

Ecological profile of the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud

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Upstream north-south axial view of Rivière-Arnaud.
The damp hillbanks mark the early boundary of the watercourse during deglaciation.

TABLE OF CONTENTS

INTRODUCTION.....	1
Foreword	1
Background	1
Objective	1
Approach	1
GENERAL FEATURES	3
Location.....	3
Bedrock type and origin	5
Geomorphology	6
Climate.....	10
Vegetation	11
ECOLOGICAL MAPPING.....	13
Ecological reference framework of Quebec.....	13
METHODOLOGY	14
Ecological inventories.....	14
Floristic inventories	14
Sampling plan.....	16
Oblique aerial photographs	16
Sampling assessment	17
Habitat typology	18
Topographic unit classification.....	20
RESULTS	22
Landforms.....	22
Surface deposits	27
Classification	33
Class A: Washed till plateau with erect dwarf shrub tundra.....	37
Class B: Till mounds with ostioles and erect dwarf shrub tundra	41
Class C: Till mounds on erect dwarf shrub tundra.....	47
Class D: Till ostiole hummocks with solifluction, erect dwarf shrub tundra.....	55
Class E: Till and rock mounds with erect dwarf shrub tundra.....	61
Class F: Margins of Rivière Arnaud with erect dwarf shrub tundra	69
Class H: Crags and tails	81
Class I: Rivière-Arnaud upstream portion.....	83
Class J: Downstream portion of Rivière-Arnaud.....	89
Class K: Rivière-Arnaud estuary	99
Unusual habitats	107
CONCLUSION.....	113
REFERENCES	115

Introduction

Foreword

This report was produced in conjunction with the 2015-2020 Action Plan for the Plan Nord Toward 2035. The northern ecological inventory work was carried out under an agreement between the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs and the Société du Plan Nord, which contributed financially to the implementation of mandates relating to environmental protection and biodiversity conservation in the northern territory.

Background

One of the policy directions of the government action plan for the Northern Plan to 2035 (Gouvernement du Québec, 2015) is to conserve biodiversity and improve knowledge of ecosystems in order to ensure balanced development of the territory. North of the 49th parallel, the *Natural Heritage Conservation Act* (R.S.Q., c. C-61.01) is part of this approach. Taking advantage of the Rivière-Arnaud Biodiversity Reserve project, a field campaign was conducted between August 5 and 23, 2019. It allowed both to understand the organization of the ecosystems of the protected area, but also to provide knowledge of a territory still poorly known.

Objective

The objective of this report is to present the ecological profile of the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud, which includes maps and a description of the organization of the biotope types found in the area. This profile also includes classification that makes it possible to establish relationships between the biotope and the biocenosis. It will make documenting the diversity of the ecosystems in the area possible using the raw filter approach based on biotope types.

Approach

The methodological approach of this ecological profile aligns with the approach developed in the Atlas of Biodiversity of Northern Quebec (Poisson et al., 2016), which is based on the ecological reference framework for Québec (ERFQ), a mapping tool that uses the spatial organization of biotope types and the hydrographic network (Ducruc et al., 2019). Biotope types are defined by landforms, characteristics of surface deposits (texture, thickness, drainage...) and the nature of the geological base when it influences ecosystem biology. Classification makes it possible to establish links between biotopes and vegetation. The derived maps summarize the organization of the area's ecosystems.

The biotope is the fundamental element in the division of the units of the ERFQ. The collection of data on deposits, pedogenesis, and relief aims to validate the division and description of the ERFQ units. By adding information on vegetation, flora and the hydrological network, it is possible to describe the organization of the terrestrial and aquatic ecosystems of a given territory, to make the link between the biotope and the biocenosis, but also to define the particular elements they contain.

First, a general description of the territory will allow us to understand the history of the establishment of the different types of biotopes found on the territory. A brief portrait of the biotope types will then be drawn up. Without having the ambition to make an exhaustive portrait of all the types of biotopes found on the territory, those which occupy a large place or of some of them which present a major attraction for the biodiversity will be described. Based on the ERFQ, we present the classification of the units of the fifth level of the ERFQ in the sector of the protected area. The classes constitute territorial units that are distinguished by a spatial organization of biotope types and a particular ecological context expressed by a different composition of vegetation. A description of each of the units allows us to relate the biotope types to the major vegetation types they support.

General features

Location

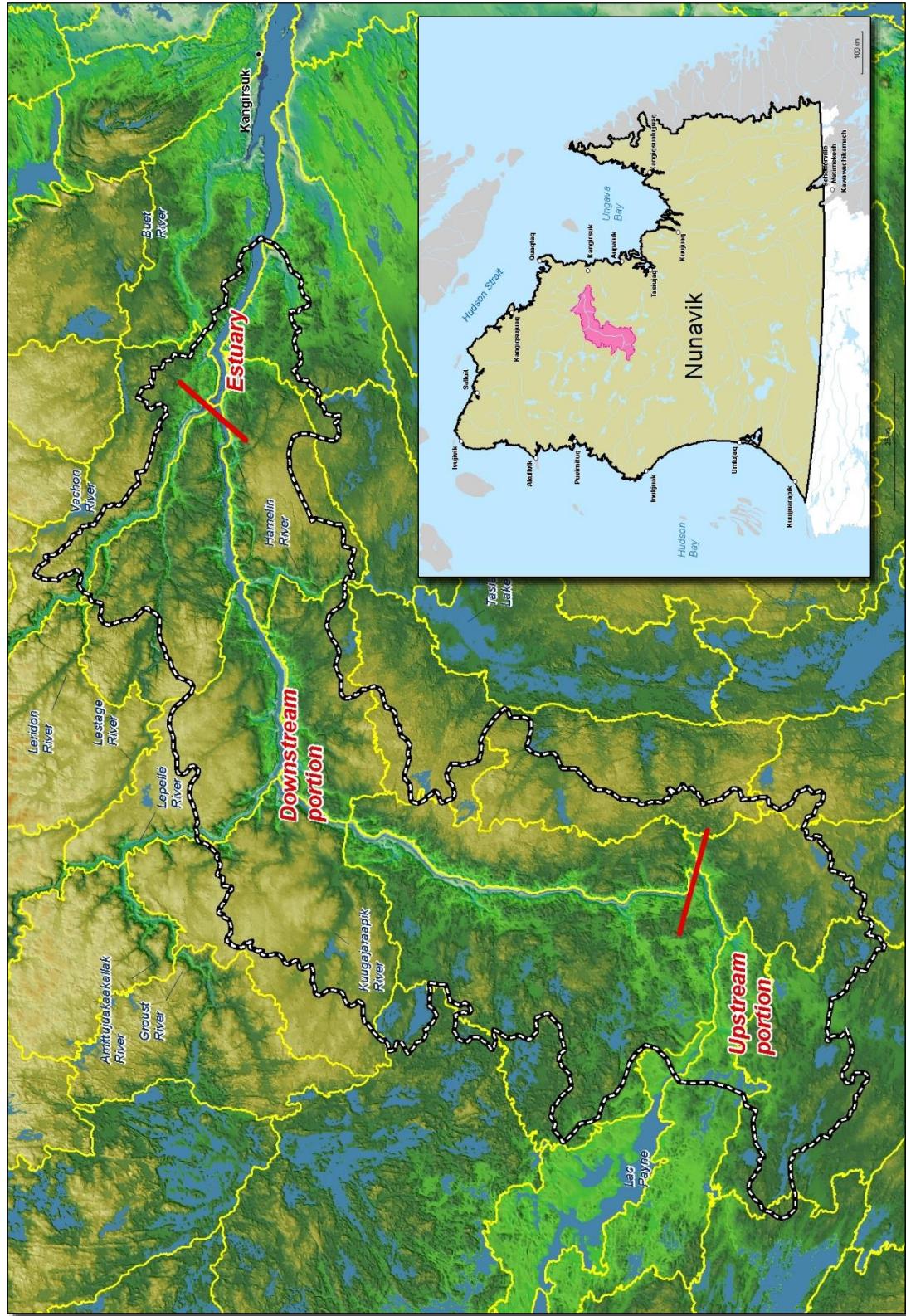
the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud is located in Nunavik, west of the village of Kangirsuk. Its eastern boundary starts about 50 km from the mouth of the river and forms a strip 235 km long and 30-45 km wide up to Lac Payne and includes the mouths of the Vachon, Lestage, Hamelin and Lepellé rivers.

The territorial reserve falls within Class III lands as stipulated in the 1975 James Bay and Northern Quebec Agreement (JBNQA). The Inuit have an exclusive right to harvest certain aquatic species and furbearing wildlife, and are actively involved in the administration and development of the territory. The use of the territory by the Inuit, and the populations that preceded them, is evidenced by the numerous cabins and the more or less early archaeological traces observed on the coast and along the rivers.

The territory is presented as a complex of uniform, more or less undulating plateaux that are distinguished by subtle differences in the thickness of the glacial deposits and the presence or absence of eskers. These plateaux are separated by deep valleys that are more or less narrow and sinuous.

The Rivière-Arnaud valley has three distinct parts:

- The estuary, which is influenced by strong tides and salt water
- The downstream portion, which retains traces of the post-glacial marine invasion of the Iberville Sea, as evidenced by the numerous glaciomarine deltas and valleys perched between 50 and 100 m in elevation. They are accompanied by layers of fluviomarine deposits and fluvial terraces that bear witness to the invasion and gradual retreat of the waters. The steep saxicolous slopes are abundant, with some of them interspersed with gorges, witnesses all to the erosion processes of successive glaciations.
- The valley in the upstream portion, near Lac-Payne, is less steep. It is located in a large depression dotted with slight reliefs where deposits are very thick. Ostioles and solifluction can be seen on the slopes, along with a high density of dwarf birch.



Map of the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud

Bedrock type and origin

The bedrock consists mainly of Archean acid igneous rocks at least 2.7 Ga old. It is partially overlain by a Paleoproterozoic thrust sheet, which forms the northern boundary of the Labrador Trough.

The area is crossed by one of the largest dyke swarms in the region, the west-northwest-southeast trending Klotz dyke (2.21 Ga) and to a lesser extent the younger Payne dyke (2.16 Ga), which is more north-northwest-southeast trending.

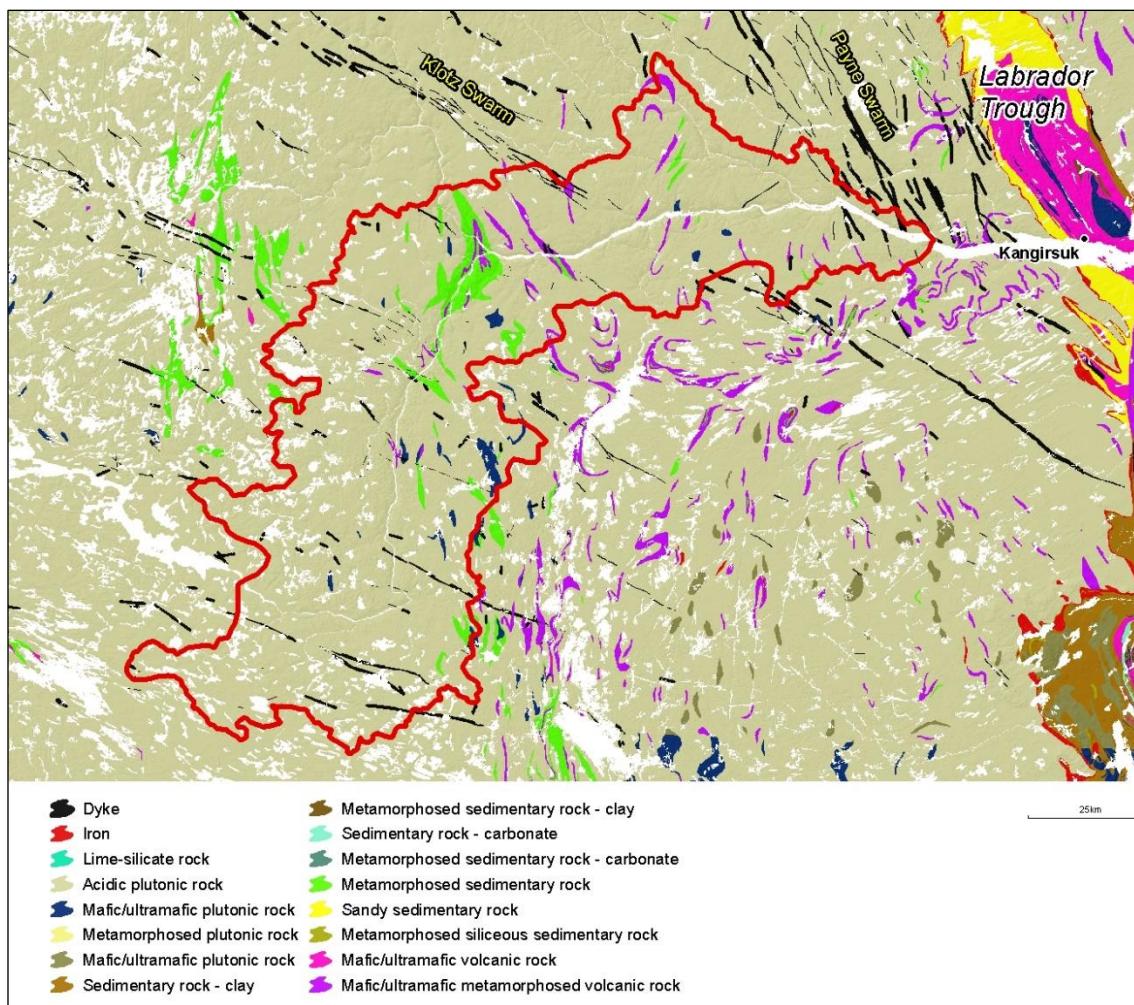
Carbonate rock veins in the saxicolous escarpments of the river, although minimal, allow for the development of basiphilic flora that significantly increases the species richness of the protected area.

Archean: One of the four eons of the geochronological time interval. It follows the Hadean and precedes the Proterozoic. The word comes from the early Greek "Αρχή" (Arkheī), meaning "beginning, origin." It begins with the appearance of life on Earth (4000 Ma) and ends with the appearance of trilobites (2500 Ma) (Wikipedia).

Swarm of dykes: Setting up simultaneously during the same intrusive event. The magma, which moves over great distances and very quickly, infiltrates the transverse fractures of the host rock. The dyke is revealed by differential erosion.

Thrust sheet: Set of geological layers which, during an orogen, were detached from the bedrock, moved and covered other layers. The constituents of the nappe are considered to be allochthonous to the underlying autochthonous basement (Wikipedia).

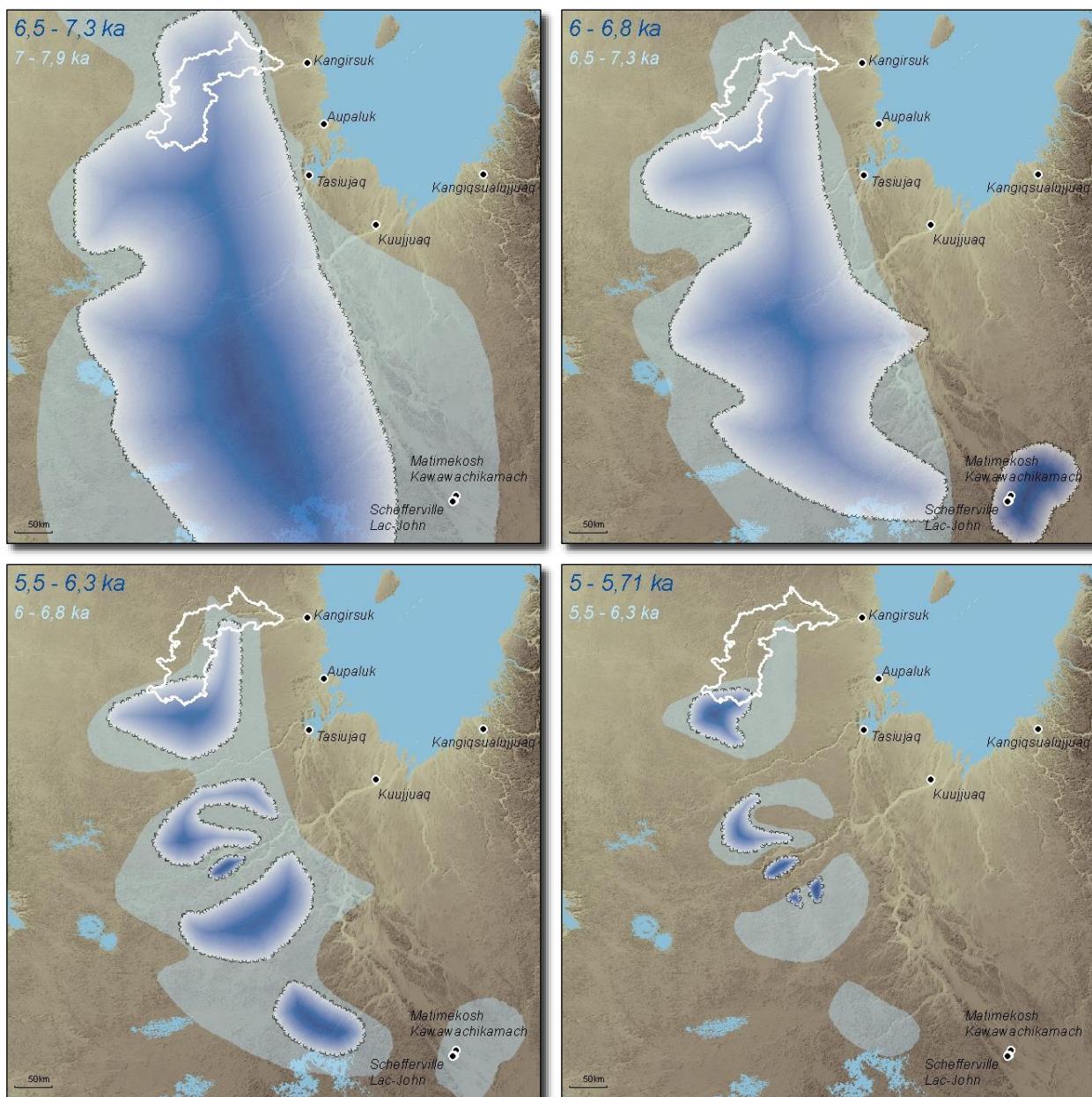
Paleoproterozoic: First era of the Proterozoic. It extends from 2500 Ma to 1600 Ma. It is marked by an increase in oxygen levels, produced by cyanobacteria (Wikipedia).



Source: Carte géologique du Québec Édition 2012, Ministère des Ressources naturelles, Géologie Québec

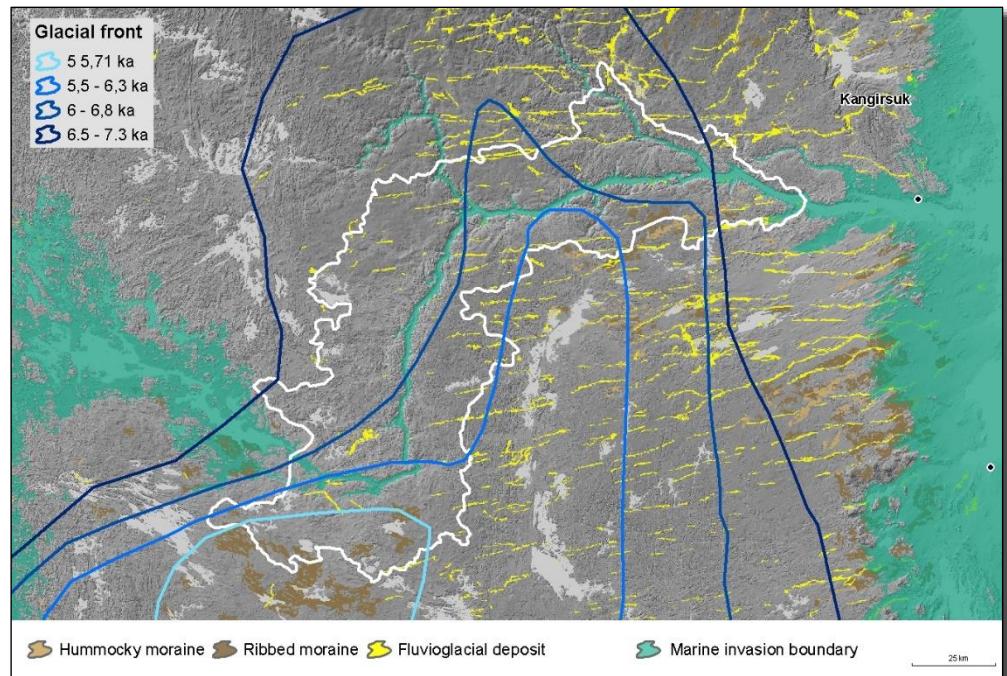
Geomorphology

The territory has known, for more than 2.5 billion years, major peneplanation. The landscape, which presents itself to us, is a uniform undulating plateau where the movements of the ice cap have left deposits of varying thickness. This monotony is broken by the major rivers and gorges that cut deeply into the territory. The last glaciation and subsequent postglacial events have left their mark on the territory. During the last glacial maximum, 18 ka ago, the whole of Quebec-Labrador was covered by the Laurentide Ice Sheet. The extension of the ice margins remained almost unchanged until 13 ka, at which time the volume of ice decreased considerably (Dyke and Prest, 1987). More recently, Dalton et al. (2020) have continued the work of Dyke et al. (2003) and Dyke (2004), to revisit, with new data, the evolution of the margins of the ice sheet complex by offering some details on the evolution of the margins in this region, particularly in the sector of the protected area where the Nouveau-Québec Dome left its last traces.

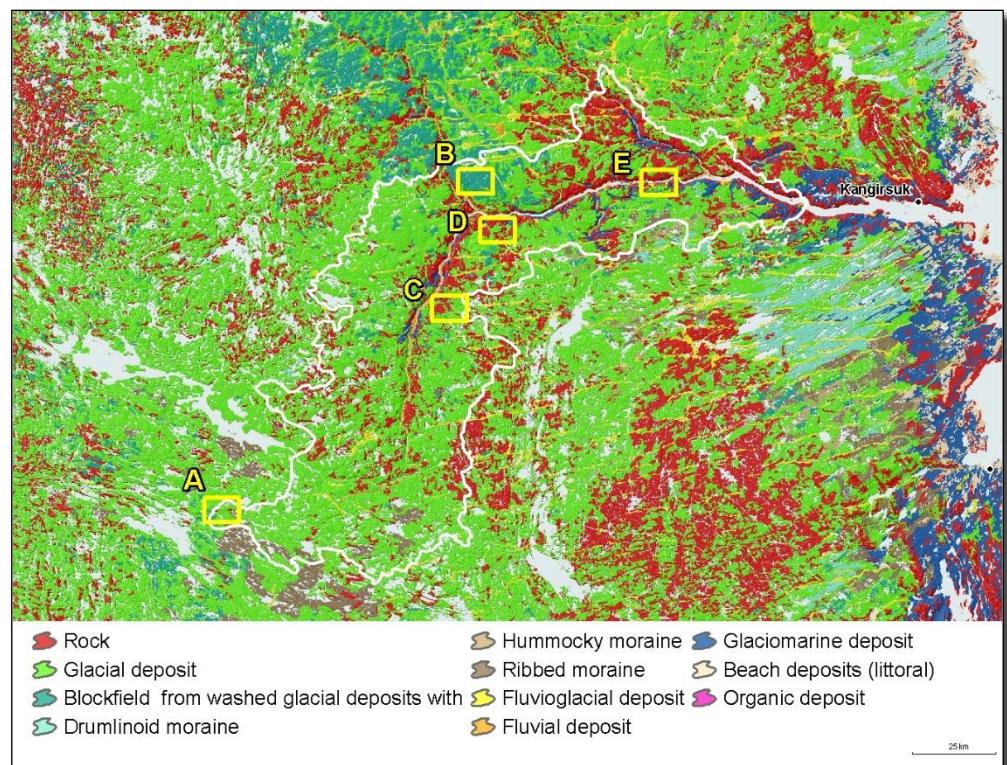


Nouveau-Québec dome melt evolution. Source: Dalton et al., 2020

The protected area surrounds the last remnants of the dome. The Rivière-Arnaud area began to be clear of ice about 7,000 years ago and was completely clear 2,000 years later. The dome melted, leaving several glacier blocks on the upper plateaux between the Arnaud, Leaf and Larch rivers. The persistence or rapid melting of the glacier favoured distinct deposit development. Eskers developed where the ice did not melt too quickly and where temperature at the base of the glacier allowed aerial melt water to penetrate. Deposits such as Rogen moraine or decay moraine are found in the areas of the last glacial blocks (Lauriol, 1982).



Effects of deglaciation on development of specific deposits, such as eskers, decay moraine and Rogen moraine. (Source: Northern Vegetation Map, MFFP)



Deposits left during deglaciation. Source: MFFP, 2016

Areas can be seen where the thick glacial deposits led to cryoturbation processes and ostioles (A).



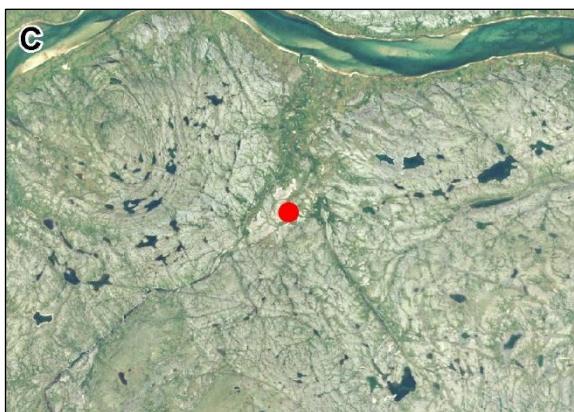
A) Thick cryoturbated glacial deposit with ostioles

The north-eastern part of the area displays boulder fields of various origins. The first, common throughout the protected area, results from matrix washing in the early subglacial melt channels, while the second, on the summits, stems from highly stony till that may have undergone cryoturbation processes, as evidenced by stone circles and frost cracks filled with blocks (B).

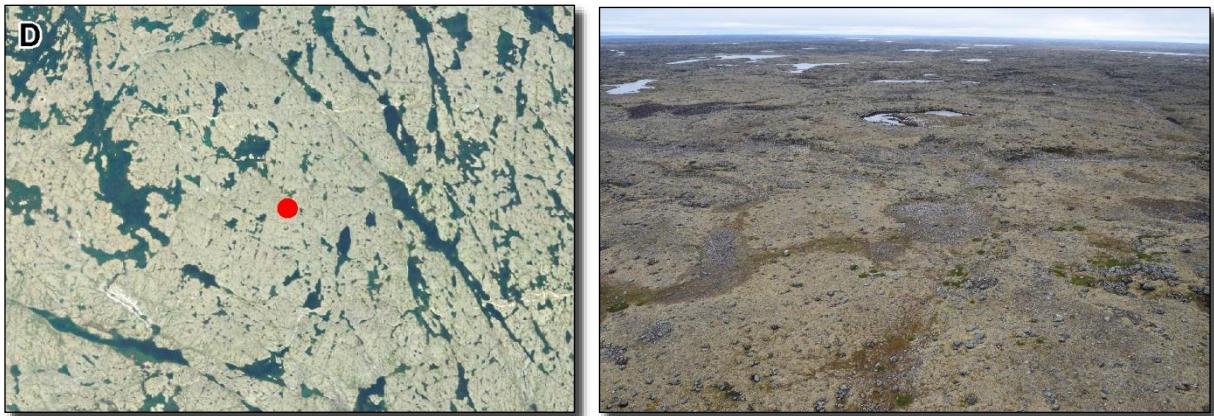


B) Thick cryoturbated glacial deposit with block fields

Other areas have abundant rock outcroppings (C), with bodies of water now occupying washed faults. In the last zone (D), which is also the largest in terms of area, insufficient glacial deposit thickness enabled cryoturbation.

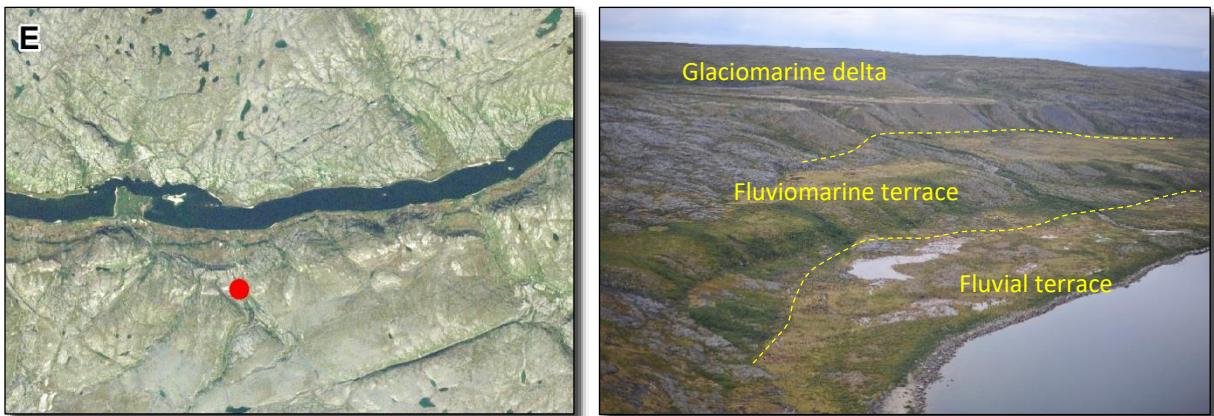


C) Rock with glacial deposit veneer



D) Glacial deposits without ostioles

Following deglaciation, the Iberville Sea flooded a significant portion of the Rivière-Arnaud, traces of which can be seen up to the present elevation of 120 m (E). Near the mouth of Rivière-Vachon, a succession of distinct terraces can be seen, marking the different levels that the Iberville Sea occupied during its progressive retreat. The highest level corresponds to an early glaciomarine delta when the glacier and the Iberville Sea were at their maximum height and the subglacial rivers were flowing into these waters, while losing their carrying capacity.

