

COSEWIC
Assessment and Status Report

on the

Hairy Valerian
Valeriana edulis ssp. *ciliata*

in Canada



ENDANGERED
2018

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC Assessment Summary

Assessment Summary – November 2018

Common name

Hairy Valerian

Scientific name

Valeriana edulis ssp. *ciliata*

Status

Endangered

Reason for designation

This long-lived perennial plant is found in wet prairies and fens in southwestern Ontario, which are very rare habitats. Declines have been observed in its distribution, number of locations, and quality of habitat, and declines are inferred in the number of mature individuals. The three remaining locations have few mature individuals, which are threatened by commercial development, invasive species, and natural succession.

Occurrence

Ontario

Status history

Designated Endangered in November 2018.



COSEWIC Executive Summary

Hairy Valerian *Valeriana edulis* ssp. *ciliata*

Wildlife Species Description and Significance

Hairy Valerian (*Valeriana edulis* ssp. *ciliata*) is a tall flowering plant, often growing one metre in height or more. In southern Ontario, it flowers in May and June, with tall stalks bearing an inflorescence of small white flowers arising from basal rosettes. This species has large taproots that were a source of food and medicine for Indigenous peoples.

Distribution

Hairy Valerian is endemic to the Great Lakes region and occurs in a narrow band from Wisconsin and Iowa in the west, through Michigan and Indiana into Ohio. The Canadian subpopulations in southwestern Ontario represent the northeastern edge of the range of the subspecies. These are entirely separate and disjunct from western ssp. *edulis*, which, in Canada, occurs only in southern BC.

Habitat

Hairy Valerian is typically found on wet and mesic prairies and fens, but it can also occur on drier sites such as hillsides and bluffs with groundwater flow. It occurs in full sun or light shade, and is sometimes associated with calcium-rich sites. The three extant Canadian subpopulations occur in dry, formerly open sites that are undergoing succession to shrub thickets.

Biology

Hairy Valerian is dioecious, with male and female flowers on separate plants. It is a long-lived perennial, and not all mature plants flower every year. Flowers are visited and likely pollinated by a variety of insects, and most pollen is deposited within 10 m of the source plant. Seeds are small and are probably dispersed by gravity, wind and water. Hairy Valerian does not reproduce vegetatively.

Population Sizes and Trends

Three southern Ontario subpopulations total 609 plants (336 flowering plants and 273 non-flowering plants). One of these subpopulations contained a single flowering plant and may no longer be viable. As there are no previous estimates of abundance at any Ontario sites, trends are unknown. However, the total number of plants in Canada can be inferred to have declined. The abundance of Hairy Valerian has declined along the Maitland River due to the recent establishment of the non-native cultivar of Reed Canary Grass. Five of the eight documented subpopulations in Canada are considered extirpated.

Threats and Limiting Factors

Habitat loss and degradation from urban and agricultural development have been the primary cause of the loss of at least half of the known Canadian subpopulations. An aggressive non-native cultivar of Reed Canary Grass appears to have recently substantially reduced suitable habitat for Hairy Valerian at the largest Canadian subpopulation. In general, invasive species are the primary threat to this taxon. Other possible threats include industrial development, succession, herbicide use, and recreational trails.

Protection, Status and Ranks

Hairy Valerian has a NatureServe conservation rank of G5T3, meaning that although the species (*V. edulis*) is considered globally secure (G5), the endemic central North American subspecies (ssp. *ciliata*) is considered Vulnerable (T3). It is ranked N3 (Vulnerable) in the United States, N1 (Critically Imperilled) in Canada, and S1 in Ontario. Hairy Valerian is legally protected in six of the seven American states where it occurs. In Ontario and Canada, it currently has no designation or legal protection. None of the documented Canadian subpopulations is currently in a protected conservation area or park.

TECHNICAL SUMMARY

Valeriana edulis ssp. *ciliata*

Hairy Valerian

Valériane ciliée

Range of occurrence in Canada: Ontario

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	at least 50 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Unknown but very unlikely b. Yes c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	125 km ² <i>Calculated as distance between Goderich and Brantford/Paris sites with a 1 km belt.</i>
Index of area of occupancy (IAO) (Always report 2x2 grid value).	8 km ²
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. Yes

Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	2-3 (Three locations are considered here, although the viability of one location containing a single subdioecious plant is questionable without restoration.)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, observed
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, observed
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, observed
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Yes, observed and inferred
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed and inferred
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)*	N Mature Individuals**
Goderich, Maitland River (2017)	182 flowering, 96 non-flowering
Brantford (2017)	153 flowering, 177 non-flowering
Paris (2008)	1 flowering, 0 non-flowering
Total	336 flowering, 273 non-flowering
<p>* A single flowering plant (sex unknown) at the Paris subpopulation is included on a precautionary basis. As a subdioecious species, this subpopulation may no longer be viable without restoration and/or augmentation.</p> <p>** Generally, flowering individuals are considered as mature individuals yet some non-flowering individuals may be mature but not flowering in a given year.</p>	

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown, PVA not available. N.B.: Although there is a report entitled "PVA for Hairy Valerian" (Molano-Flores 2000), it concludes that there is insufficient demographic information available to complete a PVA for this taxon, and that further research is needed.
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* See Definitions and Abbreviations on [COSEWIC web site](#) and [IUCN](#) (Feb 2014) for more information on this term

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

Was a threats calculator completed for this species? Yes

- i. Invasive Non-native Species (Impact: High)
- ii. Commercial and Industrial Areas (Impact: High)
- iii. Problematic Native Species (Impact: Medium)
- iv. Industrial Effluents (Impact: Medium-Low)
- v. Recreational Activities (Impact: Low)
- vi. Other Ecosystem Modifications (Impact: Low)

What additional limiting factors are relevant? Dioecious breeding system may limit viability of small populations.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Michigan (S2, declining), Ohio (S1, trend unknown)
Is immigration known or possible?	Unknown, considered unlikely
Would immigrants be adapted to survive in Canada?	Yes, probably
Is there sufficient habitat for immigrants in Canada?	Possibly <i>This species is highly conservative, occupying mainly wet calcareous meadows, shoreline fens, and prairie sites. All these habitat types are highly restricted in southern Ontario.</i>
Are conditions deteriorating in Canada?+	Yes
Are conditions for the source (i.e., outside) population deteriorating?+	Yes
Is the Canadian population considered to be a sink?+	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No
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Status History

COSEWIC: Designated Endangered in November 2018.

Status and Reasons for Designation:

Status: Endangered	Alpha-numeric codes: B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)
Reasons for designation: This long-lived perennial plant is found in wet prairies and fens in southwestern Ontario, which are very rare habitats. Declines have been observed in its distribution, number of locations, and quality of habitat, and declines are inferred in the number of mature individuals. The three remaining locations have few mature individuals, which are threatened by commercial development, invasive species, and natural succession.	

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

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Insufficient information to infer trends in abundance with only one survey, although reductions in EOO and IAO are suggestive of a decline in the number of mature individuals within the last 100 years.

Criterion B (Small Distribution Range and Decline or Fluctuation):
Meets criteria for Endangered. EOO and IAO are below thresholds and there are fewer than five extant locations. Continuing declines in EOO, IAO, quality of habitat, number of locations have been observed. Declines in the number of mature individuals can be inferred, and are also observed at one location.

Criterion C (Small and Declining Number of Mature Individuals):
May apply. Declines in the number of mature individuals are inferred, yet two subpopulations may contain >250 mature individuals when mature non-flowering individuals are considered.

Criterion D (Very Small or Restricted Population):
Meets criteria for Threatened D1 with fewer than 1000 individuals. Could also meet criteria of Threatened D2 with low IAO and only 3 locations but it is unknown whether the subspecies is prone to extinction in 1-2 generations.

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 (2018)

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

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

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

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



Environment and
Climate Change Canada
Canadian Wildlife Service

Environnement et
Changement climatique Canada
Service canadien de la faune

Canada

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

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2018

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Valeriana edulis* ssp. *ciliata* (Torrey & A. Gray) F.G. Meyer

Common Names: Hairy Valerian, Valériane ciliée

Family Name: Caprifoliaceae (Honeysuckle family); Note: *Valeriana* was previously placed in Valerianaceae, but is now recognized within Caprifoliaceae.

Major Plant Group: Angiosperm (eudicot flowering plant)

Hairy Valerian is one of three subspecies of *Valeriana edulis* (Meyer 1951). These include ssp. *ciliata* (Hairy Valerian, southern Great Lakes distribution), ssp. *edulis* (Edible Valerian¹, western US, southwestern Canada, and northern Mexico), and ssp. *procera* (limited to Mexico). Meyer (1951) considered that the current distribution of plants in the southern Great Lakes basin reflected the effects of Pleistocene glaciation, and noted that they had occupied a distinct and separate range for at least 10,000 years.

