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Reconnaissance of Vegetation and Soils Along the Dempster Highway, Yukon Territory: I. Vegetation Types

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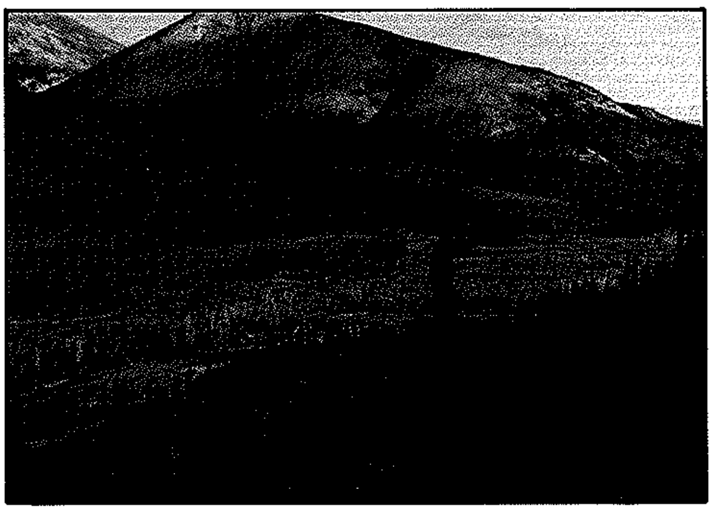
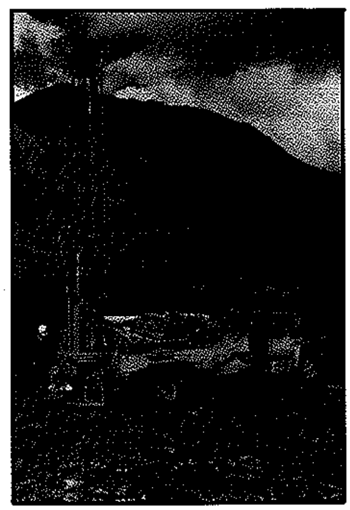
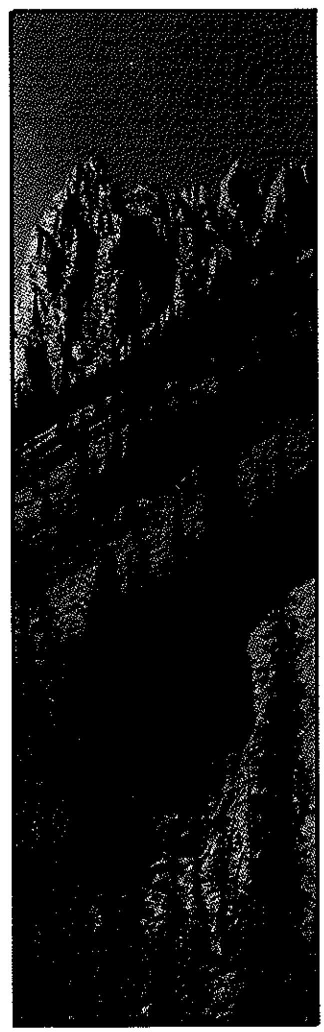
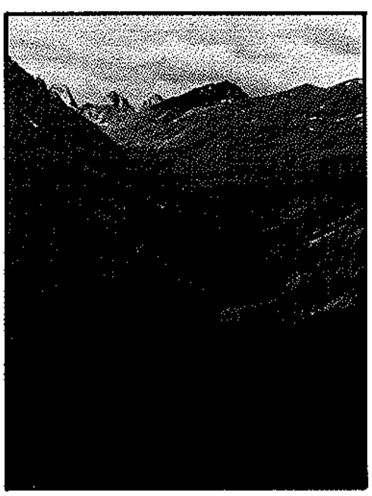
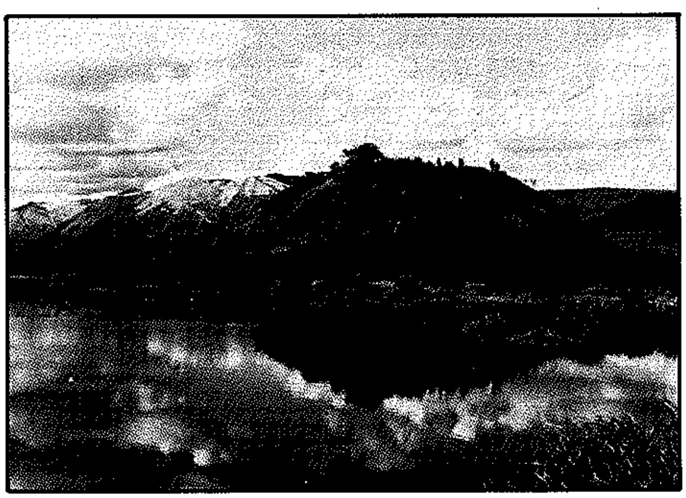

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'It is anticipated that some of the information will be published in:

Nimis, P.L. 1981. *Epigaenous* lichen *synusiae* in the Yukon Territory. Revue. Bryol. Lich. (in press).

Nimis. P.L. 1981 Phytogeography of the southern Yukon. (in preparation).

SUMMARY

This report is the result of a survey completed in **1979,** along the Dempster Highway, Yukon Territory, from the North Fork Pass (lat **64°30'N;** long **138°15'W)** to Peel River, Northwest Territories **(67°22'N; 134°55'W).** The survey was sponsored by Foothills Gas Pipe Lines (Yukon) Ltd. and the Canadian Department of the Environment, Canadian Forestry Service. Cover/abundance values were estimated for **90** species in **100** plots. From the same locations, information was obtained **on** depth to permafrost in September, generic **soil** types, soil texture, thickness of the L-H or **O** layers, exposure, slope, elevation, **soil** modifying processes and pH values of organic and mineral soils. The report contains the description of *20* vegetation types and a discussion by sections of vegetation related geological, climatical. edaphical and pedological aspects. The **results** are tentative but provide a framework for a more complete ecological inventory and information for revegetation projects.

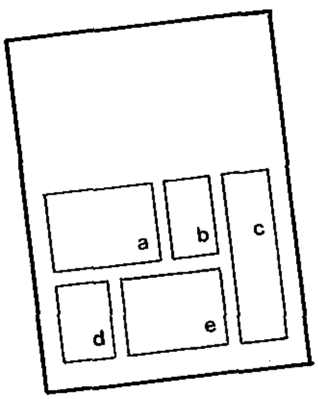
Adjacent to the Dempster Highway, three areas were identified which merit more detailed botanical surveys: **(1)** North Fork Pass **(Section 1),** on account of many arctic "alpine" species; (2) the calcareous formations of the Ogilvie mountains (Section **2).** for the presence of many potentially rare species. probably glacial relicts. the varied geomorphy and the complexity of successional series; **(3)** the alpine ranges of the Richardson Mountains (Section **5)** heretofore little investigated.

RESUME

Le present rapport donne les résultats d'une etude ***réalisé*** en **1979** le long de I'autoroute Dempster, **aù** Yukon, entre le **col** North Fork **(64°30'N 138'15'0)** jusqu'a la rivière Peel dans les Territoires du Nord-Ouest **(67°22'N; 134°55'W).** Parrainée par la Foothills Gas Pipe Lines (Yukon) Ltd. et le Service canadien des **forêts** du ministère canadien de l'Environement. cette etude. avait trait a I'estimation du rapport couverture/abondance pour **90** espèces **dans 100** placettes ainsi qu'a la collecte de données sur la presence du pergélisol en septembre. le type générique de sol. sa texture, l'éspaisseur des couches L-H ou **O,** I'exposition, la pente, la hauteur, les processus agissant sur les sols et le pH des **sols** organiques et minhaux.

Le rapport comporte la description de ***20*** types de végétation trouvés dans cette etude ainsi qu'une discussion des aspects environnementaux et botaniques pertinents. Une évaluation plus poussée des données ainsi recueillies sera entreprise en vue de determiner certains aspects environnementaux specifiques. Ce rapport servirait **plutôt à** prévoir des applications **oh** les conditions écologiques doivent **être** évaluées ou bien lorsqu'il faut préparer un relevé écologique plus complet.

Le rapport determine trois régions qui mériteraient un relevé botanique plus détaillé: le col **North** Fork, à cause de **ses** nombreuses espèces alpines rares de l'Arctique; les Ogilvies calcaires. à cause de la présence de nombreuses espèces rares. probablement relictes de la période glaciaire, de la ***variété*** des situations *géomorphologiques* ainsi que de la complexité des successions et les parcours alpins des monts Richardson, jusqu'ici peu étudiés. Dans I'ensemble. les regions du col North Fork et les terres adjacentes a la rivière Ogilvie sont celles **où** l'on doit être le plus prudent avant d'y faire intervenir l'homme, **a** cause de leùr flore particulière et de la dynamique complexe **des** systemes géomorphologiques.



Cover Pictures

Figure a. Landscape **just** south of Halfway, Ogilvie Mountains.

Figure b. Drilling for permafrost below North Fork Pass.

Figure c. White spruce on limestone scree near Halfway, Ogilvie Mountains.

Figured. Valley below Tombstone Mountain.

Figure e. Pingo, west of Chapman Lake, Dempster Highway.

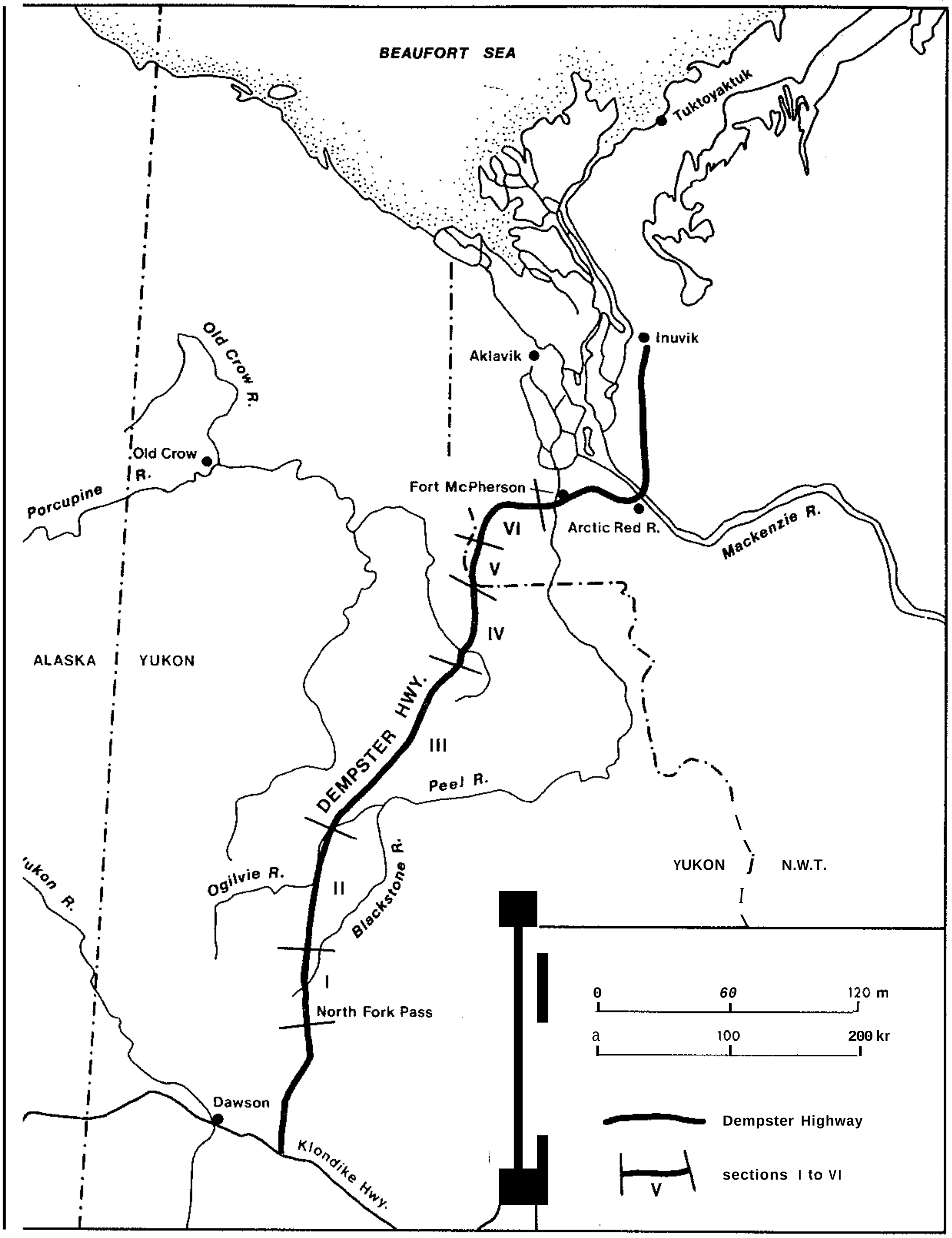


Figure 1. **Map showing the Dempster Highway and the locations of surveyed sections.**

Introduction

In July 1979, Foothills Pipe Lines (Yukon) Ltd. made an application to the Government of Canada to construct and operate the 1200 km Dempster Lateral gas pipeline from the Mackenzie Delta, Northwest Territories (N.W.T.). to a point near Whitehorse, Yukon Territory (Y.T.). The implementation of these plans will incur an engineering effort as well as measures to secure the integrity of the pipeline and to prevent or mitigate impacts on the environment.

