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Survey and Monitoring Protocol for Branched Bartonia (*Bartonia paniculata* ssp. *paniculata*) in Ontario

Prepared for the

Ministry of Environment, Conservation and Parks

north-south ENVIRONMENTAL

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Cover Photo: Branched Bartonia (*Bartonia paniculata* ssp. *paniculata*) in Ontario by Pauline K. Catling.

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Survey and Monitoring Protocol for Branched Bartonia (*Bartonia paniculata* ssp. *paniculata*)

1. Introduction and Objective

The protection of Species at Risk (SAR) and their habitat requires comprehensive and up-to-date knowledge of species identification, classification, distribution, occurrence, abundance, habitat and threats. When detailed occurrence data are unavailable, field surveys are necessary to determine if a species is present at a site and ascertain its abundance and threats in order to implement SAR protection. However, many SAR are rare, occur at low densities and may be cryptic, making detection difficult. Furthermore, some plant species may experience changes in abundance due to changes in environment or due to their annual nature, which increases the challenges associated with confirming presence and evaluating the status of the population. This survey protocol has been developed to address the need for reliable, consistent and science-based survey methods in Ontario for Branched Bartonia (*Bartonia paniculata* (Michaux) Muhlenberg ssp. *paniculata*), a vascular plant SAR, which is listed as Threatened under Ontario's *Endangered Species Act*, *2007* (ESA) (Government of Ontario 2007). Development of a standardized survey protocol for this species is identified as a high priority action in the Branched Bartonia government response statement (MECP 2020).

This document reviews existing information on Branched Bartonia including its identification, distribution, ecology and threats. The survey protocol is based on the best available scientific information at the time of publication, including information in scientific publications, technical reports and consultation with botanical experts and species experts. The survey protocol should be reviewed and, if appropriate, refined should new information become available. This document presents a science-based survey protocol that identifies:

- How to evaluate potential habitat and determine survey locations;
- How to identify Branched Bartonia, with a comparison of the features of similar species;
- How to complete a presence/no detection survey;
- How to complete monitoring;
- How to determine or estimate abundance;
- How to assess site condition and potential threats; and
- How to record and report data collected.

This document describes two different protocols. The objective of the first protocol (**Section 4.4**) is to describe the methods for detecting presence and provides a methodology that aims to maximize detection of Branched Bartonia in habitats where it may occur. The objective of the second protocol (**Section 4.5**) is to provide a standardized method for collecting population data at known

occurrences so that it is comparable over time. This protocol provides a standard method for long-term monitoring of known locations of Branched Bartonia.

Determining if there is habitat present under the ESA (general or regulated habitat) or the federal *Species at Risk Act* (SARA 2002) at a site is a complex process that is not limited to presence/ no detection surveys. For example, even at sites where survey results are negative, general or regulated habitat may still be present based on 1) nearby occurrences of the species (e.g., on an adjacent property), and 2) the manner in which the habitat is defined within a regulation, habitat description or other policy. This document provides a protocol for surveying potential Branched Bartonia sites (as defined here) and monitoring known occurrences; however, it does not include consideration of whether habitat is protected under the ESA or SARA or a delineation of regulated habitat. This protocol should be implemented by field biologists with expertise in botany who have acquired all relevant permits and permission for property access to complete surveys of Branched Bartonia.

For definitions of botanical terms see the **Glossary**.

2. Species Information

2.1. Taxonomy

Branched Bartonia is a member of the gentian family (Gentianaceae) in the tribe Gentianaea of the genus *Bartonia* Muhlenberg ex Willdenow. Two species of the genus *Bartonia* occur in Canada. Yellow Bartonia (*Bartonia virginica* (Linnaeus) Britton, Sterns & Poggenburgh) is the only other member of the genus *Bartonia* in Ontario (Canadensys 2021).

