COSEWIC
Assessment and Status Report

on the

Griscom's Arnica
Arnica griscomii ssp. *griscomii*

in Canada

THREATENED
2014

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:

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COSEWIC
Assessment Summary

Assessment Summary – November 2014

Common name
Griscom's Arnica

Scientific name
Arnica griscomii ssp. *griscomii*

Status
Threatened

Reason for designation
This mat-forming plant is a Canadian Gulf of St. Lawrence endemic found only on small, isolated calcareous cliffs and limestone barrens of Quebec and the Island of Newfoundland, is increasingly under threat due to habitat shift in response to a changing climate. The instability of some sites increases the threat of a stochastic event that could result in the loss of some small subpopulations. ATV use in limestone barrens is of some concern.

Occurrence
Quebec, Newfoundland and Labrador

Status history
Designated Threatened in November 2014.

COSEWIC
Executive Summary

Griscom's Arnica
Arnica griscomii ssp. *griscomii*

Wildlife Species Description and Significance

Griscom's Arnica (*Arnica griscomii* ssp. *griscomii*) is a small perennial herb with bright-yellow daisy-like flowers. It is a Canadian Gulf of St. Lawrence endemic, and is found only in Québec and on the island of Newfoundland. The flowers, which grow on stems about 20 cm tall, arise from a cluster of leaves that lie almost flat on the ground. These plants spread by rhizomes (underground stems), often forming dense clumps. Dense patches of showy flowers may make this a charismatic species for inspiring public interest in preserving calcareous cliffs, limestone barrens, and their plant life.

Distribution

Griscom's Arnica is endemic to Canada and is known only from five subpopulations on the Gaspé Peninsula of Quebec and from three subpopulations on the island of Newfoundland.

Habitat

Griscom's Arnica grows only on calcium-rich soils. It prefers full sun or partial shade, and is usually found on cliff faces, talus slopes, around rock outcrops, and at the edge of vegetation patches on natural limestone gravel barrens.

Biology

Griscom's Arnica is adapted to sites that are subjected to extreme weather, and the stems die down to the soil surface in winter. The plant is able to produce seeds without fertilization, and its seeds are wind-borne, like a dandelion's. Although there are some signs of herbivory, this species does not seem to be palatable to many animals. Because of its strict habitat requirements and inability to compete with faster-growing plants, Griscom's Arnica does not colonize new sites easily.

Population Size and Trends

There are 125 flowering plants in Quebec, and about 10,500 in Newfoundland. The Newfoundland subpopulations seem to be stable, but the Quebec subpopulations may be in decline.

Threats and Limiting Factors

Griscom's Arnica is limited primarily by competition from faster-growing plants. It can only thrive where other species are handicapped by extreme soil and climatic conditions. Climate change is probably the greatest threat to this plant due to the high potential for other species to take advantage of milder conditions and displace Griscom's Arnica. Other minor threats include trampling by Moose and Woodland Caribou, trampling and habitat damage by humans and their vehicles, and collecting of plants for horticulture.

Protection, Status, and Ranks

All but one of the subpopulations of Griscom's Arnica are located in federal parks or provincial protected areas, and are afforded some protection by their regulations. The only subpopulation that does not have legal protection is on St. John Island, off the coast of western Newfoundland. In Quebec the species is designated as Threatened under provincial legislation.

Griscom's Arnica has a NatureServe global conservation rank of G5T2 (the species overall is Secure, but the Gulf of St. Lawrence subspecies is Imperilled), a national rank of N2 (Imperilled), and a subnational rank of S1 (Critically Imperilled) in Quebec, and S1S2 (Critically Imperilled to Imperilled) in Newfoundland & Labrador. It is ranked as At Risk in Quebec and as May Be At Risk in Newfoundland & Labrador by General Status of Canada.

TECHNICAL SUMMARY

Arnica griscomii ssp. *griscomii*

Griscom's Arnica Arnica de Griscom

Range of occurrence in Canada: Newfoundland & Labrador (island of Newfoundland), Quebec.

Demographic Information

Generation time	2-3 years (ramets) Decades (genets)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? The only monitored subpopulation is at Port au Choix, and there does not seem to be a change in the area covered by plants, BUT the number of flowering stems does fluctuate from year to year. Dignard (1998) states that subpopulations in Quebec seem to be in decline, although Mont Saint-Alban seems to be stable.	No, in NL Possibly, in some Quebec subpopulations
Estimated percent of continuing decline in total number of mature individuals within 5 years. Subpopulations have not been followed long enough to estimate any change.	No data
Estimated percent reduction or increase in total number of mature individuals over the last 10 years.	No data
Projected percent reduction or increase in total number of mature individuals over the next 10 years.	No data
Estimated percent reduction or increase in total number of mature individuals over any 10-year period, over a time period including both the past and the future.	No data
Are the causes of the decline clearly reversible and understood and ceased?	N/A
Are there extreme fluctuations in number of mature individuals?	No
Extent and Occupancy Information	
Estimated extent of occurrence More than 80% of this area is open ocean.	60,662 km^2
Index of area of occupancy (IAO) (2 x 2 km grid value).	52 km^2
Is the population severely fragmented? More than 90% of the world population grows at one subpopulation in Newfoundland. More than half of the occupied area is in small isolated patches that may not be viable. These are far enough apart that there is an insignificant chance of genetic exchange between any two.	No
Number of locations	8
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? The loss of subpopulations would coincide with the loss of IAO.	Yes

Is there an [observed, inferred, or projected] continuing decline in number of subpopulations? One of the Newfoundland subpopulations has not been re-located, despite attempts. All Quebec subpopulations are small and on unstable substrates, and Norman Dignard considers that, except for Mont Saint-Alban, they have either declined since first found or are in imminent danger.	Yes
Is there an observed continuing decline in number of locations? The loss of subpopulations would coincide with the loss of IAO.	Yes
Is there a projected continuing decline in the area, extent of habitat?	Yes
Are there extreme fluctuations in number of (sub)populations?	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, counted as flowering stems (observations since 1990)

Subpopulation	**N Mature Individuals**
Port au Choix, NL (estimate)	10,448*
St. John Island, NL	437
Killdevil Mountain, NL	338
Mont Logan, QC	10
Premier lac des Îles (La Misère), QC	13
Mont Joseph-Fortin, QC	3
Mont Saint-Alban, QC	36
Mont Matawees, QC	63
Subtotals (NL estimate)	**NL — 11,223*** **QC — 125**
TOTAL (estimate)	**11,348***

* N.B.: Because somewhat less than 5% of plants counted at Port au Choix had 2, and occasionally 3, flowering stems, there is an overestimate of mature plants in the range of 600 to 700. The actual number of mature plants in NL is probably closer to 10,500.

Quantitative Analysis

Probability of extinction in the wild.	Not done

Threats (actual or imminent, to (sub)populations or habitats)

Climate change could change moisture regimes and rate of vegetation growth, especially on the limestone barrens—major long-term threat. Instability of cliff habitat—a minor threat to the entire population, but a major threat to Quebec subpopulations. Grazing and trampling by wildlife—minor threat to plants on Newfoundland's limestone barrens. Off-road vehicle use—minor threat on Newfoundland's limestone barrens. Increased use of habitat by hikers—minor threat. Damage during maintenance of hydro infrastructure—minor threat. Plant collecting and flower picking—minor threat in most parts of range.