In Canada, Hairy Valerian is currently recognized as a subspecies (following VASCAN, Brouillet *et al.* 2017). Hairy Valerian has also been mentioned in various treatments as a variety (e.g. Gleason and Cronquist 1991; Voss and Reznicek 2012) and in some floras as a full species (e.g. Fernald 1970; Mohlenbrock and Ladd 1978; Swink and Wilhelm 1994). Genetic analysis of *V. edulis* has not been completed to date.

Regardless of which taxonomic ranking is adopted, Hairy Valerian can be considered here as a distinct taxon on the basis of its disjunct range. Throughout this report, the common name Hairy Valerian is used in reference to *V. edulis* ssp. *ciliata*.

Morphological Description

Hairy Valerian is a flowering perennial herb growing 30-120 cm in height (Figure 1). The plant grows from a stout, sometimes branched taproot. Leaves are mostly basal, thick, nearly parallel-veined, and densely ciliate especially at the margins (Figure 2). In Canada, flowering occurs in late May and June. The inflorescence is an elongate panicle (approximately 15-65 cm in length), with numerous lateral branches bearing small white flowers. Most plants are dioecious, bearing staminate or pistillate flowers, but a very small number bear perfect flowers. The small achene bears modified sepals to aid in wind dispersal (Meyer 1951; Figure 1).

¹ Note that ssp. *ciliata* is also referred to commonly as Edible Valerian in some jurisdictions such as Michigan and Minnesota, but in this report, Edible Valerian refers to ssp. *edulis*.

Hairy Valerian is best distinguished from the Edible Valerian by dense short hairs on its leaf surfaces; western plants are usually glabrous (Voss and Reznicek 2012, Figure 2). Some character differences are very subtle and can be difficult to discern using current morphological methods (Barrie pers. comm. 2017). However, the ranges of the two taxa do not overlap anywhere in North America. The non-native *Valeriana officinalis* is infrequently established across southern Ontario in disturbed ground, but has deeply divided basal and cauline leaves (Voss and Reznicek 2012).



Fig. 19. *Valeriana edulis* ssp. *ciliata*: Habit, $\times \frac{1}{3}$; pistillate and staminate flower, $\times 7$; achene (abaxial side), $\times 4$.

Figure 1 Hairy Valerian, *V. edulis* ssp. *ciliata*. From Meyer (1951).



Figure 2 Pinnately divided cauline leaves of Hairy Valerian showing the distinctive halo of the densely ciliate leaf margins. Photo by H. Bickerton.

Population Spatial Structure and Variability

No genetic studies on Canadian subpopulations of Hairy Valerian have been published. In Ontario, there is presumably little or no gene flow between subpopulations in Brantford and Goderich, which are separated by approximately 125 km. In studies of western Edible Valerian, Petry et al. (2016) found that 90% of *V. edulis* pollen was deposited within 12 metres of the parent plant, and the maximum pollen transfer was 35.42 m. Gene flow via pollen transfer therefore seems unlikely between these widely distributed subpopulations (although gene flow between the Paris and Brantford subpopulations is possible). Little is known about propagule dispersal distances, but seed dispersal by wind between subpopulations is also unlikely given the distances. If long-distance dispersal occurs, it has been conjectured to be most likely hydrochoric (Molano-Flores 2000), yet the two largest extant subpopulations (Brantford and Goderich) occur in different drainages.

Subpopulations in the Goderich and Brantford areas are separated by at least 130 km from the nearest documented American subpopulations in southern Michigan and central Ohio (Faivre and Windus 2002; Voss and Reznicek 2012; Kartesz 2015).

Designatable Units

The Canadian population of Hairy Valerian comprises a single designatable unit within the Great Lakes Plains Ecological Area (COSEWIC 2017). All subpopulations are found in southwestern Ontario. There is no genetic or morphological evidence to support further segregating subpopulations of this subspecies into distinct DUs.

Special Significance

Hairy Valerian is an endemic subspecies of the southern Great Lakes basin. It is a rare plant throughout its range and is found in uncommon habitats. The Goderich subpopulation has historical significance: the type specimen of the subspecies (originally described as *Patrinia longifolia* McNabb) was collected by James McNabb along the banks of the Maitland River, and is housed at the Irish National Herbarium in Dublin.

The species *V. edulis* has a long history of traditional use as a food and as a medicinal plant by Indigenous people, although most documented uses are based on the related subspecies Edible Valerian (Nisbet 2012). Extracts of *Valeriana edulis* have been clinically documented to induce sleep (Francis and Dempster 2002), although it is the Eurasian *Valeriana officinalis* that appears most widely available for medicinal purposes.

DISTRIBUTION

Global Range

The range of Hairy Valerian is centred on the southern Great Lakes basin (Figure 3). It occurs in a band extending from Minnesota, Wisconsin, and Iowa through Illinois, southern Michigan, and northern Indiana. There are isolated outlying populations in central Ohio and in southwestern Ontario. Hairy Valerian is uncommon to rare throughout its range.

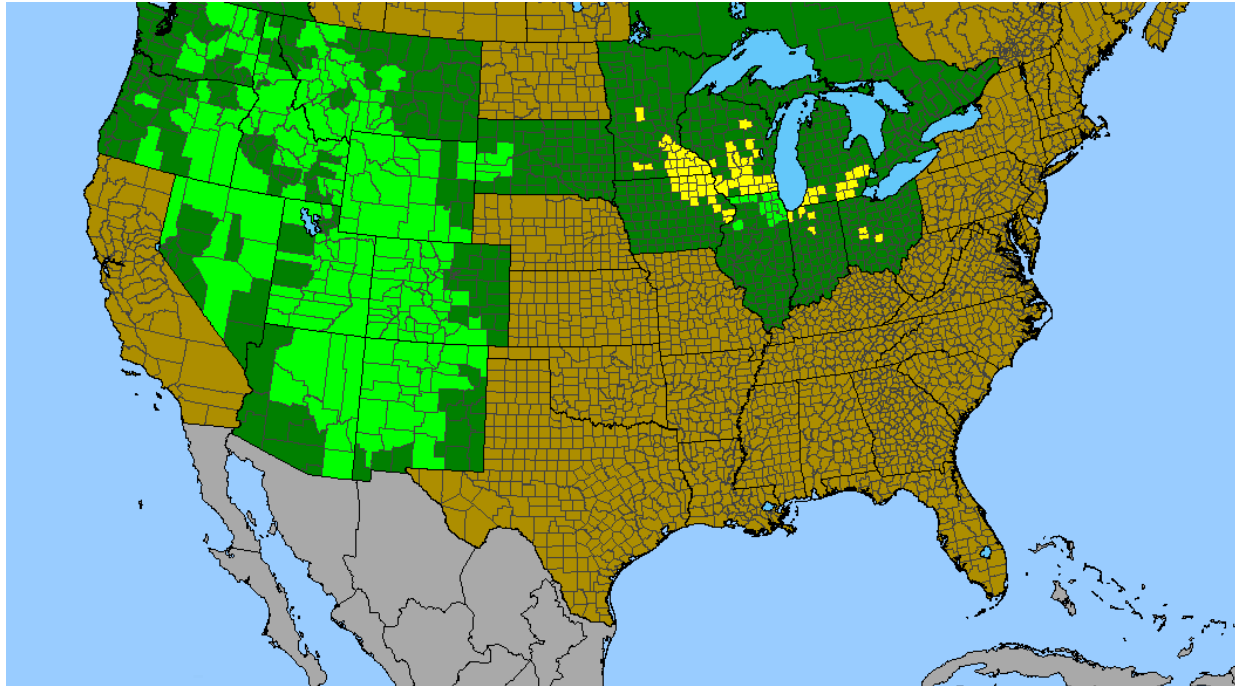


Figure 3 Distribution of *V. edulis* north of Mexico. Hairy Valerian (*V. edulis* ssp. *ciliata*), occurs around the lower Great Lakes basin while Edible Valerian (*V. edulis* ssp. *edulis*) occurs further west. Dark green indicates jurisdictions where the species is present and native. Occupied US counties where the species is not rare (light green) or rare (yellow) are shown. County mapping is not shown for Canada. Maps generated from Kartesz, J.T. 2018. Floristic Synthesis of North America, Version 1.0. BONAP. (in press).

Canadian Range

In Canada, Hairy Valerian is near the northern limit of its global range, within or just north of the Carolinian Zone. It has been reported from eight subpopulations in southwestern Ontario, ranging from the eastern shore of Lake Huron at Goderich, to London, Brantford, and Cambridge (Figure 4, Table 1). Of these, only three subpopulations are considered extant: Goderich, near Brantford, and near Paris, Ontario. However, only one plant has been recently observed in the Paris subpopulation and its viability is questionable.

