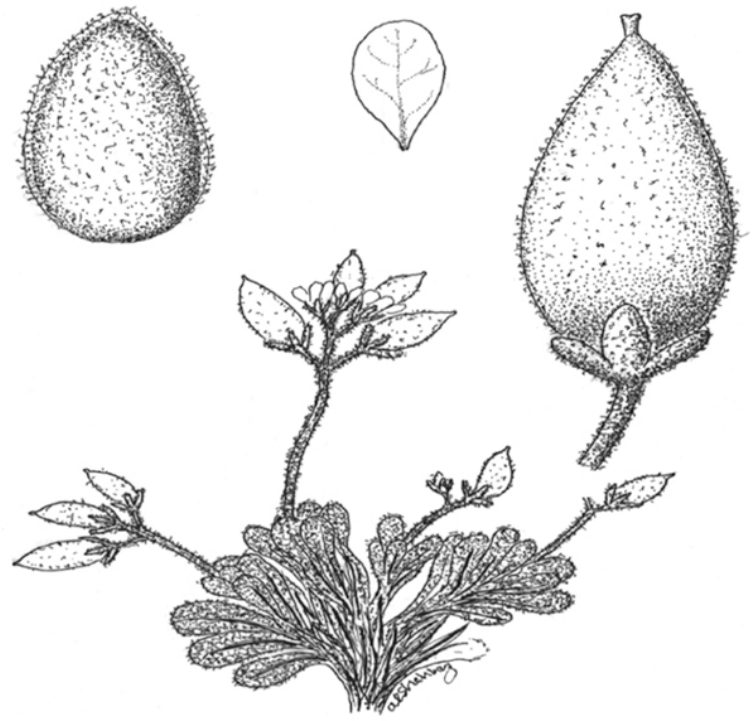
COSEWIC
Assessment and Status Report

on the

Puvirnituq Mountain Draba
Draba puvirnituqii

in Canada



SPECIAL CONCERN
2019

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2019. COSEWIC assessment and status report on the Puvirnituq Mountain Draba *Draba puvirnituqii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 31 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Production note:
COSEWIC would like to acknowledge Benoît Tremblay for writing the status report on Puvirnituq Mountain Draba, *Draba puvirnituqii*, in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Jana Vamosi, Co-chair of the COSEWIC Vascular Plants Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment and Climate Change Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
www.cosewic.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Drave des monts de Puvirnituq (*Draba puvirnituqii*) au Canada.

Cover illustration/photo:
Puvirnituq Mountain Draba — I. Al-Shehbaz.

Catalogue No. CW69-14/793-2020E-PDF
ISBN 978-0-660-35211-4

COSEWIC
Assessment Summary

Assessment Summary – November 2019

Common name
Puvirnituq Mountain Draba

Scientific name
Draba puvirnituqii

Status
Special Concern

Reason for designation
The entire global distribution of this small perennial mustard plant is restricted to two small sites on a rare type of igneous rock rubble on the tundra of Nunavik, in Northern Quebec. Its known range occupies less than 13 km^2. Although there are too few data to determine trends, the population size is undoubtedly very small, estimated to be less than 1000 individuals. Habitat changes associated with climate change are potential threats.

Occurrence
Quebec

Status history
Designated Special Concern in November 2019.

COSEWIC
Executive Summary

Puvirnituq Mountain Draba

Draba puvirnituqii

Wildlife Species Description and Significance

Puvirnituq Mountain Draba is a tiny perennial plant no taller than 6 cm with a dense cluster of leaves at the base. It forms a leafless flowering stalk with clusters of small white flowers. All portions of the plant have crisped simple hairs, an unusual trait that distinguishes the plant from all other Draba species in Canada, except for Taylor's Draba (*Draba taylori*), a yellow-flowered species endemic to British Columbia.

Distribution

The global distribution of Puvirnituq Mountain Draba consists of a single localized occurrence in Northern Quebec (Nunavik) where individuals grow sporadically in two closely spaced sites. The species occurs on extremely rare substrate, on oxidized peridotite rubble overlying fine loamy materials within the exposed Arctic tundra, at an elevation of about 450 m.

Biology

Judging from the number of dead, but still attached leaves from previous years, found on available dried specimens, the plant appears to have a fairly long lifespan. Flowering occurs early in the season. Mature seeds are dispersed by the wind. While the species is probably apomictic (asexual reproduction), the apparent presence of hybrids at one of the sites nonetheless indicates some degree of interspecies fertility. The species is serpentine tolerant and therefore likely has certain adaptations enabling it to colonize these peculiar ultramafic (highly basic) environments where growing conditions are both unusual and harsh.

Population Sizes and Trends

According to the current state of knowledge, the Canadian (and global) population comprises only about 25 individuals (excluding herbarium specimens) occurring at two sites spaced 2.3 km apart and considered as a single subpopulation. However, given the small proportion of habitat searched, the available demographic data must be considered very incomplete.

Threats and Limiting Factors

There are few tangible threats in the short or medium term. Climate change could pose a threat to the integrity of the species' habitat. However, it is difficult to predict how climate change will affect Puvirnituq Mountain Draba habitat.

Protection, Status, and Ranks

At present, Puvirnituq Mountain Draba has no international legal conservation status. In Quebec, the process for granting it legal status as a threatened species under the Quebec *Act respecting threatened or vulnerable species* is underway. NatureServe has ranked the species as Critically Imperilled both globally (G1) and nationally (N1) in Canada. In Quebec, the Centre de données sur le patrimoine naturel has assigned the species the rank of S1. Its habitat along the upper Déception River is located entirely on public lands and is not subject to mining titles.

TECHNICAL SUMMARY

Draba puvirnituqii

Puvirnituq Mountain Draba

Drave des monts de Puvirnituq

Range of occurrence in Canada: Quebec

Demographic Information

Generation time (usually average age of parents in the population: indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	Estimated at 10 years.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, projected *Few data are available that would allow for a definitive assessment but climate change projections suggest a decline.*
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]..	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No b. Yes c. No *Because decline is not observed, projected declines are all that are assessed.*
Are there extreme fluctuations in number of mature individuals?	Probably not.

Extent and Area Information

Estimated extent of occurrence	12 km² *The actual extent of occurrence is 2.3 km²; however, by convention the EOO cannot be less than the IAO.*
Index of area of occupancy (IAO) (Always report 2x2 grid value)	12 km²

Is the population “severely fragmented” ie. is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of “locations”* (use plausible range to reflect uncertainty if appropriate).	1
Is there an observed, inferred, or projected decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] continuing decline in number of populations?	No
Is there an [observed, inferred, or projected] decline in number of locations*?	No
Is there an [observed, inferred, or projected] decline in [area, extent, and/or quality] of the habitat?	Unknown *Few data are available that would allow for a definitive assessment. Climate change projections suggest the possibility of a decline, but depend on likelihood of vegetation encroachment where there is currently very little vegetation.*
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of locations*?	Unknown
Are there extreme fluctuations in extent of occurrence?	Unknown
Are there extreme fluctuations in index of area of occupancy?	Unknown

Number of Mature Individuals (in each subpopulation)

Subpopulation (give plausible ranges)	Number of mature individuals
Total (a single population)	Approximately 25 *Most, if not all, individuals were observed flowering.* *As the sampling effort was limited with this newly discovered species, the population size is estimated to be greater than 25 but likely less than 1000.*

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown

* See Definitions and Abbreviations on COSEWIC web site and IUCN (Feb 2014) for more information on this term.

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes, via email with Jana Vamosi, Benoît Tremblay, Jacques Labrecque, Stéphanie Pellerin, Del Meidinger.

The threats calculator estimated the overall threat impact to be Medium-Low. The overall threat was assigned as Low, due to the likelihood that threats are likely to fall closer to the low side of the range within the assessment time window.

i. Climate change – Habitat shifting & alteration (11.1).
ii. Climate change – Drought (11.2)

What additional limiting factors are relevant?

A high degree of habitat specificity; the apparent difficulty new plants face in terms of establishing in habitat characterized by extremely harsh conditions; the number of viable seeds produced each year, which is likely small.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada	No populations exist outside Canada.
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Not applicable
Is there sufficient habitat for immigrants in Canada?	Not applicable
Are conditions deteriorating in Canada?	There is little indication of that at present
Are conditions for the source population deteriorating? [+]	Not applicable
Is the Canadian population considered to be a sink?	Not applicable
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC Status History: Designated Special Concern in November 2019.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	not applicable

Reasons for Designation:
The entire global distribution of this small perennial mustard plant is restricted to two small sites on a rare type of igneous rock rubble on the tundra of Nunavik, in Northern Québec. Its known range occupies less than 13 km^2. Although there are too few data to determine trends, the population size is undoubtedly very small, estimated to be less than 1000 individuals. Habitat changes associated with climate change are potential threats.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect).

