

**COSEWIC**  
**Assessment and Status Report**

on the

**Quebec Rockcress**  
*Boechera quebecensis*

in Canada



**ENDANGERED**  
**2017**

**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. 2017. COSEWIC assessment and status report on the Quebec Rockcress *Boechea quebecensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 32 pp. (<http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1>).

Production note:

COSEWIC would like to acknowledge Frédéric Coursol for writing the status report on Quebec Rockcress, *Boechea quebecensis*, 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, with significant input from Bruce Bennett, former Co-chair of COSEWIC Vascular Plants and current COSEWIC Vascular Plants Specialist Subcommittee member.

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](mailto:ec.cosepac-cosewic.ec@canada.ca)  
<http://www.cosewic.gc.ca>

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur L'arabette du Québec (*Boechea quebecensis*) au Canada.

Cover illustration/photo:

Quebec Rockcress — Photo credit: Frederic Coursol.

©Her Majesty the Queen in Right of Canada, 2017.

Catalogue No. CW69-14/760-2018E-PDF

ISBN 978-0-660-26738-8



## COSEWIC Assessment Summary

### Assessment Summary – November 2017

**Common name**

Quebec Rockcress

**Scientific name**

*Boechea quebecensis*

**Status**

Endangered

**Reason for designation**

This plant is endemic to Canada and restricted to limestone cliffs and escarpments of the Gaspé Peninsula in eastern Quebec. There are few individuals located in a small number of scattered sites. It is threatened by rock-climbers, and its growth on unstable rocks makes it vulnerable to rock-fall events.

**Occurrence**

Quebec

**Status history**

Designated Endangered in November 2017.



## COSEWIC Executive Summary

### Quebec Rockcress *Boechera quebecensis*

#### Wildlife Species Description and Significance

Quebec Rockcress is an herbaceous biennial or short-lived perennial that grows 10–45 cm tall. The inflorescence comprises 11 to 41 flowers with lavender to greenish sepals and white petals arranged on a single side of the stem.

Quebec Rockcress is endemic to Canada and occurs only in eastern Quebec. The Bic and Forillon areas are known for their unique flora thought to have evolved and persisted through the last glaciation. Quebec Rockcress is a good example of this unique flora.

#### Distribution

Quebec Rockcress occurs only on the limestone cliffs and escarpments of eastern Quebec. There are eight known subpopulations of the species, but two of these are historical and one is considered extirpated, leaving five extant subpopulations.

#### Habitat

Quebec Rockcress is a calciphile that occurs on limestone cliffs and escarpments. Subpopulations generally occur in protected concave depressions at the base of slopes that partially prevent light rain from reaching the ground. Only the smallest subpopulations are exposed on the limestone, which detaches from the escarpment in small chunks. The species seems to prefer dry, sunny conditions, but it is also known to occur in cavities at the base of escarpments, which are more shaded.

#### Biology

Quebec Rockcress is a biennial or perennial of hybrid origin with the putative parents being Holboell's Rockcress, a species not known at present from Canada, and Drummond's Rockcress. Its small extent of occurrence could be attributable to its limited dispersal ability. The species reproduces mainly by apomixis (seed production without fertilization). Seed dispersal is considered limited because it lacks any obvious adaptations promoting long-distance dispersal. No herbivory of Quebec Rockcress or its seeds has been observed.

## **Population Sizes and Trends**

In 2015, 317 mature Quebec Rockcress individuals were present in Canada. Available evidence does not suggest significant change in the overall population in Canada over the past 10 years. The number of mature individuals observed shows some evidence of declines from that observed in the early 2000s but the different counting methods used preclude direct comparison.

## **Threats and Limiting Factors**

The most significant threat to Quebec Rockcress is rock climbing. Most Quebec Rockcress habitat is isolated from anthropogenic threats, but its extremely limited range makes it vulnerable to stochastic environmental events. The rock faces where Quebec Rockcress occurs are friable (easily crumbling) and such events can quickly lead to the disappearance of the micro-habitats in which the species is currently found. Climate change is a potential threat to the species, through promoting the expansion of forest cover in Arctic-alpine regions.

## **Protection, Status and Ranks**

Quebec Rockcress was designated with the provincial status of threatened in Quebec in January 2012. This designation makes it illegal to possess any specimen of the plant or any of its parts, including its progeny, outside its natural environment, or harvest, exploit, mutilate, destroy, acquire, transfer, offer to transfer, or genetically manipulate it. The species receives no specific protection under federal legislation. It has been assigned global, national and subnational conservation status ranks of “critically imperilled” (G1, N1, and S1, respectively).

The habitat of one extant, one extirpated, and two historical subpopulations of Quebec Rockcress are currently protected. The Mont Saint-Alban subpopulation is located in Forillon National Park. The historical subpopulation (Anse à Doucet) and the extirpated subpopulation (Îlet du Quai) are located within the boundaries of Bic National Park, and the historical subpopulation of Cap Bon-Ami is located in Forillon National Park. The Lac de la Falaise subpopulation is located in an exceptional forest ecosystem known as “forêt refuge du Lac-de-la-Falaise”, which is protected from forest harvesting. Although it is public land, it is not listed in Quebec’s Register of Protected Areas. The other subpopulations are located on private lands.

## TECHNICAL SUMMARY

*Boechera quebecensis*

Quebec Rockcress

Arabette du Québec

Range of occurrence in Canada (province/territory/ocean): 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)  <i>In the case of biennial behaviour. Individuals have many-branched stems, also indicating perennial behaviour.</i>	2-5 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No consistently observed declines but declines are projected.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
Inferred percent reduction in total number of mature individuals over the last 10 years.	Stable. Number of mature individuals may have declined but seedling number estimates suggest slight population increase.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown  <i>Rock climbing at Cap du Corbeau may negatively affect ~20% of population. Rock climbing also occurs to a lesser extent at La Muraille (54% of the population). The extent of the impact of rock climbing is currently unknown; see <b>Threats</b></i>
[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.  <i>Near stable in the recent past, depending on whether seedlings are counted, but future declines suspected; see <b>Abundance</b></i>
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	(a) Yes, at some sites (b) Yes, at some sites (c) No
Are there extreme fluctuations in number of mature individuals?	Insufficient data

### Extent and Occupancy Information

Estimated extent of occurrence	11 612 km <sup>2</sup>
Index of area of occupancy (IAO) (Always report 2 x 2 grid value)	24 km <sup>2</sup>

Is the population “severely fragmented” i.e. is >50% of its total area of occupancy is 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, Mont Saint-Alban is likely the only non-viable subpopulation. (b) No, potential habitat is available on several rock faces in the Gaspé region.
Number of “locations” <sup>1</sup> (use plausible range to reflect uncertainty if appropriate).	5 <i>(2 historical subpopulations have not been relocated since 1940)</i>
Is there an inferred decline in extent of occurrence?	No
Is there an inferred decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?.	No <i>Probable disappearance of the L’îlet du Quai (Bic) subpopulation but this is outside the assessment timeframe.</i>
Is there an [observed, inferred, or projected] decline in number of locations?	Inferred
Is there an inferred decline in area, extent and/or quality of habitat?	Yes <i>Potential habitat is present and the species does not appear to occupy all available potential habitat. Rock climbing could reduce the habitat quality in two subpopulations (see <b>Threats</b>).</i>
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

#### Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Anse à Doucet, Rimouski (Bic)	Historical population
L’îlet du Quai, Rimouski (Bic)	Extirpated population
Cap Bon-Ami, Forillon National Park	Historical population
Cap du Corbeau, Rimouski (Bic)	66
Hâtée River, Rimouski (Bic)	17
Mont Saint-Alban, Forillon National Park	3
Lac de la Falaise	59
La Muraille, Percé	172
Total	317

<sup>1</sup> See Definitions and Abbreviations on [COSEWIC website](#) and [IUCN](#) (Feb 2014) for more information on this term.

### Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not applicable
--	----------------

### Threats (actual or imminent, to populations or habitats, from highest impact to least)

<p>Was a threats calculator completed for this species and if so, by whom? Yes. Assessors: Bruce Bennett, SSC Co-chair; Stéphanie Pellerin, SSC member; Norman Dignard, Ministère des Forêts, de la Faune et des Parcs; Jacques Labrecque, Ministère du Développement durable, de l'Environnement et de la Lutte contre les Changements Climatiques Direction de l'expertise en biodiversité;</p> <p>i. Rock climbing The Cap du Corbeau site is only a few metres from rock climbing routes. Climbers use benches at the base of the escarpment as their starting point and have been witnessed to actively remove vegetation. At the La Muraille site, a carabiner was seen a few metres from Quebec Rockcross plants; however, the friable nature of the rock should prevent regular use of the site.</p> <p>ii. Erosion/landslides Past climate change will likely contribute to an increase in erosion and rockfall events. Detachment of material from a slope could carry away an entire subpopulation or bury it under a rockslide.</p>
---

### Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Canadian endemic
Is immigration known or possible?	No known populations outside Canada
Would immigrants be adapted to survive in Canada?	No known populations outside Canada
Is there sufficient habitat for immigrants in Canada?	No known populations outside Canada
Are conditions deteriorating in Canada?	<i>Yes. In addition to the impact from rock climbing, increases in rockslides could cause the rapid disappearance of a subpopulation.</i>
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?	Not applicable

### Data Sensitive Species

Is this a data sensitive species? No
--------------------------------------

### Status History

COSEWIC: Designated Endangered in November 2017.
--

### Status and Reasons for Designation

<b>Status:</b> Endangered	<b>Alpha-numeric codes:</b> B2ab(iii,v); C2a(i)
------------------------------	--



**Reasons for Designation:**

This plant is endemic to Canada and restricted to limestone cliffs and escarpments of the Gaspé Peninsula in eastern Quebec. There are few individuals located in a small number of scattered sites. It is threatened by rock-climbers, and its growth on unstable rocks makes it vulnerable to rock-fall events.

**Applicability of Criteria**

Criterion A (Decline in Total Number of Mature Individuals):

Not met.

Criterion B (Small Distribution Range and Decline or Fluctuation):

Meets Endangered, B2ab(iii,v), with IAO below thresholds and there are only 5 locations. Inferred loss of suitable habitat would result in declines in IAO and the number of mature individuals.

Criterion C (Small and Declining Number of Mature Individuals):

Meets Endangered, C2a(i), with no subpopulation having greater than 250 individuals and projected declines.

Criterion D (Very Small or Restricted Population):

Meets Threatened, D1, with 317 mature individuals.

Criterion E (Quantitative Analysis):

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 (2017)

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



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

# **COSEWIC Status Report**

on the

## **Quebec Rockcress** *Boecheira quebecensis*

**in Canada**

2017

## TABLE OF CONTENTS

Wildlife species DESCRIPTION and significance .....	4
Name and Classification .....	4
Taxonomic History .....	4
Morphological Description .....	5
Population Spatial Structure and Variability .....	6
Designatable Units .....	8
Special Significance .....	9
distribution.....	9
Global and Canadian Range .....	9
Extent of Occurrence and Area of Occupancy.....	10
Search Effort.....	10
HABITAT.....	12
Habitat Requirements.....	12
Habitat Trends .....	16
BIOLOGY.....	16
Life Cycle and Reproduction.....	16
Physiology and Adaptability .....	17
Dispersal and Migration .....	17
Interspecific Interactions .....	18
POPULATION SIZES AND TRENDS .....	18
Sampling Effort and Methods .....	18
Abundance .....	19
Fluctuations and Trends .....	19
Rescue Effect .....	19
THREATS AND LIMITING FACTORS .....	20
Threats .....	20
Limiting Factors .....	21
Number of Locations .....	21
PROTECTION, STATUS AND RANKS .....	22
Legal Protection and Status.....	22
Non-Legal Status and Ranks.....	22
Habitat Protection and Ownership .....	22
ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED .....	23
Authorities Contacted .....	23
INFORMATION SOURCES.....	23

BIOGRAPHICAL SUMMARY OF REPORT WRITER.....	26
COLLECTIONS EXAMINED.....	26

**List of Figures**

Figure 1. Trichomes on Quebec Rockcress leaf (Frédéric Coursol).....	6
Figure 2. Global range of Quebec Rockcress. ....	7
Figure 3. Range of Quebec Rockcress subpopulations (numbers correspond with Table 1). ....	8
Figure 4. Quebec Rockcress on mudstone limestone of Mont Saint-Alban (Frédéric Coursol).....	13
Figure 5. Concave depression in the rock face at La Muraille in Percé (Frédéric Coursol).....	14
Figure 6. Red arrows indicate the bench at the edge of a cavity at Cap du Corbeau. Two climbers are preparing to ascend a climbing route near the habitat (Frédéric Coursol).....	15

**List of Tables**

Table 1: Survey of subpopulations. ....	10
Table 2: Calcium availability and pH determination of three subpopulations.....	15

**List of Appendices**

Appendix 1. List of main companion species (Dignard 2008).....	27
Appendix 2. Threats Assessment Worksheet for Quebec Rockcress.....	28

## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and Classification

Scientific name: *Boechera quebecensis* Windham & Al-Shehbaz

Original description: Windham and Al-Shehbaz, Harvard Papers in Botany 12(1): 246-247, 2007

Synonym: *Arabis divaricarpa* var. *dechamplainii* B. Boivin

French name: Arabette du Québec

English name: Quebec Rockcress, Limestone Rockcress

Family: Brassicaceae

Order: Brassicales

Class: Equisetopsida, subclass Magnoliidae, Malvales clade (Chase and Reveal 2009)

Major plant group: Eudicot flowering plant

### Taxonomic History

Quebec Rockcress (*Boechera quebecensis*) is a species recently described by Windham and Al-Shehbaz (2007). It was initially discovered in 1907 at Bic (Cap du Corbeau), near Rimouski by the American botanists Merritt L. Fernald and J. Franklin Collins (Fernald 1942). At that time, the taxon was treated as *Arabis (Boechera) holboellii* var. *holboellii* (Fernald 1914; Hopkins 1937). Boivin (1967) subsequently described it as intermediate between *Arabis (Boechera) holboellii*, *Arabis (Boechera) lemmonii*, and *Arabis (Boechera) sparsiflora* and ultimately recognized it as *Arabis (Boechera) divaricarpa* var. *dechamplainii*. Rollins (1993) in his work on the Cruciferae of Continental North America, treated it as *Arabis holboellii* var. *holboellii*. Mulligan (1995) created a new species, *Arabis boivinii*, and mentioned two specimens collected from Bic as the paratypes. Windham and Al-Shehbaz (2007) consider *Arabis boivinii* specimens from Quebec to be different and recognize a distinct apomictic species (*Boechera quebecensis*). According to Windham and Al-Shehbaz (2007) on the basis of morphological evidence, the species arose through hybridization between Drummond's Rockcress (*Boechera stricta*; syn. *Boechera drummondii*) and Holboell's Rockcress (*Boechera holboellii*). The species is also retained in their treatment for the Flora of North America (Al-Shehbaz and Windham 2010).