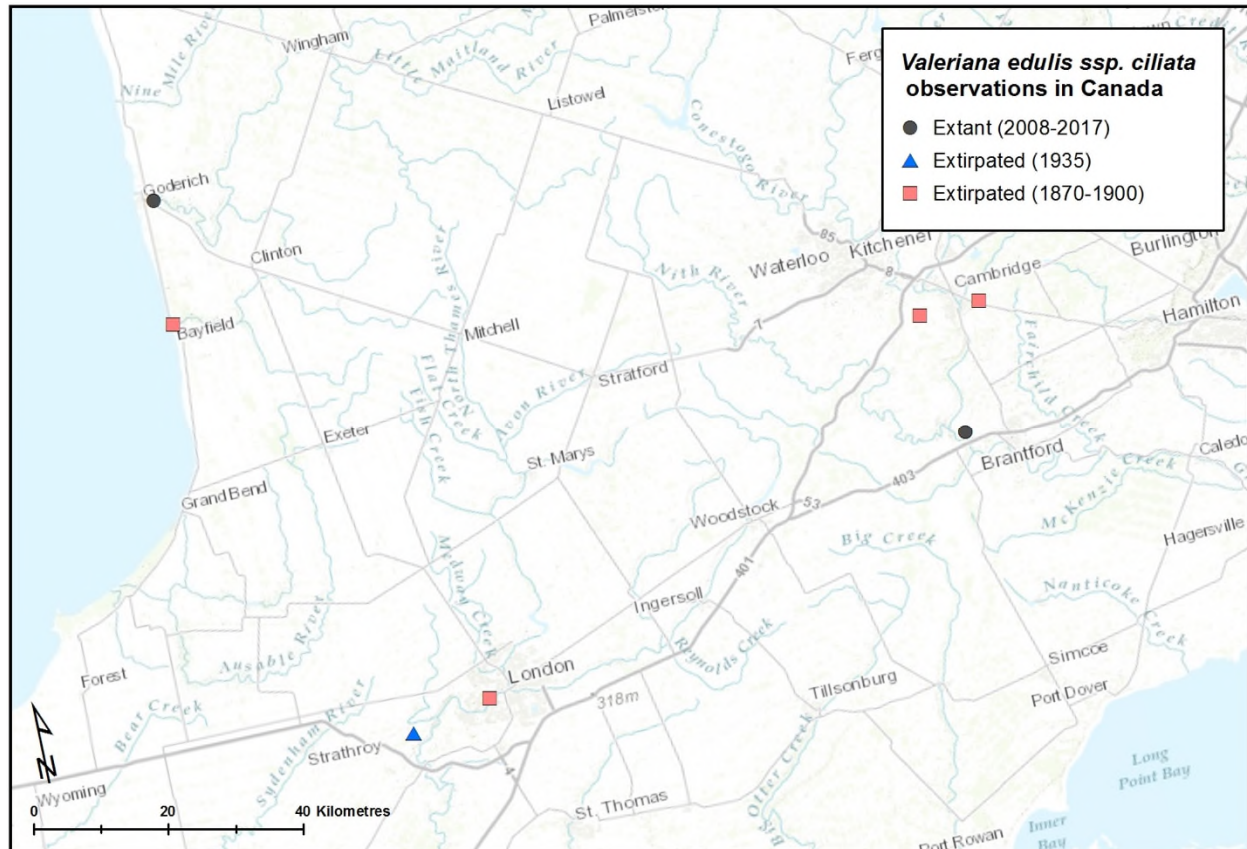


Figure 4 Distribution of Hairy Valerian in Ontario, Canada. Note that two extant subpopulations (near Brantford and near Paris) appear coincident at this scale.

Five Canadian subpopulations are considered extirpated. Many 19th and early 20th century collections in London, Ontario were made along the Thames River, where extensive urban development has occurred since the last observation in 1935. Similarly, the subpopulations at Komoka and near the City of Cambridge (formerly Galt) are presumed extirpated because of urbanization since the last observation (Table 1). One of these sites (Moffatt's Creek at McBean's Farm) remains in a natural state, but was unsuccessfully searched by Ministry of Natural Resources and Forestry (MNR) staff in 2005. This site is now dominated by non-native vegetation and the subpopulation is considered extirpated (Buck pers. comm. 2017). The Bayfield subpopulation is known only from an 1870 collection. The mouth of the Bayfield River is also dominated by Reed Canary Grass (*Phalaris arundinacea*, Bickerton, pers. obs. 2017).

Table 1 Locality and status of known subpopulations of Hairy Valerian in Canada.

Subpopulation	County	First Collector	Voucher	First Obs	Last Obs	Current status
Goderich, Maitland River	Huron	McNab	DAO, MTMG	1834	2017	Extant
Near Brantford, CN Rail line	Brant	Bakowsky	TRTE	1992	2017	Extant
Near Paris, Blue Lake Prairie	Brant	Herriott	MTMG	1870	2008	Extant but possibly non-viable
Bayfield	Huron	Gibson	MTMG	1870	1870	Extirpated
Komoka	Middlesex	Dearness	DAO, UWO	1888	1935	Extirpated
London, along Thames River	Middlesex	Saunders	DAO, OAC, UWO	1880	1900	Extirpated
Moffatt's Creek, east of Cambridge	Waterloo Region	Herriott	OAC	1898	1901	Extirpated
Moffatt's Creek at McBean's Farm	Waterloo Region	Herriott	ARVPO record	1898	1898	Extirpated

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) for all known subpopulations (8) of Hairy Valerian in Canada is 5631 km², calculated using a minimum convex polygon. The extent of occurrence (EOO) for three extant subpopulations is considered 125 km² (2.703 km² based on a minimum convex polygon but raised to 125 km² to reflect the distance between Goderich and Brantford/Paris sites with a 1 km band). This represents a decline of >95% in the EOO in Canada since records have been kept on this species. If only extirpations that occurred within the last 100 years are considered (the loss of the subpopulation in London, Ontario in 1935), then the decline is lower but still substantial.

The index of area of occupancy (IAO) for three extant subpopulations is 8 km². This represents a decline of 71% in the IAO in Canada since records have been kept on this species. Similar to the EOO, if only extirpations that occurred within the last 100 years are considered, then the decline in IAO is lower but still substantial.

Search Effort

Targeted search effort for Hairy Valerian has been minimal. The Maitland River (Goderich) subpopulation was well known from 19th century collections. Fieldwork, including prolific collection throughout the range of Hairy Valerian, was undertaken through the 19th and 20th centuries. The distinctive appearance of Hairy Valerian, even in the vegetative state, makes it unlikely to be overlooked.

The previously undocumented Brantford subpopulation was discovered in 1992 by Wasyl Bakowsky while exploring prairie remnants and railway prairies. Further targeted

surveys for Hairy Valerian were undertaken in 2005 at the Blue Lake Prairie (near Paris) and resulted in the re-discovery of a collection documented in the 19th century. An area presumed to be the historical site of an 1898 collection in Galt (now Cambridge) was also thoroughly but unsuccessfully searched for Hairy Valerian in 2005 (Buck, pers. comm. 2017).

In 2017, targeted surveys were completed at two of three known extant subpopulations and in areas thought to represent extirpated subpopulations. For further information on 2017 surveys, see **Sampling Effort**, below.

HABITAT

Habitat Requirements

Across its range, Hairy Valerian is mainly found on wet and mesic prairies and fens. It also occurs in other moist areas such as wooded valleys, stream banks, shorelines, and in open wet meadows. Hairy Valerian less commonly occurs on wooded hillsides and dry bluffs (Meyer 1951; NatureServe 2017). Associated herbaceous species throughout the range are numerous, and include characteristic prairie and fen grasses and forbs, as well as many rare species (Windus 1993; Molano-Flores 2000; Faivre and Windus 2002).

In a study of compositional variation within and amongst 31 Iowa fens, Nekola (2004) found *Valeriana edulis* to belong to a compositional cluster that was dominated by *Symphyotrichum puniceum*, *Lycopus americanus*, *Muhlenbergia glomerata*, *Viola nephrophylla* and *Lysimachia quadriflora*. Quadrats in the cluster tended to be on glacial till and had a disproportionately high frequency of bedrock outcrops. In studies of the taxon in Wisconsin, Bart (2011) found Hairy Valerian to be restricted to relatively undisturbed fen meadow with a low incidence of invasive species such as Reed Canary Grass.

A common aspect of many Hairy Valerian habitat descriptions is the presence of calcareous soils. Authors have described its habitat as “marly bogs”, “marly springy places,” “dolomitic prairies,” and “calcareous fens” (Deam 1940; Meyer 1951; Swink and Wilhelm 1994; Molano-Flores 2000). Soil pH ranges are not available, but optimal sites likely have alkaline to circumneutral soils.

Hairy Valerian prefers full sun but can tolerate partial shade provided by lightly wooded canopies (Meyer 1951). Both subpopulations observed in 2017 were found in areas lightly shaded by shrubs and young trees, although plants were more numerous in areas of full sun.