This report is concerned with the vegetation and soils along the Dempster Highway portion of the pipeline, from west of Peel River. N.W.T., to North Fork Pass, Y.T. (Fig. 1).In this area, the general regional flora and ecology have been relatively well documented (Welsh 1974: Oswald and Senyk 1977: Roberts-Pichette 1972); however, detailed information was not uniformly available in part owing to the fact that construction of the Dempster Highway was not completed until 1979 (Macleod 1979).

In the Mackenzie Valley, north of the survey area, terrain and vegetation aspects were studied in connection with northern oil and gas development (Forest Management Institute 1974; Zoltai and Pettapiece 1973: Zoltai and Tarnocai 1974; Hettinger, Janz and Wein 1973, and references therein). In the southern ranges of the Ogilvie Mountains, north of North Fork Pass, Richer (1968) provided useful information with regard to quaternary geology, including botanical criteria, which he applied to explain the chronology of morainal sequence. Hulten (1966) and Porsild (1967) conducted some studies of indigenous plants in the same area. Schultz International Ltd. (1972), Foothills (1979) and Vaartnou (1979) provided information on broad vegetation grouping. South of North Fork Pass, the vegetation is similar to that of the Boreal Forest Region (Rowe 1972) and has been described (See references in Orloci and Stanek 1980; Stanek 1980).

In 1979, the Canadian Wildlife Service, in cooperation with the Yukon Territorial Government, initiated a project to document the impact of the Dempster Highway on migrating and wintering caribou. The results are not yet available.

The objectives of this report coincide with the "Scope of Work" stipulated by Foothills in their Purchase Requisition; namely, "A vegetation-soil survey will be undertaken by the Canadian Forestry Service to provide information for future revegetation programs and biophysical inventory along the Dempster Lateral Gas Pipeline route. The survey will identify representative vegetation communities to determine their characteristic soil properties. The approximate areal extent of each community type will be determined from available imagery."

This report deals with vegetation types. The report on characteristic soil properties and any forthcoming maps will be contained in subsequent publications of the same series.

Methods

The survey was undertaken during the latter part of August and the beginning of September in 1979 for a distance of 450 km along the Dempster Highway (Fig. 1) from North Fork Pass, Y.T. (lat 64°30′N, long 138°15′W), to west of Peel River, N.W.T. (67°22′N, 134°55′W). The sampling design utilizes stratification by six sections (Table 1, Fig. 1) and ten vegetation dominance types (Table 2).

Sections I, II, III, IV, V and VI correspond to Ecoregions 16, 17, 18, 20, 22 and 21 respectively, of Oswald and Senyk 1977. In this report, Sections IV, V and VI were named differently than the Ecoregions to emphasize the geographically limited area of this survey (Table 1).

In total, 100 plots were surveyed. The distribution per section is determined according to the estimated length of highway traversed by each and the availability of replicates (preferably three) per representative physiognomic group (Table 2). The plots, 20 m in radius, are located not far from the highway in uniform, apparently undisturbed stands. Four subplots per plot were surveyed.

For each species present, the plot cover/abundance (C/A) values, which had been coded on a scale from 1-5, were converted to percentage midpoints as follows:

Code	C/A	Range	Midpoint
1	abundant, low cover	1-10%	5.5%
2	very abundant, low cover	11-25%	18%
3	high cover,	26-50%	38%
4	high cover,	51-75%	63%
5	high cover,	76-100%	88%

The method of data analysis incorporates a clustering procedure using the sum-of-squares agglomeration. The method involves successive passes through a matrix of relative distances between subsets of plots, determining overall similarities between subsets, and amalgamating those pairs of subsets which are most similar. Orloci (in Stanek and Orloci 1973) published a computer program in BASIC. This program was translated into FORTRAN IV and converted to execute larger analyses on a PDP-11/45 minicomputer.

The results of the computer clustering on cover/abundance values were used to produce dendrograms, maps of the paths through which plots were agglomerated to form increasingly larger clusters. Timing and order of clustering were given by the within-cluster sum of squares. For each analysis, a within-cluster sum of squares value was chosen as a cut-off point for terminating clustering, this choice being based on the meaningfulness of the resultant clusters.

Within each section, groups were identified as clusters of plots which have been found to be similar and which are represented by a single stem of a dendrogram at the within-sum-of-squares cut-off point. Because of an apparent similarity among the 32 groups in the sections, further clustering of similar groups into vegetation types was done using species values, a quantity which would give equal consideration to the presence/absence of a species within a group and to its C/A value and permit a more meaningful interpretation of the group relationships.

Species Value $= SV = FV_p \times FV_c = PW(1 - PO)\,CW(1 - CO)$

FV_p = a species fidelity value based on its presence in plots $= PW(1 - PO)$

FV_c = a species fidelity value based on its plot cover in plots which have the species present $= CW(1 - CO)$

PW = Presence within = the proportion of plots with a given species present, within a given group

PO = Presence outside = the proportion of plots with a given species present, outside a given group but within a larger class

CW = Mean C/A of plots with a given species present, within a given group

CO = Mean C/A of plots with a given species present, outside a given group but within a larger class

The fidelity value (FV_p) (Orloci and Stanek 1980), weighs the frequency of a species' presence inversely to its frequency of presence elsewhere. An analogous fidelity value (FV_c) was

Table 1. Sections used in stratifying the survey area, their name, location with respect to the Dempster Highway, approximate length of the Dempster Highway traversed by each Section, and sequences of sample plots.

Section	Name	Location	Length (km)	Plots
I	South Ogilvie Mountains	From south of North Fork Pass along Blackstone River to 10 km north of Chapman Lake at lat 64°57'N	60	82-100
II	North Ogilvie Mountains	From ibid. to Highway leaving Ogilvie R. and ascending Eagle Plains at lat 65°43'N	112	55-81
III	Eagle Plain	From ihid. past the Eagle R. crossing to the Arctic Circle at Lat. 66'33''	145	37-54
N	Western Foothills of Richardson Mountains	From ibid. to south of the Richardson Mountains Yukon/NWT border	60	22-36
V	Richardson Mountains	From ibid. to Highway at Long. 135°45'W	25	8, 14-21
VI	Eastern Foothills of Richardson Mountains	From ibid. to West of Peel Richardson Mountains River Richardson Mountains Crossing	50	1-7, 9-13

Table 2. Number of plots within each Physiognomic Group* by Sections.

Physiognomic Group	Section I	II	III	IV	V	VI	Sub Total
TUNDRA:							
Shrub Tundra**			3	2	1	6	12
Tussock-Sedge Tundra	8		4	3	3		18
Lichen-Shrub Tundra	3	3			4		10
TAIGA:							
Spruce Taiga		10	6		1	2	19
Lichen-Spruce Taiga			4				4
Spruce-Tamarack Taiga				5		3	8
Spruce-Paper Birch Taiga		3					3
RIVERINE							
Riverine Willow	5	2					7
Riverine Poplar-Spruce		2	1	5		1	9
CLOSED FOREST							
Conifer	3	7					10
Total	19	27	18	15	9	12	100

*named and defined for the purposes of this report:

Tundra — areas without vegetation in the tree-layer. permafrost within 1 m of the soil surface.

Taiga — areas with an open canopied and poorly developed tree-layer, permafrost within 1 m of the soil surface.

Riverine — and Closed Forest — stands in alluvial plains and areas with a well developed tree-layer, permafrost either absent or below I m of the soil surface.

**Included are: Dwarf Shrub (up to abut 30 cm high), Low Shrub (knee to waist — high) and Tall Shrub (about man's height and higher).

derived based on CIA. To make this C/A fidelity value independent of presence/absence, data were used from those plots that had the given species present (only species with PW20.5 were included in the analysis). For each vegetation type, the list of characteristic species is composed of species with PW20.5 and $SV \geqq 0.01$. The name of the vegetation type is composed of the names of the three characteristic species with the greatest SV.

The survey for the environmental factors was conducted by Pacific Forest Research Centre at the time of the vegetation survey and on the same plots. Where applicable, the information is based on four random records per plot. Depth to frozen ground up to 1 metre **was** measured, soil conditions permitting. In this report, permafrost is termed frozen ground persisting into September, in a layer that could not be penetrated by hand drilling 10 cm deep. The survey measurements were compared with those of drill-hole records (Klohn Leonoff 1978).

Soils are classified according to Canada Soil Survey Committee (1978) as determined on existing natural and artificial profile exposures and soil auger drillings. The organic and mineral horizons were sampled to a depth of 50 cm, soil texture and permafrost permitting, using a soil auger. Soil pH of organic and mineral soils is determined in a 1:1 slurry of 0.01 M $CaCl_2$ solution and soil composite of four random subsamples per plot.

Nomenclature of vascular species is according to Hulten (1968) and Welsh (1974); non-vascular nomenclature is primarily according to Crum et al. (1973) and Hale and Culberson (1970). Only characteristic species are listed under each vegetation type: complete lists of species are kept at PFRC.

The vegetation data collection consisted only of the most common species of trees, shrubs, herbs and grasses. Moss and lichen C/A, also recorded, were not identified by species. The C/A values for both were included in the data matrix as two of the 90 species identified.

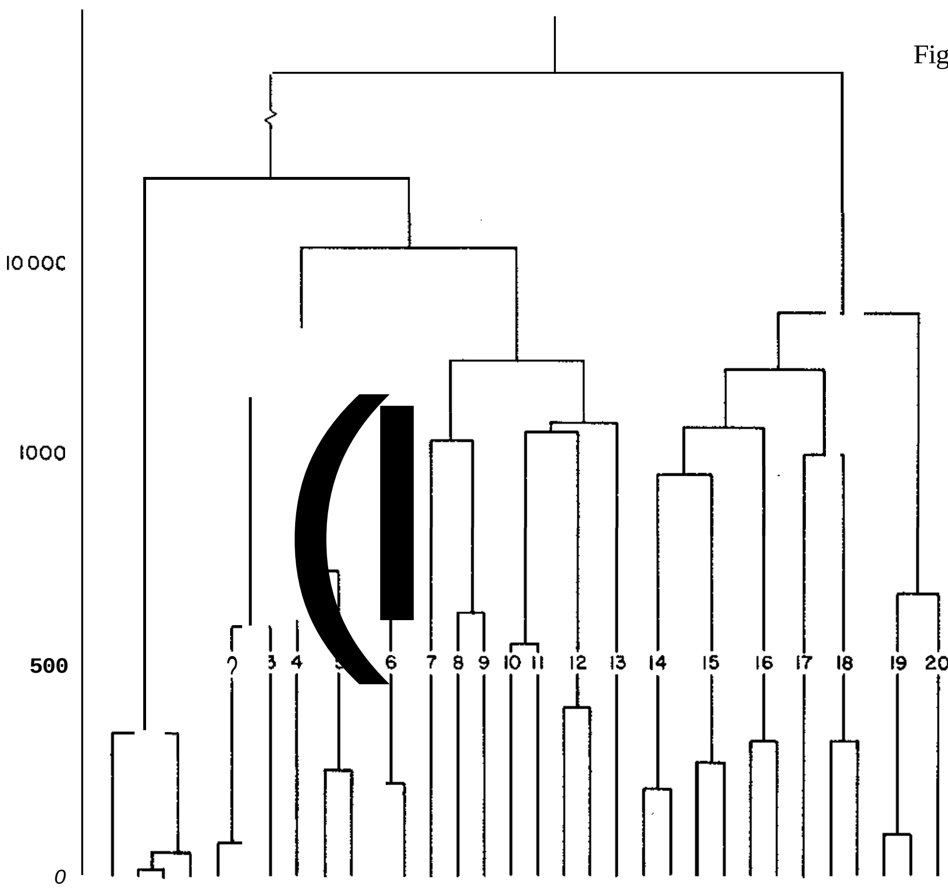


Figure 2 Dendrogram showing clustering of 32 groups to produce 20 vegetation types. Dendrogram is based on species values for each species present in a group with PW >0.50 as the data, and sum-of-squares agglommeration as the method of analysis. The types are identified by numbers 1 to 20 along the x axis. Numbers in the y axis indicate sum-of- squares.

Results

As a result of the available vegetational information, the anticipated sectional heterogeneity did not materialize. The clustering of plots within individual sections on species cover abundance values resulted in 32 specific groups, but indications were that similarities between these groups occurred throughout the surveyed area. Therefore, clustering of the 32 groups, on the species values of species with greater than 50%presence within the group was carried out. Figure **2** showsthe resulting dendrogram, which identifies 20 vegetation types. The descriptions of these 20 types follow. However, the reader should bear in mind that the results must be considered preliminary and as a step -toward .futuresurveys.