Rescue Effect (immigration from outside Canada)

Status of outside (sub)population(s)? Griscom's Arnica is endemic to Canada	N/A
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	N/A
Is there sufficient habitat for immigrants in Canada?	N/A
Is rescue from outside (sub)populations likely?	No

Data-Sensitive Species

Is this a data-sensitive species? This species has some potential to attract interest from collectors for horticultural use.	Yes

Status History

COSEWIC: Designated Threatened in November 2014.

Status and Reasons for Designation:

Status:	**Alpha-numeric code:**
Threatened	B2ab(ii,iii,iv)
Reasons for designation: This mat-forming plant, a Canadian Gulf of St. Lawrence endemic found only on small, isolated calcareous cliffs and limestone barrens of Quebec and the Island of Newfoundland, is increasingly under threat due to habitat shift in response to a changing climate. The instability of some sites increases the threat of a stochastic event that could result in the loss of some small subpopulations. ATV use in limestone barrens is of some concern.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not met. Insufficient data to determine magnitude of declines.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Threatened B2ab(ii,iii,iv) as the IAO < 500 km^2 (52 km^2), it is known from < 10 (8) locations, and there is a predicted decline in the habitat and number of subpopulations (in Quebec), which would also result in the loss of IAO.
Criterion C (Small and Declining Number of Mature Individuals): Not met. Although the population is approaching the threshold for Threatened (10,000), there is no decline documented.
Criterion D (Very Small or Restricted Population): Not met. Population size and IAO exceed thresholds.
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
(2014)

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.

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Canada

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

COSEWIC Status Report

on the

Griscom's Arnica

Arnica griscomii ssp. *griscomii*

in Canada

2014

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Arnica griscomii Fernald ssp. *griscomii*

Griscom's Arnica; Arnica de Griscom

Family Asteraceae

Synonyms
Arnica louiseana Farr ssp. *griscomii* (Fernald) Maguire [Brittonia 4: 419-420, 1943]
Arnica louiseana Farr var. *griscomii* (Fernald) Boivin [Phytologia 23: 95, 1972]
Arnica frigida C.A. Meyer *ex* Iljin ssp. *griscomii* (Fernald) S.R. Downie [Can. J. Bot. 64: 1369-1370, 1986]

Type Specimen
Fernald and Smith 26084, Gray Herbarium (GH), Cambridge, Massachusetts, USA

Arnica griscomii is an amphi-Beringian arctic-alpine species that includes two widely separated subspecies: *Arnica griscomii* ssp. *frigida* (Snow Arnica) grows in eastern Russia, Alaska, Yukon, Northwest Territories, and British Columbia. *Arnica griscomii* ssp. *griscomii* (Griscom's Arnica) is endemic to the Gulf of St. Lawrence, growing only on the west coast of the island of Newfoundland and the Gaspé Peninsula of Quebec.

This is a distinctive taxon, currently recognized as a subspecies (Wolf 2006), that has a complicated taxonomic history. Fernald proposed the name *Arnica griscomii* for a plant discovered on Mt. Mattaouisse (now Matawees) in the Gaspé region of Quebec in 1923 (Fernald 1924). The plant was collected again on the west coast of Newfoundland (Fernald 1933). Fernald (1950) eventually combined *A. griscomii* in synonymy under the name *A. louiseana* (Lake Louise Arnica). Maguire (1943) suggested that this taxon should be treated as one of three subspecies of *Arnica louiseana* (*A. louiseana* ssp. *louiseana*, *A. louiseana* ssp. *frigida*, and *A. louiseana* ssp. *griscomii*.). Downie and Denford (1985) cited phytogeographical and cytological support for separating *Arnica louiseana* ssp. *louiseana* from the other two subspecies and for the recognition of *A. frigida* ssp. *frigida* and proposed the name *A. frigida* ssp. *griscomii*. Wolf (1989) re-established the priority of Fernald's specific epithet (*griscomii*) over that of Iljin (*frigida*). Elven *et al.* (2011) reject Wolf's rationale for subspecies recognition of *frigida* and *griscomii* and consider both to be full species.

Morphological Description

Griscom's Arnica is a low (5 to 25 cm tall), showy, herbaceous, perennial plant in the Aster family that produces a rosette of basal leaves from which one to (rarely) three flowering stems arise (Figures 1 and 2). Leaves lie almost flat on the ground, and each leaf margin bears three or four pairs of small shallow teeth. Leaves are hairless, slightly fleshy, and yellow-green (compared to other local Arnica species) with faint reddish colouration along veins and margins. Each basal leaf has three main veins. About one third of the distance from the stem to the leaf tip, the two outer veins curve sharply in towards the midvein. The composite flowerhead is composed of perfect disk florets surrounded by pistillate ray florets.

Narrow-leaved Arnica (*Arnica angustifolia* ssp. *angustifolia*), Woolly Arnica (*A. angustifolia* ssp. *tomentosa*), Long-leaved Arnica (*A. lonchophylla*), and Griscom's Arnica sometimes grow intermixed, and are often closely associated (Burzynski 2007a), but are easily separated in the field by leaf morphology (Table 1, Figure 3).

Figure 1. *Arnica griscomii* ssp. *griscomii* at Port au Choix National Historic Site. Photo by M. Burzynski.

Figure 2. *Arnica griscomii* ssp. *griscomii*. Drawing M. Burzynski.

Table 1. Key to potentially confusing Arnicas of Newfoundland & Labrador and Quebec*.

A.	Basal leaves linear or lanceolate, stiff, upright, edges with few or no teeth	C
A.	Basal leaves oblong or ovate, hairless, or becoming hairless, flat to ground or held low, single or double teeth irregularly and sparsely spaced along edges.	
	B. Basal leaves (both surfaces) and stems densely covered with white silky hairs; involucre covered with hairs and small stalked glands	*A. angustifolia* ssp. *tomentosa*
	B. Basal leaves smooth to sparsely hairy	*A. angustifolia* ssp. *angustifolia*
C.	Basal leaves angled slightly upwards, tinged with red or purple with 5 main veins smoothly curving from tip to base of leaf	*A. lonchophylla.*
C.	Basal leaves flat to the ground, green, and somewhat fleshy with 3 main veins, the two lateral veins abruptly bending in towards the midvein just above the petiole	*A. griscomii* ssp. *griscomii*

* Lance-leaved Arnica (*Arnica lanceolata*) occurs in Quebec, but inhabits moist stream banks, gravel bars, and subalpine meadows, and is unlikely to be confused with Griscom's Arnica.

Figure 3. Comparison of leaves of Griscom's Arnica (*Arnica griscomii* ssp. *griscomii*), Long-leaved Arnica (*Arnica lonchophylla*), Narrow-leaved Arnica (*Arnica angustifolia* ssp. *angustifolia*), and Woolly Arnica (*Arnica angustifolia* ssp. *tomentosa*), adaxial surfaces of leaves above, abaxial below. Photos by M. Burzynski.

Population Spatial Structure and Variability

The Quebec and Newfoundland & Labrador subpopulations of Griscom's Arnica are isolated from each other by 480 km of open ocean. Even within provinces the subpopulations are isolated: In Quebec, the Mont Logan subpopulations are 6.6 km apart, and Mont Logan and Mont Saint-Alban are 200 km apart. In Newfoundland & Labrador, Killdevil Mountain is 138 km south of Port au Choix area and the three Port au Choix subpopulations (Port au Choix National Historic Site, St. John Island, and the historical subpopulation of Highlands of St. John) are approximately 15 km from each other. Even if the subpopulations were closer together, Downie and Denford (1985) state that the pollen viability of this species is between 0 and 4%, and most seeds are produced by apomixis (Barker 1966). Genetic differences [or structuring] between subpopulations could therefore be expected.

