

The Status of
Griscom's Arnica

Arnica griscomii subsp. *griscomii*

in Newfoundland and Labrador



Photo: Michael Burzynski

**THE SPECIES STATUS ADVISORY COMMITTEE
REPORT NO. 27**

February 22, 2012

**Recommended Status and Reasons for Designation
(completed by the SSAC)**

Recommended Status: Endangered	Alpha-numeric code: B 1 a) & b) iii) B 2 a) & b) iii)
Reasons for designation: Limited distribution (low extent of occurrence and low index of area of occupancy) and continuing decline in quality of limestone barrens habitat due to climate change, anthropogenic activity such as ATV use, and ungulate activity.	

Applicability of Criteria

<p>Criterion A (Decline in Total Number of Mature Individuals): N/A</p> <p>Criterion B (Small Distribution Range and Decline or Fluctuation): B1 – Extent of occurrence <5,000 km² B2 – Index of area of occupancy estimated to be <500 km² a) Severely fragmented and known to exist at ≤ 5 locations and b) Continuing decline in quality of habitat (iii).</p> <p>Criterion C (Small and Declining Number of Mature Individuals):N/A</p> <p>Criterion D (Very Small or Restricted Total Population):N/A</p> <p>Criterion E (Quantitative Analysis):N/A</p>
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Author of the original report to the SSAC: Michael Burzynski

TECHNICAL SUMMARY

Arnica griscomii* Fernald subsp. *griscomii

English common name:

Nom commun français :

Griscom's Arnica

Arnica de Griscom

Range of occurrence in Canada (province/territory/ocean): Newfoundland and Labrador, Québec

Demographic Information

<p>Generation time</p> <p>[*In cultivation, these plants can produce flowers in their second year. The process may take longer in the conditions of the limestone barrens.]</p>	Unknown*
<p>Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?</p> <p>[*Although there are four known Newfoundland collection locations for this plant, the two historic locations appear to have supported very small populations.]</p>	No*
<p>Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]</p>	No data
<p>[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].</p>	No data
<p>[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].</p>	No data
<p>[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.</p>	No data
<p>Are the causes of the decline clearly reversible and understood and ceased?</p>	N/A
<p>Are there extreme fluctuations in number of mature individuals?</p>	No

Extent and Occupancy Information

Estimated extent of occurrence In Newfoundland (Quebec occurrences not included)	2,406 km ²
Index of area of occupancy (IAO) (2x2 grid value).	28 km ²
Is the total population severely fragmented?	Yes
Number of locations [*The PAC and (historical) St. John Island populations are considered to be a single “location”, on the basis of similar threats from climate change.]	2 recent, 1 historic*
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Unknown, but probably not significant
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Unknown, but probably not significant
Is there an [observed, inferred, or projected] continuing decline in number of populations? [*The 2 historic collection localities have not been re-discovered. Plants may still occur at one or both.]	Unknown, but probably not*
Is there an [observed, inferred, or projected] continuing decline in number of locations*? [*See above.]	Unknown, but probably not*
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Decline in quality of limestone barrens habitat due to climate change, anthropogenic activity such as ATV use, and ungulate activity.
Are there extreme fluctuations in number of 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
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Number of Mature Individuals (in each population)

Population	N Mature Individuals
<p>St. John Island (historic population)</p> <p>[*The population was probably very small—M. L. Fernald collected only a single plant.]</p>	Unknown*
<p>Doctors Hill (historic population)</p> <p>[*The population was probably very small—the precipitous, narrow, waterfall area at John Kane’s Ladder, on Doctors Hill, is a small and unusual habitat.]</p>	Unknown*
<p>Port au Choix National Historic Site</p> <p>[*The figure “198” is an underestimate because only 20% of apparently appropriate habitat within Port aux Choix National Historic Site was surveyed in 2011. If the actual number of mature individuals counted in 2011 (ie.198) is multiplied by 5, the total number of mature plants theoretically present, over 100% of the Port au Choix National Historic Site barrens area, can be extrapolated to be about 990. However, the surveyor (M. Burzynski) has stated that the area initially surveyed was thought to be the most productive area for the species, and thus estimates that the total Port au Choix population may actually be as much as 40% lower than 990 individuals = $990 \times 6/10 = 594$. The Port au Choix National Historic Site has the largest population of this taxon in Newfoundland.]</p>	198 confirmed (594-990)*
<p>Killdevil Mountain</p> <p>[*50 plants in 2004; number of flowering plants was not noted. However, an extrapolation, based upon a ratio of about 9.5% of plants flowering (see PACNHS 2011 count of 198 flowering and 1884 non-flowering plants) would suggest the total number of mature individuals was about 5]</p>	(5)*
Total	198 confirmed

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Unknown, but probably
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Threats (actual or imminent, to populations or habitats)

Climate change has the potential to increase the rate of vegetation growth on the limestone barrens, thereby increasing competition for these slow-growing plants (major long-term threat, although this species is able to grow in thin turf with other low plants).