A. Descriptions of Vegetation Types.

Type 1 – Eriophorum vaginatum – Ledum palustre – Betula nana

Surveyed were 18 plots in Section (plot number): 1(82, 83, 84, 86, 87, 93, 94, 95); 3(38, 49, 52, 53), 4 (22, 23, 30); 5(8, 14, 17).

Characteristic species	mean cover %	FVp	SV
Eriophorum vaginatum	41.7	0.62	0.24
Ledum palustre	22.5	0.32	0.06
Betula nana	6.1	0.56	0.05
Carex sp.	23.5	0.20	0.04
Rubus chamaemorus	6.8	0.48	0.04
Lichen sp.	15.0	0.22	0.03
Vaccinium vitis-idaea	11.2	0.12	0.02
Betula glandulosa	4.9	0.21	0.01
Empetrum nigrum	2.9	0.23	0.01

This type includes what may be described as Tussock-Sedge Tundra. In general, this type occurs on permafrost, with frozen soil occurring mainly at depths ranging from 30-60 cm. It is poorly developed along streams and southfacing slopes. Occasional Regosolic and Brunisolic Turbic Cryosols are found soils are predominantly Gleysolic Turbic Cryosols, and are characteristically poorly drained. Above the permafrost, there is usually a thin clay-textured mineral layer and an organic layer ranging in thickness from 5-40 cm. The pH of mineral soil ranges from 3.3 to **4.9** and that of the organic layer from 3.0 to 5.1.

This type, sampled in the South Ogilvie Mountains, which is similar in composition to the understory of the "Picea mariana-Aulacomnium palustre" (see descriptions under Type 9). The type has a microtopography with tussocks comprising about 30 to 40% of the ground cover and is common on polygon fields and low gradient slopes and swells: low shrubs including birch grow around the tussocks to a height of 40 to 70 cm; moss cover is continuous.

In the Richardson mountains, poorly drained areas support vegetation dominated by Carex, Eriophorum and mainly Sphagnum, a combination which comparable to the "Seasonal Orthophyll Meadow Formation" described by Hettinger et *al.* (1973) for the Richardson Nountains.

In the Eagle Plains, sedge tussocks occur frequently, although ericaceous shrubs and lichens are also usually present. The tussocks are frequently associated with hummocks which exhibit microsite differences, with Drepanocladus occupying the depressions and Sphagna the tops.

In the Western Foothills of the Richardson Mountains, sedge tussocks also occur on hummocky terrain. The hummocks contain organic layers as thick as 45 cm, occasionally underlain by a thin layer of unfrozen mineral soil. Mineral soil is frequently found in the depressions amid the hummocks. Sedge tussocks occur also in terrain with non-sorted circles composed of friable clay with occasional stones.

Comparable to Type 1 are: Richer's (1968)

Figure 3. Tussock-Sedge Tundra (Type 1 in Section 4). In the background are the Richardson Mountains (Photo E.T. Oswald).

Figure 4. Dwarf Shrub Tundra with polygons and non-sorted circles (Type 2 in Section 3) on gently sloping terrain of the Eagle Plains.

"Shrub-Tussock community" investigated in the South Ogilwies, Viereck's (1966) "Low Shrub-Sedge Tussock Moss Tundra" in the Mt. McKinley region, Drew and Shanks' (1965) "Upland Tussock Tundra" in the Firth River region, Krajina's (1975) associations Betula (glandulosae) – Chamaemoretum or Betulo (glandulosae) – Eriophoretum vaginati described for the Subalpine Tundra Zone of the Richardson Mountains, and Dyrness and Vierecks' (1979) "Sedge Tussock – Mixed shrub".

Type 2 – Arctostaphylos alpina – Eriophorum vaginatum – Ledum palustre

Surveyed were 3 plots in Section (plot number): 3(37, 48, 50).

Characteristic species	mean cower %	FV_p	SV
Arctostaphylos alpina	13.4	0.74	0.10
Eriophorum vaginatum	16.5	0.34	0.07
Ledum palustre	21.5	0.27	0.05
Carex sp.	29.7	0.17	0.04
Arctostaphylos rubra	6.8	0.40	0.04
Vaccinium uliginosum	9.3	0.39	0.03
Lichen sp.	18.8	0.21	0.03
Empetrum nigrum	8.6	0.39	0.03
Betula glandulosa	10.5	0.21	0.03
Rubus chamaemorus	5.8	0.34	0.03
Salix pulchra	9.7	0.32	0.03
Petasites frigidus	3.7	0.72	0.03
Calamagrostis canadensis	2.8	0.66	0.02
Vaccinium witis-idaea	12.4	0.12	0.02
Arctagrostis latifolia	2.3	0.43	0.01
Picea mariana	1.8	0.45	0.01

This is a Dwarf Shrub Tundra with polygons and/or hummocks on flat to gently sloping terrain of the Eagle Plains. Picea mariana may occur irregularly scattered. Generally soils are sandy clays with stones with an organic horizon up to 10 cm. Gleying is concentrated above the permafrost layer, which occurs at 39 cm in organic soil and up to 55 cm deep in mineral soil. Regosolic and Brunisolic Turbic Cyosols are common. Occasionally, rocky soils with stone circles occur. The pH range of the organic soil is 3.4 to 3.9 and of the mineral soils it is 3.8 to 3.9.

Type 3 – Salix reticulata – Betula nana – Rubus chamaemorus

Surveyed was plot 15 in Section 5.

Characteristic species	mean cower %	FV_p	SV
Salix reticulata	31.1	0.74	0.22
Betula nana	14.9	0.83	0.11
Rubus chamaemorus	16.8	0.51	0.08
Vaccinium witis-idaea	24.9	0.16	0.03
Ledum palustre	14.9	0.26	0.03
Empetrum nigrum	8.6	0.38	0.03
Arctagrostis latifolia	2.7	0.64	0.02
Eriophorum vaginatum	4.1	0.52	0.02
Betula glandulosa	5.5	0.32	0.02
Rumex crispus	1.4	0.95	0.01

The Low Shrub Tundra is characterized by a closed ground cover of Polytrichum, Sphagna and Hylocomium splendens, widely spaced low shrubs and the absence of trees or tall shrubs. This type occupies imperfectly drained solifluction terraces on most of the silt mantled slopes in hummocky terrain in the Richardson Mountains. Permafrost depth ranges from 30-45 cm. Humus depth varies from 5 cm on top of hummocks to 20-25 cm at their side. Soil is Gleysolic Turbic Cryosol with occasional weak mottling and has a pH of 3.4 and 3.6 in the organic and mineral soil, respectively. This type is comparable to the one described for the Richardson Mountains by Hettinger et al. (1973) as "Open Deciduous Orthophyll Scrub Formation".

Type 4 – Alnus crispa – Arctostaphylos alpina. – Vaccinium uliginosum

Surveyed were plots 34 and 36 in Section 4

Characteristic species	mean cower %	FV_p	SV
Alnus crispa	28.6	0.79	0.20
Arctostaphylos alpina	14.2	0.38	0.10
Vaccinium uliginosum	28.0	0.39	0.10
Betula glandulosa	22.4	0.33	0.06
Ledum palustre	16.8	0.27	0.04
Eriophorum vaginatum	8.6	0.52	0.04
Carex sp.	22.4	0.16	0.03
Lichen sp.	12.7	0.20	0.02
Arctostaphylos rubra	3.4	0.60	0.02
Salix reticulata	2.7	0.37	0.02
Salix pulchra	5.5	0.32	0.02

Figure 5. Landscape just north of North Fork Pass (Section 1). In the foreground, natural revegetation of area disturbed by highway construction; in the middle ground, the valley of the Blackstone River (barely visible is a traverse of an abandoned highway right-of-way) showing a complex melange of tundra types (Type 2, Type 3, Type 1 plus several possible types or variants not cowered by this survey); in the background, the Ogilvie Mountains which were not included io the survey.

Figure 6. Low Shrub Tundra (Type 5 in Section 6) in the eastern foothills of the Richardson Mountains.

Tall Shrub Tundra develops on gently sloping hummocky terrain with cryoturbation (non-sorted circles) and solifluction, in the Western Foothills of the Richardson Mountains. Dense alder and willow thickets with a ground cover of sedge tussocks characterize this type. Hettinger, Janz and Wein (1973) record the presence of alder and willow associated with sedge tussocks in the warmer areas of this region. Soils are Regosolic Turbic Cryosols composed of sandy clay with stones. The organic layer is shallow (about 5 cm), except under Sphagnum, where it becomes deeper. In portions, non sorted circles are prominent and the humus layer is discontinuous. The pH of the organic layer ranges from 3.4 to 3.7: the pH of the mineral layer is about 3.7. Permafrost depth varies from 75 to 150 cm in the locations sampled.

Type 5 – Rubus chamaemorus – Betula glandulosa – Vaccinium uliginosum

Surveyed were plots 3, 4, 5, 6, 7 and 12 in Section 6

Characteristic species	mean cover %	FV_p	SV
Rubus chamaemorus	16.3	0.43	0.08
Betula glandulosa	23.3	0.34	0.07
Vaccinium uliginosum	13.9	0.40	0.05
Alnus crispa	6.4	0.53	0.05
Ledum groenlandicum	6.7	0.56	0.04
Petasites sagittatus	4.2	0.78	0.04
Ledum palustre	14.4	0.28	0.03
Vaccinium vitis-idaea	21.4	0.17	0.03
Spiraea beauverdiana	4.1	0.64	0.03
Empetrum nigrum	7.5	0.33	0.03
Lichen sp.	10.5	0.21	0.02
Eriophorum vaginatum	3.3	0.44	0.01
Eouisetum arvense	2.3	0.35	0.01

This tundra type is composed primarily of low shrubs with irregularly scattered tall alder. It was observed on 5-10 degree south and southwest slopes on hummocky terrain in the Eastern Foothills of the Richardson Mountains. The pronounced micro-relief of hummocks creates different environments within very short distances, having a profound effect on vegetation distribution and growth. The tops of the hummocks are from 30 to 60 cm above the moss-rich inter-hummock troughs. In well-drained areas, the hummocks may support ericaceous shrubs and liverworts growing in an organic layer from 1-25 cm deep, under which is mottled loamy soil. Many hummock tops, however, are completely devoid of vegetation, exposing the bare mineral soil. In this type, permafrost underlies the hummocky terrain at depths from 60-75 cm. Commonly found at the permafrost contact zone is a gleyed sticky clay. In the inter-hummock troughs a layer of dark soil, high in organic content, subtended by gleyed coarse soil material with stones is prevalent. Gleysolic and Brunisolic Static or Turbic Cryosols are common. The pH of the organic soil ranges from 2.9 to 3.6 and of the mineral soil from 3.3 to 3.8.

Type 6 – Lichen sp. – Betula glandulosa – Ledum palustre

Surveyed were 6 plots in Section (plot number): 1 (90, 97, 98); 2 (72, 75, 81).

Characteristic species	mean cover %	FV_p	SV
Lichen sp.	43.0	0.21	0.08
Betula glandulosa	0.7	0.28	0.05
Ledum palustre	22.3	0.28	0.05
Vaccinium uliginosum	7.3	0.19	0.02
Empetrum nigrum	5.7	0.40	0.02
Salix pulchra	7.0	0.33	0.02
Vaccinium vitis-idaea	9.8	0.17	0.02
Arctostaphylos rubra	2.3	0.40	0.01
Arctagrostis latifolia	1.8	0.32	0.01
Petasites frigidus	1.6	0.48	0.01

This is Lichen-Shrub "Alpine" Tundra: stunted spruce (P. glauca and/or P. mariana) may occur. It occupies open, steep, north facing slopes in the North and South Ogilvie Mountains. The slopes exhibit typical step and dike formations created by solifluction. Richer (1968) verifies the presence of these soliflucted slopes in the North Fork Pass region of the Ogilvie Mountains. This type is characterized by the presence of Cerastium beeringianum which, although infrequent in the areas sampled, is common on open slopes in the Yukon (Welsh 1974). Soils are Gleysolic Static Cryosols, with an organic layer ranging from 3-20 cm underlain by a shallow gleyed layer of mineral soil over permafrost. The active layer ranges from 30 to 55 cm. Depending on thickness of the organic layer, the pH ranges from 3.5 to 5.9: pH of the mineral layer is from 4.1 to 5.9. Under dry conditions, on rocky outcrops and rubbly talus, often windblown and free of snow during part of the winter, a comparable type identified