Designatable Units

Griscom's Arnica is found in two areas so widely separated that gene flow has been severely limited or non-existent for an extended period of time. The plants occur in the COSEWIC Atlantic Ecological Area in Quebec and in the Boreal Ecological Area in Newfoundland & Labrador. The alpine habitat of the plants in Atlantic Ecological Area of Quebec closely resembles some of the habitat for this taxon in the Boreal Ecological Area. The plants in Quebec grow in very small colonies on unstable isolated cliffs, and the plants in Newfoundland & Labrador grow, for the most part, in larger colonies on limestone barrens near sea level. The differences in elevation may promote significant adaptive differences.

Due to apomixy, the widely separated subpopulations in Quebec and Newfoundland & Labrador may also be genetically distinct (Bayer 1990). The genetic significance of the separation has not been tested and even though the proposed populations are in different ecoregions, they are occupying similar habitats with some species common to both, so the argument for two designatable units cannot be made with certainty.

Special Significance

Griscom's Arnica is a Canadian Gulf of St. Lawrence endemic. Its dense clumps of showy flowers may be used to inspire public interest in preservation of calcareous cliffs, limestone barrens, and their flora. This plant responds easily to cultivation and the flowers are relatively long-lasting.

Requests were made to members of Miawpukek First Nation and Qalipu Mi'kmaq First Nation, but no Aboriginal traditional knowledge about this taxon was identified.

There are no known ethnobotanical (no mention in Arnason *et al.* 1981), medicinal, or culinary uses of Griscom's Arnica, although related species, Leopard's-bane (*Arnica montana*), Heart-leaved Arnica (*A. cordifolia*) and Hillside Arnica (*A. fulgens*) are widely used in Europe as anti-inflammatories and bactericides and in topical creams and homeopathic remedies (Agriculture and Agri-food Canada 2013; University of Maryland Medical Centre 2013).

DISTRIBUTION

Global and Canadian Range

Griscom's Arnica occurs only in Canada and is a Gulf of St. Lawrence endemic restricted to the island of Newfoundland and Quebec (Figure 4-6). Within those two provinces it is known from eight subpopulations and one historical locality—Highlands of St. John, NL where plants have not been seen since 1949 and are considered extirpated (Table 2).

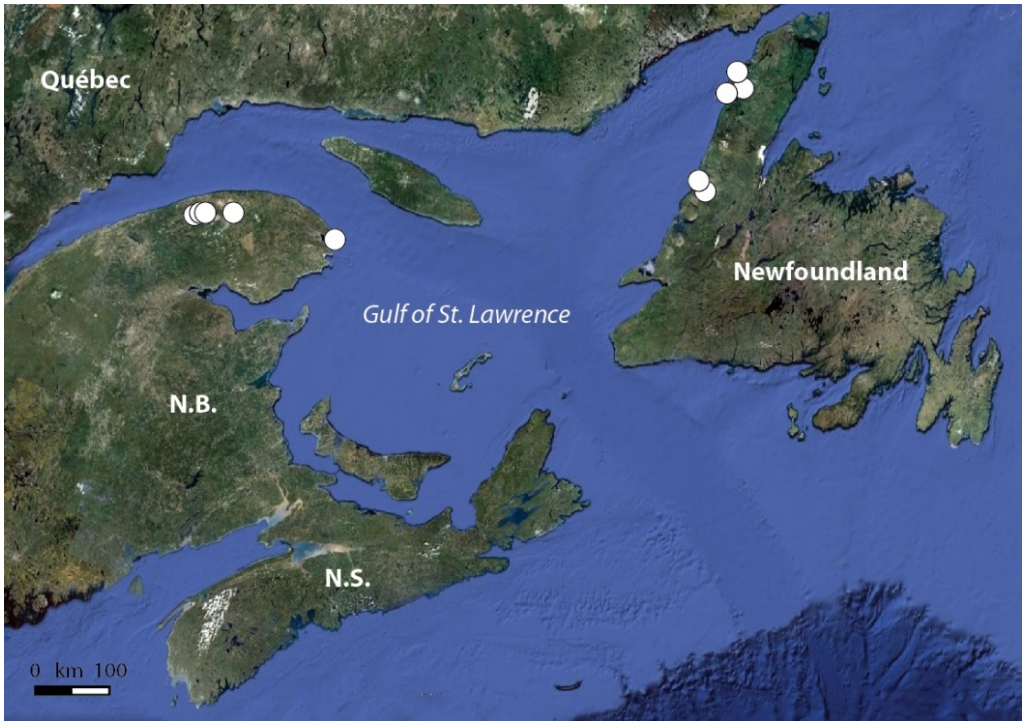

Figure 4. Entire range of *Arnica griscomii* ssp. *griscomii*, all reported sites shown. Base map from GoogleEarth Nov. 2012.

Figure 5. Subpopulations of Griscom's Arnica in Newfoundland & Labrador. The single cultivated plant at Rocky Harbour is shown with a "C", and the historical site in the Highlands of St. John is shown with an "H". Base map from GoogleEarth Nov. 2012.

Figure 6. Subpopulations of Griscom's Arnica in Quebec. Base map from GoogleEarth Nov. 2012.

Table 2. Localities of Griscom's Arnica subpopulations with discoverer and most recent observations.

Newfoundland & Labrador	Discovered by	Most Recent Observation
Port au Choix	M.L. Fernald *et al.* 1927	M. Burzynski *et al.* 2012
St. John Island	M.L. Fernald *et al.* 1929	M. Burzynski *et al.* 2012
Highlands of St. John (Doctors Hill)	R.K. Tuomikoski 1949	R.K. Tuomikoski 1949
Killdevil Mountain	A. Bouchard *et al.* 1996	M. Burzynski & A.Marceau 2012

Quebec (Dignard 1998)	Discovered by	Most Recent Observation
Mont Logan	Pease and Smith 1923	N. Dignard 1992
Premier lac des Îles: La Misère	N. Dignard 1993	N. Dignard 1993
Mont Saint-Alban	S.R. Downie 1984	Brodeur and Duquette 2012
Mont Joseph-Fortin	N. Dignard and Gagnon 1998	N. Dignard and J. Gagnon 1998
Mont Matawees: Head of Big Chimney	M.L. Fernald *et al.* 1923	Labrecque, Tremblay, Piché and Jolicoeur 2014

Extent of Occurrence and Area of Occupancy

Extent of occurrence (EO) of Griscom's Arnica is 60,662 km^2 for the species across Canada (Newfoundland population – 1,208 km^2, Quebec population – 912 km^2).

Index of area of occupancy (IAO; calculated as the best fit within a 2 x 2 km grid) for species across Canada is 52 km^2 (13 grids). For the Newfoundland population the IAO is 32 km^2 (8 grids), and for the Quebec population it is 20 km^2 (5 grids).

Biological area of occupancy of the Newfoundland & Labrador subpopulations is estimated to be approximately 1.8 km^2. For the known Quebec subpopulations it is approximately 15 m^2 (Table 3).