Ungulate grazing and trampling (medium threat in parts of this species' habitat).

Use of off-road vehicles on limestone barrens (minor threat, can be controlled by management and stewardship actions).

Potential for increase in use of habitat by hikers (minor threat, can be controlled by management actions).

Damage during maintenance of road and hydro infrastructure (minor threat, can be controlled by management actions).

Flower picking (minor threat due to small number of hikers, restricted habitat, restricted flowering period, and low ratio of flowering plants to non-flowering).

**Rescue Effect
(immigration from outside Newfoundland)**

Status of outside population(s)?	
Is immigration known or possible? [*Immigration is possible, but unlikely. The only other populations of this subspecies occur in Québec, where CDPNQ (2012) reported fewer than 250 plants.]	Possible*
Would immigrants be adapted to survive in Newfoundland?	Yes
Is there sufficient habitat for immigrants in Newfoundland?	Yes, but relatively little
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Not yet assessed
SSAC: Not yet assessed

Author of Technical Summary: Michael Burzynski

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STATUS REPORT

Arnica griscomii Fernald subsp. *griscomii*

Griscom's arnica; Arnica de Griscom

Newfoundland population

Synonyms:

Arnica louiseana Farr subsp. *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 subsp. *griscomii* (Fernald) S.R. Downie [Can. J. Bot. 64: 1369-1370, 1986]

Family: Asteraceae, (Daisy Family)

Life Form: Showy herbaceous perennial calciphile.

Systematic/Taxonomic Clarifications

Arnica griscomii is divided into a western North American subspecies and an eastern North American subspecies. *Arnica griscomii* subsp. *frigida* is found in British Columbia, Northwest Territories, Yukon, Alaska, and eastern Russia. *Arnica griscomii* subsp. *griscomii* is endemic to the Gulf of St. Lawrence, and is found only in Newfoundland and Labrador and Québec. Downie and Denford (1986) used flavonoid profiles to show the close similarities between these two subspecies.

The province of Newfoundland and Labrador contains four taxa of arnica. The most widespread of these is *Arnica angustifolia* subsp. *angustifolia* which has been collected on the west coast of the Island from the Port au Port to Cape Norman, and as far north in Labrador as Ramah Bay (M. Burzynski 2009). On the Island, the most commonly encountered species is probably *Arnica lonchophylla*, which Rouleau and Lamoureux (1992) map as occurring from the Port au Port Peninsula to the northern tip of the Great Northern Peninsula - always in association with basic bedrock. Both *Arnica griscomii* subsp. *griscomii* and *A. angustifolia* subsp. *tomentosa* are restricted to less than a half-dozen sites (all on the west coast of the Island), and are uncommon even there.

Distribution

Global:

Arnica griscomii subsp. *griscomii* is found only in North America. One hundred percent of its global range is in Canada.

National:

This taxon is found only in eastern Canada, where it is restricted to two provinces: Newfoundland and Labrador, and Québec.



Figure 1. Distribution of *Arnica griscomii* subsp. *griscomii* populations in Canada.
Base map: Google Earth.

Provincial:

Known collection localities (north to south), with their discoverers and discovery dates:

St. John Island	Fernald <i>et al.</i> 1929
Highlands of St. John (Doctors Hill)	Tuomikoski, 1949
Port au Choix	Fernald <i>et al.</i> 1927
Killdevil Mountain	Bouchard <i>et al.</i> 1999



Figure 2. Distribution of *Arnica griscomii* subsp. *griscomii* populations in Newfoundland. “H” marks historic populations. Base map: Google Earth.

