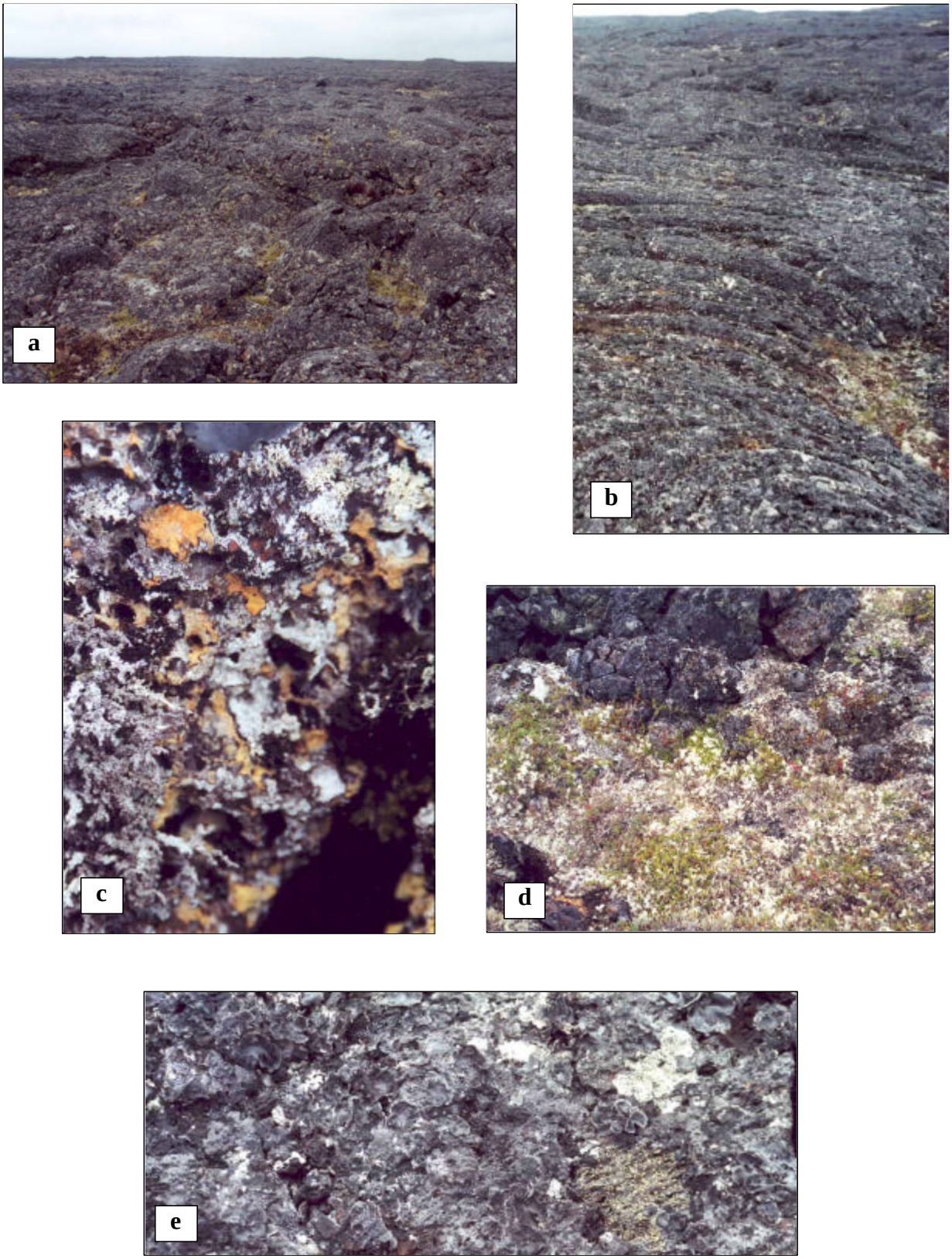


QC 45: Kigluaik Mtns, Seward Peninsula. Lichen tussock tundra on slight slope to NE. Soil: pergelic cryohemist dysic. Moist *Eriophorum vaginatum*, *Cladonia* species, *Sphagnum lenense*, dwarf shrub/lichen/tussock tundra.

QC 49: Alder savannah on northern side of Kigluaik Mtns., 20 miles south of Kougarak River, Seward Peninsula. 3º slope to west. Soil: histic pergelic cryaquept. Moist *Betula nana, Alnus crispa, Vaccinium uliginosum, Carex bigelowii,* low shrub/graminoid tundra.



Lava. Seward Peninsula lava flow. Patches of vegetation occur on more weathered areas. Younger lava flow, on the right side of photo, overlies older lava (**a**). Close up of lichen mat (**b**): appears to be moist *Loiseluria procumbens, Empetrum nigrum, Cladonia stellaris, Cetraria nivalis,* prostrate dwarf-shrub/lichen.



Lava. Seward Peninsula lava flow: view of landscape (**a, b**); close up of lichens growing on lava rock (**c, e**); lichen mat amongst lava (**d**).

A preliminary Landsat MSS-derived land-cover map of the Seward Peninsula, Alaska: classification methods, and comparison with existing data sets

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ABSTRACT:

Present climate-change and ecosystem research studies in Arctic and Sub-Arctic areas have created a high demand for detailed land-cover maps. I produced a preliminary land-cover map of the Seward Peninsula, Alaska, using Landsat Multi-Spectral Scanner (MSS)-derived imagery. I used a multiple scene mosaic furnished by the USGS, EROS Data Center, and an Isoclass clustering algorithm to arrive at 10 broad land-cover classes. The Seward Peninsula Multi-Spectral Scanner Map (MSS) has the following land-cover classes and respective percentages: Barrens, 5.3%; Dry tundra, 4.6%; Wet herbaceous tundra, 14.2%; Moist herbaceous, dwarf-shrub tundra, 42.6%; Moist low-shrub tundra, 6.8%; Tall shrublands or Deciduous forest, 16.1%; Evergreen forest, 5.4%; Water, 4.7%; Snow and ice, <1%; Shadows, <1%.

The MSS map gives a high level of spatial detail that is unequaled by the comparison data sets: the Major Ecosystems of Alaska (MEA) map, and the Seward Peninsula Soil Conservation Service (SCS) map. Comparative graphs show the breakdown of land-cover percentages for each of the three data sets. Additionally, difference matrices were calculated, which provide a quantitative indication of how well the land-cover classes of the three data sets overlay each other. The MSS map gives a better representation of the variable spatial distribution of vegetation within the otherwise homogeneous SCS and MEA map land-cover designations. Overall, the high level detail provided by the MSS data set offers a superior map for understanding the complex patterns of vegetation distribution on the Seward Peninsula.

INTRODUCTION:

Present climate change and ecosystem research studies in Arctic and Sub-Arctic areas are creating a high demand for detailed land-cover maps. The MSS-derived Seward Peninsula land-cover map (MSS) was created to supply a detailed land-cover map for two National Science Foundation funded projects: the Arctic Transitions in the Land-Atmosphere System (ATLAS) project, and the Circumpolar Arctic Vegetation Map (CAVM) project(Walker, 1995).

The ATLAS project addresses the role of energy, water vapor, and trace gasses in the Arctic region, and ultimately, how these variables interact with the global-scale climate structure. When combined with field observations, the MSS map provides a basis for calculating total trace gas fluxes, biomass, radiation and heat flux on the Seward Peninsula.

The goal of the CAVM project is to provide the first detailed vegetation map of the entire circumpolar area. When completed, the CAVM map will provide a framework for global-scale climate and ecosystem studies such as the ATLAS project. The Seward MSS map serves as an indication of the effectiveness of integrating Multi-Spectral Scanner data into the overall CAVM project.

Geography of the Seward Peninsula and study area

Sometimes referred to as the "nose" of Alaska, the Seward Peninsula is a remote, yet diverse region located in northwestern Alaska. Bordered by the Chukchi Sea to the north, the Bering Strait to the west, and Norton Sound to the south, the Peninsula is surrounded by relatively cold water to the north and west but relatively warm water to the south. The temperature of surrounding water bodies serves as a large determinant to the distribution of land-cover present on the Peninsula. Vegetation types range from dense evergreen forests to the southeast to treeless wet herbaceous tundra to the north.

The study area is defined as the entire Seward Peninsula west of an arbitrary line drawn between the Elephant Point to the north, and the Koyukuk River Delta to the south (Figure 1). The study area is approximately 50, 000 square kilometers, roughly double the land area of Vermont.

Existing Maps of the Seward Peninsula

I compared the MSS-derived Seward map with two other digital-form maps: The Major Ecosystems of Alaska (MEA) map (Joint Federal State Land

Use Planning Commission, 1973) and the Range Survey of the Seward Peninsula Reindeer Ranges, Alaska (U.S. Department of Agriculture's Soil Conservation Service, 1985). I will refer to these maps as the MEA and SCS maps respectively.

The MEA map is the historic standard for all other vegetation-distribution maps of Alaska (Figure 2). The digital MEA vector based data set is based on a map created by John Spetzman in 1959. The MEA data set was digitized from the Spetzman-derived MEA map in 1991 at a scale of 1:2, 500, 000. The Seward Peninsula portion of the MEA map contains seven land-cover classes. However, for map comparison, the seven categories were reduced to six (Table 1a). Although the MEA data does a good job at conveying the state-wide distribution of vegetation in Alaska, it is highly generalized due to its small production scale, and is generally not an appropriate base map for current scientific research.

The vector based SCS map is the current standard for vegetation maps of the Seward Peninsula (Figure 3). The primary purpose of its production was to aid in the management of large commercial reindeer herds throughout the Seward Peninsula and immediate area. The hard copy SCS map was published in 1985, the culmination of a ten-year effort. Photo interpretation of 1:60, 000 scale high altitude infrared color photos resulted in a staggering 169 distinct land-cover types. For the purpose of map comparison, the large number of land-cover classes were combined into eight broad land cover categories, which closely correspond with the MSS map categories (see crosswalk in Table 1b). In contrast to the MEA data, the SCS map is superior in both spatial detail and stratification of land-cover categories. The SCS data is the primary rival of the MSS data set.

METHODS:

MSS data characteristics

The Seward-MSS data set was derived from a multiple scene mosaic prepared by the USGS, EROS Data Center in 1999. Mosaic-ing of the image was accomplished using the Large Area Mosaic Software (LAMS), which is a component of the Land Analysis Software (LAS). Each scene was acquired during the summer snow-free growing season, however, each scene was presumably captured at a different time and date, and thus there are minute differences in the appearance of each scene. The original 80-meter pixels were resampled to a 50-meter pixel size using an unknown algorithm. The original and

resampled image consists of three bands (red, near-infrared, and green). Visual analysis of the image revealed several problems including striping, missing data, and poor radiometric correction. These errors could not corrected because of time constraints, and the fact that the image had previously been geo-referenced and mosaic-ed. The simple land-cover classification scheme I employed lessened the negative effects of striping and poor radiometric correction. Cropping the image to the study area eliminated the majority of missing data except for two small areas: the westernmost tip of the Peninsula, and a portion of the southwest coastline.

Alteration of original MSS data set

To simplify land-cover classification, data set comparison, and to shorten processing time, I made three alterations to the original data. Since the Seward Peninsula was the exclusive area of interest, The original three-band image was cropped to a rectangular area of interest polygon that included all data between approximately 64.3 and 66.8 degrees North, and 162.5 and 169.9 degrees West. The initial crop of the image lowered the file size from 584.1 MB to 105.6 MB.

To facilitate integration with GPS collected ground-truth information, and comparison with the SCS and MEA data sets, the cropped MSS data was re-projected from Albers Equal Area WGS84 datum to Universal Transverse Mercator (UTM), zone 3, North American Datum 1927 (NAD27). UTM zone 3 NAD27 serves as the common comparison projection for all three data sets. The spatial boundaries of the Seward Peninsula slightly overlap into UTM zone 2 (168^0 to 174^0 W) and zone 4 (156^0 to 162^0 W). However, map distortion in these small overlap areas is negligible given all but centimeter accuracy.

A portion of the pixels within the re-projected MSS image were filled with zeros to eliminate pixels representing large areas of ocean and land, which were superfluous to the study area. Although the 105.6 MB file size was retained, unwanted pixels that would otherwise add additional data for the classification algorithm were eliminated.

Alteration of the original SCS and MEA data sets

The SCS data were projected from Albers Equal Area NAD27 to UTM zone 3 NAD27, the common comparison projection. The data set was cropped to conform to the eastern boundary of the altered MSS data set. Finally, the 169 different land-cover categories were simplified into eight broad classifications:

Barrens, Dry tundra, Wet herbaceous tundra, Moist herbaceous dwarf-shrub tundra, Moist low-shrub tundra, Tall shrublands or Deciduous forest, Evergreen forest, and Water (see Table 1b for crosswalk).

The MEA data was reprojected from Albers NAD27 to the common comparison projection of UTM zone 3 NAD27. The statewide data was cropped to conform to the spatial boundaries of the MSS and SCS data sets. Upon examination of the cropped data, two errors in the original MEA data were found and corrected. A small polygon with a curious value of 0 for all attribute fields belongs in the "water" category. In addition, a polygon labeled "low brush, muskeg-bog" was correctly relabeled as "high brush." Finally, the seven original land-cover classes were altered to include these six categories: Alpine tundra, Moist tundra, Wet tundra, High brush, Evergreen forest, and Water (see Table 1a for crosswalk).