Table 3. Biological area of occupancy (estimated).	
Newfoundland & Labrador Subpopulations	
Port au Choix	1.31 km^2
St. John Island	0.20 km^2
Killdevil Mountain	0.30 km^2
TOTAL biological area of occupancy, NL	1.81 km^2
Quebec Subpopulations (Dignard 1998)	
Mont Logan	3 m^2
Premier lac des Îles: La Misère	3 m^2
Mont Matawees	5 m^2
Mont Joseph-Fortin	1 m^2
Mont Saint-Alban: cliff rim	3 m^2
TOTAL biological area of occupancy, QC	15 m^2

Search Effort

Arnica griscomii ssp. *griscomii* is only known from Newfoundland & Labrador and Quebec. Throughout both provinces, calcareous habitat has been carefully surveyed, either specifically for Griscom's Arnica or for calciphiles in general, because it is important to so many uncommon species (Table 4). Calcareous habitat occurs in small patches that are often widely separated on the landscape. Calcareous barrens and outcrops comprise less than 0.01% of the land area of Newfoundland & Labrador (estimated to be less than 40 km^2), and far less of Quebec. Only a few small areas of this habitat remain to be searched:

Two difficult-to-reach islands with limestone barrens should be checked in Newfoundland & Labrador: Flat Island, an area of about 5 km^2, is 2 km west of St. John Island; and Round Head Island, with an area of about 2 km^2, is 1 km southeast of St. John Island (Figure 4).

In Quebec, Dignard (1998) recommended that the area northwest of Mont Fortin and the flanks and summits of Mont des Loupes, Mont Coleman, Mont Nicol-Albert, Mont Frère de Nicol-Albert, and Mont Blanc should all be searched, as well as the habitat for Drummond's Mountain-avens (*Dryas drummondii*) mapped by Morisset on Mont Saint-Alban.

Table 4a. General Search Efforts in Newfoundland and Labrador.

Date	Location	Notes
1933	St. John Island NL, Port au Choix peninsula, NL	M.L. Fernald *et al.* found this species in western Newfoundland.
1949	Highlands of St. John, NL	R.K. Tuomikoski collected Griscom's Arnica on the Highlands of St. John.
1970s to present	West coast of island of Newfoundland	H. Mann (Botany Professor, Sir Wilfred Grenfell College, retired) searched for rare plants throughout western Newfoundland.
1976	Gros Morne NP area, NL	S.G. Hay produced The Vascular Flora of St. Barbe South, Newfoundland.
1980s to present	West coast of island of Newfoundland	J. Maunder (Curator Emeritus of Natural History, Provincial Museum of NL) checked sites throughout western Newfoundland for rare plants.
1984 to 1990	Newfoundland	A. Bouchard *et al.* conducted fieldwork throughout western Newfoundland and produced The Rare Vascular Plants of the Island of Newfoundland in 1991, listing Griscom's Arnica as an S1 species.
1986	Gros Morne National Park, NL	A. Bouchard *et al.* completed fieldwork and produced a rare plant report for Gros Morne.
1990s	West coast of island of Newfoundland	S.J. Meades (Botanical Researcher) searched for rare plants throughout the Island.
1993	Port au Choix National Historic Site, NL	A. Bouchard *et al.* completed fieldwork and produced a rare plant report for Port au Choix.
1996	Gros Morne National Park, NL	A. Bouchard *et al.* completed fieldwork and published a report about the rare vascular plants of remote and unstudied sites in Gros Morne NP.
1996 to 2000	Gros Morne National Park, NL	M. Anions and other Parks Canada staff established sampling plots in rare plant habitat and surveyed rare species during this work.
1999	Gros Morne National Park, NL	A. Bouchard, L. Brouillet, and S. Hay 1999 checked highlands around Bonne Bay for rare species, locating Griscom's Arnica on Killdevil Mountain.
1999 to 2001	Western Newfoundland	Newfoundland Rare Plant Project surveyed 1,645 sites along the west and northeast coasts of the island of Newfoundland, with special emphasis on limestone barrens and outcrops.
2000 to 2005	West coast of island of Newfoundland	N. Djan-Chékar (Provincial Museum of NL) searched for rare plants throughout western Newfoundland.
2000 to present	West coast of island of Newfoundland	C. Hanel (Ecosystem Management Ecologist, Wildlife Division, Dept. of Environment and Conservation) searched for rare plants throughout western Newfoundland.
2001 to 2011	Gros Morne National Park and Port au Choix NHS, NL	M. Burzynski (Field Unit Vegetation Biologist) alone and with assistants visited known sites throughout Gros Morne NP and Port au Choix NHS to inventory rare plants.

Date	Location	Notes
2002	Port au Choix NHS, NL	C. Wentzell surveyed the hydro line on the Port au Choix Peninsula and noted several occurrences of Griscom's Arnica.

Table 4b. General Search Efforts in Quebec.

Date	Location	Notes
1923	Mt. Matawees, QC	Plant first discovered by M.L. Fernald *et al.*
1961	Mont Logan and Mont Matawees, QC	C. Gervais studied the flora of the Mont Logan region.
1986	Mont Saint-Alban, QC	S.R. Downie and K.E. Denford located Griscom's Arnica on the cliffs.
1992/1993	Mont Logan and Premier lac des Îles, QC	N. Dignard surveyed the plants of the Parc de la Gaspésie.
1995	Mont Saint-Alban, QC	P. Morisset inventoried plants on the cliff at the mountaintop.
1998	QC	N. Dignard conducted fieldwork and his status report about Griscom's Arnica is published.
1998	Mont Joseph-Fortin, QC	N. Dignard and J. Gagnon found Griscom's Arnica on a cliff above Lac aux Americains.
2002	Mont Saint-Alban, QC	H. Gilbert updated rare plant inventories in Forillon N. Park, including Griscom's Arnica.
2010	Mt. Mattawees	G. Lavoie observed 3 small colonies
2014	Mt. Mattawees	J. Labrecque *et al.* observed 2 small colonies

Targeted Search Efforts in Newfoundland & Labrador *(Table 6)*

- Port au Choix in 2011 and 2012, Burzynski and three other searchers spent a total of 19 searcher hours surveying this species on different parts of the Port au Choix and Point Riche peninsulas (Burzynski 2012b).
- Highlands of St. John, 2005 and 2010, Hanel and two other searchers spent a total of 9 hours searching for this species around the waterfall on Doctor's Brook. No plants were found either time (Hanel 2005; Hanel pers. com. 2012).
- St. John Island July 5, 1999, Anions and eight other searchers spent a total of 45 searcher hours but did not find Griscom's Arnica (Anions 1999).
- St. John Island (Figure 7), July 27 to 29, 2012, Burzynski and four other searchers spent a total of 78 searcher hours surveying all of the limestone barrens on the island. The subpopulation of Griscom's Arnica first found by Fernald *et al.* in 1923 was re-located for the first time in 89 years. The searchers found 437 flowering plants (Burzynski 2012b).

- Killdevil Mountain, July 12, 2004, Burzynski and Bennett spent a total of 8 searcher hours surveying the western end of the mountain, and found 45 flowering plants.
- Killdevil Mountain (Figure 8), July 5, 2012, Burzynski and Marceau spent a total of 9 searcher hours surveying the plants on the eastern end of the mountain and found 293 flowering plants (Burzynski 2012b).