Applicability of Criteria

Criterion A (decline in total number of mature individuals): Not applicable. Data are lacking to determine a percentage of reduction.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although the EOO and IAO are very restricted with only 1 location, no other subcriteria are met (no declines in EOO, IAO, habitat quality, locations or number of mature individuals). There is some likelihood of future decline in habitat quality projected based on climate change but data are limited and the extent and timing of decline is uncertain.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. While the number of known individuals is currently small (meets the threshold for Endangered), information is insufficient to determine precise population size or a decline of the population.
Criterion D (Very Small or Restricted Population): Comes close to meeting Threatened, D1 with an estimated number of individuals possibly below 1000. May meet Threatened, D2, with IAO less than 20 km^2, 1 location and the plausible threat of climate change but the severity of this threat is uncertain.
Criterion E (Quantitative Analysis): Not applicable. Not done

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2019)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Puvirnituq Mountain Draba

Draba puvirnituqii

in Canada

2019

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Scientific name: *Draba puvirnituqii* G.A. Mulligan & Al-Shehbaz, Harvard Pap. Bot. 18: 110. 2013.

Synonym: none.

Common names: Puvirnituq Mountain Draba, drave des monts de Puvirnituq (Brouillet *et al*., 2010+)

Family: Brassicaceae (Mustard Family)

Major plant group: Eudicot flowering plant (Angiosperms)

Puvirnituq Mountain Draba was discovered by the writer of this report. It was observed only in the natural environment and collected only once, on August 6, 2011, at two sites located close together in Nunavik (Arctic region of Quebec). Puvirnituq Mountain Draba was officially recognized and described as a distinct species two years later by Gerry Mulligan and Ihsan Al-Shehbaz (Al-Shehbaz and Mulligan, 2013).

Morphological Description

Puvirnituq Mountain Draba (Figure 1) is a cespitose perennial herb that produces leaves in basal rosettes, each with a leafless central flowering stalk, called a scape. The plant persists through the winter with its simple or branched caudex (thickened base near root collar), on which marcescent leaves (withered leaves of previous seasons) persist, decomposing slowly over time. Basal leaves are subsessile and densely imbricate, oblong to linear-oblanceolate, 3–6 mm long and 1.5–2.5 mm wide; the leaves have ciliate margins pubescent with crisped simple hairs mixed with 4–12 branched subdendritic hairs. The scape is 0.3–6 cm long and has the same pubescence as the basal leaves. The inflorescence is a corymbose raceme with 2–6 flowers, only slightly elongated in fruit. The rachis and pedicels are covered in crisped simple hairs and shorter, subdendritic hairs. The sepals are pubescent like the rachis and pedicels. The petals are white, obovate and caducous. The fruit, a silique, is ovate or lanceolate, flattened and not twisted, pubescent with crisped simple and slightly forked hairs. Seeds are brown, wingless and number 16 to 20.

Figure 1. Dried herbarium specimens of Puvirnituq Mountain Draba. Upper: general view of plants. Lower, from left to right: close-up of basal rosette leaves showing the dense pubescence of crisped simple hairs; close-up of an inflorescence showing the dense hairs on the upper scape as well as the sepals and petals; close-up of a silique covered with a mixture of crisped simple hairs and slightly forked hairs. Source of digital images: Flore nordique du Québec-Labrador project (northern flora of Quebec and Labrador project), Louis-Marie Herbarium, Université Laval.

According to G. Mulligan (pers. comm., 2017), the most unusual characteristic of Puvirnituq Mountain Draba is the presence of crisped simple hairs on all parts of the plant. Vestiture (type of hairs) is an important character used to distinguish between Draba species. In Canada, there is only one other Draba species that has a mixture of simple crisped and slightly forked hairs on the underside of the rosette leaves: Taylor's Draba (*Draba taylori*), a species endemic to British Columbia with yellow flowers and indehiscent anthers.

Puvirnituq Mountain Draba resembles the Milky Draba (*Draba lactea*), a much more common species that is widely distributed in the Canadian Arctic. The Milky Draba does not have crisped simple hairs; its raceme is elongated in fruit, its petals are larger, and its siliques are glabrous.

Population Spatial Structure and Variability

The only known population in the world is restricted to a peridotite (a type of ultrabasic rock) enclave along the upper Déception River, in Puvirnituq Mountains in Nunavik. Individuals of the species were found at two sites 2.3 km apart. According to NatureServe, two observation points separated by less than 1 km or by a distance of 1 to 3 km without a gap of persistently unsuitable habitat more than 1 km wide between them are considered to be one subpopulation. This subpopulation concept will be applied to Puvirnituq Mountain Draba in this report as it aligns reasonably well with COSEWIC's own definition for "subpopulation" (COSEWIC, 2016).

At the two sites where Puvirnituq Mountain Draba was found, the individuals were discontinuously and sporadically distributed as single plants or small patches of no more than a few plants.

At present, there are no genetic data available for Puvirnituq Mountain Draba to support the species status suggested by the distinct morphological traits distinguishing it from its closest Draba relatives (*D. lactea* and *D. subcapitata*). It is reasonable to assume that Puvirnituq Mountain Draba is a polyploid species because, according to Jordon-Thaden and Koch (2008), high ploidy levels (>4×) are common in Draba, particularly in Arctic-alpine Draba species.

In its habitat, Puvirnituq Mountain Draba grows in association with the Milky Draba. Two of the collected specimens (*Tremblay 327B-11*, DAO) seem to be hybrids of these two Draba species (Al-Shehbaz and Mulligan, 2013). The apparent presence of hybrids of the two species suggests that introgression is possible. Although this phenomenon could threaten the genetic integrity of Puvirnituq Mountain Draba over the long term, hybridization is considered rare in Arctic Draba species given that apomixis is prevalent, and the resulting hybrids are often sterile, having tiny aborted siliques (Mulligan and Findlay, 1969; Karl and Koch, 2013).

The existence of individuals of Puvirnituq Mountain Draba that are fertile and grow in association with "normal" Milky Draba plants, as well as apparent hybrids of these two species, suggests that Puvirnituq Mountain Draba plants are not simply unusual or mutant forms of the Milky Draba that arise due to the unique conditions created by serpentine soils.

Designatable Units

No infraspecific entities are recognized for Puvirnituq Mountain Draba. Accordingly, the species is treated as one designatable unit.

Special Significance

Puvirnituq Mountain Draba is endemic to a small enclave of peridotite in Arctic Quebec. This single subpopulation represents the species' entire known global population, making it one of the rarest and most localized plant species in Canada.

This Draba is one of 12 vascular species endemic to Quebec (Tardif *et al*., 2016). Its presence in this area of Nunavik, in conjunction with a second endemic species that is slightly more widespread on the Ungava Peninsula (Cayouette's Draba, *Draba cayouettei*), is of particular biogeographic interest. This is particularly surprising given that the eastern Canadian Arctic has almost no endemic vascular plants.

DISTRIBUTION

Global and Canadian Range

The global range of Puvirnituq Mountain Draba consists of a single localized occurrence in Northern Quebec (Nunavik), occupying a small peridotite enclave on the upper Déception River, between its main channel and a secondary channel farther east (Figure 2). This enclave is roughly 18 km north of Kattiniq (Raglan Mine) and about 16 km east of Purtuniq (former Asbestos Hill mine or Colline-de-l'Amiante). The species was observed and collected there only once, on August 6, 2011.

The entire population is located in the Northern Ungava Peninsula Ecoregion, which is part of the Northern Arctic Ecozone (Ecological Stratification Working Group, 1995). It is located in the physiographic unit of the province's ecological reference framework called the Tuttuquaaluk River High Plateau in the Salluit Plateau natural region (Gouvernement du Québec, 2003).