Description

Arnica griscomii subsp. *griscomii* is a low-growing perennial herb that is only found on limestone soils. Its yellow, daisy-like, flowerheads are borne up to 20 cm above a basal cluster of leaves (See Appendix B, Photos 5, 6, and 7 for illustrations of flowerhead and entire plants). There is usually only one flower per flowering stem. Leaves are spatulate and flat to the ground, green with faint reddish coloration along veins and edges, and are somewhat fleshy. Petioles are short. Each basal leaf has three main veins, and about two-thirds of the distance from the leaf tip to its base the two outer veins bend sharply in towards the midvein (Appendix B, Figure 8).

In the field, this species might be confused with *Arnica lonchophylla*, from which it differs in the following ways: *A. lonchophylla* leaves are usually tinged with red or purple, basal leaves are broad, long-petioled, and sparsely toothed, but leaves on the lower portions of flowering stems are elongate and untoothed, basal leaves have five main veins, all of which run smoothly from their tips to the base of the leaf. Flowers are often borne two to three per stem, occasionally five. Flowering stems can reach 40 cm high, but are usually around 30 cm.

Habitat

In Newfoundland and Labrador, this species grows on frost-shattered limestone gravel at the top of rock outcrops and low cliffs, on limestone talus and ledges at the base of low cliffs, and in heath vegetation along coastal limestone headlands (Figures 3 and 4). All occurrences of exposed limestone constitute less than 2% of the land area of the Island of Newfoundland. *Arnica griscomii* is not a plant of open gravel barrens, as it is rarely found more than a few metres from a limestone outcrop (M. Burzynski, pers. obs.). Québec plants were recorded as growing on “moist rock walls and shelves of hornblende-schist” (Fernald 1924). In Newfoundland, the species occurs at a range of altitudes (10-50 m at St. John Island, around 350 m on the Highlands of St. John, 10-30 m at Port au Choix, and 650 m on Killdevil Mountain), but is never more than a few kilometres from the ocean. See Appendix B, Figures 12, 13, and 14 for more photographs of habitat.

Arnica griscomii subsp. *griscomii* usually grows in association with *Juniperus communis*, *Juniperus horizontalis*, *Betula pumila*, *Dryas integrifolia*, *Arctous alpina*, *Empetrum nigrum* (*sensu lato*), *Shepherdia canadensis*, *Anemone parviflora*, and the other three local taxa of *Arnica*.



Figure 3. Typical full-sun habitat for *Arnica grisea*, Port au Choix National Historic Site. Photo: M. Burzynski.



Figure 4. Typical partially-shaded habitat for *Arnica grisea*, Port au Choix National Historic Site. Photo: M. Burzynski.

Overview of Biology

This plant is easily grown from stratified seed (Appendix B, Figure 10, compare with Figure 11). In cultivation, a plant can bear flowers in its second growing season (Cover photograph shows plants in cultivation after four seasons). It is not known whether this timetable is generally true in the harsher growing conditions of the limestone barrens, although plants set out at Port au Choix after one year's growth were able to flower the following summer (Burzynski and Alyward 2011). Plants are also easily transplanted into organic mat soils, and have a strong fibrous root system. However, they lose vigour quickly if shaded by nearby plants, and can die within two years.

Dignard (1998) stated that the adaptability of this plant to culture is probably very limited as a result of its narrow habitat range and its limited capacity to compete with faster-growing plants. He suggested that it may suffer from a genetic "fatigue" as a result of isolation from other populations. This was not the case with plants raised from Port au Choix seed for restoration work (M. Burzynski, pers. obs.). The viability of the seeds was high, growth was fast and vigorous, and the plants produced lush root systems. Plants transplanted easily, and most survived to flower the next year (Burzynski and Alyward 2011).

Downie and Denford (1986) grew this species in greenhouses but they do not mention whether the plants produced seeds. Plants raised from seed in Rocky Harbour have produced seeds annually, and plants from the same batch of seeds transplanted to Port au Choix also have produced seeds since being set out.

These plants flower between mid-June and the end of July. In the 2011 partial survey of *Arnica griscoyii* at Port au Choix, only 9.5% of the 2,082 plants counted were flowering. Whether, or not, this is representative of most years and all sites is unknown. Clumps in full-sun have a higher percentage of flowering stems than clumps growing in partial shade.

The slightly fleshy leaves of this species, and its general proximity to limestone outcrops, suggests that it has a higher requirement for soil moisture than the other three arnicas.

Except for a few spittlebugs (Cercopidae), remarkably little herbivore damage was seen on wild plants.