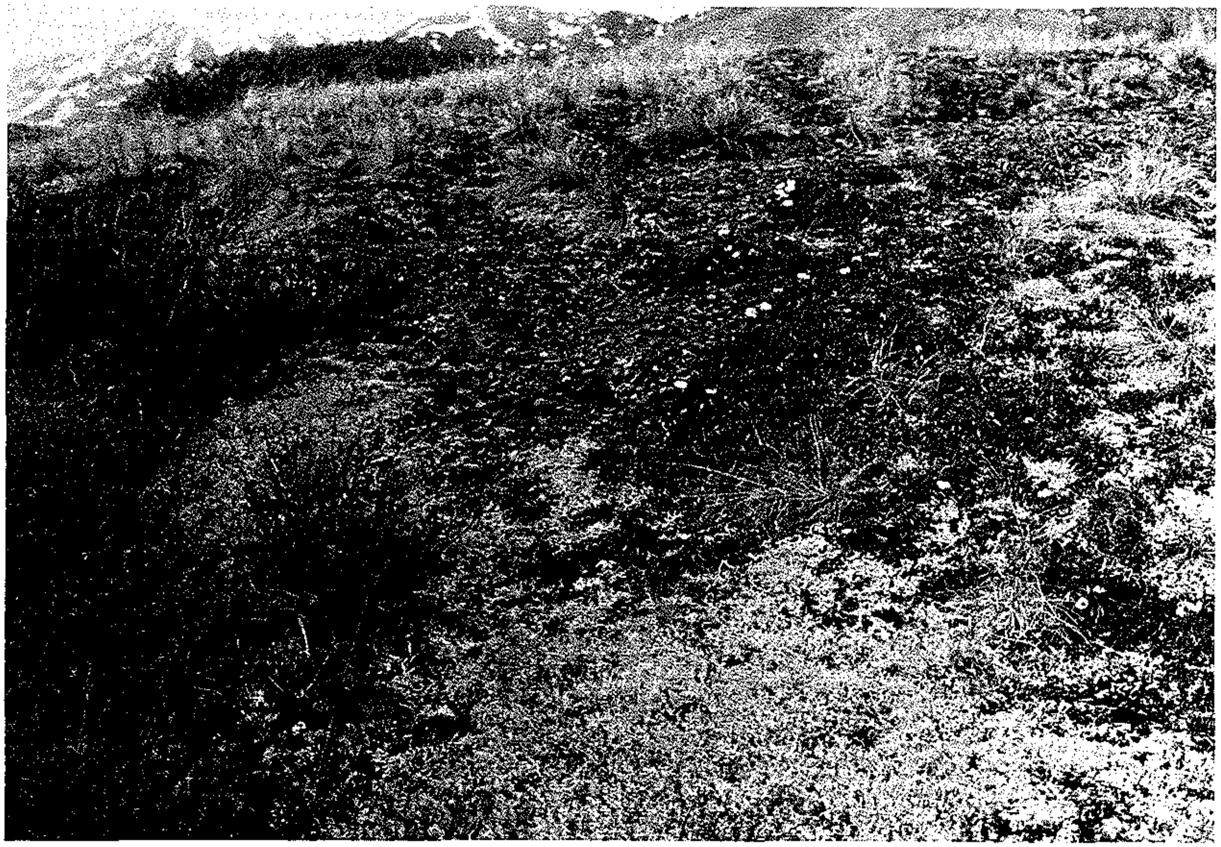


Figure 7. Lichen-Shrub Tundra (similar to Type 8) found on steeper exposed slopes: the example stems from the southern exposures in the vicinity of the North Fork Pass, Ogilvie Mountains. (Photo E.T. Oswald).

by Nimis (personal comm.) as "Lichenes-Hierochloe alpina" occurs. Vegetation cover is composed primarily of lichens. The specific floristic composition is as follows: Hierochloe alpina, Empetrum nigrum, Vaccinium vitis-idaea, Alectoria ochroleuca, Cetraria richardsonii, Dactylina madreporiformis, D. arctica, Nephroma arcticum, Cetraria nivalis, C. cucullata, C. islandica, Cladonia mitis, C. rangiferina, C. arbuscula, C. coccifera, C. uncialis. C. alpestris, C. amaurocraea.

Type 7 – Lichenes – Cassiope tetragona – Petasites sagittatus

Surveyed was plot 16 in Section 5

Characteristic species	mean cover %	FV_p	SV
Lichen sp.	75.5	0.20	0.13
Cassiope tetragona	5.5	0.95	0.05
Petasites sagittatus	5.5	0.90	0.05
Betula nana	5.5	0.83	0.04
Arctostaphylos alpina	5.5	0.77	0.04
Salix reticulata	5.5	0.74	0.04
Arctagrostis latifolia	4.1	0.64	0.03
Empetrum nigrum	5.5	0.38	0.02
Vaccinium uliginosum	5.5	0.38	0.02
Ledum palustre	5.5	0.26	0.01

This Lichen-Shrub Tundra exists on slopes with a northern exposure in the Richardson Mountains. Dominant are lichens and Cassiope tetragona, with important secondary species including Salix reticulata and Empetrum nigrum. While mosses are present, lichens are most abundant, with no particular species predominant. A pattern of nonsorted circles and/or sorted circles may exist on the upper slopes, while solifluction dikes occurs on the lower slopes. Soils are Gleysolic Turbic Cryosols. Portions of the ground surface may be exposed mineral soil; organic horizons are often buried. Permafrost depth varies from 60 cm to more than 100 cm (deepest in centres of circles). The pH of the mineral soils is 3.6 and of the organic soil 3.4.

Krajina (1963) has listed several "late-snow-lie" associations from the flanks of the Richardson Mountains, of which his "Cassiope tetragona – Hylocomium splendens var. alaskanum – (Dryas punctata) Association" of the Alpine Tundra Zone resembles the type described here. Richer (1968) describes a "Late-Snow-lie Community" characterized by Cassiope tetragona, which is comparable in species compositon to this type. Hettinger, Janz and Wein (1973) verify the presence of Cassiope tetragona, lichen and dwarf willow on well-drained solifluction slopes in the Richardson Mountains.

Type 8 – Betula glandulosa – Lichen sp. – Vaccinium uliginosum

Surveyed were plots 18, 19, 21 in Section 5

Characteristic species	mean cover %	FV_p	SV
Betula glandulosa	43.4	0.33	0.13
Lichen sp.	22.2	0.21	**0.04**
Vaccinium uliginosum	8.3	0.39	0.03
Salix reticulata	4.1	0.50	0.03
Petasites frigidus	3.8	0.47	0.03
Empetrum nigrum	6.1	0.39	0.02
Festuca altaica	2.3	0.58	0.02
Loiseleuria procumbens	1.8	0.66	0.02
Calamagrostis canadensis	2.3	0.43	0.01

This is a Lichen Low Shrub Tundra, in which Betula glandulosa and large patches of lichens and grasses are abundant. No trees or tall shrubs are present. This type is observed on moderate to steep southern, southeastern and northwestern slopes in the Richardson Mountains. Soil is extremely stony, 20-25 cm deep, overlying bedrock of coarse plated schist. Permafrost depth is estimated to range from 60-150 cm. The organic layer, mainly of fibrous material, is 1-4 cm thick and covers only about half the ground surface: the rest is exposed mineral soil.

The pH of the organic soil ranges from 3.2 to 3.9 and of the mineral soil from 3.4 to 3.9. Depending on depths of the active layer, the prevailing subgroups are lithic phases of either Gleyed Dystric Brunisols, Orthic Regosols and Orthic Dystric Brunisols or Brunisolic Static Cryosols.

Type 9 – Picea mariana – Eriophorum vaginatum – Carex sp.

Surveyed were plots 60, 62, 65, 66, 69, 70, 77 and 79 in Section 2

Characteristic species	mean cover %	FV_p	SV
Picea mariana	13.6	0.53	0.08
Eriophorum vaginatum	10.8	0.48	0.05
Carex sp.	29.7	0.17	0.05
Betula glandulosa	13.0	0.35	**0.04**
Ledum palustre	12.6	0.28	0.03
Vaccinium uliginosum	7.2	0.35	0.03
Ledum groenlandicum	4.0	0.50	0.03
Oxycoccus microcarpus	2.2	0.72	0.02
Salix reticulata	2.7	0.38	0.02
Andromeda polifolia	2.1	0.58	0.02
Salix pulchra	6.3	0.29	0.02
Arctostaphylos rubra	3.0	0.38	0.02
Lichen sp.	8.6	0.22	0.02
Vaccinium vitis-idaea	8.8	0.17	0.01

Structurally, this type is an open, treed-bog-like Spruce Taiga dominated by Picea mariana and a tussocky microtopography, of Eriophorum vaginatum. It closely resembles the open-canopied Picea – Ledum – Aulacomnium Type (Orloci and Stanek 1980 Stanek 1980) and is comparable to the moss-rich "Picea mariana – Aulacomnium palustre" described by Nimis (personal comm.). It is observed on mainly flat terrain, often with hummocks, in the North Ogilvie Mountains as well as along the Dempster Highway south of North Fork Pass. Permafrost is always present, with depths ranging from 33 to 55 cm. Soils are mainly Terric-Mesic,

Mesic and Humic Organic Cryosols with more than 40 cm of tundra peat and Gleysolic Static Cryosols in places with less than 40 cm of organic surface horizons. The pH of the organic soil ranges from 3.4 to 6.2 and of the mineral soil from 3.8 to 6.4.

A sub-type dominated by Sphagna is recognizable on acid parent material with a shallow active layer. Micro-units of vegetation exist; for example, within this type, tied to microsites, a unit, characterized by fruticose lichens, occurrs in dry habitats on hummocks, or a Drepanocladus vernicosus unit persists under water in depressions among hummocks.

Two distinct phases are also recognizable. The first, characterized by the presence of Andromeda polifolia, occupies wet, silty clays on flat terrain, where drainage is usually impeded. The second phase, with high sedge cover, is observed on the fringe of marsh areas or river banks, where conditions are extremely wet.

The floristic composition of the "Picea mariana – Aulacomnium palustre" community as described by Nimis (personal comm.) is as follows:

Picea mariana, Potentilla fruticosa, Arctostaphylos rubra, Ledum decumbens, Andromeda polifolia, Salix reticulata, S. glauca, Vaccinium uliginosum ssp. typicum and ssp. microphyllum, Dryas intergrifolia, Rhododendron lapponicum, Salix myrtillifolia. Betula glandulosa, B. nana, Rubus chamaemorus, Oxycoccus microcarpus, Empetrum nigrum, Carex consimilis C. capillaris. C. scirpoidea, C. membranacea, C. microchaeta, Eriophorum vaginatum, Equisetum arvense, E. sylvaticum, Tofieldia pusilla, Senecio lugens, Pedicularis labradorica, Equisetum scirpoides, E. variegatum, Petasites hyperboreus. Polygonum viviparum, Rumex arcticus, Senecio atropurpureus. Lycopodium alpinum, Selaginella selaginoides, Aulacomnium palustre, Drepanocladus vernicosus, Rhytidium rugosum, Sphagna, Dactylina arctica. Cladonia mitis, C. rangiferina, Peltigera aphthosa, P. leucophlebia, Cladonia arbuscula, C. alpestris, C. amaurocraea, Cetraria nivalis. C. cucullata, Thamnolia subuliformis. Cladonia deformis, Nephroma arcticum, Icmadophyla ericetorum (the latter only in sub-association sphagnetosum).

Type 10 – Ledum groenlandicum – Picea mariana – Betula papyrifera

Surveyed were 5 plots; namely, 47.51 and 54 in Section 3 and plots 1 and 2 in Section 6

Characteristic species	mean cover %	FV,	SV
Ledum groenlandicum	24.9	0.67	0.16
Betula papyrifera	7.7	0.58	0.07
Picea mariana	10.0	0.71	0.06
Vaccinium vitis-idaea	26.9	0.17	0.04
Spiraea beauverdiana	3.3	0.61	0.02
Rosa acicularis	3.0	0.55	0.02
Betula glandulosa	5.8	0.26	0.02
Calamagrostis canadensis	1.9	0.39	0.01
Rubus chamaemorous	2.2	0.30	0.01

Open Spruce Taiga, is mainly found on gentle slopes in the Eagle Plains and Eastern Foothills of the Richardson Mountains. The trees are generally clumped, apparently of layer origin, and are surrounded by low shrubs. In the Eastern Foothills of the Richardson Mountains, hummocky terrain governs vegetation distribution and growth in this type. Less than 10% of the trees grow on hummock tops, the rest being equally divided among the sides of the hummocks and inter-hummock troughs (Zoltai and Pettapiece, 1974). Spruce is often tilted and leaning away from the hummocks (Zoltai and Tarnocai 1974). Ericaceous shrubs and liverworts dominate the tops of the hummocks and Sphagnum cuspidatum and purpureum dominate the inter-hummock troughs. Moss cover in this type is high, with Hylocomium splendens and Sphagna being most common. Soils are Gleysolic Turbic Cryosols with 10-30 cm of fibrous tundra peat, underlain by a layer of organic rich silty clay. Occasionally, there are signs of very active cryotqrbation. Mineral soil consists of gleyed, compacted, non-plastic silty clay. The pH of the organic soil ranges from 3.2 to 4.0 and of the mineral soil from 3.2 to 4.8. Permafrost depth ranges from 45-120 cm in the communities sampled.

Figure 8. Open, treed-bog-like Spruce Taiga (Type 9, Section **2).** The trees are over **100** years old. The site is wet; the active layer is relatively shallow.