Branched Bartonia is one of three infraspecific taxa (subspecies or varieties) of *Bartonia paniculata* (Michaux) Muhlenberg (Ciotir et al. 2013; ECC 2017; NatureServe 2022a, b, c). Purplish Bartonia *(Bartonia paniculata* subsp. *iodandra* (B.L. Robinson) J.M. Gillett), the other subspecies in Canada, occurs in the Maritime region and is not present in Ontario (COSEWIC 2003; Canadensys 2021). Texas Screwstem (*Bartonia texana* Correll) was previously considered a distinct species but has been reclassified as a subspecies (*Bartonia paniculatum subsp. texanum*), which is limited to Louisiana and Texas in the United States (Ciotir et. al. 2013; NatureServe 2022). The name, Branched Bartonia, has been used to refer to all *Bartonia paniculata* subspecies; however, for the purposes of this document Branched Bartonia only refers to *Bartonia paniculata* (Michaux) Muhlenberg ssp. *paniculata*. The other infraspecific taxa are henceforth referred to as Purplish Bartonia and Texas Screwstem. Latin synonyms for Branched Bartonia include *Bartonia lanceolata* Small and *Centaurella paniculata* Michaux (Canadensys 2021). Additional English vernacular names for Branched Bartonia include Panicled Screwstem, Twining Bartonia and Twining Screwstem (Canadensys 2021).

Genetic studies on Branched Bartonia in Ontario suggest that this population is genetically distinct from populations within the main range of the species (Ciotir et. al. 2013). There is so far not enough

evidence to suggest it should be a distinct species or subspecies separate from Branched Bartonia (*Bartonia paniculata* (Michaux) Muhlenberg ssp. *paniculata*) located elsewhere.

2.2. Identification

Screwstems, the genus *Bartonia*, derive their common name from stems that twist or twine (Hill 2003). Branched Bartonia (**Figure 1**) is a small annual herb, ranging from 10 to 40 cm tall. The thin stem is green or purple, angled and may be twining, creeping or partially buried in *Sphagnum* moss (COSEWIC 2003; Hill 2003; ECCC 2017). Individuals growing in open habitats have darker purple stems and those growing in shaded areas may be weaker and yellowish (S. Brinker, pers. comm. 2022). Leaves are small and appear to be minute scales in an alternate arrangement on the stem. The inflorescence is a panicle with divergent or curved ascending branched with a few to many, single, small, white, four-lobed flowers. Capsules are 4.2 mm long on average and taper to a blunt tip (COSEWIC 2003; Hill 2003; ECCC 2017).

Figure 1. Branched Bartonia (*Bartonia paniculata* ssp. *paniculata*). Photos by P.K. Catling.

2.2.1. Similar Species

The distinguishing features between Branched Bartonia and Yellow Bartonia include leaf arrangement, anther length, calyx cleft and where capsules dehisce (Reznicek et al. 2011). A slender and lax stem with alternate leaves and pedicels, a calyx that is cleft from 2/3 or more to the base and yellow anthers distinguish Branched Bartonia from the other taxa in the genus (COSEWIC 2003; Hill 2003). Purple Bartonia also has alternate cauline leaves, but these are on a thick stout stem and anthers and filaments of the flowers are purple. Yellow Bartonia has opposite to subopposite cauline leaves and pedicels and has a lobed calyx (COSEWIC 2003; Hill 2003; Reznicek et al. 2011). Yellow Bartonia inhabits moist areas of *Polytrichum* or *Sphagnum* moss over granite rock and is typically not found in the bog and fen habitats Branched Bartonia occurs in (Reznicek and Whiting 1975). Surveys in Ontario recorded Yellow Bartonia growing in the same wetland as Branched Bartonia at two sites; however, the two species never co-occurred in the same location within the wetland (Catling et al. 2024). Comparison photos of distinguishing features are provided in **Figure 2** and **Figure 3**.

Figure 2. Branched Bartonia (top) and Yellow Bartonia (bottom) showing alternate and opposite arrangement, respectively. Photo by P.K. Catling.