Targeted Search Efforts in Quebec (Figure 6)

- Mont Saint-Alban (Figure 9), Griscom's Arnica was first found here by Downie and Denford in 1986; Morisset checked the site in 1995; Gilbert inventoried the species at this site in 2002; and the species was most recently inventoried by Brodeur and Duquette in July, 2012, when 10 plants were found (Brodeur 2012).
- Mont Logan area, N. Dignard searched this area in 1992 and did not find any additional subpopulations (Dignard 1998).
- Premier lac des Îles, Dignard surveyed this area in 1993 and found 13 mature plants (Dignard 1998).
- Mont Matawees (Réserve écologique Fernald, north face of), J. Labrecque, B. Tremblay, V. Piché and G. Jolicoeur, found 2 small colonies growing in rock crevices in a very steep slope. The first colony has 15 rosettes and two flowering stems and the second colony had 20 rosettes and only one flowering stem on August 2, 2014. (Réserve écologique Fernald, north face of Mt. Mattawees, eastern end of glacial cirque, near the summit) G. Lavoie observed 3 small colonies on July 15, 2010 on a steep slope at the foot of a rock outcrop including 20 flowering stems growing in a mat of *Empetrum hermaphroditum, Rhododendron groenlandicum, Salix vestita* and *S. uva-ursi*; 10 flowering stems in mossy rock crevices; 30 flowering stems on a rocky outcrop nearby. C. Gervais spent 40 days doing plant inventories in 1964 and only found one small clump (Dignard 1998).
- Mont Joseph-Fortin, N. Dignard and J. Gagnon (1998) found 3 Griscom's Arnica at this site (Dignard 1998).

Figure 7. Typical habitat of Griscom's Arnica on St. John Island. Photo by M. Burzynski.

Figure 8. Typical habitat of Griscom's Arnica on Killdevil Mountain. Photo by M. Burzynski.

Figure 9. Typical habitat of Griscom's Arnica on Mont Saint-Alban, Quebec. Photo by Serge Brodeur, with permission.

Table 5. Substrates and altitudes at subpopulation sites.

Newfoundland & Labrador subpopulations		
Port au Choix	Limestone	10 to 15 m
St. John Island	Limestone	20 to 35 m
Killdevil Mountain	Limestone and calcium-rich shale beds in quartzite	660 m
Quebec subpopulations (Dignard 1998)		
Mont Logan	Calcium-rich chlorite schist	900 to 1000 m
Premier lac des Îles: La Misère	Calcium-rich chlorite schist	900 to 1000 m
Mont Matawees	Calcium-rich chlorite schist	900 to 1000 m
Mont Joseph-Fortin	?	960 m
Mont Saint-Alban: cliff rim	Limestone & calc-mudstone	220 m

Table 6. Recent search effort for Newfoundland subpopulations.

Site	Number of flowering plants	Date of field visit	Number of searchers	Total number of searcher hours	Search team leader
St. John Island (southern barren)	No plants found	1999, July	9	45	Marilyn Anions
St. John Island (all barrens)	437	2012, July 27-29	5	78	Michael Burzynski
Highlands of St. John	No plants found	2005	2	8	Claudia Hanel

Site	Number of flowering plants	Date of field visit	Number of searchers	Total number of searcher hours	Search team leader
Highlands of St. John	No plants found	2010	2	9	Claudia Hanel
Port au Choix National Historic Site (PAC peninsula Barbace Cove barrens and around navigation light)*	198	2011, June 25	3	6	Michael Burzynski
Port au Choix National Historic Site (the rest of the site)*	10,250 (estimate)	2012, July 11	2	13	Michael Burzynski
Killdevil Mountain (east)*	45	2004, July 4	2	8	Michael Burzynski
Killdevil Mountain (west)*	293	2012, July 5	2	9	Michael Burzynski

* Because of the large areas and difficulty of reaching these sites, counts of different portions of the sites undertaken in different years have been combined to give a site total.

HABITAT

Habitat Requirements

Griscom's Arnica is endemic to well-drained calcareous soils on coastal and alpine cliffs, ledges, talus slopes, outcrops, and natural gravel barrens, usually on limestone or calcareous schist (eFloras 2013; Figures 8-9). This plant grows in full sun to partial shade in the vegetation fringing the calcareous outcrops and barrens, and on vegetation islands in the barrens. This taxon flourishes where peaty soil is shallow and associated vegetation is low and sparse. In Newfoundland this taxon is usually found in full sun on open limestone barrens, but can also grow in partial shade on ledges and at the base of low cliffs. Griscom's Arnica does not survive competition with faster-growing plants (Burzynski pers. obs.). In Quebec, this plant grows on calcareous cliff talus facing NE to SSE at an angle of about 40°, in fine dry stone fragments about 3 cm in diameter (Dignard 1998).

Associated species fall within three groups: typical boreal plants (more prevalent at the Quebec occurrences, but few in Newfoundland); typical arctic-alpine basiphiles (mostly seen in Newfoundland); and low growing shrubs and basiphiles that do not compete with Griscom's Arnica for light and space (Appendix 1).

Substrate and Altitude

The Newfoundland & Labrador subpopulations all grow on limestone at altitudes ranging from 10 to 660 metres above sea level. The Quebec subpopulations grow on limestone or calcium-rich chlorite schist and mudstone at altitudes between 220 and 1,000 metres (Table 5).

Scoggan (1950) reported a pH of 8.0 for limestone material at the base of the cliff at Mont Saint-Alban, and that Gervais (1982) reported pH readings of 3.8 to 6.4 for Mont Logan samples.

Habitat Trends

Since the end of the last glaciation, the large expanses of limestone and other calcareous substrate around the Gulf of St. Lawrence have become overgrown with forest and wetlands. This has reduced available habitat for this taxon to very small areas of coastal barrens and cliffs. Although this taxon produces wind-borne seeds, its restricted distribution, its relatively small population size, and the rarity of suitable calcareous substrate severely restrict the ability of this species to spread.

Despite widespread quarrying of Newfoundland's coastal limestone barrens, none of the known subpopulations of Griscom's Arnica in Newfoundland or Quebec have been significantly affected by human actions. This plant seems to require stable, thin vegetation mats to form peaty soil on the barrens without allowing competitive species to become established. In the last 50 years, road construction, quarrying, garbage dumping, home-construction, and off-road vehicle use have damaged a large portion of the limestone barrens on the island of Newfoundland (Janes 1999). Griscom's Arnica has not colonized anthropogenically damaged limestone barrens, probably because of distance and the removal of the soil layer.

BIOLOGY

There is very little information available about the biology of Griscom's Arnica. In Newfoundland, Burzynski has grown this plant for almost a decade, and much of the following information is from personal observations.

Life Cycle and Reproduction

Griscom's Arnica is a perennial herb. As the plant increases vegetatively it produces rosettes of leaves that spread out from the original seedling site. The ratio of non-flowering rosettes to flowering rosettes was found to vary between 3:1 at Killdevil Mountain and 7.5:1 on St. John Island (Burzynski 2012b).

This plant reproduces with seeds that are, for the most part, produced by apomixis (Downie and Denford 1985). This taxon is tetraploid (Wolf 1980) and has a chromosome number of 2n=76 (Gervais 1979; Downie and Denford 1986). Plants flower between mid-June and the end of July. From 30 to 50 seeds are produced per flowerhead. Each achene bears a pappus consisting of a single row of rigid white barbellate bristles. The pappus greatly increases the potential for wind distribution of the achenes, especially on the windy limestone barrens. Leaves and flowering stems die down to soil level in winter.