Figure 9. Open treed-bog-like Spruce Taiga (Type 9, Section **2)** after a surface fire about a decade ago. Before fire. the stand looked similar to the one in Figure 8. The fire exposed the typical microtopography of hummocks and tussocks.

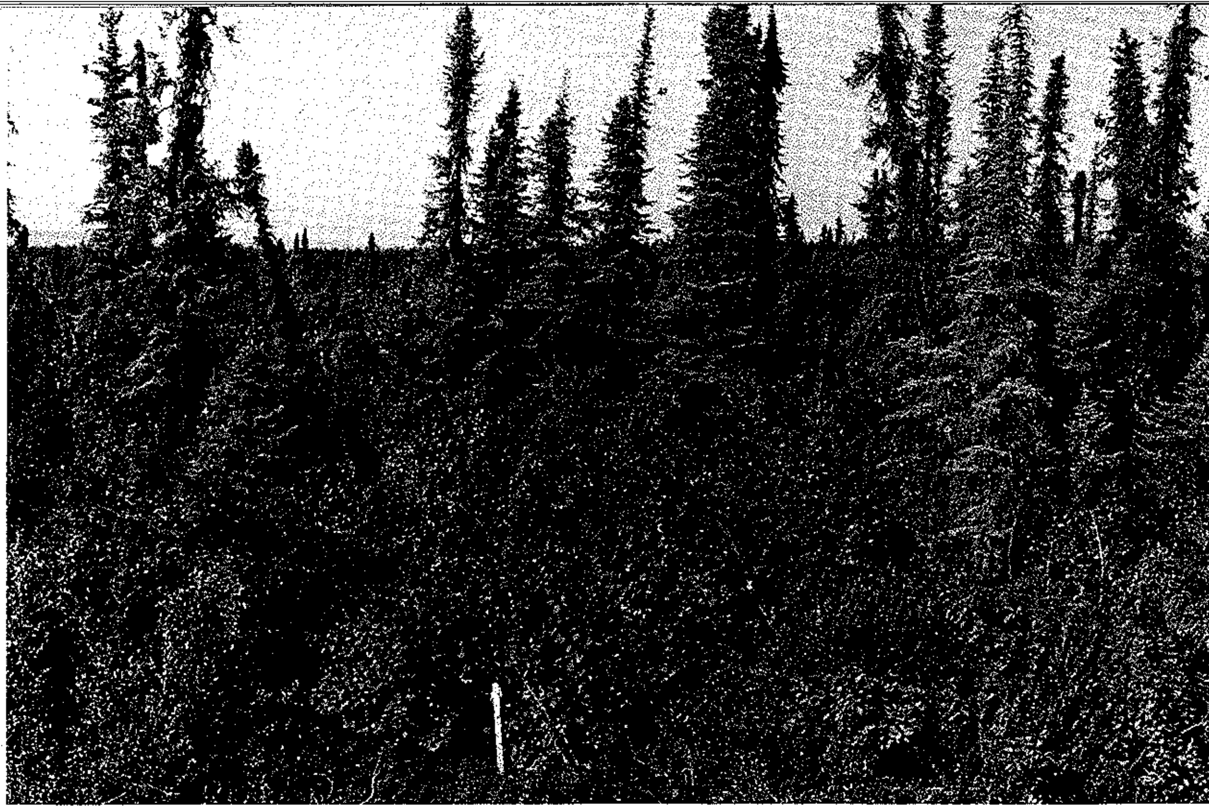


Figure 10. Open Spruce Taiga (Type 10, Section 3) extensively occur. ring in the Eagle Plains.

Figure 11. Relatively open Spruce – Tall Shrub Taiga (Type 11, Section 3). Black and white spruce may occur together.

Type 11 – Picea mariana – Betula glandulosa – Ledum palustre

Surveyed were **plots 42, 44** and **46** in Section **3** and plot **20** in Section **5.**

Characteristic species	mean cover %	FV_p	SV
Picea mariana	28.0	0.70	0.17
Betula glandulosa	18.6	0.33	0.05
Ledum palustre	19.7	0.27	0.05
Alnus crispa	6.3	0.59	0.05
Rubus chamaemorus	7.8	0.38	0.04
Vaccinium vitis-idaea	20.8	0.17	0.03
Spiraea beauverdiana	2.8	0.76	0.02
Equisetum arvense	3.1	0.53	0.02
Salix pulchra	5.5	0.23	0.02
Petasites friaidus	1.7	0.35	0.01

Relatively open Spruce-Tall Shrub Taiga on tundra peat occurs on mainly gently sloping terrain in the Eagle Plains and Richardson Mountains. Picea mariana, found at various stages of successional development, is dominant, Picea glauca may occur, and tall shrubs comprise the understory. Alnus crispa and Salix pulchra are common companions. Type **11** is comparable to Picea – Ledum – Hylocomium (Orloci et al. **1980;** Stanek **1980).** Northeastern and northern exposures are common. Cryoturbation is evident. In the Richardson Mountains, this type may occupy hummocky terrain. The soil profile is commonly **10-40** cm of tundra peat over 10-15 cm of sandy or silty mineral soil, slightly gleyed above the permafrost level. Type **11** is comparable to the "Open Evergreen Narrow Sclerophyll Forest Formation" described by Hettinger, Janz and Wein **(1973)** for the Porcupine Plateau.

In general, permafrost is present at **45-65** cm. Terric Mesic Organic Cryosols, Orthic Turbic Cryosols and Gleysolic Turbic Cryosols have been recorded. The pH of the organic layer ranges from **3.1** to **3.3** and of the mineral layer from **3.7** to **3.9.**

Figure **12.** Open canopied, Lichen Spruce Taiga (Type 12) common in the Eagle Plains.

Type 12 – Picea mariana – Lichenes – Ledum palustre

Surveyed were plots 39, 40, 43, 45 in Section 3

Characteristic species	mean cover %	FV_p	SV
Picea mariana	32.1	0.70	0.19
Lichen sp.	63.3	0.21	0.11
Ledum palustre	16.4	0.27	0.04
Vaccinium vitis-idaea	23.6	0.12	0.03
Liverwort sp.	2.2	0.49	0.02
Spiraea beauverdiana	2.8	0.52	0.02
Vaccinium uliginosum	4.4	0.40	0.02
Rosa acicularis	2.4	0.69	0.02
Equisetum arvense	2.1	0.35	0.01
Betula glandulosa	4.2	0.33	0.01

This open canopied, Lichen Spruce Taiga on flat terrain or gently sloping western or southwestern exposures was found in the Eagle Plains. The trees are characterized by a short, ragged growth form. Lichens dominate in the understory. The organic layer is from 3-5 cm deep; the mineral soils consist usually of a deep layer of sandy soil with mottling or strong gleying, subtended by a layer of wet clay above platy stones. Generally, permafrost is found at depths ranging from 100 to 150 cm. Soils are commonly Gleyed Dystric Brunisols. The pH of the organic layer ranges from 2.8 to 3.1 and of the mineral layer from 3.2 to 3.8.

Type 13 – Picea mariana – Vaccinium uliginosum – Larix laricina

Surveyed were 8 plots; namely, plots 9, 10, 11 in Section 6 and plots 24, 25, 27, 28 and 32 in Section 4

Characteristic species	mean cover %	FV_p	SV
Picea mariana	11.1	0.63	0.07
Vaccinium uliginosum	15.9	0.41	0.06
Larix laricina	8.1	0.60	0.07
Betula glandulosa	12.0	0.35	0.04
Rubus chamaemorus	7.2	0.47	0.04
Empetrum nigrum	8.2	0.41	0.03
Lichen sp.	13.3	0.22	0.02
Spiraea beauverdiana	3.0	0.38	0.02
Ledum palustre	9.2	0.24	0.02
Arctagrostis latifolia	2.9	0.59	0.02
Salix pulchra	6.5	0.24	0.02
Carex sp.	11.2	0.14	0.02
Ledum groenlandicum	2.6	0.33	0.02
Vaccinium vitis-idaea	9.6	0.17	0.01
Arctostaphylos alpina	1.8	0.39	0.01

This is open Black Spruce Tamarack Taiga, with a closed shrub understory. This type occurs prominently in the Eastern Foothills of the Richardson Mountains on gentle slopes with poor drainage. Apparently the dominance and density of the tree stratum is dependent on the fire history (Hettinger, et *al.* 1973). In the Eastern Foothills, this type is often found on hummocky terrain with 15-20 cm of organic soil over 25-30 cm of unfrozen mineral soil above permafrost. In the Western Foothills, organic layers are generally deeper, ranging from 10-45 cm over fine textured clays and silt, often heavily gleyed. Soil mottling, evidence of fire in the mineral layers, unsorted circles and polygons have been found on these sites. Permafrost is present at depths ranging from 33 to 65 cm (Klohn Leonoff Consultants Ltd. 1977). The soils are of the Cryosolic order.

Type 14 – Picea glauca – Equisetum arvense – Lupinus arcticus

Surveyed were 9 plots: namely, plots 92, 99, 100 in Section 1 and plots 59, 61, 63, 67, 68, 78 and 80 in Section 2.

Characteristic species	mean cnver %	FV_p	SV
Picea glauca	31.8	0.78	0.22
Equisetum arvense	7.4	0.36	0.05
Lupinus arcticus	4.7	0.81	0.04
Arctostaphylos rubra	6.2	0.51	0.04
Ledum groenlandicum	5.0	0.40	0.03
Salix pulchra	10.8	0.30	0.03
Shepherdia canadensis	2.2	0.57	0.02
Vaccinium uliginosum	5.3	0.23	0.02
Rosa acicularis	2.3	0.49	0.02
Potentilla fruticosa	1.8	0.45	0.02
Hedysarum alpinum	1.5	0.44	0.01
Calamagrostis canadensis	1.9	0.40	0.01

White Spruce Forest is common on narrow strips along river banks in the North and South Ogilvie Mountains. This type is similar to the "Corno-Piceetum glaucum" described by Nimis (personal comm.) occurring on stable southern and south-western slopes with 5-40 cm of organic soil, underlain by sandy mineral soil and gravel.

In the South Ogilvie Mountains, this type occurs on relatively well drained soils with shallow organic layers. Permafrost may be absent. In the North Ogilvie Mountains, it is present as a relict; the stand age is greater, the humus is deeper and permafrost may occur irregularly. Where permafrost is present, the active layer is always deeper than that in the Picea mariana taiga (Type 9). In the localities sampled, soil pH ranges from 3.9 to ***6.5*** in the organic layers and from 4.6 to 7.1 in the mineral layers. The soils are frequently of the Regosolic order.

Several succession stages of this type are recognizable and include multi-layered stands of Picea glauca, Populus balsamifera and Salix pulchra on gravel terraces with Orthic or Cummulic Regosols, as well as an almost pure spruce forest, the "Corno – Piceetum Glaucae", described by Nimis (personal comm.), with floristic composition as follows:

Picea glauca, Vaccinium vitis-idaea, Shepherdia canadensis, Cornus canadensis, Rosa acicularis, Empetrum nigrum, Ribes triste, Linnaea borealis, Viburnum edule, **Alnus** crispa ssp. sinuata, Ledum groenlandicum, Calypso bulbosa, Epilobium angustifolium. Mertensia paniculata, Pyrola secunda, Equisetum scirpoides, Geocaulon lividum, Pyrola asarifolia, Carex concinna, Lycopodium annotinum, Habenaria obtusata, Anemone richardsonii, Peltigera aphthosa, Nephroma arcticum, Cladonia arbuscula, C. ecmocyna, C. turgida, C. chlorophaea, C. multiformis, Hylocomium splendens, Pleurozium schreberi, Abietinella abietina, Rhytidium rugosum, Dicranum tenuifolium, D. scoparium.

On undisturbed sites and where the forest canopy has had an opportunity to close, the moss-rich white spruce forest, Hylocomio – Piceetum Glaucae (Nimis, personal comm.), occurs. It is rare and restricted, though it occurs in similar sites as the previous association. Floristically, it is somewhat similar, the difference being the lack of shrubs (only Linnea borealis and Rosa acicularis are present with low frequency) and the presence of Moneses uniflora, Listera borealis and Corallorhiza trifida as characteristic species in the understory. Hylocomium splendens covers 80 to 100% of the ground.