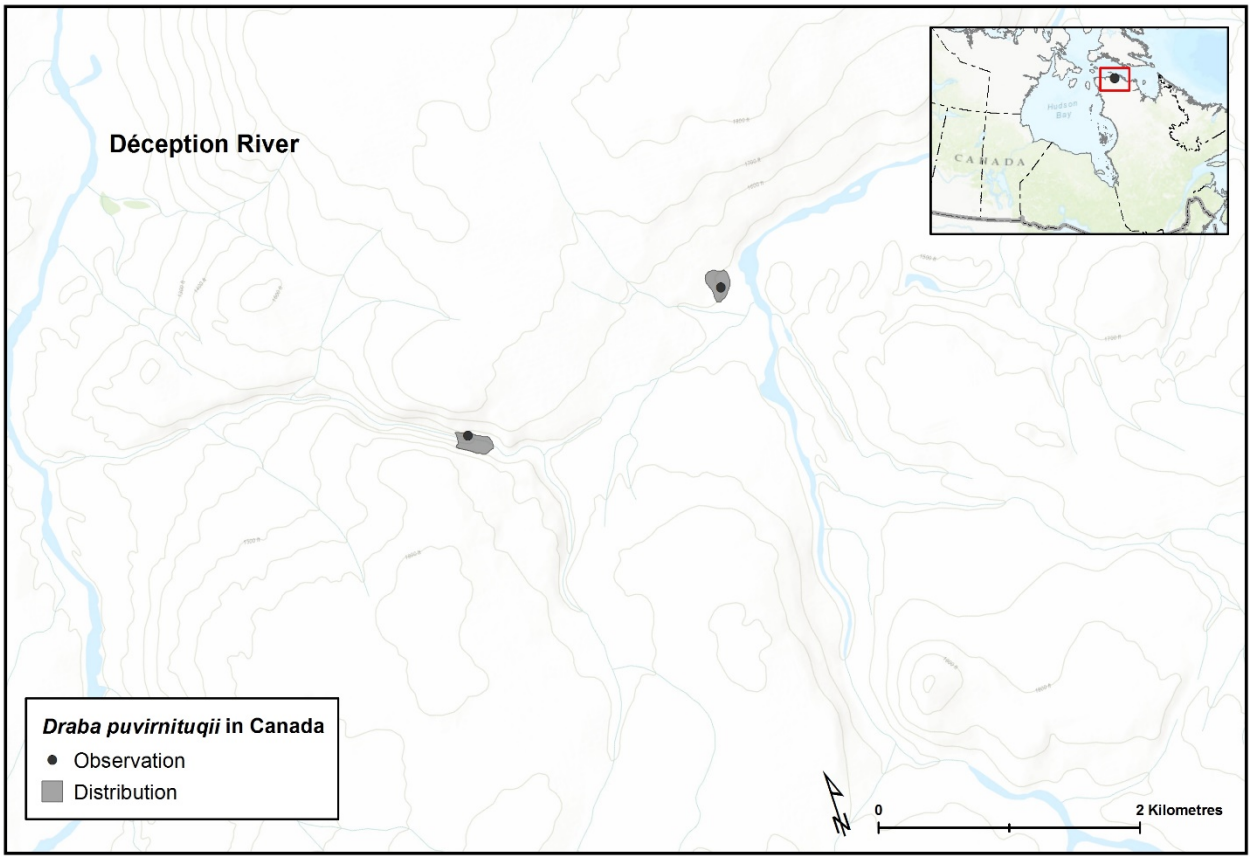


Figure 2. Distribution of Puvirnituq Mountain Draba in Canada.

Extent of Occurrence and Area of Occupancy

The minimum extent of occurrence (EOO) calculated for Puvirnituq Mountain Draba is only 2.3 km^2 (i.e., the distance between the sites). The index of area of occupancy (IAO) is 12 km² based on three 2 km x 2 km grid cells. It is much larger than the extent of occurrence. According to the guidelines of the International Union for Conservation of Nature (IUCN), however, the EOO cannot be less than the IAO. In cases where the EOO is smaller, the value of the EOO becomes the same as that of the IAO (both are equal to 12 km²). The total area of habitat occupied by the individuals at the westernmost site consists of a few square metres at most, whereas at the second site, the plants occupy an area of approximately 4,000 to 4,500 m², but have a sporadic and scattered distribution. The total biological area of occupancy is therefore less than 5,000 m².

Other individuals of Puvirnituq Mountain Draba may be present elsewhere within the peridotite enclave, which covers an area of 27 km² between the two branches of the Déception River (however, less than one fifth of this enclave is made up of apparently suitable habitat, see under **Search Effort** and **Extent of Potential Habitat in Canada**). Therefore, the extent of occurrence, the biological area of occupancy, and the IAO may actually be larger (but nonetheless very limited) than the values mentioned above but would remain below 27 km^2.

Search Effort

In terms of time and extent, very little search effort was devoted specifically to Puvirnituq Mountain Draba. In 2011, about four hours of search effort conducted by B. Tremblay as part of general floristic and phytosociological surveys were spent at the two sites where the species was found. Although B. Tremblay realized that the Draba plants collected during the field survey were different from those known from the eastern Canadian Arctic, it was not then suspected that these individuals represented an entirely new species. The demographic data and information on the population's ecology and distribution remain very fragmentary.

Since 2006, floristic and vegetation surveys have taken place at hundreds of sites in many portions of the high boreal and Arctic regions of Quebec (Figure 3). These surveys, carried out by B. Tremblay and colleagues, covered a wide diversity of tundra habitats located on igneous, sedimentary or metamorphic rocks, whether acidic (granite, gneiss, tonalite, iron formations, etc.), basic or ultrabasic (diabase, basalt, shale, dolomite, marble, peridotite, pyroxenite, etc.) (Tremblay 2016 a,b,c). Puvirnituq Mountain Draba was not found at any of the sites visited, not even those with apparently suitable rocky habitat.

The habitat in which Puvirnituq Mountain Draba is found presents a striking facies because the peridotite rocks (gravel, cobble and boulders) have oxidized surfaces giving them a more or less bright orange colour that makes them very easy to detect from the air and on satellite images. A Nunavik-wide survey undertaken to identify areas of peridotite rubble resembling those in which Puvirnituq Mountain Draba was found (Tremblay, 2017), using RapidEye satellite images (5 m spatial resolution) and a geological map of Nunavik, revealed that only a small proportion of the Arctic region of Quebec contains habitat that this species appears to favour, specifically about 13 km^2 or 0.006%.

During the helicopter vegetation surveys conducted in the Kovik River watershed in 2014, most areas of oxidized peridotite rubble in the region around Chassé and Laza lakes (Tremblay, 2016b) were searched. These areas of rubble are located about 150 km west of Puvirnituq Mountain Draba occurrence, but at the same latitude and on the same type of geological formation. Although each enclave was only partly surveyed, the areas covered were searched carefully (for approximately 10 hours) for Draba species, particularly Puvirnituq Mountain Draba. Unfortunately, the latter was not found at any of the sites. The most extensive areas of peridotite rubble, located near Laza Lake on the southwestern edge of a lake with no official name, appeared identical to those where Puvirnituq Mountain Draba was found. They supported essentially the same assemblage of plant species as the

expanses of peridotite rubble on the upper Déception River, but no Puvirnituq Mountain Draba plants were found.

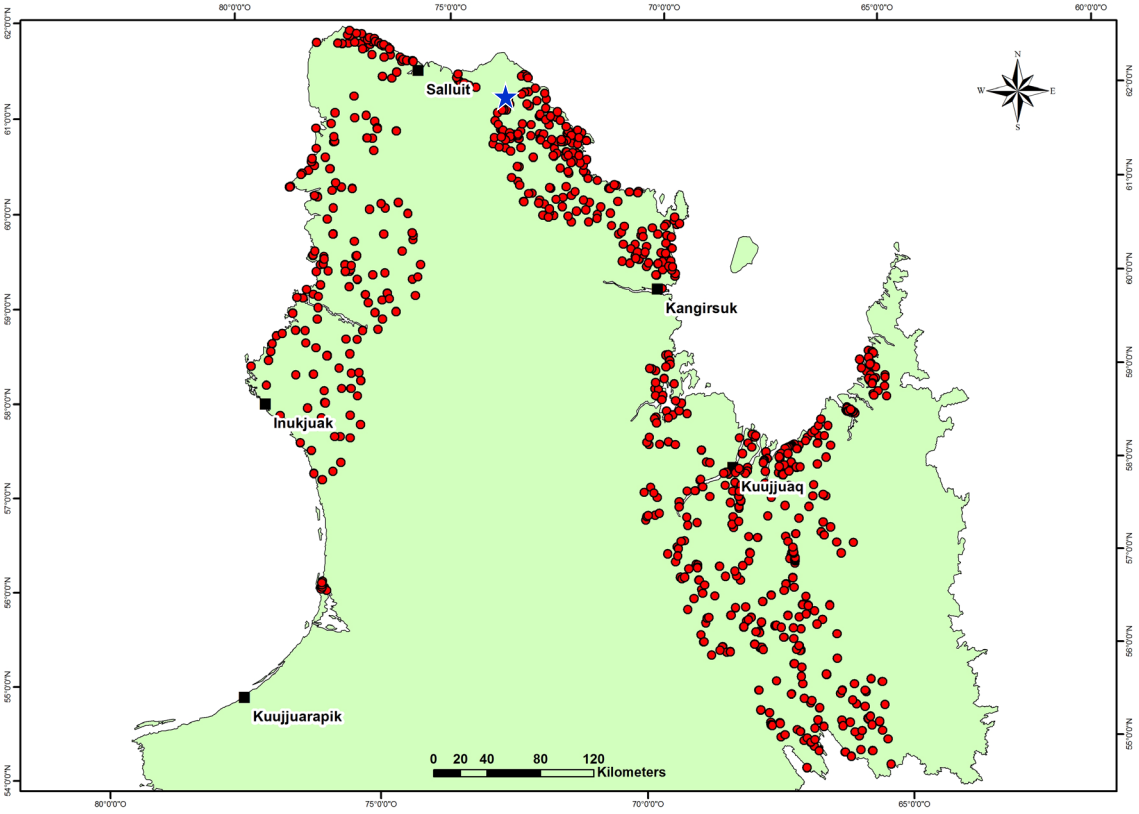


Figure 3. Map of Nunavik (northern Quebec) showing sites where floristic and vegetation surveys were carried out by B. Tremblay and colleagues from 2006 to 2018 (red dots). The blue star shows the location of the single known occurrence of Puvirnituq Mountain Draba.