Classification procedure

Using the United States Geological Survey's free remote sensing software, LAS (version 7.2), I preformed an Isoclass unsupervised classification algorithm utilizing the red and near-infrared bands (bands 2 and 4, respectively). The paragraph below refers to table 2, which contains descriptions of six important parameters used for the Isoclass algorithm.

The LAS Isoclass algorithm begins by calculating the mean vector and standard deviations of all pixel values contained in the specified bands of the input image. On the first iteration, the original mean-vector and standard deviation calculation is split into two clusters. For each of the following iterations, the resulting clusters are continually split or combined based upon the values of parameters CLUSDIST and MAXCLSTD. For example, the digital number (DN) mean cluster centroids of clusters 42 and 43 are 90.7, 19.01 and 99.73, 16.5 respectively (Figure 3), therefore, these two clusters were not combined because their inter-cluster values are greater than the distance of 3.0 specified by the CLUSDIST parameter. MAXCLSTD operates in a similar fashion, except clusters are split only if the inter-cluster standard deviation is greater than the 3.5 specified for MAXCLSTD, and also only if the cluster has more than 10002 pixels, which is equal to (2*(MINCLUST+1)). If a cluster had less than MINCLUST, the cluster is deleted altogether, and the pixels again become available for inclusion into another cluster on the next iteration of the Isoclass algorithm. Each iteration is either designated a split or combine iteration. This designation is based upon a pre-programmed sequence of SSSSCSCSCSC…S where S is a split and C is a combine iteration. Given twelve iterations, the first four are split iterations, and then combine and split, combine and split for the

remaining eight. On the last iteration, clusters are "chained" (combined) together if their mean inter-cluster distance is less than the 3.0 specified by CHNTHR. Once in a chain, any clusters within CHNTHR pixel values are also included into the chain. Note that the number of clusters cannot be specified, rather only the maximum number of desired clusters. The CHNTHR value can be tweaked so that more or fewer clusters are chained on the last iteration.

The output of the Isoclass algorithm was a one-band gray value image composed of 70 clusters. Each pixel in the Isoclass image was assigned a value of 0 through 70 depending on what cluster assignment it was given. Pixels containing values of 0 in the input two-band image were put into cluster 1, which represents areas of "no data" within the image . Clusters 2 through 70 represent land-cover categories.

When assigning clusters to a land-cover category, I used the SCS data set, high altitude CIR aerial photographs, and my personal recollection of the area to group the 70 clusters into 8 land-cover categories (Table 1c). Since my familiarity of the Seward Peninsula is confined to the areas around Council, the Kuzatrin River, and the roads connecting them, I gave these areas the most weight when assigning clusters to a certain land-cover category. I identified 11 clusters that overlapped land-cover categories. These include clusters 18, 26, 33, 35, 41, 44, 47, 48, 53, 54, and 58. I felt that clusters 35, 41, and 48 are the most necessary candidates for cluster stratification. Due to time limitations and difficulty with the cluster stratification routine in LAS, I did not have the opportunity to further differentiate these 11 clusters. I assigned the overlapping clusters to the dominant land-cover category they represented.

GIS Integration and manipulation of the MSS data

The Isoclass image was converted to an ESRI ArcInfo grid using the "LAS2ARC" command available in LAS. The spatial modeling abilities available in ArcInfo and ArcView Geographic Information System (GIS) software packages allowed for the spatial overlay of the MSS, SCS, MEA, and ground-truthing data sets. In addition, I used ArcView to tabulate spatial statistics such as total area, percentage land-cover, and area of agreement.

Taking land-cover comparison into consideration, I decided it was necessary to crop the ARC form MSS grid to the spatial boundaries of the previously cropped and re-projected SCS data set. It should be noted that the SCS and MSS data sets were derived completely independent of each other, each using different input data, spatial rectification routines, and processing software. As a result of different production methods, the MSS grid data and the SCS data do not overlay each other perfectly. The maximum spatial offset

occurs along the NE coastal boundary, where the MSS data is shifted approximately 800 meters to the NE. I believe the relatively large offset in this area is due to poor mosaic-ing and/or rectification of the MSS data set (evident upon close examination of the MSS .bil file). Further, I believe the SCS data to be the more spatially precise representation of the NE coastal area of disagreement. Taking this into account, I cropped the MSS data set to a grid-based representation of the SCS data set. In this way, the SCS and MSS data sets were overlaid for comparison.

The first version of the Isoclass image had a problem. Due to the low DN values, shadows in the taller mountains were incorrectly classified as water. This problem was rectified by using a set of mask polygons digitized over areas of concern. All occurrences of water that were within the boundaries of the mask polygons were reclassified as shadows.

Comparison of the MSS, SCS, and MEA data sets

To quantitatively compare the data sets, I used both area-wise and spatial overlay comparisons. Using a cell size of 50-meters, the vector based MEA and SCS data were converted to raster based data, the identical form of the MSS data. Although the MSS data was clipped to the boundaries of the altered SCS data, the numbers of pixels in these two data sets are not exactly the same. This is due to a small polygon in the original vector based SCS data that was incorrectly labeled as having a 0 value for a land-cover class. I did not have time to correct this small error. Compared to the MSS data, the grid based MEA data has an even larger difference as to the total number of pixels contained in the data set. This is a result of the generalized nature of the original MEA data set. The disparity between the number of pixels in each data set is not a significant factor affecting the land-cover categories in each data set

The data for the area-wise comparison were calculated in terms of percentage of total area within a given land cover type. Two different area-wise comparisons were made. The first, comparing the MEA and MSS data, and the second, comparing the SCS and MSS data. In each instance, the MSS land-cover categories were generalized in order that be compatible to the land-cover categories presented in the other data sets. Table 3a illustrates the crosswalk that was used to simplify the MSS to the MEA data. Also, the SCS data was simplified for comparison to the MEA data set (Table 3b).

For the spatial overlay comparison, I generalized the MSS data in the same fashion as in the area-wise comparison, using the same land-cover crosswalk. Two difference matrices were produced. The first comparing the MEA

and MSS data (Table 4a), and the second, comparing the SCS and MSS data (Table 4b). The difference matrices show the agreement between each land-cover category in each map. Values are in number of pixels contained in each land-cover category.

RESULTS:

Comparison of land-cover area

Of the 20, 211, 710 pixels (50, 529 sq. km) in the MSS data, the land-cover category Barrens comprise 5.3%; Dry tundra, 4.6%; Wet herbaceous tundra, 14.2%; Moist herbaceous, dwarf-shrub tundra, 42.6%; Moist low-shrub tundra, 6.8%; Tall shrublands or Deciduous forest, 16.1%; Evergreen forest, 5.4%; Water, 4.7%; Snow and ice, <1%; Shadows, <1%. When put into the land-cover categories used for the SCS data, the percentages round out to be approximately the same. This is because the only difference between the MSS and SCS categories is that the MSS categories "Snow and Ice" and "Shadows" (both less than 1%) were put into the MSS class "Barrens" since this is the category where snow, ice, and shadows would most likely be found. However, when the MSS categories are grouped to correspond with the MEA categories, the MSS map indicates the following: Alpine tundra comprises 10.2%; Moist tundra, 49.4%; Wet tundra, 14.2%; High brush, 16.1%; Evergreen forest, 5.4%; and Water 4.7%. The MSS map land-cover percentages are, of course, different from the land-cover percentages calculated from the MEA and SCS maps. Consult figures 5a and 5b for a graphical and tabular comparison of the percent of total area within each land-cover category.

Comparison of spatial overlay

MEA versus MSS:

There is an overall 38.7% agreement between the MEA and MSS maps. In the MSS map, 44.1% of the Alpine tundra area overlay the MEA Alpine tundra areas (horizontal comparison). In contrast, 22.8% of the Alpine tundra areas of the MEA map are identified as Alpine tundra on the MSS map (vertical comparison). The lower agreement of the MSS map can largely be attributed to the greater resolution of the MSS data. While the MEA map only identifies large homogeneous polygons of Alpine tundra, the MSS map identifies individual 50 by 50-meter areas of Alpine tundra. This large disparity in mapping units and general mapping precision is the source of much disagreement between maps.

Table 4a contains the complete results of the MEA versus MSS spatial overlay analysis.

SCS versus MSS:

Between the SCS and MSS maps there is an overall agreement of 41.8%. The land-cover Barrens designated by the MSS map overlays 51.2% of the area designated as Barrens in the SCS map (horizontal comparison). Alternately, 50.4% of the SCS Barrens category overlays the MSS Barrens category (vertical comparison). The higher resolution of the SCS data is a large contributing factor to the improvement in overall agreement between the SCS and MSS maps. Table 4b contains the complete results of the SCS versus MSS spatial overlay analysis.

DISCUSSION:

Qualitative Evaluation of the three data sets

All three maps give a reasonable representation of the distribution of the major vegetation categories on the Seward Peninsula. The most general grouping of land-cover categories: Alpine tundra, Moist tundra, Wet tundra, Tall brush, Evergreen forest, and Water, have roughly similar distribution patterns. For instance, all three maps correctly identify mountainous areas as either Alpine tundra (MEA map), or a combination of Barrens and Dry tundra (MSS and SCS maps). However, when a high level of detail is an issue, the differences of land-cover classifications and spatial precision between maps becomes apparent.

The MEA map contains six land-cover classes (originally seven, see Table 1a), the SCS map has eight (originally 169, see Table 1b), and the MSS map, ten (see table 1c). In terms of land-cover classes, the unaltered SCS map is unquestionably the most detailed representation. However, differentiating between 169 land-cover categories on a hard copy map is virtually impossible. If hard-copy production of a map is desirable, generalization of land-cover classes is a necessity. Cartographically speaking, it is best to keep the number of land-cover categories to a minimum, yet at the same time, it is important not to generalize categories to the point of having a map that does not effectively represent vegetation differences. Taking this into account, eight to ten land-cover categories is an appropriate number, six is too generalized, and 169 is far too complex.

Both the MEA and SCS maps were derived from a vector polygonal data set (i.e. uses polygons with coordinate referenced vertices to represent data).

The vector approach is generally a more precise form of data, since the location of a point in space can be infinitely specified. The MSS data is raster based (i.e. uses groups of 50 by 50-meter pixels to represent data). In the case of the MSS data set, spatial location can only be specified to within a 50-meter polygon (pixel). Because of this, raster based data is generally less precise than vector data. However, when attempting to represent land-cover at a small-scale (for example, a 1:1, 000, 000 scale) superior results are obtained by raster based data. This fact becomes apparent when you consider that the vector based SCS data has approximately 9, 000 polygons of variable sizes. On the other hand, the MSS data has over 20 million polygons in the form of 50 by 50-meter pixels. Because vector data is limited to how many coordinates a human can punch into a computer, the digitally collected and processed MSS satellite data is able to show more spatial detail. For example, the SCS map indicates the presence of tall shrublands and moist herbaceous tundra within mountain valleys, areas that were simply classed as Alpine tundra by the MEA map. However, SCS polygons that represent areas of dominant Tall shrublands also commonly contain small areas of Moist herbaceous, dwarf-shrub tundra. While the SCS data does not give any sort of indication of the heterogeneous nature of its vector polygons, this important information is provided by the MSS map on a pixel by pixel basis.

Overall, the MSS map shows more plant diversity in areas that were classed as only one land-cover type by the MEA and SCS maps. This fact is most apparent in areas that were categorized as Moist tundra (MEA map) and Moist herbaceous, dwarf-shrub tundra (SCS map). The MSS map indicates that these areas also contain extensive areas of tall and low shrublands (in addition to intermittent patches of Wet herbaceous tundra, Dry tundra, and small bodies of standing water). The higher diversity of land-cover indicated by the MSS map is a significant improvement over the SCS and MEA maps.

Major shortcomings of the three data sets

The MEA data set is by far the most generalized. It represents shoreline and vegetation boundaries as very linear and sharp-angled features, even at small scales. Additionally, no inland fresh water lakes, except one are represented. This fact is the dominant reason why the % area of Water was so low on the MEA map (Figure 5). Future use of the MEA map should include the integration of a lakes and rivers map layer. The seven land-cover classes (reduced to six for map comparison) are too few, and the boundaries are of insufficient precision to warrant the use of the MEA map by any serious scientific research.

Land-cover classification and spatial detail of the SCS map are far superior to that of the MEA map. Similar to the MEA data, the complete lack of inland fresh water bodies is a curious drawback to a generally representative data set. Future use of the SCS map should include the integration of a lakes and rivers map layer. Although the SCS is the superior vector based data set, it gives no indication as to the diversity of land-cover types within its 9, 000+ polygons. As stated before, 169 different land-cover designations are very difficult, if not impossible to differentiate on a printed map. Therefore, simplification of the original land-cover categories is a necessity on a printed map.