This arnica, like all of the arnicas that grow in the province, is polyploid and apomictic (see breeding system information in Additional Sources of Information, below). Considering that all four taxa of arnica can be in flower in close proximity at the same time at the same site, the lack of intergrading hybrids illustrates their reproductive isolation. Not only do the taxa not interbreed, but even within each of the taxa cross-fertilization is probably rare or non-existent. Within each taxon, the

physical separation of subpopulations and their apomictic breeding system suggest that for conservation purposes each subpopulation may have to be regarded as genetically unique.

Pollen viability is low (0 to 4%) and most seeds are produced by apomyxis (Downie and Denford 1985). Because this species spreads by stolons as well as by seeds, flowering and non-flowering plants often grow in dense clusters. *A. griscomii* seems more tolerant of light shade than the other species of *Arnica* in this area.

For the purpose of this report, the definition of a mature plant follows COSEWIC guidelines (adapted from IUCN 2010), and includes only those individuals “known, estimated, or inferred to be capable of reproduction”, excluding individuals that will never produce new recruits. Reproducing units within a clone are considered individuals. Re-introduced plants must produce viable offspring before being counted as mature individuals.

Population Size and Area of Occupancy

St. John Island: Area of the island is approximately 25 km², only about 25% of which is limestone barrens. The exact location of the historic population of *Arnica griscomii* is unknown. The size of the historic population is also unknown; however, it was probably very small; M. L. Fernald (1926) collected only a single specimen. The population was not re-located during fieldwork in 1999. Area of Occupancy cannot be calculated.

Doctors Hill: Area of the “hill” is approximately 60 km², mostly quartzite, with small outcrops of limestone. Area of limestone is unknown, but is quite small. The exact location of the historic population of *Arnica griscomii* is unknown. The size of the historic population is unknown. No *A. griscomii* were found during a recent botanical survey (C. Hanel 2005). Area of Occupancy cannot be calculated.

Port au Choix National Historic Site (PACNHS): The national historic site, which includes all known populations of *A. griscomii* in the barrens near the town, is approximately 8 km², only about 50% of which is limestone barrens or low heath vegetation. The COSEWIC website (http://www.cosewic.gc.ca/eng/sct3/index_e.cfm#12) suggests that, based on four point locations inventoried, Newfoundland has a total population size of about 2,000 plants. It is not clear whether this inventory counted clumps (presumably clones) of plants, or individual meristems. If the latter, this estimate is very low, since a 2011 inventory of about 20% of Port au Choix National Historic Site alone yielded 2,082 plants (198 flowering plants, 1884 non-flowering plants). If the actual number of mature individuals counted in 2011 (ie.198) is multiplied by 5,

the total number of mature plants actually present, over 100% of the PACNHS barrens area, can be extrapolated to be about 990. However, the surveyor (M. Burzynski) has stated that the area initially surveyed was thought to be the most productive area for the species, and thus estimates that the total Port au Choix population may actually be as much as 40% lower than 990 individuals = $990 \times 6/10 = 594$. *A. griscomii* is the most common arnica on the Port au Choix Peninsula (M. Burzynski, pers. obs.). See “Additional Sources of Information”, below. Area of Occupancy calculated on a 2 square kilometre grid is 16 km². Area of Occupancy calculated on a 1 square kilometre grid is 3 km²

Killdevil Mountain: The area of limestone talus covers about 0.1 km² at an altitude of 650 m, within which there are three outcrops of frost-shattered limestone surrounded by quartzite blocks and outcrops. The 2004 estimate of the population of *Arnica griscomii* subsp. *griscomii* at this site was 50 plants (Burzynski 2007a). An extrapolation, based upon a ratio of about 9.5% of plants flowering (see PACNHS 2011 count of 198 flowering and 1884 non-flowering plants) would suggest the total number of mature individuals was about 5. Area of Occupancy calculated on a 2 square kilometre grid is 12 km². Area of Occupancy calculated on a 1 square kilometre grid is 5 km².

Aboriginal, Traditional and Local Ecological Knowledge

Requests were made to members of Miawpukek First Nation and Qalipu Mi'kmaq First Nation, but no known aboriginal, traditional, or local ecological knowledge has been forthcoming for this taxon. No mention of *Arnica griscomii* can be found in the review of plant use by native peoples of Eastern Canada (Arnason *et al.* 1981).

Trends

Of four locations at which this taxon has been collected, only two populations have been observed within the last 25 years. The Killdevil Mountain and Port au Choix populations are well documented, but the Doctors Hill and St. John Island populations have not been re-located since their original discovery, although there has been botanical work at both of these difficult-to-reach sites within the last 25 years.