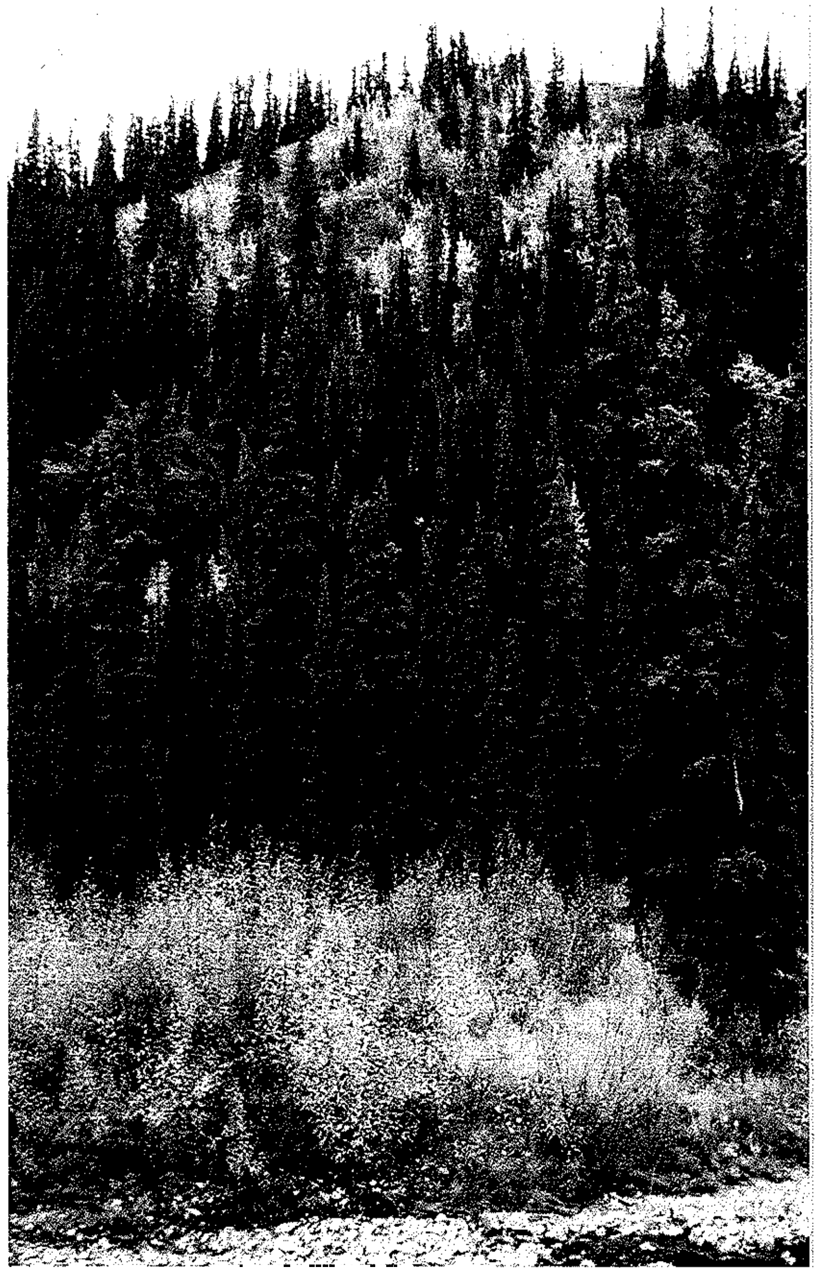


Figure 13. East to south exposure slopes in the Ogilvie River Valley (Section **2).** In the foreground, Riverine Willow (Type 18) occupies the floodplain: in the middle ground, White Spruce Forests (Type 14) reach from the valley floor partly up the slope; the upper slope favors the Spruce-Paper Birch Taiga (Type **15).**

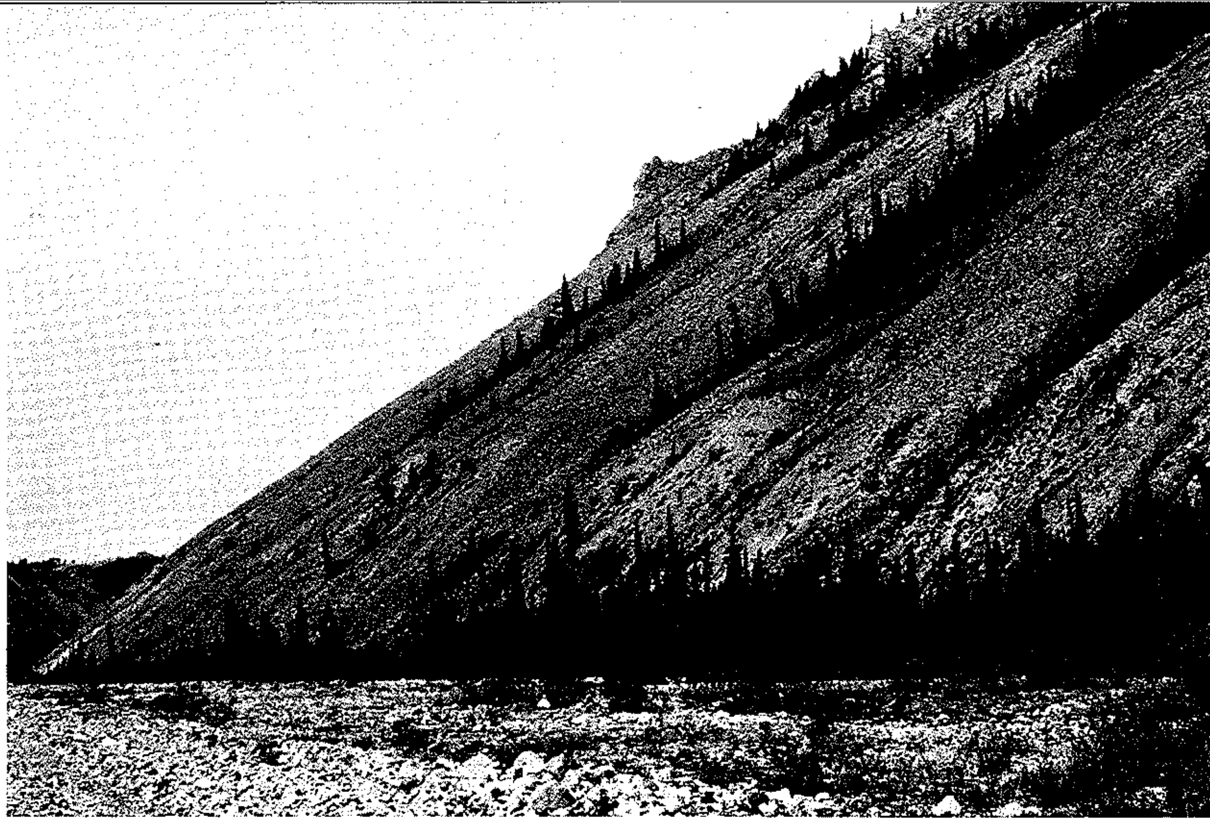


Figure **14.** Open Spruce Taiga (Type **16)** colonizing the calcareous scree in the northern part of the Ogilvie Mountains. The presence and extent of this type depends greatly on slope stability.

Figure **15.** Riverine stands (Type **17)** on floodplains and terraces of alluvial valleys in the western foothills of the Richardson Mountains. The flood plains are occupied by white spruce and balsam poplar; the terraces, usually with permafrost, support mainly white spruce.

Type 15 – Picea glauca – Betula papyrifera – Vaccinium vitis-idaea

Surveved were plots 57.71.74 in Section 2

Characteristic species	mean cover %	FV_p	SV
Picea glauca	21.5	0.72	0.13
Betula papyrifera	8.0	0.96	0.07
Vaccinium vitis-idaea	27.5	0.17	0.04
Alnus incana	5.4	0.61	0.04
Empetrum nigrum	7.5	0.25	0.03
Rosa acicularis	3.3	0.45	0.02
Ledum groenlandicum	3.3	0.43	0.02
Ledum palustre	5.9	0.17	0.01

Spruce-Paper Birch Taiga is found on steep southern exposures io the North Ogilvie Mountains. The sites are prone to solifluction. Lichens are scarce and moss cover is reduced; the dwarf shrub layer is restricted, with only Vaccinium vitis-idaea throughout the understoy. Organic layer ranges from 10 to 40 cm with pH from 3.4 to 4.7. Mineral soils are friable, granular clay loams with pH from 3.3 to 5.9. Orthic Static, Terric Mesic Organic and Gleysolic Turbic Cryosols are found. Permafrost depth ranges from 40 to 100 cm in the communities sampled.

Type 16 – Dryas integifolia – Dryas octopetala – Rhododendron lapponicum

Surveyed were plots 64 and 76 in Section 2

Characteristic species	mean cover %	FV_p	SV
Dyas integrifolia	32.1	0.94	0.29
Dyas octopetala	18.1	0.49	0.17
Rhododendron lapponicum	11.8	0.95	0.11
Potentilla fruticosa	7.1	0.84	0.06
Alnus crispa	7.4	0.39	0.05
Picea glauca	8.6	0.71	0.05
Arctostaphylos rubra	7.2	0.60	0.04
Hedysarum alpinum	4.3	0.43	0.04
Elymus innovatus	2.7	0.50	0.03
Carex sp.	18.0	0.16	0.03
Festuca altaica	2.7	0.43	0.02
Arctostaphylos uva-ursi	2.1	0.49	0.02
Lichen sp.	9.1	0.20	0.02
Vaccinium uliginosum	4.3	0.19	0.02
Dyas drummondii	1.4	0.49	0.01

Open Spruce Taiga colonizes the calcareous scree io the Northern Ogilvie Mountains. Common are Picea glauca stands, which differ greatly from other described types in which Picea glauca is dominant. The spruce is stunted and its cover is reduced, owing to frequent sliding of the loose, rubbly limestone material and an arid condition created by rapid drainage and percolation. Moss and lichen cover are reduced. This type with several calciphillic species was examined in two unique locations. The first was on a 20" river slope with rendzina-like humus (Kubiena 1953) on calcareous rock, and permafrost at 75 cm. The pH of the organic soil was 6.6 and of the mineral soil 6.2. The second location was on an outwash plain, apparently without permafrost. The soil was a silty-sandy Regosol over limestone gravel and cobbles with a generally shallow rendzina-like humus. Organic soil was not sampled; pH of the mineral soil was 7.1 in this site.

The floristic compositon of the community (Nimis personal comm.) is as follows:

Picea glauca, P. mariana (rare),Salix alaxensis, Cassiope tetragona, Arctostaphylos rubra, Ledum groenlandicum, Vaccinium vitis-idaea, Andromeda polifolia, Potentilla fruticosa, Rhododendron lapponicum, Salix reticulata, Juniperus communis, Arctostaphylos uva-ursi, Vaccinium uliginosum, Dyas integrifolia, Salix glauca, Carex petricosa, C. capillaris, C. consimilis, C. scirpoidea, C. membranacea, C. vaginata, C. rostrata, Eriophorum vaginatum, Equisetum arvense, Minuartia arctica, Tofieldia pusilla, Pedicularis labradorica, Amerorchis rotundifolia, Saxifraga hirculus, S. hieracifolia. Equisetum scirpoides, Eriophorum angustifolium, Arnica alpina ssp. attenuata, Anemone richardsonii, Cypripedium passerinum, C. guttatum, Festuca altaica, Solidago decumbens, Zigadenus elegans, Mertensia paniculata, Senecio lugens, Geocaulon lividum, Hedysarum alpinus ssp. americanum, Saussurea angustifolia, Arenaria arctica, Silene acaulis, Pyrola asarifolia, Stellaria longipes, Polygonum viviparum, Petasites hyperboreus, Calamagrostis canadensis, Hylocomium splendens, Aulacomnium palustre, Rhytidium rugosum. Abietinella abietina, Dicranum tenuifolium, Dactylina arctics, Cladonia rangiferina, Parmelia omphalodes, Cetraria cucullata, Peltigera aphthosa, Cetraria islandica, Cladina mitis, Cetraria nivalis, Cornicularia aculeata, Cladonia chlorophaea, Masonhalea richardsonii, Cladonia alpestris.

Type 17 – Equisetum arvense – Picea glauca – Salix pulchra

Surveyed were **plots** 26, 29, 31, 33, 35 in Section 4

Characteristic species	mean cover %	FV_p	SV
Equisetum arvense	28.9	0.73	0.18
Picea glauca	18.9	0.73	0.11
Salix pulchra	21.8	0.33	0.06
Populus balsamifera	5.2	0.53	0.04
Arctagrostis latifolia	5.3	0.66	0.03
Vaccinium uliginosum	9.1	0.23	0.03
Hedysarum alpinum	3.0	0.52	0.03
Arctostaphylos rubra	4.0	0.36	0.02
Salix reticulata	2.9	0.45	0.02
Rosa acicularis	3.2	0.40	0.02
Petasites frigidus	1.9	0.43	0.01
Ranunculus lapponicus	1.1	0.59	0.01

Riverine stands of Picea glauca and Populus balsamifera occupy alluvial valleys in the Western Foothills of the Richardson Mountains. The species composition depends on the stage of the successional sere. Various associations of balsam poplar, white birch and white spruce were found in this region by Hettinger. Janz and Wein (1973). The soils of the flood plain are frequently deep sandy Regosols (soils with little horizon development). Permafrost is absent.

On the terraces and river valley slopes with 25-30 cm of fibrous peat over 10 to 20 cm of well-decomposed peat that is frozen at 45 cm, Picea glauca becomes codominant with alder, to the exclusion of poplar. Vegetation is similar to that of Types 10 and 11 as well as 13. These sites may exhibit hummocky terrain and water-logging. The soils are of the Cryosolic order. Drew and Shanks (1965) describe similar spruce-forest terrace vegetation types in the Upper Firth River.