HABITAT

The single known population of Puvirnituq Mountain Draba occurs on Arctic tundra in Puvirnituq Mountains, in the northern part of the Ungava Peninsula not far from Quebec's northern border. Encompassed within the continuous permafrost zone (Payette, 2001), these mountains rise to an elevation of 700 m and form a vast exposed, windswept plateau covered by relatively shallow deposits and extensive rubble and boulder fields. Flat summits alternate with shallow depressions where waters drain via a branched and poorly defined river system. Climate conditions are harsher there than in the surrounding lowlands, creating an enclave of vegetation and climate with a High Arctic facies. Puvirnituq Mountain Draba population is located between the annual -7.5°C and -10°C isotherms and the 200 mm and 300 mm annual isohyets. According to a spatial interpolation study conducted by Gérardin and McKenney (2001), the population is located in an area with a mean annual temperature of -8.9°C to -10.8°C and total annual precipitation of 451 mm to 571 mm.

Puvirnituq Mountain Draba population is located in the Ungava Orogen geological zone in the Churchill Province (Roy, 2012; Thériault, 2012). The areas of rubble on which the species grows overlie a very unusual geological formation: the Paleoproterozoic peridotite formation of the Watts Group (about 2 billion years old), which consists of a narrow enclave extending discontinuously over about 160 km along a predominantly east-west axis (Lamothe, 2007). Peridotite is a type of ultramafic rock (syn.: ultrabasic rock) that is composed of more than 90% ferromagnesian silicates (Alexander *et al.*, 2007). When exposed to heat and water during metamorphism, peridotite is altered to serpentine, a general term used to designate a family of minerals with the formula $Mg_3Si_2O_5(OH)_4$.

Habitat Requirements

Puvirnituq Mountain Draba occurs on expanses of oxidized peridotite rock including gravel, pebbles and boulders. The species is likely confined to this type of habitat, because the many vegetation surveys carried out since 2011 in a wide variety of other tundra habitats across much of Quebec's Arctic region have not revealed its presence.

The expanses of peridotite rubble are underlain by a fine loamy matrix, which holds moisture well and makes the areas vulnerable to periglacial phenomena including cryoturbation (churning of soil materials due to freeze/thaw cycles) and solifluction (gradual movement downslope of wet topsoil overlying permafrost); these phenomena result in continual reworking of the substrate. The habitat is therefore very active from a geomorphological standpoint. Owing to these characteristics, this open habitat remains almost devoid of vegetation, with less than 5% vascular plant cover in most places, and probably less than 1%. Bryophyte and lichen cover is also very limited and even the oxidized peridotite surfaces are devoid of crustose lichen. While the austere and sterile appearance of this rocky and denuded habitat points to xeric moisture conditions, conditions there are actually rather mesic and even subhumid locally. The sparse vegetation cover is not attributable to deficient soil moisture, but rather to a combination of factors, including rock type, the fairly high elevation, exposure to strong winds and the marked influence of periglacial phenomena. Table 1 presents a list of the vascular plants identified at the observation points surveyed in Puvirnituq Mountain Draba habitat. The flora found there includes a large proportion of basiophiles.

Table 1. Vascular plants found in association with Puvirnituq Mountain Draba on oxidized peridotite rubble along the upper Déception River (Nunavik, Quebec).

Arenaria humifusa Wahlenb.	*Micranthes nivalis* (L.) Small
Armeria scabra Pall. ex Roem. & Schult.	*Oxyria digyna* (L.) Hill
Carex bigelowii Torr. ex Schwein. subsp. *bigelowii*	*Papaver labradoricum* (Fedde) Solstad & Elven
Carex lachenalii Schkuhr	*Poa hartzii* R.Br. subsp. *hartzii*
Carex nardina Fr.	*Sabulina rubella* (Wahlenb.) Dillenberger & Kadereit
Cerastium alpinum L. *s. lat.*	*Sagina caespitosa* (J. Vahl) Lange
Cherleria biflora (L.) A.J. Moore & Dillenberger	*Sagina nivalis* (Lindblom) Fr.
Cochlearia groenlandica L.	*Salix arctica* Pallas
Deschampsia brevifolia R.Br.	*Saxifraga cernua* L.
Deschampsia cespitosa (L.) P. Beauv. subsp. *cespitosa*	*Saxifraga cespitosa* L.
Draba lactea Adams	*Saxifraga oppositifolia* L. subsp. *oppositifolia*
Juncus biglumis L.	*Silene acaulis* (L.) Jacquin
Luzula confusa Lindb.	*Woodsia glabella* R.Br. ex Richardson

At the easternmost observation point, Puvirnituq Mountain Draba was found at an elevation of 455 m on a mound, near some small frost boils and amidst peridotite pebbles on a loamy base (Figure 4). Micro-exposure is highly variable there. At the other observation point, the species was found on tundra frost boils at the base of a steep solifluction slope in a steep-sided valley with late snowmelt, also characterized as peridotite rubble underlain by a fine loamy substrate (Figure 5). This site has a northeastern exposure and is at an elevation of 440 m.

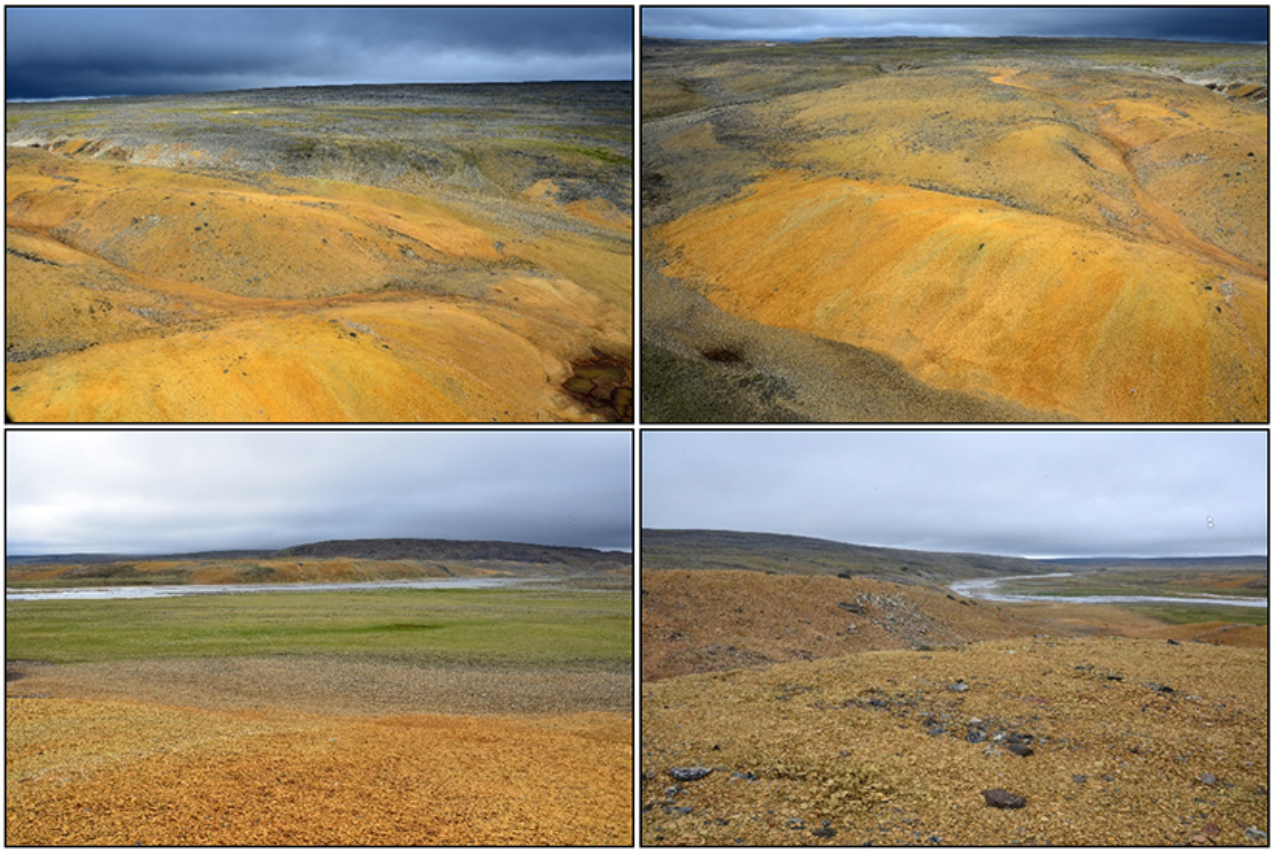


Figure 4. Habitat of Puvirnituq Mountain Draba at the easternmost observation point where it was found (upper Déception River, Arctic region of Quebec). Top, left and right: oblique aerial photos of peridotite rubble whose oxidized surfaces have a striking bright orange colour. Bottom, left and right: ground-level photos of oxidized peridotite rubble. The rocks are underlain by a fine loamy material. Individuals of Puvirnituq Mountain Draba were found on the mounds in the foreground of the two photos. The watercourse in the distance is the main eastern channel of the Déception River.