In North America, the genus *Boechea* includes 109 species of which 71 are sexual diploid species, and 38 are apomictic species (Windham and Al-Shehbaz 2007; Al-Shehbaz and Windham 2010). Only 16 species occur in Canada and five are found in Quebec (Brouillet *et al.* 2010+). In addition to Quebec Rockcress, the latter include Graham's Rockcress (*B. grahamii*), Collins' Rockcress (*B. collinsii*), Drummond's Rockcress, and Reflexed Rockcress (*B. retrofracta*). One of the two parental species of Quebec Rockcress, *B. holboellii*, does not occur in Quebec and is currently known only from Greenland (Windham and Al-Shehbaz 2007). A rare confluence of hybridization, apomixis, and polyploidy, makes this one of the most difficult genera in the North American flora. The sexual diploid species are relatively distinct from one another, but they hybridize wherever they come into contact. Through apomixis and polyploidy, the hybrids become stable, self-propagating lineages (Al-Shehbaz and Windham 2010).

### **Morphological Description**

Quebec Rockcress is described by Al-Shehbaz and Windham (2010) as a herbaceous biennial or perennial, 10–45 cm tall, with a simple or branched caudex and solitary or several stems emerging from the centre of a basal rosette. The stems are simple or branched and erect. The inflorescence is a secund (all the flowers are on the same side of the stem) raceme having 11–41 flowers.

The species mostly likely to be confused with Quebec Rockcress are Collins' Rockcress, Reflexed Rockcress, and Drummond's Rockcress, which also grow in the area of Bic National Park. No other species of rockcress (*Boechea* spp.) has been observed in the subpopulations. Drummond's Rockcress has a glabrous to moderately pubescent stem with malpighian (hairs which are straight and attached by the middle; Figure 1) or simple trichomes and its siliques are erect and not secund. Reflexed Rockcress has cauline leaves that are not auriculate and the valves of the siliques are pubescent. Collins' Rockcress can be distinguished by the presence of pedicels abruptly recurved at the base of the siliques.



Figure 1. Trichomes on Quebec Rockcress leaf (Frédéric Coursol).

## Population Spatial Structure and Variability

In Canada, Quebec Rockcress is limited to five extant subpopulations, plus two historical and one presumed extirpated subpopulation (Figure 2). Four subpopulations (including one historical subpopulation) occur in the Gaspé Peninsula area; they are approximately 260 km from the four subpopulations in the vicinity of Bic National Park (Figure 3). The Gaspé subpopulations are at least 30 km apart, with the exception of the two Forillon National Park subpopulations, which are approximately 300 m apart. The Bic National Park subpopulations are at least 3 km apart and are considered separate subpopulations (see **Global and Canadian Range**). The genetic differentiation between the subpopulations has not been studied.





Figure 2. Global range of Quebec Rockcress.



Figure 3. Range of Quebec Rockcress subpopulations (numbers correspond with Table 1).

In Canada, Quebec Rockcress produces large quantities of viable seeds (see **Life Cycle and Reproduction**). At the sites visited at Cap du Corbeau in Rimouski (Bic) and Muraille (Percé), the species is very prolific, with the presence of many seedlings, which was not the case at the other sites.

### Designatable Units

In Canada, Quebec Rockcress is restricted to a small portion of the COSEWIC Atlantic National Ecological Area within the Quebec administrative regions of Bas-Saint-Laurent and Gaspésie. There is no evidence of finer-scale discreteness beyond its species designation and therefore the Canadian population is best considered a single designatable unit.

## Special Significance

Quebec Rockcress is one of few plant species endemic to Eastern Canada. This raises interesting questions about postglacial evolution and persistence of a flora specific to the Bic and Forillon regions. Quebec Rockcress may have evolved from a parent species (*Boechera holboellii sensu stricto*) that no longer exists in North America and that is now only found in Greenland. In his status report on Quebec Rockcress in Quebec, Dignard (2008) mentions the scientific, heritage and educational value of an endemic element. Quebec Rockcress could serve as a model for the study of geographic isolation and morphological and genetic differentiation of populations, and evolution. According to Rushworth *et al.* (2011), the genus *Boechera* could serve as a model system for ecological genomics. No Canadian Aboriginal traditional knowledge was available for this species at the time of the preparation of this report (Jones pers. comm. 2015).

## DISTRIBUTION

### Global and Canadian Range

Quebec Rockcress is endemic to Canada and occurs only on the limestone cliffs and escarpments of eastern Quebec (Figure 2). To date, Quebec Rockcress is, or was, known from eight subpopulations (Table 1; Figure 3): the Anse à Doucet, Îlet du Quai, Cap du Corbeau, and Hâtée River subpopulations are in the municipality of Rimouski (formerly called Bic prior to its annexation in 2009); the Lac de la Falaise subpopulation is in the unorganized territory of Collines-du-Basque; the Mont Saint-Alban and Cap Bon-Ami subpopulations are in Forillon National Park in Gaspé; and the La Muraille subpopulation (formerly known as La Grande Coupe) of Mont Blanc is in Percé.

The Anse à Doucet and Cap Bon-Ami subpopulations are considered historical, because, despite recent search efforts, the last observations date back to their discovery on July 16 and July 31, 1940. However the habitat remains relatively undisturbed and inaccessible areas may still harbour undetected plants. The Îlet du Quai subpopulation is considered extirpated, because despite much search effort at that locality in 2000, 2014 and 2015, the subpopulation observed by J. Rousseau on June 28, 1927, has not been relocated. Although the two extant subpopulations in the vicinity of Bic National Park are approximately 600 m apart, they are separated by habitat that is inhospitable to Quebec Rockcress and they occur on different slopes of the same mountain. Dispersal by animals is unlikely, because the vertical faces are between 40 and 60 m high, making genetic exchange unlikely (see **Dispersal and Migration**).

**Table 1: Survey of subpopulations.**

	Subpopulations	Number of individuals (2015)	Previous records	Last observed	Observer
1.	Anse à Doucet Bic Provincial Park	Not found Site visited in 2001 and 2014		1940-07-16	H.J. Scoggan, 1586
2.	Îlet du Quai Bic Provincial Park	Extirpated Sites visited in 2014 and 2015		1927-06-28	J. Rousseau, 26348
3.	Cap du Corbeau Rimouski	1606 seedlings 66 mature individuals	Approximately 250 stems and rosettes 2000-06-20	2015-06-22	Frédéric Coursol
4.	Hâtée River Rimouski	7 seedlings 17 mature individuals	30 individuals 2002-09-02	2015-06-26	Frédéric Coursol
5.	Lac de la Falaise Non-organized territory	112 seedlings 59 mature individuals	Approximately 50 2000-07-04	2015-06-25	Frédéric Coursol
6.	Cap Bon-Ami Forillon National Park	Not found Site visited in 2014 without success		1940-07-31	H.J. Scoggan, 952
7.	Mont Saint-Alban Forillon National Park	0 seedlings 3 mature individuals	Approximately 35 stems and rosettes 2002-07-19	2015-06-23	Frédéric Coursol
8.	La Muraille Percé	600 seedlings 172 mature individuals	Approximately 300 stems and rosettes 2001-07-18 Approximately 100 rosettes and a profusion of seedlings 2002-06-28	2015-06-24	Frédéric Coursol

## Extent of Occurrence and Area of Occupancy

Under COSEWIC guidelines (COSEWIC 2014), the extent of occurrence (EOO) of extant subpopulations is 11,141 km<sup>2</sup>, whereas the historical extent of occurrence (including historical and extirpated subpopulations 1, 2 and 6 in Table 1) is 11,612 km<sup>2</sup>. The index of area of occupancy (IAO) for extant populations, derived using a 2 x 2 km grid aligned with 10 km x 10 km UTM grid squares, is 24 km<sup>2</sup>. The index of area of occupancy of extant sites is more than 5x4km<sup>2</sup> because the Forillon National Park subpopulation, which comprises only three individuals that are only 460 m apart, straddles two different grid squares. The biological area of occupancy is significantly smaller, with occurrences of Quebec Rockcress being found on narrow ledges that are typically just a few square metres in area. The biological area of occupancy is estimated at 300 m<sup>2</sup>.