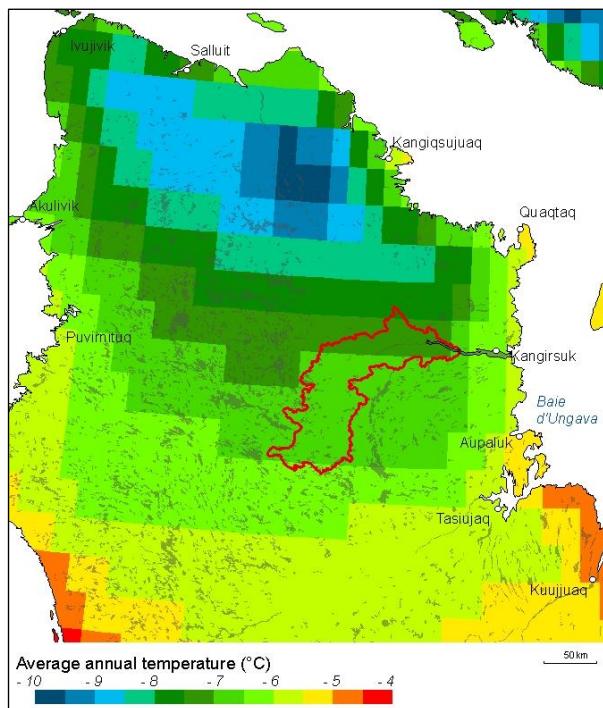


E) Fluvial terrace topped by a fluviomarine terrace and a glaciomarine delta

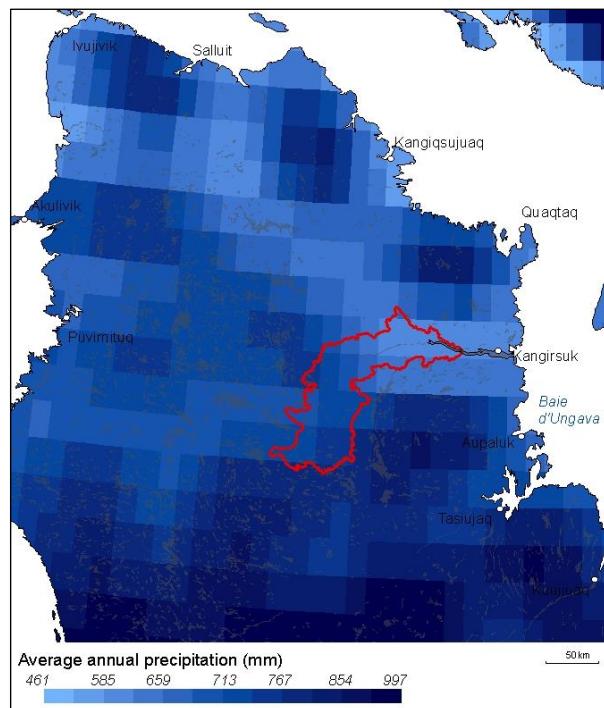
Climate

The regional climate becomes harsher approaching the high plateaux west of Kangiqsujuaq. The water masses of Hudson Bay, Hudson Strait and Ungava Bay lose their influence moving inland. The Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud area is influenced by large arctic air masses moving in from the northwest, with mean annual temperatures ranging from -6.5 to -7.2°C, annual precipitation ranging from 586 to 758 mm (of which 310 mm water equivalent is snow), and a growing season at 5°C ranging from 88 to 96 days. According to the Litynski (1988) classification used by Gérardin and McKenney (2001), this is a moderately dry polar climate with a very short growing season.

Arctic winds sweep the snow cover off the surface of exposed plateaux. Vegetation adapts to these extreme conditions by rarely exceeding 50 cm in height. At the foot of the valleys and in the hollows of the relief, vegetation is denser and taller.



Annual average temperature (Source: Ouranos)



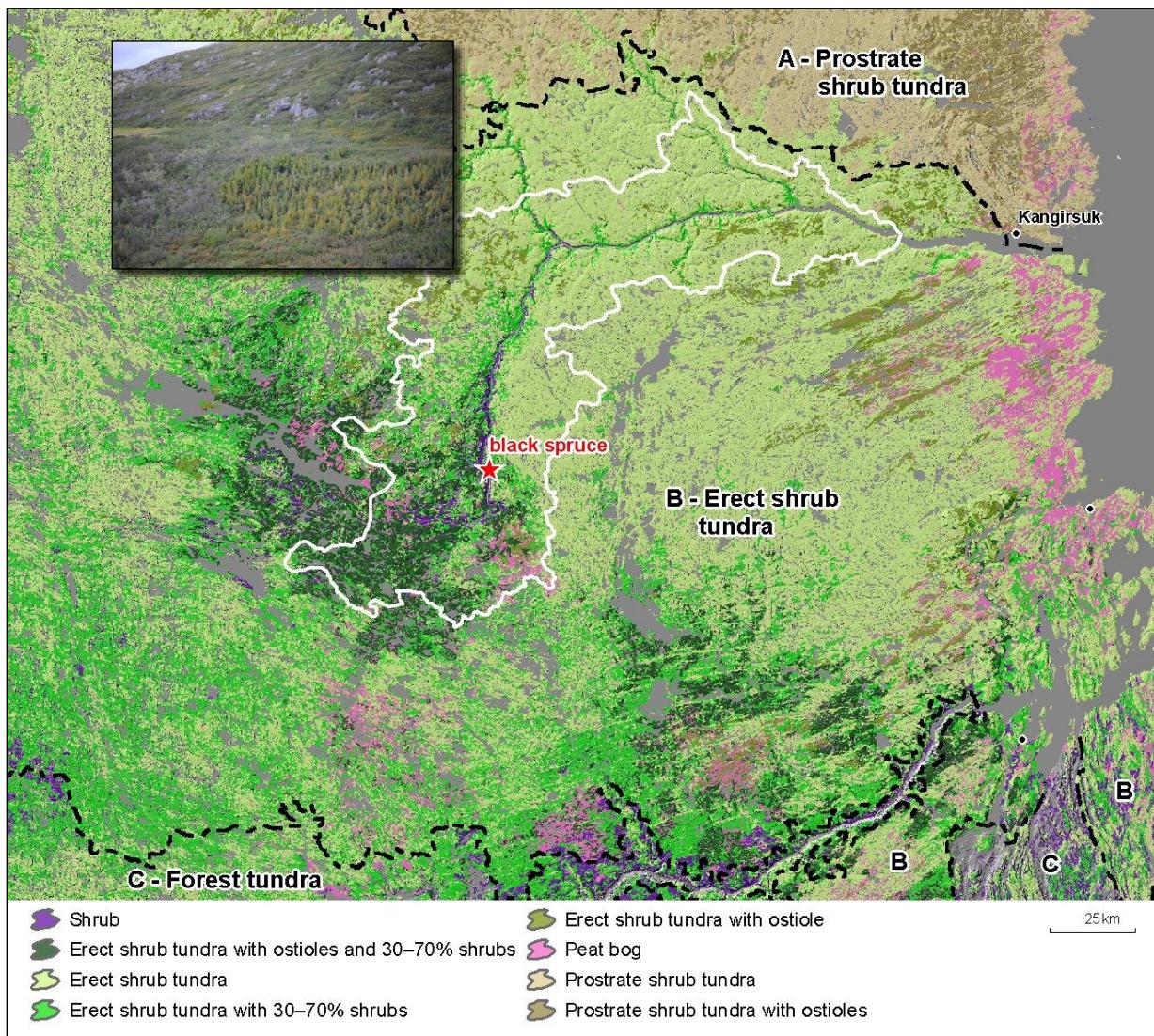
Annual average precipitation (Source: Ouranos)

Vegetation

The protected area lies above the tree line in the bioclimatic domain of erect shrub tundra at the edge of prostrate shrub tundra (MFFP, 2018). Erect dwarf shrub tundra (15–40 cm in height) is the dominant vegetation, occupying areas of moderately thick till. It is primarily composed of *Betula glandulosa* and ericaceous species such as *Vaccinium vitis-idaea*, *Vaccinium uliginosum*, and *Rhododendron tomentosum* subsp. *subarcticum*. Where deposits are thicker, as in the southern portion, or where the terrain allows for accumulation of the snow cover that protects the vegetation, dwarf birch forms a denser and taller canopy.

Along the Rivière-Arnaud at the mouth of the streams that flow into it, *Salix planifolia* and *Alnus alnobetula* subsp. *crispa* shrubland can be found. Next to these stands and on the terraces near the river, dwarf birch is dense, with individuals reaching a height of above one meter.

The most striking discovery we made here is undoubtedly the population of black spruce on a hillside near the Rivière-Arnaud. It is in fact a clone that by layering has developed a colony of individuals forming a 36 m by 16 m polygon. This is the northernmost location of black spruce discovered to date in Quebec.



Vegetation map of Northern Quebec and its bioclimatic domain (Source: MFFP)
(Inset: black spruce found at the edge of the rivière-Arnaud)



Betula glandulosa



Vaccinium vitis-idaea



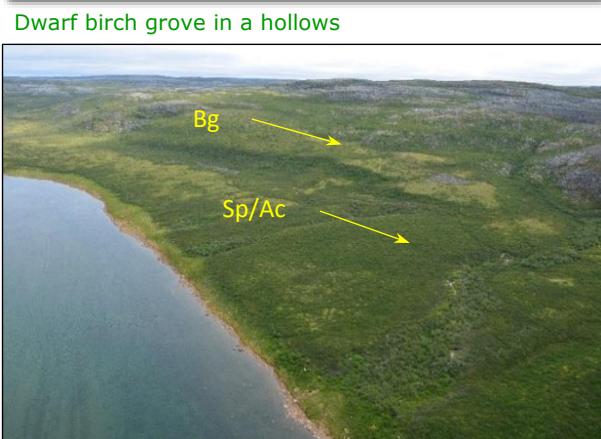
Vaccinium uliginosum



Rhododendron tomentosum subsp. subarcticum



Dwarf birch grove in a hollows



Salix planifolia and *Alnobotula* subsp. *crispa* (Sp/Ac) along streams flowing into the Rivière-Arnaud and *Betula glandulosa* (Bg) on the terraces



Ecological mapping

Ecological reference framework of Quebec

The ecological reference framework for Québec (ERFQ) is a tool for mapping and classifying the territory. It is a hierarchical system of interlocking levels of perception. At each level of perception, ERFQ trims the territory along biotope contrast expressed at that scale, as well as along the structure of the indicative hydrographic network (Ducruc et al., 2019). Given the size of the protected area under study, the topographic unit is the level of perception chosen to describe the territory (fifth level of ERFQ perception).



ERFQ: Biosphere contrast cut-out

ERFQ: Hierarchical system (adapted from Li & Ducruc, 1999)

Perception level	Preponderant trim factor
I Natural province	Plate tectonics (craton, continental margin, ocean basin, orogen, etc.)
II Natural region	Regional geological events (structural domain, terrain, sedimentation basin, graben, etc.) Major geomorphological events (marine invasion, glaciolacustrine phase, etc.)
III Physiographic unit	Regional geological events (shear zone, batholith, thrust sheet, dome, fault, etc.)
IV Ecological district	Regional geomorphic events (delta, alluvial plain, decay moraine, etc.)
V Topographical unit	Base structure cell (hill, depression, hillside, valley, etc.)

The biotope corresponds to the physical part of the ecosystems. Under ERFQ, the biotope of a map unit is the description of the spatial organization of its biotope types. For levels 1 and 2, the description of map units is literal. From level 3 upward, the spatial organization of the biotope is expressed by the percentage occupancy of each biotope type within the unit. At levels 3 and 4, biotope types are defined by landform, surface deposit, and geological origin of the bedrock if it has a potential influence on plant communities. At level 5, a slope class and a drainage class are added.

Initial division and preliminary description are derived from interpretations of the available information (satellite image, surface deposit map, digital elevation model, topographic map, etc.).

Methodology

The ecological inventories conducted in the protected area established the link between biotope and biocenosis and thus describe the organization of ecosystems in any given area. Complete ecological surveys were conducted per the Poisson and Villeneuve's (2022) vade mecum. Data on the physical environment and vegetation, along with sketches and photos, were digitally entered on forms developed for Survey 123 on the ArcGIS platform (MELCC, 2019).

Ecological inventories

Ecological surveys are performed by analyzing plots of 1 m per side for prostrate shrub vegetation and 5 m per side for erect shrub vegetation. Information associated with the biotope based on vade mecum alphanumeric codes limited note-taking (cf. sample record).

Collected data related to:

- topography
- slope
- surface deposits
- organic matter
- speckles
- induration
- permafrost
- water table
- drainage

Data associated with vegetation include:



- Percent of open water, bare soil, bare rock, bare stone, litter, shrub, forb, bryophyte, ground lichen and rock lichen cover
- Surveyed taxa with cover ratings, arranged by stratum (shrub, grassy, mucinal, lichenic and rock taxa were generally excluded)
- Habitat type
- Preliminary name of plant association

Notes were permitted.

Lastly, a topographic profile was drawn up to geolocate surveys conducted at a single site.

Floristic inventories

Ecological inventories were based on sampling biotopes expressed at the scale of the physiographic unit, which can be considered an average analytical grid. However, some unusual and/or rare biotopes contained elements of flora that could not be considered in this grid. Specific floristic inventories were therefore conducted in areas of high potential, depending on circumstances.

Sample ecological inventory record (paper records were used when technical problems arose)

Plot #	KF24A	Latitude	60°11'27,3"	Length (m)	1																																												
Date	24-07-15	Longitude	69°38'59,6"	Width (m)	1																																												
GPS Coord.	084	Authors	G. Lavoie, F. Poisson																																														
TOPOGRAPHY		SURFACE DEPOSITS		MOTTLING		WATER TABLE																																											
• Shape	TE	• Origin	6DB	• Abundance	Ø	• Depth (cm)	30																																										
• Location	7	• Underlying deposit	Ø	• Dimension	Ø	• Vertical	5																																										
SLOPE		• Thickness (cm)	>100	• Depth (cm)	Ø	• Lateral	1																																										
• Longitudinal shape	R	• Depth reached (cm)	50	• Present	Ø	OTHER	Ø																																										
• Transverse shape	R	• Substrate type	Acid	• Depth (cm)	Ø	• Water pH	8																																										
• Length	L	• Thickness (cm)	15	• Depth (cm)	Ø	• Periglacial shapes	Ø																																										
• Declivity	0,5	• Type	FIB	• Depth (cm)	50	• Disturbances	Ø																																										
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0	50	50	Li	PP	B																																												
% Open water	0	% Bare earth	0	% Bare rock	0	% Bare stone	0																																										
% Litter	5	% Shrubs	70	% Grasses	15	% Bryophytes	100																																										
% Ground lichen	0	% Rock lichen	0																																														
TREES		GRASSES		BRYOPHYTES		LICHENS																																											
Taxa	% cov.	height	Taxa	% cov.	R	Taxa	% cov.	R																																									
			Dipontia fisheri	3		Aulac. pal.	5																																										
						Sphagnum cap.	5	1																																									
						Drepanocladus	2	2																																									
						Aulac. targ.	2																																										
						Tomenth. nitens	2	3																																									
						Sphagnum sp.	2	4																																									
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Sal. arva-arsii	3	1																																															
Sal. herbacea	5	1																																															
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Preliminary classification	Ø																																																
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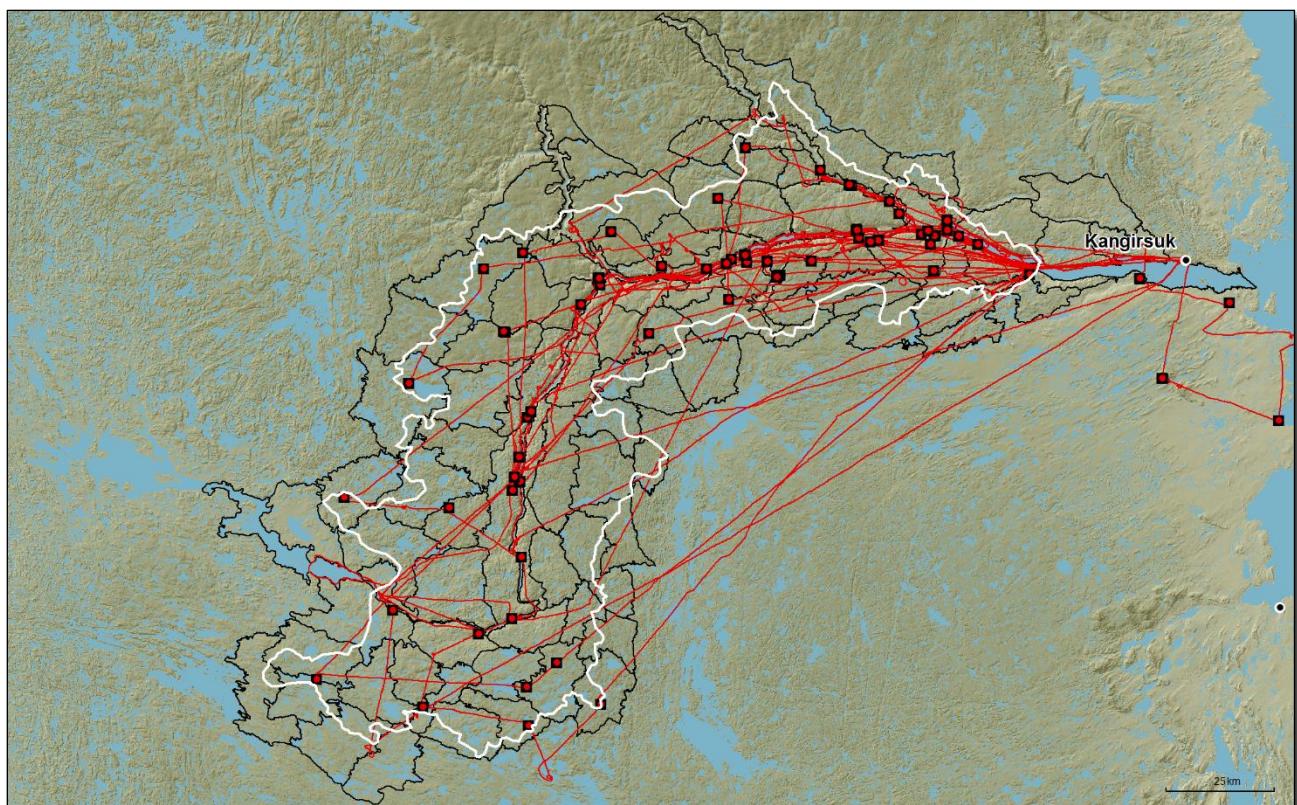
Sampling plan

The sampling plan, developed at our office, was based on the desired level of interpretation. This objective normally defines the inventory effort. However, one must also take into account transportation and accommodation infrastructures, as well as uncertain weather conditions that increase costs and decrease small team efficiency.

Within allotted time and budget constraints, the inventories took place from August 5 to August 23, 2019. There were 60 sites visited and 88 ecological surveys completed (56 sites and 81 surveys on topographic plots that affect the proposal). There are 35 topographic complexes that contain at least one sampling point out of the 98 within the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud, which covers an area of 13,946 km².

Oblique aerial photographs

Helicopter overflight allowed observations to be made for validating divisional boundaries and identifying biotopes. Photos were used to validate satellite image interpretation and illustrate the descriptions herein. Approximately 1250 oblique aerial photos were taken, in addition to the 1100 field survey photos.



Ecological surveys and flight paths

Sampling assessment

Sampling is, in the main, a function of intended objectives. Analysis of soil fragility to erosion requires more in-depth knowledge than simply developing knowledge on ecosystem organization. Researchers set the definition of sampling (survey) intensity levels in terms of an index that makes it possible to determine which level has been reached by a field campaign on the basis of obtained results, thereby defining achievable analytical contours.

Guide des niveaux d'intensité d'échantillonnage (adapted from Valentine, 1986 and Ecosystems Working Group Terrestrial Ecosystems Task Force, 1998)

Sampling intensity level	Density (pt./ km ²)	Point representation Cartographic scale	% of polygon visited by at least one point	Distance between points	Field methodology	Objectives
1	> 50	2 ha 1:5,000 1:10,000	100%	500 m	On foot	Prescription for silviculture, soil sensitivity to erosion, compaction
2	5-50	2–20 ha 1:20,000	95–100%	1 km	On foot, sometimes by vehicle	Silviculture planning; tree species selection
3	1–5	20–100 ha 1:50,000	50–90%	1–4 km	By vehicle, sometimes on foot or by helicopter	Potential for vegetation, forest productivity, habitat improvement
4	0.1–1	100–1000 ha 1:100,000 1:250,000	25–75%	8 km	By vehicle, sometimes by helicopter	Forest and wildlife capacity, ecosystem representation, overall forest productivity, local resource and landscape planning
5	< 0.1	> 1000 ha 1:500,000 1:1,000,000	< 25%	20 km	Validation by other map data, helicopter or airplane	Regional land planning

Based on the table and the established objectives, the fourth level of sampling intensity was targeted.

In relation to the territory of the protected area, the sampling effort represented the following:

- a density of 0.006 points per km²
- a minimum distance between sites of 500 m
- an average distance between sites of 70.1 km (Q1: 32.6 km and Q3: 105.4 km)
- a maximum distance between sites of 189.5 km
- 36% of the topographic units were visited

Based on results, the intensity of sampling corresponded to the fifth level. The absence of roads, the remoteness, and the northern environment were all constraints that affected both logistics and budgets and greatly limited our accomplishments. Since the only reliable means of travel in this area is by helicopter, field work mainly depended on chopper availability, as well as on weather conditions. The sampling campaign must of necessity be seen as exploratory, because it lacks replicas of the inventoried environments that would allow us to establish stronger links between the biotope and the biocenosis.

Habitat typology

While *biotope* refers to ecosystem physicality, botanists have chosen the term *habitat* to address living ecosystem components. The habitat defines the structure and physiognomy of vegetation associated with the hydrology (and sometimes the substrate) of an ecosystem.

A typology of habitats in Northern Quebec has been developed (cf G. Lavoie, personal communication) using all inventories conducted since 2011. It distinguishes 10 groups of habitats, as follows.

- A** - Marine and estuarine environments
- B** - Aquatic and non-tundra mineral wetlands
- C** - Uniform peatlands
- D** - Structured peatlands
- E** - Periglacial peatlands
- F** - Bare rock areas
- G** - Dry Forest and quasi-forest environments
- H** - Uniform tundra
- I** - Structured tundra
- J** - Nival areas

In a second stage, classes were defined on the basis of deposit texture, pH, location on the relief, and specific composition and/or structure. There are 69 different habitat types (see table on following page).

Finally, qualifiers were used to distinguish geographical, physical and climatic conditions as descriptors of habitat type.

Climate qualifier: coastal–continental

Layering: alpine–subalpine–mountain–arctic–boreal

Physicochemical: basic–acidic

Drainage: xeric–subxeric–mesic–subhydric–hydric

Deposit qualifier: rock–coarse loose deposit–glacial loose deposit–fine loose deposit

Minerotrophic qualifier (fens): poor–moderately rich–rich–extremely rich–calcareous

Periglacial qualifier: with thermokarst pools–without thermokarst pools

The 69 habitat types in the 10 types of environments

Marine and estuarine environments		Bare rock areas	
A01	<i>Salt/brine marsh</i>	F01	<i>Rocky outcropping</i>
A02	<i>Bare muddy shoreline</i>	F02	<i>Escarpmment and scree slope</i>
A03	<i>Sandy/ sandy stony shoreline</i>	F03	<i>Boulder and scree field</i>
A04	<i>Rocky/stony shoreline</i>	Dry Forest and quasi-forest environments	
Aquatic and non-tundra mineral wetlands		G01	<i>Fir stand</i>
B01	<i>Open water/grass bed</i>	G02	<i>Black spruce stand</i>
B02	<i>Marsh and grass bed</i>	G03	<i>Black spruce-larch spruce stand</i>
B03	<i>Wet meadow</i>	G04	<i>Black spruce spruce/lichen stand</i>
B04	<i>Shrub swamp (alder/willow/myrtle)</i>	G05	<i>Black spruce spruce/moss stand</i>
B05	<i>Deciduous wooded swamp</i>	G06	<i>White spruce stand</i>
B06	<i>Coniferous wooded swamp</i>	G07	<i>Jack pine stand</i>
B07	<i>Rocky/stony riverbank</i>	G08	<i>Larch stand</i>
B08	<i>Sandy beach riverbank</i>	G09	<i>White birch stand</i>
B09	<i>Muddy shore</i>	G10	<i>Balsam poplar stand</i>
B10	<i>Marly riverbank</i>	G11	<i>Aspen stand</i>
B11	<i>Alluvial plain/terrace</i>	G12	<i>Speckled alder stand</i>
B12	<i>Dry lake/temporary pond</i>	G13	<i>Dwarf birch/evergreen heath</i>
Uniform peatlands		G14	<i>Shrubby lichen grove</i>
C01	<i>Bog (ombrotrophic peatland)</i>	G15	<i>Active dune</i>
C02	<i>Wooded bog</i>	Uniform tundra	
C03	<i>Fen (minerotrophic peatland)</i>	H01	<i>Fir/white spruce krummholz</i>
C04	<i>Treed fen</i>	H02	<i>Black spruce krummholz</i>
C05	<i>Shoreline fen</i>	H03	<i>Discontinuous xeric tundra</i>
C06	<i>Slope fen</i>	H04	<i>Prostrate shrub tundra</i>
C07	<i>Arctic fen</i>	H05	<i>Erect dwarf shrub tundra</i>
Structured peatlands		H06	<i>Low shrubby tundra</i>
D01	<i>Reticulated bog</i>	H07	<i>Tall shrubby tundra</i>
D02	<i>Concentric bog</i>	H08	<i>Mesic grassy tundra</i>
D03	<i>Eccentric bog</i>	H09	<i>Drenched grassy tundra</i>
D04	<i>Feather fen</i>	Structured tundra	
D05	<i>Corded fen</i>	I01	<i>Ostiole tundra</i>
Periglacial peatlands		I02	<i>Ostiole/collared tundra</i>
E01	<i>Ice wedge bog</i>	I03	<i>Ostiole stone circle tundra</i>
E02	<i>Anastomotic fen</i>	I04	<i>Striated soil tundra</i>
E03	<i>Ice wedge fen</i>	I05	<i>Mesic thufur tundra</i>
E04	<i>Thufur fen</i>	I06	<i>Drenched thufur tundra</i>
E05	<i>Palsa fen/plateau</i>	I07	<i>Drenched anastomotic tundra</i>
E06	<i>Palsa fen/treed plateau</i>	Nival origin	
		J01	<i>Snowbed</i>
		J02	<i>Nivation hollow</i>

Topographic unit classification

The protected area reserve covers 97 topographic units averaging 135 km² each. A mass of collected data requires summarization in order to understand the organization of the area. If the cartographic divisions are based on recognition of differences in physical environments, the latter will, in given climatic conditions, influence the organization of vegetation.

On this basis, our analysis of the main components and hierarchically ascending classification enabled us to define various classes (see below). The description of polygons provided biotope and vegetation type proportionality, using the northern vegetation map (MFFP, 2018).

Results

The results of our efforts primarily derived from landform and surface deposit types, which allowed for biotope inventory validation. These elements form the basis for the topographic unit description and classification, and constitute the core of this report, for it allows us to describe and show the organization of biotope types. In sum, it is the basis for understanding the organizational potential and fragility of the biocenosis.

Landforms

Mound (BU)

Convex relief with a difference in level of between 50 and 100 meters.



Button (BN)

Convex relief with a difference in height of between 25 and 50 metres.



Knoll (MN)

Convex relief with a difference in height of less than 25 metres

**Terrain (TR)**

Portion of land with convex and concave parts, having no well-defined shape.

**Coteau (CT)**

Landform of low convexity with a significant summit portion and a difference in level generally inferior to 100 metres.



Esker ridge (CR)

Very elongated relief with a narrow convex summit and steep slopes.



Dyke ridge (CR)

Very elongated relief with a narrow convex summit and steep slopes.



Slope (VE)

Surface between the upper of the marked reliefs (hills, knolls) and the bottom (valley surface, depression).



Valley (VA)

Geographical depression generally of elongated shape with relief shaped by a river and/or glacier.



Gorge (GO)

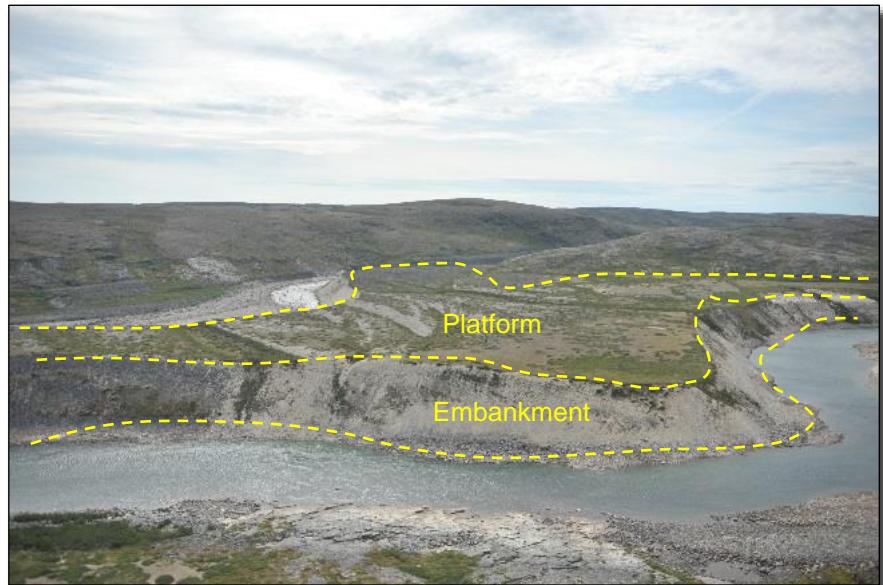
A narrow, deep depression cut into the rock by glacial and fluvioglacial processes with steep slopes and differences in level that can exceed 50 meters.

Particularity: Lauriol (1982) reports that it will certainly have taken several glacial cycles to form these gorges and that they are closely linked to fractures in the bedrock.



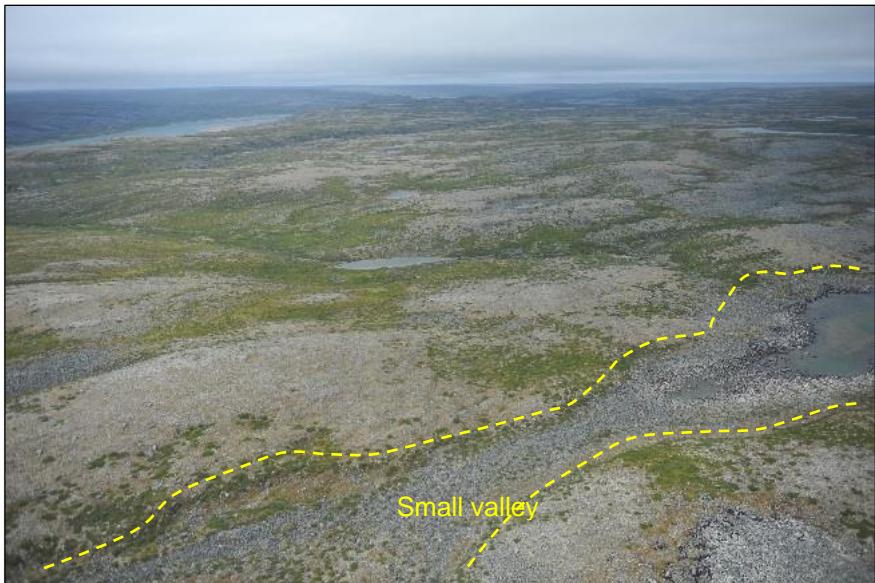
Terrace (TE)

Surface formed by a sloped embankment and a platform beyond the reach of floods.



Small valley (VN)

A short and shallow valley with gentle slopes.



Depression (DE)

Land that is generally concave with at least one area of outward flow, but is not a marked flow unit.



Surface deposits

Rocky outcrop (OR)

Here, relief has been totally stripped by glacier action. No deposits are evident, which allows us to occasionally view the dykes.