In Canada, Hairy Valerian is known from both prairies and shoreline prairies, many of which are now degraded in quality. At the Maitland River locality, plants were previously found in both habitat types, but those previously known from small patches along exposed shoreline prairie and rocky ledges were not found in most recent surveys (Oldham, pers.

comm. 2017; Reznicek, pers. comm. 2017). These shoreline prairies and associated limestone ledges had a rich and unusual assemblage of species. River flats were dominated in some areas by prairie grasses such as Big Bluestem (*Andropogon gerardii*) and Indian Grass (*Sorghastrum nutans*), with many other species having prairie affinities (Oldham et al. 1994). Plants could not be found along the shoreline prairie in 2017, perhaps due to the dominance of Reed Canary Grass.

Hairy Valerian was also previously observed along the Maitland River on calcareous ledges and in drier areas at the top of the riverbank (Oldham pers. comm. 2017, Reznicek pers. comm. 2017). In 2017, only one extant patch was found at a drier, degraded site on the high south bank of the Maitland River in Mineral Cultural Thicket (CUT1) vegetation (as per Lee et al. 1998). Hairy Valerian plants are found mainly in openings in the shrub thicket. The dominant shrub at this site was Ninebark (*Physocarpus opulifolius*), which appeared diseased, resulting in increased light penetration to Hairy Valerian and other ground plants (Figure 5; Bickerton pers. obs. 2017).



Figure 5 Hairy Valerian habitat on a high bank of the Maitland River at Goderich. Photo by H. Bickerton.

The Brantford subpopulation occurs on an open, north-facing slope of a railway cut (Figure 6). In 2005, the area was considered by Bakowsky (pers. comm. 2017) to be disturbed Dry Tallgrass Prairie (TPO1) vegetation containing many prairie forbs but with significant non-native species and shrub cover. In the spring of 2017 dominant shrubs included Ninebark and the non-native Tartarian Honeysuckle (*Lonicera tatarica*). Hairy Valerian occurred more commonly in openings between shrubs. This site has a high shrub cover and is in the process of natural succession. Occupied habitat at this site covers approximately 1200 m² (12 x 100 m averaged) in a linear shape along the rail line.



Figure 6 Hairy Valerian habitat along a CN rail cut near Brantford. Photo by H. Bickerton.

An extant subpopulation consisting of a single plant at Blue Lake prairie near Paris, Ontario occurs in Staghorn Sumac (*Rhus typhina*) Mineral Cultural Thicket (CUT1, see Ontario Ecological Land Classification) (Lee et al. 1998, Buck pers. comm. 2017).

Habitat Trends

There is little doubt that the habitat of Hairy Valerian has declined substantially in Canada over the past 150 years (the time period over which declines can be assessed (three generations)). Intensive agricultural and urban development characterize the Canadian range of Hairy Valerian, and habitat destruction and fragmentation are often considered as threats to species within the Carolinian life zone as well as southern Ontario prairie habitat (Allen et al. 1990; Argus and Pryer 1990; Oldham 1990). Even where habitat has not been lost entirely, drainage and natural succession may degrade remaining available habitat to the point where subpopulations could be lost.

More recently, the habitat of Hairy Valerian has been overtaken by aggressive invasive species. The overwhelming establishment and dominance of Reed Canary Grass along the Maitland and Bayfield river shorelines has resulted in a substantial decline in the amount of available habitat. The prairie and fen habitats of Hairy Valerian have also been susceptible to invasion by non-native species such as Glossy Buckthorn (*Frangula alnus*), Tartarian Honeysuckle, Narrow-leaved Cattail (*Typha angustifolia*), Purple Loosestrife (*Lythrum salicaria*), and Common Reed (*Phragmites australis* ssp. *australis*) (Faivre and Windus 2002; Barrie pers. comm. 2017).

BIOLOGY

Details on the reproductive biology of Hairy Valerian are primarily from Windus (1993) and Faivre and Windus (2002) and are based on studies of Ohio populations. Additional information included here is from observations made during surveys in 2017 or as indicated.

Life Cycle and Reproduction

Hairy Valerian rosettes and flowering stalks emerge from its robust overwintering taproot in early spring. In Canada, plants flower from mid-May to mid-June. Plants were in peak flower in southern Ontario during fieldwork completed from May 28 to May 31, 2017. Not all plants flower annually: between 22 and 66% of tagged plants flowered in an Ohio population (n=94) studied over seven years (Windus 1993).

Plants may produce flowers that are pistillate (all female parts), staminate (all male parts), or perfect (both male and female parts) (Faivre and Windus 2002). Plants bearing perfect (hermaphroditic) flowers are generally much less common, making up only 2-4% of the overall population. Perfect flowers also found to produce significantly fewer fruits than pistillate flowers (Faivre and Windus 2002).

This species is long-lived. Estimations based on sex- and size-specific annual rates of growth and survival (collected in four populations between 1978 and 1980) suggest that some individuals of *V. edulis* can live more than 100 years (Petry et al. 2016). No information could be found on age of first flowering in Hairy Valerian but one study on *V.*

edulis found that most (96-97%) individuals first flower within three years (Soule 1981). Generation time (average age of flowering plants in the current cohort) was roughly estimated (based on the reproductive period of Hairy Valerian spanning 3-100 years) as at least 50 years.

Hairy Valerian is pollinated by a variety of insects. The most common insect visitors to Ohio Hairy Valerian plants were small bees, flies, and ants. More than 15 different insect taxa were observed feeding on flowers during one study, although these were not identified to species (Windus 1993). Hairy Valerian does not reproduce vegetatively (Petry et al. 2016).

Information on the longevity of seeds in soil is not available, although the fragile seed coat is thought to limit the seed banking potential of Hairy Valerian (Hill pers. comm. cited in Molano-Flores 2000).

Physiology and Adaptability

Hairy Valerian is a tap-rooted perennial species of prairie and fen habitats. It tolerates early spring burns within its habitat. Prescribed burning is therefore considered an appropriate management tool to control woody species in its habitat (Hannan 2005). Spring burns have, however, been found to reduce or eliminate flower and/or fruit production in this spring-flowering species (Lovell et al. 1982).

Valeriana edulis is not commonly cultivated for sale in North America or elsewhere. Seed collected at the Brantford railway sites was successfully germinated and grown in a nursery (Buck pers. comm. 2017). The feasibility of using cultivated individuals in restoration work is unknown.

Dispersal and Migration

Seeds are probably dispersed by gravity, wind, and possibly water. Most of the small achenes are likely deposited directly under the parent plant (Molano-Flores 2000). The sepals of Hairy Valerian seeds are modified into short plumose bristles which are thought to assist in wind dispersal (Faivre and Windus 2002). Seeds of plants growing along shorelines and floodplains are thought to be dispersed by water. Dispersal distances are unknown.

Interspecific Interactions

No data on interspecific interactions exists for Hairy Valerian. Lepidopteran larvae in the family Tortricidae feed on Edible Valerian (Mooney et al. 2012). Several specialist herbivore arthropods are known to feed exclusively on Edible Valerian in the Colorado Rockies (Petry et al. 2013).

In the western subspecies, Edible Valerian, a strong and consistent sex-biased difference exists in insect association and predation: female plants typically support several times greater densities of aphids and other arthropods than do males (Mooney et al. 2012; Petry et al. 2013). This appears to be because floral nectar in female plants is more attractive to insect herbivores (Mooney et al. 2012). Unidentified species of aphids were observed feeding on several plants at the Brantford site in 2017.

The species (presumed to refer to *V. edulis* broadly) is reportedly highly palatable to deer and livestock, making it susceptible to overgrazing (Molano-Flores 2000).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

To determine the Canadian range of Hairy Valerian, observation data were obtained from the Natural Heritage Information Centre (NHIC 2017). To ensure no records were missed for this new report, collections managers at several herbaria were also contacted to obtain any Ontario records, and online databases were searched where available (see **Collections Examined**).

Between May 28 and 31, 2017, six sites from two subpopulations were surveyed by Holly Bickerton, Gerry Waldron, and Rachel White in southern Ontario for the presence of Hairy Valerian. The subpopulation on privately owned land (Blue Lake Railway Prairie near Paris) for which access was not granted was viewed from the roadside to determine whether habitat remained present. Exploratory searches were also undertaken in suitable habitat upstream from known subpopulations on the Maitland River in Goderich, Ontario. On-ground search effort for the preparation of this report is estimated at 26 person-hours.

Searches were conducted by walking through suitable habitat to locate plants. Where plants were found, plants or groups of plants were marked with flagging tape. Plants were counted and their reproductive status recorded (i.e. flowering or non-flowering). Because multiple rosettes often arise from a single taproot, a “plant” was judged visually to be a rosette or group of rosettes arising from the same taproot and counted accordingly. The number of non-flowering plants may be an underestimate, because basal rosettes are more difficult to detect.

There have also been directed searches for this species in the past. In 2005, MNRF Guelph district staff searched what is believed to be the former McBean Farm site along Moffatt Creek in Cambridge. The Blue Lake Railway Prairie (Paris) site was searched in 2000 and 2008 by MNRF staff. Exploratory surveys of the Maitland River valley upstream from Goderich were conducted in June and August 1993 by M.J. Oldham, A.A. Reznicek, and others (Oldham et al. 1994). These surveys focused on exposed river flats and limestone cliff habitat, and Hairy Valerian was identified and collected there. The Brantford site was first discovered in 1992 by Wasyl Bakowsky and has been visited periodically by MNRF staff, most recently in 2005.