## Search Effort

The Gaspé Peninsula was visited by many botanists since the early 20th century following the discoveries by John Macoun and Merritt Lyndon Fernald. The open exposed habitats, such as limestone cliffs, that is inhabited by Quebec Rockcress were particularly targeted across Eastern Canada due to the presence of arctic-alpine plants they may contain.

In 2002, H  l  ne Gilbert (2003) verified the occurrences of Quebec Rockcress on the Mont Saint-Alban escarpment in Forillon National Park.

During the preparation of an unpublished status report on Quebec Rockcress for the Quebec government, all subpopulations known at the time were visited in 2000 by Norman Dignard (2008), with the exception of the H  t  e River subpopulation, which was discovered by a group of botanists from FloraQuebeca in 2002 during a visit to a locality of Cathcart's Woodsia (*Woodsia oregana* subsp. *cathcartiana*).

The localities of all known subpopulations (extant, historical or extirpated) were visited in 2014 and 2015 to prepare this report. The Mont Saint-Alban subpopulation, which was not found in 2014, was relocated in 2015. The number of individuals in the Cap du Corbeau and Lac de la Falaise subpopulations was higher in 2015 owing to the discovery of previously undocumented patches on ledges. Although Quebec Rockcress is clearly rare, there is some possibility that small numbers of additional occurrences may eventually be found on limestone slopes in inland areas of the Gasp   region. The number of undetected subpopulations is predicted to be very small, however, because of the rarity of the specific habitat. The presence of appropriate steep slopes and rocky outcrops in the Gasp   Peninsula is estimated to occupy a maximum total area of only 2,388 hectares (Labrecque pers. comm. 2017; Figure 2) and very little remains completely unexplored. However, the habitat is extremely difficult to search and a very few subpopulations may remain undetected.

The Anse    Doucet subpopulation was visited several times by Dignard in 2008, but the species was not relocated. The area surrounding the   let du Quai subpopulation was visited several times between 1996 and 2002 by Dignard (2008), and only Collin's Rockcress was observed.

Lastly, a herbarium specimen collected in 2002 (specimen 02-371 at herbarium QUE) on an escarpment in Baie de la Presqu'  le d'en Bas, in the municipality of Sheen-Esher-Aberdeen-et-Malakoff in western Quebec, was annotated as possibly *Boechera quebecensis?* by Ishan Al-Shehbaz (an expert on *Boechera* from the Missouri Botanical Garden, St. Louis). The uncertainty raised by Al-Shehbaz prompted the report writer to revisit the site. During the initial visit in 2002, the herbarium specimen collected was only the tip of a fruiting stalk. The site was revisited in September 2014 and the individuals observed on the escarpment were found to be Drummond's Rockcress.

## HABITAT

### Habitat Requirements

Quebec Rockcress is a calciphile that occurs on limestone cliffs and escarpments. It can occur near the base of almost vertical dolomitic limestone faces, like at Mont Saint-Alban in Forillon National Park (Figure 4) and at Lac de la Falaise, despite the occurrence of mudstone slides that form large talus slopes. However, the largest subpopulations are generally protected by the overhanging cliff in the rock face. Individuals occur on a bench at the edge of a cavity formed by the dissolution of limestone at the base of the escarpment. The subpopulations of La Muraille in Percé (Figure 5) and of Cap au Corbeau in Bic are protected in this way (Figure 6). Part of the subpopulation of La Muraille grows behind falls from an intermittent stream.

Although Dignard (2008) considers it a heliophilous (sun-loving) species, Quebec Rockcress is not always exposed to direct light. All known and historical subpopulations occur on north- or east-facing slopes, with the exception of the Hâtée River escarpment, which is south-facing. The benches are thus shaded by the slope. The plant seems to tolerate periods of drought because the rock faces are not subject to seepage and the cavities prevent light rain from reaching the ground. The Mont Saint-Alban and Lac de la Falaise subpopulations occur on limestone, small boulders of which break off from the rock face. The Hâtée River subpopulation grows on a fine-textured substrate overlying large detached boulders on the escarpment. The other subpopulations grow on a dusty fine-textured substrate, at the margin of the cavities. The species appears to be dependent on erosion, because in the absence of erosive phenomena, its habitat could become colonized by trees, resulting in its loss. In his work on the flora of Bic and the Gaspé Peninsula, Scoggan (1950) indicates the calcium availability and pH for three subpopulations (Table 2).





Figure 4. Quebec Rockcress on mudstone limestone of Mont Saint-Alban (Frédéric Coursol).





Figure 5. Concave depression in the rock face at La Muraille in Percé (Frédéric Coursol).





Figure 6. Red arrows indicate the bench at the edge of a cavity at Cap du Corbeau. Two climbers are preparing to ascend a climbing route near the habitat (Frédéric Coursol).

**Table 2: Calcium availability and pH determination of three subpopulations.**

Subpopulations	Ca (ppm)	(HCO <sub>3</sub> ) <sub>2</sub> (ppm)	pH
Mont Saint-Alban	47.4	192.5	8.0
Cap Bon-Ami	60.6	247.2	8.2
La Muraille	34.0	138.0	7.6

## Habitat Trends

The habitat occupied by Quebec Rockcress has changed little in recent decades, with the exception of Îlet du Quai at Bic. The construction of the wharf has facilitated access to the shores of the islands located nearby, resulting in significant trampling by visitors who climb on the rocks. Following the establishment of Bic National Park, access was prohibited and a permit is now required to access the area. Nonetheless, the writer has observed people continuing to access the area. The habitat descriptions and photos taken by Dignard (2008) are still current and, overall, the subpopulations have undergone no major changes. The current habitat of the Cap du Corbeau subpopulation is exposed to the effects of increased rock climbing on that face (Figure 6), as detailed further in the **Threats** section. The increase in rock climbing activity has a more significant effect on Quebec Rockcress, because it is found directly at the base of the escarpments that are popular among climbers. Given that access is limited due to the tides, which prevent climbers from accessing the site at certain times of the day, the growth in rock climbing activity will likely continue at a slow pace; however, it could also have the opposite effect by providing refuge for climbers cut off by the high tide.

## BIOLOGY

Almost nothing is known about the biology of Quebec Rockcress. The only source of published information is the original description of the species by Windham and Al-Shehbaz (2007) and the results of fieldwork published by Norman Dignard (2008) in his status report on Quebec Rockcress in Quebec. The list of main companion species observed by Dignard (2008) is in Appendix 1. A large part of the information that follows is based on limited observations in the field in 2014 and 2015 by the report writer or is taken from information on other species of the genus *Boechera*.