Trends are not possible to determine. Population size is unknown for the two historic sites, St. John Island and Doctors Hill, assuming that they are still extant. The inventory of plants at Port au Choix was first conducted in 2011, and is only 20% complete. The population on Killdevil Mountain is very small and has been re-inventoried only once.

There are five known occurrences of the taxon in Quebec, all on the Gaspé

Peninsula, and all within protected sites (Parc national de la Gaspésie [a Québec provincial park] and Forillon National Park). All have extremely small populations. This taxon is considered to be in decline in Québec (<http://MDDEP.gouv.qc.ca>).

Threats and Limiting Factors

Northern Peninsula limestone barrens are particularly threatened by climate change. Warming will probably result in the incursion of more substantial vegetation onto the barrens, further reducing available habitat for this arnica. Although *Arnica griscomii* is far more successful at growing in low vegetation than *A. angustifolia* subsp. *tomentosa* - which requires open gravel - taller vegetation will eventually shade and smother it.

Northern Peninsula limestone barrens are particularly threatened by climate change. Downscaling models by Slater (2005) predict a mean annual air temperature rise of approximately 4°C by the 2080s. Southern barrens, such as Port au Port, Gros Morne National Park, and Port au Choix, are expected to experience an increase in minimum air temperatures (thus there will probably be less snow cover to protect plants and soil from winter wind desiccation). Precipitation will probably increase throughout the barrens. There will also be a longer snow-free period and increased degree-days of heat. The result will probably be the incursion of more substantial vegetation onto the barrens, further reducing available habitat for this arnica and other limestone barren species.

St. John Island: This site can only be reached by boat, but has 13 cabins that are used each summer mostly by fishing families from Port au Choix. At least two all-terrain vehicles (ATVs) are used, mostly to drive to the beach, but occasionally on the limestone barrens (Millie Spence and Stella Mailman pers. comm.). During the 1999 visit, searchers were dismayed at the amount and extent of ATV tracks already present on the island. It is not known where on the island the historic collection of *Arnica griscomii* was made. Starting 10 or 12 years ago, moose and caribou swam or walked out to this island. There are now an estimated 80 moose and 25 caribou on the island (Stella Mailman, pers. comm.), and since the island is only about 25 km², and vegetation is sparse, their grazing could have a serious effect on rare plants such as *Arnica*. It is not known how palatable this species is for ungulates. Trampling by such a large herd could also cause problems in the thin limestone soils. Apart from the effects of climate change, no other threats are known for this site.

Doctors Hill: This site is remote requiring a multi-hour hike or a helicopter trip. Apart from climate change, no threats are known for this site.

Port au Choix National Historic Site: Within the national historic site, there has been extensive illegal ATV, dirt bike, and off-road vehicle use in the last 20 years,

although since 2010 it has declined dramatically. Some of the damage done by these vehicles has been concentrated in areas where the highest populations of *Arnica griscomii* are found (Crow Head on the Point Riche Peninsula and near the navigation light on the Port au Choix Peninsula. Luckily, the damage has been mainly on the open gravel barrens and has avoided outcrops and the arnicas. A power line runs across the Port au Choix Peninsula to the navigational beacon and passes directly over an outcrop with a large population of *A. griscomii*, but the maintenance corridor at this site bypasses the plants (Wentzell 2002). The Dorset Trail (a popular walking trail) also crosses Crow Cliff, and a few dozen plants are within a step or two of the trail. Because of its large colourful flowers, this species is probably more at risk from casual flower picking than most other rare plants, although this has not been noticed as a problem at this site.

Killdevil Mountain: Although this site is remote, the mountain is a destination for a small number of hikers (fewer than 100) each year. The limestone outcrops at each end of this quartzite mountain are in places where climbers congregate or descend, and each has an area of about 500 m². Because of this, an increase in the number of climbers could have an effect on the very small number of plants and their limited habitat.

Existing Protection

The two recently-verified occurrences of this species are within protected sites; the limestone barrens at Port au Choix are within a national historic site, and Killdevil Mountain is within Gros Morne National Park. The plants at these sites are protected by the National Historic Parks Wildlife and Domestic Animals Regulations and the Canada *National Parks Act*, respectively.

The St. John Island and Doctors Hill populations, if they are still extant, have no protection.