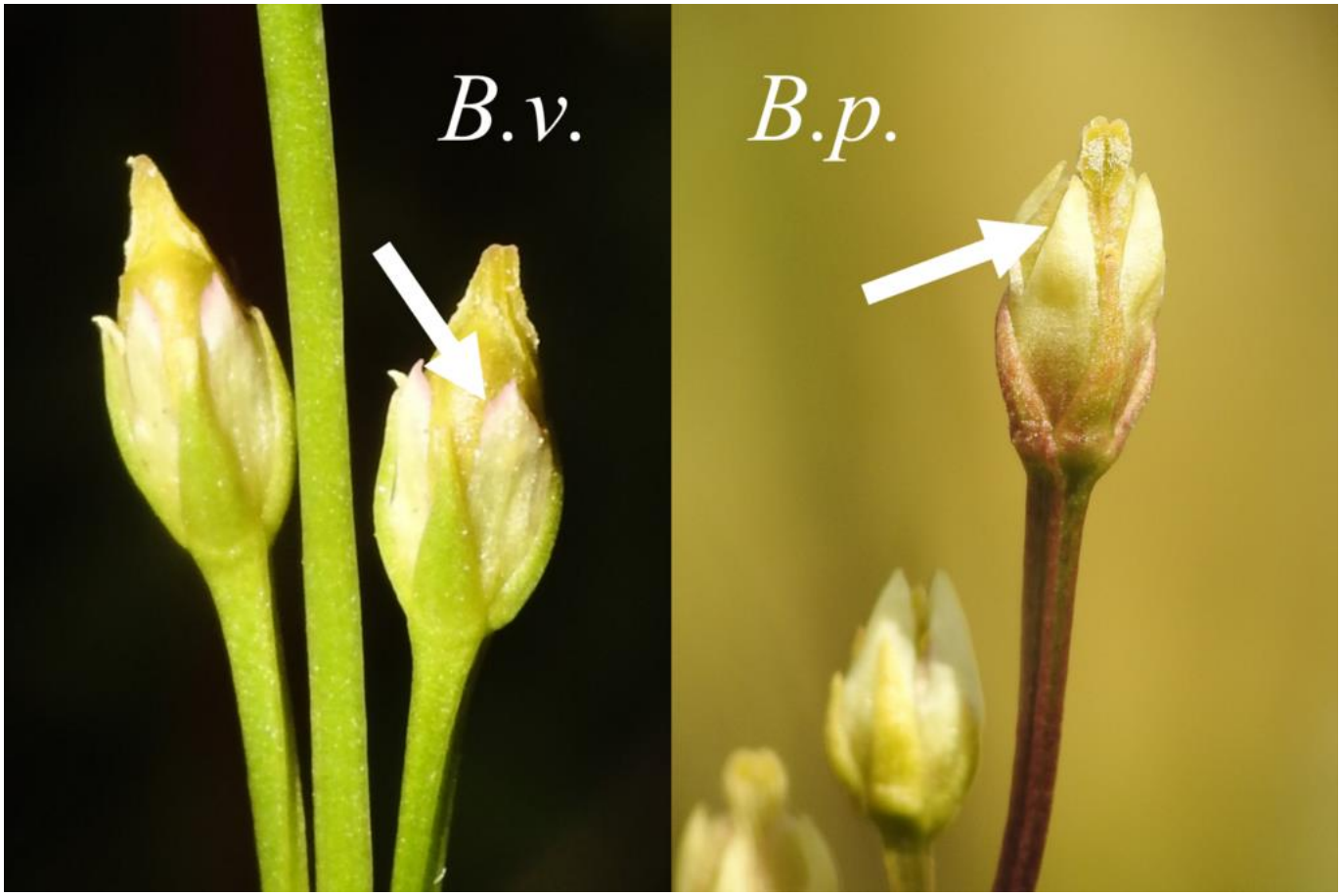

Figure 3. Yellow Bartonia (*Bartonia virginica*) (left) and Branched Bartonia (*Bartonia paniculata* ssp. *paniculata*) (right) flowers showing different calyx morphology. Photos by W. Van Hemessen

2.3. Distribution

Branched Bartonia occurs across the eastern North America, from Louisiana and Texas in the south to southcentral Ontario in the north (COSEWIC 2003). Its range is entirely within the Eastern Temperate Forest ecological region (EPA 2021). This species has an Atlantic Coastal Plain affinity. In Ontario, Atlantic Coastal Plain disjuncts grow on sand deposits associated with postglacial lakes or drainage channels (Reznicek 1994). The population of Branched Bartonia in Central Ontario is considered disjunct by approximately 600 km (COSEWIC 2003; ECCC 2017). The divergence time is estimated at approximately 534,000 years ago (Ciotir et. al. 2013).