### Life Cycle and Reproduction

Quebec Rockcress is a biennial or perennial. Field observations in the last two years confirm that the species is perennial, as the observation of ramified stems on mature plants indicates that the specimens had been growing over a longer period than one year. In addition, mature plants, with ramified stems and in full flower observed in 2014 were still present and in full flower during the 2015 visit.

According to the herbarium specimens, Quebec Rockcress begins flowering in the second half of May and continues into the first half of July. Fruiting begins in early June and continues until early August. Approximately 12% of individuals were in bloom at the time of the inventory.

Nothing is known about the seed biology of Quebec Rockcress. The herbarium specimens studied by Windham and Al-Shehbaz (2007) often exhibit malformed pollen, but those successfully completing sporogenesis produce large, spheroidal pollen grains with asymmetrical colpi characteristic of apomictic triploids. In Brassicaceae, apomixis (asexual seed formation) is known only in the genus *Boechea* (Schranz *et al.* 2005). The siliques of an individual were harvested in 2014 by the report writer, from which 982 seeds were collected. Attempts to cultivate the seeds of Quebec Rockcress in 2016 at the Montreal Botanical Garden were unsuccessful.

## **Physiology and Adaptability**

Quebec Rockcress is found in only a few localities in eastern Quebec, which suggests that the species tolerates a limited range of environmental conditions. Its small extent of occurrence could also be attributable to its limited dispersal capacity.

The distribution of Quebec Rockcress in Quebec is mainly limited by the extent of maritime limestone. In the Lower St. Lawrence and Gaspé Peninsula, it occurs only on an extremely limited portion of what appears to be favourable habitat, which is relatively common in these areas. Its population density is typically low. Interspecific competition is not believed to be a limiting factor in rocky open habitats because the areas that can be colonized are large. However, it may be a critical factor on ledges of escarpments (where the plant can also be found) and where its development may be highly limited or its survival threatened by the density of other species, particularly shrubs.

## **Dispersal and Migration**

Passive dispersal is the only method used by Quebec Rockcress. The seeds do not appear to be dispersed over large distances, likely relying on abiotic vectors (primarily strong winds causing sufficient turbulence to disperse the seeds). Water may be another abiotic vector, particularly in the case of the subpopulation of La Muraille in Percé, where there are falls directly above the colony. Dignard (2008) suggests the possibility of predation by small rodents and ants, but did not observe it. Seed predation may, however, be a vector of dispersal over short distances (Howe and Smallwood 1982).

Bloom *et al.* (2002) carried out a study on seed dispersal in Smooth Rockcress (*Boechea laevigata*), a species with winged seeds similar to those of Quebec Rockcress. They show that the majority of seeds fell less than 0.5 m from the parent plants, but that a few seeds were capable of dispersing up to 3 m. Bloom *et al.* (2002) state that extended seed dispersal is an aerial version of the soil seed bank and may also be a buffer against the loss of the soil seed bank from wash-off.

## Interspecific Interactions

Interspecific interactions between Quebec Rockcress and other species are unknown. However, the species seems to be relatively resistant to herbivores. Plants growing in the wild do not appear to have insect damage. It should be mentioned that most sites are not accessible to large herbivores such as White-tailed Deer (*Odocoileus virginianus*), with the exception of the Hâtée River site, where a juvenile deer was observed on the escarpment, near where Quebec Rockcress occurs.

## POPULATION SIZES AND TRENDS

COSEWIC (2014) separates subpopulations if there is typically less than one successful genetic exchange per generation. Subpopulations are defined in this report using habitat-based plant element occurrence delimitation standards (NatureServe 2004), under which occurrences are lumped into a single element occurrence (i.e., COSEWIC subpopulation) if separated by less than 1 km, or if separated by 1 to 3 km with no break in suitable habitat between them exceeding 1 km, or if separated by 3 to 10 km but connected by linear water flow and having no break in suitable habitat between them exceeding 3 km. The occurrences on Mont Saint-Alban and Cap Bon-Ami in Forillon National Park, on the escarpment of Lac de la Falaise, at La Muraille in Percé and in the area of Bic National Park (Anse à Doucet, Îlet du Quai, Cap du Corbeau and Hâtée River) can reasonably be assumed to be eight separate subpopulations. The distance between the Gaspé and Bic subpopulations is 260 km, but the subpopulations themselves are at least 30 km (Percé – Forillon National Park) and 80 km (Forillon National Park – Lac de la Falaise) apart. The two recently discovered subpopulations of the Bic region are only 1.3 km apart.

The subpopulations of Cap du Corbeau, the Hâtée River, Îlet du Quai, and Anse à Doucet were not considered to form a single subpopulation, as wind dispersal over the snow or frozen surface of the St. Lawrence River is considered implausible given the distance between them (3 km at most) (see Bloom *et al.* (2002) in **Dispersal and Migration**). The two subpopulations of Forillon National Park (Mont Saint-Alban and Cap Bon-Ami) are 300 m apart, but due to apomixis, genes are not exchanged between the two subpopulations.

## Sampling Effort and Methods

Surveys of known occurrences of the species were conducted over five days in 2015 (June 22 to 26) by Frédéric Coursol, Robin Ardito, and Yoann Delamarche (Montréal Botanical Garden) and over three days in 2014 (July 7 to 9) by Frédéric Coursol and André Lapointe (a consulting botanist). The visits took from several hours to an entire day depending on how difficult it was to access the sites. The survey at each site generally took one-half hour or less. On the basis of the observations made in 2014, new areas were identified as the focus of search efforts in 2015 (e.g., the second escarpment above the known escarpment at Lac de la Falaise). The experience gained in 2014 at the Mont Saint-Alban escarpment facilitated the 2015 visit to the site and made it possible to cover the

entire base of the escarpment. Accessible steep slopes and rocky outcrops in the Gaspé Peninsula have been explored to some extent (Labrecque pers. comm. 2017; Figure 2) yet some areas are deemed too dangerous to reach. Therefore, it is considered plausible that some occurrences may remain undetected.

## **Abundance**

The count conducted during the 2015 surveys indicates a total population of 2642 individuals (Table 1), including seedlings, whereas the count conducted in 2014 indicated a total population of 800 individuals for the known subpopulations. It is difficult to determine where one individual ends and the next begins, because it is impossible to clearly see the source of all rosettes due to the many ramified stems observed. The number of genetically distinct individuals is certainly less than the figures above, given that a count conducted on the same subpopulation by the two botanists in 2014 shows a discrepancy of 140 individuals in the same subpopulation. To avoid confusion in the counts and to avoid damaging the plants, each flowering stem was considered to be a mature individual. Most individuals bear a single flowering spike. Only a few large individuals may produce more than one flowering stalk. The presence of a single rosette is considered a juvenile. The global population of Quebec Rockcress therefore totals 317 mature individuals. The significant increase in the population relative to the observations in 2014 can be explained by the abundance of juveniles (2377) observed at the base of the mature individuals, whereas the number of mature individuals has remained near stable (from ~465 mature individuals and rosettes in 2000-2002; Table 1). The higher seedling survival in 2015 can be attributed to two factors: (1) the 2015 survey was conducted in the third week of June as opposed to the second week of July in 2014 (a period over which only some juveniles survive and the number of surviving seedlings decreases over time); (2) the cool wet weather of 2015 favoured seedling survival whereas in 2014, the hot dry weather likely affected recruitment.