The region (and general habitat of Hairy Valerian) has been heavily botanized and it would seem unlikely that too many undiscovered subpopulations exist. Hairy Valerian is a large and distinctive plant that is unlikely to be overlooked.

Abundance

During surveys in 2017, 608 plants were counted at two subpopulations. Of these, 335 were flowering, and 273 were non-flowering (basal rosettes only). One flowering plant was observed by Graham Buck in 2008 in a targeted search at the Paris Blue Lake Prairie site, to which access was not granted in 2017 (Appendix 1). This subpopulation can be included in all calculations in this report because it is considered extant, although its existence is clearly precarious. Therefore, the Canadian population contains 609 plants in three subpopulations, with 336 flowering and 273 non-flowering.

The total number of mature individuals is estimated by the number of flowering plants (336). This may be a slight underestimate of the number of mature individuals, because most but not all mature plants flower in a given year (Petty et al. 2016).

Although flowering plants are highly visible, the number of non-flowering plants is probably an underestimate because the basal rosettes are more difficult to detect in tall or dense vegetation.

Fluctuations and Trends

Five of eight (~63%) documented Canadian subpopulations have been extirpated within the past three generations (~150 years). The historical sizes of the extirpated subpopulations is unknown.

There are no previous counts available for two of the extant subpopulations (Goderich and Brantford). However, it is clear that the Goderich subpopulation along the Maitland River has decreased in the past three decades, perhaps substantially (Appendix 1). This subpopulation previously occurred in intermittent patches along at least two kilometres of shoreline, and was thought to be the largest Canadian subpopulation (Oldham et al. 1994). Although no counts were made in 1994, plants were “numerous,” with easily 150-200 in a patch (Reznicek pers. comm. 2017). It is likely that Reed Canary Grass expanded in the Maitland River habitat after 1994. In 2017, Hairy Valerian could not be found along the north shore of the Maitland River, although it is possible that some rosettes may persist amid dense vegetation or on higher banks.

One remnant site was found, in a drier habitat not susceptible to Reed Canary Grass invasion.

The Brantford subpopulation may be stable. It was estimated at “hundreds of plants” in 2005 (NHIC 2017) and numbered 330 plants in 2017 (Buck pers. comm. 2017; NHIC 2017). Trends at the Paris site are impossible to assess because there is no indication of

abundance on the original 19th century record. Since rediscovery in 2005, two plants had apparently decreased to one plant by 2008 (Buck pers. comm. 2017). There is high confidence in recent counts because Hairy Valerian is very distinctive and the remnant area occupied is extremely small (several square metres).

Rescue Effect

The likelihood that localized Ontario subpopulations may be recolonized from the USA is considered low. The considerable distance to the nearest US sites is probably beyond the range of seed dispersal, and Hairy Valerian is rare in almost all states where it occurs. Hairy Valerian also occupies a very rare and highly fragmented habitat, which makes rescue even less likely.

THREATS AND LIMITING FACTORS

Direct threats to extant subpopulations were assessed using the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master et al. 2012). Threats are defined as the proximate activities or processes that directly and negatively affect the population. Results on the impact, scope, severity, and timing of threats are presented in tabular form in Appendix 2. The assigned overall threat impact for Hairy Valerian is Very High (Appendix 2).

Headings in the following narrative correspond to categories or subcategories of the threats calculator together with the calculated impact, in the approximate order of their perceived importance (High to Low).

Invasive Non-native Species (8.1, High Impact)

The establishment of invasive species is probably the most urgent threat facing Hairy Valerian subpopulations. In 2017, the formerly suitable habitat of Hairy Valerian along the limestone river flats of the Maitland River was dominated by a Eurasian cultivar of Reed Canary Grass, which had been essentially absent during a site visit in 1994 (Reznicek pers. comm. 2017). It seems likely that this invasion has greatly reduced the floodplain portion of this subpopulation (a sizable but unknown proportion). Occupied habitat along the Maitland River is upland and not susceptible to further Reed Canary Grass invasion. No other aggressively invasive species were present at the Goderich subpopulation. Reed Canary Grass was also abundant along the Bayfield River (an extirpated subpopulation) in 2017. At the Brantford site, invasive Tartarian Honeysuckle was a dominant shrub making up about half the 30% shrub cover, and presents a possible threat by shading plants.

Commercial and Industrial Areas (1.2, High Impact)

Commercial development is considered a High impact threat to Hairy Valerian. The only observed site remaining in the formerly more widespread Goderich subpopulation (278 plants) occurs on private industrial land, and there have been other development proposals in the immediate area. However, development in this area is considered relatively unlikely (but possible) because of zoning and natural heritage designations, its floodplain situation next to a steep slope, and its regular use as part of a recreational trail system (White pers. comm. 2018). Currently there are no industrial by-products known to be deposited in the area. The railway line site at Brantford would not easily accommodate commercial or industrial development, but it is possible. Should the development take place, its effects would have extreme severity on a large subpopulation.

Problematic Native Species (8.2, Medium Impact)

Natural succession by native species may be problematic at both subpopulations. This species depends on open conditions, often caused by fire. The Brantford subpopulation remains relatively open, probably due to spraying and cutting, although some (~30%) of the occupied area is becoming shaded by young poplars and shrubs. Without maintenance in the next 10 years, some areas may become unsuitable. The Goderich subpopulation is currently under a patch of thick shrubs (Ninebark) that is dying back, allowing light penetration. Increased succession or shading of this subpopulation could have a negative effect on the abundance. The Paris Blue Lake site has not been recently visited, but the site is described as degraded and overgrown former prairie.

White-tailed Deer (*Odocoileus virginianus*) may also be problematic for this species. Hairy Valerian is reportedly palatable to deer (Molano-Flores 2000). Deer populations are large in many areas of southern Ontario. However, no evidence of browsing was observed in 2017 or has been reported in Ontario. The extant subpopulations along the Maitland River and Brantford rail line probably do not have large deer populations. Nothing is known of deer pressure at the third extant subpopulation at Blue Lake Prairie.

Industrial Effluents (9.2, Medium-Low Impact)

Herbicide use is a threat at the Brantford site. Right-of-way vegetation maintenance using herbicide appeared to affect Hairy Valerian at the Brantford site in 2016 (Buck pers. comm. 2017). Much of the Brantford subpopulation is situated away from the tracks and the possible reach of herbicide application. While such maintenance may have benefited Hairy Valerian by preventing natural succession and maintaining open prairie conditions, herbicide use could injure plants if used without appropriate caution.

Recreational Activities (6.1, Low Impact)

Although the Goderich subpopulation occurs next to a frequently used hiking trail within the town limits, current trail use does not seem to pose a threat to plants, which occur on either side of the trail. Trampling did not appear to be a threat. However, trail maintenance (e.g. brush or weed cutting, if it occurs) may directly injure plants. This subpopulation is known to the Town of Goderich and will likely be monitored in future for recreational impacts.

Other Ecosystem Modifications (7.3, Low Impact)

Mowing has occurred at the railway line at Brantford but may have some beneficial effects. Recently, maintenance appears to have involved herbicide use (see **Industrial Effluents** above). The Goderich subpopulation occurs next to a frequently used hiking trail that is maintained. Trail maintenance (e.g. brush or weed cutting, if it occurs) may directly injure plants. In 2017 there was no evidence that trail maintenance had damaged plants.

Annual and perennial non-timber crops (2.1, Negligible Impact)

The Paris subpopulation is on privately owned agricultural land. The single plant in this subpopulation occurs along a treed farm lane that was formerly prairie.

Fire and Fire Suppression (7.1, Not a threat)

Fire is not considered a threat, because Hairy Valerian has been shown to tolerate prescribed burns, and may benefit from them (Hannan 2005). Fire suppression may pose a threat, although this is not clear. Over the past two centuries of human settlement of southern Ontario, historical fire frequency and intensity has declined, leading to natural succession in many areas (Bakowsky and Riley 1994). The Brantford subpopulation along a rail line may have been maintained in an open state in part by occasional fires. It is unlikely that fires would be permitted to burn at any extant site. Overall, fire and fire suppression is not considered a threat because of the neutral or potential benefit.

Roads and Railroads (4.1, Not calculated)

The impact of this threat was not calculated, being considered outside of the assessment timeframe. The largest extant subpopulation (336 plants) occurs along a railway cut near Brantford. It is not known whether Canadian National (CN) Rail is aware of the Hairy Valerian subpopulation. While the likelihood of a rail accident is considered very low, there is some possibility of track twinning in the future in this increasingly populated area.