Seeds require a period of cold stratification, and can have a viability of about 80%. Seedlings form a rosette in their first year, and can (but do not necessarily) flower in their second year (in cultivation). Rosettes are monocarpic, but before flowering they spread vegetatively by rhizomes, often forming dense colonies that in the wild cover a square metre or more. It is not known how long such a clone can live in the wild, but in cultivation in Rocky Harbour, a single plant grown from seed produced 24 rosettes of leaves (including 4 flowering bearing stems) by its 8th year, covering an area of about 25 cm x 25 cm. On the limestone barrens, many (presumed) clonal clusters (genets) consist of 40 or more rosettes (ramets). It is not known how long it would take a genet to reach this size. Genets appear to be long-lived—photographs taken at Port au Choix over a ten-year period do not show obvious changes in the area covered by a genet.

Griscom's Arnica often grows intermixed with, or very close to, Long-leaved Arnica, Narrow-leaved Arnica, and Woolly Arnica. However, because the pollen viability of Griscom's Arnica is quite low at about 4% (Downie and Denford 1985) there appears to be a low probability of hybridization. No hybrids have been noticed in the field.

Physiology and Adaptability

Griscom's Arnica seems more tolerant of light shade than the other arnicas within its range. In natural conditions, these plants grow on basic (calcium-rich) substrates, but in cultivation they can be grown on neutral soil as long as competing plants are controlled. In cultivation they seem unable to compete with faster-growing species (Burzynski pers. obs.).

Dignard (1998) thought that this taxon would not be easy to grow *ex situ.* Downie and Denford (1986) grew plants in a greenhouse, but did not mention whether they produced seeds. In 2004, Burzynski raised 41 plants of Griscom's Arnica from seed acquired at Port au Choix National Historic Site. The seeds were planted in March, most sprouted and grew vigorously, producing lush root systems, and 35 young plants were successfully transplanted into disturbed peat soil at the national historic site as part of a restoration effort in August that year (Burzynski and Alyward 2011). Most of the transplants (26) survived their first winter, and nine flowered and produced seeds the summer of 2005. A survey in the summer of 2012, found 30 plants, 12 of which were in flower. One of the seedlings is still growing in cultivation at Rocky Harbour. Because these plants live in peaty vegetation mats, they are far easier to cultivate and to transplant than plants of the open limestone barrens (such as Fernald's Braya [*Braya fernaldii*] and Long's Braya [*B. longii*]). In cultivation, Griscom's Arnica can be planted in soil plugs and develop vigorous root systems (Figure 10). Because Griscom's Arnica is transplanted into peaty soil, not limestone gravel, the transplants are less subject to frost heaving.

Figure 10. Roots of six-year old Griscom's Arnica plant grown in garden conditions, dug up in late autumn. Photo by M. Burzynski.

Dispersal and Migration

Calcareous barrens, ledges, and talus slopes are uncommon, and in most cases are so far away that even though the achenes are wind-borne, all subpopulations should be considered isolated. Because Griscom's Arnica is apomictic, each subpopulation may also be genetically distinct. Although airborne seeds can disperse over great distances, the probability of seed flow between any two sites in Quebec or Newfoundland is extremely low, and is much less likely between the two provinces. Even where there are large populations (such as Port au Choix NHS and St. John Island), the plants grow in limited portions of the sites and have not colonized what appears to be suitable habitat nearby. There seems to be an unrecognized habitat component that restricts the ability of these plants to spread.

Because pollen viability is low, and the distances between subpopulations are great, gene flow via cross-pollination is probably negligible.

Interspecific Interactions

Moose (*Alces alces*—an introduced species on the island of Newfoundland), Woodland Caribou (*Rangifer tarandus caribou*), and Snowshoe Hare (*Lepus americanus*—also introduced to the island of Newfoundland) are common in parts of the range of Griscom's Arnica; yet herbivory does not seem to be a limiting factor for this taxon. This plant may not be palatable to large herbivores. Invertebrate herbivory was infrequently observed in the field, although spittlebugs (Cercopidae) are relatively common on flowering stems. The number of spittlebugs per plant was small, so there is probably no direct threat caused by these animals; however they are potential vectors of viruses. No signs of disease were observed during fieldwork.

The relatively thick and sparsely ramified roots of Griscom's Arnica suggest that it may rely on mycorrhizal relationships. The European species, Mountain Arnica, *Arnica montana*, is always colonized in natural conditions by arbuscular mycorrhizal fungi (Jurkievicz *et al.* 2010; Ryszka *et al.* 2010). If this is true for *Arnica griscomii*, and if this taxon can only grow with specific mycobionts, this might explain why Griscom's Arnica is restricted to certain portions of what appears to be appropriate habitat.

POPULATION SIZE AND TRENDS

Sampling Effort and Methods

Numbers for Newfoundland subpopulations are based on direct counts in the field (Table 7). Field surveys in Quebec were not conducted during the preparation of this report.

At the Newfoundland sites, for each section of barren or cliff, searchers walked parallel transects, recording any Griscom's Arnica that they encountered. For each sighting, UTM coordinates were obtained, the number of flowering stems was counted (or estimated in tens at Port au Choix where numbers were too dense to count), and where possible the number of non-flowering plants and the area covered by the plants was estimated and recorded. For this inventory, each rosette of leaves was considered an individual plant, although this species spreads by rhizomes and a cluster of plants may all be clones of one individual. Although a small proportion of rosettes (less than 5%) produced two or even three flowering stems, for ease of counting each flowering stem was tallied as a separate plant. It is important to note that this leads to an overestimate of the number of flowering plants. The subpopulation at Port au Choix NHS is spread over a large area that had to be divided into two units and counted over two consecutive summers (2011 and 2012). The two counts were added to provide the population estimate.

At St. John Island, all appropriate habitats were searched over a three-day period. At Port au Choix, previous rare plant inventories had indicated where Griscom's Arnica grew, and only those sites were revisited by searchers. The Killdevil Mountain subpopulation is small, and restricted to two limestone outcrops on either end of the summit ridge of the mountain.

The 2012 fieldwork showed that Port au Choix National Historic Site is by far the most important site for Griscom's Arnica. The rediscovered St. John Island subpopulation turns out to have the second greatest abundance of this taxon in the world.

Table 7. Number of flowering stems* at each subpopulation, with source of count.

Newfoundland & Labrador subpopulations		
Pt au Choix, Crow Head & Nav. light	198	Burzynski *et al.*, 2011
Pt au Choix, Point Riche & VRC (estimate)	10,250*	Burzynski and Marceau, 2012
St. John Island	437*	Burzynski *et al.*, 2012
Killdevil Mountain SE	338	Burzynski and Marceau, 2012
TOTAL NEWFOUNDLAND (estimate)	11,220*	

* N.B.: Because somewhat less than 5% of plants counted at Port au Choix had 2, and occasionally 3, flowering stems, there is an overestimate of mature plants in the range of 600 to 700. The actual number of mature plants in NL is probably closer to 10,500.

Quebec subpopulations		
Mont Logan	10	Dignard (1998)
Premier lac des Îles: La Misère	13	Dignard (1998)
Mont Joseph-Fortin	3	Dignard (1998)
Mont Matawees (site 1)	60	Lavoie (2010)
Mont Saint-Alban: cliff rim	36	Brodeur (2012)
Mont Matawees (site 2)	3	Labreque (2014)
TOTAL QUEBEC	125	

Abundance

Counts of Newfoundland subpopulations in 2011 and 2012 found an estimated 11,220 flowering stems. Counts of Quebec subpopulations between 1990 and 2014 (all but two conducted before 1998) found 125 flowering stems (Table 7).