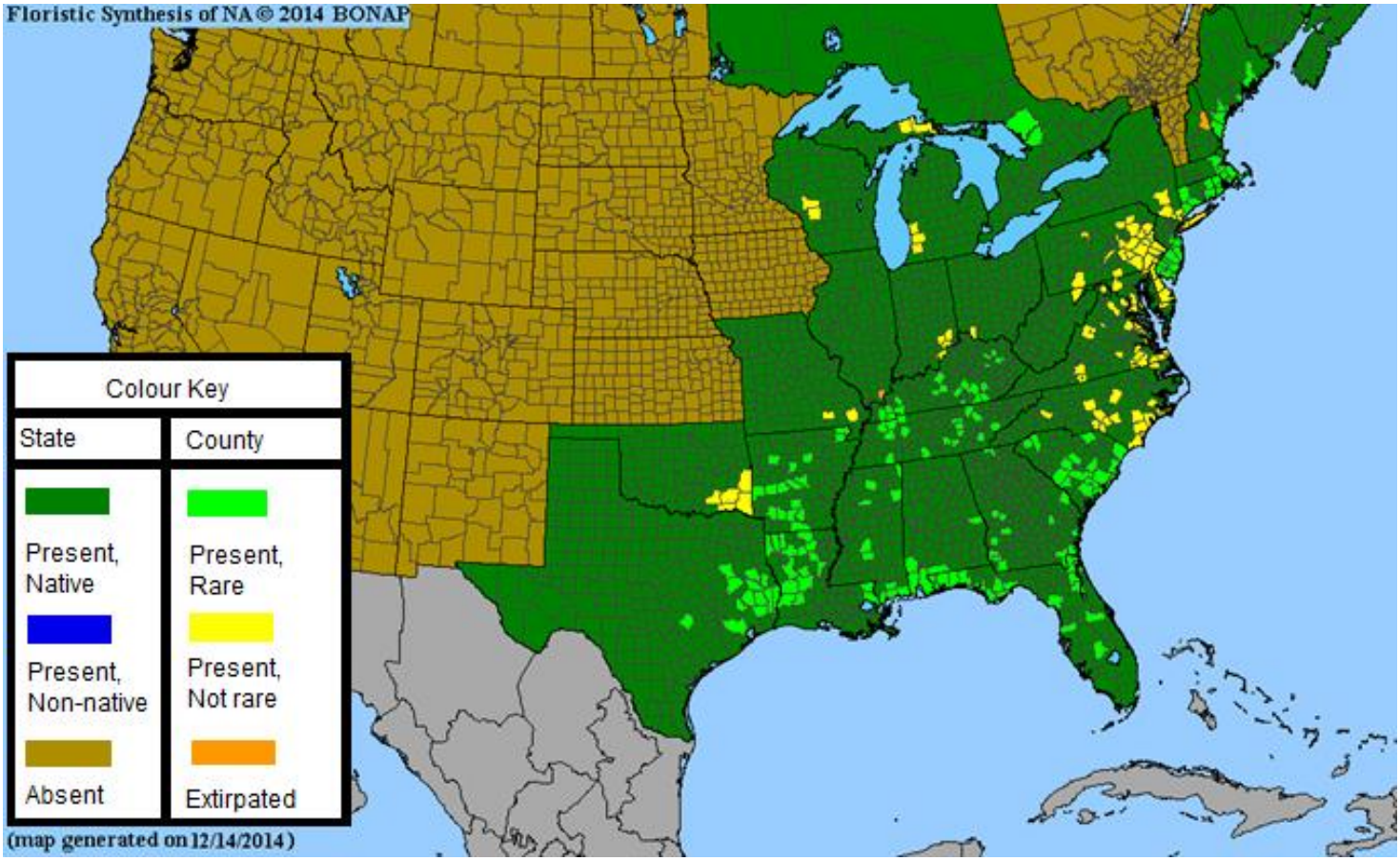

Figure 4. Global distribution of Branched Bartonia. Edited from Kartesz (2015).