Special Significance

Apart from its significance as a rare and beautiful Gulf of St. Lawrence endemic with incalculable biodiversity and conservation values, this taxon has no known special scientific or cultural significance.

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Susan J. Meades, Botanical Researcher; Director of Northern Ontario Plant Database project

Millie Spence, Site Supervisor, Port au Choix National Historic Site

Carson Wentzell, Botanical Survey Contractor with Newfoundland and Labrador Hydro

Additional Sources of information

Michael Burzynski undertook a partial survey of Port au Choix National Historic Site for *Arnica griscomii* in July of 2011, during which this species was located at 23 sites, and at these there were 198 flowering plants and 1,884 non-flowering plants, for a total of 2,082 plants. The plants were often in dense clusters, some reaching 3 m x 3 m in area. During this survey, only about 20% of the appropriate habitat in the NHS was surveyed, and from his earlier work at this site the surveyor is confident that this represents only a fraction of the site's population of *A. griscomii*. If the remaining habitat were equally productive, there might be 10,000 plants (flowering plus non-flowering) of this taxon at Port au Choix. However, based on the surveyor's knowledge of the site, he concentrated his first survey on the most productive sites. He thinks that remaining appropriate habitat will be less productive, and the number of *A. griscomii* plants will be lower. So he estimated that the population at Port au Choix National Historic Site would be between 6,000 and 10,000 (flowering plus non-flowering).

The populations on St. John Island and Doctors Hill seem to have always been very small, and the survey of Killdevil Mountain in 2004 located only 50 plants. The surveyor thinks that it is safe to consider the Port au Choix National Historic Site population to be the most important population of this taxon in Newfoundland and Labrador. The other sites contain contain so few plants that they lie within the error of the population estimate at Port au Choix. Thus the Port au Choix estimate for *Arnica griscomii* subsp. *griscomii* stands as the population estimate for the entire Province of Newfoundland and Labrador.

During Burzynski's surveys, an individual plant was considered to be any whorl of basal leaves, with or without flowers. Since both *A. griscomii* and *A. lonchophylla* often occur in dense clusters, and it is unclear whether these are clones (most likely) or accumulations of genetically different individuals, the approach taken was to consider each meristem a separate plant.

All four Newfoundland and Labrador arnicas (*Arnica angustifolia* subsp. *angustifolia*, *A. angustifolia* subsp. *tomentosa*, *A. lonchophylla*, and *A. griscomii* subsp. *griscomii*) were encountered at Port au Choix, often closely associated, sometimes intermixed. The most frequently encountered species at the site are *Arnica angustifolia* subsp. *angustifolia* and *A. lonchophylla*, which are seen in throughout the barrens. *A. griscomii* subsp. *griscomii* can be found in dense clones, but its distribution is patchy. *A. angustifolia* subsp. *tomentosa* is uncommon and difficult to find.

Following is a simple key to vegetative material that will usually separate the four arnica taxa found in Newfoundland and Labrador:

- 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* subsp. *tomentosa*
 - B. Basal leaves smooth to sparsely hairy..... *A. angustifolia* subsp. *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* subsp. *griscomii*

Breeding systems of arnicas of Newfoundland and Labrador (with sources):

- Arnica angustifolia* subsp. *angustifolia*, apomictic, triploid, tetraploid, and pentaploid populations in eastern NA and Greenland (Wolf 1980)
- Arnica angustifolia* subsp. *tomentosa*, apomictic (Downie 1988)
- Arnica lonchophylla*, apomictic (Barker, 1966)
- Arnica griscomii* subsp. *griscomii*, apomictic, tetraploid (Wolf 1980)

Collections Examined

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

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).

Rank or Status

Global	
G-rank	G5T2 (COSEWIC Jan. 2012)
IUCN	N/A
National	
N-rank	N2 (COSEWIC)
National General Status (2005) May Be at Risk in NL (2) At Risk in Quebec (1)	4 (for <i>Arnica frigida</i> = <i>Arnica griscomii</i> both subspecies) (Wild Species 2005, Jan. 2012))
COSEWIC	Not ranked
Provincial	
Provincial General Status	May be at Risk (COSEWIC Jan. 2012)
Newfoundland S-rank	S1 (COSEWIC Jan. 2012)
Newfoundland General Status	May be at Risk (COSEWIC Jan. 2012)
Labrador S-rank	Not present
Labrador General Status	N/A
Adjacent Jurisdictions	
Nova Scotia S-Rank	Not present
Nova Scotia General Status	N/A
Prince Edward Island S-Rank	Not present
Prince Edward Island General Status	N/A
New Brunswick S-Rank	Not present
New Brunswick General Status	N/A
Québec S-Rank	S1 (Centre de données sur le patrimoine naturel du Québec 2008)
Québec General Status	At Risk (COSEWIC Jan. 2012)