Fluctuations and Trends

The subpopulations of Griscom's Arnica have not been studied closely enough to enable comment on fluctuations and trends. No obvious year-to-year differences have been noted at Port au Choix National Historic Site over the last ten years. The St. John Island subpopulation has only recently been rediscovered and Fernald's historical notes do not contain any numerical information. Based on historical descriptions, the Mont Matawees, Mont Logan, and Premier lac des Îles subpopulations had fewer plants in 1998 than when they were discovered. The Quebec expert on the species, Norman Dignard, considers that "…*Arnica griscomii* seems to be in marked decline at all occurrences (except maybe in Forillon (Mont Saint-Alban)). Causes are unknown. There is a serious need to upgrade information that we have about the known occurrences and evaluate the demographic trends" (Dignard pers. comm. 2012).

Rescue Effect

Because Griscom's Arnica is endemic, rescue from outside the country is not possible.

THREATS AND LIMITING FACTORS

Climate change is probably the greatest threat to this taxon (Table 8). Finnis (2013) used downscaling of a range of global and regional models to predict the effects of climate change on Newfoundland & Labrador. He predicts an increase in daily mean temperatures throughout the province, with the greatest increase in the winter. Hurricanes and tropical storm events (with accompanying precipitation) are expected to become more frequent, there will be an increase in the number of growing-degree-days resulting in a longer growing season, there will be fewer days of frost and a shorter winter, more days with greater than 10 mm of precipitation, and an increase in extreme precipitation events, especially in fall and winter. This trend towards warmer, moister, and longer summers could lead to faster growth of competing species on the barrens at the expense of Griscom's Arnica.

Table 8. Reported and potential threats, by subpopulation.

	Threats	Cause	Type	Scope	Severity	Timing
Newfoundland & Labrador						
Port au Choix	Habitat shifting and alteration (11.1)	Expansion of vegetation over limestone barrens and replacement of arnica by other species if summers become warmer and moister	Anthropogenic	Pervasive	Moderate	Moderate
	Recreational activities (6.1)	Crushing and habitat damage due to illegal use of ATVs, dirt bikes, and other vehicles	Anthropogenic	Small	Slight	Low
	Recreational activities (6.1)	Trampling by hikers leaving designated trails	Anthropogenic	Small	Slight	High
	Invasive non-native species (8.1)	Trampling by Moose (and perhaps by less numerous native Caribou)	Natural, wildlife	Small	Slight	High
	Gathering terrestrial plants (5.2)	Potential for collection by commercial and private gardeners	Anthropogenic	Small	Slight	Low
	Avalanches/landslides (10.2)	Unstable cliff and talus substrate	Natural, physical	Restricted	Slight	Low
St. John Island	Habitat shifting and alteration (11.1)	Expansion of vegetation over limestone barrens and replacement of arnica by other species if summers become warmer and moister	Anthropogenic	Pervasive	Moderate	Moderate
	Oil & gas drilling (3.1)	Damage to habitat due to construction and maintenance of onshore rigs drilling under sea bed	Anthropogenic	Restricted	Moderate	Moderate
	Recreational activities (6.1)	ATV use by summer residents and fishers	Anthropogenic	Small	Slight (at current levels)	High
	Invasive non-native species (8.1)	Trampling by Moose (and perhaps by less numerous native Caribou)	Natural, wildlife	Small	Slight	High
Killdevil Mountain	Habitat shifting and alteration (11.1)	Expansion of vegetation over limestone outcrops and replacement of arnicas by other species if summers become warmer and moister	Anthropogenic	Small	Slight	Slight
	Low viability of subpopulation	Small number of isolated plants	Stochastic	Small	Potentially severe	High
	Little habitat available	Strict habitat requirements, and competition	Natural, physical	Entire sub-population	Severe	High

	Threats	Cause	Type	Scope	Severity	Timing
Quebec						
Mont Logan	Avalanches/ landslides (10.3)	This patch of plants can be destroyed by a single landslide	Natural, physical	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	Moderate
	Low viability of subpopulation	Small number of isolated plants subject to stochastic events	Natural	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High
	Little habitat available	Strict habitat requirements, and competition	Natural restriction on population increase	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High
Premier lac des îles	Avalanches/ landslides (10.3)	This patch of plants can be destroyed by a single landslide	Natural, physical	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	Moderate
	Low viability of subpopulation	Small number of isolated plants subject to stochastic events	Natural	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High
	Little habitat available	Strict habitat requirements, and competition	Natural restriction on population increase	Pervasive (affects this entire sub-pop-ulation)	Extreme (for this sub-population)	High
Mont Matawees	Avalanches/ landslides (10.3)	This patch of plants can be destroyed by a single landslide	Natural, physical	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	Moderate
	Low viability of subpopulation	Small number of isolated plants subject to stochastic events	Natural	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High
	Little habitat available	Strict habitat requirements, and competition	Natural restriction on population increase	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High
Mont Joseph-Fortin	Avalanches/ landslides (10.3)	This patch of plants can be destroyed by a single landslide	Natural, physical	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	Moderate
	Low viability of subpopulation	Small number of isolated plants subject to stochastic events	Natural	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High
	Little habitat available	Strict habitat requirements, and competition	Natural restriction on population increase	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High

	Threats	Cause	Type	Scope	Severity	Timing
Mont Saint-Alban	Avalanches/ landslides (10.3)	This patch of plants can be destroyed by a single landslide	Natural, physical	Pervasive (affects this entire subpopulation)	Extreme (for this sub-population)	Moderate
	Low viability of subpopulation	Small number of isolated plants subject to stochastic events	Natural	Pervasive (affects this entire subpopulation)	Extreme (for this sub-population)	High
	Little habitat available	Strict habitat requirements, and competition	Natural restriction on population increase	Pervasive (affects this entire sub-population)	Extreme (for this sub-population)	High

All of the Griscom's Arnica in Quebec lives on cliff ledges or talus. This cliff habitat is inherently unstable and may be a limiting factor for the taxon in the province. The subpopulations at each site are very small, and it would take very little movement to seriously reduce their numbers. However, this same instability reduces competition and allows this taxon to survive. In Newfoundland this species grows on very low cliffs (10 m or less in height) where there is little chance of a catastrophic collapse and only a tiny portion of the province's plants live in this habitat.

Although few signs of herbivory have been observed, in some parts of this taxon's range, such as Port au Choix and St. John Island, there are large numbers of Moose, Woodland Caribou, and Snowshoe Hare. Grazing and trampling might become a problem.

The Western Newfoundland and Labrador Offshore Licence Area (approximately from Port au Port peninsula to New Ferole) is being opened up to petroleum exploration (LGL Ltd. 2007). At this point, licences are only being granted from Port au Port to just north of Parsons Pond, and what is being discussed is onshore and offshore drilling (with "fracking") for oil and gas in the sub-sea sediments. A map in Enachescu (2006) shows oil leases to be let by the NL government right up to the Port au Choix and St. John Island area. St. John Island might at some time be considered as a location for one or more drill rigs. Development of this kind could damage the Griscom's Arnica subpopulation and its habitat.

ATV and off-road vehicle damage are potential problems for plants growing on low-lying limestone barrens. The plants associated with cliffs are safe from this threat. At Port au Choix National Historic Site this problem is being managed by strict enforcement of park regulations.

One cluster of plants at Port au Choix National Historic Site is close to a hydro power-line that supplies a navigation beacon. Heavy equipment is occasionally used in this area.

Some plants at Port au Choix National Historic Site are within metres of a public walking trail, so there is a chance of trampling or damage to the plants during trail maintenance.