Type 18 – Salix pulchra – Equisetum arvense – Calamagrostis canadensis

Surveyed were 7 plots: namely, ***85***, 88, 89, 91 and 96 in Section 1 and plots 56 and 73 in Section 2

Characteristic species	mean cover %	FV_p	SV
Salix pulchra	64.8	0.33	0.19
Equisetum arvense	17.8	0.52	0.11
Calamagrostis canadensis	6.6	0.48	0.04
Potentilla fruticosa	3.0	0.61	0.03
Agropyron violaceum	1.8	0.55	0.02
Carex sp.	11.1	0.08	0.01
Delphinium glaucum	1.4	0.54	0.01
Festuca brachyphylla	1.2	0.57	0.01

This is a Riverine Willow of dense, vigorous Salix pulchra in the South Ogilvies. It is less prevalent in the North Ogilvies. This type is common on riverine sites or meadows of generally hygric to mesic moisture conditions. Permafrost is absent. Equisetum arvense may be abundant; lichen cover is reduced. The presence of Delphinium glaucum, common to thickets along stream banks (Welsh 1974), characterizes this type. Silt and sand mixed with organic debris form the substrate. Soils are Gleyed Regosols, often underlain with gravel and boulders. Little or no organic horizon is present. The pH of the organic soil ranges from 5.4 to 6.9 and of the mineral soil from 4.8 to 7.2

In the North Fork Pass region, Richer (1968) describes a "Moist Shrub Meadow Community Complex" which occupies gentle slopes, troughs, flat floored depressions and shallow gullies. Richer compares his type to Porsild's (1951) "Subalpine Meadow Habitat" as defined within the Mackenzie Mountains, and to Spetzman's (1959) "Tall Shrub Stage" of the "Flood Plain Community" of the North slope of Alaska. This type has also been recognized by Nimis (personal comm.) and is called "Artemisio-Salicetum Pulchrae". Nimis's type is composed of dense Salix thickets and a mixture of grasses, which can be more-or-less open, with dominance of lichens in the understory, or more-or-less closed and very poor in species. The specific floristic compositon of the type described by Nimis is as follows:

Salix pulchra, Betula glandulifera, Ledum

Figure 16. Riverine Poplar-Spruce on a terrace of the Blackstone River (Type 19).

palustre, Empetrum nigrum, Rubus arcticus, Rubus chamaemorus, Salix reticulata, Vaccinium uliginosum ssp. microphyllum, Artemisia arctica, Valeriana capitata, Petasites hyperboreus, Epilobium angustifolium, Polemonium acutiflorum. Polygonum bistorta, Luzula parwiflora, Carex consimilis, Pedicularis sudetica, Stellaria longipes, Mertensia paniculata, Senecio lugens, Festuca altaica, Calamagrostis canadensis, Trisetum spicatum, Gentiana algida, Veronica wormskjoldii, Anemone parwiflora, Gentiana glauca, Erigeron elatus, Equisetum arwense, Myosotis alpestris ssp. sibirica, Carex microchaeta, Aconitum delphinifolium, Rumex arcticus, Parnassia kotzebuei, Rhodiola integrifolia, Saxifraga hieracifolia, Lloydia serotina, Solidago multiradiata, Aulacomnium palustre, Hylocomium splendens, Polytrichum juniperinum, Dicranum tenuifolium, Nephroma arcticum, Cladonia mitis, Masonhalea richardsonii, C. cucullata, C. nivalis, C. Islandica, C. ericetorum, C. pinastri, Cladonia rangiferina, C. chlorophaea, Dactylina arctica, Peltigera aphthosa, Cladonia gracilis, C. alpestris, Stereocaulon tomentosum, Cladonia amaurocraea, Stereocaulon alpinum, Cladonia coccifera.

Type 19 – Alnus incana – Populus balsamifera – Equisetum arvense

Surveyed were plots 55 and 58 in Section 2 and plot 41 in Section 3.

Characteristic species	mean cover %	FV_n	SV
Alnus incana	41.3	0.93	0.35
Populus balsamifera	34.3	0.89	0.28
Equisetum arvense	27.8	0.71	0.17
Pyrola asarifolia	7.4	0.91	0.07
Shepherdia canadensis	4.8	0.61	0.04
Rosa acicularis	4.6	0.68	0.03
Picea glauca	5.2	0.72	0.03
Calamagrostis canadensis	3.8	0.43	0.02
Viburnum edule	1.8	0.65	0.02
Salix pulchra	6.2	0.32	0.02
Agropyron sp.	1.8	0.63	0.02

Riverine Poplar-Spruce was observed in alluvial valleys of the Ogilvie Mountains and the Eagle Plains. This type, recognized by Nimis as "Populetum Balsamiferae", occurs as a relict in the surveyed region. It is common on permafrost-free flood plains and terraces. Floristically, this type is characterized by the presence of permafrost-intolerant species. Mosses and lichens are scarce. The ground is either bare or covered with hardwood litter. Soils are Gleyed Regosols, with sandy mineral soil underlain by gravel; there is little or no humus layer. Where an organic horizon is present, the pH is 6.5; pH of the mineral soil ranges from 6.2 to 7.1.

The floristic composition of the community described by Nimis is as follows:

Populus balsamifera, Populus tremuloides, Picea glauca, Salix pulchra, Salix alaxensis, Ribes hudsonianum, Ribes triste, Shepherdia canadensis, Viburnum edule, Alnus incana. Arctostaphylos rubra, Salix arbusculoides, Epilobium angustifolium, Mertensia paniculata, Artemisia borealis, Equisetum arvense, Delphinium glaucum. Aconitum delphinifolium, Anemone richardsonii, Ranunculus macounii, Pyrola grandiflora, Cypripedium passerinum, C. guttatum, Lupinus arcticus, Galium boreale, Solidago decumbens, Deschampsia caespitosa, Hedysarum alpinum ssp. americanum.

Type 20 – Populus balsamifera – Lupinus arcticus – Betula glandulosa

Surveyed was plot 13 in Section 6

Characteristic species	mean cover %	FV_p	SV
Populus balsamifera	13.6	0.87	0.10
Lupinus arcticus	5.5	0.83	0.04
Betula glandulosa	11.7	0.32	0.03
Salix pulchra	11.7	0.31	0.03
Lichen sp.	14.9	0.20	0.03
Empetrum nigrum	5.5	0.38	0.02
Rosa acicularis	2.7	0.02	0.02
Epilobium angustifolium	1.4	0.99	0.01
Poa alpigena	1.4	0.95	0.01
Vaccinium vitis-idaea	8.6	0.16	0.01
Petasites sagittatus	1.4	0.90	0.01

These are stunted, tall-shrub-like stands on southwestern exposure alluvial valley slopes in the Eastern Foothills of the Richardson Mountains (possibly a phase of Type 19) of scattered poplar, birch, white spruce and willow. Tree growth is poor in comparison with the stands located in the Ogilvies and Eagle Plains (Type 19). Ground cover is reduced to litter and lichens. The soil is Gleyed Dystric Brunisol. The upper 20 cm is gravelly with fine textured soil material. With depth, the soil contains larger stones and, finally, boulders. Organic layer is not more than 4 cm and consists of fibrous material. The pH of the organic horizon is 4.8 and of the mineral horizon 4.3. Though not determined, permafrost could be suspected at a depth of 1.5 metres.

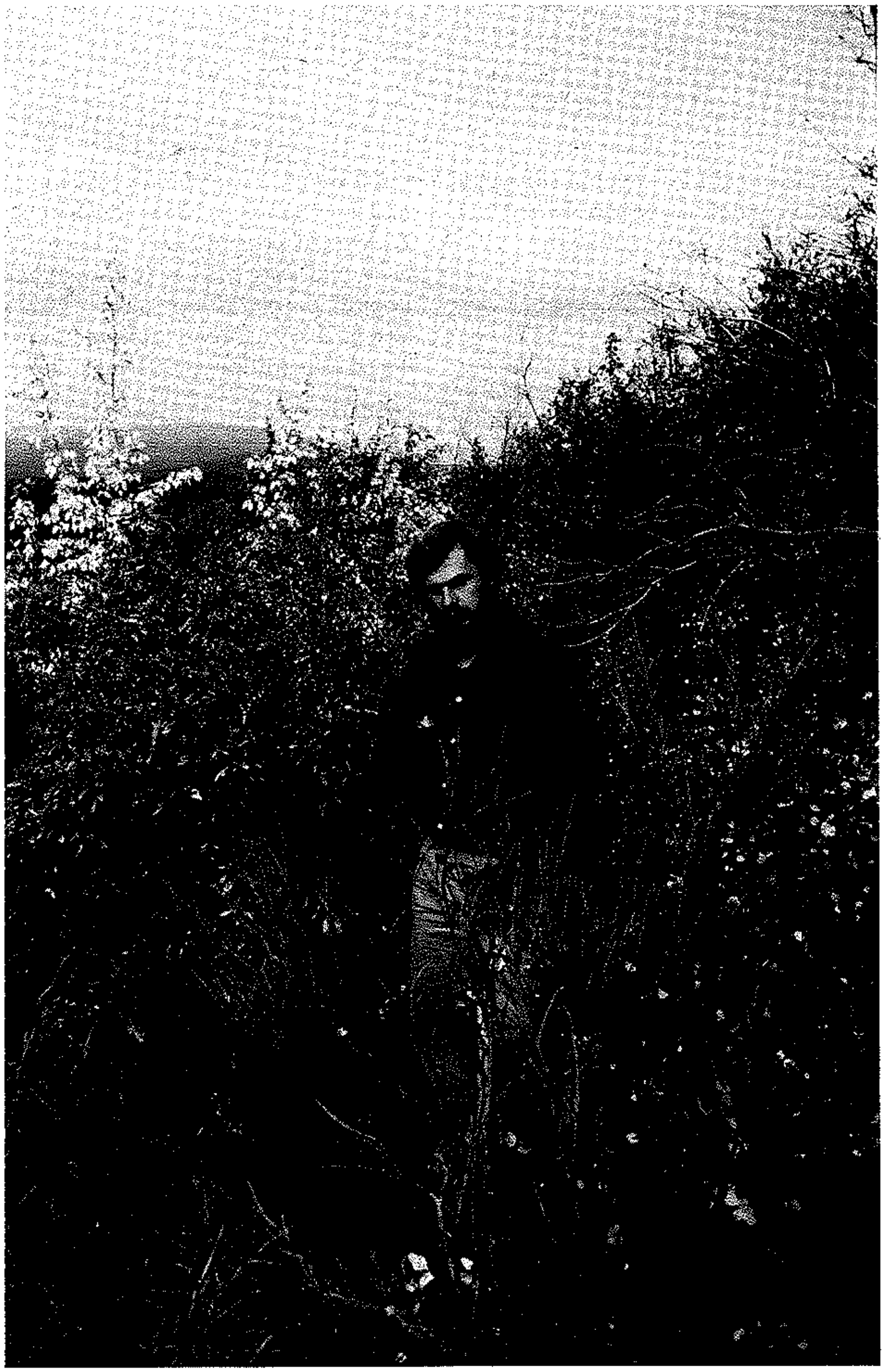


Figure 17. Tall-shrub-like stands (Type 20) on south-west exposure alluvial valley slope in the eastern foothills of the Richardson Mountains.

B. Discussion of Discrete Sections.

Because of relevance to the conducted survey. a description of areas south of North Fork Pass along the Dempster Highway is included.

1. Areas from Klondike Highway to North Fork Pass:

The lower North Klondike valley lies within the zone of the main boreal forest (Richer 1968). The types present in this section are similar to those occurring in Southern and Central Yukon and to several types north of North Fork Pass, where their occurrence is limited in area. Black Spruce stands (Type 9) are the dominant vegetation type on the lowlands. The rivers are lined with the typical White Spruce stands (Type 14) which, when their canopy closes, become "Hylocomio-Piceetum glaucae" community (description under Type 14).

Stands of Populus tremuloides occurs on steep slopes. very similar floristically to the "Populetum tremuloides" which occupies vast areas along the Klondike and Alaska highways after fire or occurs as an edaphic climax community on arid slopes.

Riverine Poplar (Type 19) occurring along streams near the water on gravel, can be considered a relict of a vegetation which is better developed further south. Carex communities are found along margins of ponds, mostly in standing water. A pioneer community of Salix occurs along the river on gravel, usually within reach of flood water. Further north in this section, the boreal forest gives way to a "sub-alpine'' vegetation which in turn assumes an "alpine" character in the Ogilvie Mountains.