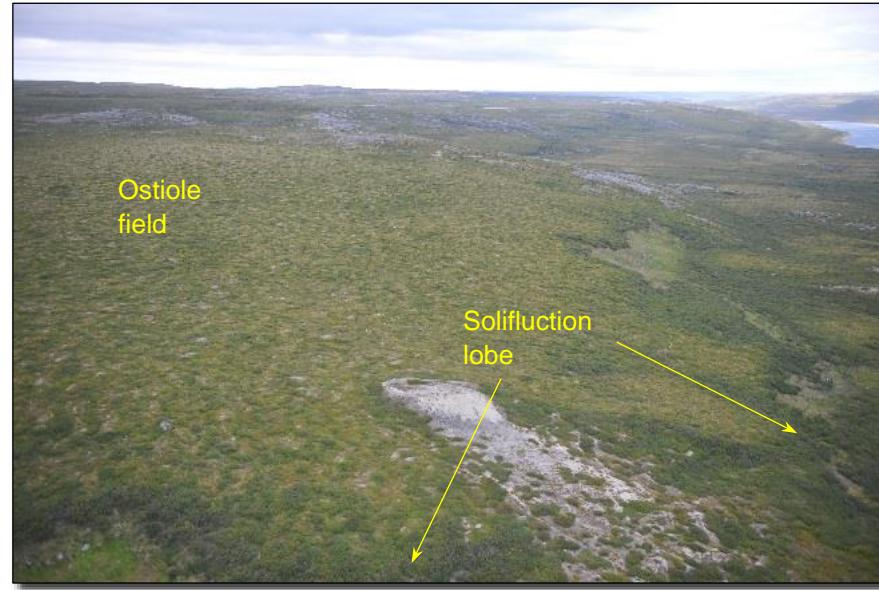
Rock covered by discontinuous glacial deposit veneers (0T)

Discontinuous glacial deposit veneers are found in many different landforms such as slopes, hummocks and buttons.



Thick glacial deposits (1AE)

Elevations in excess of 200 m characterize the north-western fringe of the protected area. Some flat summits and extended slopes are covered with thick glacial deposits that have a loamy, sandy texture and high degree of pierosity. The depth and texture of the deposits favour the development of ostioles.



Feature: Ostioles. Ostioles form during the freeze-thaw cycles of the uppermost layer of soil that lies above the permafrost. They are responsible for convective cell movements, which separate constituent parts of deposits and consist largely of water saturated fine matter (Robitaille et Allard, 2007). In glacial deposits, coarse matter (boulders, pebbles, gravel and sand) are "ejected" at the perimeter, forming bulges of organic matter whose thickness is from 20 to 30 cm. In the center of the convection, only fine deposits (fine sand, silt and clay) remain, and no vegetation can take hold while the process remains active.

Solifluction: The slow mass movement of deposits saturated with liquid water. In this area, solifluction mainly occurs on the long slopes of the southeast sector.

Blockfield from washed glacial deposits (1AEVB)

These deposits are formed by the washout of thick glacial deposits by melt water from beneath the glacier. This location is close to the glacial divide of the Laurentide Ice Sheet. Here, boulders ripped from the rock matrix have experienced little movement or erosion. They show poorly worn edges and a fine, washed matrix (Dyke & Prest, 1987). Two types of washed glacial deposits occur here: In valleys that have early preferential flow channels and on relatively flat plateau terrain.



Fluvioglacial esker deposits (2AK)

Elongated, more or less sinuous curves from a few kilometers to more than 100 km in length, they were formed by melt water from a river flowing through an ice tunnel at the base of the glacier during deglaciation. They show loose sandy-gravelly matter that includes highly worn stones.



Fluvioglacial kame deposits (2AT)

Irregular, small-scale relief that consists of sand and gravel deposited by rivers flowing in subglacial braids. In the protected area sector, the kames occupy a strip 2 km wide and in excess of 50 km long.



Fluvioglacial delta deposits (2BD)

Deposits left by rivers emerging from the head of the glacier to coalesce with the waters of the Iberville Sea. They are comprised of distinct layers of sand and gravel.



Arctic fen organic deposits (7A)

Conditions encountered here are not conducive to the rapid accumulation of organic matter. We noted that a 15-cm thickness of organic matter in wet depressions or flats nearby streams is sufficient to support peatland species. We thus recognize this type of deposit, although it is below the standards set for peatlands further south.

The organic matter is hardly deteriorated, but fibrous, mesic and rarely humic. It is associated with major species that serve as indicators, such as the *Trichophorum cespitosum*, *Eriophorum angustifolium* subsp. *angustifolium* and the *Carex* - *C. rariflora*, *C. rotundata*, *C. rupestris* grasses or the *Sphagnum subfulvum* *S. russowii*, *S. rubellum*, *Dicranum elongatum*, *Ptilidium ciliare* bryophytes. The peatlands mainly develop on three types of terrain.

(A) In the small valleys formed by early preferential sub-glacial melt water flow channels. Closer to bodies of water, these fens develop on shoreline permafrost blocks. (Dionne, 1978).

(B) On alluvial plains. These flat surface fens may be polygonal and have ice wedges.

(C) On marine terrace deposits bordering the Rivière-Arnaud.



A- Early preferential sub-glacial flow channel fens.



A – Permafrost shoreline block fens.



B - Flat alluvial plain polygonal ice wedge fens.



C- Glaciomarine terrace fens bordering Rivièr-Arnaud.

Feature:

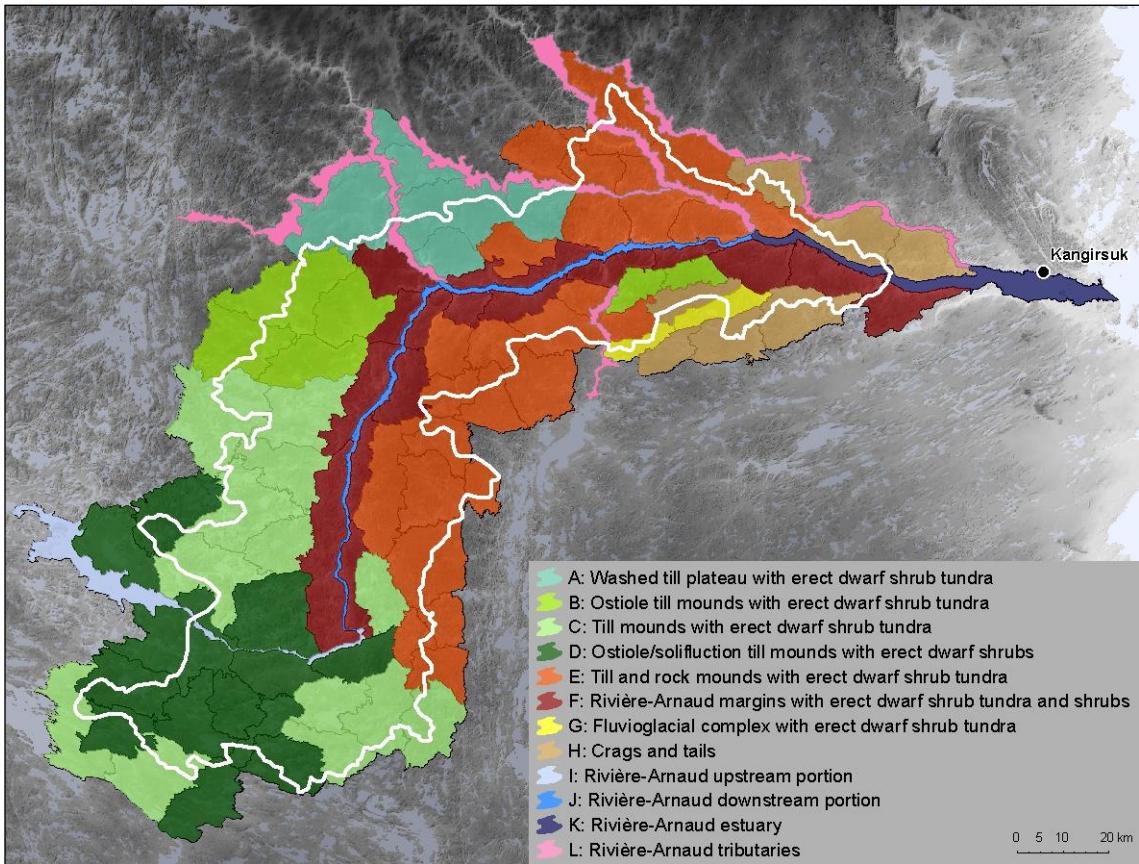
On one of the Rivière-Arnaud peatlands terraces, we noted a few palsas of less than 50 cm in height. Palsas are formed by lenses of ice that lift up organic matter.

The name "palsa" comes from the words Same Palsa, meaning "raised area of a bog."

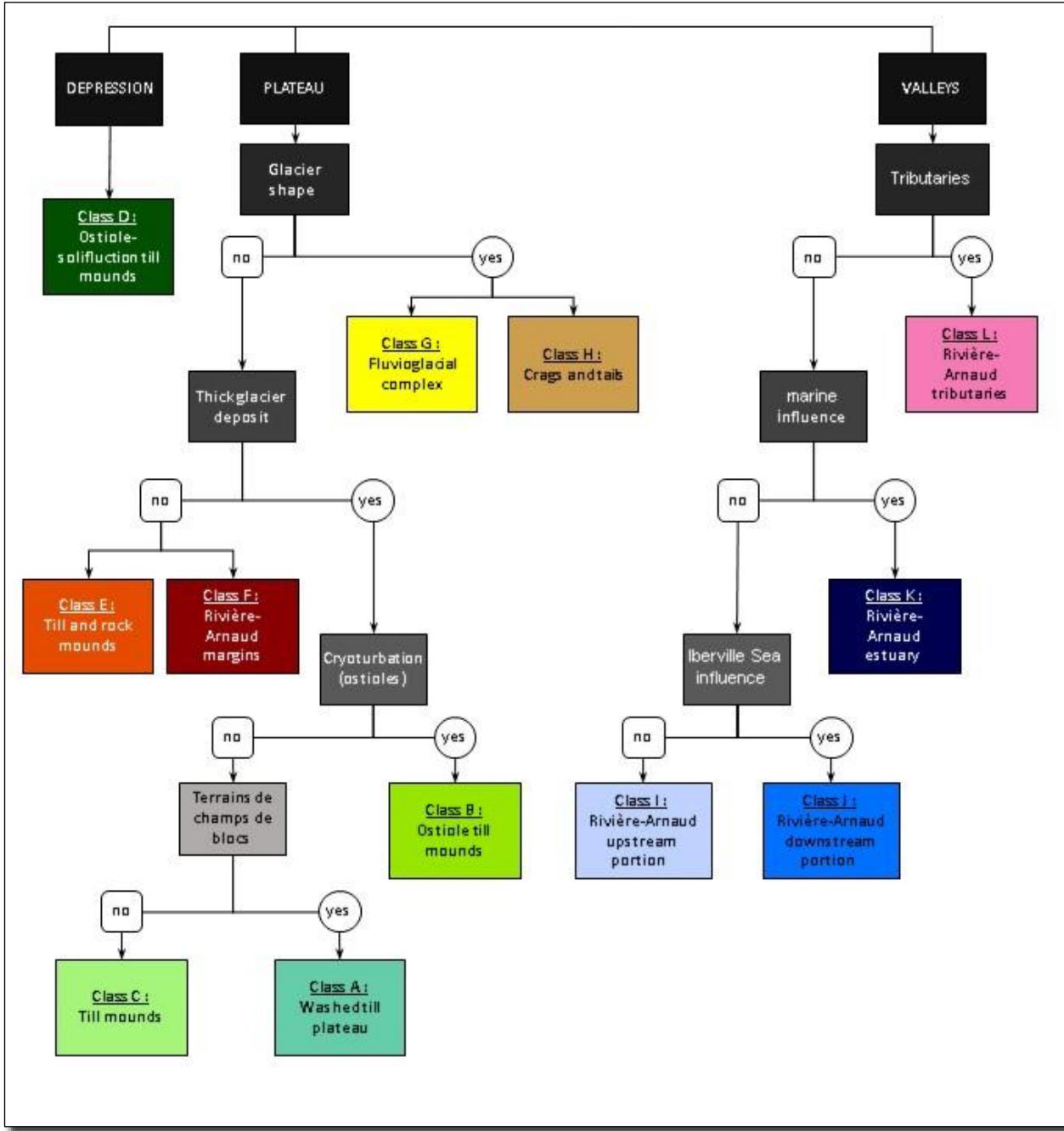
Classification

Topographic units

Using data from the (MFFP, 2018) vegetation map, topographic units can be grouped together by landform and surface deposit type, and topographic units can be grouped together to determine land units that are distinguished from each other by a particular biotope organization and habitat.



Classification within the territorial reserve for the purpose of the Rivière-Arnaud protected area.



Classification of topographic units in the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud.

Classification of the vegetation

The allocated field campaign time and resources did not always allow for sufficient repetition of sampling for every type of habitat encountered in the area in order to carry out valid statistical analyses and phytosociological studies. This work can be handled in future campaigns covering a great part of Nunavik.

However, it is possible to extract data from the current survey on the major habitat types that satisfactorily represent each of the categories in the topographic unit, demonstrating the wealth of information contained in the database.

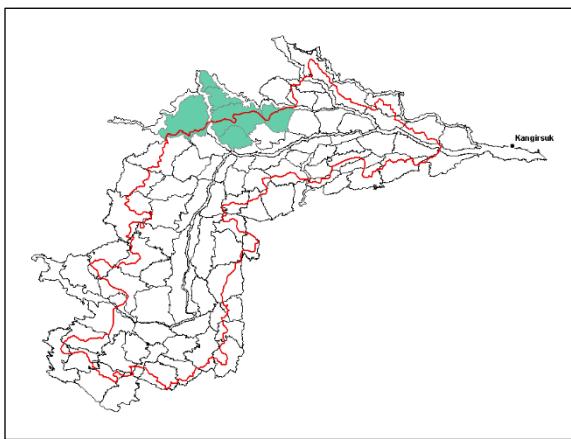
Habitat groups	Number of records
H Uniform tundra	38
B Aquatic and non-tundra mineral wetlands	12
C Uniform peatlands	10
E Periglacial peatlands	10
I Structured peatlands	9
A Marine and estuarine environments	4
J Nival areas	2
D Structured peatlands	2
G Dry Forest and quasi-forest environments	1

Uniform tundra is by far the most common habitat group here. As with most groups, it is very heterogeneous. Uniform tundra grows on a variety of deposits with drainage ranging from xeric to very poor. Cover is dominated, in order of magnitude, by shrubs, bryophytes, lichens and grasses.

Wetlands are also very common even if they occupy only small areas. On the plateau, peatlands are found at the foot of the valleys, riverbank scrublands (including the Rivière-Arnaud), and wetlands of glaciomarine deposits on valley surfaces.

A few habitat types stand out and will be described following presentation of the topographic unit categories.

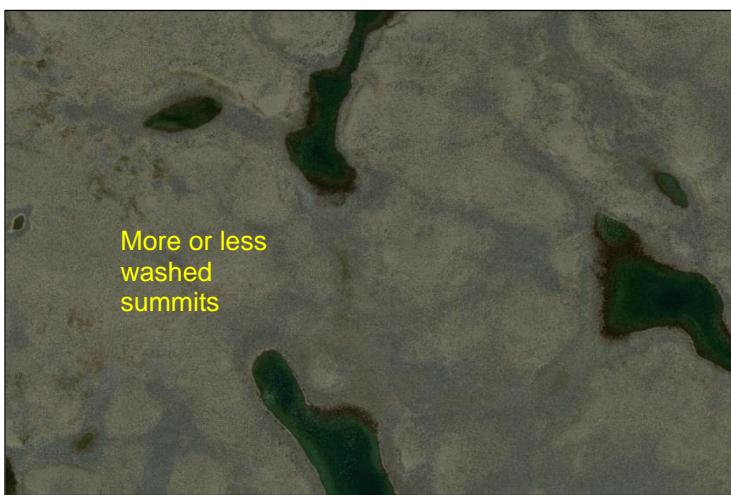
Class A: Washed till plateau with erect dwarf shrub tundra



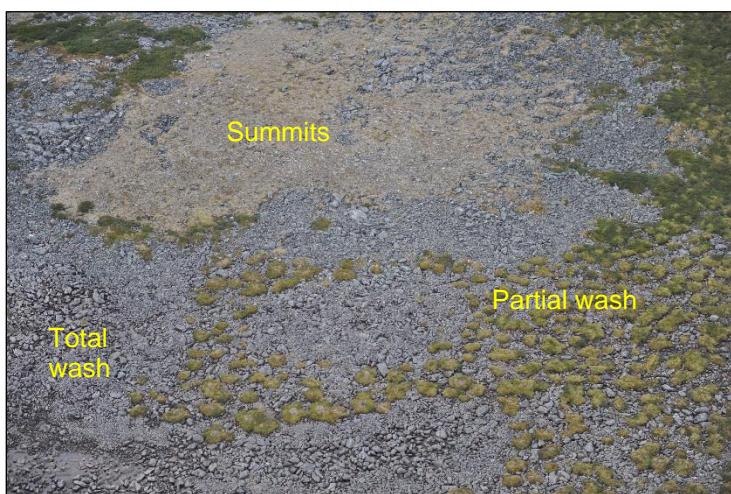
This type of landscape is typical of the Rivière-Vachon watershed, which is located further north in the protected area. Boulder field cover is ubiquitous on this peneplain sloping towards the Rivière-Arnaud. Lakes are rare. The boulder fields are the result of the washout of excessively stony glacial material. On the slightly elevated parts, the process almost disappears as one descends, revealing a network of partial washouts that form lenses of loose material where erect dwarf shrub tundra develops.

In the early preferential flow valleys of sub-glacial melt waters, washout is total. These valleys show traces of surface water that must have once connected the lakes in spring.

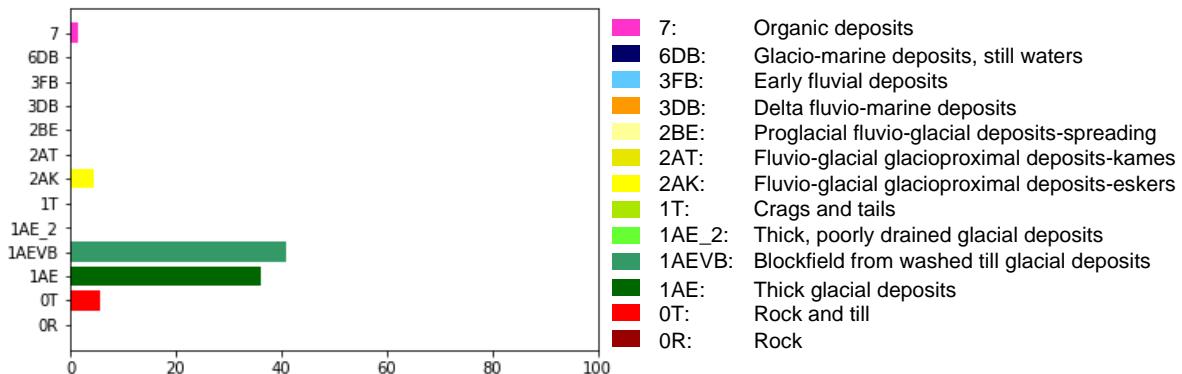
This is one of the poorest sectors of the area, with altitudes between 400 and 500 m providing a rigorous climate in which only erect dwarf shrub tundra can take hold. The few lakes and small streams that flow in the valleys support dwarf birch here and there at the higher levels.



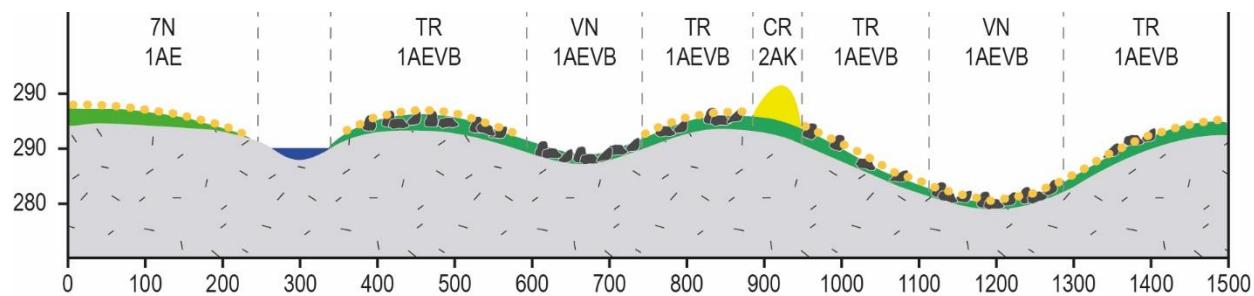
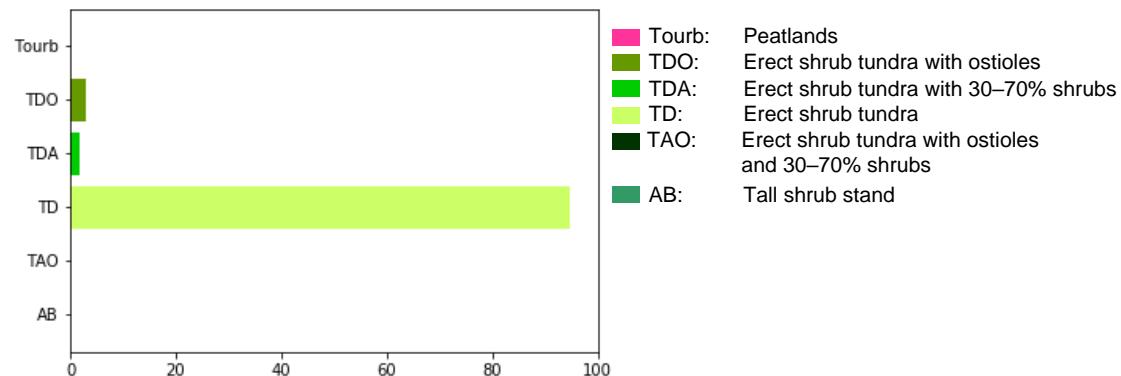
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Class A



Class A



- 7N 1AE
- TR 1AEVB
- VN 1AEVB
- TR 1AEVB
- CR 2AK
- TR 1AEVB
- VN 1AEVB
- TR 1AEVB

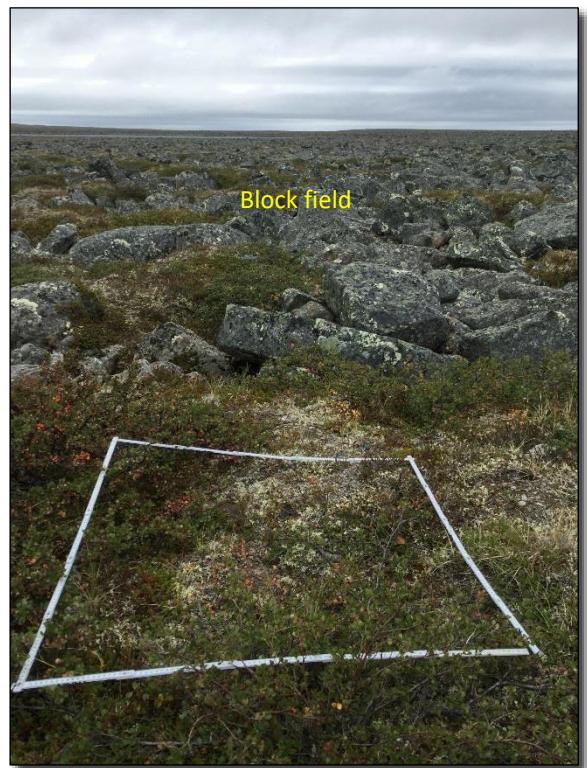
Habitat group	H–Uniform tundra
Habitat type	H05–Erect dwarf shrub tundra
Preliminary associated plant names	<i>Betula glandulosa-Cassiope tetragona</i> var. <i>tetragona/Flavocetraria nivalis-Cladonia mitis.</i>

This type of tundra is associated with boulder fields and grows on ostioles, with boulders over a meter in height that form spectacular, massive stone circles, providing a protective shield that fosters the growth of dwarf birch. The 1 meter by 1 meter plots did not capture the full diversity of the environment. Many species have been identified outside the plots, such as *Salix glauca* var. *cordifolia*, *Phyllodoce caerulea*, *Salix planifolia*, *Vaccinium uliginosum*, for shrubs, *Trisetum spicatum*, *Antennaria monocephala* subsp. *angustata*, *Luzula confusa*, *Poa arctica* subsp. *arctica*, for grasses and *Dicranum elongatum*, *Dicranum acutifolium* for bryophytes.

Noteeworthy: chionophilous species such as *Phyllodoce*, *Antennaria* and *Salix herbacea* that have adapted to the extreme cold that is common in this sector.



Plot #	A085A_19
Topographic situation	Flat terrain
Longitudinal slope	Regular
Transverse slope	Regular
Length of slope	Long (> 200 m)
Incline	0–2%
Station exposure	Full
Surface deposit	1AE: Glacial deposits; moraine without morphology; thick
Vertical drainage	2: Good
Oblique drainage	None
Depth reached	60 cm
Full depth of deposit	> 1 m
Thickness of organic matter	0 cm
Type of organic matter	N.A.
Water table depth	Not observable
Permafrost depth	Not observable

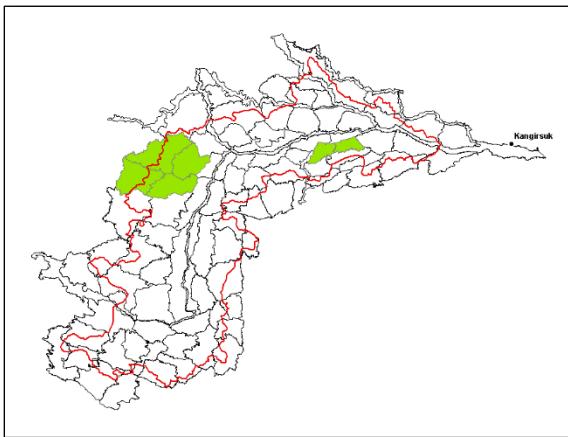


% free water	0
% bare earth	1
% rock	0
% stones	5
% litter	10
% shrubs	50
Average shrub height	Erect dwarf (.15-.40m)
% grasses	2
Average height of grasses	< .5 m
% bryophytes	10
% ground lichen	40
% saxicolous lichen	5

Shrubs	Level	Cover	Height
<i>Betula glandulosa</i>	Upper	25–50%	Erect dwarf (15-40 cm)
<i>Cassiope tetragona</i> var. <i>tetragona</i>	Upper	15–25%	Prostrate/semi-prostrate (0-15 cm)
<i>Vaccinium vitis-idaea</i>	Upper	5–15%	Prostrate/semi-prostrate (0-15 cm)
<i>Empetrum nigrum</i> subsp. <i>hermaphroditum</i>	Upper	5–15%	Prostrate/semi-prostrate (0-15 cm)
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	Upper	1–5%	Prostrate/semi-prostrate (0-15 cm)
<i>Salix herbacea</i>	Upper	< 1%	Prostrate/semi-prostrate (0-15 cm)

Grasses		Cover	Height
<i>Calamagrostis lapponica</i>		1–5%	< .5 m
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>		< 1%	< .5 m
Bryophytes		Cover	
<i>Ptilidium ciliare</i>		5–15%	
Lichens		Cover	
<i>Cladonia mitis</i>		15–25%	
<i>Flavocetraria nivalis</i>		5–15%	
<i>Flavocetraria cucullata</i>		5–15%	
<i>Cladonia stygia</i>		1–5%	
<i>Dactylina arctica</i>		< 1%	
<i>Sphaerophorus globosus</i>		< 1%	
<i>Cladonia borealis</i>		< 1%	
<i>Cetraria islandica</i> subsp. <i>crispiformis</i>		< 1%	

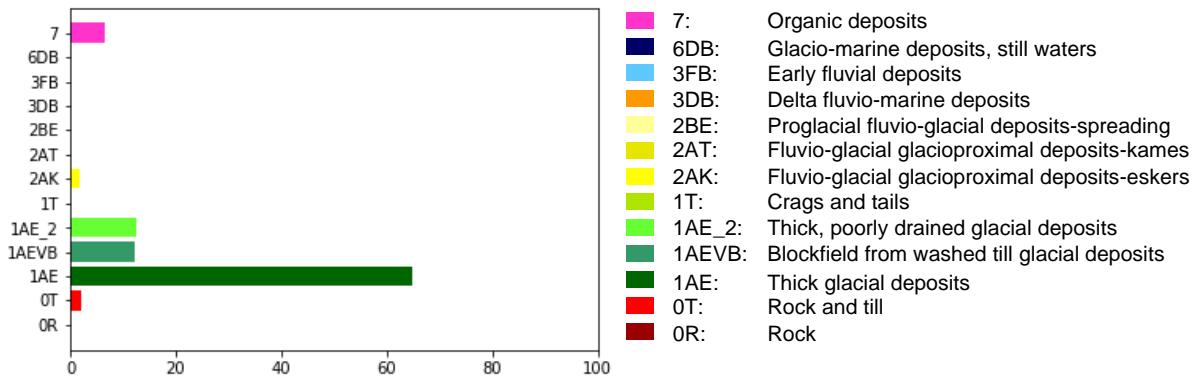
Class B: Till mounds with ostioles and erect dwarf shrub tundra



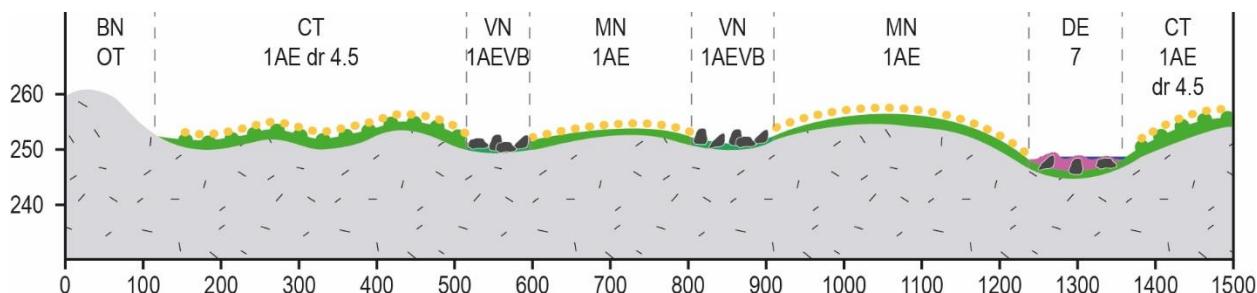
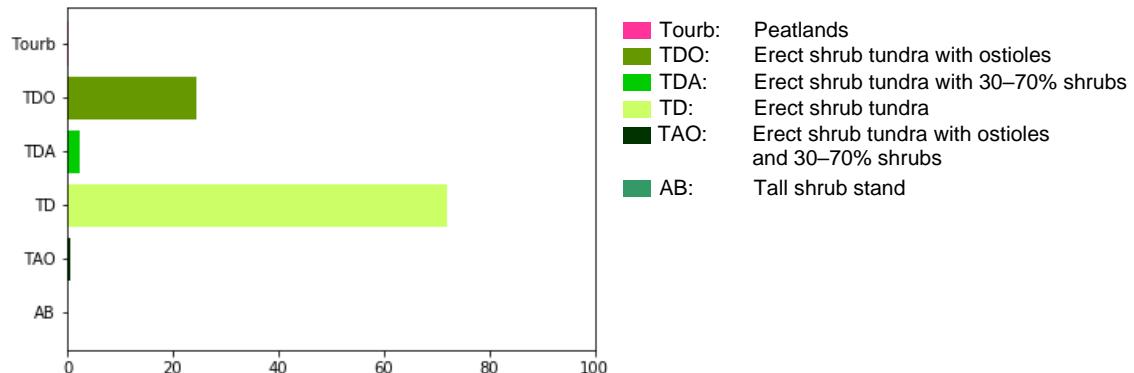
The topographic units in this class are located in two areas. The first is east of Lac Pélican and forms a transitional area with the previous class to the north. The second area is near the Rivière-Arnaud estuary. Washed till valleys are common here; thick till landforms associated with dwarf shrub tundra are dominant. A few hillsides of poorly drained till with ostioles adds richer and taller vegetation. Depressions occupied by arctic marshes are found in the continuity of washed till valleys.