Appendix A. Population Information

Recently Verified Occurrences/Range Use (recorded within the last 25 years)

Sensitive location information removed. Data included in report from Atlantic Canada Conservation Data Centre (15 specimens), Gros Morne National Park Herbarium (10 specimens), Historical Verified Occurrences/Range Use (9 specimens).

Other Observations (Unverified)

None

Recent Search Effort (areas searched within the last 25 years with estimate of effort)

Known Locations

St. John Island: A team of nine, all with botanical field experience, spent seven hours surveying a large barren on the south end of the island, which was estimated to represent about 10% of the total area of the island, on July 5, 1999. Only one arnica plant was encountered during that time, and it was *A. lonchophylla* (Anions 1999). The plants may have been very uncommon even when they were discovered on the island, Fernald (1926) mentions finding only one specimen.

Highlands of St. John: South Summit (Doctors Hill) was searched by Claudia Hanel in 2005 and 2010. The 2005 survey examined the area below the highest waterfall ("John Kane's Ladder"), in the vicinity of Tuomikoski's 1949 collection, and several hours were spent searching the talus and rock walls there. The rest of the day was spent getting to and from the site. During a day spent in botanical survey, most of the time was spent reaching the top of the waterfall, and only about 0.5 hour searching the limestone there. No *A. griscomii* were found.

Port au Choix National Historic Site: *Arnica griscomii* locations have been noted during rare plant surveys at this site in 2003 and 2004, and a concerted effort was made to inventory plants during the summer of 2011 (Burzynski 2007c 2011a).

Killdevil Mountain: *Arnica griscomii* was first located at this site by André Bouchard, Stuart Hay, and Luc Brouillet in 1996 (Bouchard *et al.* 1996). The population was inventoried along with other rare species on July 12, 2004

(Burzynski 2007a).

Other Locations

Big Hill, Gros Morne, Birchy Hill, Berry Barrens, Tuckers Head and nearby talus slopes and cliffs: All of the highlands near Killdevil Mountain were checked for rare species in 1999 by Bouchard, Brouillet, and Hay, by Anions, and by Burzynski in 2004-2005.

General Surveys: In 1999 and 2001, the Newfoundland Rare Plant Project surveyed 1,645 sites on the west and northeast coasts of Newfoundland, with special emphasis on the Point Riche-Port au Choix-St. John Island area. Rare plant inventories have been conducted by Parks Canada personnel in Gros Morne, Port au Choix, and other Parks Canada Agency sites in western Newfoundland and Labrador since 1996. John E. Maunder, formerly of the Provincial Museum, has checked sites throughout the west coast of the Island, as have Botanical Researcher Susan J. Meades (1990s), Henry Mann of Sir Wilfred Grenfell College (1970s to present), and Nathalie Djan-Chékar of the Provincial Museum.

Targeted Surveys: In 1976, Stuart G. Hay produced *The Vascular Flora of St. Barbe South, Newfoundland*. André Bouchard and his team from l'Université de Montréal did botanical field work throughout western Newfoundland between 1984 and 1990, leading to the publication of *The Rare Vascular Plants of the Island of Newfoundland* in 1991. They also concentrated on Parks Canada sites, producing rare plant reports for Gros Morne National Park (1986 and 1996), Port au Choix National Historic Site (1992), and L'Anse aux Meadows National Historic Site (1993). Claudia Hanel, Ecosystem Management Ecologist, Wildlife Division, Newfoundland and Labrador Department of Environment and Conservation, has conducted surveys and inventories of rare plant species throughout western Newfoundland, with special emphasis on limestone barrens and slopes.

Potential Sites Unexplored

In addition to the known locations for this species, most of the limestone barrens, cliffs, talus slopes, and outcrops along the west coast of the Island have been searched by the Newfoundland and Labrador Rare Plant Project, by the Limestone Barrens Species at Risk Recovery Team, and by individual botanists over the last fifteen years (see Other Locations, above). It is possible that some unknown sites for this species exist, but they would be small and very isolated. Some possibilities include:

- Smaller limestone islands surrounding St. John Island.
- The bulldozed limestone barrens around the town of Port au Choix (although *Arnica griscomii* has not been found growing on disturbed soil elsewhere). Portions of this area have already been searched (C. Hanel pers. comm.)