## **Fluctuations and Trends**

Available evidence does not suggest significant change in the overall population in Canada over the past 10 years. The number of individuals observed corresponds to that observed by Dignard (2008). However, as outlined in the **Threats** section, the two largest subpopulations could undergo major population change over the next 10 years.

## **Rescue Effect**

No rescue is possible because the entire global population is in Canada.

## THREATS AND LIMITING FACTORS

### Threats

Direct threats facing Quebec Rockcress assessed in this report were organized and evaluated based on 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 2. The overall calculated and assigned threat impact is Medium. The numbers associated with the threats listed below correspond to IUCN threat numbers and the threat calculator completed for this species.

Most Quebec Rockcress habitat is isolated from direct anthropogenic threats, but its extremely limited range (all occurrences cover less than 300 m<sup>2</sup> in total) makes it vulnerable to environmental events.

#### 6.1 Recreational activities

The most serious anthropogenic threat to this species is from rock climbing activity (calculated threat impact of Medium-Low), which has been observed to have detrimental effects on vegetation in other systems (McMillan and Larson 2002). During the visit to the Cap du Corbeau site in 2015, the writer witnessed the cleaning of rock faces by climbers to clear potential climbing routes. The Arctic-alpine plants were scattered on the ground at the base of the escarpment. One of the rock climbing routes started just a few metres from one of the two benches on which Quebec Rockcress occurs (Figure 6). Trampling of the plants could quickly put this location at risk. La Muraille of Mont Blanc in Percé does not appear to be conducive to climbing, as it is composed primarily of an unstable conglomerate, but in 2015 a carabiner was left a few metres from where individuals of Quebec Rockcress were found. It was not there at the time of the 2014 visit. Like at Cap du Corbeau, trampling by rock climbers could quickly destroy this subpopulation. The faces of the escarpments of Lac de la Falaise could attract climbers, but the considerable distance through the forest to access the site makes it less attractive.

#### 10.3 Avalanches/landslides

The friable nature of the rock faces on which the species occurs can quickly lead to the loss of the micro-habitats in which it is currently found. All subpopulations can undergo rapid alteration if erosion of the rock face causes a large rock fragment to fall from the rock face onto the benches (giving a calculated threat impact of Medium-Low, which incorporates uncertainty in the severity of the threat, as well as the degree of anthropogenic contribution to this process). Erosion is active at all sites, but the Lac de la Falaise, Forillon National Park, and La Muraille of Mont Blanc in Percé sites are particularly vulnerable due to their talus slopes, which are constantly fed by rockfall from adjacent cliff faces. The combination of increased rainfall and thermal stress associated with recent climate change

will likely elevate the rate of erosion and rockfall events (Collins and Stock 2016). Rock climbing activity (see 6.1 Recreational activities) may also increase the likelihood of erosion and rockslides (Lorite *et al.* 2017).

## 11 Climate change & severe weather

Climate change is a likely future driver of change to Quebec Rockcress habitat (threat impact calculated as likely to occur outside the assessment timeframe). According to a report by Parks Canada (Scott and Suffling 2000), the climate in the Forillon National Park vicinity in coming decades will be significantly warmer than it has currently been. Based on the projections, there is the potential for warmer climatic conditions and expanded colonization opportunities for other pioneering species. The combination of the two factors could lead to the extirpation of certain Arctic-alpine species present in Forillon National Park (Scott and Suffling 2000) which share the same habitat as Quebec Rockcress.

### **Limiting Factors**

As discussed in **Dispersion and Migration**, dispersal and/or establishment of Quebec Rockcress from seed appears limited given the species' absence from vast areas of apparently suitable habitat in eastern Quebec. The apomictic mode of reproduction of Quebec Rockcress limits genetic diversity and the ability of the species to adapt to new environmental conditions, diseases or predators. However, limited genetic diversity does not seem to be a threat to the species because it has persisted at Cap du Corbeau since its initial discovery, more than 100 years ago and at Mont Saint-Alban since its discovery 75 years ago, despite the presence of very few individuals at that site.

### **Number of Locations**

Rock-climbing activity is considered the most serious plausible threat, which occurs at extant subpopulations comprising >50% of the mature individuals (IUCN 2017). By defining locations by rock-climbing activity, a location is a single area used for rock climbing (i.e., Cap du Corbeau or La Muraille). Increased erosion or rockfall events could occur at the other locations and can be used to define and count locations in those areas not affected by the most serious plausible threat (but will occur stochastically at each location). The number of locations is thus best estimated to be five (or equivalent to the number of extant subpopulations).

## PROTECTION, STATUS AND RANKS

### Legal Protection and Status

Quebec Rockcress was listed as threatened by the Quebec government in January 2012. As such, it is legally protected under the Quebec *Act Respecting Vulnerable or Threatened Species* (CQLR, c. E-12.01). No person may possess any specimen of a threatened or vulnerable plant species or any of its parts, including its progeny, outside its natural environment, or harvest, exploit, mutilate, destroy, acquire, transfer, offer to transfer, or genetically manipulate it. The species receives no specific protection under federal legislation.

### Non-Legal Status and Ranks

NatureServe's conservation status ranks for Quebec Rockcress are globally, nationally and subnationally "critically imperilled" (G1, N1 and S1, respectively). The global rank was last reviewed on December 12, 2009, the national rank was last reviewed on February 20, 2012 (NatureServe 2015), while the subnational rank was last reviewed on March 24, 2015 (Labrecque, pers. comm. 2017). The species has not been assessed by IUCN and is not listed on the IUCN Red List.

### Habitat Protection and Ownership

The recently discovered subpopulation of Mont Saint-Alban and the historical subpopulation of Cap Bon-Ami are located in Forillon National Park and receive some measure of protection under the *Canada National Parks Act* and Regulations. Under the Act, picking of any plants (removal or destruction of a natural object) is prohibited; scientific collection of any kind required a Parks Canada research permit.

The recently discovered subpopulation of Lac de la Falaise is located in an exceptional forest ecosystem known as "forêt refuge du Lac-de-la-Falaise", which is protected from forest harvesting. The Quebec *Sustainable Forest Development Act* legally protects this subpopulation from any activity likely to affect it. Under the Act, areas with unique characteristics may be classified as exceptional forest ecosystems. However, this exceptional forest ecosystem is not listed in Quebec's register of protected areas. A historical subpopulation (Anse à Doucet) and an extirpated subpopulation (Îlet du Quai) are located within the boundaries of Bic National Park.

The other subpopulations (Hâtée River, Cap du Corbeau, La Muraille) are located on private land.



## ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The report writer would like to thank the following individuals for their generous assistance: André Lapointe, André Sabourin, Geoffrey Hall, Yoann Delamarche, Robin Ardito, Jacques Labrecque, Norman Dignard, Pierre Petitclerc and Ihsan A. Al-Shehbaz. All authorities contacted are listed below.