Class B



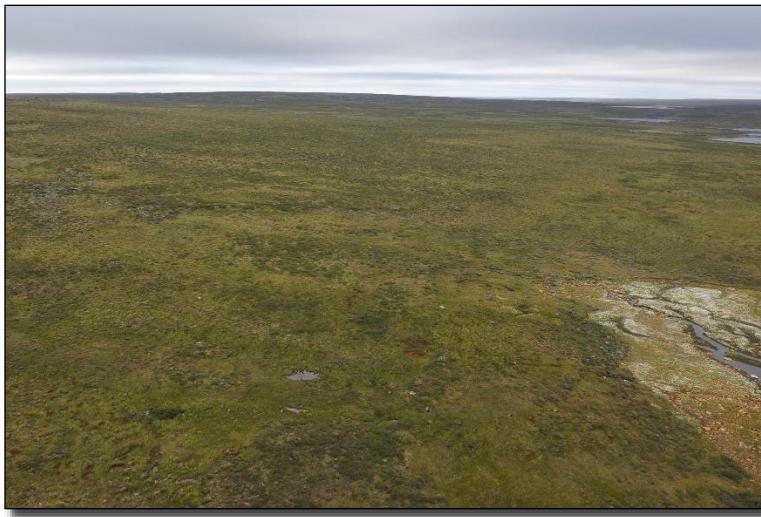
Class B



- Bedrock
- 1AE : Glacial deposits
- 1AEVB : Washed glacial deposits
- 7 : Organic deposits
- Hydrography
- Erect shrub tundra
- Ostioles

Habitat group H–Uniform tundra
Habitat type H05–Erect dwarf shrub tundra
Preliminary associated plant name Erect dwarf *Betula glandulosa*-*Vaccinium uliginosum*/*Dicranum elongatum*-*Hylocomium splendens*

Uniform tundra forms the dominant habitat group of this class, developing on thick glacial deposits. Shrubs and bryophytes dominate the cover here.



Plot #	A181A_19
Topographic situation	Gentle slope
Longitudinal slope	Regular
Transverse slope	Regular
Length of slope	Long (> 200 m)
Incline	5 à 10%
Station exposure	North-northeast
Surface deposit	1AE: Glacial deposits; moraine without morphology; thick
Vertical drainage	3: moderate
Oblique drainage	Present
Depth reached	55 cm
Full depth of deposit	In excess of 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	6 cm
Water table depth	Not observable
Permafrost depth	Not observable
Permafrost depth	55 cm



% free water	0
% bare earth	0
% rock	0
% stones	15
% litter	15
% shrubs	60
Average shrub height	Erect dwarf (15-40 cm)
% grasses	15
Average height of grasses	< .5 m
% bryophytes	70
% ground lichen	15
% saxicolous lichen	15

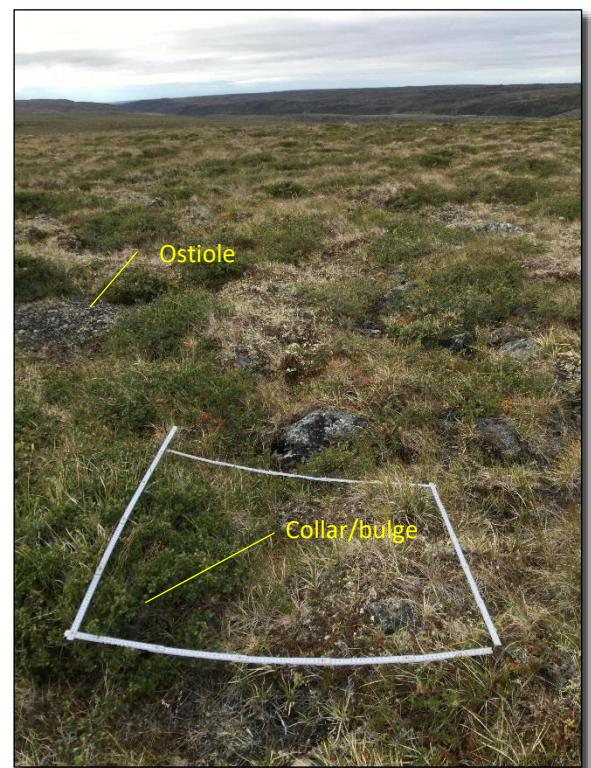
Shrubs	Cover	Height	Level
<i>Vaccinium uliginosum</i>	25–50%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Betula glandulosa</i>	15–25%	Erect dwarf (15-40 cm)	Upper
<i>Vaccinium vitis-idaea</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Salix arcupperhila</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	height	
<i>Calamagrostis lapponica</i>	5–15%	< .5 m	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	5–15%	< .5 m	
<i>Equisetum arvense</i>	< 1%	< .5 m	
<i>Bistorta vivipara</i>	< 1%	< .5 m	
<i>Pedicularis flammea</i>	< 1%	< .5 m	
<i>Pyrola grandiflora</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Dicranum elongatum</i>	25–50%		
<i>Hylocomium splendens</i>	15–25%		
<i>Ptilidium ciliare</i>	5–15%		
<i>Anastrophyllum minutum</i>	1–5%		
<i>Aulacomnium turgidum</i>	1–5%		
<i>Dicranum acutifolium</i>	1–5%		
Lichens	Cover		
<i>Flavocetraria cucullata</i>	5–15%		
<i>Dactylina arctica</i>	1–5%		
<i>Flavocetraria nivalis</i>	1–5%		
<i>Lepra dactylina</i>	1–5%		
<i>Alectoria ochroleuca</i>	< 1%		
<i>Cladonia borealis</i>	< 1%		
<i>Ochrolechia frigida</i>	< 1%		
<i>Cladonia stygia</i>	< 1%		
<i>Cladonia mitis</i>	< 1%		
<i>Cladonia amaurocraea</i>	< 1%		

Habitat group I—Structured peatlands
Habitat type I02—Ostiole collared tundra
Preliminary associated plant name Erect dwarf *Betula glandulosa*-*Vaccinium vitis-idaea*/*Calamagrostis lapponica*-*Carex bigelowii* subsp.
bigelowii

Since the survey was conducted on the margin, vegetation was drier than in edaphic conditions within the ostiole. Vegetation does not differ much from the survey outside the ostiole, described above.



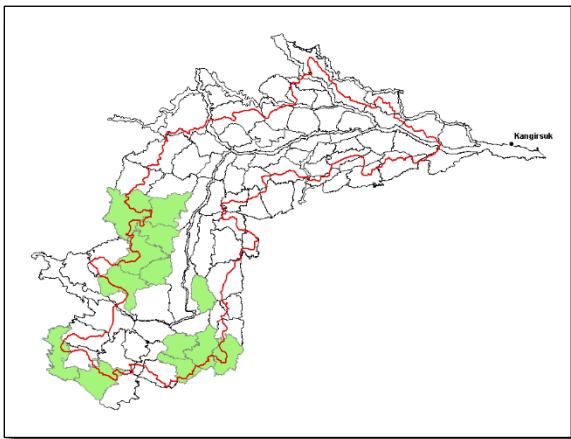
Plot #	A154A_19
Topographic situation	Rounded summit
Longitudinal slope	Not applicable
Transverse slope	Not applicable
Length of slope	Zero
Incline	0–2%
Station exposure	Full
Surface deposit	1AE: Glacial deposits; moraine without morphology; thick
Vertical drainage	4: Imperfect
Oblique drainage	None
Depth reached	35 cm
Full depth of deposit	>1 m
Type of organic matter	Not observable
Thickness of organic matter	0 cm
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	0
% stones	7
% litter	45
% shrubs	60
Average shrub height	Erect dwarf (15-40 cm)
% grasses	20
Average height of grasses	< .5 m
% bryophytes	15
% ground lichen	15
% saxicolous lichen	5

Shrubs	Cover	Height	Level
<i>Betula glandulosa</i>	25–50%	Erect dwarf (15-40 cm)	Upper
<i>Vaccinium vitis-idaea</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Rhododendron tomentosum subsp. <i>subarcticum</i></i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Salix glauca</i> var. <i>cordifolia</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Upper
Grasses	Cover	Height	
<i>Calamagrostis lapponica</i>	15–25%	< .5 m	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	1–5%	< .5 m	
Bryophytes	Cover		
<i>Dicranum elongatum</i>	15–25%		
<i>Hylocomium splendens</i>	5–15%		
<i>Aulacomnium turgidum</i>	1–5%		
<i>Sanionia uncinata</i>	1–5%		
<i>Ptilidium ciliare</i>	< 1%		
Lichens	Cover		
<i>Flavocetraria nivalis</i>	1–5%		
<i>Cladonia stygia</i>	1–5%		
<i>Cladonia mitis</i>	1–5%		
<i>Flavocetraria cucullata</i>	< 1%		
<i>Cladonia stellaris</i>	< 1%		
<i>Cladonia amaurocraea</i>	< 1%		
<i>Cladonia borealis</i>	< 1%		
<i>Dactylina arctica</i>	< 1%		
<i>Alectoria ochroleuca</i>	< 1%		

Class C: Till mounds on erect dwarf shrub tundra

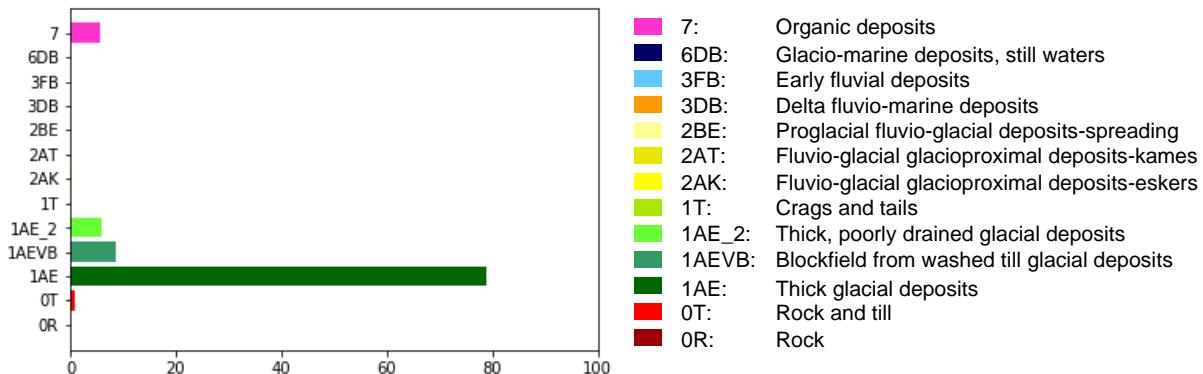


This class occurs in the western part of the protected area, northeast of Lac Payne. It is characterized by somewhat more relief than the washed till plateau with dwarf shrub tundra and the ostiole till mounds with dwarf shrub tundra classes. These mounds are covered by more or less thick glacial deposits. The thickness of the deposits allow for only minor solifluction and ostiole formation. This is what distinguishes it from the following class. It presents a complex of reliefs covered by prostrate shrub tundra where rock outcroppings are sometimes observed on parts of the summit.

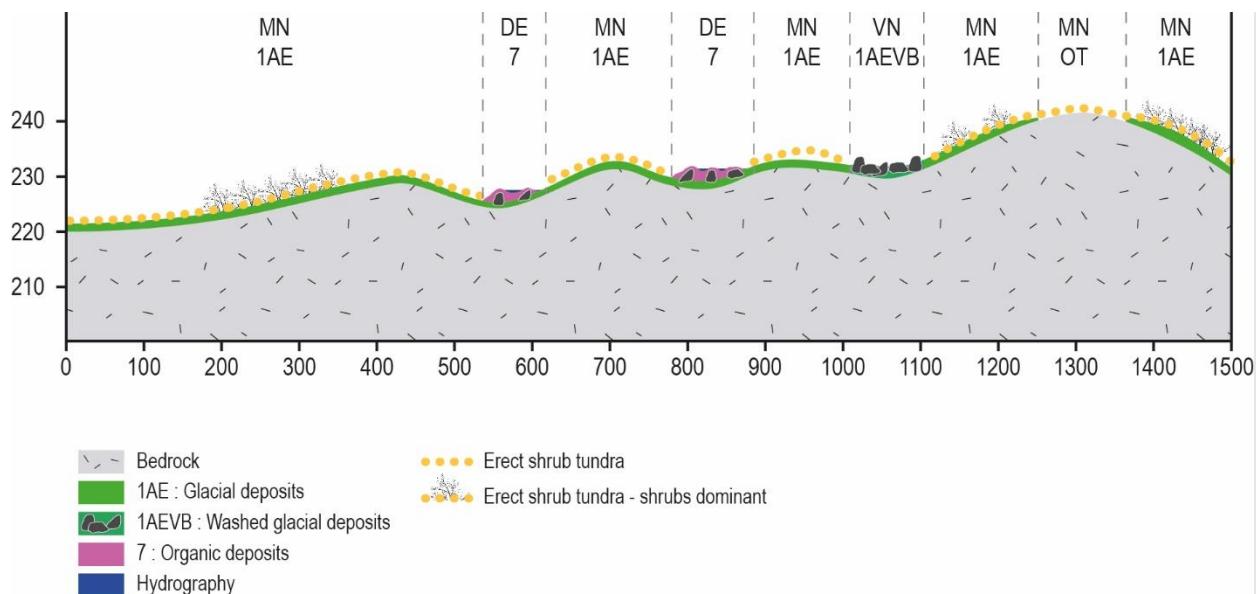
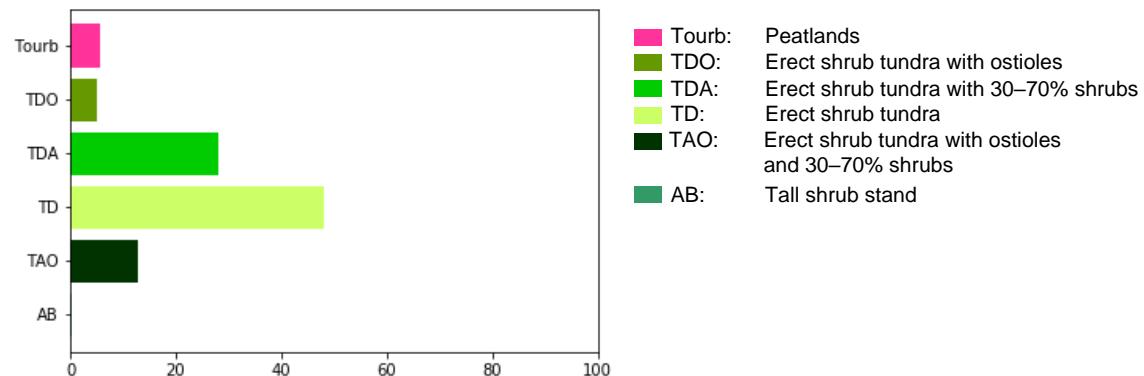
The valleys, which are more protected by snow cover in winter, display dwarf erect shrub tundra dominated by dwarf birch in their downstream portions. In the valley surfaces, blockfields from washed till with some wetlands form the network that connects the lakes. The zone southeast of the protected area boundary has a high concentration of wetlands.



Class C



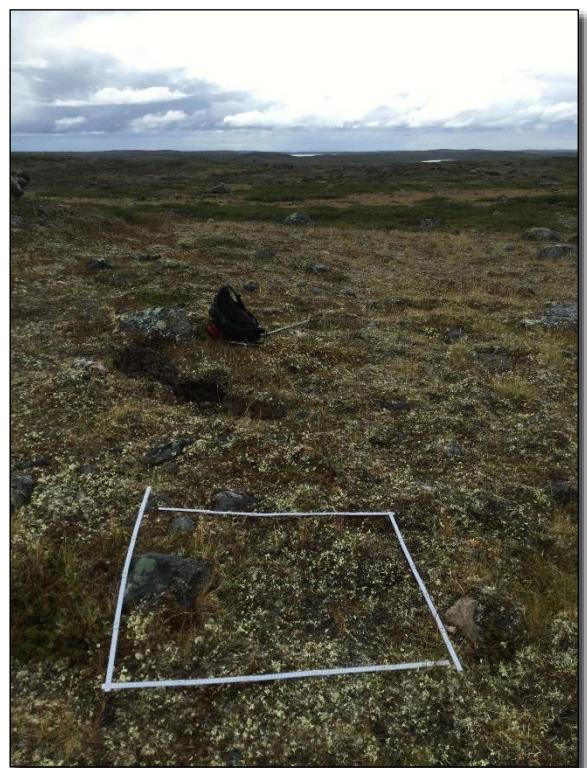
Class C



Habitat group H–Uniform tundra
Habitat type H04–Prostrate shrub tundra
Preliminary associated plant name Prostrate dwarf vaccinium *vitis-idaea*-*Rhododendron tomentosum* subsp. *subarcticum*/*Polytrichum juniperinum*/*Flavocetraria nivalis*-*Alectoria ochroleuca*



Plot #	A264A_19
Topographic situation	Rounded summit
Longitudinal slope	Irregular
Transverse slope	Irregular
Slope length	Zero
Slope	0–2%
Station exposure	Full
Surface deposit	1AM: Glacial deposits; moraine without morphology; thin
Vertical drainage	3: moderate
Oblique drainage	None
Reached depth	40 cm
Total deposit thickness	30 cm
Type of organic matter	Mor (L,F,H)
Organic matter thickness	1 cm
Water table depth	25 cm
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	0
% stone	15
% litter	1
% shrubs	25
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	10
Average height of grasses	< .5 m
% bryophytes	20
% ground lichen	60
% saxicolous lichen	15

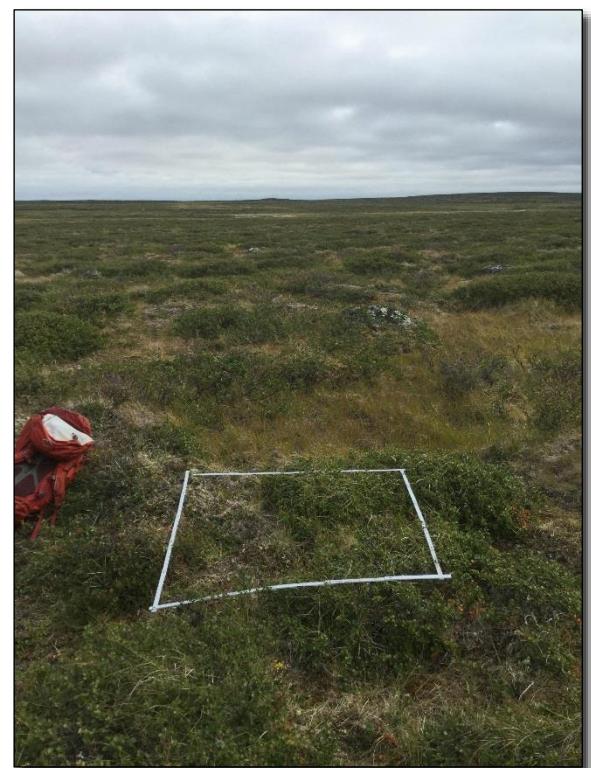
Shrubs	Cover	Height	Level
<i>Vaccinium vitis-idaea</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Upper
Grasses	Cover	Height	
<i>Calamagrostis lapponica</i>	5–15%	< .5 m	
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	1–5%	< .5 m	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Polytrichum juniperinum</i>	15–25%		
<i>Racomitrium lanuginosum</i>	1–5%		
<i>Tetralophozia setiformis</i>	1–5%		
<i>Pogonatum urnigerum</i>	< 1%		
<i>Dicranum fuscescens</i>	< 1%		
Lichens	Cover		
<i>Flavocetraria nivalis</i>	15–25%		
<i>Bryoria nitidula</i>	1–5%		
<i>Alectoria ochroleuca</i>	1–5%		
<i>Bryocaulon divergens</i>	1–5%		
<i>Ochrolechia frigida</i>	1–5%		
<i>Cladonia mitis</i>	1–5%		
<i>Cladonia stygia</i>	1–5%		
<i>Flavocetraria cucullata</i>	< 1%		
<i>Lepra dactylina</i>	< 1%		
<i>Cladonia stellaris</i>	< 1%		
<i>Sphaerophorus globosus</i>	< 1%		

Habitat group H–Uniform tundra
Habitat type H05–Erect dwarf shrub tundra
Preliminary associated plant name *Betula glandulosa/Calamagrostis lapponica/Dicranum scoparium* erect dwarf shrub

Tundra is somewhat more elevated here than in the preceding case.



Plot #	A317A_19
Topographic situation	Gentle slope
Longitudinal slope	Regular
Transverse slope	Convex
Length of slope	Long(> 200 m)
Incline	0–2%
Station exposure	Complete
Surface deposit	1AE: Glacial deposits; moraine without morphology; thick
Vertical drainage	4: Imperfect
Oblique drainage	None
Depth reached	70 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	5 cm
Water table depth	Not observable
Permafrost depth	70



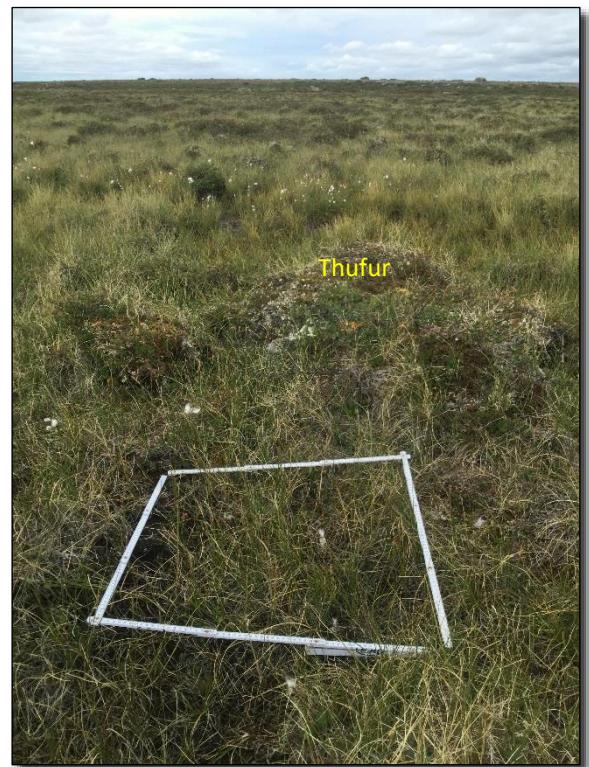
% free water	0
% bare earth	0
% rock	0
% stones	0
% litter	15
% shrubs	0
Average shrub height	Erect dwarf (15-40 cm)
% grasses	20
Average height of grasses	< .5 m
% bryophytes	65
% ground lichen	15
% saxicolous lichen	0

Shrubs	Level	Cover	Height
<i>Betula glandulosa</i>	Upper	25–50%	Erect dwarf (15-40 cm)
<i>Vaccinium vitis-idaea</i>	Lower	15–25%	Prostrate/semi-prostrate (0-15 cm)
<i>Vaccinium uliginosum</i>	Lower	1–5%	Prostrate/semi-prostrate (0-15 cm)
Grasses		Cover	Height
<i>Calamagrostis lapponica</i>		15–25%	< .5 m
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>		1–5%	< .5 m
<i>Luzula confusa</i>		< 1%	< .5 m
Bryophytes		Cover	
<i>Dicranum scoparium</i>		15–25%	
<i>Polytrichum juniperinum</i>		5–15%	
<i>Polytrichum piliferum</i>		5–15%	
<i>Dicranum elongatum</i>		5–15%	
<i>Racomitrium lanuginosum</i>		1–5%	
<i>Pleurozium schreberi</i>		1–5%	
<i>Ptilidium ciliare</i>		1–5%	
<i>Aulacomnium turgidum</i>		< 1%	
<i>Anastrophyllum minutum</i>		< 1%	
Lichens		Cover	
<i>Cladonia mitis</i>		5–15%	
<i>Cladonia rangiferina</i>		5–15%	
<i>Ochrolechia frigida</i>		1–5%	
<i>Flavocetraria cucullata</i>		< 1%	
<i>Flavocetraria nivalis</i>		< 1%	
<i>Cladonia amaurocraea</i>		< 1%	
<i>Peltigera polydactylon</i>		< 1%	

Habitat group E-Periglacial peatlands
Habitat type E04—Thufur fen
Preliminary associated plant name *Carex rotundata-Eriophorum angustifolium* ssp.
angustifolium/Sphagnum compactum-Gymnocolea inflata
mucinal peat grassland



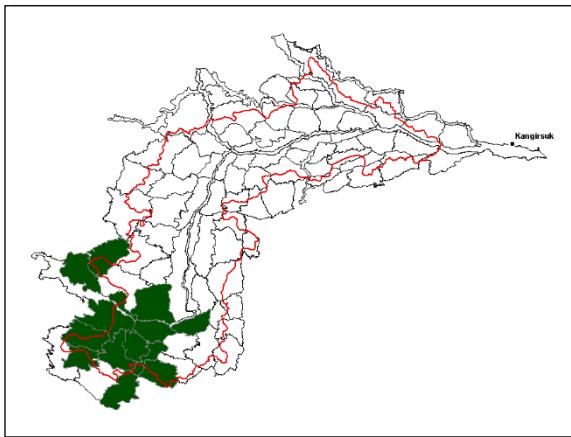
Plot #	A332B_19
Topographic situation	Open depression
Longitudinal slope	Regular
Transverse slope	Concave
Length of slope	Short (< 100 m)
Incline	2–5%
Station exposure	Full
Surface deposit	7M: Organic deposits; minerotrophic
Vertical drainage	6: Very poor
Oblique drainage	Present
Depth reached	30 cm
Full depth of deposit	> 1 m
Type of organic matter	Fibrous (0f)
Thickness of organic matter	30 cm
Water table depth	1 cm
Permafrost depth	Not observable



% free water	0
% bare earth	10
% rock	0
% stones	0
% litter	50
% shrubs	10
Average shrub height	Average (100–150 cm)
% grasses	40
Average height of grasses	< .5 m
% bryophytes	35
% ground lichen	0
% saxicolous lichen	0

Shrubs	Cover	Height	Level
<i>Betula glandulosa</i>	1–5%	Prostrate/semi-prostrate (0–15 cm)	Upper
<i>Rubus chamaemorus</i>	1–5%	Prostrate/semi-prostrate (0–15 cm)	Lower
<i>Salix arcupperhila</i>	< 1%	Prostrate/semi-prostrate (0–15 cm)	Lower
<i>Vaccinium uliginosum</i>	< 1%	Prostrate/semi-prostrate (0–15 cm)	Lower
Grasses	Cover	Height	
<i>Carex rotundata</i>	15–25%	< .5 m	
<i>Eriophorum angustifolium</i> subsp. <i>angustifolium</i>	5–15%	< .5 m	
<i>Carex rariflora</i>	< 1%	< .5 m	
<i>Trichophorum cespitosum</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Sphagnum compactum</i>	15–25%		
<i>Gymnocolea inflata</i>	15–25%		
<i>Nardia geoscyphus</i>	< 1%		
Lichens	Cover		

Class D: Till ostiole hummocks with solifluction, erect dwarf shrub tundra

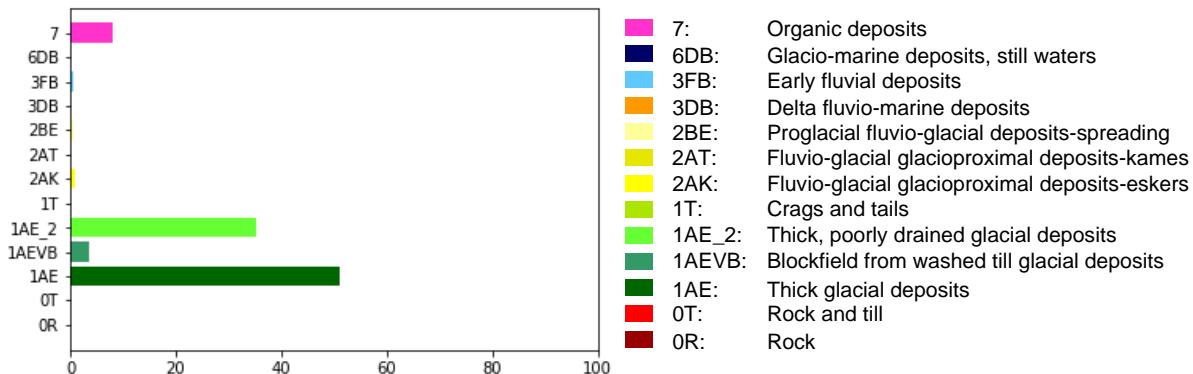


This class is located in the south-western sector of the protected area, south of Rivière-Arnaud. It is characterized by a slightly more pronounced relief recovered from very thick glacial deposits. Freeze-thaw cycles associated with the texture and thickness of the deposits favour ostioles. These same cycles combined with the length and incline of the slopes evidence a solifluction process. The long hillsides of ostiolated solifluent deposits are cut by wetter streaks where organic matter can accumulate. At the base of the hillsides, the valleys are occupied by wetlands, lakes, and infrequent washed till with only

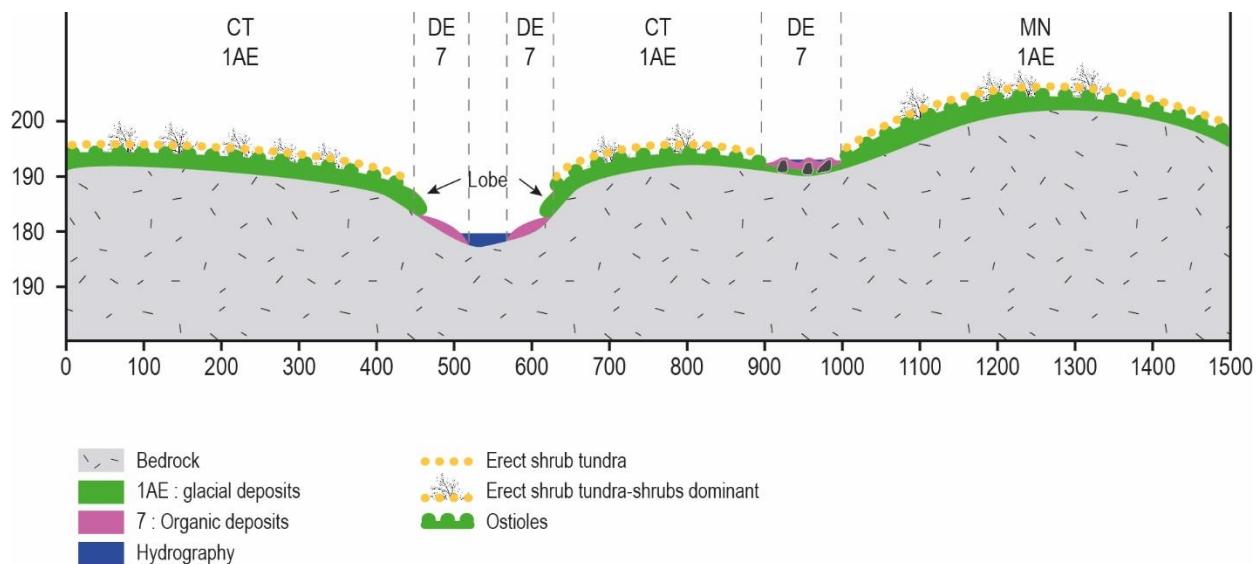
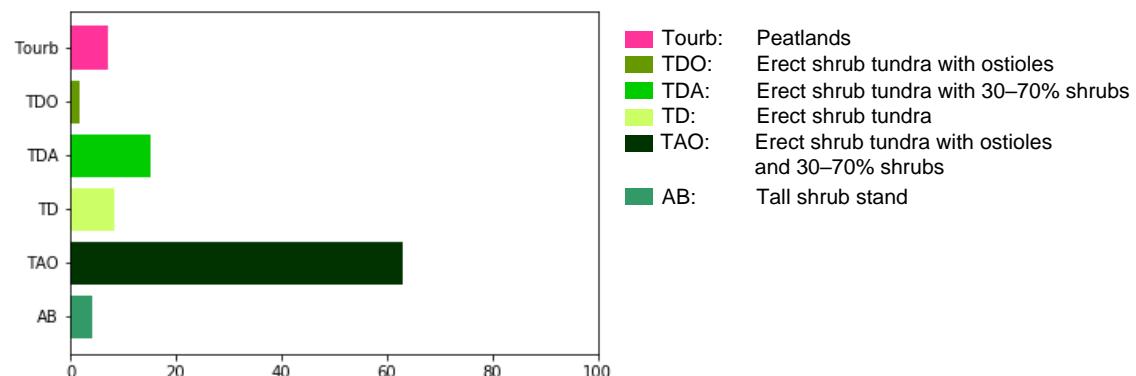
boulders and cobbles remaining. Along with the slopes of the Rivière-Arnaud valley, this is the greenest area of the reserve, where dwarf birch dominates and where the concentration of wetlands is the greatest.