In Ontario, Branched Bartonia occurs within the Georgian Bay ecoregion (5E). The areas where it occurs within the Muskoka (eleven subpopulations) and Parry Sound (two subpopulations) Districts (**Table 1**; **Figure 5**) are known to have Atlantic Coastal Plain disjuncts (COSEWIC 2003), including Virginia Meadow Beauty (*Rhexia virginica* Linnaeus), Southern Twayblade (*Neottia bifolia* (Rafinesque) Baumbach), Bayonet Rush (*Juncus militaris* Bigelow), Golden Hedge-hyssop (*Gratiola lutea* Rafinesque) and Ridged Yellow Flax (*Linum striatum* Walter) (Reznicek and Whiting 1975). A total of 15 subpopulations have been recorded; however, two may be extirpated due to development of housing and railroads. The Ontario population was previously estimated as 767 plants (ECCC 2017). However, totals of 3,970 and 9,640 flowering stems were recorded in 2022 and 2023, respectively (Catling et al. 2024). This drastic increase corresponds with targeted search effort, and the discovery of three new subpopulations and should not be mistaken for an increasing abundance trend. The abundance of Branched Bartonia in Ontario is expected to fluctuate, and it is unknown if these years were particularly high for the species. Regular monitoring is required to determine a population trend. Many of the subpopulations in Ontario occur on private lands (COSEWIC 2003) and there is still

suitable habitat on private lands which has not yet been surveyed. Additional potentially suitable areas on crown land and within protected areas have not yet been surveyed, and there is a potential that new locations may be found.

Many factors contribute to the cryptic nature of this species. It is small, inconspicuous, annual, inhabits a habitat that can be difficult to access, and there is little knowledge about its dispersal or how long-lived it may be in the seed bank. The remoteness and inaccessibility of some areas with suitable habitat and the demographic fluctuations of the species make it difficult to be certain of exact distribution and abundance in Ontario.