Appendix B. Supplementary Details

Taxonomic Clarifications

The name *Arnica griscomii* was proposed by M.L Fernald for a plant discovered on Mt Mattaouisse (now Matawees) in the Gaspé region of Québec by M.L. Fernald, L. Griscom, K.K. Mackenzie, A.S. Pease, and L.B. Smith in 1923 (Fernald 1924). The species was named after Ludlow Griscom. During a field trip in Newfoundland a year later, they found the plant again on the west coast (Fernald 1926). Fernald later combined *A. griscomii* under the name *A. louiseana*. Maguire (1943) disagreed with this combination, and suggested that this taxon should be treated as one of three subspecies of *Arnica louiseana* (*A. louiseana* subsp. *louiseana*, *A. louiseana* subsp. *frigida*, and *A. louiseana* subsp. *griscomii*.). Downie and Denford (1985) cited phytogeographical and cytological support for separating *Arnica louiseana* subsp. *louiseana* from the other two subspecies, and for the recognition of *A. frigida* subsp. *frigida* and proposed the name *A. frigida* subsp. *griscomii*. In 1989 Wolf re-established the priority of Fernald's specific epithet (*griscomii*) over that of Iljin (*frigida*).



Figure 5. *Arnica griscomii* flowerhead. Photo: M. Burzynski.



Figure 6. *Arnica griscomii* involucre. Note spittlebug below flowerhead.
Photo: M. Burzynski.



Figure 7. Mature and vegetative plant on rock outcrop, Port au Choix
National Historic Site. Photo: M. Burzynski.



Figure 8. *Arnica grisea* subsp. *grisea* clump near Crow Head, Port au Choix National Historic Site. This shows the typical dense growth within a clump, and the preponderance of non-flowering plants. Photo: M. Burzynski.

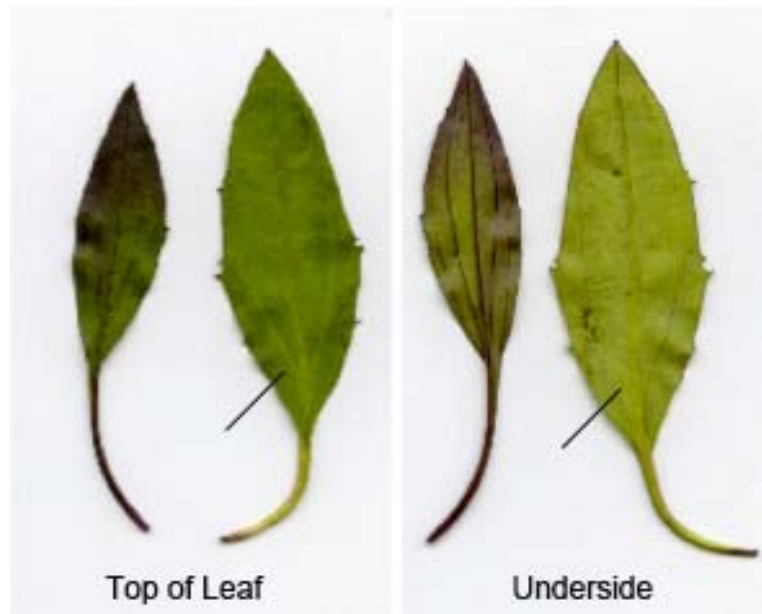


Figure 9. Comparison of basal leaves of *Arnica grisea* subsp. *grisea* (right side of each pair) and *A. lonchophylla* (left side of each pair). Note five veins in *A. lonchophylla*, and how the two lateral veins bend in towards the midvein in *A. grisea*. Photos: M. Burzynski.



Figure 10. Seedling *Arnica griscomii* in June, grown for restoration project at Port au Choix National Historic Site. Photo: M. Burzynski.



Figure 11. Three non-flowering plants growing wild in limestone gravel at Port au Choix National Historic Site. Photo: M. Burzynski.



Figure 12: Limestone barren on St. John Island. Photo: M. Burzynski.



Figure 13: Limestone barrens at Barbace Cove, Port au Choix National Historic Site.



Figure 14: Limestone outcrop on Killdevil Mountain. Photo: M. Burzynski.