Class D



Class D

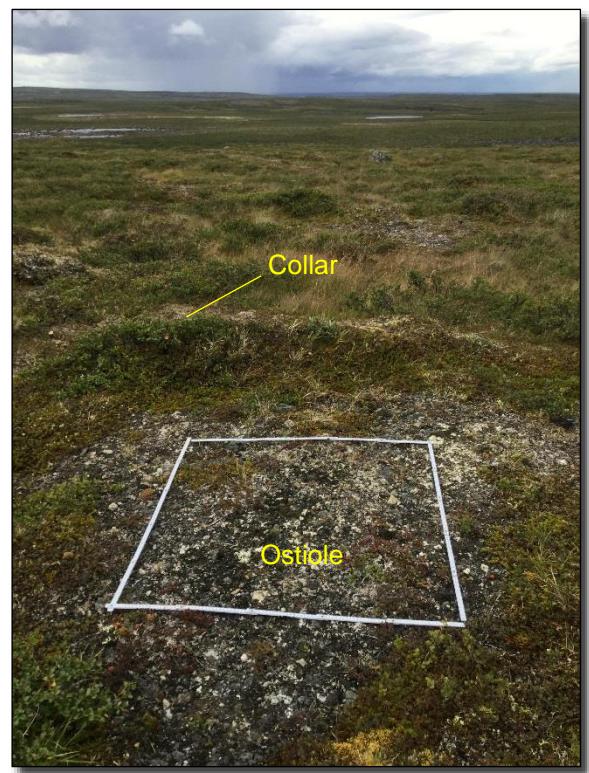


Habitat group I –Structured peatlands
Habitat type I02–Ostiole collared tundra
Preliminary associated plant name *Salix uva-ursi*-*Vaccinium uliginosum*/ *Anthelia juratzkana* mucinous basophils shrubs

This type of tundra is typical east of Lac Payne on both sides of Rivière-Arnaud. It develops on long thick till slopes. The ostioles are in tandem to well-formed moss bulges, often *Dicranum elongatum* recovered from shrubs and lichens. Nothing in the composition of the surface deposits or bedrock explains the presence of basophilic species.



Plot #	A257A_19
Topographic situation	Hilltop
Longitudinal slope	Regular
Transverse slope	Regular
Length of slope	Average (100–200 m)
Incline	2–5%
Station exposure	Complete
Surface deposit	1AE: Glacial deposits; moraine without morphology; thick
Vertical drainage	4: Imperfect
Oblique drainage	None
Depth reached	120 cm
Full depth of deposit	> 1m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	1 cm
Water table depth	Not observable
Permafrost depth	120 cm



% free water	0
% bare earth	3
% rock	0
% stones	40
% litter	1
% shrubs	15
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	2
Average height of grasses	< .5 m
% bryophytes	35
% ground lichen	15
% saxicolous lichen	35

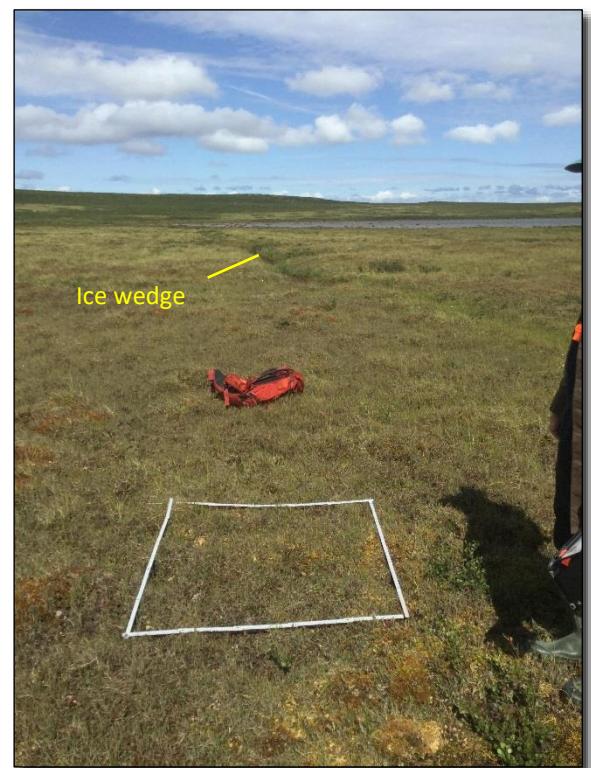
Shrubs	Level	Cover	Height
<i>Vaccinium uliginosum</i>	Upper	5–15%	Prostrate/semi-prostrate (0-15 cm)
<i>Salix uva-ursi</i>	Upper	5–15%	Prostrate/semi-prostrate (0-15 cm)
<i>Rhododendron lapponicum</i>	Upper	1–5%	Prostrate/semi-prostrate (0-15 cm)
<i>Empetrum nigrum</i> subsp. <i>hermaphroditum</i>	Upper	1–5%	Prostrate/semi-prostrate (0-15 cm)
<i>Diapensia lapponica</i> var. <i>lapponica</i>	Upper	1–5%	Prostrate/semi-prostrate (0-15 cm)
<i>Betula glandulosa</i>	Upper	< 1%	Prostrate/semi-prostrate (0-15 cm)
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	Upper	< 1%	Prostrate/semi-prostrate (0-15 cm)
Grasses		Cover	Height
<i>Carex capillaris</i> subsp. <i>fuscidula</i>		1–5%	< .5 m
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>		< 1%	< .5 m
Bryophytes		Cover	
<i>Anthelia juratzkana</i>		15–25%	
<i>Gymnomitriion coralliooides</i>		1–5%	
<i>Tortella fragilis</i>		1–5%	
<i>Racomitrium canescens</i> subsp. <i>canescens</i>		< 1%	
<i>Dicranum spadiceum</i>		< 1%	
<i>Racomitrium lanuginosum</i>		< 1%	
Lichens		Cover	
<i>Ochrolechia frigida</i>		5–15%	
Black lichenic crust		5–15%	
<i>Ochrolechia androgyna</i>		1–5%	
<i>Flavocetraria nivalis</i>		< 1%	
<i>Flavocetraria cucullata</i>		< 1%	
<i>Stereocaulon glareosum</i>		< 1%	
<i>Proupperannaria pezizoides</i>		< 1%	

Habitat group E-Periglacial peatlands
Habitat type E03-Ice wedge fen
Preliminary associated plant name *Andromeda polifolia/Carex rariflora/Sphagnum subfulvum* mucinal peatland grass

Ice wedge fens are infrequent and are found at the margins of bodies of water. They are the result of the concentration of water in thermal shrinkage cracks, which themselves accentuate the phenomenon through freezing and thawing cycles. Bryophytes (and more precisely sphagnum moss) dominate both in cover and numerically. No lichens were observed. Numerous species of grasses were observed outside of the plot, including *Tofieldia pusilla*, *Carex rotundata*, *Dupontia fisheri*, *Pinguicula villosa*, and *Coptidium lapponicum*.



Plot #	A328A_19
Topographic situation	Flat terrain
Longitudinal slope	Regular
Transverse slope	Regular
Length of slope	N.A.
Incline	0-2%
Station exposure	Full
Surface deposit	7M: Organic deposits; minerotrophic
Vertical drainage	6: Very poor
Oblique drainage	None
Depth reached	45 cm
Full depth of deposit	> 1 m
Type of organic matter	Fibrous (Of)
Thickness of organic matter	45 cm
Water table depth	15 cm
Permafrost depth	45 cm



% free water	0
% bare earth	0
% rock	0
% stones	0
% litter	15
% shrubs	20
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	40
Average height of grasses	< .5 m
% bryophytes	90
% ground lichen	0
% saxicolous lichen	0

Shrubs	Cover	Height	Level
<i>Andromeda polifolia</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Salix arcupperhila</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Rubus chamaemorus</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Vaccinium oxycoccus</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Upper

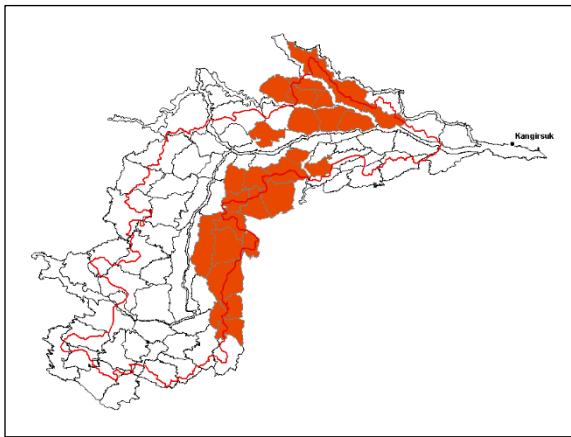
Grasses	Cover	Height	
<i>Carex rariflora</i>	25–50%	< .5 m	
<i>Comarum palustre</i>	1–5%	< .5 m	
<i>Carex chordorrhiza</i>	< 1%	< .5 m	

Bryophytes	Cover		
<i>Sphagnum subfulvum</i>	25–50%		
<i>Sphagnum subsecundum</i>	5–15%		
<i>Aulacomnium turgidum</i>	5–15%		
<i>Sphagnum steerei</i>	1–5%		
<i>D'ischium capillaceum</i>	< 1%		
<i>Paludella squarrosa</i>	< 1%		
<i>Sphagnum warnstorffii</i>	< 1%		
<i>Tomentypnum nitens</i>	< 1%		

Lichens			
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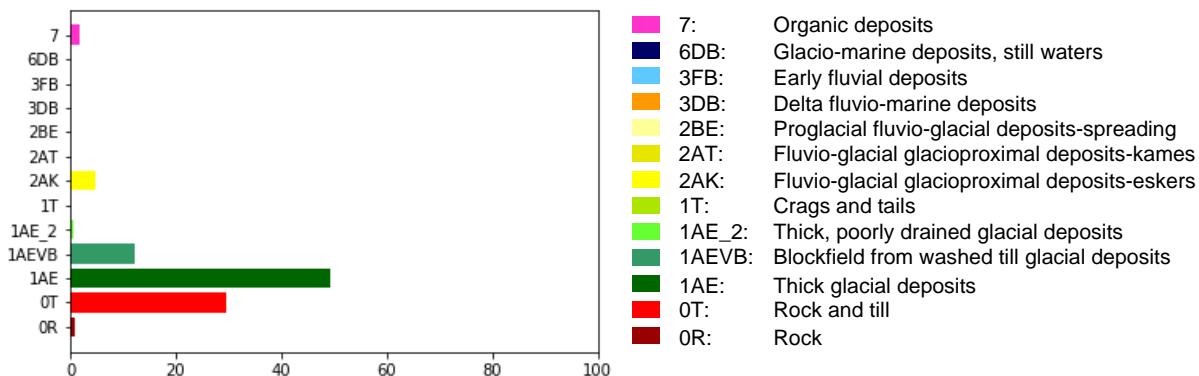
Class E: Till and rock mounds with erect dwarf shrub tundra



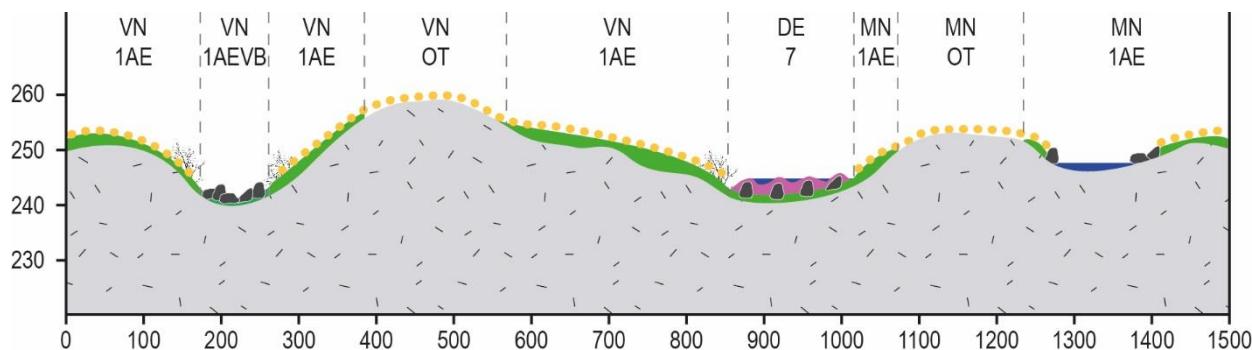
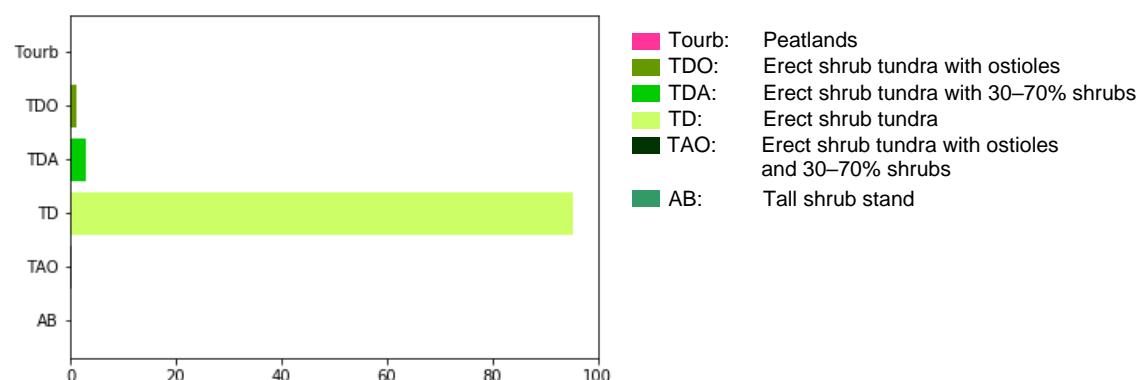
In this class, bedrock control is obvious. Valleys are straight and mark the fault lines in the bedrock. Deposits are thinner and the tops of the reliefs (without being sharp) often present rocky outcroppings dominated by tundra. The inter-relief valleys are protected from the winds, which favours, in winter, the conservation of snow cover that allows birch to develop and dominate the cover. At the surface of the valleys, washed till deposits and fens are sometimes present.



Class E



Class E



Habitat group H–Uniform tundra
Habitat type H03–Discontinuous xeric tundra
Preliminary associated plant name *Rhododendron tomentosum* ssp. *subarcticum*/ *Alectoria ochroleuca*-*Flavocetraria nivalis*-*Cladonia stygia* scrubland prostrate lichen

Discontinuous xeric tundra is by far the most dominant habitat type on the glacial deposits. It is characterized by a dominance of prostrate shrubs and lichens.



Plot #	A197A_19
Topographic situation	Rounded summit
Longitudinal slope	Irregular
Transverse slope	Irregular
Length of slope	N.A.
Incline	0–2%
Station exposure	Complete
Surface deposit	1AM: Glacial deposits; moraine without morphology; thin
Vertical drainage	2: Good
Oblique drainage	None
Depth reached	40 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	10 cm
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	0
% stones	15
% litter	1
% shrubs	30
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	2
Average height of grasses	< .5 m
% bryophytes	10
% ground lichen	70
% saxicolous lichen	15

Shrubs	Cover	Height	Level
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Vaccinium vitis-idaea</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Upper
Grasses	Cover	Height	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	1–5%	< .5 m	
<i>Luzula confusa</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Tetralophozia setiformis</i>	5–15%		
<i>Ptilidium ciliare</i>	1–5%		
<i>Dicranum elongatum</i>	1–5%		
Lichens	Cover		
<i>Alectoria ochroleuca</i>	15–25%		
<i>Flavocetraria nivalis</i>	5–15%		
<i>Cladonia stygia</i>	5–15%		
<i>Cladonia stellaris</i>	1–5%		
<i>Cetraria nigricans</i>	1–5%		
<i>Bryoria nitidula</i>	1–5%		
<i>Sphaerophorus globosus</i>	1–5%		
<i>Cladonia deformis</i>	< 1%		

Habitat group H–Uniform tundra
Habitat type H06–Low shrubby tundra
Preliminary associated plant name *Betula glandulosa*-*Vaccinium vitis-idaea*-*Cassiope tetragona* var. *tetragona*/ *Calamagrostis lapponica*/ *Dicranum elongatum* low scrubland

Snow cover is maintained in the areas most protected from the wind, enabling dwarf birch to develop and form dense, relatively high cover.



Plot #	A159A_19
Topographic situation	Open depression
Longitudinal slope	Irregular
Transverse slope	Concave
Length of slope	Short (< 100 m)
Incline	2 à 5
Station exposure	Western
Surface deposit	1AE: Glacial deposits; moraine without morphology; thick
Vertical drainage	3: moderate
Oblique drainage	None
Depth reached	45 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	10 cm
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	0
% stones	15
% litter	20
% shrubs	60
Average shrub height	Low (40-100 cm)
% grasses	7
Average height of grasses	< .5 m
% bryophytes	60
% ground lichen	10
% saxicolous lichen	15

Shrubs	Cover	Height	Level
<i>Betula glandulosa</i>	25–50%	Low (40-100 cm)	Upper
<i>Cassiope tetragona</i> var. <i>tetragona</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Vaccinium vitis-idaea</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Salix herbacea</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Vaccinium uliginosum</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Calamagrostis lapponica</i>	5–15%	< .5 m	
<i>Pedicularis lapponica</i>	< 1%	< .5 m	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Dicranum elongatum</i>	25–50%		
<i>Dicranum acutifolium</i>	15–25%		
<i>Ptilidium ciliare</i>	1–5%		
Lichens	Cover		
White lichenic crust	5–15%		
<i>Cladonia borealis</i>	< 1%		
<i>Flavocetraria nivalis</i>	< 1%		
<i>Cladonia mitis</i>	< 1%		
<i>Ochrolechia frigida</i>	< 1%		
<i>Cetrariella delisei</i>	< 1%		

Habitat group D–Structured peatlands
Habitat type D05–Corded fen
Preliminary associated plant name *Vaccinium uliginosum/Carex rotundata-Carex rariflora/Sphagnum rubellum-Sphagnum fuscum*
 shrubby peat meadowland

Structured peatlands are not rare at valley surfaces near bodies of water and develop crossing block fields stemming from glacial deposit washout.



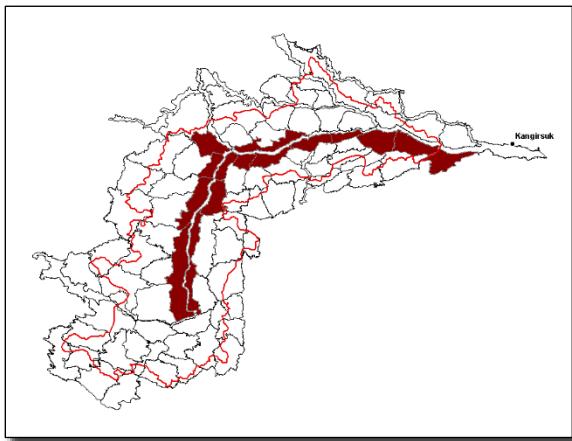
Plot #	A051A_19
Topographic situation	Open depression
Longitudinal slope	Regular
Transverse slope	Concave
Length of slope	Long(> 200 m)
Incline	0–2%
Station exposure	Complete
Surface deposit	7MT: Organic deposits; minerotrophic; on till, sand and gravel
Vertical drainage	6: Very poor
Oblique drainage	Present
Depth reached	40 cm
Full depth of deposit	12 cm
Type of organic matter	Fibrous (Of)
Thickness of organic matter	12 cm
Water table depth	10 cm
Permafrost depth	Not observable



% free water	5
% bare earth	0
% rock	30
% stones	2
% litter	30
% shrubs	Prostrate/semi-prostrate (0-15)
Average shrub height	3
% grasses	< 0.5
Average height of grasses	2
% bryophytes	35
% ground lichen	5
% saxicolous lichen	5

Shrubs	Cover	Height	Level
<i>Vaccinium uliginosum</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Betula glandulosa</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Andromeda polifolia</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Rhododendron tomentosum subsp. <i>subarcticum</i></i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Salix arctica</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Cassiope tetragona</i> var. <i>tetragona</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Carex rotundata</i>	15–25%	< .5 m	
<i>Carex rariflora</i>	5–15%	< .5 m	
<i>Eriophorum angustifolium</i> subsp. <i>angustifolium</i>	1–5%	< .5 m	
<i>Eriophorum vaginatum</i> var. <i>spissum</i>	1–5%	< .5 m	
Bryophytes	Cover		
<i>Sphagnum rubellum</i>	25–50%		
<i>Dicranum elongatum</i>	5–15%		
<i>Sphagnum fuscum</i>	5–15%		
<i>Sphagnum balticum</i>	1–5%		
<i>Sphagnum compactum</i>	1–5%		
<i>Aulacomnium turgidum</i>	1–5%		

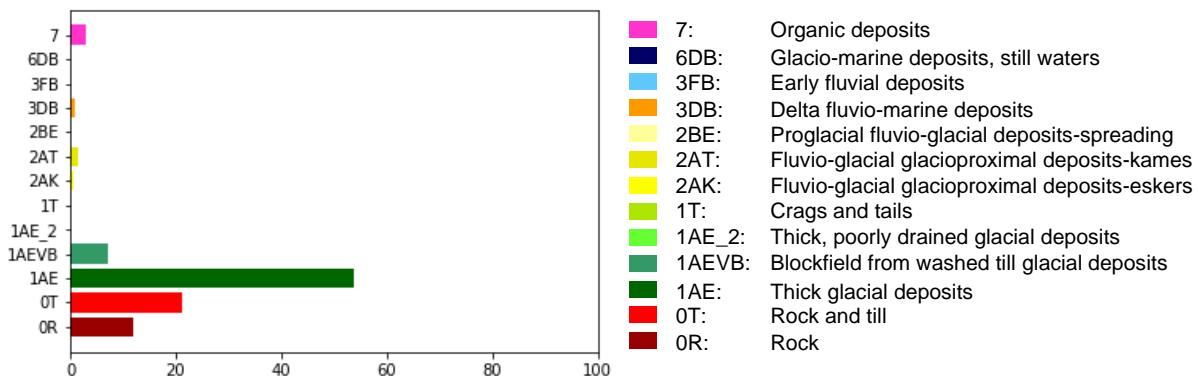
Class F: Margins of Rivière Arnaud with erect dwarf shrub tundra



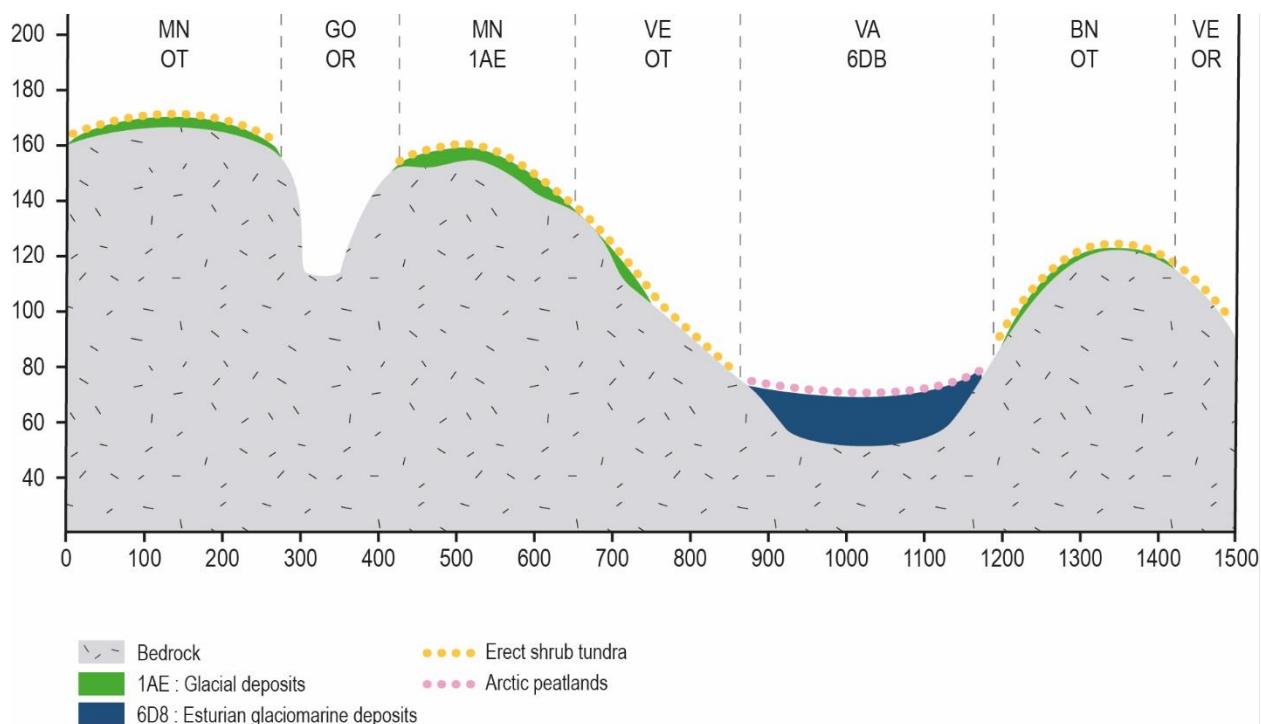
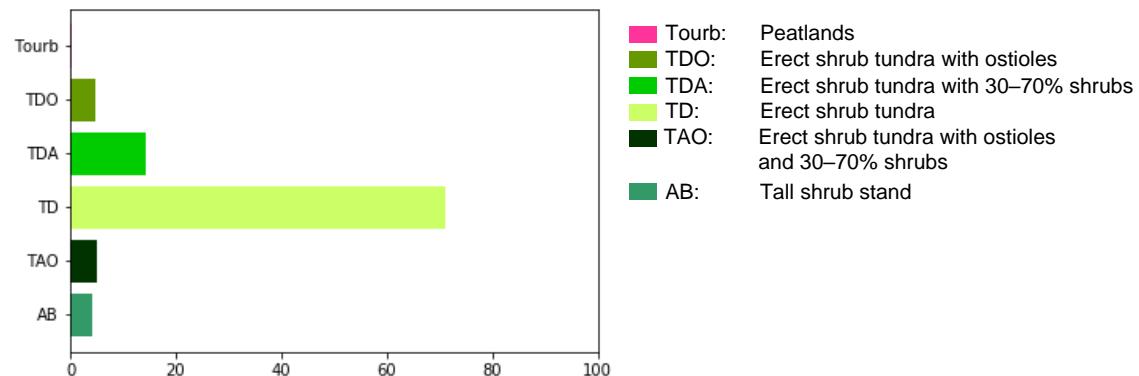
This class is characterized by marked relief and steep rocky slopes that plunge toward Rivière-Arnaud. At the summit, rocky relief dominates. Several valleys of washed till, sometimes covered with arctic fens, are present. It is in this class that we find spectacular gorges that are perpendicular to the river, as well as major tributaries: the Tukimurtuk, Niungalupik, Saniqitik, Kuugajaraapik, Siniqimatik and Hamelin rivers. On both sides of the river, the tributaries empty into flat valleys filled with fine glaciomarine deposits. Glaciomarine deltas overhang the Rivière-Arnaud at several locations on its right bank in the downstream portion.



Class F



Class F

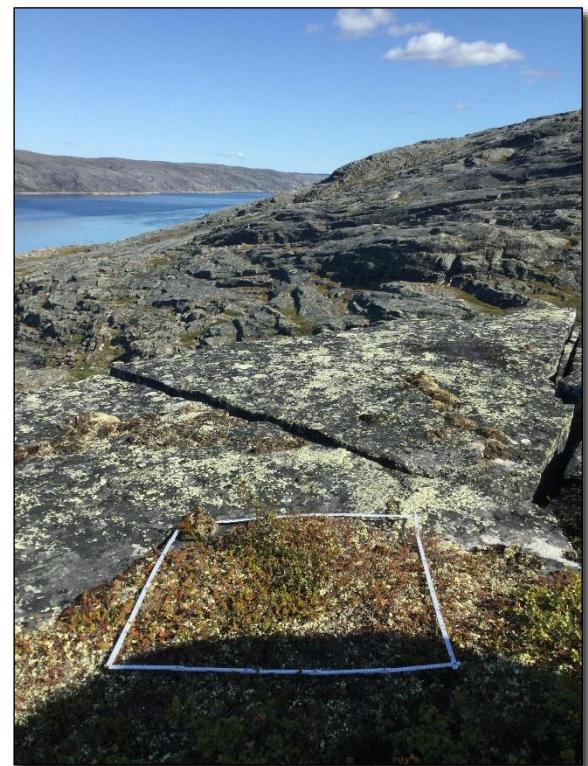


Habitat group	Uniform tundra
Habitat type	H03–Discontinuous xeric tundra
Preliminary associated plant name	<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i> - <i>Vaccinium vitis-idaea</i> - <i>Empetrum nigrum</i> subsp. <i>hermafroditum</i> / <i>Ptilidium ciliare</i> - <i>Tetralophozia setiformis</i> / <i>Flavocetraria nivalis</i> - <i>Cladonia stellaris</i> prostrate shrubs

These terraced rock formations that favour the development of prostrate shrub tundra carpets can be found on the right bank of Rivière-Arnaud, between the Lepellé and Vachon rivers.



Plot #	A976A_19
Topographic situation	Escarpment
Longitudinal slope	Not applicable
Transverse slope	Not applicable
Length of slope	Not applicable
Incline	Not applicable
Station exposure	78
Surface deposit	0B: Rocky outcroppings with peat
Vertical drainage	1: Excessive
Oblique drainage	None
Depth reached	0
Full depth of deposit	0
Type of organic matter	Fibrous (Of)
Thickness of organic matter	3 cm
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	5
% stones	0
% litter	10
% shrubs	60
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	0
Average height of grasses	Not applicable
% bryophytes	30
% ground lichen	50
% saxicolous lichen	5

Shrubs	Cover	Height	Level
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	25–50%	Prostrate/semi-prostrate (0-15)	Lower
<i>Vaccinium vitis-idaea</i>	15–25%	Prostrate/semi-prostrate (0-15)	Lower
<i>Betula glandulosa</i>	5–15%	Erect dwarf (15-40)	Upper
<i>Empetrum nigrum</i> subsp. <i>hermaphroditum</i>	5–15%	Prostrate/semi-prostrate (0-15)	Lower
Grasses	Cover	Height	
Bryophytes	Cover		
<i>Ptilidium ciliare</i>	15–25%		
<i>Tetralophozia setiformis</i>	5–15%		
<i>Dicranum elongatum</i>	1–5%		
<i>Anastrophyllum minutum</i>	1–5%		
Lichens	Cover		
<i>Flavocetraria nivalis</i>	15–25%		
<i>Cladonia stellaris</i>	5–15%		
<i>Cladonia amaurocraea</i>	1–5%		
<i>Cladonia stygia</i>	1–5%		
<i>Flavocetraria cucullata</i>	< 1%		
<i>Cetrariella delisei</i>	< 1%		

Habitat group H–Uniform tundra
Habitat type H05–Erect dwarf shrub tundra
Preliminary associated plant name *Betula glandulosa*-*Vaccinium vitis-idaea*-*Rhododendron tomentosum* subsp. *subarcticum*/*Flavocetraria nivalis*-*Bryoria nitidula* erect dwarf shrubs

Located on glaciomarine deltas, this tundra has no special features compared to tundra found on well drained glacial and fluvioglacial deposits.