2. Section 1 – South Ogilvie Mountains

The Southern Ogilvie Ranges rise as a distinct fault-line scarp to the northeast of the Tintina Valley. The ranges are underlain by a complex, folded and faulted Precambrian to Cretaceous succession of layered volcanics, clastic sediments and prominent dolerite sills (diabase dike or sheet, Richer 1968). The average and maximum relief of the ranges are approximately 900 and 1800 metres, respectively (Cockfield 1920). Estimated precipitation is about 380 mm in the west and 635 mm in the northeast. The mean annual precipitation is 453 mm (Oswald and Senyk 1977). Mean annual temperature measured at a station at 991 m is -7C.

Beginning at the Tombstone campsite, the road rises in a short distance from 1034 to 1289 m through Precambrian volcanic rocks, quartzite and schists. This results in a sharp change in vegetation; the subalpine character gives way to an "alpine tundra" at the crest of North Fork Pass. Black Spruce Taiga (Type 9) is replaced by Salix thickets (Type 18), which dominates the river banks and seepage sites until the road descends to the level of the Blackstone River. Richer (1968) estimates that this willow community covers one quarter to one third of the section. Solifluction is extremely common on the high gradient slopes, giving way to a micro-pattern in the vegetation distribution not studied during our survey. Wind-blown rock outcrops and colluvium are colonized by Type 6, a Lichen Heath "Alpine" Tundra. The frequent seepage sites support a characteristic vegetation with Claytonia tuberosa. This type restricted to the edges of small drainage channels. Nimis (personal comm.) provides the following floristic composition:

Claytonia tuberosa, Saxifraga reflexa, Juncus castaneus, Parnassia kotzebuei. Polemonium acutiflorum. Cardamine pratensis ssp. angustifolia, Polygonum bistorta, Valeriana capitata, Petasites hyperboreus, Luzula parviflora, Rumex arcticus, Veronica wormskjoldii.

On both sides of the Blackstone River, the landscape is dominated by a Low Shrub Tussock Tundra (Type 1) occurring intermittently on low gradient slopes and polygon fields. Going futher north from the pass, there is an interdigitation of several tundra types giving way to what Richer (1968) refers to as Sylvotundra or Forest Tundra, with the typical White Spruce Wood (Type 14) growing on stable southern exposure slopes. At the margin of the ponds, a Carex association, not sampled here, occurs.

On the whole, the passage from Klondike River to the Blackstone River reveals drastic changes, topographically and floristically with the appearance of many potentially rare arctic "alpine" species. Permafrost is common throughout the area, affecting nearly all the vegetation types [except, as it appears, the association with Hierochloe alpina (Type 6) and the one with Claytonia tuberosa]. According to Brown 1978, the area lies within the discontinuous widespread permafrost subzone.

3. Section 2 – North Ogilvie Mountains.

The vegetation of the calcareous Ogilvie Mountains is most interesting because of the presence of many potentially rare species, probably glacial relicts, the varying geomorphology and the complexity of successional seres. This area should be studied in more detail.

Apparently, the geomorphology of the area affects the vegetation distribution and succession. Where the road turns west of the Blackstone River, the landscape changes drastically. Hills consisting of calcareous material appear and continue to about 3 miles north of the Ogilvie River. As the result of cryoclastic action, rocky debris covers much of the slopes from the top to the base. Here and there, but mainly on top, serrated ramparts and tors persist, providing an almost eerie scenery. Most elevations are between 900 and 1350 metres (Oswald and Senyk 1977).

The surface of the scree is unstable and by this, the development of the vegetation cover is strongly affected. Climatic conditions appear to be similar to those encountered in Section I. The flora colonizing the hills includes a number of potentially rare basiphytic species: many of them can be considered as glacial relicts. Among others are Antennaria friesiana, Campanula aurita, Lesquerella arctica, Phlox sibirica, Parrya nudicaulis, Thalictrum alpinum, Eritrichium aretioides, Tofieldia coccinea, Senecio hyperborealis, Aster alpinus ssp. vierhapperi (Nimis personal comm.). Thus, the vegetation differs strongly from that on comparable sites in the other sections.

The bare rock is colonized by scattered individuals of Asplenium viride, Cystopteris fragilis and Saxifraga tricuspidata. Among the lichens, the most common are Cetraria tilesii and Cladonia pyxidata (on Regosols). This pioneer stage is followed by an interesting association, colonizing most of the more stable slopes, containing the greatest concentration of potentially rare species. Nimis (personal comm.) provides the following floristic composition:

Carex petricosa, C. glacialis, Dryas integrifolia, Saxifraga oppositifolia, Eritrichium aretioides, Cardamine purpurea, Festuca altaica, Asplenium viride, Androsace lehmanniana, Cystopteris fragilis, Antennaria friesiana, Campanula aurita, Lesquerella arctica, Phlox sibirica, Senecio hyperborealis, Parrya nudicaulis, Arctostaphylos uva-ursi, Aster alpinus ssp. vierhapperi, Anemone multifida, Thalictrum alpinum, Zigadenus elegans, Saxifraga tricuspidata. Carex rupestris, Anemone richardsonii, Tofieldia pusilla, Castilleja elegans, Cetraria nivalis, C. tilesii, Cladonia alpestris, C. chlorophaea. Cornicularia aculeata, Thamnolia subuliformis, Cetraria islandica, C. cucullata.

On steep, open, north exposure slopes, which exhibit typical step formations created by solifluction, is the Lichen Heath Alpine Tundra community identified by Nimis as "Lichen-Heirochloe alpina" and described as Type 6 in our survey.

On arid slopes, the vegetation tends to evolve toward Type 16, an open Spruce Dryas Taiga, characterized by the presence of calciphilic species unique to this section. Frequently, this type is destroyed by slope creep and replaced by the pioneer association mentioned previously.

Near the road, in protected areas and in well-drained river valleys, there are remnants of Type 14, a White Spruce Wood, and the "Hylocomio-Piceetum glaucae". In the lower elevations where mesic to moist conditions prevail, Black Spruce Taiga (Type 9), occupies areas with organic soils and shallow active layers. This latter association, particularly the sub-association dominated by Sphagna, is not as common in this section as in the area from Klondike Highway to North Fork Pass, probably because water percolating through the calcareous debris is enriched in bases and the Sphagna are acidophytic plants.

Well-drained warmer sites with permafrost-free soils along rivers and in recent floodplains support Type 19, a Riverine Poplar community, tall

Salix thickets (Type 18) are widespread mainly along the river floodplains. On extreme gradient slopes with southern exposure, Picea mariana is associated with Betula papyrifera and forms Spruce Birch Taiga communities (Type 15).

It may be stated that this section requires most care in case of any anthropogenic action, both for the peculiar flora and vegetation, and for the complex dynamics of the geomorphological processes.

4. Section 3 – Eagle Plains

The bedrock underlying the Eagle Plain include sedimentary rock consisting of shale, conglomerate, sandstone and surficial deposits of limestone and dolomite (Douglas and Maclean 1963). Although the region was not glaciated during Laurentide or Wisconsin periods, ice fronts lying adjacent to the Eagle Plains discharged melt waters, a process which resulted in deposits of glaciofluvial and lacustrine materials in upstream valleys of the Eagle River.

Precipitation in this region ranges from 250 to 500 mm. Mean annual temperatures are between -7C and -lOC (Burns 1973, 1974). Permafrost is extensive, the active layer ranging in depth from 40 to 150 cm in the areas sampled, but is absent from the drainage channels and river beds.

Picea mariana provides the most common tree cover of the Eagle Plain. On gentle western or southwestern slopes below treeline, an open-canopied Lichen Spruce Taiga (Type 12) occurs, which is unique to this section. Complex open Black Spruce Tall Shrub Taigas (Type 11) are found on steep southern exposures. Where hummocks are present, a variety of microsites are present in the hummmocks and inter-hummock troughs: this terrain supports an open taiga with clumps of stunted spruce surrounded by low ericaceous shrubs (Type 10).

Where drainage is impeded, hummocks and polygons are colonized by Heath Sedge (Type 2) and Tussock Sedge (Type 1) Tundra. On flats along the Eagle River is found Riverine Poplar characterized by the presence of permafrost-intolerent species (Type 19). Over much of the Eagle Plain, but not consistently, Larix laricina is associated with Picea marianna in the tree layer. The understory, though not sampled, appears to be similar to that of other black spruce taiga types.

5. Section 4 – Western Foothills of the Richardson Mountains

From about the Arctic Circle, the highway parallels the Western Foothills of the Richardson Mountains, which are comprised of a series of prominent pediments shaped as whalebacks. The bedrock consists of shale. The slopes drain into the Porcupine River, the Bell River being a major channel (Oswald and Senyk 1977). This area was apparently not glaciated during the Wisconsin or Laurentide periods as the mountains formed an effective barrier to the westerly moving Laurentide ice sheet.

Burns (1973, 1974) gives the mean annual precipitation of 500 mm and mean annual temperatures at about -9C for the Richardson Mountains. This section appear to lie just south of the continuous permafrost.

Peat plateaus are common in the foothills and have polygonal surfaces. Hummocky terrain is also common, although not as prominent as in areas further east. Unsorted circles, solifluction patterns and active cryoturbation are widespread.

Carex and Eriophorum tussocks are prevalent among the tundra types (Type 1); where soils are stony, alder and willow thickets are associated with the tussocks to form a Tall Shrub Tundra (Type 4).

Prominent, but infrequent, are spruce and poplar stands on well-drained river banks and stabilized flood plains; Picea glauca becomes dominant and associated with alder on peat plateaus (Type 17). Picea mariana and Larix laricina with a closed shrub understory and a thick cover of Sphagnum moss (Type 13) occur in hummocky terrain.

6. Section 5 – Richardson Mountains

Section 5, the shortest of the surveyed sections, covers the traverse of Richardson Mountains by the Dempster Highway. The bedrock materials are complex, with Jurassic shales, sandstone and conglomerates overlain by Permian sandstones and conglomerates, with some isolated Cambrian and Precambrian outcrops (Hettinger, Janz and Wein 1973). With the exception of their southern tip, the Richardson Mountains lie within the zone of continuous permafrost (Oswald and Senyk 1977). Vegetation distribution is presumably governed by the continuous permafrost; the active layer is shallow in most of the section.

In the surveyed part of this section, tundra predominates; the Richardson Mountains lie within the tundra region of Rowe (1972). Sedge Tussock Tundra (Type 1) is extensive on a variety of terrain types. Where the terrain is hummocky, a closed ground cover of Sphagnum, Polytrichum and Hylocomium persists under widely spaced low shrubs and dwarf willow (Type 3). On steep northern exposure slopes, Type 7, characterized by Cassiope tetragona, is found. On moderate slopes where soil is extremely stony and organic layers are shallow, the tundra is dominated by Betula glandulosa and lichens (Type 8). On tundra peat, stunted Picea mariana among tall shrubs (Type 11) occurs. The tundra at a higher elevation, though meriting attention, was not surveyed.

7. Section 6 – Eastern Foothills of the Richardson Mountains

This section covers the Eastern Foothills of the Richardson Mountains and is part of the Peel Plateau. Bedrock materials are Lower Cretaceous shales, sandstones and conglomerates (Hettinger. Janz and Wein 1973). Much of the area was glaciated by the Laurentide ice sheet, and has been mapped by Hughes (1972) as ridged moraine with glacial till covered by silt and organic deposits. except those areas in river valleys. Deep, medium textured morainal material is extensive along these eastern slopes (Hughes 1972). The slopes drain eastward by several tributaries to the Peel River and Mackenzie Delta. Temperature extremes, recorded at Fort McPherson, are a high of 34°C and a low of -56°C. Mean annual air temperatures indicate that the study area is almost entirely within a continuous permafrost zone (Brown 1970). Frost-free days have averaged 75 for Fort McPherson, with an annual variation of 103 to 8 (Canada Department of Transport 1967).

The distribution of vegetation in the Eastern Foothills is greatly influenced by a continuous hummocky micro-relief found on most of the medium and fine textured materials. Depth of organic layers, soil moisture content, depth of active layer, soil texture and rate of seasonal thawing are different on different parts of the hummocks, producing varied plant environments within very short distances, and determining the distribution and growth of vegetation. Hummocks, composed of soil with high organic content, rise 40-70 cm above thick moss layers (usually Sphagna) found in the inter-hummock troughs. Generally, soils associated with this terrain are extremely cryoturbated and high in ice content.

An open taiga with stunted Picea mariana (Type 10) and Shrub Tundra (Type 5) are found on this hummocky terrain. Picea mariana occupies more than 50% of this area (Forest Management Institute, CFS, 1974). In areas devoid of hummocks, on wet, poorly drained sites, open treed-bog-like stands of Picea mariana and Larix laricina develop (Type 13), often with a dense shrub layer in the understory. Oswald and Senyk (1977) recorded that larch is common, with black spruce, on poorly drained areas in the Peel Plateau.

Special conditions exist on alluvial soils in the major river valleys; these sites are generally the warmest in the region and protected valleys are periodically enriched with alluvial deposits (Zoltai and Pettapiece 1973). This fact, and the depth of the active layer (up to 150 cm) caused by the warmer conditions, contribute to the development of a "River Bank Taiga" (Type 20) with a vegetation-soil-permafrost system peculiar to these sites.

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