The MSS-derived land-cover map has shortcomings as well. The effect of spectral mixing between mountain shadows and the Barrens and Dry tundra categories often resulted in the classification of Wet herbaceous tundra, which in reality should be areas of either Barrens or Dry tundra. Similarly, the sunny side of a hill gives off a different spectral reflectance than the shaded side of the same hill, even if the land-cover is entirely the same. As a result, some areas of the same land-cover type were classed differently, based upon aspect. This distortion caused by elevation and aspect is rectifiable by the integration of a digital elevation model (DEM). This is a planned future activity. Poor radiometric correction is another consideration. In many instances, the seams between the individual MSS scenes are very apparent, this is a particular problem for an area to the west of the Kigluaik Mountain Range. The probable result is the partially incorrect land-cover classification of the immediate area surrounding the seam areas. Using the present mosaic-ed MSS data set, this problem cannot be solved. Also, an area of low clouds and fog on the southwest coast of the Peninsula gives a false impression of Tall shrublands, which in reality, should be classed as either Moist herbaceous, dwarf-shrub tundra or Wet herbaceous tundra. The use of a simple polygonal mask could easily be used to change the land-cover assignment. Additionally, a curious blob on the western edge of Imuruk Basin is also an area of concern. This blob could be a large mat of seaweed or perhaps a low cloud. Regardless of its composition, the blob area should be classed as Water. A simple polygonal mask could easily vanquish the Imuruk Basin blob. Despite the problems, the MSS data offers the most precise spatial representation of the distribution of vegetation on the Seward Peninsula.

CONCLUSIONS:

1) A raster-based remote sensing approach was an appropriate method of mapping the distribution of vegetation on the Seward Peninsula.

2) The MSS map provides a higher degree of spatial detail than the SCS and MEA vector-based maps.

3) The MSS map offers a better representation of the diversity of land-cover types within the individual SCS and MEA land-cover polygons.

4) Overall, percentages of each land-cover category are closely approximated by all three data sets (Figures 5a and 5b). However, the precise distribution of the land-cover categories is highly variable, as indicated by the difference matrices (Tables 4a and 4b).

5) Areas of Tall shrublands and Moist low-shrub tundra that are not present on the SCS and MEA maps are identified on the MSS map. Since the MSS map indicates these areas occur in drainage-like patterns (associated with small intermittent streams), it is assumed that the shrublands do indeed exist.

6) Total agreement between the three maps is not impressive (38.7% between the MSS and MEA maps, and 41.8% between the MSS and SCS maps). The main cause of the relatively large margin of disagreement is most likely due to the comparison between vector based data (MEA and SCS) and raster based data (MSS). An additional factor affecting the low agreement of the maps could be caused by the independently derived land-cover classification systems employed by the creators of each data set.

7) The MSS map offers possibly the first Multi-Spectral Sensor-derived land-cover map of the Seward Peninsula. An accuracy assessment of MSS map is planned for the near future.

ACKNOWLEGEMENTS:

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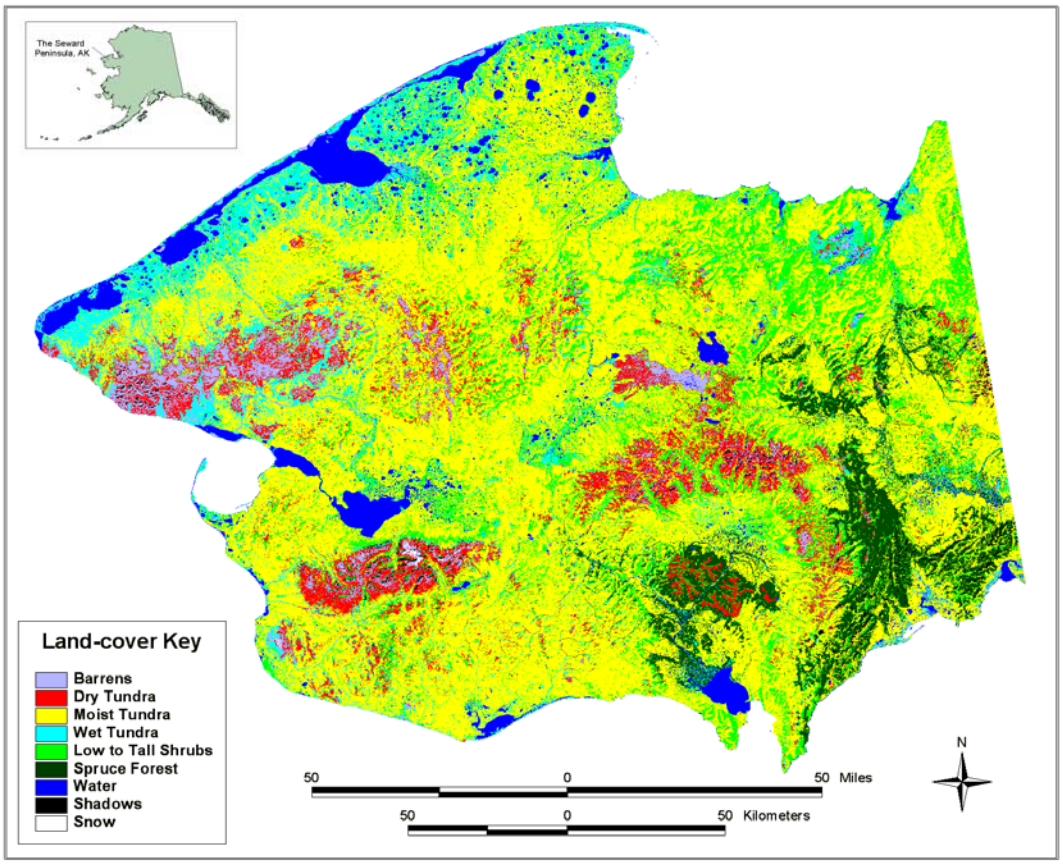


Figure 1: The SP-MSS land-cover map.

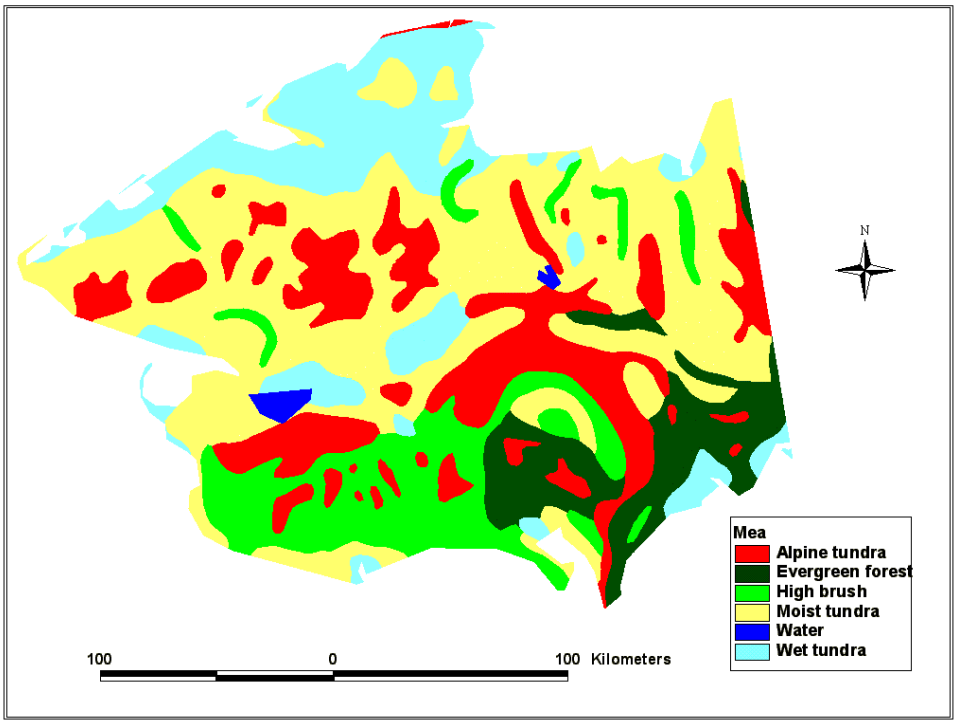


Figure 2: The MEA land-cover map.

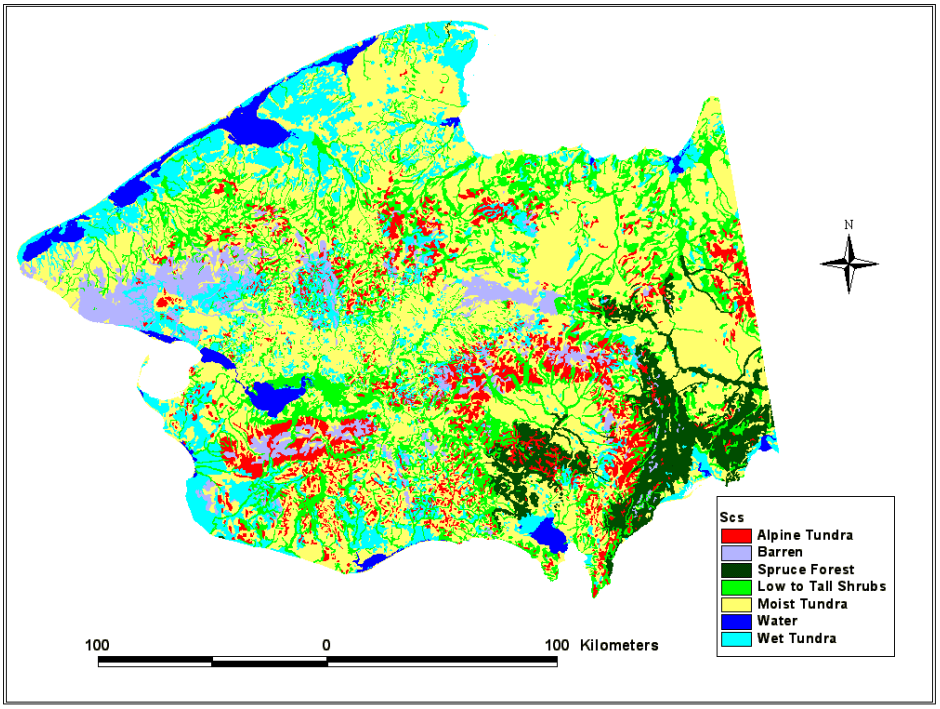


Figure 3: The SCS land-cover map.

Figure 4. Scatter plot graph of Isoclass cluster cetroids. Values are in digital numbers. The x-axis represents the near-ir band, the y-axis represents the red band.

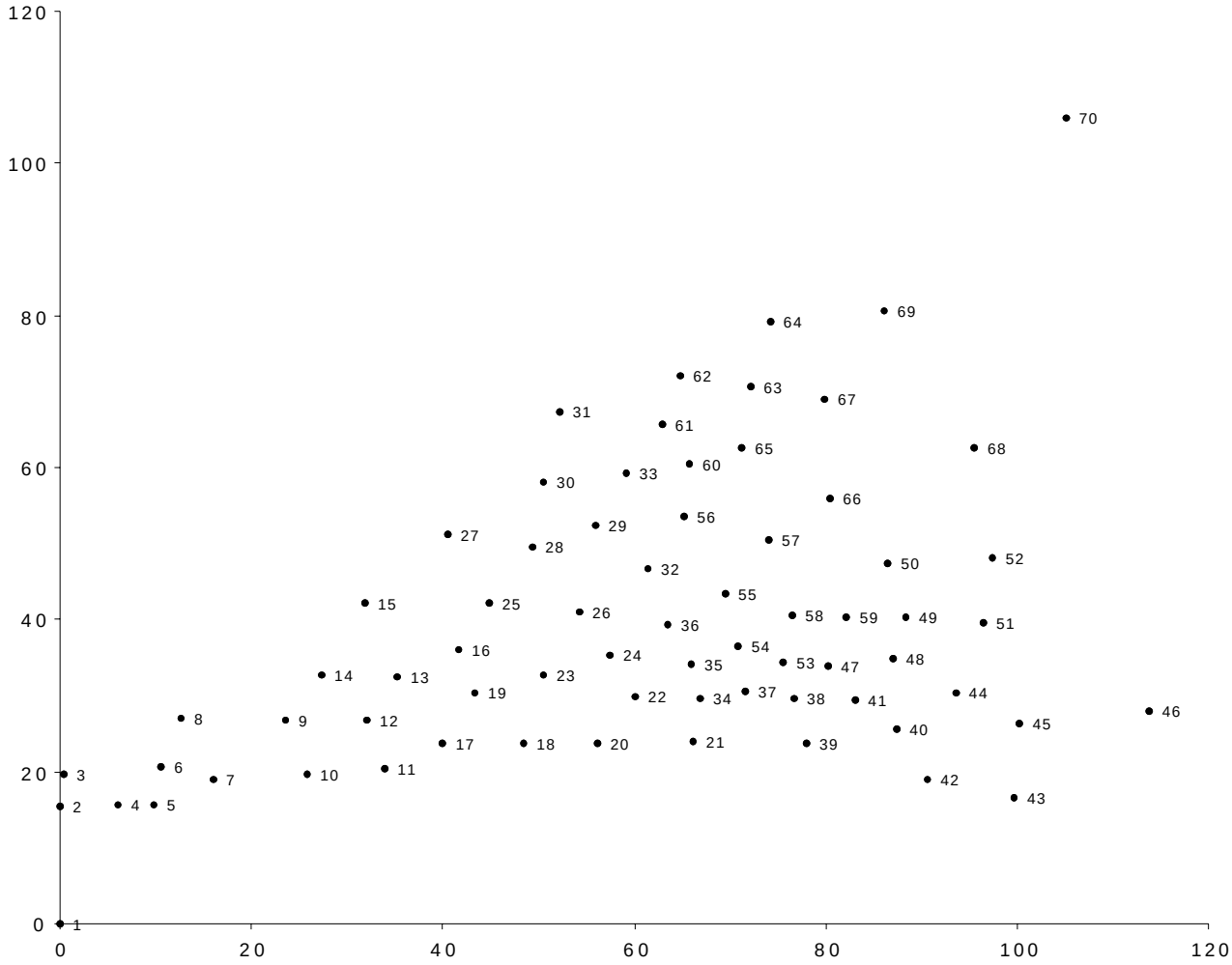
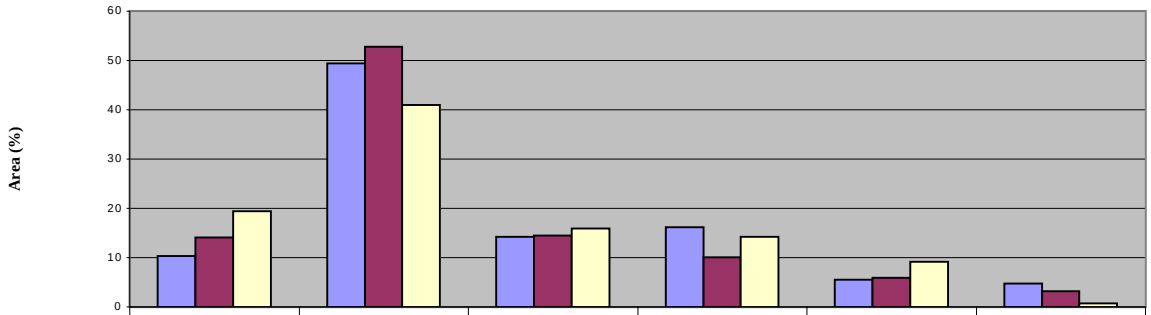