Plot #	A997A_19
Topographic situation	Flat terrain
Longitudinal slope	Not applicable
Transverse slope	Not applicable
Length of slope	Not applicable
Incline	0–2%
Station exposure	Full
Surface deposit	3DBE: Alluvial deposits; marine deltaic; early; thick
Vertical drainage	2: good
Oblique drainage	None
Depth reached	60 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	4 cm
Water table depth	Not observable
Permafrost depth	Not observable



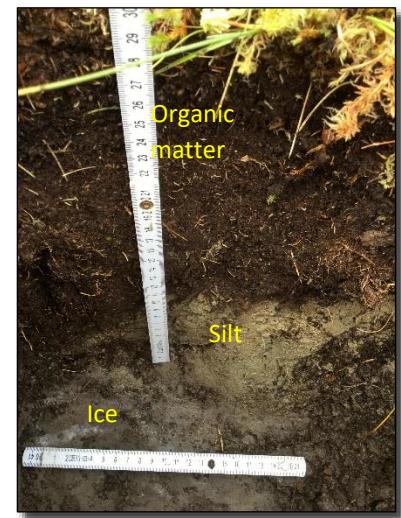
% free water	0
% bare earth	1
% rock	0
% stones	15
% litter	5
% shrubs	55
Average shrub height	Erect dwarf (15-40 cm)
% grasses	1
Average height of grasses	< .5 m
% bryophytes	1
% ground lichen	40
% saxicolous lichen	10

Shrubs	Cover	Height	Level
<i>Vaccinium vitis-idaea</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Betula glandulosa</i>	5–15%	Erect dwarf (15-40 cm)	Upper
<i>Rhododendron tomentosum subsp. subarcticum</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Vaccinium uliginosum</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Cassiope tetragona</i> var. <i>tetragona</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	1–5%	< .5 m	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Polytrichum juniperinum</i>	< 1%		
Lichens	Cover		
<i>Flavocetraria nivalis</i>	5–15%		
<i>Bryoria nitidula</i>	5–15%		
<i>Alectoria ochroleuca</i>	1–5%		
<i>Cladonia mitis</i>	1–5%		
<i>Cladonia stygia</i>	1–5%		
<i>Sphaerophorus globosus</i>	1–5%		
<i>Flavocetraria cucullata</i>	< 1%		
White and black lichen crust	< 1%		

Habitat group E-Periglacial peatlands
Habitat type E04—Thufur fen
Preliminary associated plant name *Rhododendron tomentosum* subsp. *subarcticum*-*Vaccinium vitis-idaea/Dicranum elongatum* prostrate peatland shrubs

These peatlands are found in the silty glaciomarine deposits of valley surfaces. Some have periglacial forms. The thufurs are formed by the lifting of deposits by ice lenses that have been observed at a depth of 35 cm.

As the survey was taken on the thufurs, species were characteristic of rather dry or mesic environments. The species observed outside the plots are present between hummocks in the hollows and express the peaty character of the site.



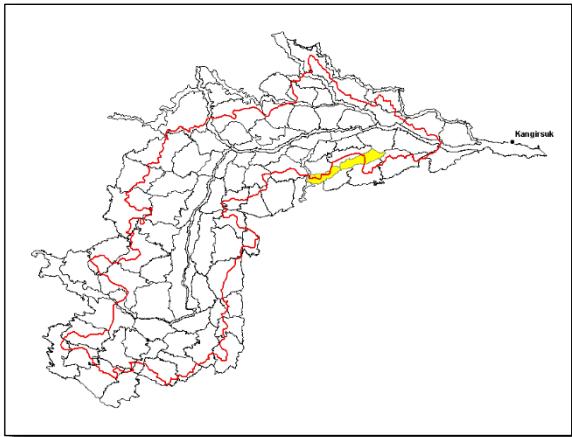
Plot #	A993A_19
Topographic situation	Open depression
Longitudinal slope	Irregular
Transverse slope	Regular
Length of slope	Long (> 200 m)
Incline	0–2%
Station exposure	Full
Surface deposit	7M: Organic deposits; minerotrophic; on glaciomarine silt
Vertical drainage	6: Very poor
Oblique drainage	Present
Depth reached	35 cm
Full depth of deposit	> 1 m
Type of organic matter	Fibrous (Of)
Thickness of organic matter	20 cm
Water table depth	Not observable
Permafrost depth	35 cm



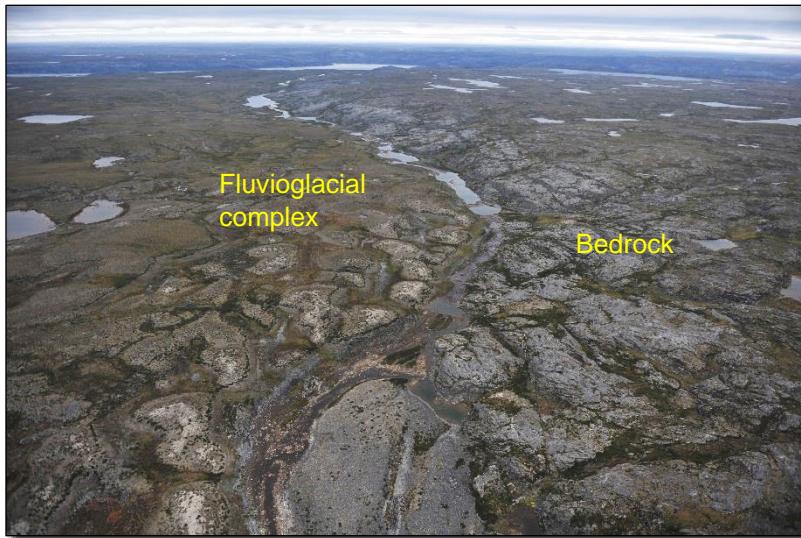
% free water	0
% bare earth	0
% rock	0
% stones	0
% litter	30
% shrubs	75
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	5
Average height of grasses	< .5 m
% bryophytes	15
% ground lichen	5
% saxicolous lichen	0

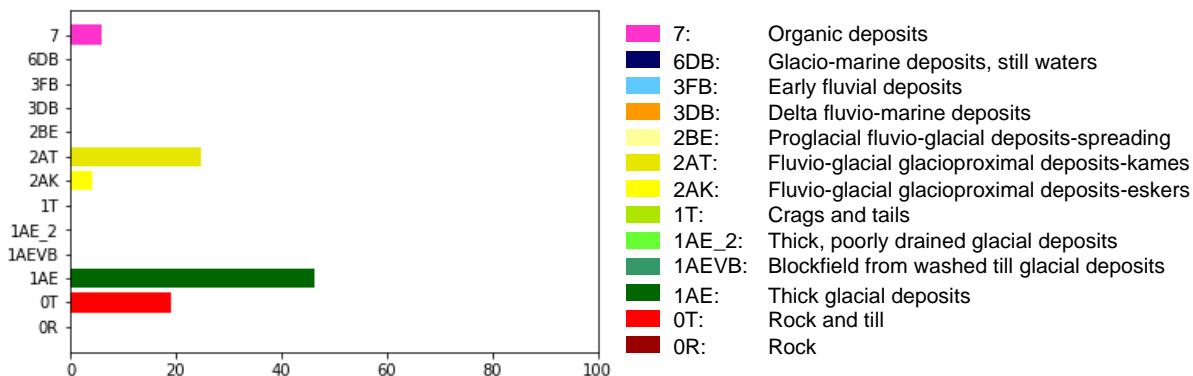
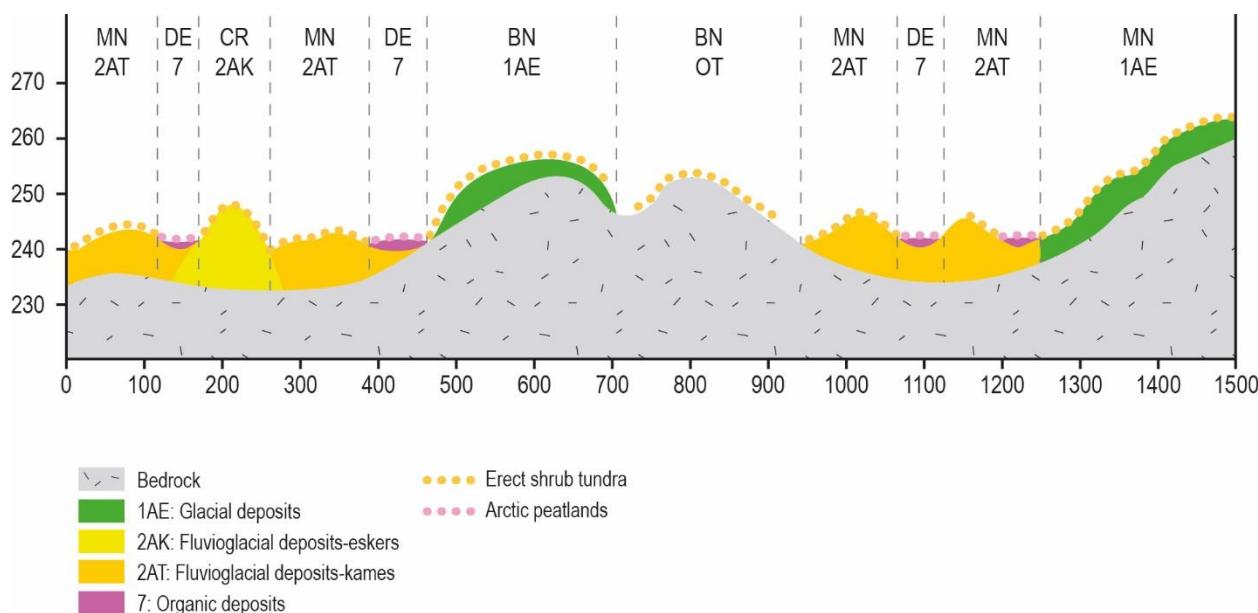
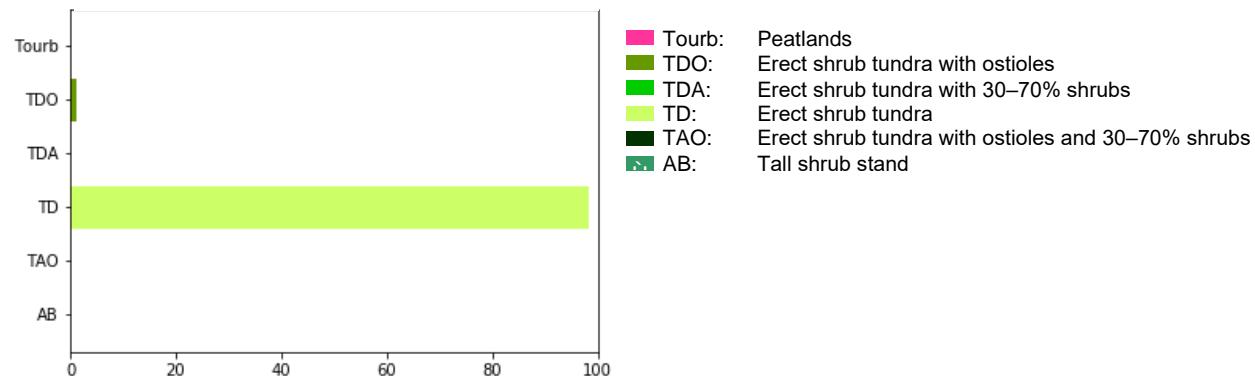
Shrubs	Cover	Height	Level
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	50 à 75%	Prostrate/semi-prostrate (0-15)	Upper
<i>Vaccinium vitis-idaea</i>	25–50%	Prostrate/semi-prostrate (0-15)	Upper
<i>Rubus chamaemorus</i>	1–5%	Prostrate/semi-prostrate (0-15)	Upper
Grasses	Cover	Height	
<i>Eriophorum vaginatum</i> var. <i>spissum</i>	1–5%	< 0.5	
<i>Carex rotundata</i>	Outside the plot		
Bryophytes	Cover		
<i>Dicranum elongatum</i>	5–15%		
<i>Anastrophyllum minutum</i>	1–5%		
<i>Ptilidium ciliare</i>	< 1%		
<i>Sphagnum balticum</i>	Outside the plot		
<i>Sphagnum lenense</i>	Outside the plot		
<i>Sphagnum capillifolium</i>	Outside the plot		
Lichens	Cover		
<i>Flavocetraria nivalis</i>	1–5%		
<i>Cladonia mitis</i>	1–5%		
<i>Cladonia borealis</i>	< 1%		
<i>Flavocetraria cucullata</i>	< 1%		
<i>Cladonia deformis</i>	< 1%		
<i>Ochrolechia frigida</i>	< 1%		

Class G: Fluvioglacial complex with erect dwarf shrub tundra



This class represents an element of the landscape that is distinguished by its size. It is a fluvioglacial complex more than 50 km in length and 4 km in width, where scoured reliefs and a succession of gravelly sand mounds meet. It is also the most northerly representative of this complex, located just northwest of the village of Aupaluk.



Class G**Class G**

Habitat group H–Uniform tundra
Habitat type H03–Discontinuous xeric tundra
Preliminary associated plant name *Salix uva-ursi/Carex bigelowii subsp. bigelowii-Anthoxanthum monticola subsp. alpinum/Sphaerophorus globosus-Bryoria nitidula* sparse prostrate scrubland lichen
 Located on flavioglacial deposits, this type of tundra has no particular features compared to tundra found on eskers and xeric glacial deposits.



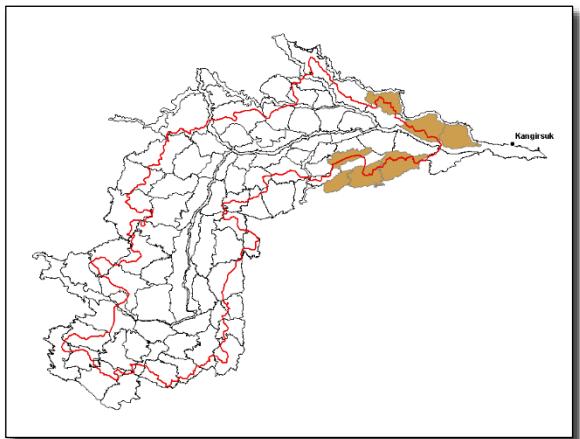
Plot #	A995A_19
Topographic situation	Rounded summit
Longitudinal slope	Convex
Transverse slope	Convex
Length of slope	Not applicable
Incline	Not applicable
Station exposure	Full
Surface deposit	2AT: Flavioglacial and glacioproximal deposits; kame
Vertical drainage	1: excessive
Oblique drainage	None
Depth reached	50 cm
Full depth of deposit	> 1 m
Type of organic matter	Not applicable
Thickness of organic matter	0
Water table depth	Not observable
Permafrost depth	Not observable



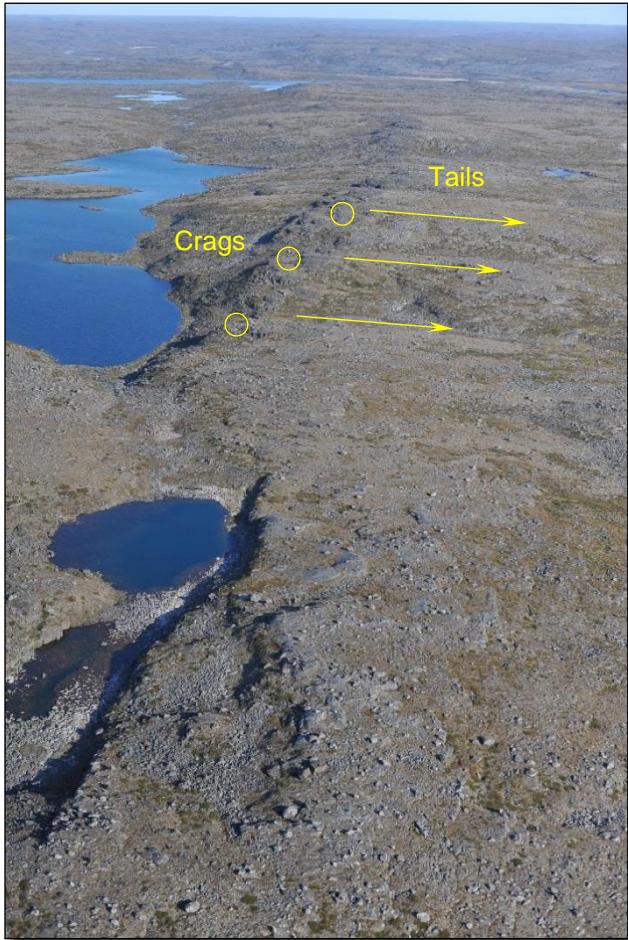
% free water	0
% bare earth	1
% rock	0
% stones	65
% litter	2
% shrubs	15
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	5
Average height of grasses	<.5 m
% bryophytes	1
% ground lichen	20
% saxicolous lichen	25

Shrubs	Cover	Height	Level
<i>Salix uva-ursi</i>	5-15%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Vaccinium vitis-idaea</i>	1-5%	Prostrate/semi-prostrate (0-15 cm)	Upper
Grasses	Cover	Height	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	1-5%	<.5 m	
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	1-5%	<.5 m	
Bryophytes	Cover		
<i>Polytrichum piliferum</i>	< 1%		
Lichens	Cover		
<i>Sphaerophorus globosus</i>	5-15%		
<i>Bryoria nitidula</i>	5-15%		
Black lichen crust	5-15%		
<i>Alectoria ochroleuca</i>	< 1%		
<i>Flavocetraria nivalis</i>	< 1%		
<i>Cladonia mitis</i>	< 1%		
<i>Thamnolia</i> sp.	< 1%		

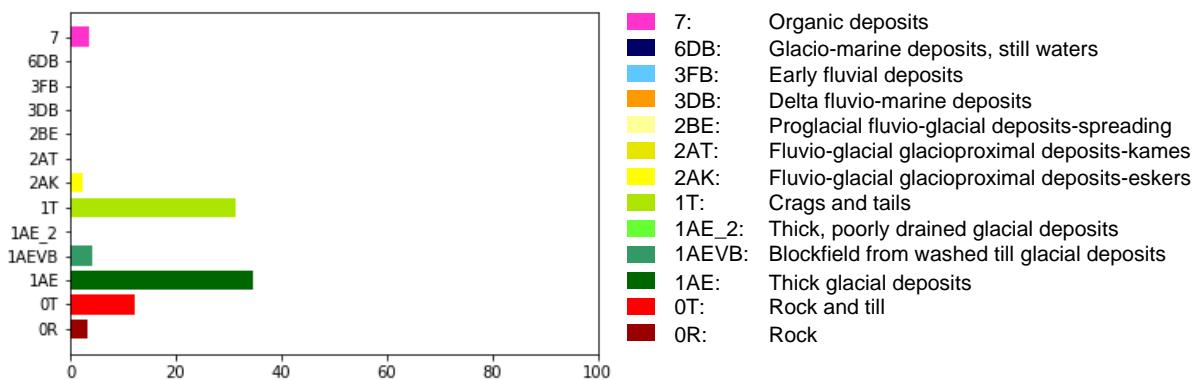
Class H: Crags and tails



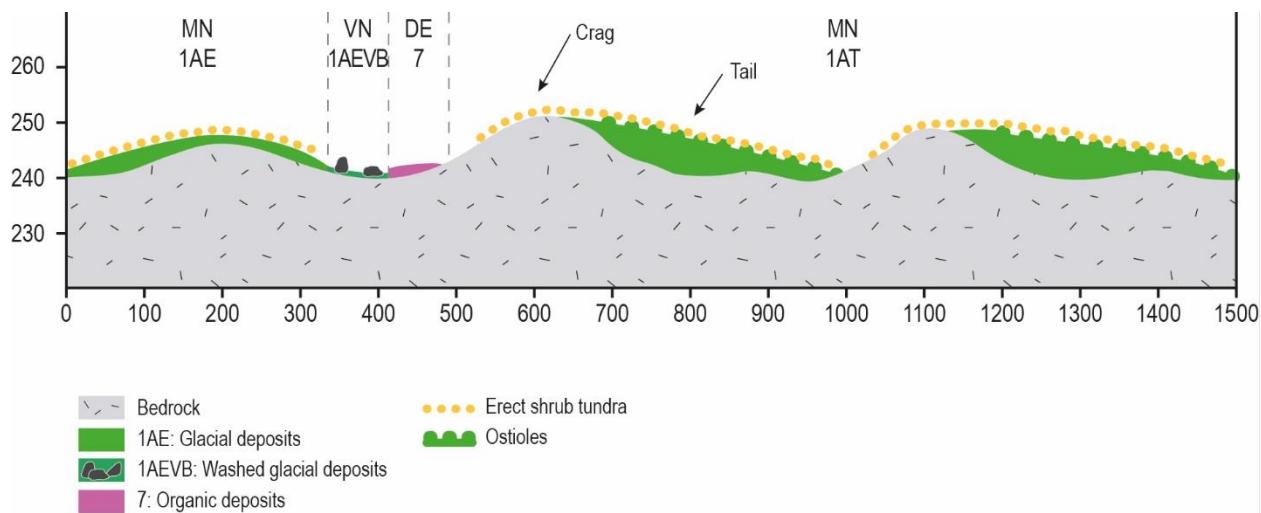
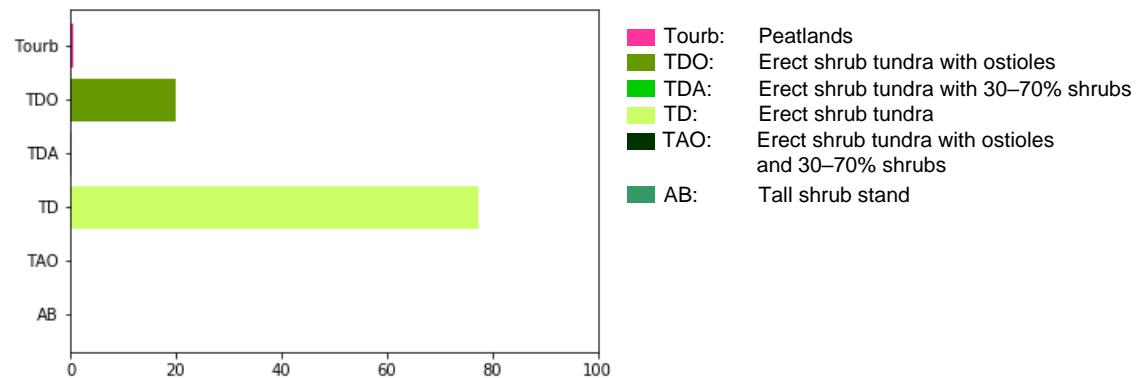
This class comprises an unusual glacial deposit which was formed accidentally. In fact, the glacial flow had to be perpendicular to the cleavage of the rock masses to create a rocky ridge from the glacial deposit (minimal in this case) and a more or less elongated ramp that ends in a point composed of glacial deposits. The geomorphological term “crag and tail” (taken literally from the Scottish) illustrates this particular shape. Vegetation is mainly tundra. Ostioles develop on the thick deposits of the ramps.



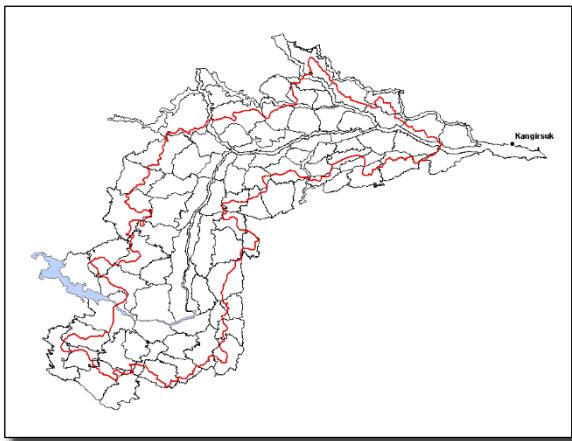
Class H



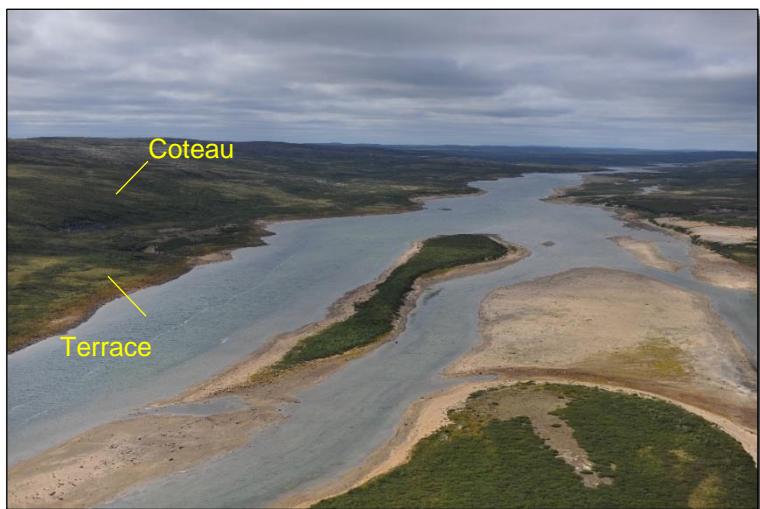
Class H



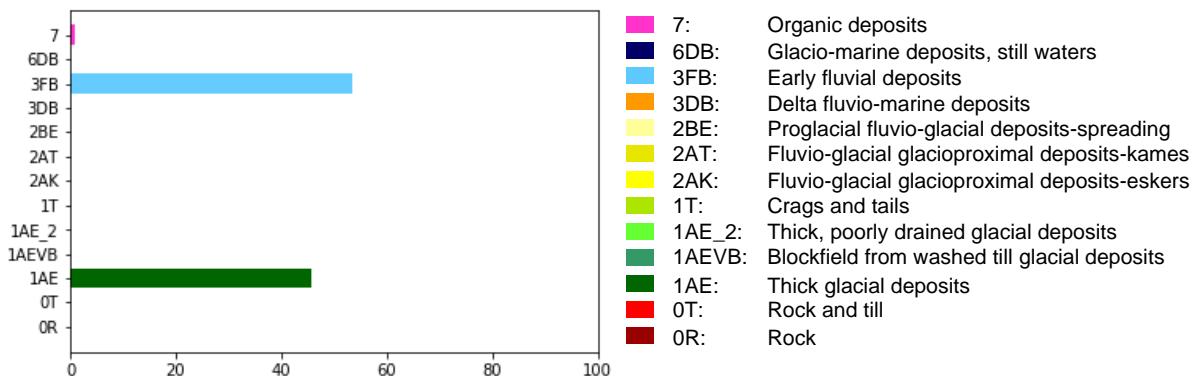
Class I: Rivière-Arnaud upstream portion



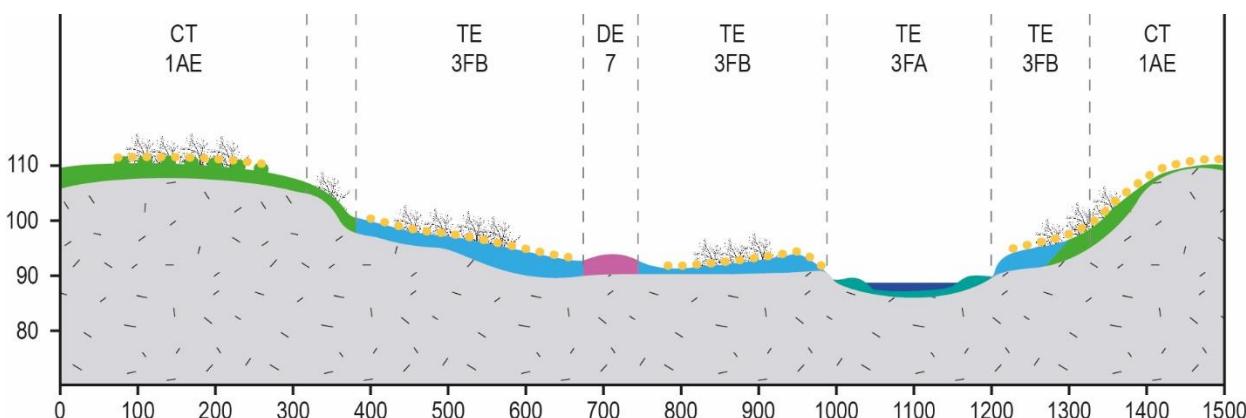
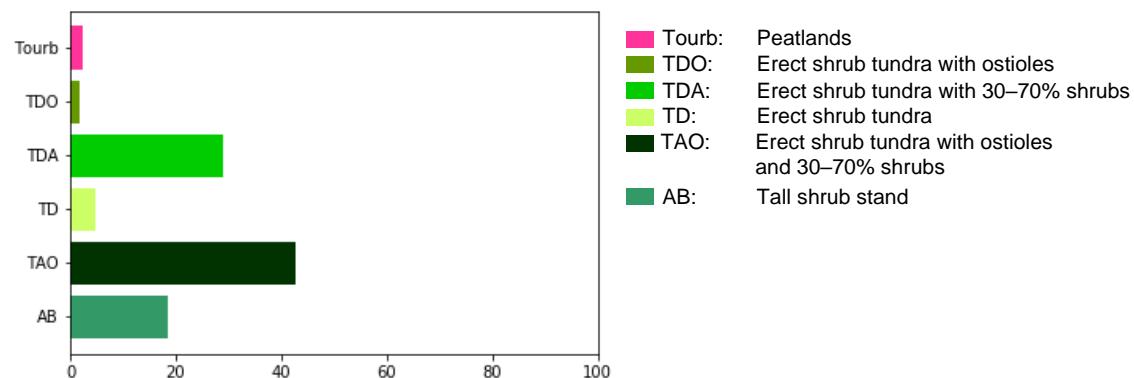
This portion corresponds to the upstream part of the river between the outlet of Lac Payne and the Sangummaq bend. This is where the river turns to the north, still flowing eastward, and the long valley slopes are covered in solifluous till. A few fluvial deltas are present along the river. Dwarf birch dominates the cover all along the riverbank, while fens develop on the early river terraces.



Class I



Class I



Habitat group H–Uniform tundra
Habitat type H03–Discontinuous xeric tundra
Preliminary associated plant name
Vaccinium vitis-idaea-Sibbaldia tridentata/Polytrichum piliferum/Stereocaulon paschale scrubland prostrate xerophile

Located on flavioglacial deposits, this tundra has no special features compared to tundra found on eskers and xeric glacial deposits.