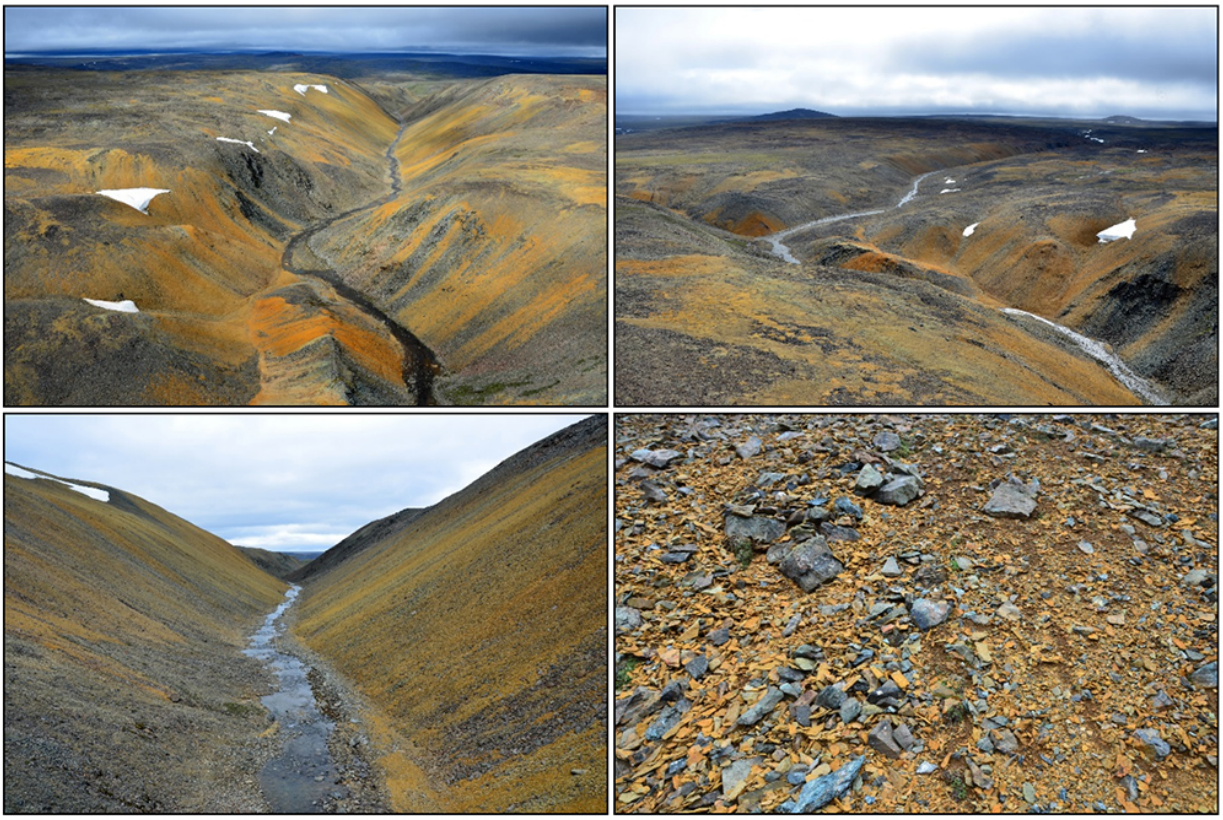


Figure 5. Habitat of Puvirnituq Mountain Draba at the westernmost observation point (upper Déception River, Arctic region of Quebec). Upper, left and right: oblique aerial photos of vast expanses of peridotite rubble that cover the flat summits and slopes of a valley in which a tributary stream of the Déception River flows. Bottom, left: close-up of the portion of the valley located in the upper right side of the upper, left photo. Individuals of Puvirnituq Mountain Draba were found on the left (south) edge of the stream. Bottom, right: close-up of the areas of peridotite rubble that cover the slopes of the valley in the bottom, left photo. They are practically devoid of vegetation, with the exception of scattered individuals of *Saxifraga oppositifolia* subsp. *oppositifolia*. The peridotite rocks are underlain by a fine loamy substrate.

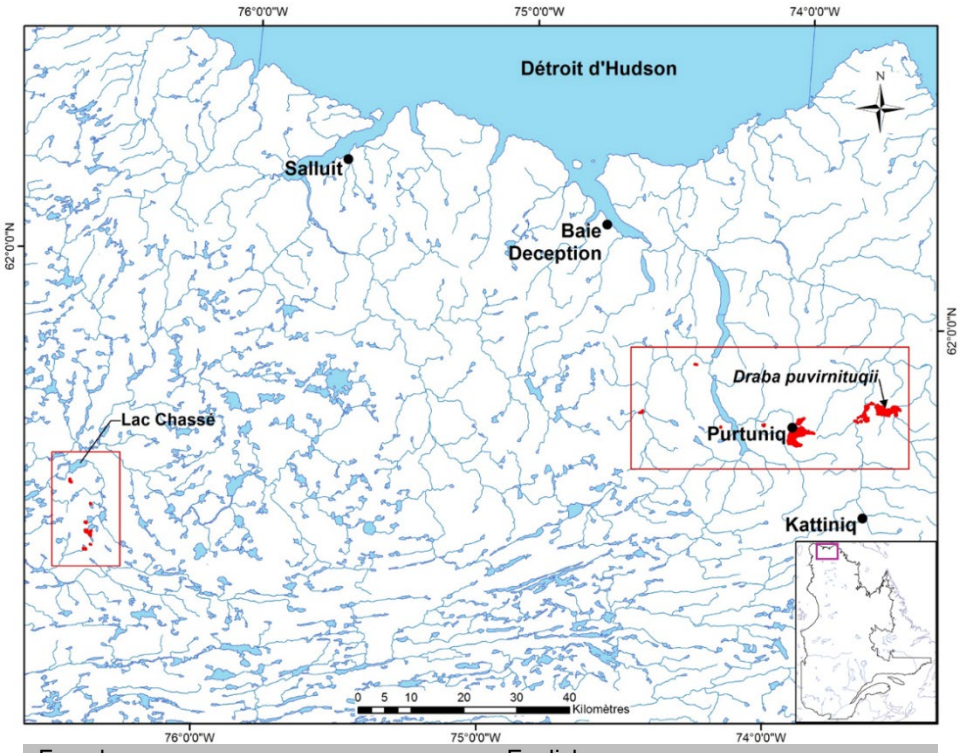
Extent of Potential Habitat in Canada

Habitat apparently suitable for Puvirnituq Mountain Draba is fragmented, patchily distributed and very limited in extent. This fragmentation and the isolation of favourable microsites result from natural processes. As detailed below and mentioned previously in **Search Effort**, only a very small proportion of the peridotite enclaves in the Ungava Orogen—which are rare and of limited size to begin with—feature oxidized peridotite gravel on a loam base.

The analysis of satellite images from across Nunavik (Tremblay, 2017) revealed that all the sites similar to the place where Puvirnituq Mountain Draba was found are located at roughly the same latitude (between 61°30' and 61°50' N, Figure 6) and are underlain by the same geological formation: the Paleoproterozoic peridotite formation of the Watts Group. Aside from the Déception River site, which has about 5.2 km² of suitable habitat, another area of favourable habitat was identified farther west, near the former Purtuniq asbestos

mine (about 7 km²), along with a few locations to the west of Watts Lake (<0.2 km² in all) and, lastly, much farther west near Chassé and Laza lakes, in the Kovik River watershed (6 small enclaves covering a total area of 0.95 km²). At present, it is difficult to determine whether suitable habitat for Puvirnituq Mountain Draba exists elsewhere in Canada or the rest of the world, but larger scale analysis of satellite imagery may reveal further potential habitat.

The most extensive areas of peridotite rubble are those found near Purtuniq, which cover nearly 7 km² and are located only 14 km west of the westernmost site where Puvirnituq Mountain Draba was found (Figure 6). This vast expanse of ultramafic rubble certainly holds the most promise in terms of discovering new subpopulations of this Draba species.



French	English
Détroit d'Hudson	Hudson Strait
Salluit	Salluit
Baie Déception	Deception Bay
Lac Chassé	Chassé Lake
Draba puvirnituqii	*Draba puvirnituqii*
Purtuniq	Purtuniq
Kattiniq	Kattiniq
Kilomètres	Kilometres

Figure 6. Distribution of areas of oxidized peridotite rubble (red areas in the two insets) in Nunavik. This is the type of habitat used by Puvirnituq Mountain Draba within the single known global occurrence, which is indicated by an arrow.

Habitat Trends

The distribution and configuration of apparently suitable Puvirnituq Mountain Draba habitat in Nunavik has likely changed little since the retreat of the Laurentide Ice Sheet at the end of the Wisconsinan glaciation. In the absence of direct anthropogenic disturbances, a certain degree of stability in the extent of available habitat can be expected in the future, even under a warming climate, because of the nature of the rock and the harsh climatic conditions that characterize this region of Northern Quebec. The only net loss of suitable habitat (about 1.7 km²) is that attributable to the Asbestos Hill mine (Purtuniq), a chrysotile (asbestos) mine that was in operation from 1972 to 1984.

BIOLOGY

Almost nothing is known about the biology of Puvirnituq Mountain Draba, and no studies have been conducted on it to date. The information presented here consists solely of what is known about other Arctic Draba species and what can be deduced by establishing links with certain habitat characteristics.