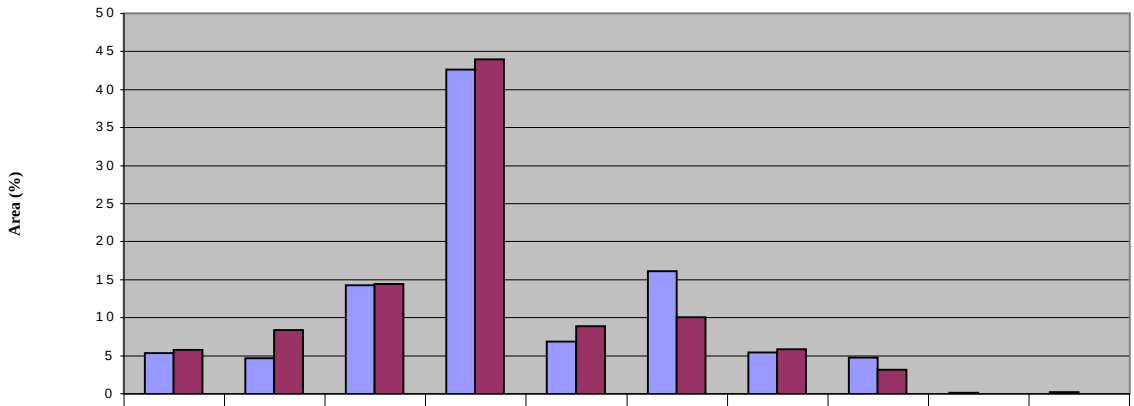
Figure 5. Percentage of total area based on land cover category.
(a) MSS, SCS, and MEA maps, (b) MSS and SCS maps.

a.



	alpine tundra	moist tundra	wet tundra	high brush	upland spruce	water
MSS	10.2	49.4	14.2	16.1	5.4	4.7
SCS	14	52.7	14.4	10	5.8	3.1
MEA	19.4	40.9	15.9	14.1	9.1	0.6

b.



	barrens	dry tundra	wet herbaceous	moist herbaceous,	moist low-shrub	tall shrublands or	evergreen forest	water	snow and ice	shadows
MSS	5.3	4.6	14.2	42.6	6.8	16.1	5.4	4.7	0.1	0.2
SCS	5.7	8.3	14.4	43.9	8.8	10	5.8	3.1	0	0

Table 1. (a) Crosswalk between original and altered MEA land-cover classes, (b) Crosswalk between original SCS "fmuid" land-cover numbers and altered SCS land-cover classes. Note that if not otherwise specified, "complex" fmuid numbers (i.e. 10-22) were classified as the first fmuid land-cover (10), (c) Crosswalk between original cluster values and MSS land-cover classes.

a.

Original Name	Altered Name
Alpine tundra	Alpine tundra
Moist tundra	Moist tundra
Wet tundra	Wet tundra
High brush	High brush
Bottomland spruce-poplar forest	Evergreen forest
Upland spruce-hardwood forest	Evergreen forest
Water	Water

b.

Original Fmuid Numbers	Altered Name
72,74,80,81,82,60-80	Barrens
60,61,63,63-43,64,65,66,70,71	Dry tundra
51,52,54,55,56,57	Wet herbaceous tundra
41 to 45,50,60,63,66-20,66-54,66-55,91	Moist herbaceous, dwarf-shrub tundra
32,34,35	Moist low-shrub tundra
14,20,21,22	Tall shrublands or Deciduous trees
10,11,12,13,15,90	Evergreen forest
4,5	Water

c.

Cluster Number	Land-Cover
9,11-16,25,27,30,31,60-69	Barrens
26,28,29,32,33,50,52,55,56,57	Dry tundra
17,19,23,24,36,54	Wet herbaceous tundra
35,37,41,44,48,49,51,58,59	Moist herbaceous, dwarf-shrub tundra
34	Moist low-shrub tundra
18,22,38,39,40,45,46	Tall shrublands, or Deciduous trees
20,21	Evergreen forest
2-8,10	Water
42,43,70	Clouds and ice

Table 2. LAS parameters used in the Isoclass Clustering Algorithm

Structure of my parameter descriptions are as follows:

LAS PARAMETER = **value:** (parameter and value) Description…

PARAMETERS:

MAXNUMIT = **12**: (maximum number of iterations = 12) Upon each iteration, Isoclass analyses the input data and assigns pixels to a cluster using a split or combine operation. Isoclass will terminate upon its MAXNUMIT iteration.

CLUSDIST=**3.0**: (threshold mean cluster distance = 3.0) Clusters with a mean inter-cluster distance of less than CLUSDIST pixel values will be combined.

MAXCLSTD=**3.5**: (threshold standard deviation = 3.5) A cluster with a standard deviation of greater than MAXCLSTD and number of pixels is greater than 2 * (MINCLUST+1) will be split into two clusters.

MINCLUST=**5000**: (minimum pixels = 5000) A cluster with less than MINCLUST pixels will be deleted. Also, this parameter is used in determining if a cluster is split (see above parameter MAXCLSTD).

MAXCLUST=**70**: (maximum number of clusters = 70) Upon reaching MAXCLUST number of clusters, Isoclass will no longer split or combine clusters.

CHNTHR=**3.0**: (cluster chaining threshold = 3.0) After MAXNUMIT has been reached, clusters are chained (combined) into one cluster if their mean inter-cluster distances are less than CHNTHR.

Table 3. (a) MSS to MEA land-cover crosswalk, (b) SCS to MEA land-cover crosswalk, (c) MSS to SCS land-cover crosswalk

a.

MSS Land-Cover	MEA Land-Cover
Barrens	Alpine tundra
Dry tundra	Alpine tundra
Moist herbaceous, dwarf-shrub tundra	Moist tundra
Wet herbaceous tundra	Wet tundra
Moist low-shrub tundra	Moist tundra
Tall shrubland or Deciduous forest	Tall brush
Evergreen forest	Evergreen forest, previously (Bottomland and Upland Spruce)
Water	Water
Clouds and snow	Alpine tundra
Shadows	Alpine tundra

b.

SCS Land-Cover	MEA Land-Cover
Barrens	Alpine tundra
Dry tundra	Alpine tundra
Moist herbaceous, dwarf-shrub tundra	Moist tundra
Wet herbaceous tundra	Wet tundra
Moist low-shrub tundra	Moist tundra
Tall shrubland or Deciduous forest	Tall brush
Evergreen forest	Evergreen forest, previously (Bottomland and Upland Spruce)
Water	Water

c.

MSS Land-Cover	SCS Land-Cover
Barrens	Barrens
Dry tundra	Dry tundra
Moist herbaceous, dwarf-shrub tundra	Moist herbaceous, dwarf-shrub tundra
Wet herbaceous tundra	Wet herbaceous tundra
Moist low-shrub tundra	Moist low-shrub tundra
Tall shrubland or Deciduous forest	Tall shrubland or Deciduous forest
Evergreen forest	Evergreen forest
Water	Water
Clouds and snow	Barrens
Shadows	Barrens

Table 4. Difference matrices (a) MSS versus MEA map , (b) MSS versus SCS map. Values are in number of 50 by 50-meter pixels.

a.	**Major Ecosystems of Alaska Map**							
MSS	Alpine tundra	Moist tundra	Wet tundra	High brush	Evergreen forest	Water	Total	Agreement (%)
Alpine tundra	**868463**	629933	187491	231420	43393	6590	1967290	44.1
Moist tundra	1610141	**4731935**	1250820	1606245	692593	12172	9903906	47.8
Wet tundra	548923	881366	**934537**	339184	93633	3788	2801431	33.4
High brush	619488	1329178	347292	**474754**	451044	10950	3232706	14.7
Evergreen forest	133500	289237	97536	92191	**458012**	5697	1076173	42.6
Water	20511	105061	253524	11820	36804	**83105**	510825	16.3
Total	3801026	7966710	3071200	2755614	1775479	122302	19492331	
Agreement(%)	22.8	59.4	30.4	17.2	25.8	68.0		
							Total Agreement=38.7%	

b.	**Soil Conservation Service Map**									
MSS	Barrens	Dry tundra	Wet herbaceous tundra	Moist herbaceous, dwarf-shrub tundra	Moist low-shrub tundra	Tall shrublands or Decid forest	Evergreen forest	Water	Total	Agreement (%)
Barrens	**575531**	174613	120651	123058	24006	41414	33559	32015	1124847	51.2
Dry tundra	248600	**194433**	179748	230640	21429	45749	2570	2505	925674	21.0
Wet herbac tundra	160273	393589	**900769**	1069489	122077	161139	58375	11622	2877333	31.3
Moist herbaceous, dwarf-shrub tundra	101730	645273	1103711	**4890943**	821986	854179	181158	6412	8605392	56.8
Moist low-shrub tundra	10545	59960	125814	750690	**197781**	151108	80519	827	1377244	14.4
Tall shrublands or Decid forest	33403	161978	275395	1462466	459886	**595935**	262439	10696	3262198	18.3
Evergreen forest	9248	30381	39710	201543	112193	159564	**525607**	6928	1085174	48.4
Water	3133	10817	156125	153997	21882	13922	33748	**560129**	953753	58.7
Total	1142463	1671044	2901923	8882826	1781240	2023010	1177975	631134		
Agreement(%)	50.4	11.6	31.0	55.1	11.1	29.5	44.6	88.7		
									Total Agreement=41.8%	

Table 5 Council Road Truck Survey Observers: Walker and Snyder Date: 7/16/00

Guess/Land Cover Codes
1a - barren
1b - prostrate shrub/lichen
1c - prostrate shrub w/ no lichen, Loipro and Empnig
2 - moist acidic tundra (MAT)
3 - moist non-acidic tundra (MNT)
4 - moist dwarf shrub/lichen/graminoid
5a - prostrate dwarf shrub, Empnig, Loipro, and heath
5b - erect dwarf shrub, Vaculi and Betnan
5c - low shrub, Salix sp and Betgla
5d - tall shrub, Alncri
5e - alder savanah
6 - wet
7a - needleleaf woodland w/ Salix spp.
7b - needleleaf woodland w/ lichen
8 - broadleaf forebalst, Pop
9 - water
10 - ice

Veg. Cover (Shrub and Tree)
1 - scattered: <5%
2 - patchy: 5-25%
3 - open: 25-75%
4 - closed: >75%

Shrub Height
1 - <5cm
2 - 5-40cm
3 - 40-200cm

Tree Height
1 - <2m
2 - 2-10m
3 - >10m

Site	GPS N	GPS E	Relative Position	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water%	Barren%	Guess	Land Cover	SCS	Plant Association/Notes
144	7196350	562488	50m W	3	2	0	0	<5	0	4	4		lichen, empnig, vaculi, rubcha, erivag (10%), shrubs 30%
145	7195881	562361	50m E	3	2	0	0	0	0	4	4		lichen 50%, dwarf shrubs 40%, graminoids 10%
145a	7194106	562074	10m SE	4	3	0	0	10	0	4	4		tall riparian shrubland
146	7193740	562084	10m E	3	3	3	2	0	0	7a	7a		picgla, salpla, betgla (40-200cm)
147	7162499	561794	10m E and W	3 to 4	3	1	2	10	0	5	5		closed low salpla with a few tall salpla, dwarf shrub understory
148	7192267	561741	100m E	3	2	0	0	0	0	4	4		lichen 40%, dwarf shrub 50%, graminoid 10% (clas sp, betnan, leddec, empnig, erivag)
149	7191529	561562	10m E	3	2	0	0	<5	0	6 and 4	6 and 4		drainage with wet graminoid tundra (erivag, caraqu) with H.C. polygons with betnan, rubcha, etc
150	7191404	651532	200m E	3	2	0	0	0	0	4	4		releve C2 is in this polygon
151	7191010	651434	20m E	3	3	1	2	10	5	5	5		tall salpla with widely scattered picgla