Collection of flowers and plants for horticultural purposes may become a threat. This taxon is colourful and easy to grow, but so far has been protected by its rarity and its short flower stems. It is an attractive and dependable plant for growing in rock gardens.

Number of Locations

The term location "defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present" (IUCN 2011). Griscom's Arnica is known from eight locations.

1) Port au Choix National Historic Site

This is a coastal site with limestone cliffs and barrens on two peninsulas: Port au Choix and Point Riche. This is by far the most important location for Griscom's Arnica (containing more than 90% of the world's population), and most of those plants are on the Port au Choix peninsula. In 2004, 35 Griscom's Arnica raised from seed were planted at a site on the Point Riche peninsula. The site is subject to illegal vehicle damage (but prohibitions are currently being enforced). This site is also visited by a large number of trail users during the summer. The site may have a large number of plants, and it may appear stable; however, the actual area covered by the plants is concentrated into only about 0.3 km^2. So the possibility of a stochastic event is believed to meet the criterion that defines it as a single location.

2) St. John Island

This is also a coastal site, an isolated island with numerous limestone barrens on former beach levels. The island is 12 km from the closest Griscom's Arnica on the Port au Choix peninsula. This is the second-most-important location for the taxon. Currently, there are 13 cabins and 3 ATVs on the 25 km^2 island. An increase in the establishment of cabins or use of ATVs on this island could endanger the plants.

3) Killdevil Mountain

The summit of Killdevil Mountain is almost inaccessible and is separated by 135 km from the next closest subpopulation (Port au Choix). Because of high winds and exposure, the three small occurrences of this taxon on the top of this mountain are susceptible to changes in available moisture in summer. The plants grow in two very small areas of low limestone cliffs near the mountaintop.

4) Mont Logan Area

This site consists of inland outcrops at the crests of mountains. There are three small sites (Mont Matawees, Mont Logan, and Premier lac des Îles) over a distance of 6.6 km with very small subpopulations on unstable substrate. As the threatening event is based on the substrate, each site is considered a separate location.

5) Mont Joseph-Fortin

This is also an inland outcrop at the crest of a mountain. It has a very small subpopulation on a restricted area of unstable substrate, about 42 km from Mont Logan.

6) Mont Saint-Alban

At this coastal site the cliff top subpopulation is still extant, but the lower talus subpopulation has not been seen recently. There is a very small subpopulation on a restricted area of unstable substrate, about 133 km from Mont Joseph-Fortin.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

All but one of the subpopulations of Griscom's Arnica occur in federal parks or provincial protected areas, and are afforded some level of protection by their regulations (Table 9). The only subpopulation that does not have any legal protection is on St. John Island. It is considered Threatened in Quebec under the Quebec *Act Respecting Threatened or Vulnerable Species* (R.S.Q., c. E-12.01; CDPNQ 2008).

Table 9. Legal protection, by subpopulation.

Subpopulation	Status	Regulation
Newfoundland & Labrador		
Port au Choix	National Historic Site	National Historic Parks Wildlife and Domestic Animals Regulations.
St. John Island	Provincial Crown land?	No legal protection. There are 13 fishing establishments and cabins along the shore of the island.
Killdevil Mountain	Gros Morne National Park	Canada National Parks Act
Quebec		
Mont Logan	Parc national de la Gaspésie	Québec Loi sur les parcs
Premier lac des Îles: La Misère	Parc national de la Gaspésie	Québec Loi sur les parcs
Mont Matawees	Réserve écologique Fernald	Québec Loi sur la conservation du patrimoine naturel
Mont Joseph-Fortin	Parc national de la Gaspésie	Québec Loi sur les parcs
Mont Saint-Alban	Parc national Forillon	Canada National Park Act

Non-Legal Status and Ranks

Griscom's Arnica has a Global NatureServe conservation rank of G5T2 (the species overall is Secure, but the Gulf of St. Lawrence subspecies is Imperilled), a National rank of N2 (Imperilled), and Subnational ranks of S1 (Critically Imperilled) in Quebec and S1S2 (critically imperilled to imperilled) in Newfoundland (NatureServe 2012).

Wild Species (2012) reports that Griscom's Arnica is considered to be At Risk in Quebec and May Be at Risk in Newfoundland & Labrador. A recent Newfoundland & Labrador provincial status report (pending ministerial approval) recommends endangered status for the plant (Burzynski 2012a).

Habitat Protection and Ownership

All of the land upon which Griscom's Arnica is known to occur is afforded some form of federal or provincial protection, except for Newfoundland's St. John Island. It is not known whether the subpopulation on St. John Island is growing on provincial Crown land or private land.

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COLLECTIONS EXAMINED

Gros Morne National Park Herbarium (GMNP), 8 specimens examined.

Agnes Marion Ayre Herbarium, Memorial University of Newfoundland (NFLD) Examined by proxy (by John Maunder).

The Rooms Provincial Museum (formerly the Provincial Museum of Newfoundland and Labrador) Herbarium (NFM); six collections examined by proxy (by John Maunder and Nathalie Djan-Chékar).

A Digital Flora of Newfoundland and Labrador Vascular Plants, http://digitalnaturalhistory.com/flora_asteraceae_index.htm#arnicaangustifoliatomentosa, 3 specimens examined (images).

Appendix 1. Associated species*, those occurring in both provinces shown in grey.

Species	Newfoundland & Labrador	Quebec
Alnus crispa	•	•
Anemone parviflora	•	•
Antennaria alpina	•	
Arnica lonchophylla	•	
Artemisia canadensis		•
Asplenium viride		•
Betula papyrifera		•
*Campanula gieseckiana (*syn*. C. rotundifolia)*	•	•
Carex capillaris	•	•
Carex eburnea		•
Carex scirpoidea	•	•
Castilleja septentrionalis	•	
Cladonia rangiferina		•
Conioselinum chinense	•	•
Cornus canadensis		•
Dasiphora fruticosa	•	
Deschampsia flexuosa		•
Diapensia lapponica		•
Diervilla lonicera		•
Draba nivalis		•
Dryas drummondii		•
Dryas integrifolia	•	•
Empetrum nigrum	•	•
Erigeron hyssopifolius	•	•
Festuca brachyphylla		•
Fragaria virginiana		*
Juniperus communis	•	
Juniperus horizontalis	•	•
Juncus trifidus		•
Larix laricina	•	
Linnaea borealis		•
Maianthemum canadense		•

Species	Newfoundland & Labrador	Quebec
Lycopodium annotinum		•
Packera paupercula	•	
Picea glauca		•
Poa alpina	•	
Potentilla nivea	•	•
Potentilla tridentata		•
Racomitrium lanuginosum	•	
Rhytidium rugosum		•
Salix bebbiana		•
Salix glauca	•	
Salix uva-ursi	•	•
Salix vestita	•	•
Saxifraga paniculata		•
Shepherdia canadensis	•	
Sibbaldiopsis *tridentata*		•
Solidago hispida	•	•
Solidago multiradiata	•	•
Sorbus decora		•
Thuja occidentalis		•
Trientalis borealis		•
Trisetum spicatum	•	•
Vaccinium uliginosum	•	•
Vaccinium vitis-idaea	•	•

* Quebec species from Dignard (1998), Centre de données sur le patrimoine naturel du Québec (2012), and Hélène Gilbert (pers. comm.). Newfoundland & Labrador species from Burzynski (2007b and 2007c).