Life Cycle and Reproduction

Puvirnituq Mountain Draba is a perennial species that overwinters as a caudex, the thickened woody base of its stem at ground level. The caudex elongates over time, producing a series of basal leaves in rosettes with each new growing season. Nothing is known about the life span of the plants or mean age at first reproduction. Given the harsh growing conditions in the species' habitat, the plant may go through several growing seasons in vegetative form before it is large enough and has sufficient energy stores to flower for the first time. The plant appears to have a fairly long life span, judging from the specimens in the *Tremblay 342-11* (DAO) collection, which have a long caudex with marcescent leaf remains of previous seasons (the oldest consisting solely of midrib tissue). Counting of these leaf remains indicates that all of the collected plants were quite old (i.e., at least 10 to 15 years), and thus generation time was roughly estimated as the average age of mature individuals, or 10 years.

From collection and field specimens, it can be concluded that Puvirnituq Mountain Draba flowers around mid-July. Flowering likely continues until at least mid-August, when the seeds in the first siliques mature. Once fruiting is complete, the raceme and the siliques dry up, and the valves of the siliques become partly detached, exposing the mature seeds attached to the septum. Exposure of the stems to sudden and repeated gusts of wind results in the small and thin seeds getting detached and then dispersed by the wind (anemochory).

Vegetative reproduction appears to be non-existent in Draba species. As previously mentioned, Puvirnituq Mountain Draba is likely polyploid and apomictic; both of these traits are prevalent in Arctic-alpine Draba species (Mulligan and Findlay, 1969; Jordon-Thaden and Koch, 2008; Karl and Koch, 2013). According to Molau (1993), the high prevalence of

polyploidy in these environments is concomitant with the selective pressure toward higher rates of apomixis (which allows for the persistence of polyploidy) in highly unfavourable environments, rather than selective pressure toward polyploidy per se. Allopolyploidy in Arctic Draba species appears to provide a means of avoiding genetic depauperation caused by inbreeding at the diploid level (Brochmann and Elven, 1992; Brochmann, 1993). Puvirnituq Mountain Draba produces hermaphroditic flowers. Autogamous Draba species are characterized by small, unscented, non-protogynous and rapidly selfing flowers (Brochmann, 1993). Therefore, if Puvirnituq Mountain Draba is similarly self-fertilizing or apomictic, pollinator insects likely do not visit these plants or do so only occasionally. The apparent presence of hybrids with the Milky Draba at the easternmost site nonetheless suggests that a certain degree of interfertility is associated with Puvirnituq Mountain Draba. This situation is very unusual in Draba, because hybrids of Arctic Draba species are generally considered very rare and typically sterile.

Physiology and Adaptability

The single known occurrence of Puvirnituq Mountain Draba is associated with peridotite rubble. Enclaves of ultramafic rock are known to support a highly specialized flora, rich in endemics to this type of enclave (Alexander *et al*., 2007). Puvirnituq Mountain Draba is an ultramafic (or serpentine) species and therefore a serpentinophyte. We do not know, however, whether it is a strict serpentinophyte; that is, whether it is a species that can only grow on ultramafic rock or on soils derived from that type of rock (serpentine soils).

High magnesium and, in some cases, nickel concentrations appear to be responsible for impaired plant growth on serpentine soils and for the specific adaptations observed in serpentinicolous species or in populations of non-serpentinicolous species adapted to serpentine soils (Gabbrielli and Pandolfini, 1984: Gabbrielli *et al*., 1990; Nagy and Proctor, 1997). The physiological adaptations found in plants growing on serpentine soils, developed in response to adverse growth conditions (drought, nutrient deficiency, toxicity, etc.) include exclusion or reduced translocation of heavy metals or their accumulation in a non-toxic form, sequestration of cations, selective calcium or nutrient uptake, and drought tolerance (Alexander *et al*., 2007).

The physiological adaptations of serpentinophytes or of non-serpentinicolous plant species growing on serpentine soils can lead to reproductive isolation as a byproduct and thus give rise to sympatric or parapatric speciation (Alexander *et al*., 2007). Reproductive isolation is promoted by geographic isolation and the absence of gene flow between populations. This applies particularly well to enclaves of ultramafic rock, which are often small, sporadic and highly geographically isolated, particularly in eastern North America.

No information is available on artificial reproduction, seed germination, horticultural production or transplantation tolerance in this species.

Dispersal and Migration

The small, thin seeds of Puvirnituq Mountain Draba are dispersed by the wind. The fact that the plant has been found at two sites that are about 2 km apart indicates that 1) Puvirnituq Mountain Draba produces viable seeds, and 2) it is capable of colonizing new habitats offering favourable ecological conditions. Wind has a strong influence on tundra habitats, particularly in exposed areas at high elevations. Seeds adapted for anemochory can be dispersed over large distances. Therefore, the sometimes considerable distance between peridotite enclaves is not an impediment to colonization; instead, what acts as a constraint on colonization is that these enclaves are very small and isolated in the landscape. It follows that colonization of such enclaves by dispersal from a parent population is a question of chance.

Interspecific Interactions

We do not have any information on the specific insect pollinators of Puvirnituq Mountain Draba, if indeed any such pollinators exist. However, if the plant is autogamous, its flowers are likely not very attractive to insects.

Draba species do not form parasitic relationships with other plants, nor do they, to our knowledge, establish mutualistic relationships with other organisms, such as mycorrhizal fungi. There is currently limited interspecific competition between Puvirnituq Mountain Draba and other vascular and nonvascular plant species. While there is a vast expanse of potentially suitable habitat, which is essentially devoid of vegetation, only a small number of Puvirnituq Mountain Draba plants were found and their density was low. The species may occasionally have a commensal relationship with crustose lichens of the genus *Ochrolechia*, because thalli of the lichen *O*. *androgyna* were found on air-exposed portions of caudex from a Draba plant in the *Tremblay 327B-11* (DAO) collection, which is an apparent hybrid of *D*. *puvirnituqii* and *D*. *lactea*.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Sampling effort for Puvirnituq Mountain Draba consisted of a few hours spent walking through its habitat accessed by helicopter on August 6, 2011, while carrying out other vegetation surveys. The effort devoted to exploring suitable habitat covering the approximately 5 km^2 along the upper Déception River is considered incomplete at this time. No previous vegetation surveys were carried out in the area prior to this visit, and none have been carried out since.

Abundance

According to current knowledge, the total Puvirnituq Mountain Draba population in Canada (and in the world) comprises a single subpopulation of approximately 25 individuals divided in two sites located about 2.3 km apart. Although some 20 plants were counted at the easternmost observation point and about 12 at the western observation point, the total number of plants is about 25 (i.e., this number does not include the collection specimens).

In light of what is mentioned in the previous section, the available demographic data should be interpreted with caution. Although more individuals likely exist than the number detected and although the plant may grow in other areas of peridotite rubble in this part of Nunavik, the global population is nevertheless considered to be very small.

Fluctuations and Trends

It is likely that Puvirnituq Mountain Draba has always been rare, given the scarcity of the specialized habitat it seems to prefer. No information is available with regard to fluctuations in numbers or the density of individuals in the only known population. Our knowledge is so limited that it is difficult to provide, with any degree of certainty, an assessment of present or future population trends for the species. No plantlets were observed in the field (although they were not specifically searched for these and they may easily have been overlooked) and the plants that were found seemed to be fairly old. Such a small population in an area with an expanse of potential habitat available for colonization—where there are few other plants competing for space—suggests that 1) a very small number of viable seeds are produced and/or 2) germination and/or the establishment of new plants in this type of habitat is very difficult and rarely successful.

Rescue Effect

Because Puvirnituq Mountain Draba is endemic to Canada, no rescue effect is possible.

THREATS AND LIMITING FACTORS

Threats

Direct threats to extant subpopulations were assessed using the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master *et al*. 2012). Threats are defined as the proximate activities or processes that directly and negatively affect the population. Results on the impact, scope, severity, and timing of threats are presented in tabular form in Appendix 1. The overall threat impact was estimated as Medium-Low but assigned as Low (Appendix 1) because only climate change presents a plausible threat. Puvirnituq Mountain Draba habitat along the upper Déception River can currently only be accessed by helicopter. It is not subject to anthropogenic disturbance, the closest potential source of which is a road more than 11 km

to the southwest linking the Raglan mine (Kattiniq) to the ore transshipment site at Déception Bay. The closest village, Kangiqsujuaq, is located 95 km to the southeast and it is not linked by any roads.

Climate Change (Threat 11; Impact: Medium-Low)

Climate change could pose a threat to the integrity of Puvirnituq Mountain Draba's habitat within three generations. Climate simulations performed for Nunavik with a 2100 time horizon show major changes to all climatic parameters, even within an "optimistic" scenario (Mailhot and Chaumont, 2017). In the area where Puvirnituq Mountain Draba is found, depending on the scenario (optimistic or pessimistic), the models project an increase of between 4°C and 10°C in mean annual temperature, an extension of the growing season of between 22 days and 93 days, an annual decrease of between 10 and 46 in the number of freeze-thaw cycles and an increase in total annual precipitation of between 120 mm and 498 mm, with a decrease in the solid fraction (snow) of between 8% and 20%. It is difficult to predict what effects these changes could have on the species' habitat, let alone the species itself.