Table 5 Council Road Truck Survey (continued)

Site	GPS N	GPS E	Relative Position	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water%	Barren%	Guess	Land Cover	SCS	Plant Association/Notes
152	7190510	561316	50m E	3	2	0	0	0	0	4	4		dwarf shrub 60%, lichen 50%, sedge 10%
153	7190084	561212	50m E	3	3	1 to 2	2	<5	0	5	5		tall salpla with widely scattered picgla
154	7189564	561091	50m E	3	3	3	2	0	0	7a	7a		picgla, salpul woodland, open tall picgla
163	7188528	560475	800m W	3	3	3	2	0	0	5	5		alder shrubland with widely scattered picgla
164	7188147	560410	250m E	3	3	3	2	0	0	7a	7a		open picgla/willow woodland, 20-30% tree cover
165	7188147	560410	100m E	3	3	3	2	0	0	7a	7a		open picgla/willow woodland, 20-30% tree cover
167	7187671	560061	1km WSW	3	3	0	0	0	0	4 and 5	5 and 4		complex of birch shrublands and lichen, dwarf shrub, graminoid tundra
168	7188015	560322	1km SW	2	1	0	0	0	80	1b	1b		probably alpine lichen, prostrate shrub tundra
169	7187245	559776	20m SSE	3	2	0	0	0	0	4	1b		complex of lichen, prostrate shrub (empnig, betnan, leddec) and shrubs (betnan, salpul, salgla)
170	7187599	559951	1km W	2	1	0	0	0	0	1b	1b		alpine tundra, looks like lots of lichens
171	7186546	559002	1km ENE	3	3	0	0	0	0	5	5		tall alders
172	7186546	559002	300m ENE	3	3	0	0	0	0	5	5		low willows with open tall alders
173	7186480	558917	1km W	3	3	0	0	0	0	5	5		tall open alders
174	7186497	558939	50m SSE	3	2	1	2	0	0	1b	1b		lichen, empnig, leddec, betnan, prostrate shrub with scattered dwarf shrubs (mainly betnan, salgla)
175	7186150	558573	30m S	2	1 to 2	0	0	0	0	1b	1b		nice, lichen 65%, prostrate shrub 25% (loipro, empnig, betnan, vaculi) loipro 30%, betnan 20%
176	7185795	558308	20m S	3	2	1	2	0	0	1b	1b/5		lichen heath with low shrubs 20%, mostly betnan low shrubs
177	7185196	557949	10m NE	0	0	0	0	0	>90	1a	1a		gravel pit!
178	7184902	557839	1.2 km SSW	3	3	1	2	0	0	5	5		open tall alders
179	7184478	557439	20m S	2	2	0	0	0	0	1b	1b		lichen heath, 15% dwarf and low shrubs (betnan, salpul)
180	7184103	557261	20m S	2	2	1	2	0	0	1b	1b		lichen heath, 15% dwarf and low shrubs (betnan, salpul)
181	none	none	none	none	none	none	none	none	none	none	none	none	none
182	7182762	555932	?	2	2	0	0	1	0	4	2		MAT with carbig (lichen only about 5-10%), betnan 20%, leddec 20%, rubcha 5%, carbig 35%, vaculi 20%

Table 5 Council Road Truck Survey (continued)

Site	GPS N	GPS E	Relative Position	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water%	Barren%	Guess	Land Cover	SCS	Plant Association/Notes
183	7181932	555594	120m SSE	2	1	0	0	0	5 to 10	1b/1a	1b/1a		mostly 1a with 20% rocks
184	7182132	556042	20m SSW	3	3	0	0	0	0	5	5		mixed low willow 60% and tall alders 40%
191	7191742	561614	10m E and W	3 to 4	3	1	2	5 to 10	0	5	5		salpul (low and tall) with widely scattered picgla
192	7189690	561119	20m E	3	2 to 3	0	0	0	0	4	4		dwarf shrub 50%, lichen 40%, erivag 10%
193	7187076	559622	1km W	3	3	0	0	0	0	5	5		tall alders
194	7187076	559622	600m W	3	3	0	0	0	0	5	5/1b		low willows with patches of dwarf shrub lichen
195	7186027	558236	20m E	3	3	0	0	10	20	5 and 1	5 and 1		tall salale and gravel bars
196	7185196	557949	1km SE	3	3	0	0	0	0	5	5		tall alders
197	7185196	557949	500m E	3	3	1	2	0	0	5	5		low willows with patches of 1b and a few scattered picgla

Table 6 Council Area Helicopter Survey 7/18/00 Observers: Walker and Snyder

Site #	GPS N	GPS E	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water %	Barren %	Guess	Land Cover	SCS	Plant Association/Notes
1	7223000	559970	2	1	0	0	0	90	1a	1a	70	85% 1a with 15% 1b
2	7222900	?	3	1	0	0	0	45	1b	1b	70	1b Dryas, oxybry
3	7221422	559800	3	2	0	0	0	10	5	5 and 2?	41	dwarf shrubland, solifluc, vaculi, dryoct,betnan, salpul
4	7220988	559800	3	2	0	0	0	0-5	4	1b	41	lichen, betnan, loipro, leddec, photo 00-05-24,23,22
5	7220880	559800	3	2	0	0	0	10	comp 4/5	1b, 5, and 1a	41	complex of rocks, shrubs, and lichens (dominant)
6	7219000	559530	3	3	0	0	0	2	5	5	21	mix of dwarf and low shrubland (riparian), 20% tall shrubs
7	7218533	559778	3	2	0	0	0	0	4	4	60	lichen, carbig - close to 1b but no sedges and more sphagnum
8	7218400	559690	3	3	0	0	5	1	5	5	21	open salpla with eriang, equarv understory, 1 m tall
9	7218030	560640	3	2	0	0	0	0	4	4, 2, and 6	60	complex, lichen rich, quite a bit of sphagnum
10	7215700	560150	1	1 to 2	0	0	0	90	1a	1a and 1b	60	barren hill, 20%1b, 80%1a
11	7216006	560788	3	3	0	0	10	1	5	5	20-34	low shrubland willow
11a	7215630	562450	3	1 to 2	0	0	0	0	4	4 and 2	60-54	none
12	7213615	564323	2	1	0	0	0	0	4	4	60	lichen rich tussock tundra
13	7212922	564369	3	2	0	0	0	0	4	4	35	lichen rich carbig tundra
14	7212300	563429	3	2 to 3	0	0	0	0	comp 5/4	5 and 1b	35	complex of low betgla with lichen stripes (<20%)
15	7212300	563429	3	2 to 3	0	0	0	0	4	5 and 1b	35	complex of low betgla with lichen stripes (~40%)
16	7210000	562835	3	3	0	0	0	0	7a	5	35	willow/birch low shrubs, closed
17	7208800	562740	3	3	2	2	0	0	7a	5	35	willow/birch shrubland, some popbal on upper slope
18	7208680	563500	3	3	1	2	0	0	7a	5	35	birch/willow shrubland, 10% lichen heath
19	7207900	563960	3	3	1	2	0	0	7a	5 and 8	35	birch/willow shrubland, with island of poplars <10%, low willows

Table 6 Council Area Helicopter Survey (continued: see Table 5 for codes)

Site #	GPS N	GPS E	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water %	Barren %	Guess	Land Cover	SCS	Plant Association/Notes
20	7207170	563000	3	3	0	0	0	0	5	5	72	willow/birch low shrubland
21	7207617	562280	2	1	0	0	0	20	comp 5/4	1b	72	dryas tundra with ~10% barren (mostly continuous cover)
22	7207500	567685	1	1	0	0	0	?	1b	1b and 1a	35	barren with dryas tundra
23	7206800	562600	3	2 to 3	0	0	0	0	5	5	35	open low birch willow shrubland
24	?	?	?	?	?	?	?	?	5	5	35	tall???
25	7203200	561500	3	3	2	2	0	0	5	5	35	patches of alders (40%), poplars (10%), and willows (50%)
26	7202850	562850	3	3	1	2	0	0	7a	5	35	mostly low willow/birch, scattered picgla, patches of alders (20%)
27	7203645	565630	2	1	0	0	0	5	1b	1b	61	lichen heath with patches of willows
28	7203300	565650	3	3	1	2	0	0	5	5	22	low willow shrubland with some poplars at lower edge
29	7202680	565724	3	3	3	2 to 3	0	0	7	7a	12	open picgla with some popbal and willow understory
30	7201500	567700	1	1	0	0	0	1	1a	1b	61	dryas oxybry
31	7201130	567763	3	3	0	0	0	0	4	3, 1b, and 5	12	complex of MNT, dryas tundra, and low willows
32	7200950	567700	3	3	2	2 to 3	0	0	5	5	12	willow shrubland with scattered picgla and popbal
33	7200560	567360	3	2 to 3	3	2 to 3	0	0	7a	7a	35	open picgla with scattered popbal and willow understory
34	7200000	563900	3	2 to 3	3	2 to 3	0	0	7a	7a	12	open picgla with willows
35	7197832	563950	3	2 to 3	3	2 to 3	0	0	7a	7a	35	open picgla with willows
36	7197750	564129	3	3	2	2	0	0	5	5	35	50% alders with scattered picgla, 40% low willows
37	7196145	563835	2	2	0	0	0	0	2	2	60	tussock tundra
38	7195847	558919	2	2	0	0	0	0	4	4	60-54	lichen, graminoid, dwarf shrub, sphagnum, <10% water tracks, photo 00-05-21,20,19,18,17
39	7192450	558660	4	2	0	0	0	0	5	5	22	closed alder shrubland

Table 6 Council Area Helicopter Survey (continued: see Table 5 for codes)

Site #	GPS N	GPS E	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water %	Barren %	Guess	Land Cover	SCS	Plant Association/Notes
40	7193490	559850	2	1 to 2	0	0	0	0	4	4	60	lichen, graminoid, sphagnum, dwarf shrub (carag?)
41	7193615	560550	2	2	0	0	0	0	4	4	60	lichen, graminoid, sphagnum, dwarf shrub (carag?)
42	7193850	561200	3	3	3	2 to 3	0	0	7a/5	7a and 5	10	open picgla, willow
43	7193676	562245	3	3	3	2	0	0	7a	7a	10	open picgla, willow/birch
44	7194025	562526	3	3	0	0	0	0	5	5 and 7a	10	riparian shrub and scatterd picgla
45	7193615	563563	3	1 to 2	0	0	0	0	4	4	10 66	lichen tussock tundra
46	7193305	564366	3	2 to 3	3	2 to 3	0	0	7a	7b	10 66	lichen woodland, 40-50% trees
47	7191700	565696	3	2 to 3	3	2 to 3	0	0	7a	7b	10 66	lichen woodland, ~35% trees
48	7191360	567570	3	3	3	2 to 3	0	0	7a	7a	10	picgla/willow, photo 00-05-10, 9, 8
49	7192330	568915	2	1	0	0	0	0	5	4	12	graminoid, lichen, dwarf shrub, sphagnum tundra
50	7190080	568340	3	2	3	2	0	0	5	8	10 20	popbal to 5m, photo 00-05-7,6
51	7190020	569195	3	3	3	2	1	0	5	8 and 5	10 20	70%popbal, 30% tall willows
52	7191483	571211	2	1	0	0	0	0	5	4	60	lichen, dwarf shrubs, graminoids, sphagnum tundra, lots of rubcha
53	7189090	571200	3	3	2	3	0	0	7a	7a	10	open and tall picgla/willows, photo 00-05-7,6
54	7189100	571919	3	3	3	2	0	0	5	8 and 5	10 20	open popbal/willows
55	7189000	572700	3	3	3	2	0	0	7a	7a	10 20	open and tall picgla/willows
56	7188590	572360	3	3	3	2	0	0	5	8	10 20	open popbal, 10m tall
57	7187810	573000	3	3	2	2	0	0	5	5 and 8	10 20	riparian willows and popbal
58	7187560	571780	3	3	3	2	5	0	7a	7a	10	picgla/willow
59	7106400	571770	3	3	3	2 to 3	0	0	7a	7a	10 20	picgla/willow
60	7185877	571109	3	2	0	0	5	0	4	4	10 20	lichen, graminoid, dwarf shrub
61	7185100	570590	3	3	2	2 to 3	0	0	7a	7b and 7a	10 20	lichen woodland

Table 6 Council Area Helicopter Survey (continued: see Table 5 for codes)