Climate Change (11.3, Not calculated)

There are no data to indicate effects of climate change on Hairy Valerian. However, a 35-year demographic dataset (1976-2014) from high elevation Colorado subpopulations of Edible Valerian showed that the flowering phenology of this species had advanced by 3.1 days/decade. Within this same timeframe, male plants became more frequent. Such climate-induced shifts may result in a replacement of females with males, threatening population viability (Petty et al. 2016). It is possible that climate warming could result in similar effects in Canadian subpopulations of Hairy Valerian if average seasonal temperatures increase.

Gathering Terrestrial Plants (5.2, Not calculated)

Historical medicinal use has been documented but currently there is no evidence of Hairy Valerian being collected from the wild.

Limiting Factors

Hairy Valerian's dioecious breeding system may limit successful reproduction in some circumstances, particularly if the abundance of its pollinators has declined in recent decades (Vamosi and Otto 2002). The breeding system probably also disadvantages very small populations, which may become non-reproductive as abundance decreases, and may be more vulnerable to inbreeding depression.

Insect herbivory was observed at the Paris Hairy Valerian subpopulation in 2005, with defoliation of one of two remaining plants. The cause is unknown, and may be the result of a naturally occurring insect herbivore. The impact of insect herbivory on Hairy Valerian in Canada is not known.

Number of Locations

"Location" defines a geographically or ecologically distinct area in which a single event may affect all individuals of the taxon present. The predominant threats to extant Canadian subpopulations of Hairy Valerian are Invasive Species and Commercial and Industrial Development, which threaten the extant subpopulations differently due to their separation distance, differing ownership and land use, and habitat. It is unlikely that all subpopulations would be affected by any single event. Therefore, there are considered to be three locations, corresponding to the three extant subpopulations.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Hairy Valerian was assessed by COSEWIC as Endangered in November 2018. It currently has no status in Ontario, nor federal or provincial protection.

This taxon is accorded legal protection in six of the seven American states where it occurs. It is considered Endangered in Indiana and Ohio (Indiana DNR 2017; Ohio DNR 2017), Threatened in Michigan and Minnesota (Michigan Natural Features Inventory 2007; Minnesota DNR 2013) and Special Concern in Iowa and Wisconsin (Wisconsin Natural Heritage Program 2016; Iowa DNR 2017). Hairy Valerian does not have legal protection in Illinois (Illinois Endangered Species Protection Board 2015).

Non-Legal Status and Ranks

NatureServe's Global Rank for this taxon is G5T3, reflecting the relative rarity of the variety in the southern Great Lakes basin. Hairy Valerian has a conservation rank of S1 (Critically Imperilled) in Ontario and Ohio, S2 (Imperilled) in Minnesota and Michigan, and S3 (Vulnerable) in Illinois and Wisconsin. It is unranked in Iowa and Indiana (NatureServe 2017).

Habitat Protection and Ownership

None of the extant subpopulations are protected. Two subpopulations are in private ownership (Goderich-Maitland River and Blue Lake Prairie near Paris), and a third is along a CN railway allowance (Brantford).

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Authorities Contacted

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INFORMATION SOURCES

- Allen, G.M., P.F.J. Eagles, and S.D. Price (Eds.). 1990. *Conserving Carolinian Canada: Conservation Biology in the Deciduous Forest Region*. University of Waterloo Press, Waterloo, Canada. 346 pp.
- Argus, G.W. and Pryer, K.M. 1990. *Rare Vascular Plants in Canada – Our Natural Heritage*. Canadian Museum of Nature, Ottawa, Canada. 191 pp.
- Bakowsky, W. 2017. *Email to H. Bickerton*. Community Ecologist, Ontario Ministry of Natural Resources.
- Bakowsky, W., and J.L. Riley. 1994. A survey of the prairies and savannas of southern Ontario. Pages 7-16 *in* Proceedings of the Thirteenth North America Prairie Conference.
- Barrie, F. pers. comm. 2017. *Email to H. Bickerton*. Research Scientist, Missouri Botanical Garden.
- Bart, D., M. Simon, Q. Carpenter and S. Graham. 2011. Historical Land Use and Plant-Community Variability in a Wisconsin Calcareous Fen. *Rhodora* 113(954):160-186.

- Brouillet, L., F. Coursol, S.J. Meades, M. Favreau, M. Anions, P. Belisle, and P. Desmet. 2017. VASCAN, the Database of Vascular Plants of Canada.
- Buck, G., pers. comm. 2017. *Email to H. Bickerton*. Management Biologist, Ontario Ministry of Natural Resources.
- COSEWIC. 2017. COSEWIC National Ecological Areas. Website: https://www.canada.ca/content/dam/eccc/migration/cosewic-cosepac/dd31eaae-efba-448b-86ab-4ba8a68d7ea4/fig1-terrestrialecologicalareas_eng.jpg. [accessed 17 October 2017].
- Deam, C.C. 1940. Flora of Indiana. Indiana Department of Conservation. 1236 pp.
- Faivre, A.E., and J.L. Windus. 2002. Genetic variation among populations of *Valeriana ciliata* T. & G. (Prairie valerian) in midwestern prairie fens. *Journal of the Torrey Botanical Society*:39-47.
- Fernald, M.L. 1970. Gray's Manual of Botany. American Book Co., New York, xiv+ 1632 pp. Reprinted by D. Van Nostrand Co., New York.
- Francis, A.J.P., and R.J.W. Dempster. 2002. Effect of valerian, *Valeriana edulis*, on sleep difficulties in children with intellectual deficits: randomised trial. *Phytomedicine* 9: 273–279.
- Gleason, H.A., and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada, Second edition. New York Botanic Gardens, Bronx, NY.
- Hannan, G. L. 2005. Effects of controlled burns on vegetative growth and sexual reproduction in *Valeriana ciliata* in a Michigan fen. *Michigan Botanist* 44:149-158.
- Illinois Endangered Species Protection Board. 2015. Checklist of Illinois Endangered and Threatened Animals and Plants. 10 pp.
- Indiana DNR. 2017. Endangered, Threatened, Rare, and Extirpated Plants of Indiana. 19 pp.
- Iowa DNR. 2017. Endangered, Threatened and Special Concern Plants. 9 pp. <http://www.iowadnr.gov/Conservation/lowas-Wildlife/Threatened-and-Endangered>.
- Kartesz, J.T., The Biota of North America Program (BONAP). 2018. Taxonomic Data Center. (<http://www.bonap.net/tdc>). Chapel Hill, North Carolina. [maps generated from Kartesz, J.T. 2018. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)]
- Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig, and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch.

- Lovell, D.L., R.A. Henderson, and E.A. Howell. 1982. The response of forb species to seasonal timing of prescribed burns in remnant Wisconsin prairies. Pages 11-15 in Proceedings of the Eighth North American Prairie Conference. Western Michigan University Press, Kalamazoo.
- Master L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, and A. Tomaino. 2012. NatureServe Conservation Status Assessments: Factors for Evaluating Species and Ecosystem Risk. NatureServe, Arlington, VA. 64 pp.
- Meyer, F.G. 1951. *Valeriana* in North America and the West Indies (Valerianaceae). Annals of the Missouri Botanical Garden 38:377-503.
- Michigan Natural Features Inventory. 2007. Rare Species Explorer (Web Application). Website: <http://mnfi.anr.msu.edu/explorer> [accessed Sep 26, 2017].
- Minnesota DNR. 2013. Minnesota's List of Endangered, Threatened and Special Concern Species. St. Paul, Minnesota. 18 pp. Website: http://files.dnr.state.mn.us/natural_resources/ets/endlist.pdf
- Mohlenbrock, R.H., and D.M. Ladd. 1978. Distribution of Illinois Vascular Plants. Southern Illinois University Press. 282 pp.
- Molano-Flores, B. 2000. Population viability assessment for Hairy Valerian (*Valeriana edulis* Nuttall var. *ciliata* (Torr. & Gray) Cronq.). Illinois Natural History Survey, Center for Biodiversity.
- Mooney, H.A., and E.E. Cleland. 2001. The evolutionary impact of invasive species. *in* Proceedings of the National Academy of Sciences of the United States of America.
- Mooney, K. A., A. Fremgen, and W. K. Petry. 2012. Plant sex and induced responses independently influence herbivore performance, natural enemies and aphid-tending ants. *Arthropod-Plant Interactions* 6:553-560.
- Natural Heritage Information Centre (NHIC). 1995. Southern Ontario Floristic Quality Assessment System. Ontario Ministry of Natural Resources, Peterborough, Ontario.
- Natural Heritage Information Centre (NHIC). 2017. Tracked Species Database. Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario.
- NatureServe. 2017. NatureServe Explorer: An online encyclopedia of life [web application]. Arlington, Virginia. Website: <http://explorer.natureserve.org> [Accessed 15 October 2017].
- Nekola, J.C. 2004. Vascular plant compositional gradients within and between Iowa fens. *Journal of Vegetation Science* 15(6):771-780.
- Nisbet, J. 2012. David Douglas, a Naturalist at Work: An Illustrated Exploration Across Two Centuries in the Pacific Northwest. Sasquatch Books.
- Ohio DNR. 2017. Rare Native Ohio Plants: Status List. Web page. http://naturepreserves.ohiodnr.gov/portals/dnap/pdf/Rare_Plant_Abstracts/2016-17%20Ohio%20Rare%20Plants%20Status%20List.pdf