Clearly, periglacial phenomena, such as cryoturbation and solifluction, play an important role in the region, contributing to the rocks found on the surface and maintaining an open habitat with very little plant cover. Models of warming would predict lesser freeze-thaw cycles and a thicker active layer, thus a lower intensity and influence of cryoturbation. With less or no habitat shifting, it is possible that this habitat will experience colonization by taller plant species and see a densification of vegetation cover which could result in Puvirnituq Mountain Draba being outcompeted, yet the severity of this effect within three generations has a large amount of uncertainty.

Mining and Quarrying (Threat 3.2; Impact: outside the assessment window)

While not considered a current threat, the possibility of future threats from mining is worth noting (see Appendix 1). A chrysotile mine, situated about 16 km to the west of Puvirnituq Mountain Draba sites, was shut down in 1984. Nearby asbestos mines were closed in 2011 (Gobeil, 2016). Two nickel deposits associated with the peridotite enclaves of the Esker Lake Suite are currently being developed not far south of the Puvirnituq Mountain Draba location: the Glencore Raglan mine about 20 km away and the Canadian Royalties Nunavik Nickel mine about 35 km away. The Watts Group formation where Puvirnituq Mountain Draba occurs has little mineral potential other than as a source of asbestos; thus, it is unlikely that mining projects will occur in the near future.

Limiting Factors

A number of factors make this species particularly vulnerable: the great specificity of its preferred habitat; the rarity, patchiness and limited extent of its habitat; and the apparent difficulty plants face in terms of becoming established due to the harsh growing conditions in their habitat. Therefore, any loss of individuals could not easily be offset, through either natural or assisted means, and any loss of habitat could not be compensated for, because

no additional favourable habitat will be created naturally in the foreseeable future and because artificial habitat creation does not appear to be technically or financially feasible.

Number of Locations

From the standpoint of regional threats or global threats such as climate change, Puvirnituq Mountain Draba occurs in a single location, both in Canada and globally. Puvirnituq Mountain Draba remains very vulnerable to extreme stochastic events of local or regional scope—events that may increase in frequency with continuing climatic disruptions.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Puvirnituq Mountain Draba has no international conservation status. In Quebec, the species is described as Threatened (recommended) in the paper by Tardif *et al*. (2016) on vascular plants at risk. On September 15, 2014, the advisory committee on the threatened and vulnerable flora of Quebec recommended that it be designated as a threatened species under the *Act respecting threatened or vulnerable species* (LEMV, R.S.Q., c. E-12.01). The legal designation process is still ongoing. Once it has been legally designated as threatened, Puvirnituq Mountain Draba will have full protection. Indeed, under section 16 of the LEMV, no person may have any specimen of a threatened or vulnerable plant species or any of its parts, including its progeny, in their possession outside its natural environment, or harvest, exploit, mutilate, destroy, acquire, transfer, offer to transfer or genetically manipulate it. Its designation as a threatened species will also make it possible to create a protected area under section 10 of the LEMV, specifically in order to confer the status of “habitat of a threatened plant species” to the area determined by the Quebec Department of Sustainable Development, Environment and the Fight Against Climate Change (MDDELCC).

Non-Legal Status and Ranks

NatureServe ranked Puvirnituq Mountain Draba Critically Imperilled (G1) both globally and nationally (N1) in Canada (NatureServe, 2017). At the subnational level (Quebec), the CDPNQ has assigned it the rank of S1 (critically imperilled; Tardif *et al*., 2016). The International Union for the Conservation of Nature (IUCN) has not assessed the species yet.

Habitat Protection and Ownership

At present, no portions of Puvirnituq Mountain Draba habitat have legal protection status. All areas of peridotite rubble along the upper Déception River are located on public land owned by the Quebec government and are not subject to mining titles. They are located on Category III lands as defined under the James Bay and Northern Quebec Agreement. These are provincial public lands where Aboriginal peoples have exclusive

rights to the harvesting of certain aquatic species and fur-bearing animals and the right to participate in administering and developing the territory. All of the preceding points also apply to the areas of peridotite rubble around Purtuniq (former Asbestos Hill mine), the site that shows the most promise in terms of the possibility of discovering another Puvirnituq Mountain Draba population. MDDELCC also plans to create a protected area (habitat of a threated plant species) along the upper Déception River to protect the habitat of Puvirnituq Mountain Draba.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The report writer wishes to thank the following individuals who provided him with information and comments concerning Puvirnituq Mountain Draba:

Gerald A. Mulligan, retired scientist and research director, and honorary research associate, Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada

Ihsan Al-Shehbaz, Ph.D., Senior Curator, Missouri Botanical Garden, and Adjunct Professor, University of Missouri

Michelle Garneau, Louis-Marie Herbarium (QFA), Université Laval

The report writer also wishes to thank Jacques Labrecque and Vincent Piché of the Centre de données sur le patrimoine naturel du Québec (CDPNQ). Thanks also to Serge Payette and Kim Damboise of the Louis-Marie Herbarium, at Université Laval, for their kind permission to reproduce the digital images of Puvirnituq Mountain Draba. Gustavo A. Romero, editor of the journal *Harvard Papers in Botany*, graciously agreed to allow the line drawing of the Draba produced by I. Al-Shehbaz and initially published in the study by Al-Shehbaz and Mulligan (2013) to be reproduced on the cover of this report. Lastly, thanks go to the members of COSEWIC's Vascular Plants Specialist Subcommittee, particularly Jana Vamosi of the University of Calgary.

INFORMATION SOURCES

Alexander, E.B., R.G. Coleman, T. Keeler-Wolf and S.P. Harrison. 2007. Serpentine geoecology of Western North America. Geology, soils, and vegetation. Oxford University Press, New York, New York. 512 pp.

Al-Shehbaz, I. pers. comm. 2017. Email to B. Tremblay. October 2017. Senior Curator, Missouri Botanical Garden and Adjunct Professor, University of Missouri, St. Louis, Missouri.

Al-Shehbaz, I. and G.A. Mulligan. 2013. New or noteworthy species of *Draba* (*Brassicaceae*) from Canada and Alaska. Harvard Papers in Botany 18(2): 101-124.

Brochmann, C. and R. Elven. 1992. Ecological and genetic consequences of polyploidy in Arctic *Draba* (*Brassicaceae*). Evolutionary Trends in Plants 6(2): 111-124.

Brochmann, C. 1993. Reproductive strategies of diploid and polyploid populations of Arctic *Draba* (*Brassicaceae*). Plant Systematics and Evolution 185: 55-83.

Brouillet, L., F. Coursol, S.J. Meades, M. Favreau, M. Anions, P. Bélisle and P. Desmet. 2010+. *Draba puvirnituqii* G.A. Mulligan & Al-Shehbaz in VASCAN, Canadian vascular plant database. Web site: http://data.canadensys.net/vascan/name/ Draba puvirnituqii [accessed October 2017].

COSEWIC. 2016. COSEWIC definitions and abbreviations. Approved by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in November 2016. Web site: https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife/definitions-abbreviations.html. Accessed April 2019.

Ecological stratification working group. 1995. A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull. Report and national map at scale 1:7,500,000.

Gabbrielli, R. and T. Pandolfini. 1984. Effect of Mg and Ca on the response to nickel toxicity in a serpentine endemic and nickel-accumulating species. Physiologia Plantarum 62: 540-544.

Gabbrielli, R., T. Pandolfini, O. Vergnano and M.R. Palandri. 1990. Comparison of two serpentine species with different metal tolerance strategies. Plant and Soil 122: 271-277.

Gerardin, V. and D. McKenney. 2001. Une classification climatique du Québec à partir de modèles de distribution spatiale de données climatiques mensuelles : vers une définition des bioclimats du Québec. Ministère de l'Environnement du Québec, Direction du patrimoine écologique et du développement durable, Québec. 40 pp.

Gobeil, M. 2016. Où l'amiante est-il interdit? La réponse en carte. Web Site: http://ici.radio-canada.ca/nouvelle/1006204/amiante-carte-monde-pays-interdiction-maladie-travailleur-canada-fibre-chrysotile [accessed December 2017].

Gouvernement du Québec. 2013. Cadre écologique de référence du Québec (CERQ) [Données numériques vectorielles]. Gouvernement du Québec, ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, Direction du patrimoine écologique et des parcs, Québec.

Jordon-Thaden, I. and M.A. Koch. 2008. Diversity patterns in the genus Draba: a first global perspective. Plant Ecology and Diversity 1: 255-263.

Karl, R. and M.A. Koch. 2013. A world-wide perspective on crucifer speciation and evolution: phylogenetics, biogeography and trait evolution in tribe *Arabideae*. Annals of Botany 112: 983-1001.

Lamothe, D. 2007. Lexique stratigraphique de l'Orogène de l'Ungava. Ministère des Ressources naturelles et de la Faune, Québec, DV 2007-03. 61 pp.

MacArthur, R.H. and E.O. Wilson. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, New Jersey. 203 pp.