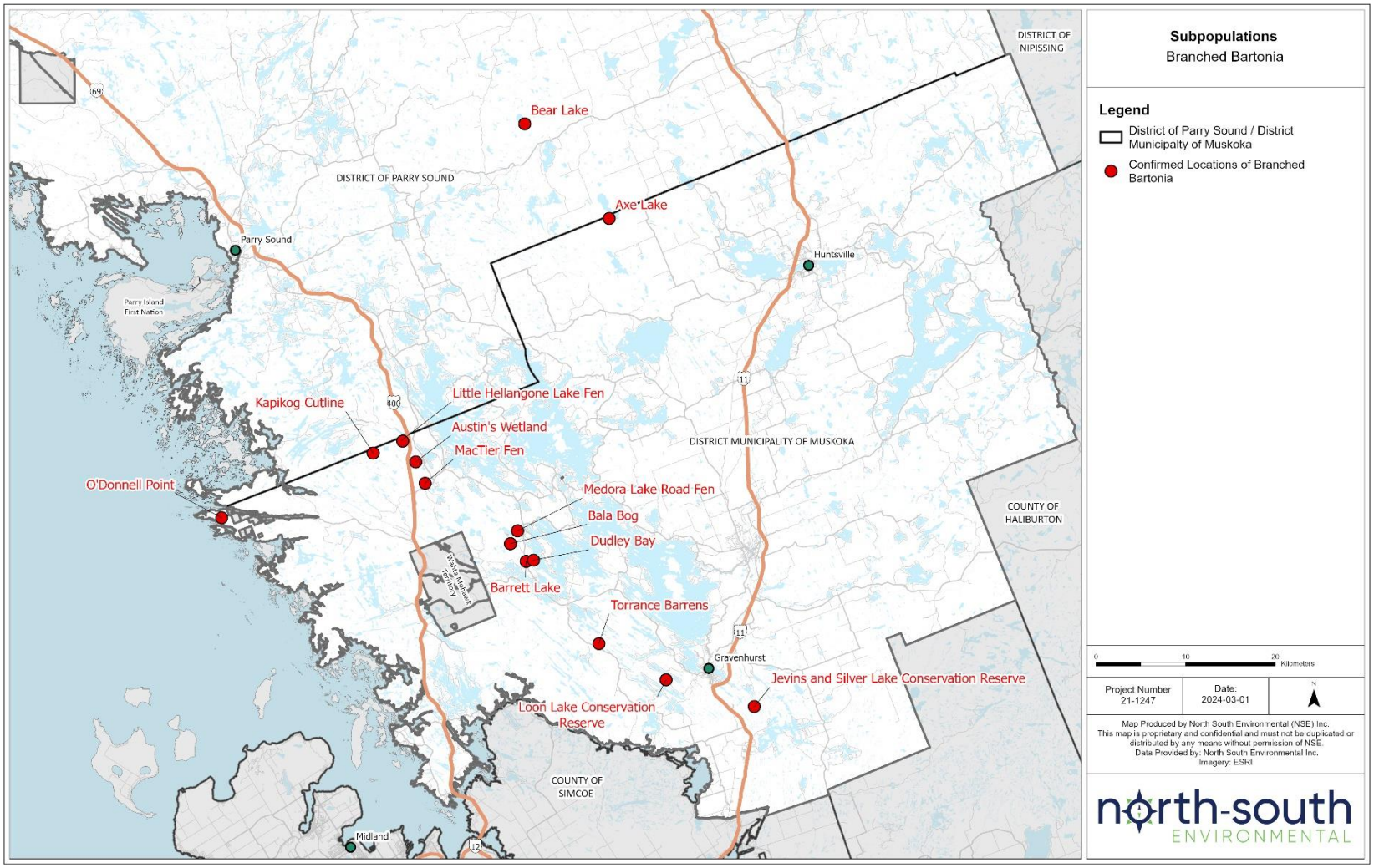

Figure 5. Known subpopulations of Branched Bartonia in Ontario as of 2023 (Catling et al. 2024).

Table 1. Subpopulations of Branched Bartonia in Ontario as of 2023

Subpopulation (District)	First Observed (Observer)	Last Observed (Observer)	Abundance	Habitat	Status
Austin's Wetland (Muskoka)	2007 (J. Rouse)	2022 (P.K. Catling)	26 (2007), 479 (2022), 184 (2023)	*Carex utriculata - Chamaedaphne calyculata* fen with scattered low Larix laricina.	Extant
Axe Lake (Parry Sound) [1]	1983 (I. Wisheu)	2008 (B. Korol)	10 to 20 (1983), 209 (2005), >5 (2008), 0 (2023)	*Myrica gale - Chamaedaphne calyculata / Cladium mariscoides* shore fen with low (<10%) tree cover on a medium sand with a southern exposure, although a few individuals were found on the north facing shoreline.	Possibly Extirpated
Bala Bog (Muskoka) [6]	1977 (J. Goltz)	2023 (P.K. Catling)	A few plants (1977), 30 (1979), 19 (2002), 57 (2005)	Moderately-rich and poor *Rhynchospora alba - Sphagnum* fen with low (<10%) tree cover on organic-humic substrates.	Extant
Barrett Lake (Muskoka) [2]	1975 (J. Goltz)	2005 (S. Brinker)	16 (1991), 0 (2002), 4 (2005)	*Nemopanthus mucronatus - Myrica gale* low shrub shore fen on a floating mat of organic-humic with no tree cover.	Possibly Extirpated
Bear Lake (Parry Sound)	2022 (W. Van Hemessen and P.K. Catling)	2022 (W. Van Hemessen and P.K. Catling)	11 (2022), 0 (2023)	Growing in *Polytricum* moss on a rock outcrop within an expansive *Sphagnum* dominated bog.	Extant
Corson Lake (Muskoka)	2023 (K. Hall and K. Black)	2023 (K. Hall and K. Black)	24 (2023)	Open fen/shrub fen dominated by a ground cover of open sphagnum with *Rhynchospora alba, Andromeda polifolia, Eriophorum virginicum, Carex* spp., *Chamadaphne calyculata* and Sarracenia purpurea. A sparse canopy/sub canopy	Extant