Site #	GPS N	GPS E	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water %	Barren %	Guess	Land Cover	SCS	Plant Association/Notes
62	7186018	569728	3	3	2	2	0	0	7a	7b and 7a	10 20	open lichen/shrub/woodland
63	7186920	570630	0	0	0	0	15	0	comp 5/6	6	66 54	drained lake, wet tundra, carsax, eriang
64	7188070	570260	2	3	3	2 to 3	0	0	7a	7a	66 54	picgla/willow with quite a bit of lichens
65	7188198	569700	2	2	0	0	0	0	4	4	66 54	lichen, graminoid, dwarf shrub
66	?	?	?	?	?	?	0	0	7a	7a	54	picgla/willow/lichen
67	?	?	?	?	?	?	0	0	7a	7a	54	picgla/willow
68	7187625	569550	3	3	1	2	0	0	5	5 and 8	54	willow/wetland complex
69	7185477	567227	3	1 to 2	0	0	1	0	comp 4/5	4 and 5	54	dwarf shrub, lichen, graminoid, shrub, water tracks 20%
70	7186625	566680	3	2	0	0	0	0	4	4	12	dwarf shrub, lichen, graminoid
71	7186200	564260	3	3	1	2	0	0	5	5	12	willow shrubland with scattered picgla
72	7187253	564353	3	2	1	1	0	0	4	4	60	dwarf shrub lichen with betnan, leddec, rubcha, sphag, and empnig
73	7186970	563090	3	3	3	2	0	0	7	7a	12	open picgla/willow
74	7186160	561822	3	3	1	2	0	0	5	5	22	open alders with low willows
75	7186830	561340	2	1	0	0	0	0	1b	1b	61	empnig, loipro, and lichens
76	7182388	566682	3	1 to 2	0	0	0	0	comp 4/5	4	60	dwarf shrub, lichen, graminoid
77	7182529	566280	3	3	2	2	0	0	7	7a	12	open picgla willow
78	7182525	565786	2	1 to 2	0	0	5	0	5	6	12	moss, graminoid, wet meadow, 10% shrubs
79	?	565840	3	3	0	0	5	0	5	5	12	riparian willows
80	7191020	564185	1	1	0	0	5	0	6	6	54	caraqu, eriang
81	7189090	564945	2	2 to 1	0	0	5	0	6	8 and 4	60 54	complex of wetland lichen, tussock tundra, mostly shrub lichens
82	?	?	?	?	?	?	?	0	7b	7b	60 20	lichen woodland
83	7188100	566100	2	3	2	2	0	0	7b	7b	60 20	lichen woodland
84	7224421	566632	1	1	0	0	0	65	1a	1a	81	dryas tundra, few scattered alders
85	?	?	?	?	?	?	?	0	5	5	22	alder shrublands
86	7225400	562669	3	3	0	0	0	0	5	5	22	closed alder shrublands

Table 7. Quartz Creek road survey (seeTable 5 for codes) 7/20/00

Site	GPS N	GPS E	Relative Position	Guess	Actual	Species	Notes
1	7152918	485274	50m W	2	2,6	Erivag,Eriang,Betnan,Empnig	hummocks, almost strangmoor, very wet between strang
2	7154539	486232	-	2	2	Eritri,Caaq,Erivag,Empnig,Betnan	similar to 1, drier, MAT dominated by dwarf shrub
3	7155782	487318	50m NW	2,5	5b,2		dwarf shrub with some MAT patches
3a	7159367	488257	-		5a	Empnig, Loipro,Betnan	few lichen, some Salpul
4	7159570	488427	-	5	5b	Vaculi,Empnig,some Betnan/Betgla,Salpul patches to 15cm	taller stripes of low shrubs to 2m
5	7167405	485589	50m NW	5	5c,5b		mostly low shrub, some prostrate
6	7171394	485617	200m S	2,5	3,5b	Carbig,Eritri,Equarv,Tomnit,Hylspl,Salret,Dryint, some Carmem,Caragua	low shrub stripes/hummocks with Vaculi,Betnan
7	7173118	485661	100m WNW	5	5c		mixed birch,willow
7a	7174669	485896	100m W		3		MNT, small patches of shrub
8	7176142	486217	100m W	5	5d	Alncri,Sal spp.	
9	7176142	486217	2km W	5	5c		too far to get details
10	7181849	489634	200m W	5	5c	Salgla,Sallan,Betgla	
10a	7181849	489634	1km NW		3		MNT, too far to see details
11	7183941	489743	-	5c	5d,some 5c	Alncri patches, Empnig,Betnan,Vaculi between	between second & third ditch
11a	7183941	489743	100m E		5c	Sal spp,Betgla to 1.5m, patches of Vaculi open areas	between first and second ditch
11b	7183941	489743	?		1b	Loipro,lichen,Dryoct,Rhocam,Arcalp,Empnig	top of ridge, some is drier - Dryoct,forb community
12	7186203	490084	600m W	5b,5c	5c		low shrub
12a	7186247	490085	1.5km NW	3	3		
13	7190167	488390	50m NW	5a	5b,5c	Vaculi,Carbig,Salret	patches of Salpul
14	7191055	487528	-	1b,5a	1c,5b	Empnig,Vaculi,Loipro	patches of Salpul
15	7193923	487733	50m SW	1b	1c	Empnig,Loipro	bare soil on hummock tops, moister areas have Vaculi, some Salpul
16	7195200	488380	75m W	1b	1c		same as 15
17	7195486	488519	550m E	5b	5b,3,5c		mostly dwarf shrub, with some patches of MNT (25%), some low shrub (10%)
18	7195486	488519	?	5c	5c		low shrub, some MNT
19	7196284	490635	700m S	5d	5c		
20	7196284	490635	50m N & S		1c		
21	7196273	491891	100m N	5b	5b	Vaculi,Betnan,Salpul,Leddec,Empnig	

Table 7. Quartz Creek road survey (continued: seeTable 5 for codes)

Site	GPS N	GPS E	Relative Position	Guess	Actual	Species	Notes
22	7196500	492473	75m N	5c	5c	Salix spp.	
23	7196930	493587	75m NNW	1c	1c,5b	Empnig	Empetrum heath with scattered Salpul
24	7197376	494771	100m NE	5b,5c	5b,5c	Salpul	complex, low shrub to 1.5m, lots dwarf shrub
25	7197828	496458	75m NE	5c	5d		dense alders on side of mountain, covering both sides of road
26	7198676	499360	100m N	3	1b	Loipro,Betnan,Stetom,Leddec,Cetisl	scattered Salpul
27	7199296	500511	600m N	5b,5c	5c		low shrub, farther up slope 5c/5b complex on solufluction lobes
28	7200094	502808	-	5b	1c	Betnan,Vaculi,Loipro,Rhocam,Dryint,Leddec	some lichen, bare soil & rocks, no Empnig
29	7199935	504623	500m N	5c,5d	5d,5c		Alder mixed with tall willow and low shrub patches
30	7202329	508017	700m E		5c		
31	7203350	509135	200m NW	5d	5d		
32	7204000	510048	-	1c	3,6	Erivag,Caraqua,Salpul,Saxhir,Dryint	quite wet
33	7204538	510414	350m N	5b	3	Carbig,Carsci,Carmem,Dryint,Equarv,Salret,Tomnit,Vaculi,Betnan,Rubcha,Rholap	
34	7204919	510827	50m SE	1c	1c	Loipro	
35	7205176	511108	50m NW	1c	1c	Loipro	
36	7206419	512448	50m NW	5c	5d		tall willows
37	7208410	514128	-	1c	3	Dryint,Salret,Carsci,Equarv,Tomnit,Carbig	MNT
38	7209963	514268	-	1a	1b	Empnig,Aleoch,Cetraria,Arcalp,Carbig,Brydiv,Dialap	dark color due to lichen - closer to top up to 50% barren
39	7210112	514498	-	5b	2	Carbig,Leddec,Empnig,Betnan,Cetcuc,Sphag	60% cover dwarf shrub, very hummocky
40	7211564	513821	-	5c,5b	2	Betnan,Vaculi,Empnig,Caraqu,Carbig	MAT with lots of dwarf shrubs (more than 39), alders along ditches
41	7212905	513350	50m NE	5d	5d		tall alders
42	7214637	514202	-	2	2	Erivag,Leddec,Rubcha,Vaculi,Betnan,Sphag	tussocks
43	7215717	515091	200m E	2	2		like 42
44	7216261	515679	50m ESE	5c	5c		low & dwarf shrubs
45	7218725	515417	100m W	4	4	Erivag,Empnig,Sphag,Leddec,Rubcha,Cetrarias	25% lichen cover
46	7220340	514390	200m WSW	4	4	Erivag,Sphfus,Leddec,Rubcha,Cetrarias	20% lichen cover
47	7220696	514128	100m SW	5c	5c,2		complex dwarf shrub, MAT,low shrubs on edges

Table 7. Quartz Creek road survey (continued: seeTable 5 for codes)

Site	GPS N	GPS E	Relative Position	Guess	Actual	Species	Notes
48	none	none	none	2	can't see		can't see
49	7224577	510676	100m SW	5c	5e, some 5d		evenly spaced alder (1m high) & low shrub - alder savannah,
50	7226648	509055	100m SW		5e	Erivag,Leddec,Empnig,Vaculi,Sphag,Alncri	tussock tundra with scattered alders
51	7227549	508396	100m SW	4	2	Erivag,Carbig,Betnan,Sphag,Vacvit,Leddec,Rubcha	
52	7229283	508414	100m E	1b	1b	Stetom,Betnan,Empnig,Brydiv,Carbig	
53	7230550	507985	100m E	5e	5b,5c	Betgla,Salpul,Betnan,Carbig,Vaculi,Leddec,Sphag,Cladran,Aulpal	mix of MAT, dwarf shrub
54	7231590	508176	200m W	5b	5c	Betgla,Arclat,Carbig,Fesalt,Rhyrug,Aultur	across river from actual site of 54
55	7234962	508641	100m W	5b	5c	Betgla,Salpul	open from road is more open
56	7237082	509496	50m N	5b	5c	Salpul,Betnan	open low shrub to 1m
57	7238817	509665	100m N	2	3,5c	Salpul,Sallan,Betnan/Equarv,Carbig,Equarv,Vaculi,Leddec,Hylspl,Tomnit,Dryint,Salret,Aulpal	low shrub & MNT
58	7240017	510567	100m W	4	2,borderline3	Carbig,Salret,Vaculi,Tomnit,Salgla,Sallan,Salgla,Rholap,Carsci,Leddec,Arcrub,Betnan	
59	7241513	511042	200m W	2	2	Erivag	great MAT
60	7242976	513122	100m N	2	5b	Vaculi,Leddec,Rosaci,Cetraria,Empnig,Salphl/Betgla,Salgla,Salpul,Leddec	dry stripes with shrubs in between to 1m, farther above road more solid dwarf shrub
61	7244742	514275	50m W	5c	2		MAT with shrubs (60%)
62	7246926	515111	25m W	5c	2	Erivag,Betnan,Leddec,Salpul,Pelt,Sphgir	shrubby MAT
63	7250382	515611	100m SE	4	2	Erivag,Betnan,Vacvit,Leddec,Rubcha,Petfri,matSphag,Aulpal	shrubby MAT, more shrubby than 62 (60%)

Table 8. Quartz Creek Helicopter Survey (see Table 5 for codes) 7/24/00 Observers: Walker and Thayer

Site #	GPS N	GPS E	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water %	Barren %	Guess	Land Cover	SCS	Plant Association/Notes
1	7260320	517234	2	1	0	0	0	0	4	4b		MNT with lichens, photo 00-06-2,1
2	7261173	516710	2	3	0	0	0	0	6	1b/5c		complex of 1b and low birch and willow
3	7262846	517578	1	1	0	0	0	1	4	4		MAT with lichens, carbig, betnan, leddec stripes, cetcuc, claarb, some dryas
4	7267200	519892	2	1	0	0	0	80	1b	1a		barren with 20% dryoct patches
5	7261190	519925	1	1	0	0	0	20	1b/5b	1b		? Ilegible ? < 30% barren
6	7262160	520456	2	2	0	0	0	0	4	4		MNT with lots of lichens (cetcuc), carbig, ?, ?, ?
7	7261444	517580	3	3	0	0	0	0	5c/4 or 1b	5c/4 or 1b		stripes with willow and lichen, dwarf shrub
8	7259372	517245	3	3	0	0	0	0	5b	5c		low and tall salpul
9	7259094	516845	3	3	0	0	0	0	5c	5c		low and tall salpul
10	7258704	516805	2	2	0	0	0	0	3	blank		MNT with 10% salgla, <15% ?, lots of ?
11	7260312	515750	3	3	0	0	0	0	5c	5c		drainage with low salpul
12	7257555	518450	2	2	0	0	0	0	4	1b/5b		stripe complex with lichen stripes, dwarf birch interstripes, photo 00-07-24,23,22,21,20,19
13	7257840	518805	3	3	0	0	0	0	5b	5c		low and tall willows
14	7256933	518545	3	2	0	0	0	0	5c	5c/2		indistinct drainage with low salpul and MAT
15	7257056	515801	3	1	0	0	0	0	2	2		MAT with lots of erivag (60%)
16	7258532	516675	3	3	0	0	0	0	5b	5c/3?		low salpul with ?, salret, ?, ?, hylspl
17	7262365	520050	3	1	0	0	0	50	1b/5b	1b/1a		drint?, carrup, thasub, ?, with 30% barren
18	7256978	516325	3	2	0	0	0	0	2	2/5b		MAT with lots of dwarf birch patches
19	7258169	515030	3	3	0	0	0	0	5c	5c		mostly betnan with scattered taller salpul
20	7261075	515332	3	2	0	0	0	0	4	4		MNT with lichens, 10% low salgla
21	7258750	516225	3	2	0	0	0	0	2	5b		dwarf betnan, salpul, carbig, vaculi, leddec, equarc
22	7259118	517260	3	3	0	0	0	0	5c	5c		low and tall salpul, (plot QC3?)
23	7259731	517107	2	2	0	0	0	0	4	4/1b		strip complex with 1b and 4 (acidic) carbig,, salret, betnan, vaculi, empnig
24	7258882	517002	1	2	0	0	0	0	2	2		MAT
25	7260488	515757	3	3	0	0	0	0	5b	5c/2		low to tall open salgla and salpul with MAT