### Authorities Contacted

Name	Title	Affiliation	City	Province/territory
Norman Dignard	Associate Curator	Ministère des Ressources naturelles / Direction de la recherche forestière	Québec	Quebec
Pierre Petitclerc	In charge of the protection of threatened or vulnerable plant species	Ministère des Ressources Naturelles et de la Faune / Direction de l'aménagement et de l'environnement forestier	Québec	Quebec
Jacques Labrecque	Botanist	Ministère du Développement durable, de l'Environnement et de la Lutte contre les Changements Climatiques / Direction générale de l'écologie et de la conservation / Direction du service de l'expertise en biodiversité	Québec	Quebec
André Sabourin	Botanist	Consultant	Blainville	Quebec
Ihsan A. Al-Shehbaz	Specialist in Brassicaceae	Missouri Botanical Garden	St. Louis	Missouri, United States

## INFORMATION SOURCES

Al-Shehbaz, I.A., and M.D. Windham. 2010. *Boechea*. p. 348-412, in Flora of North America Editorial Committee, ed. 1993+. Flora of North America North of Mexico, 16+ vols. New York and Oxford, Vol. 7. Website:

[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=250094528](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250094528) [accessed October 2016].

Bloom, T.C., J.M. Baskin, and C.C. Baskin. 2002. Ecological life history of the facultative woodland biennial *Arabis laevigata* variety *laevigata* (Brassicaceae): seed dispersal. *Journal of the Torrey Botanical Society* 129:21-28.

Boivin, B. 1967. Énumération des plantes du Canada. VI – Résumé statistique et régions adjacentes. *Naturaliste Canadien* 94:625-655.

Brouillet, L., F. Coursol, S.J. Meades, M. Favreau, M. Anions, P. Bélisle, and P. Desmet. 2010+. VASCAN, the Database of Vascular Plants of Canada. Website: <http://data.canadensys.net/vascan/> [accessed on 2016-10-02].

- Chase, M.W., and J.L. Reveal. 2009. A phylogenetic classification of the land plants to accompany APG III. *Botanical Journal of the Linnean Society* 161:122–127.
- Collins, B. D., and G.M. Stock. 2016. Rockfall triggering by cyclic thermal stressing of exfoliation fractures. *Nature Geoscience* 9:395–400.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014. Instructions for the preparation of COSEWIC status reports. Website: [http://www.cosewic.gc.ca/html/documents/Instructions\\_e.htm#11](http://www.cosewic.gc.ca/html/documents/Instructions_e.htm#11) [accessed on 2016-10-02].
- Dignard, N. 2008. La situation de l'arabette du Québec (*Boechera quebecensis*) au Québec. Herbarium du Québec, Direction de la recherche forestière, ministère des Ressources naturelles et de la Faune, unpublished report prepared for the Centre de données sur le patrimoine naturel du Québec, ministère du Développement durable, de l'Environnement et des Parcs. 17 p.
- Fernald, M.L. 1914. Some *Antennarias* of Northeastern America. *Rhodora* 16:129-134.
- Fernald, M.L. 1942. Incidents of field-work with J. Franklin Collins. *Rhodora* 44:98-147.
- Gilbert, H. 2003. Vérification des occurrences de plantes rares au parc national de Forillon, été 2002. Protection et rétablissement. Parcs Canada, Service de la conservation des écosystèmes, Québec. 35 p.
- Howe, H.F., and J. Smallwood. 1982. Ecology of seed dispersal. *Annual Review of Ecology and Systematics* 13:201-228.
- Hopkins, M.L. 1937. *Arabis* in eastern and central North America. *Rhodora* 39:63-98, 106-148, 155-186.
- IUCN 2012. International Union for Conservation of Nature and Natural Resources 2012. IUCN The IUCN Red list of threatened species 2012.2, 1994 Categories & Criteria (version 2.3) [http://www.iucnredlist.org/static/categories\\_criteria\\_2\\_3](http://www.iucnredlist.org/static/categories_criteria_2_3).
- IUCN 2017. Standards and Petitions Subcommittee. Guidelines for Using the IUCN Red List Categories and Criteria. Version 13. Prepared by the Standards and Petitions Subcommittee. Website: <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> [accessed December 2017].
- Jones, N. pers. comm., 2015. *E-mail message to F. Coursol. November 1999.* Scientific Project Officer and ATK Coordinator, COSEWIC, Canadian Wildlife Service, Environment Canada, Gatineau (Québec).
- Labrecque, J. pers. comm., 2017. Email correspondence to J. Vamosi. September 2017. Ecologist and Botanist, Ministère du Développement durable, de l'Environnement et de la Lutte contre les Changements Climatiques.
- Lorite, J, F. Serrano, A. Lorenzo, E.M. Cañadas, M. Ballesteros, and J. Peñas. 2017. Rock climbing alters plant species composition, cover, and richness in Mediterranean limestone cliffs. *PLoS ONE* 12: e0182414.

- Löve, A., and D. Löve. 1975. Nomenclatural notes on Arctic plants. *Botaniska Notiser* 128:497-523.
- Master L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher and A. Tomaino. 2012. NatureServe conservation status assessments: factors for evaluating species and ecosystems risk. NatureServe, Arlington, Virginia. Website: [http://www.natureserve.org/sites/default/files/publications/files/natureserveconservationstatusfactors\\_apr12\\_1.pdf](http://www.natureserve.org/sites/default/files/publications/files/natureserveconservationstatusfactors_apr12_1.pdf) [accessed November 2017]
- McMillan, M. A., and D. W. Larson. 2002. The effects of rock climbing on the vegetation of the Niagara Escarpment in Southern Ontario, Canada. *Conservation Biology* 16:389–398.
- Mulligan, G.A. 1995. Synopsis of the genus *Arabis* (Brassicaceae) in Canada. *Rhodora* 97:109-163.
- NatureServe. 2004. A Habitat-Based Strategy for Delimiting Plant Element Occurrences: Guidance from the 2004 Working Group. Available online: [http://www.natureserve.org/library/delimiting\\_plant\\_eos\\_Oct\\_2004.pdf](http://www.natureserve.org/library/delimiting_plant_eos_Oct_2004.pdf) [accessed March 2016].
- NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://explorer.natureserve.org> [accessed September 30, 2015].
- Rollins, R.C., 1993. The Cruciferae of Continental North America. Systematics of the Mustard Family from the Arctic to Panama. Stanford University Press, Stanford, California. 976 p.
- Rushworth, C.A., B.-H. Song, C.-R. Lee, and T. Mitchell-Olds. 2011. *Boecheira*, a model system for ecological genomics. *Molecular Ecology* 20:4843-4857.
- Schranz, M. Erich, C. Dobes, M.A. Koch, and T. Mitchell-Olds. 2005. Sexual reproduction, hybridization, apomixis, and polyploidization in the genus *Boecheira* (Brassicaceae). *American Journal of Botany* 92:1797–1810.
- Scoggan, H.J., 1950. The Flora of Bic and the Gaspé Peninsula, Quebec. National Museum of Canada, Bulletin No. 115, Biological Series No. 39, Ottawa. 399 p.
- Scott, D., and R. Suffling. 2000. Climate change and Canada's national park system: A screening level assessment. Adaptation and Impacts Research Group, Environment Canada and University of Waterloo. 183 p. (available at: <http://publications.gc.ca/collections/Collection/EN56-155-2000E.pdf>).
- Windham, M.D., and I. Al-Shehbaz. 2007. New and noteworthy species of *Boecheira* (Brassicaceae) III. Additional sexual diploids and apomictic hybrids. *Harvard Papers in Botany* 12:235-257.