Subpopulation (District)	First Observed (Observer)	Last Observed (Observer)	Abundance	Habitat	Status
				of *Larix laricina, Myrica gale* and *Alnus* sp.	
Dudley Bay (Muskoka)	1997 (Unknown)	1997 (Unknown)	Unknown (1997), 0 (2016?)	No description available.	Assumed Extirpated-land use change
Jevins & Silver Lake Conservation Area (Muskoka)	2010 (S. Brinker)	2023 (P.K. Catling and W. Van Hemessen)	130 (2010), 104 (2023)	*Carex utriculata - Rhyncospora - Larix laricina* poor fen with *Carex lasiocarpa, Pogonia ophioglossoides, Aronia melanocarpa, Platanthera blephariglottis*.	Extant
Kapikog (Muskoka)	2022 (S. Mainguy and K. Shelly)	2023 (P.K. Catling and P. Strzalkowski)	954 (2022), 4,327 (2023)	Inclusion within a larger wetland area. Open sphagnum with *Aronia melanocarpa, Alnus* sp., *Eriophorum virginicum, Carex* spp., *Woodwardia virginica, Chamadaphne calyculata* and *Symphyotrichum boreale*.	Extant
Little Hellangone Lake Fen (Muskoka)	2009 (S. Brinker)	2023 (M. Jackson)	46 (2009), 15 (2022), 103 (2023)	A relatively open graminoid dominated poor fen with *Carex utriculata, Rhyncospora alba, Juncus pelocarpus*, and *Carex trisperma var. billingsii*. Shrub cover included *Aronia melanocarpa, Vaccinium macrocarpon, Chamaedaphne calyculata* and *Andromeda polifolia*.	Extant
Loon Lake Conservation Reserve (Muskoka) [3]	1973 (R. E. Whiting)	2023 (P.K. Catling and S. Mainguy)	78 (1991), 20 (2002), 100 (2005), 1,686 (2022), 3,567 (2023)	A poor semi-treed *Larix laricina* - ericaceous shrub - graminoid - *Sphagnum* fen on organic mesic	Extant

Subpopulation (District)	First Observed (Observer)	Last Observed (Observer)	Abundance	Habitat	Status
				substrate. Tree cover was approximately 20%.	
Mac Tier Fen (Muskoka) [4]	1990 (J. Goltz)	2023 (P.K. Catling and P. Strzalkowski)	12 (1990), 122 (2002), 120 (2005)	Moderately-rich and poor semi-treed *Picea mariana - Larix laricina* - ericaceous shrub - graminoid - *Sphagnum* fen with 10 to 25% tree cover, A poor *Chamaedaphne calyculata - Rhynchospora alba - Sphagnum* fen and a moderately-rich poor *Carex lasiocarpa - Sphagnum* fen. All on organic-mesic substrate.	Extant
Medora Lake Road Fen (Muskoka) [5]	1997 (J. Goltz)	2023 (P.K. Catling)	>200 (1997), 52 (2002), 46 (2005)	A moderately-rich and poor *Carex utriculata - Sphagnum* fen and a moderately-rich poor *Carex lasiocarpa - Sphagnum* fen. Both with less than ten percent tree cover and organic-mesic substrate.	Extant
O'Donnell Point Nature Reserve (Muskoka) [7]	1977 (S. Darbyshire et. al.)	2007 (S. Mainguy and S. Piett)	20 to 30 (1977), 44 (2005), 3 (2007)	Large open (<10% tree cover) moderately-rich and poor *Rhynchospora alba - Sphagnum* fen on organic-mesic substrates (the few plants noted in 2007 occurred only in moderately rich fen).	Assumed Extant
Torrance Barrens (Muskoka)	2009 (S. Brinker and B. Korol)	2023 (S. Mainguy and D. Bettencourt)	52 (2009), 2 (2022), 30 (2023)	*Carex utriculata - Chamaedaphne calyculata* fen with scattered low *Larix laricina*. Also recorded in Polytrichum mat on rock.	Extant

Note: Site numbers from the COSEWIC status report have been provided in subscript beside the subpopulation name.