Plot #	A989A_19
Topographic situation	Hilltop
Longitudinal slope	Irregular
Transverse slope	Irregular
Length of slope	Short (< 100 m)
Incline	2 à 5
Station exposure	South-southeast
Surface deposit	3FBE: Alluvial, fluvial deposits; early; thick
Vertical drainage	1: Excessive
Oblique drainage	None
Depth reached	100 cm
Full depth of deposit	> 1m
Type of organic matter	Not applicable
Thickness of organic matter	0
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0
% bare earth	10
% rock	0
% stones	1
% litter	1
% shrubs	75
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	1
Average height of grasses	< .5 m
% bryophytes	10
% ground lichen	20
% saxicolous lichen	0

Shrubs	Cover	Height	Level
<i>Vaccinium vitis-idaea</i>	50 à 75%	Prostrate/semi-prostrate (0-15)	Upper
<i>Sibbaldia procumbens</i>	< 1%	Prostrate/semi-prostrate (0-15)	Upper
Grasses	Cover	Height	
<i>Sibbaldia tridentata</i>	25-50%	< 0.5 m	
<i>Stellaria longipes</i> subsp. <i>longipes</i>	< 1%	< 0.5 m	
Bryophytes	Cover		
<i>Polytrichum piliferum</i>	5-15%		
Lichens	Cover		
<i>Stereocaulon paschale</i>	15-25%		
<i>Bryoria nitidula</i>	1-5%		
<i>Flavocetraria cucullata</i>	< 1%		
<i>Flavocetraria nivalis</i>	< 1%		
<i>Alectoria ochroleuca</i>	< 1%		
<i>Cladonia stellaris</i>	< 1%		
<i>Cetraria nigricans</i>	< 1%		

Habitat group E-Periglacial peatlands
Habitat type E01-Ice wedge bog
Preliminary associated plant name *Rubus chamaemorus-Rhododendron tomentosum-Vaccinium vitis-idaea/* peat scrubland prostrate spp
lichens

This is an example of an ice wedge bog. It results from water freezing in the thermal shrinkage cracks. The cracks form an irregular polygonal network of about ten metres in size. The dominant vegetation is equivalent what is found on the ombrotrophic palsae, except for the cracks. This is a rare environment due to the unusual concentration of *Rubus chamaemorus*.



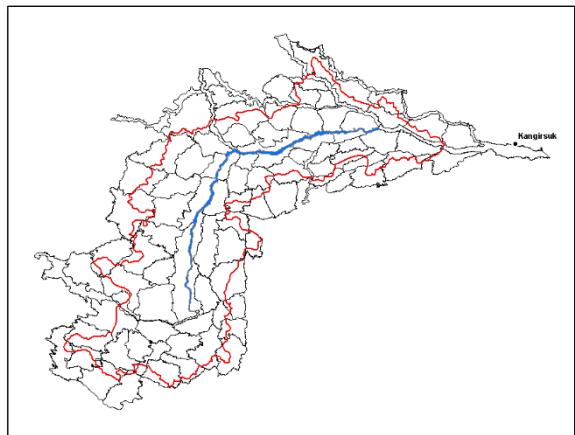
Plot #	A308A_19
Topographic situation	Open depression
Longitudinal slope	Regular
Transverse slope	Convex
Length of slope	Long (> 200 m)
Incline	0–2%
Station exposure	Full
Surface deposit	7O: Organic deposits; ombrotrophic
Vertical drainage	6: Very poor
Oblique drainage	None
Depth reached	60 cm
Full depth of deposit	> 1 m
Type of organic matter	Mesic (Om)
Thickness of organic matter	45 cm
Water table depth	Not observable
Permafrost depth	60 cm



% free water	0
% bare earth	0
% rock	0
% stones	0
% litter	15
% shrubs	60
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	3
Average height of grasses	< .5 m
% bryophytes	5
% ground lichen	20
% saxicolous lichen	0

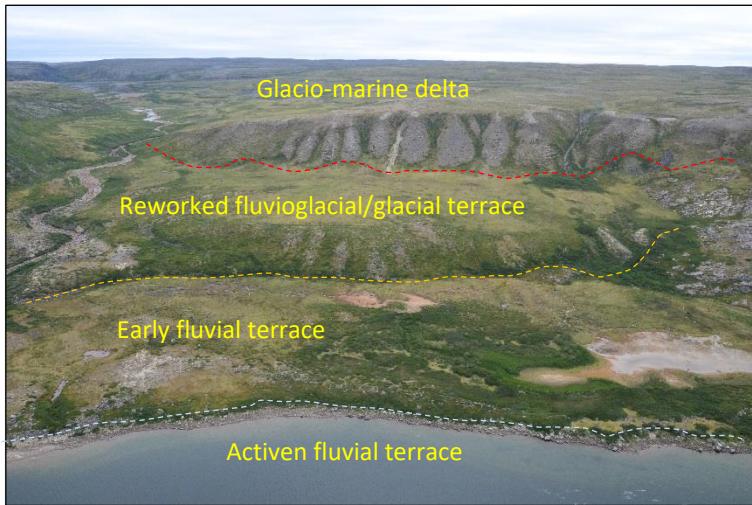
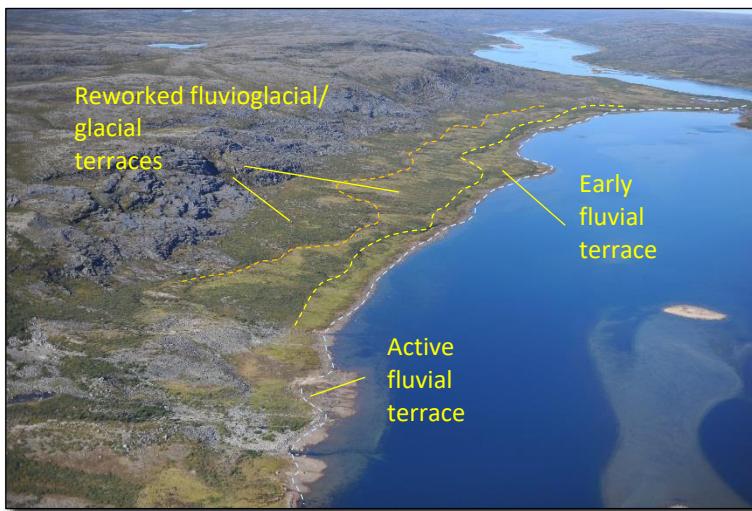
Shrubs	Cover	Height	Level
<i>Rubus chamaemorus</i>	25–50%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Vaccinium vitis-idaea</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Eriophorum vaginatum</i> var. <i>spissum</i>	1–5%	< .5 m	
Bryophytes	Cover		
<i>Dicranum elongatum</i>	< 1%		
Lichens	Cover		
<i>Ochrolechia frigida</i>	5–15%		
<i>Cladonia stygia</i>	5–15%		
<i>Flavocetraria cucullata</i>	< 1%		
<i>Flavocetraria nivalis</i>	< 1%		
<i>Alectoria ochroleuca</i>	< 1%		
<i>Cladonia borealis</i>	< 1%		

Class J: Downstream portion of Rivière-Arnaud

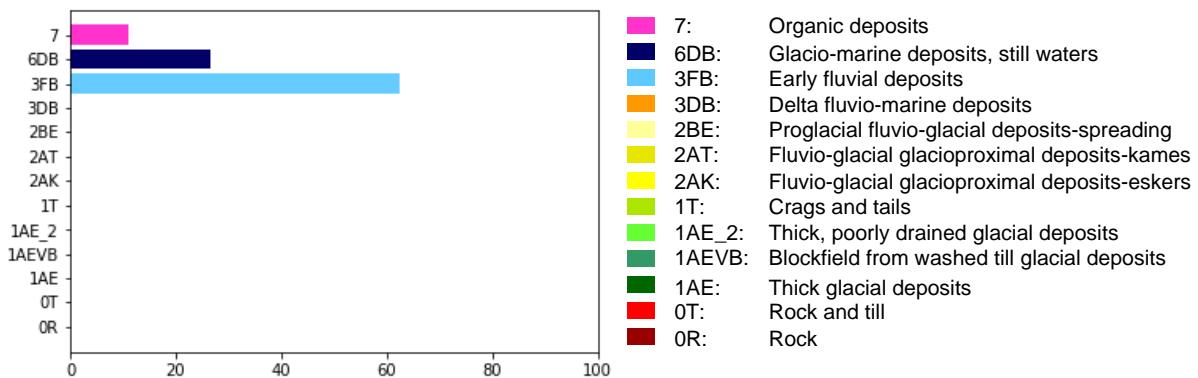


This portion of Rivière-Arnaud is located between the Sangummaq bend and the mouth of Rivière-Vachon. The river flows north to the mouth of Rivière-Lepellé then eastward. The valley slopes are hillsides of varying lengths, cut by embankments that evidence the periods of pause in the retreat of the waters of the Iberville Sea. The drier parts of the slopes support dwarf birch scrublands, while on the upstream portion, wetlands develop. The marginal slope demarcates the boundary of the active channel and supports stands of dwarf birch, alder and willow (infrequently) at the mouths of smaller streams.

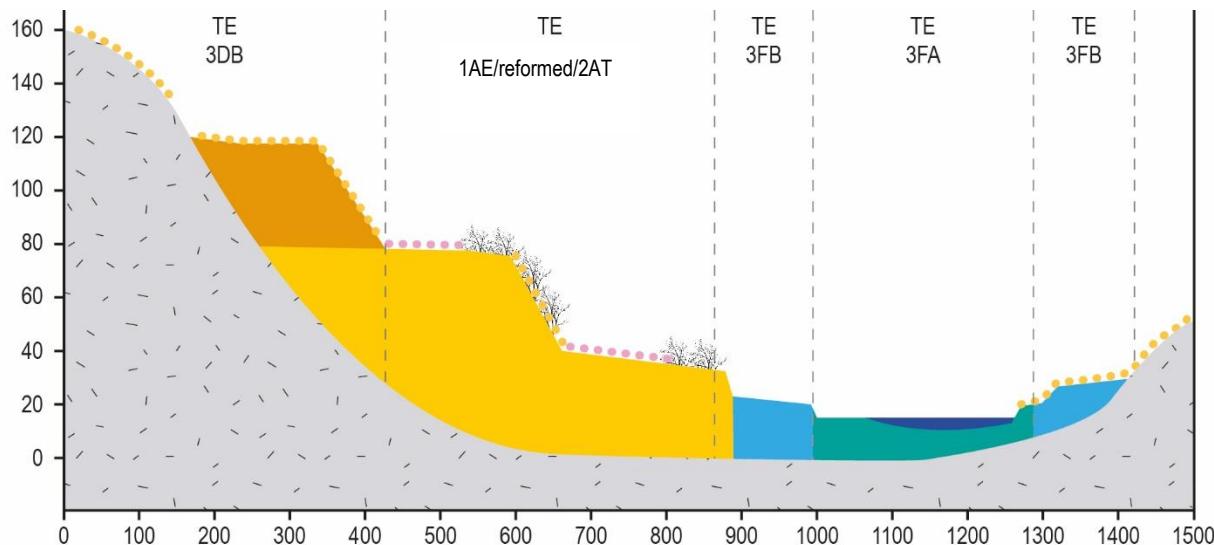
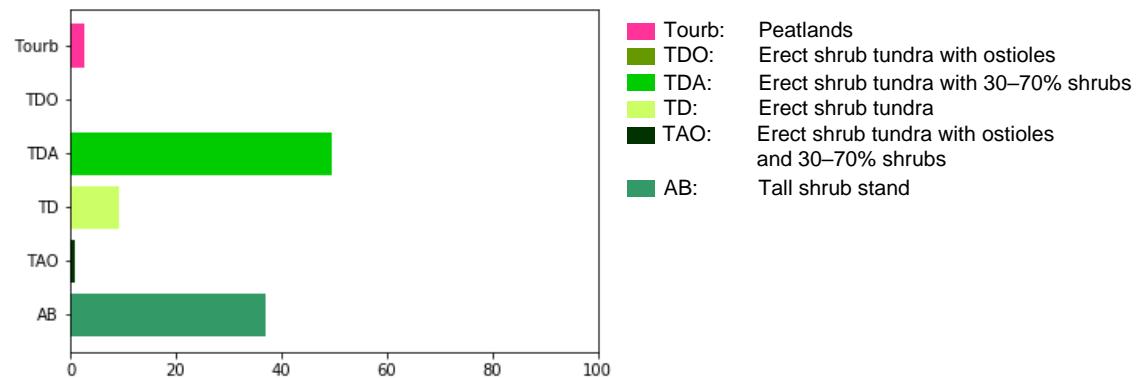
The hillsides are abutted by steeper and more spectacular rocky slopes. Downstream, the channel is wider and one can observe a succession of very well-defined terraces on the right bank. If their final shape is undoubtedly linked to action by glaciomarine waters, the origin of the deposit is more likely glacial and fluvioglacial. The slopes, terraces, gorges, glaciomarine deltas, and glaciomarine depositional valleys are mostly located on the right bank of the river. This is due to the direction of glacial flow and glacial melt water that originated in the southwest during the late glacial period (10,000 to 7,500 BP) and crossed the valley from the south at this point (Lauriol, 1982).



Class J



Class J

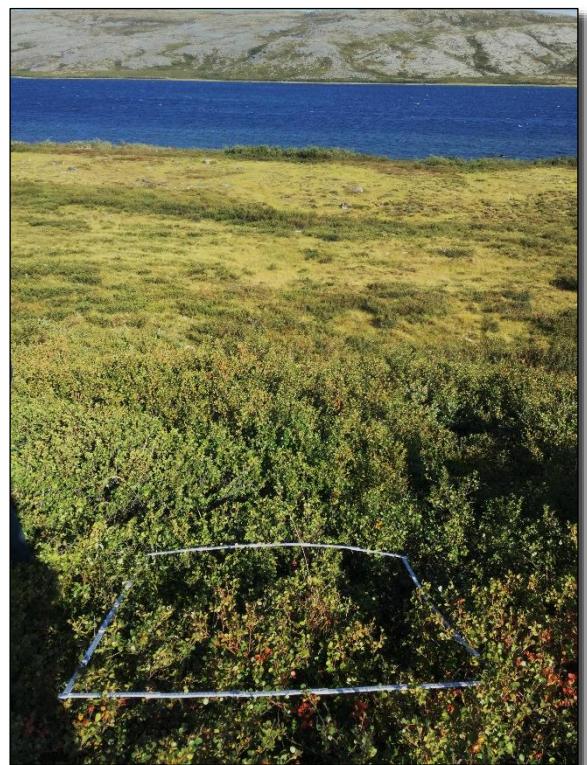


Habitat group H–Uniform tundra
Habitat type H06–Low shrubby tundra
Preliminary associated plant name
*Betula glandulosa-Empetrum nigrum subsp.
hermafroditum* prostrate scrubland shrub

This low formation is found on the edges and slopes of the terraces. The dwarf birch trees, ranging in size from 40 centimetres to 1 metre, cover the entire plot of land.



Plot #	A971B_19
Topographic situation	Gentle slope
Longitudinal slope	Convex
Transverse slope	Convex
Length of slope	Short (< 100 m)
Incline	15 à 30%
Station exposure	North-northwest
Surface deposit	2BE: Fluvioglacial, proglacial deposits; spreading
Vertical drainage	2: Good
Oblique drainage	None
Depth reached	40 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	6 cm
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	0
% stones	0
% litter	5
% shrubs	100
Average shrub height	Low (40-100 cm)
% grasses	5
Average height of grasses	< .5 m
% bryophytes	2
% ground lichen	0
% saxicolous lichen	0

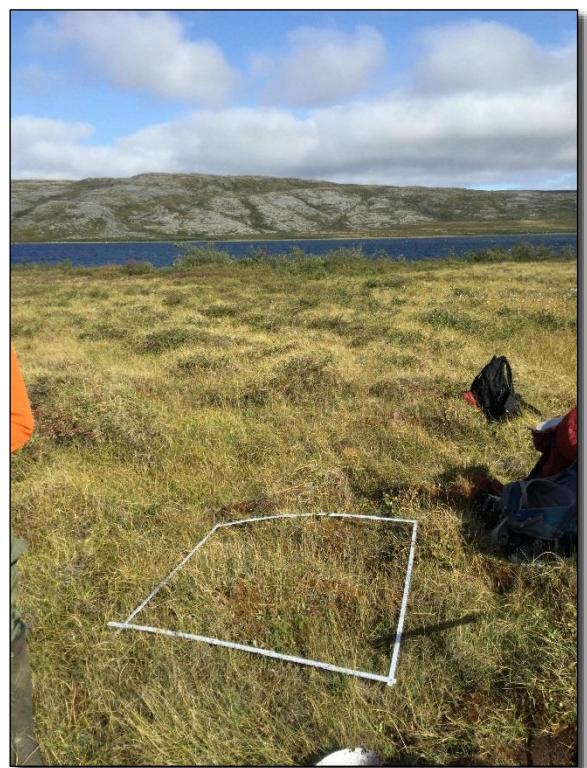
Shrubs	Cover	Height	Level
<i>Empetrum nigrum</i> subsp. <i>hermaphroditum</i>	75–100%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Betula glandulosa</i>	50–75%	Bas (40-100 cm)	Upper
<i>Vaccinium vitis-idaea</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Vaccinium uliginosum</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Salix glauca</i> var. <i>cordifolia</i>	1–5%	Erect dwarf (15-40 cm)	Lower
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Calamagrostis lapponica</i>	1–5%	< .5 m	
<i>Carex bigelowii</i> subsp. <i>bigelowii</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Ptilidium ciliare</i>	1–5%		
Lichens	Cover		

Habitat group C–Uniform peatlands
Habitat type C07–Arctic fen
Preliminary associated plant name *Carex rariflora-Carex rotundata/Sphagnum steerei-Scorpidium revolvens*, peat scrubland

The peatlands develop on the flats that occupy a large part of the terrace.



Plot #	A971D_19
Topographic situation	Flats
Longitudinal slope	Regular
Transverse slope	Concave
Length of slope	Short (< 100 m)
Incline	2–5%
Station exposure	Full
Surface deposit	7MT: Organic deposits; minerotrophic; on till, sand and gravel
Vertical drainage	6: Very poor
Oblique drainage	Present
Depth reached	55 cm
Full depth of deposit	> 1m
Type of organic matter	Fibrous (Of)
Thickness of organic matter	35 cm
Water table depth	10 cm
Permafrost depth	55 cm



% free water	0
% bare earth	0
% rock	0
% stones	50
% litter	20
% shrubs	Prostrate/semi-prostrate (0-15 cm)
Average shrub height	50
% grasses	< 0.5
Average height of grasses	85
% bryophytes	0
% ground lichen	0
% saxicolous lichen	0

Shrubs	Cover	Height	Level
<i>Salix arcupperhila</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Andromeda polifolia</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Betula glandulosa</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Upper
Grasses	Cover	Height	
<i>Carex rariflora</i>	25–50%	< .5 m	
<i>Carex rotundata</i>	5–15%	< .5 m	
<i>Eriophorum angustifolium</i> subsp. <i>angustifolium</i>	1–5%	< .5 m	
Bryophytes	Cover		
<i>Sphagnum steerei</i>	50–75%		
<i>Scorpidium revolvens</i>	1–5%		
<i>Sphagnum subfulvum</i>	1–5%		
<i>Sarmentypnum sarmentosum</i>	1–5%		
<i>Loeskyphnum badium</i>	< 1%		
<i>Oncophorus wahlenbergii</i>	< 1%		
Lichens	Cover		

Habitat group	B—Aquatic and wet mineralized environments (non tundroid)
Habitat type	B04—Shrub swamp (alder/willow/myrtle)
Preliminary associated plant name	<i>Salix planifolia-Alnus alnobetula subsp. crispa- Ribes glandulosum/Calamagrostis canadensis-Solidago macrophylla</i>

These formations occur on the slopes just above the active river terrace and at the mouths of small streams emptying into to Rivière-Arnaud. Interestingly, they represent islands of boreal vegetation throughout the tundra. The density and height of the cover, as well as significant snow cover, provide favourable microclimatic conditions for the development of more southerly species, as shown by the presence of *Ribes glandulosum* and a procession of herbaceous species.



Plot #	A971E_19
Topographic situation	Lower slope
Longitudinal slope	Convex
Transverse slope	Irregular
Length of slope	Short (< 100 m)
Incline	10–15%
Station exposure	North-northwest
Surface deposit	2BE: Fluvioglacial, proglacial deposits; spreading
Vertical drainage	3: Moderate
Oblique drainage	None
Depth reached	0
Full depth of deposit	0
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	8 cm
Water table depth	Not observable
Permafrost depth	Not observable



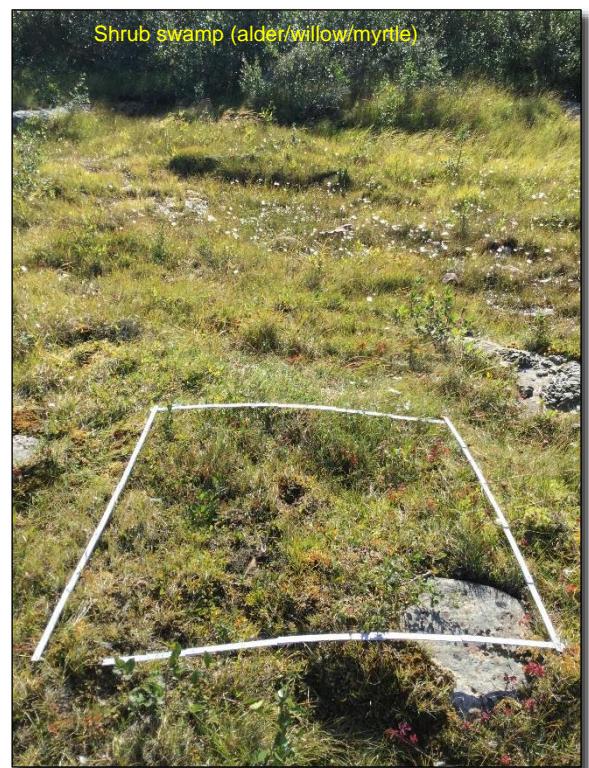
% free water	0
% bare earth	0
% rock	0
% stones	0
% litter	100
% shrubs	95
Average shrub height	Tall (> 150 cm)
% grasses	95
Average height of grasses	> .5 m
% bryophytes	2
% ground lichen	0
% saxicolous lichen	0

Shrubs	Cover	Height	Level
<i>Salix planifolia</i>	50–75%	Tall (> 150 m)	Upper
<i>Betula glandulosa</i>	25–50%	Tall (> 150 m)	Upper
<i>Ribes glandulosum</i>	15–25%	Erect dwarf (15-40 m)	Lower
<i>Alnus alnobetula</i> subsp. <i>crispa</i>	1–5%	Tall (> 150 m)	Upper
<i>Rubus arcticus</i> subsp. <i>acaulis</i>	< 1%	Prostrate/semi-prostrate (0-15 m)	Lower
Grasses	Cover	Height	
<i>Calamagrostis canadensis</i>	75 à 100%	< .5 m	
<i>Solidago macrophylla</i>	15–25%	< .5 m	
<i>Linnaea borealis</i> subsp. <i>longiflora</i>	1–5%	< .5 m	
<i>Lycopodium annotinum</i>	1–5%	< .5 m	
<i>Pyrola minor</i>	< 1%	< .5 m	
<i>Stellaria borealis</i> subsp. <i>borealis</i>	Beyond plot		
Bryophytes	Cover		
<i>Calliergon cordifolium</i>	1–5%		
<i>Sanionia uncinata</i>	1–5%		
Lichens	Cover		

Habitat group H–Uniform tundra
Habitat type H04–Prostrate shrub tundra
Preliminary associated plant name *Salix arcupperhila-Andromeda polifolia/Carex rariflora/Sphagnum compactum-S. arcticum*, prostrate riparian scrubland



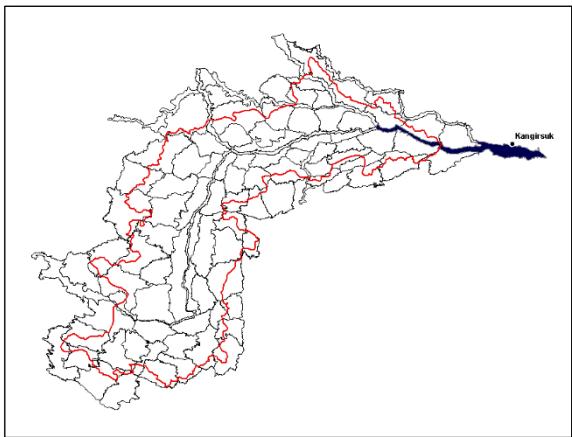
Plot #	A971F_19
Topographic situation	Flat
Longitudinal slope	Irregular
Transverse slope	Irregular
Length of slope	Short (< 100 m)
Incline	0–2%
Station exposure	Full
Surface deposit	3FAE: Active alluvial and fluvial deposits; active; thick
Vertical drainage	5: Poor
Oblique drainage	Not applicable
Depth reached	120 cm
Full depth of deposit	> 1 m
Type of organic matter	Not applicable
Thickness of organic matter	0 cm
Water table depth	20 cm
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	15
% stones	20
% litter	60
% shrubs	Prostrate/semi-prostrate (0-15 cm)
Average shrub height	40
% grasses	< 0.5
Average height of grasses	80
% bryophytes	0
% ground lichen	15
% saxicolous lichen	0

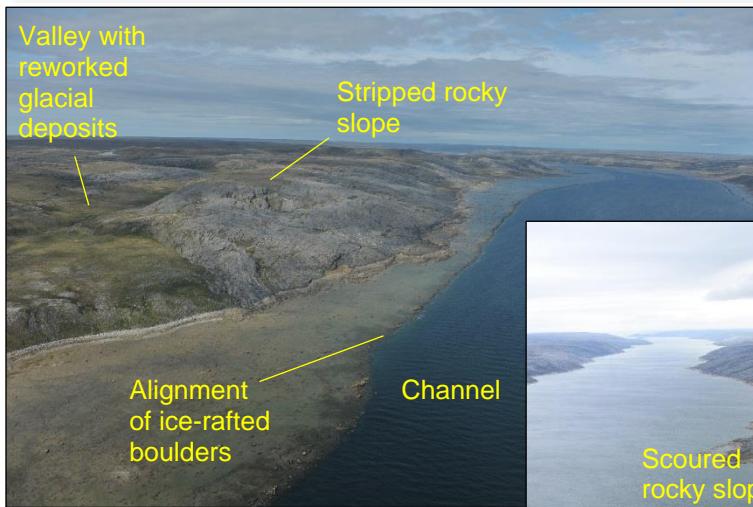
Shrubs	Cover	Height	Level
<i>Andromeda polifolia</i>	25–50%	Prostrate/semi-prostrate (0-15 m)	Lower
<i>Salix arcupperhila</i>	25–50%	Prostrate/semi-prostrate (0-15 m)	Lower
<i>Alnus alnobetula subsp. <i>crispa</i></i>	1–5%	Prostrate/semi-prostrate (0-15 m)	Upper
<i>Salix planifolia</i>	1–5%	Prostrate/semi-prostrate (0-15 m)	Upper
<i>Betula glandulosa</i>	1–5%	Prostrate/semi-prostrate (0-15 m)	Upper
<i>Rhododendron groenlandicum</i>	1–5%	Prostrate/semi-prostrate (0-15 m)	Upper
Grasses	Cover	Height	
<i>Carex rariflora</i>	15–25%	< .5 m	
<i>Comarum palustre</i>	5–15%	< .5 m	
<i>Carex saxatilis</i>	5–15%	< .5 m	
<i>Eriophorum angustifolium subsp. <i>angustifolium</i></i>	1–5%	< .5 m	
<i>Tofieldia pusilla</i>	< 1%	< .5 m	
<i>Calamagrostis stricta subsp. <i>stricta</i></i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Sphagnum compactum</i>	15–25%		
<i>Sphagnum subfulvum</i>	15–25%		
<i>Sphagnum arcticum</i>	15–25%		
<i>Aulacomnium palustre</i>	5–15%		
<i>Aulacomnium turgidum</i>	1–5%		
<i>Sphagnum squarrosum</i>	1–5%		
<i>Polytrichum jensenii</i>	1–5%		
<i>Sphagnum steerei</i>	1–5%		
<i>Anthelia juratzkana</i>	1–5%		
<i>Straminergon stramineum</i>	< 1%		
<i>Sphagnum arcticum</i>	< 1%		
Lichens	Cover		

Class K: Rivière-Arnaud estuary

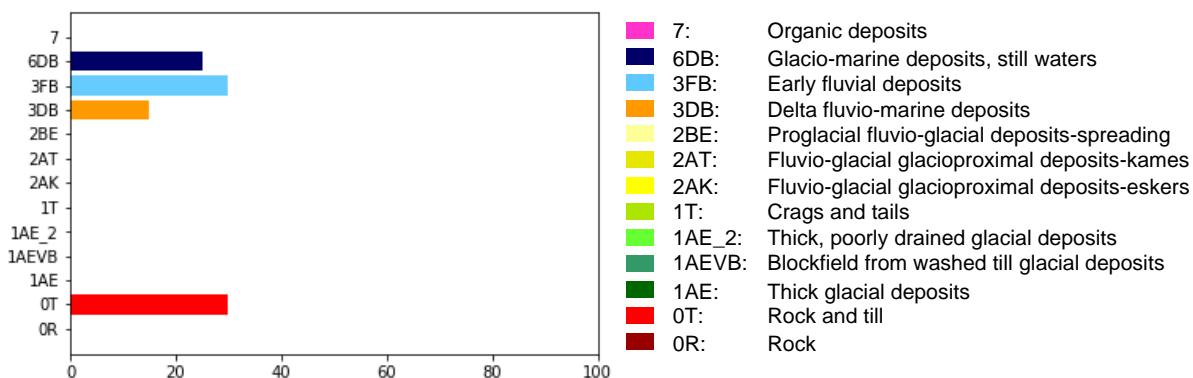


This is the section of the Rivière-Arnaud located between the mouth of Rivière-Vachon and its own mouth, in the vicinity of the village of Kangirsuk. The Rivière-Arnaud flows eastward and is tidally influenced throughout this section. High tides range from 7.2 to 10.9 metres and it is not uncommon to observe a rapid and dramatic rise of water. At low tide, the channel is bordered on both sides by a line of ice-raftered boulders that demarcate the limits of the channel. The slopes have been almost completely scoured by the waters of the Iberville Sea. This allows us to observe the gabbro dykes embedded in the

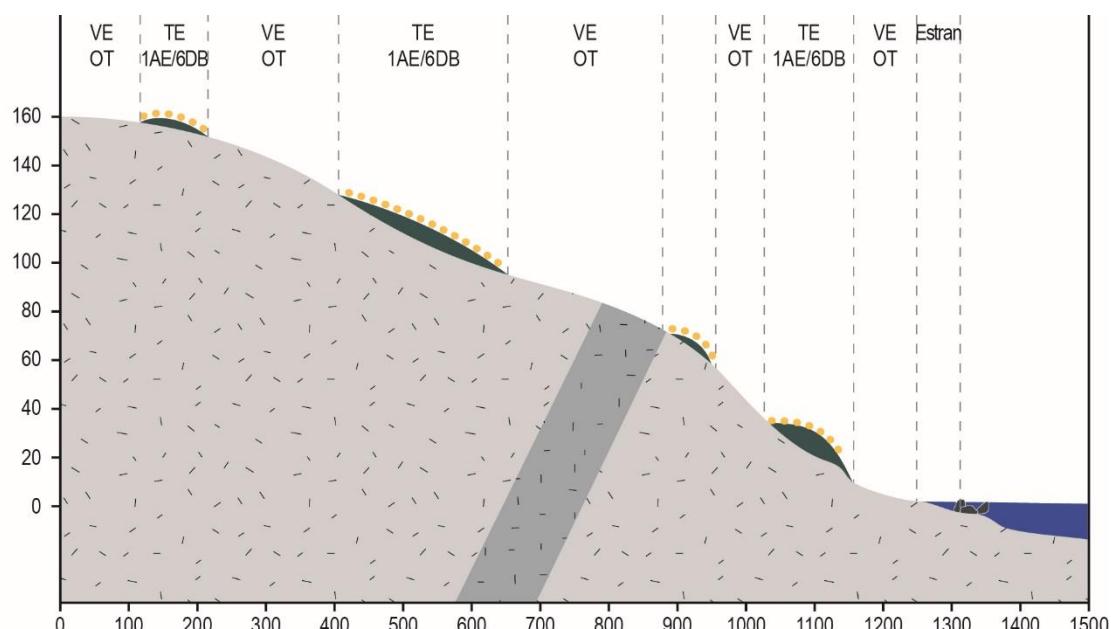
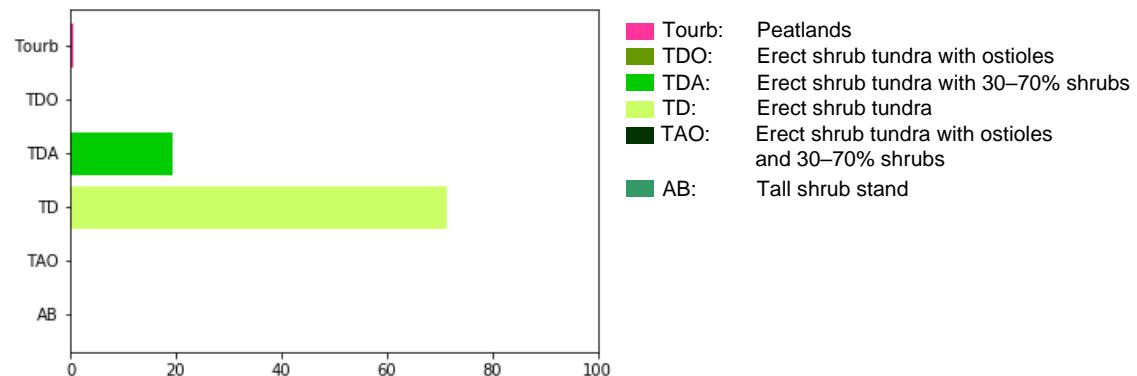
bedrock, mainly composed of gneiss. Only a few scattered valleys still show deposits reworked by the waters of the Iberville Sea.