Table 8. Quartz Creek Helicopter Survey (continued: see Table 5 for codes)

Site #	GPS N	GPS E	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water %	Barren %	Guess	Land Cover	SCS	Plant Association/Notes
26	7259860	514675	4	3	0	0	0	0	5c	5c		willows
27	7261077	517633	3	3	0	0	0	0	5c	5c		low to tall salpul
28	7261280	517663	3	3	0	0	0	0	5c	5c		low to tall willows
29	7261405	518980	2	2	0	0	0	0	2	2		MAT, 30%dwarf shrubs
30	7262629	515685	3	2	0	0	0	0	5c	5c		mixed willow/birch to about 50cm
31	7259822	515716	3	3	0	0	0	0	2	2/5c		MAT with 30% salpul (low)
32	7257190	515278	3	3	0	0	0	0	5c	5c		mixed low willow and birch
33	7267695	520415	1	1	0	0	0	90	1b	1a		10% 1b, barren with dryoct patches
34	7268695	520340	1	1	0	0	0	90	1b	1a		<25% 1b, barren with dryoct patches
35	7266500	521357	3	2	0	0	0	0	4	3		solifluction area with MNT (good)
36	7264880	522702	3	3	0	0	0	0	5c	5c		salpul 1.5 m tall
37	7263711	522580	3	3	0	0	0	0	5b	5c/2		open salpul with MAT
38	7262060	522704	1	1	0	0	0	20	2	2		burned MAT with lots of arclat
39	7262125	523231	1	1	0	0	0	20	5b/5c	2		lightest patch with calcan, burned area
40	7256210	521390	1	1	0	0	0	20	5b/5c	2		burned MAT
41	7254624	522769	2	2	0	0	0	2	2	2		burned MAT with lots of calcan, 20% black soil
42	7254567	522907	1	2	0	0	0	5	5b	2		burned MAT with 50% black soil
43	7255094	523924	2	3	0	0	0	0	5c/6	6/5c		calcan with salpul, burned area, drainage
44	7251760	522324	1	2	0	0	0	2	4	2		burned MAT, lots of dead sphag, 20% dwarf shrubs
45	7250757	523545	2	2	0	0	0	0	6 and 2	6/5b		caraqu, erivag, dwarf birch on hummocks, 20% dead ?, no lichens
46	7250296	523833	1	2	0	0	0	5	2 and 6	6/2 or 2/6?		burned ice wedge polygons
47	7247313	522541	1	1	0	0	35	0	6 and 2	6/2 or 6/5a		wetland complex with large circular sphagnum mats
48	7249047	524068	1	1	0	0	0	0	6 and 2	6 and 2		ice wedge polygons, 30% MAT
49	7249110	525000	2	2	0	0	0	0	2 and 6	2 and 6		ice wedge polygons, burned 30%, wet
50	7246780	522377	1	1	0	0	30	0	6 and 2	6/1a or 6/2		none
51	7248273	522753	1	2	0	0	0	0	4	2		burned MAT, lots of sphang and standing dead
52	7251500	521547	1	1	0	0	0	1	4	2		MAT short tussocks, <5% lichens, lots of dead sphagnum litter

Table 8. Quartz Creek Helicopter Survey (continued: see Table 5 for codes)

Site #	GPS N	GPS E	Shrub Cover	Shrub Height	Tree Cover	Tree Height	Water %	Barren %	Guess	Land Cover	SCS	Plant Association/Notes
54	7246135	520154	3	3	3	2	0	0	5c/5b	5c		tall willows and poplars
55	7246000	519375	3	3	0	0	0	0	5c	5c		bluff with low birch and willows
56	7247000	519132	3	2	0	0	0	0	2 and 6	2/5b		flat polygons with with dwarf birch and MAT
57	7247590	518330	1	3	0	0	0	0	6	6/5c		drained lake, 6 with 5c around edges
58	7248260	519447	3	2	0	0	0	0	4	2 or 5b		MAT (carbig), 65% shrubs
59	7248820	522877	3	2	0	0	0	1	5c	5b/6		5b dwarf betnan, wetland complex with erisch ?
60	7246746	520030	3	2	0	0	0	0	5c	5b/2		dwarf birch and ?, 20% MAT
53	7245400	522697	3	3	0	0	0	0	5c	5c/6		low shrub/wetland, heterogeneous polygon
61	7243423	515250	3	3	0	0	0	0	MAT short tussocks, <5% lichens, lots of dead sphagnum litter			
67	7237399	516107	1	1	0	0	0	0	6	6		6 with sphagnum
68	7236777	512956	3	3	0	0	0	0	2	5c/5b		low salpul,carret, carvar, scattered betnan, a few palsas
69	7236687	515513	3	2	0	0	0	0	2 or 5b	2		2, 25% dead shrubs
70	7238300	509060	3	3	0	0	0	0	5c	5c		low salpul, 85% cm
71	7244182	505959	1	1	0	0	0	95	1b	1a/1b		limestone barren with 10% dryint
72	7241250	507449	3	2	0	0	0	0	4/5b	1b/5b		stripe complex dominated by lichen stripes
73	7241639	506948	3	2	0	0	0	0	2	5b/1b		stripe complex dominated by dwarf shrubs
74	7245988	507954	3	2	0	0	0	0	5b	5b/2 or 3		open shrubs on solifluction lobes with tossuck tundra
75	7245913	506466	2	2	0	0	0	0	4	4		stripe complex with MNT and lichen, equarc
76	7264800	514685	3	3	0	0	0	0	5c	5c		low to tall willows
77	7265700	516516	3	3	0	0	0	0	5c	5c		low to tall willows
78	7265835	517255	3	3	0	0	0	0	5c	5c		low to talll willows, like plot QC2
91	7250624	519720	3	3	0	0	0	0	5c	5c		closed low birch

A comparison of forest composition and structure of old and new growth *Picea glauca* forests of Council, AK

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Introduction

In forest ecosystems, tree and shrub canopy cover affect many ecosystem processes. It can exert biotic control over the microclimate of the ground, while potentially affecting soil pH and chemistry and understory composition and structure. Ultimately, these factors play a role in the development of a forest ecosystem, controlling multiple floral and faunal interactions.

In the ATLAS project, several flux-monitoring sites were selected as representatives of large ecosystems. One of the sites, C1, is located in a new growth *Picea glauca* forest that was logged in the early 20th Century. Selected for its accessibility, the forest was assumed to have similar ecosystem processes and gas fluxes as the extensive old growth *Picea glauca* forests of interior Alaska. The purpose of our study was to examine contrasts between site C1 and the closest old growth forest at Glacier Creek (Figure 1). We hypothesize the C1 new growth forest differs from the old growth forest in the following ways: (1) smaller basal area and diameter of trees, (2) greater density of trees, (3) greater shrub density and cover, and (4) greater plant diversity.

Methods

We measured and compared basal area and tree density of three *Picea glauca* stands in northwestern Alaska: (1) an old growth forest adjacent to Glacier Creek (Figure 2), (2) the C1 Council new growth forest (Figure 3), and (3) a remnant stump forest within the C1 site (Figure 3). We used the Point-Centered Quarter (PCQ) method (Cottam and Curtis, 1962). Four quadrants based on the four cardinal directions were defined at 10-meter intervals along a 100-meter transect. The distances to the closest live tree and stump was measured in each quadrant and the corresponding basal diameter at knee height (Figure 4). Tree density per hectare was calculated by the equation: $D = 10^4 m^2 / \bar{d}^2$, where $\bar{d}$ is the mean distance to the nearest tree or stump for all quadrants. Basal area was determined by the equation: $A = \pi r^2 \times D$, where A is area, r is the radius at knee height, and D is density of trees. In addition, plant species composition was obtained using the Braun-Blanquet relevé method. (Westoff, 1978) At each site, species richness and percent cover of vegetation were estimated using the Braun-Blanquet cover estimate scale. The following describes the specific methods used for each site.

<u>Glacier Creek Old Growth Forest</u> N 64.8852º W 163.3188º

This site is approximately 20 miles east of the Council site, and was unscathed by the turn-of-the-Century logging. Three randomly selected transects were employed using a 100-meter tape, and PCQ was used to measure the density and basal area of the forest.

Council New Growth Forest N 64.9076º W 163.6748º

This is the ATLAS one-hectare forest grid, C1. Located approximately 2 miles north of Council, AK, this is a new growth forest that was logged at the turn of the century. Three transects were used from the grid for PCQ.

Council Stump Forest

Within the Council site, C1, are hundreds of stumps from the remnant old growth forest. (Figure 3) For this site, the same transects from the Council new growth forest site were used to measure the density and basal area of the remnant old growth forest.

Results

Basal area of the Council stump forest and Glacier Creek forest is 4980 ± 18 m^2 per hectare and 4205 ± 107 m^2 per hectare, respectively, compared to 2719 ± 175 m^2 per hectare at the Council new growth forest (Figure 5). The density of the Council new growth forest is 1554 ± 296 individuals per hectare compared with 734 ± 35 and 823 ± 111 individuals in the Council stump forest and Glacier Creek forest, respectively (Figure 6).

The Council new growth and the Glacier Creek old growth forests also had important differences in vegetation composition and structure. Glacier Creek was dominated by the dwarf shrubs, *Empetrum nigrum* and *Betula glandulosa*, and the low shrub, *Salix planifolia* ssp. *pulchra* -with many open spaces containing numerous *Picea glauca* seedlings less than 2 m high (Figure 7). The Council site had a greater density of low shrub thickets composed of *Salix lanata*, *Salix planifolia* ssp. *pulchra*, *Salix hastata*, and *Populus balsamifera* (Figure 7). It contained significantly less *Empetrum nigrum*, yet possessed a much higher vascular plant species richness - 51 compared to 19 species (Figure 8). Both sites were dominated by a *Hylocomium splendens* and *Pleurozium schreberi* moss carpet.

Conclusions

- Climax succession *Picea glauca* forests contain larger, fewer trees when compared with new growth *Picea glauca* stands. Over time, individuals die out due to competition for resources, disease, or stochastic events, opening the forest canopy for recruitment, while allowing for the unhindered growth of the remaining trees. In addition, the shrubs - *Empetrum nigrum*, *Salix planifolia* ssp. *pulchra* and *Betula glandulosa* - have out competed the primary succession species and created a stable understory structure (Figure 2).

- At the Council site, the continued dominance of *Salix lanata*, *Salix plantifolia* ssp. *pulchra*, *Salix hastata*, *Populus balsamifera*, and many other vascular plant species in the understory is due to multiple factors. The turn-of-the-Century logging left the shrubs relatively unscathed, augmenting their growth and success, while the immature new growth forest has only begun to naturally reduce their abundance (Figure 3).

- The effects of greater shrub and tree cover could potentially affect trace gas fluxes. The observed differences in vegetation between Glacier Creek and Council forest could play a role in heat exchange and CO_2 production. Although many other factors play a role, age of the forest and the vegetation composition and structure should be considered when measuring gas flux in the forest ecosystems of Alaska.

Acknowledgements

NSF grant OPP 990829, Chris Thayer-Snyder, Martha Raynolds, and VECO support at Council