## BIOGRAPHICAL SUMMARY OF REPORT WRITER

Frédéric Coursol holds a degree in biological sciences from Université de Montréal (in 1992). He has written five status reports on threatened or vulnerable species in Quebec (*Saururus cernuus*, *Onosmodium molle* var. *hispidissimum*, *Cicuta maculata* var. *victorinii*, *Gentianopsis victorinii*, and *Eriocaulon parkeri*). For COSEWIC, he participated in the drafting of status reports on Serpentine Sandwort (*Minuartia marcescens*) and Parker's Pipewort (*Eriocaulon parkeri*) and the update status report on Provancher's Fleabane (*Erigeron philadelphicus* var. *provancheri*). With Jacques Labrecque and Luc Brouillet, he co-authored the update status report on Anticosti Aster (*Symphyotrichum anticostense*). His knowledge of estuarine taxa comes from fieldwork carried out in 1995 for the 2001 report written by L. Brouillet, D. Bouchard, and F. Coursol on the threatened and vulnerable plants and other rare plants of the upper St. Lawrence Estuary between Grondines and Saint-Jean-Port-Joli. He contributed to the writing of a collective work entitled *Plantes rares du Québec méridional*, and he provided close to half of the species photographs for that work.

## COLLECTIONS EXAMINED

Specimens from the Marie-Victorin Herbarium (MT) and Quebec Herbarium (QUE) collections were examined to compare specimens of Quebec Rockcress with similar species that occupy the same habitat.

## Appendix 1. List of main companion species (Dignard 2008).

Cap du Corbeau: *Festuca rubra*, *Poa pratensis*, *Cerastium arvense*, *Hedysarum americanum*, *Shepherdia canadensis*, *Draba glabella*, *Primula laurentiana*, *Juniperus communis* var. *depressa*, *Antennaria rosea* subsp. *pulvinata*.

Hâtée River: *Aquilegia canadensis*, *Arctostaphylos uva-ursi*, *Danthonia spicata*, *Elymus trachycaulus*, *Juniperus communis* var. *depressa*, *Rhus typhina*, *Woodsia alpina*, *W. oregana* subsp. *cathcartiana*.

Lac de la Falaise: *Campanula gieseckeana*, *Draba arabisans*, *Woodsia alpina*, *Cryptogramma stelleri*, *Saxifraga paniculata*, *Carex eburnea*, *C. concinna*, *Asplenium viride*, *Gymnocarpium robertianum*, *Calamagrostis purpurascens*, *Anemone parviflora*, *Shepherdia canadensis*, *Acer spicatum*, *Diervilla lonicera*.

Mont Saint-Alban: *Amelanchier* sp., *Thuja occidentalis*, *Solidago hispida*, *Juniperus horizontalis*, *Campanula gieseckeana*, *Poa alpina*, *Diervilla lonicera*, *Artemisia campestris*, *Erigeron compositus*, *Rosa blanda*, *Hieracium vulgatum*.

La Muraille: *Toxicodendron radicans* var. *rydbergii*, *Rosa blanda*, *Amelanchier* sp., *Calamagrostis stricta*, *Symphyotrichum novi-belgii* var. *novi-belgii*, *Maianthemum stellatum*, *Graphephorum melicoides*, *Festuca rubra*, *Hieracium vulgatum*, *Vicia cracca*, *Zigadenus glaucus*.

## Appendix 2. Threats Assessment Worksheet for Quebec Rockcress.

<b>Species or Ecosystem Scientific Name</b>	Quebec Rockcress, <i>Boecheira quebecensis</i>		
<b>Element ID</b>		<b>Elcode</b>	PDBRA40060
<b>Date (Ctrl + ";" for today's date):</b>	06/09/2016		
<b>Assessor(s):</b>	Bruce Bennett SSC co-chair; Stéphanie Pellerin SSC member; Norman Dignard Ministère des Forêts, de la Faune et des Parcs (QC); Jacques Labrecque Ministère du Développement durable, de l'Environnement et de la Lutte contre les Changements Climatiques Direction de l'expertise en biodiversité (QC)		
<b>References:</b>			

  

**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	2	0
D	Low	0	2
<b>Calculated Overall Threat Impact:</b>		<b>Medium</b>	<b>Low</b>

  

**Assigned Overall Threat Impact:** C = Medium

**Impact Adjustment Reasons:**

**Overall Threat Comments** *The most serious plausible threat is from rockclimbing activity, which occurs at 2 locations comprising >50% of the population (317 mature individuals in total).*

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					
2.1 Annual & perennial non-timber crops					

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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						
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		Negligible	Small (1-10%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants		Negligible	Small (1-10%)	Negligible (<1%)	Low (Possibly in the long term, >10 yrs)	The collection of herbarium specimens of endemic species by botanists could become problematic. The number of individuals of <i>B. quebecensis</i> is so small that even the harvest of a single individual could affect the survival of subpopulations.
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	Recreational activities (rock climbing and associated trampling) are the most important threats to the survival of <i>B. quebecensis</i> subpopulations. The occurrences at Bic (Pointe à Corbeau) and Percé (La Muraille) are most likely to be affected, or even destroyed, in the short term by trampling or cleaning of the rock faces. While Quebec Rockcress may be able to withstand, or even benefit from, the disturbance caused by trampling, the cleaning of rock faces is almost certain to reduce the number of individuals in these subpopulations.
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		Not Calculated (outside assessment timeframe)	Small (1-10%)	Slight (1-10%)	Low (Possibly in the long term, >10 yrs)	
8.1	Invasive non-native/alien species						
8.2	Problematic native species		Not Calculated (outside assessment timeframe)	Small (1-10%)	Slight (1-10%)	Low (Possibly in the long term, >10 yrs)	The increasing shrub cover could be detrimental.
8.3	Introduced genetic material						
9	Pollution						
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						



Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High – Low	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides	CD	Medium- Low	Large (31-70%)	Moderate - Slight (1-30%)	High – Low	Erosion, collapse of rock faces, and landslides are the most important threats to the survival of <i>B. quebecensis</i> which may increase within the assessment timeframe partly as a result of past climate change.. Whether these events provide establishment opportunities by clearing competitors, or cause declines in Quebec Rockcross will be a very stochastic process.
11	Climate change & severe weather		Not Calculated (outside assessment timeframe)	Pervasive - Restricted (11-100%)	Moderate (11-30%)	Low (Possibly in the long term, >10 yrs)	
11.1	Habitat shifting & alteration		Not Calculated (outside assessment timeframe)	Restricted (11-30%)	Moderate (11-30%)	Low (Possibly in the long term, >10 yrs)	Warming climatic conditions could lead to a change in the nature, structure and density of the vegetation of <i>B. quebecensis</i> habitat, which could have a negative impact on the subpopulations.
11.2	Droughts		Not Calculated (outside assessment timeframe)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs)	It is possible that an increase or decrease in precipitation would have a detrimental effect on the survival or reproduction of individuals. Recruitment of seedlings would probably be greatly affected by a prolonged drought.
11.3	Temperature extremes		Not Calculated (outside assessment timeframe)	Small (1-10%)	Slight (1-10%)	Low (Possibly in the long term, >10 yrs)	An increase in temperature could have an adverse effect on the survival or reproduction of individuals.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding		Not Calculated (outside assessment timeframe)	Restricted (11-30%)	Moderate (11-30%)	Low (Possibly in the long term, >10 yrs)	Flash floods can cause discontinuities in the rock walls. The occurrence at Bic (Cap au Corbeau) could be affected by a long-term increase in the level of the St. Lawrence River and the habitat could be subject to salt spray and coastal erosion. The occurrence at Percé (La Muraille) is likely to be affected by possible inundation because it is located in an area that may be affected by the flood of a creek.

Classification of Threats adopted from IUCN-CMP, Salafsky et al. (2008).