- Oldham, M.J. 1990. Provincially rare plants of the Carolinian zone. In G.M. Allen, P.F.J. Eagles, and S.D. Price (Eds.), *Conserving Carolinian Canada: Conservation Biology in the Deciduous Forest Region*. University of Waterloo Press, Waterloo, Canada. 346 pp.
- Oldham, M.J., A.A. Reznicek, T.J. Lobb, J.M. Bowles, D. Kilgour. 1994. Field Trip Report, Maitland River, Huron County, Ontario. Unpublished report. 11 pp.
- Oldham, M.J., pers. comm. 2017. *Email correspondence to H. Bickerton*. Botanist, Natural Heritage Information Centre.
- Petry, W.K., K.I. Perry, A. Fremgen, S.K. Rudeen, M. Lopez, J. Dryburgh, and K. A. Mooney. 2013. Mechanisms underlying plant sexual dimorphism in multi-trophic arthropod communities. *Ecology* 94:2055-2065.
- Petry, W. K., J.D. Soule, A.M. Iler, A. Chicas-Mosier, D.W. Inouye, T.E. Miller, and K.A. Mooney. 2016. Sex-specific responses to climate change in plants alter population sex ratio and performance. *Science* 353:69-71.
- Renner, S.S., and R.E. Ricklefs. 1995. Dioecy and its correlates in the flowering plants. *American Journal of Botany* 82:596-606.
- Reznicek, A.A., pers. comm. 2017. *Email correspondence to H. Bickerton*. Research Scientist, University of Michigan.
- Soule, J. D. 1981. Ecological consequences of dioecism in plants: a case study of sex differences, sex ratios, and population dynamics of *Valeriana edulis* Nutt. Michigan State University, PhD Thesis.
- Swink, F., and G. Wilhelm. 1994. *Plants of the Chicago Region*, 4th ed. Indiana Academy of Science Indianapolis, Indiana. 936 pp.
- Vamosi, J.C., and S.P. Otto. 2002. When looks can kill: the evolution of sexually dimorphic floral display and the extinction of dioecious plants. *Proceedings of the Royal Society of London B: Biological Sciences* 269:1187-1194.
- Voss, E., and A. Reznicek. 2012. *Field Manual of Michigan Flora*. University of Michigan. Ann Arbor.
- White, R., pers. comm. 2018. *Email correspondence to H. Bickerton*. Stewardship Coordinator, Huron County, Ontario.
- Windus, J.L. 1993. Reproductive ecology of a rare dioecious fen species in Ohio, *Valeriana ciliata* T. & G. Ohio State University, M.Sc. Thesis.
- Wisconsin Natural Heritage Program 2016. Wisconsin Natural Heritage Working List. Bureau of Natural Heritage Conservation, Madison WI. 24 pp.
<http://dnr.wi.gov/topic/NHI/documents/NHIWorkingList.pdf>

BIOGRAPHICAL SUMMARY OF REPORT WRITER

Holly Bickerton is a biologist with over 15 years of field experience in southern Ontario. She holds a B.A.Sc. from McMaster University and a Master's in Environmental Studies from York University. She has undertaken ecological and species at risk work for the Ontario Ministry of Natural Resources and the Department of Environment and Heritage in South Australia. Since 2005, she has worked as an independent consulting ecologist, conducting flora and fauna inventories, vegetation mapping, invasive species assessments, ecological monitoring, and policy research. She previously wrote or co-wrote three COSEWIC status reports, and many other documents on rare and at-risk species.

COLLECTIONS EXAMINED

The following herbaria were checked for Canadian specimens of *V. edulis* ssp. *ciliata*: Agriculture Canada (DAO), Canadian Museum of Nature (CAN), University of Guelph (OAC), Royal Botanical Gardens (HAM), Marie-Victorin Herbarium, Université de Montréal (MTMG), Royal Ontario Museum (TRT), University of Waterloo (WAT), University of Michigan (MICH), Yale University Peabody Museum (YU), and the Gray Herbarium, Harvard University (GH).

Appendix 1. Canadian subpopulations of Hairy Valerian, *V. edulis* ssp. *ciliata*.

Subpopulation Name	Site	County	Ownership	Previous Records	Year of most recent obs.	No. Mature Individuals (Year)	Comments
EXTANT							
Goderich, Maitland River (EO 2717, 2718, 33779)	1 (EO 2717)	Huron	Private and municipal	1993 - Oldham et al. 1936 - Marie-Victorin et al. 1834 - McNabb (Type)	1993	2017 - Not found 1993 - Common on river flats	Along north shore of Maitland River near Saltford
	2 (EO 33779)	Huron	Private (Sifto Salt)	2017 - Bickerton and Waldron 1993 - Oldham et. al 1975- Catling and Mackay	2017	2017 - 278 plants, 182 flowering 1993 - Common on river flats	Site is on south shore of Maitland River along the high banks adjacent the Millennium hiking trail. Presumed to be the same location as Catling & McKay based on site description.
	3 (EO 2718)	Huron	Probably private	1993 - Oldham et. Al 1966 - Dore et al. (DAO)	1993	2017 - Not found 1993 - Common on river flats	
Near Brantford, along CN Rail Line (EO 33781)		Brant	CN Rail	2017 - Bickerton and Waldron 2005 - Bakowsky et al. 2005 - Kirk and Hay 1992 - Bakowsky et al.	2017	2017 - 330 plants, 153 flowering 2005 - "hundreds of plants"	
Near Paris, at Blue Lake Prairie (EO 2714)		Brant	Private	2008 - Buck 2005 - Kirk and Hay 1870 - Herriot	2008	2008- 1 plant 2005 - 2 plants, 1 flowering	Viability of single plant unknown but marginal. Recent ownership change, permission not obtained to visit site in 2017. From nearby, habitat appears unchanged.
EXTIRPATED							
Bayfield (EO 2716)		Huron	Unknown	1870 - Gibson, MTMG 793	1870	-	Exact locality unknown. The floodplain of the Bayfield River is dominated by non-native species. Only a small portion of potential habitat was surveyed.
Komoka, Wannacotts Flats (EO 2712)		Middlesex	Unknown	1888 - Dearness, DAO 1934 - Wood, DAO 1935 - Colgrove, UWO 19230	1935	-	Exact locality unknown, likely extirpated.
London, along Thames River (EO 2713)		Middlesex	Unknown	1880 - Saunders, DAO 1900 - Baker, OAC 15223	1900	-	Known only from several old collections within the City of London within now-developed areas; presumed extirpated.
Moffatt's Creek, East of Galt (now Cambridge, EO 2715)		Waterloo Region	Unknown	1901 - Herriott, TRT 21698) 1898 - Herriott, OAC 681)	1901	-	Exact locality unknown, likely extirpated.

Subpopulation Name	Site	County	Ownership	Previous Records	Year of most recent obs.	No. Mature Individuals (Year)	Comments
Galt, Moffatt's Creek at McBean's Farm		Waterloo Region	Municipal	1898 - ARVPO 1869	1898	-	Searched by G. Buck and other MNR staff in 2005 without success. Habitat now dominated by non-native weedy species, presumed extirpated.

Appendix 2. Threats assessment for Hairy Valerian.