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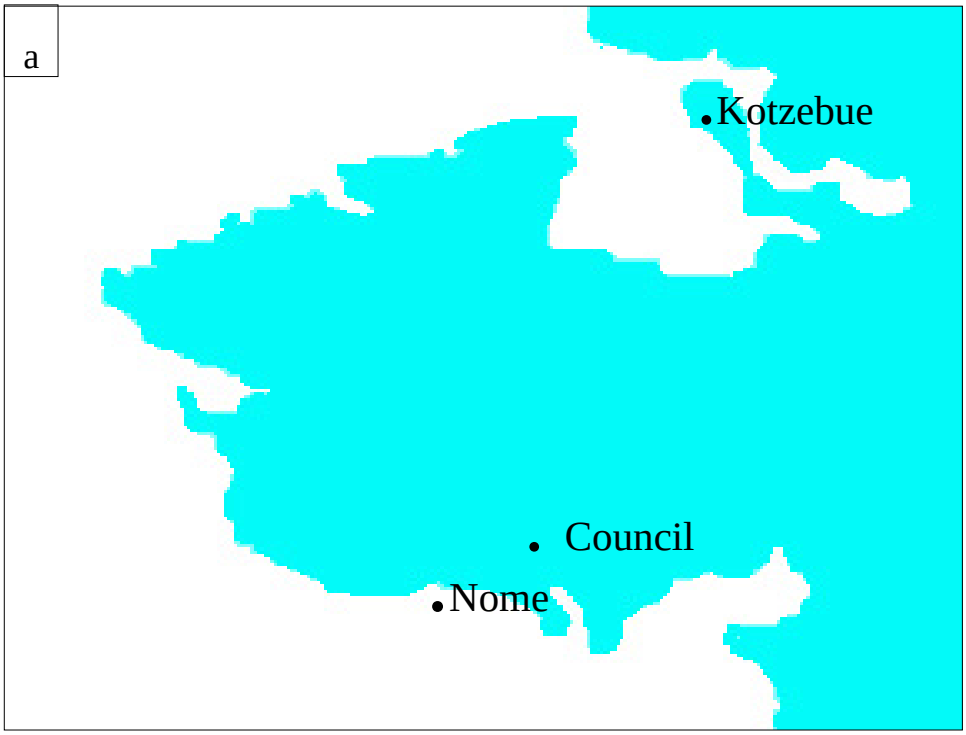
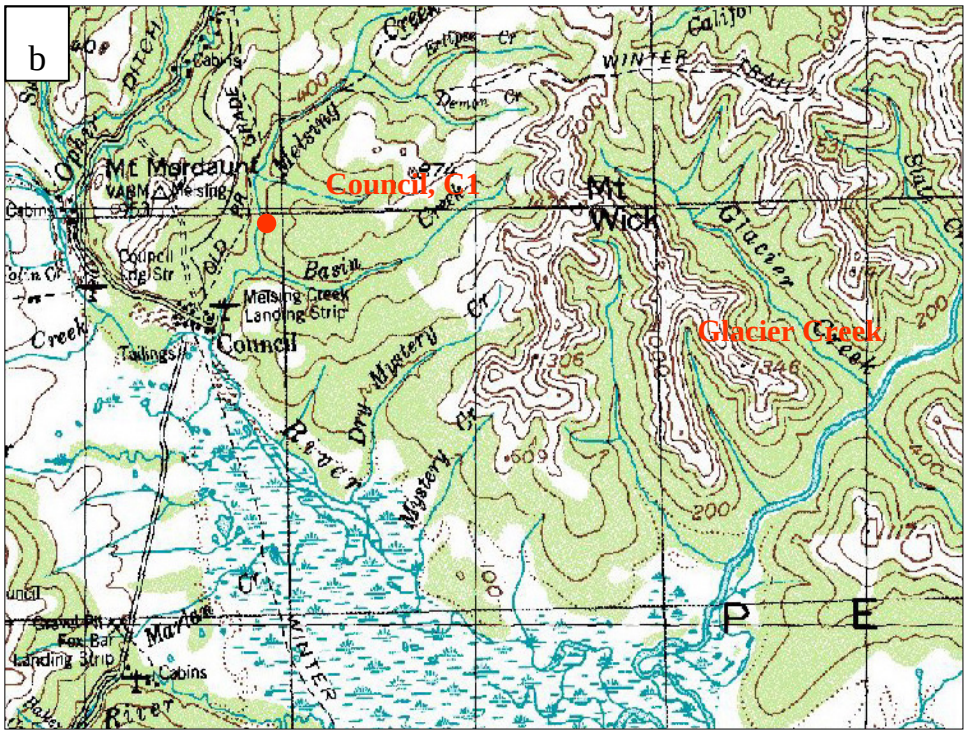
Westoff, V. and van der Maarel, V. 1978. Classification of plant communities. Den Haag: Dr. W. Junk.

Figure 1.



a. Map of the Seward Peninsula, Alaska.



b. Topographical map of Council area showing study sites.

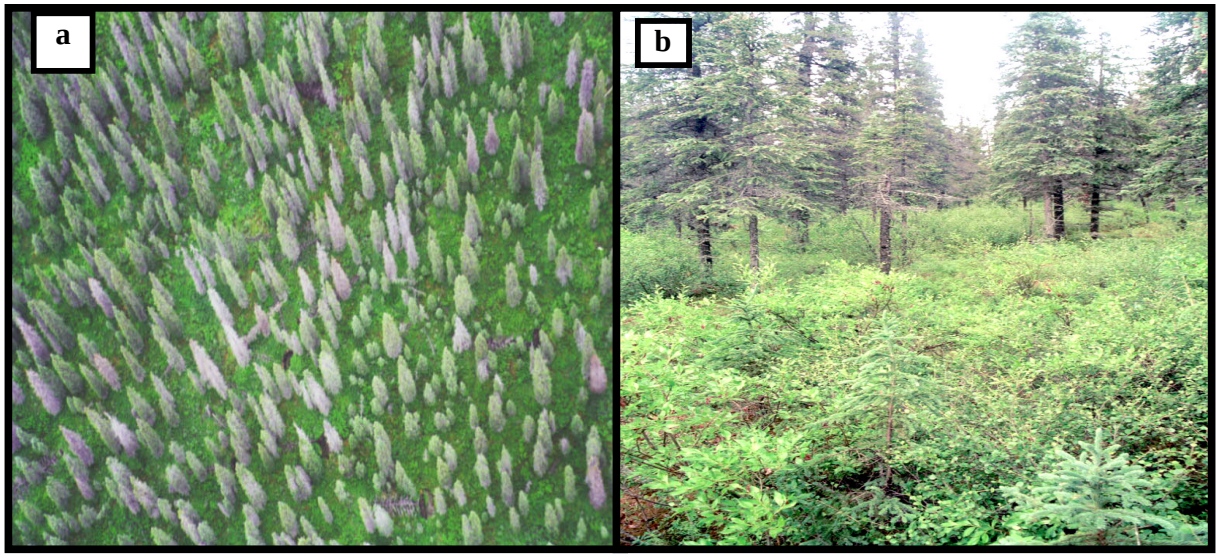


Figure 2a Overhead view of Glacier Creek. Note the dead and overturned *Picea glauca* individuals not observed at the Council site. **2b** The open understory of Glacier Creek dominated by the dwarf shrubs *Empetrum nigrum* and *Betula glandulosa* and the low shrub *Salix planifolia ssp. pulchra*. Note the *Picea glauca* seedlings in the foreground.

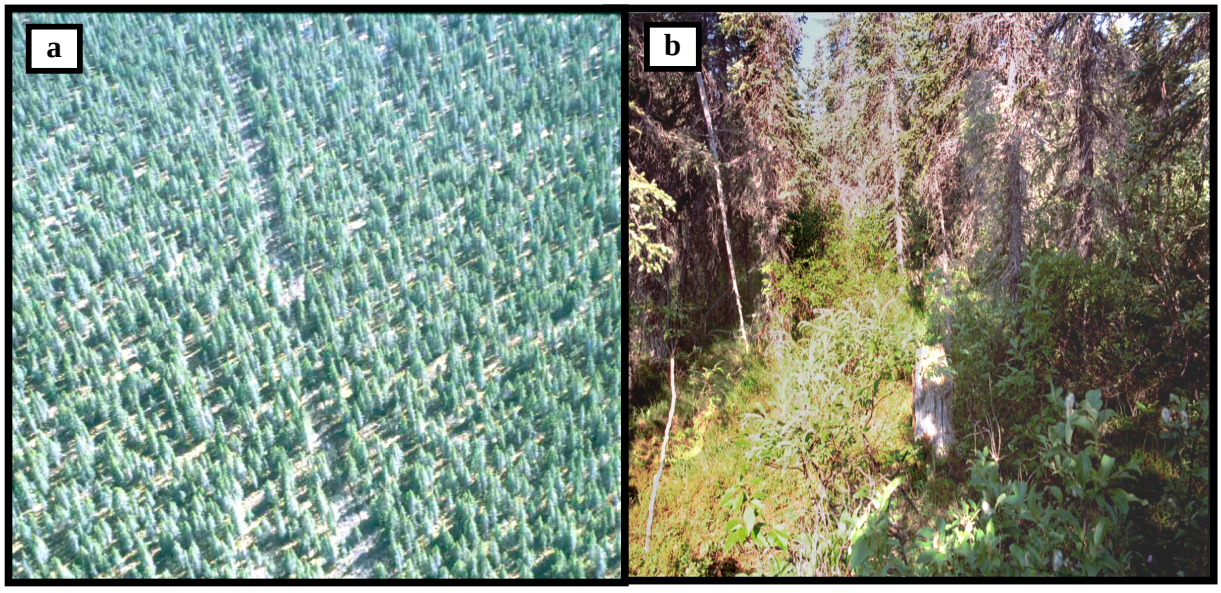


Figure 3a. 1. Overhead view of the Council, C1, site. **3b**. The dense understory of the Council site dominated by the low shrubs *Salix lanata*, *Salix planifolia ssp. pulchra*, *Salix hastata,* and *Populus balsamifera.*

Figure 4 a One of the many *Picea glauca* stumps found within the Council new growth forest site.

Figure 4 b. A diagram of the PCQ Method and Chris Thayer-Snyder measuring stump diameter at knee height.

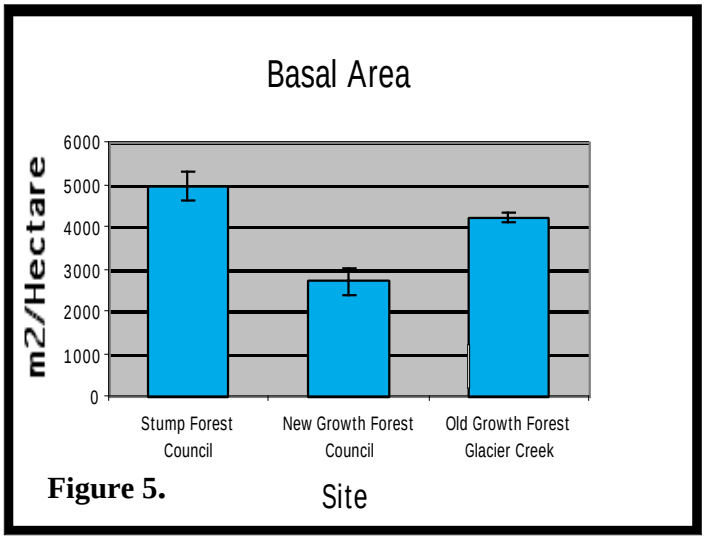


Figure 5.

Braun-Blanquet Cover Estimate Values:

r=rare

+common,but <1%

1=1-5%

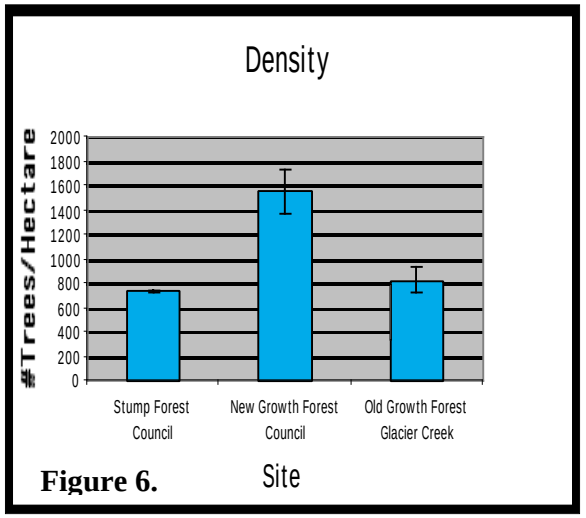


Figure 6.

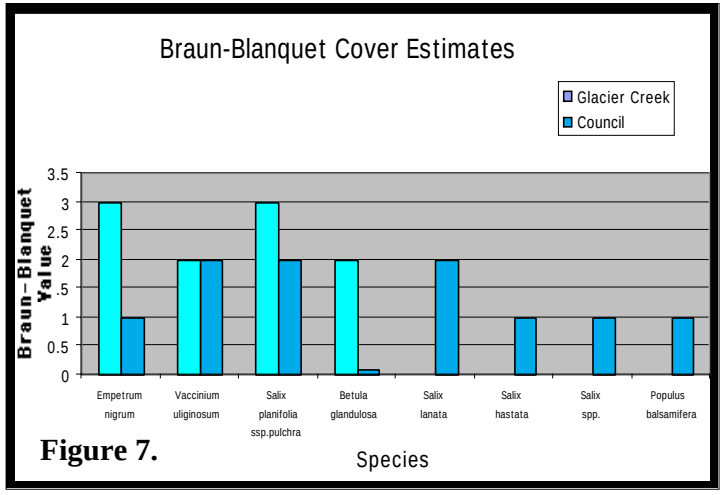


Figure 7.

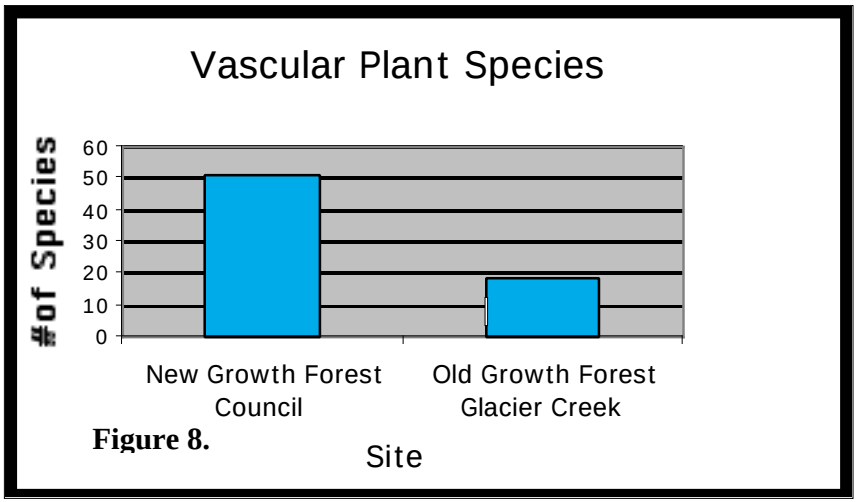


Figure 8.