Mailhot, A. and D. Chaumont. 2017. Élaboration du portrait bioclimatique futur du Nunavik – Tome I. Report submitted to the Ministère des Forêts, de la Faune et des Parcs du Québec by Ouranos, Montreal, Quebec. 216 pp.

Master, L., D. Faber-Langendoen, R. Bittman, G. A. Hammerson, B. Heidel, L. Ramsay, Snow, K., A. Teucher, and A. Tomaino. 2012. NatureServe Conservation Status Assessments: Factors for Evaluating Species and Ecosystem Risk. NatureServe, Arlington, VA. 64 pp.

Molau, U. 1993. Relationships between flowering phenology and life history strategies in tundra plants. Arctic and Alpine Research 25(4): 391-402.

Mulligan, G.A. pers. comm. 2017. Email to B. Tremblay. October 2017. Scientist and retired Research Manager, Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa, Ontario.

Mulligan, G.A. and J.N. Findlay. 1969. Sexual reproduction and agamospermy in the genus *Draba*. Canadian Journal of Botany 48: 269-270.

Nagy, L. and J. Proctor. 1997. Soil Mg and Ni as causal factors of plant occurrence and distribution at the Meikle Kilrannoch ultramafic site in Scotland. New Phytologist 135: 561-566.

NatureServe. 2004. A habitat-based strategy for delimiting plant element occurrences: guidance from the 2004 working group. Nature Serve, Arlington, Virginia. Available online: http://www.natureserve.org/library/delimiting_plant_eos_Oct_2004.pdf.

NatureServe. 2017. NatureServe Explorer, an online encyclopedia of life: *Draba puvirnituqii* - G.A. Mulligan & Al-Shehbaz. Web Site: http://explorer.natureserve.org/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=926632&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=926632&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=926632 [accessed December 2017].

Payette, S. 2001. Chapitre 9 : Processus et formes périglaciaires, in S. Payette and L. Rochefort (eds.), Écologie des tourbières du Québec-Labrador, Les Presses de l'Université Laval, Québec, pp. 199-239.

Roy, G. 2012. Les grands ensembles géologiques du Québec. Gouvernement du Québec, ministère des Ressources naturelles, Direction de l'information géologique du Québec. Carte à l'échelle 1: 10 000 000.

Tardif, B., B. Tremblay, G. Jolicoeur and J. Labrecque. 2016. Les plantes vasculaires en situation précaire au Québec. Centre de données sur le patrimoine naturel du Québec (CDPNQ). Gouvernement du Québec, ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC), Direction de l'expertise en biodiversité, Québec. 420 pp.

Thériault, R. 2012. Géologie du Québec. Gouvernement du Québec, ministère des Ressources naturelles, Direction générale de Géologie Québec. Carte DV2012-06 à l'échelle 1: 2 000 000.

Tremblay, 2016a. La flore vasculaire, la végétation et les écosystèmes de l'aire d'étude du projet de parc national du Cap-Wolstenholme (Nunavik, Québec). Document préparé pour l'Administration régionale Kativik, Service des ressources renouvelables, de l'environnement, du territoire et des parcs, Kuujjuaq, Québec. 122 pp.

Tremblay, B. 2016b. La flore vasculaire, la végétation et les écosystèmes de l'aire d'étude du projet de réserve aquatique de la Rivière-Kovik (Nunavik, Québec). Document prepared for the Kativik Regional Government, Service des ressources renouvelables, de l'environnement, du territoire et des parcs, Kuujjuaq, Quebec. xvi + 114 pp.

Tremblay, B. 2016c. La flore vasculaire, la végétation et les écosystèmes de l'aire d'étude de la réserve de biodiversité projetée de Quaqtaq-Kangirsuk (Nunavik, Québec). Document prepared for the Kativik Regional Government, Service des ressources renouvelables, de l'environnement, du territoire et des parcs, Kuujjuaq, Quebec. 117 pp.

Tremblay, B. 2017. Chapitre 5. La végétation dans un climat changeant : portrait et perspectives d'évolution, in A. Mailhot, and D. Chaumont (eds.). Élaboration du portrait bioclimatique futur du Nunavik, Tome I. Report submitted to the Ministère de la Forêt, de la Faune et des Parcs du Québec by Ouranos, pp. 86-162.

BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Benoît Tremblay has a B.Sc. in biology with specialization in ecology from the Université du Québec à Rimouski (UQAR) and a Master's in Arctic plant ecology from the Université du Québec à Trois-Rivières (UQTR). He has been working as a botanist for more than 15 years, both as a consultant and as an employee of a university institution or the Quebec government. An expert in Arctic environments, he has conducted a large number of vascular plant and vegetation surveys since 2003 and has written several works on the flora, vegetation and ecosystems of Nunavik. Over the years, thanks to his extensive fieldwork, he has also developed in-depth knowledge of the flora and ecosystems of Quebec as a whole. He is a member of the advisory committee on threatened and vulnerable flora of Quebec and the Comité expert sur la révision de la liste des plantes susceptibles d'être désignées menacées ou vulnérables au Québec. Since 2017, he has been working as a project lead for the conservation of threatened or vulnerable plant species with the Quebec Department of the Environment and the Fight Against Climate Change.

COLLECTIONS EXAMINED

Agriculture and Agri-Food Canada Herbarium, Ottawa (DAO)

Tremblay 327A-11 (DAO), August 6, 2011

Tremblay 342-11 (DAO), August 6, 2011

Tremblay 381-11 (Holotype: DAO), August 6, 2011

Tremblay 385-11 (DAO), August 6, 2011

Appendix 1. Threat assessment for Puvirnituq Mountain Draba.

Species or Ecosystem Scientific Name	*Draba puvirnituqii* G.A. Mulligan & Al-Shehbaz		
Element ID	2.926632	**Elcode**	PDBRA11 3X0
Date (Ctrl + ";" for today's date):	23/08/2018		
Assessor(s):	Benoît Tremblay (report writer), Jana Vamosi (VP SSC Co-Chair), Stephanie Pellerin (VP SSC), Jacques Labrecque, Del Meidinger (VP SSC Co-Chair), Karen Timm (COSEWIC Secretariat)		
References:			

Overall Threat Impact Calculation Help:

	Threat Impact	Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	1	0
D	Low	0	1
	Calculated Overall Threat Impact:	Medium	Low

Assigned Overall Threat Impact:	**D = Low**
Impact Adjustment Reasons:	Overall, climate change impacts on *Draba puvirnituqii* and its habitat in the assessment timeframe appears to be likely but towards the low range.
Overall Threat Comments	Generation time was estimated at approximately 10 years. All the specimens collected are >10-15 years old, judging by the remaining marcescent leaves. Individuals may reproduce for the first time at 2-3 years after establishment, such that a generation length of ~10 years seems a good approximation. With only 1 location in a fairly remote area, the only plausible threat in the assessment timeframe is climate change, and the severity of the impacts linked to this in the short term are probably low, although they remain quite difficult to foresee, evaluate and ascertain.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying		Not Calculated (outside assessment timeframe)	Large (31-70%)	Serious (31-70%)	Low (Possibly in the long term, >10 yrs/3 gen)	Although the only two subpopulations currently known of *Draba puvirnituqii* are located in a fairly high mining activity area (two active nickel mines located respectively 20 and 35 km south of the two subpopulations), there are currently no mining projects in the specific area where these subpopulations are found. These are located on public-owned land which is free of any mining titles. Although an asbestos mine located on the same geological formation was active until 1984 16 km west of the two subpopulations, asbestos mining is no longer a threat in Canada where its use in all its forms is now prohibited.
3.3	Renewable energy						
4	Transportation & service corridors						
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance						
6.1	Recreational activities						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications						
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						
8.2	Problematic native species/diseases						
8.3	Introduced genetic material						The apparent presence of hybrids with Milky Draba suggests that introgression is possible but there are no further data to bear on this potential threat.
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution						
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	*Draba puvirnituqii* grows on open and exposed very sparsely vegetated serpentine gravels, themselves resting on a loamy substrate or mixed with a loam matrix. This habitat is very susceptible to cryoturbation and solifluction, two periglacial processes that maintain an open and sparsely vegetated landcape. The threat of climate change to this particular species stems from predictions that less or no habitat shifting is expected in the future and thus its habitat will experience colonization by dense vegetation cover (including erect shrubs if the climate warms considerably) and this small draba will be outcompeted. Climate modelling (recently carried out by Ouranos) for the period present-2100 suggests a substantial warming of Arctic Quebec. Such warming would imply lesser freeze-thaw cycles and a thicker active layer, thus a lesser intensity and influence of cryoturbation. However the actual severity of changes in climate that will occur within 3 generations (~30 years) and how these will affect *D. puvirnituqii* and its habitat are uncertain, but likely to remain below affecting 30% of the individuals.
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Although drought episodes may well negatively affect *D. puvirnituqii*, draba are usually relatively drought-tolerant species and the loamy substrate on which it grows retains moisture fairly well. The actual threat of drought thus appears to be low.
11.3	Temperature extremes		Negligible	Pervasive (71-100%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	It remains unclear how extreme temperatures (on the warm side of the scale) might affect *D. puvirnituqii.*
11.4	Storms & flooding						
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).							