Species or Ecosystem Scientific Name	Valeriana edulis ssp. ciliata (Hairy Valerian)																																						
Element ID		Elcode																																					
Date (Ctrl + ";" for today's date):	28/03/2018																																						
Assessor(s):	Participants: Holly Bickerton, Jenny Heron, Jana Vamosi, Dan Brunton, Vivian Brownell, Burke Korol (CWS), Rachel White, Graham Buck, Karen Timm and Andrea Clouston (Secretariat)																																						
References:	COSEWIC in prep																																						
Overall Threat Impact Calculation Help:	<table border="1"> <thead> <tr> <th colspan="2"></th> <th colspan="2">Level 1 Threat Impact Counts</th> </tr> <tr> <th>Threat Impact</th> <th></th> <th>high range</th> <th>low range</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Very High</td> <td>0</td> <td>0</td> </tr> <tr> <td>B</td> <td>High</td> <td>1</td> <td>1</td> </tr> <tr> <td>C</td> <td>Medium</td> <td>2</td> <td>1</td> </tr> <tr> <td>D</td> <td>Low</td> <td>2</td> <td>3</td> </tr> <tr> <td colspan="2">Calculated Overall Threat Impact:</td> <td>Very High</td> <td>Very High</td> </tr> <tr> <td colspan="2">Assigned Overall Threat Impact:</td> <td colspan="2">A = Very High</td> </tr> <tr> <td colspan="2">Impact Adjustment Reasons:</td> <td colspan="2"></td> </tr> </tbody> </table>					Level 1 Threat Impact Counts		Threat Impact		high range	low range	A	Very High	0	0	B	High	1	1	C	Medium	2	1	D	Low	2	3	Calculated Overall Threat Impact:		Very High	Very High	Assigned Overall Threat Impact:		A = Very High		Impact Adjustment Reasons:			
		Level 1 Threat Impact Counts																																					
Threat Impact		high range	low range																																				
A	Very High	0	0																																				
B	High	1	1																																				
C	Medium	2	1																																				
D	Low	2	3																																				
Calculated Overall Threat Impact:		Very High	Very High																																				
Assigned Overall Threat Impact:		A = Very High																																					
Impact Adjustment Reasons:																																							
Overall Threat Comments	<p>Generation Time: 50 years (3 generations at 150 years, so severity of threats were estimated over a span of 100 years (the maximum)); This taxon is being assessed at the subspecies level. Found in calcareous meadows, this taxon is a very tall plant (~1 m in height) that is not difficult to identify or spot. It is dioecious with ~3% flowers exhibiting bisexuality (subdioecious). It has a large taproot, such that the species is somewhat resilient to mowing but shows no ability to reproduce vegetatively. Population size is very small, just over 600 plants with ~50% flowering. Plants do not flower every year, so mature individuals were counted as the total number of plants surveyed. The Blue L. Paris subpopulation (1 plant) has not been surveyed since 2008. Considering the dioecious nature of the species, this subpopulation has questionable viability. Nevertheless it is included as a location. However, because it represents such a small proportion of the total number of mature individuals, the scope used in calculations largely considers the impacts to the Goderich subpopulation (182 flowering +96 nonflowering)/609 = 46% of the Canadian population) and the Brantford subpopulation (153 flowering +177 nonflowering)/609 = 54%). The subpopulation at Goderich is on a floodplain near L. Huron, along cliffs, and was searched extensively. To the east is the Brantford subpopulation, currently the largest subpopulation, which is along an industrial railway line but is otherwise not heavily impacted. Permission could not be obtained to provide an updated count for the Blue L. (Paris) subpopulation.</p>																																						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	B	High	Large (31-70%)	Extreme (71-100%)	Moderate - Low	
1.1	Housing & urban areas						All extant sites are privately owned. It is remotely possible that one (Blue Lake near Paris) could be lost to housing. Others would not be easy to develop (floodplains, railway corridor).

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.2	Commercial & industrial areas	B	High	Large (31-70%)	Extreme (71-100%)	Moderate - Low	The only remaining part of the formerly more widespread Goderich subpopulation (278 plants) occurs on private industrial land owned by Compass Minerals. It is along a well-used public recreational trail (created as a Millennium project) and the known occurrence is unlikely to be developed for this reason. However, other development plans have been presented in the area. The site is zoned and designated as Natural Environment in the town's Official Plan. The subpopulation is behind the salt factory, adjacent to a fairly steep slope (so development is unlikely to be near site). There is currently no depositing of any industrial product including salt on or near the site. The steeply sloped area that is adjacent to the site is a treed area so it would be an unlikely salt storage place. Overall there is a low to moderate probability of development at Goderich. There is a railway line at Brantford that would not easily accommodate commercial or industrial development. There is a drainage stream nearby so there would be some protection through the <i>Riparian Act</i> .
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	The Paris site (1 plant, 2008) is on privately owned agricultural land. It has recently changed hands and the owner is unaware of the plant and appears uninterested. Permission was not granted to visit the site, which is along a treed farm lane that was formerly prairie. This single plant could easily be extirpated in the near future by lane expansion, vehicle use, herbicide use, or brush cutting.
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						Grazing by livestock likely contributed to the historical decline of the Midwestern subspecies, possibly including some Ontario subpopulations. Grazing not considered a threat.
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						There is salt factory/processing near a site but not salt mining.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.3	Renewable energy						
4	Transportation & service corridors		Not Calculated (outside assessment timeframe)	Large (31-70%)	Serious - Slight (1-70%)	Low (Possibly in the long term, >10 yrs)	
4.1	Roads & railroads		Not Calculated (outside assessment timeframe)	Large (31-70%)	Serious - Slight (1-70%)	Low (Possibly in the long term, >10 yrs)	The largest extant population (336 plants) occurs along a rail cut right of way near Brantford. It is not known whether CN Rail is aware of this Hairy Valerian subpopulation. It is on a straight section of railway so railway accident likelihood is very low. However, there is a road intersection a few hundred metres from the subpopulation. As with other CN rail operations there is some possibility of twinning the track in the future as this area becomes more developed.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						Historical medicinal use documented but no evidence of it being collected for use presently.
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Although the Goderich subpopulation occurs next to a frequently used hiking trail within the town limits, current trail use does not seem to pose a threat to plants, which occur on either side of the trail. Trampling did not appear to be a threat. However, trail maintenance (e.g., brush or weed cutting, if it occurs) may directly injure plants unless care is taken. This subpopulation is known to the Town of Goderich and will likely be monitored in future for recreational impacts.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7	Natural system modifications	D	Low	Large (31-70%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	
7.1	Fire & fire suppression		Not a Threat	Pervasive (71-100%)	Neutral or Potential Benefit	Moderate (Possibly in the short term, < 10 yrs)	In terms of natural wildfire, this species tolerates fire. There is no ongoing fire management in Goderich. Fires would not be allowed to burn at Brantford (rail line) but other ecosystem modifications (described below) decrease their likelihood.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications	D	Low	Large (31-70%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	Mowing has occurred at the railway line at Brantford but may have some beneficial effects. Recently, maintenance appears to have involved herbicide use. Trail maintenance occurs at Goderich but not in the immediate vicinity of Hairy Valerian.
8	Invasive & other problematic species & genes	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	
8.1	Invasive non-native/alien species	B	High	Large (31-70%)	Serious (31-70%)	High (Continuing)	In 2017, the formerly suitable habitat of Hairy Valerian along the limestone river flats of the Maitland River was entirely dominated by a non-native strain of Reed Canary Grass (<i>Phalaris arundinacea</i>), which was essentially absent during a site visit in 1994 (Reznicek pers. comm. 2017). It seems likely that this invasion has greatly reduced if not functionally excluded the floodplain portion of this subpopulation (a sizable but unknown proportion). However, occupied habitat along the Maitland River is upland and not susceptible to further <i>Phalaris</i> invasion. No other aggressively invasive species were present at the Goderich subpopulation. At the Brantford rail subpopulation, invasive Tartarian Honeysuckle was a dominant shrub making up about half the 30% shrub cover, and presents a possible threat by shading plants.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs)	Natural succession by native species may be problematic for both subpopulations. This species depends on open conditions, often caused by fire. The Brantford subpopulation remains relatively open, probably due to spraying and cutting, although some (~30%) of the occupied area is becoming shaded by young poplars and shrubs, and, without maintenance in the next 10 years, some areas may be unsuitable due to shade. The Goderich subpopulation is currently under a patch of thick shrubs (Ninebarks) which is dying back, allowing light penetration. Increased succession or shading of this population could have a negative effect on the abundance. The Paris Blue Lake subpopulation has not been recently visited, but the site is described as degraded and overgrown former prairie. White-tailed Deer may also be problematic for this species. Hairy Valerian is reportedly palatable to deer (Molano-Flores 2000). Deer populations are large in many areas of southern Ontario. However, no evidence of browsing was observed in 2017 or has been reported in Ontario. The two remaining extant sites are in the Town of Goderich and along an active rail line in an industrial area, and probably do not have large deer populations, although this is not known with certainty. Nothing is known of the third extant site. Insect damage seen at Paris subpopulation in 2005 but only some aphids noted in other subpopulations. It is not known if these are detrimental to Hairy Valerian.
8.3	Introduced genetic material						
9	Pollution	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs)	
9.1	Household sewage & urban waste water						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.2	Industrial & military effluents	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs)	Herbicide use for maintenance but only along track at Brantford. Now much of the Brantford subpopulation is away from the tracks, somewhat uncertain how far the herbicide spray travels on either side of the track. Maintenance of the rail cut presumably occurs to limit vegetation encroachment and maintain sight lines; herbicide use appeared to be a possible threat to Hairy Valerian in 2016 (Buck pers. obs.). While such maintenance may have benefited Hairy Valerian by preventing natural succession and maintaining open prairie conditions, herbicide use and brush cutting or mowing could injure plants if used without appropriate caution.
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Not Calculated (outside assessment timeframe)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs)	
11.1	Habitat shifting & alteration						
11.2	Droughts						
11.3	Temperature extremes		Not Calculated (outside assessment timeframe)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs)	There is evidence from a related subspecies that climate-induced shifts may result in a replacement of females with males, threatening population viability (Petty et al. 2016). Because the breeding system is identical, this could also threaten Hairy Valerian viability in Ontario as average seasonal temperatures increase.
11.4	Storms & flooding						

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