Class K



Class K



Bedrock

Dyke

1AE/6DB : Glacial or estuarial marine deposits

Hydrography

Erect shrub tundra

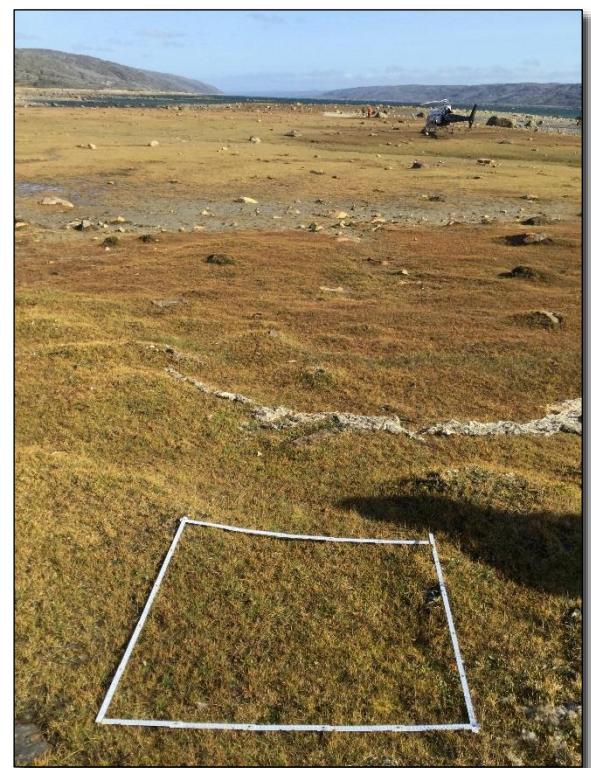
Ice-raftered boulders

Habitat group A–Marine and estuarine environments
Habitat type A01–Salt/brine marsh
Preliminary associated plant name *Carex subspathacea-Euphrasia wettsteinii-Agrostis mertensii/Polytrichum jensenii-Sarmentypnum exannulatum* briny shrubland

Brackish marshes are very rare in the protected area, for two reasons: first, the water is brackish only up to the mouth of Rivière-Vachon, which accounts for only about 20 km of the 220 km of river in the project; second, marshes require a high water area with fine matter in order to develop. These conditions are only found at the mouths of the rivers that flow into Rivière-Arnaud and these conditions are only found in two locations within the protected area reserve.



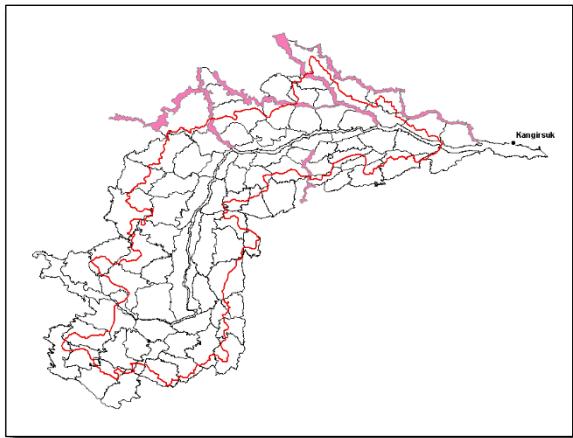
Plot #	A969B_19
Topographic situation	Hilltop
Longitudinal slope	Regular
Transverse slope	Convex
Length of slope	Zero
Incline	5–10%
Station exposure	East-southeast
Surface deposit	6DBE: Coastal, early glaciomarine, low beach deposits; thick
Vertical drainage	5: Poor
Oblique drainage	Not applicable
Depth reached	30 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	1
Water table depth	0 cm
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	0
% stones	2
% litter	1
% shrubs	5
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	85
Average height of grasses	< .5 m
% bryophytes	90
% ground lichen	0
% saxicolous lichen	0

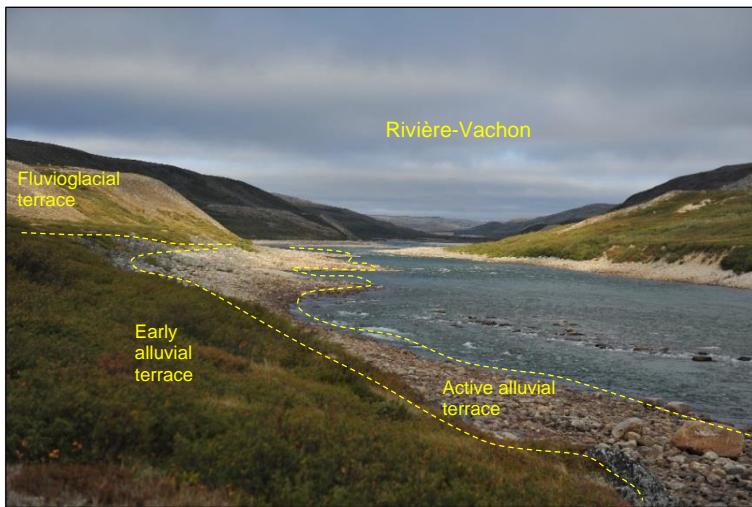
Shrubs	Cover	Height	Level
<i>Salix arctica</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Betula glandulosa</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Salix herbacea</i>	< 1%	Prostrate/semi-prostrate (0-15 cm)	Upper
Grasses	Cover	Height	
<i>Carex subspathacea</i>	50–75%	< .5 m	
<i>Euphrasia wettsteinii</i>	15–25%	< .5 m	
<i>Agrostis mertensii</i>	15–25%	< .5 m	
<i>Potentilla anserina</i> subsp. <i>egedi</i>	5–15%	< .5 m	
<i>Carex glareosa</i> subsp. <i>glareosa</i>	1–5%	< .5 m	
Bryophytes	Cover		
<i>Sarmentypnum exannulatum</i>	25–50%		
<i>Polytrichum jensenii</i>	25–50%		
<i>Aulacomnium palustre</i>	15–25%		
<i>Cephaloziella varians</i>	1–5%		
<i>Pohlia</i> sp.	< 1%		
<i>Hamatocaulis vernicosus</i>	< 1%		
Lichens	Cover		

Class L: Rivière-Arnaud tributaries

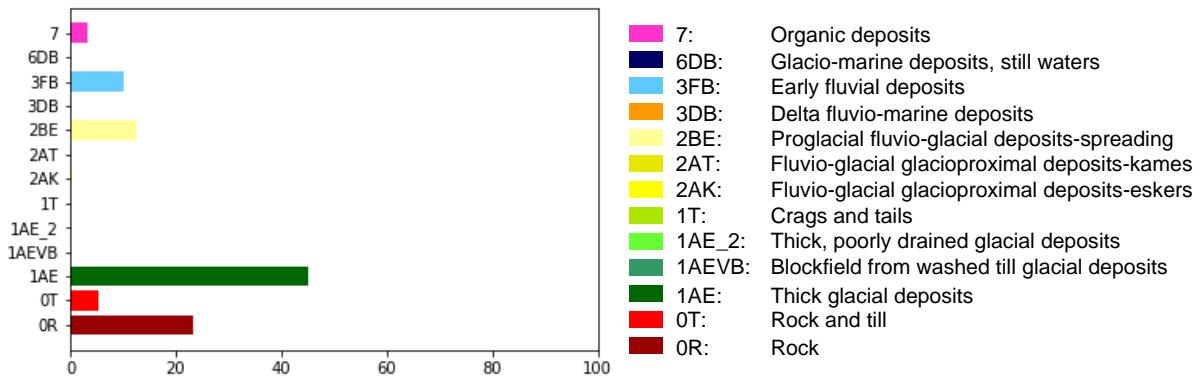


Most of the topographic units in this class are found on the left bank of Rivière-Arnaud. It is a very heterogeneous class. The four main valleys are watered by the Buet, Vachon, Lepellé, and Hamelin rivers. The first three were partially flooded by the waters of the prehistoric Iberville Sea. Their profiles are identical, although to a lesser extent, to the upstream sector of Rivière-Arnaud, with perched glaciomarine deltas, reworked fluvioglacial terraces and alluvial terraces. The Rivière-Lestage, a tributary of Rivière-Vachon, is unique in that it flows in the axis of a fluvioglacial complex. The Rivière-

Hamelin has its source in the large Lac Tasialujjuaq. It crosses three glaciofluvial complexes and ends its course through a valley that is perpendicular to Rivière-Arnaud. The Lestage and Groust rivers are tertiary watercourses with low slopes and early and active alluvial terraces. The mouth of Rivière-Vachon demarcates the end of the present tidal influence on the Rivière-Arnaud estuary.

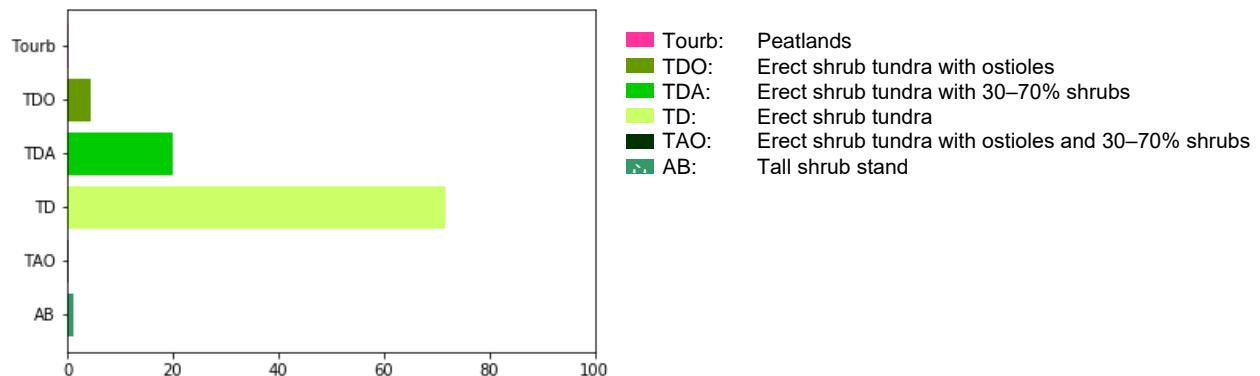


Class L

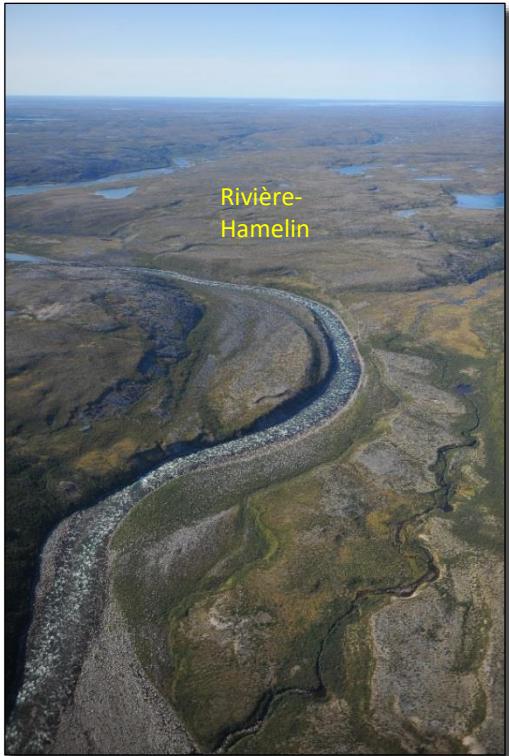


- 7: Organic deposits
- 6DB: Glacio-marine deposits, still waters
- 3FB: Early fluvial deposits
- 3DB: Delta fluvio-marine deposits
- 2BE: Proglacial fluvio-glacial deposits-spreading
- 2AT: Fluvio-glacial glacioproximal deposits-kames
- 2AK: Fluvio-glacial glacioproximal deposits-eskers
- 1T: Crags and tails
- 1AE_2: Thick, poorly drained glacial deposits
- 1AEVB: Blockfield from washed till glacial deposits
- 1AE: Thick glacial deposits
- 0T: Rock and till
- OR: Rock

Class L



Rivière-Hamelin



Habitat group H–Uniform tundra
Habitat type H03–Discontinuous xeric tundra
Preliminary associated plant name *Cassiope tetragona* var. *tetragona* - *Rhododendron tomentosum* subsp. *subarcticum*/ *Anthoxanthum monticola* subsp. *alpinum*/ *Bryoria nitidula*-*Cetraria nigrans*
 prostrate lichen

Xeric erect shrub tundra is found mainly on glaciofluvial deposits (esker or outwash) here. The coarse gravelly sand deposits have excessive drainage, and organic matter is almost non-existent. Lichens and *Cassiopeia* dominate.



Plot #	A059B_19
Topographic situation	Gentle slope
Longitudinal slope	Regular
Transverse slope	Regular
Length of slope	Short (< 100 m)
Incline	30 à 60%
Station exposure	Northern
Surface deposit	2BE: fluvioglacial and proglacial deposits; spreading
Vertical drainage	1: Excessive
Oblique drainage	None
Depth reached	140 cm
Full depth of deposit	> 1 m
Type of organic matter	Not observable
Thickness of organic matter	0 cm
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0	
% bare earth	5	
% rock	0	
% stones	30	
% litter	2	
% shrubs	30	
Average shrub height	Prostrate/semi-prostrate (0-15 cm)	
% grasses	3	
Average height of grasses	< .5 m	
% bryophytes	2	
% ground lichen	35	
% saxicolous lichen	5	

Shrubs	Cover	Height	Level
<i>Cassiope tetragona</i> var. <i>tetragona</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Upper
<i>Vaccinium vitis-idaea</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	1–5%	< .5 m	
<i>Luzula confusa</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Dicranum elongatum</i>	1–5%		
<i>Racomitrium lanuginosum</i>	< 1%		
<i>Polygonatum urnigerum</i>	< 1%		
Lichens	Cover		
<i>Bryoria nitidula</i>	15–25%		
<i>Alectoria ochroleuca</i>	5–15%		
<i>Cetraria nigricans</i>	5–15%		
<i>Flavocetraria nivalis</i>	1–5%		
<i>Sphaerophorus globosus</i>	< 1%		
<i>Bryocaulon divergens</i>	< 1%		
<i>Cladonia decorticata</i>	< 1%		

Unusual habitats

Habitat group I-Structured soil tundra

Habitat type I04-Striated soil tundra

Preliminary associated plant name Prostrate basiphilic *Vaccinium uliginosum*-*Salix uva-ursi*-*Rhododendron lapponicum*/*Dicranum elongatum*

This type of tundra is quite rare in the area. It results from a combination of ostiolation and solifluction processes. The ostioles are elongated in the direction of the slope and form in this case a radiant network since it develops on a dome at the top of a relief.



Lot #	A990A_19
Topographic situation	Hilltop
Longitudinal slope	Convex
Transverse slope	Convex
Length of slope	Short (< 100 m)
Incline	5–10%
Station exposure	Southern
Surface deposit	8CAE: Alteration and slope deposits; colluvium; active; thick
Vertical drainage	3: Moderate
Oblique drainage	Present
Depth reached	70 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L,F,H)
Thickness of organic matter	1 cm
Water table depth	Not observable
Permafrost depth	Not observable



% free water	0
% bare earth	0
% rock	0
% stones	10
% litter	1
% shrubs	80
Average shrub height	Prostrate/semi-prostrate (0-15 cm)
% grasses	2
Average height of grasses	< .5 m
% bryophytes	30
% ground lichen	15
% saxicolous lichen	8

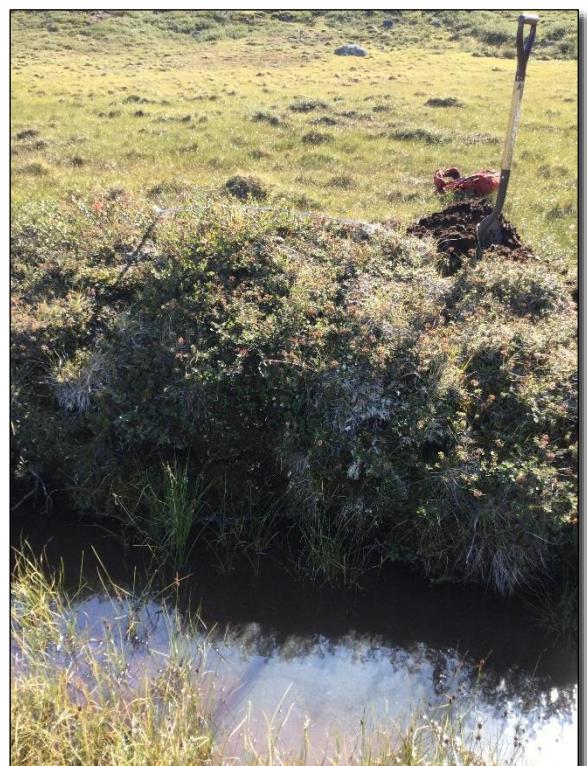
Shrubs	Level	Cover	Height
<i>Vaccinium uliginosum</i>	Upper	50–75%	Prostrate/semi-prostrate (0-15 cm)
<i>Salix uva-ursi</i>	Upper	15–25%	Prostrate/semi-prostrate (0-15 cm)
<i>Arctous alpina</i>	Upper	5–15%	Prostrate/semi-prostrate (0-15 cm)
<i>Rhododendron lapponicum</i>	Upper	5–15%	Prostrate/semi-prostrate (0-15 cm)
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	Upper	1–5%	Prostrate/semi-prostrate (0-15 cm)
<i>Diapensia lapponica</i> var. <i>lapponica</i>	Upper	< 1%	Prostrate/semi-prostrate (0-15 cm)
Grasses		Cover	Height
<i>Oxytropis campestris</i> var. <i>minor</i>		1–5%	< .5 m
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>		1–5%	< .5 m
<i>Huperzia selago</i>		< 1%	< .5 m
Bryophytes		Cover	
<i>Dicranum elongatum</i>		25–50%	
<i>Ptilidium ciliare</i>		1–5%	
<i>Rhytidium rugosum</i>		1–5%	
<i>Aulacomnium turgidum</i>		1–5%	
<i>Polytrichum strictum</i>		1–5%	
<i>Cephaloziella varians</i>		1–5%	
<i>Polytrichum piliferum</i>		< 1%	
Lichens		Cover	
<i>Ochrolechia frigida</i>		5–15%	
Black lichenic crust		5–15%	
<i>Ochrolechia androgyna</i>		1–5%	
<i>Flavocetraria nivalis</i>		< 1%	
<i>Flavocetraria cucullata</i>		< 1%	
<i>Stereocaulon glareosum</i>		< 1%	
<i>Proupperannaria pezizoides</i>		< 1%	

Habitat group E-Periglacial peatlands
Habitat type E05-Palsa fen/plateau
Preliminary associated plant name Erect dwarf *Vaccinium vitis-idaea-Rhododendron tomentosum* subsp. *subarcticum-Betula glandulosa*

Palsas are very rare at these latitudes, observed at only one station. In 2015, the campaign north of Kangirsuk village found the northernmost known individual.



Plot #	A970B_19
Topographic situation	Palsa summit
Longitudinal slope	Not applicable
Transverse slope	Not applicable
Length of slope	Short (< 100 m)
Incline	2–5%
Station exposure	Full
Surface deposit	7P: Organic deposits; ombrotrophes; palsas
Vertical drainage	6: Very poor
Oblique drainage	None
Depth reached	50 cm
Full depth of deposit	> 1 m
Type of organic matter	Humic (Oh)
Thickness of organic matter	> 1 m
Water table depth	water surge at the foot of the hill
Permafrost depth	40 cm



% free water	0
% bare earth	0
% rock	0
% stones	3
% litter	70
% shrubs	Prostrate/semi-prostrate (0-15 cm)
Average shrub height	3
% grasses	< 0,5
Average height of grasses	5
% bryophytes	15
% ground lichen	0
% saxicolous lichen	0

Shrubs	Cover	Height	Level
<i>Vaccinium vitis-idaea</i>	50–75%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Rhododendron tomentosum</i> subsp. <i>subarcticum</i>	25–50%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Betula glandulosa</i>	15–25%	Erect dwarf (15-40 cm)	Upper
<i>Vaccinium uliginosum</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Calamagrostis lapponica</i>	1–5%	< .5 m	
<i>Eriophorum vaginatum</i> var. <i>spissum</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Dicranum elongatum</i>	1–5%		
<i>Aulacomnium turgidum</i>	< 1%		
Lichens	Cover		
Black and white lichenic crust	5–15%		
<i>Cladonia stygia</i>	1–5%		
<i>Cladonia gracilis</i> subsp. <i>gracilis</i>	1–5%		
<i>Flavocetraria cucullata</i>	1–5%		
<i>Cladonia mitis</i>	1–5%		
<i>Cladonia borealis</i>	1–5%		
<i>Cladonia deformis</i>	< 1%		
<i>Flavocetraria nivalis</i>	< 1%		
<i>Cladonia pleurota</i>	< 1%		

Habitat group H–Uniform tundra
Habitat type H02–Black spruce krummholz
Preliminary associated plant name *Picea mariana*-*Betula glandulosa*-*Rhododendron groenlandicum*-*Rubus chamaemorus*/*Equisetum sylvaticum*/*Pleurozium schreberi*-*Sphagnum russowii*
elevated scrubland

It is unusual to observe black spruce in this area. A systematic and meticulous aerial search on both banks of this section of Rivière-Arnaud did not locate any other site. An assessment of the growth rings taken from one of the individuals (near the largest trunk) gave an age of 150 years. The nearest known sites are around Lac Payne, about 50 km away.



Plot #	A987A_19
Topographic situation	Gentle slope
Longitudinal slope	Regular
Transverse slope	Regular
Length of slope	Short (< 100 m)
Incline	15 à 30%
Station exposure	South-southwest
Surface deposit	8CAM: Alteration and slope deposits; colluvium; active; thin
Vertical drainage	4: Imperfect
Oblique drainage	None
Depth reached	60 cm
Full depth of deposit	> 1 m
Type of organic matter	Mor (L, F, H)
Thickness of organic matter	12 cm
Water table depth	Not observable
Permafrost depth	Not observable

% free water	0
% bare earth	0
% rock	0
% stones	0
% litter	10
% shrubs	60
Average shrub height	Average (100–150 cm)
% krummholz	50
% grasses	15
Average height of grasses	< .5 m
% bryophytes	70
% ground lichen	5
% saxicolous lichen	0

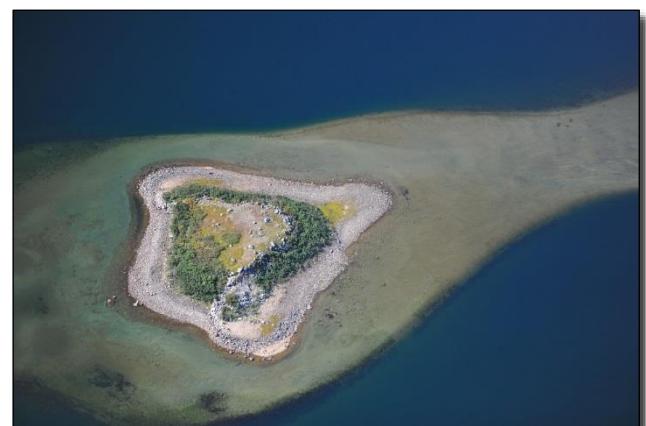
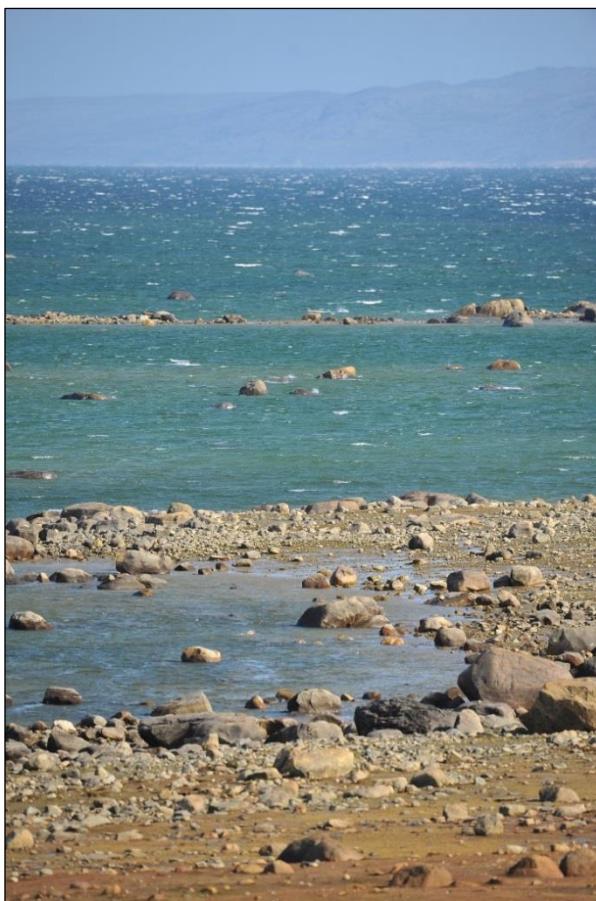
Krummholz	Cover	Shape	
<i>Picea mariana</i>	50–75%	Candlestick	
Shrubs	Cover	Height	Level
<i>Rhododendron groenlandicum</i>	25–50%	Low (40-100 cm)	Upper
<i>Betula glandulosa</i>	15–25%	Average (100–150 cm)	Upper
<i>Rubus chamaemorus</i>	15–25%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Empetrum nigrum</i> subsp. <i>hermaphroditum</i>	5–15%	Prostrate/semi-prostrate (0-15 cm)	Lower
<i>Vaccinium vitis-idaea</i>	1–5%	Prostrate/semi-prostrate (0-15 cm)	Lower
Grasses	Cover	Height	
<i>Equisetum sylvaticum</i>	15–25%	< .5 m	
<i>Calamagrostis lapponica</i>	< 1%	< .5 m	
Bryophytes	Cover		
<i>Pleurozium schreberi</i>	25–50%		
<i>Sphagnum russowii</i>	15–25%		
<i>Polytrichum juniperinum</i>	< 1%		
Lichens	Cover		
<i>Peltigera scabrosa</i>	1–5%		
<i>Cladonia stellaris</i>	< 1%		
<i>Cladonia rangiferina</i>	< 1%		

Conclusion

This approach presents the ecological profile of the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud, details the diversity of landscapes encountered here and shows how the thickness and composition of the glacial deposits on the plateaux influence the physiognomy and floristic composition of the tundra. Sometimes prostrate in the most exposed parts, the shrubs stand erect in the protected and richer parts of the reserve. The slopes of Rivière-Arnaud bear witness to the geomorphological history of the region, leaving traces that contribute to the beauty and diversity of the landscapes, such as gorges, rocky cliffs and wide valleys of green glaciomarine deposits. This protected area is very representative of the entire sector.

Also, despite the harsh climate, the Réserve de territoire aux fins d'aire protégée de la Rivière-Arnaud contains boreal ecosystems (willow and alder stands, black spruce krummholz) and very rare mafic intrusions that allow adapted species to find refuge. Without being exceptional, this adds to the interest of the protected area.

As the profile of the terrestrial part of the territory is now complete, we cannot remain silent before the majesty of Rivière-Arnaud and its tributaries. Very calm and narrow upstream, the river is wide downstream and influenced by tides and winds, which rush into the valley without encountering any obstacle. This gives the waterway an impressive allure.



Wildlife enjoys favourable conditions for survival here. Muskox herds occupy valley surfaces filled with grassy glaciomarine deposits. The open vegetation plateaux are suitable for caribou calving. Black bears were observed throughout the campaign. And a remarkable, if fleeting, encounter with a polar bear in the heart of the area provided an unforgettable moment.



Because of its sheer size, protecting the entire watershed of the river is not feasible. Although Lac Payne is not protected, it is hoped that the slopes and uplands along Rivière-Arnaud will maintain the integrity of the river as a source of livelihood for the Kangirsuk community.

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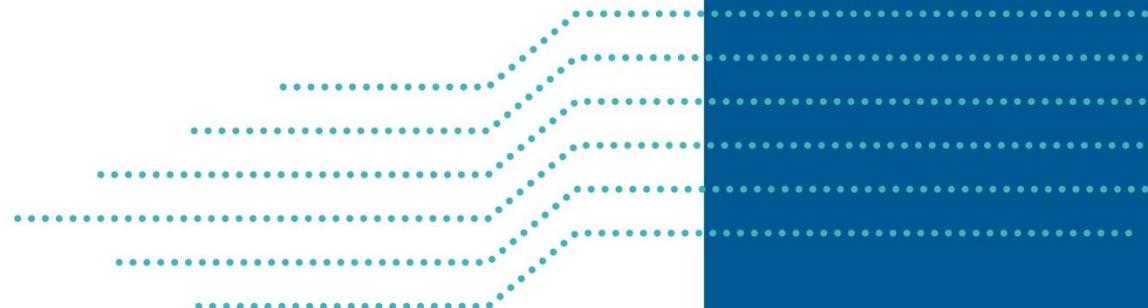
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