2.4. Habitat

2.4.1. Edaphic Conditions

This species grows in nutrient-poor peat, peaty soil or sandy soils of mildly acidic wetlands (COSEWIC 2003; Hill 2003; North-South Environmental Inc. 2008; ECCC 2017). Very rich fens typically have a pH above 6.9, whereas poor fens tend to have a pH between 4.5 and 5.5. Branched Bartonia has been observed primarily in moderately poor fens or poor fens. *Sphagnum* moss is often a dominant where it grows (Hill 2003); however, it has been observed growing in *Polytrichum* moss (Catling et al. 2024) (**Figure 6**).

Figure 6. Branched Bartonia growing in *Sphagnum* (left) and *Polytrichum* (right) moss. Photos by P.K. Catling.

Soil samples of plots containing Branched Bartonia had moderate phosphorus level but were low to deficient in nitrate nitrogen, ammonium, potassium and magnesium (North South Environmental Inc. 2008).

2.4.2. Hydrology

Branched Bartonia requires continuous moisture for establishment and growth (ECCC 2017). The hydrology of the moderately rich fens and bogs that Branched Bartonia inhabits is considered relatively stable, but water levels do fluctuate seasonally. The water that supports this type of habitat consists of direct precipitation (in bogs) or groundwater (in fens). Groundwater in poor to moderately rich fens on the Canadian Shield contains low to moderate degrees of mineral nutrients (depending on the underlying rock) but is lacking in organic nutrients. It is assumed Branched Bartonia is tolerant of seasonal flooding, but it is uncertain to what extent this species can tolerate prolonged flooding. This species has been noted to decline as wetlands dry. It is uncertain if those declines are due to increased competition or overshading as woody cover increases or an intolerance to the hydrological change.

2.4.3. Ecological Classification and Associate Species

The habitat of Branched Bartonia is typically open fens or bogs (see examples in **Figure 7**) dominated by *Sphagnum* with low shrubs and graminoids (COSEWIC 2003; V. Brownell per. comm. 2022). According to Lee et. al. (1998) these habitats could be classified as Open Fen, Shrub Fen, Treed Fen, Open Bog, Shrub Bog or Treed Bog (FEO, FES, FET, BOO, BOS and BOT). Even when present in communities with woody vegetation, such as Shrub Bog or Treed Bog, this species is more likely to be present in canopy gaps or open patches within these community types. Branched Bartonia is shade intolerant and unable to compete with woody vegetation (ECCC 2017). According to the Ontario Wetland Evaluation System (MNRF 2013) the habitats Branched Bartonia occurs in include low shrub shore fens and poor fens.

Branched Bartonia typically occurs in areas with very little woody vegetation except low shrubs. The species is often growing with other coastal plain species, including Southern Twayblade (*Neottia bifolia* (Rafinesque) Baumbach) (V. Brownell per. comm. 2022). Associate species of Branched Bartonia include Black Chokeberry (*Aronia melanocarpa* (Michaux) Elliott), Virginia Cotton-grass (*Eriophorum virginicum* Linnaeus), Larch (*Larix laricina* (Du Roi) K. Koch), Mountain-holly (*Illex mucronata* (Linnaeus) M. Powell, V. Savolainen & S. Andrews), Black Spruce (*Picea mariana* (Miller) Britton, Sterns & Poggenburgh), White-fringed Orchid (*Platanthera blephariglottis* (Willdenow) Lindley), Rose Pogonia (*Pogonia ophioglossoides* (Linnaeus) Ker Gawler), White Beak-rush (*Rhynchospora alba* (Linnaeus) Vahl), Virginia Chain Fern (*Anchistea virginica* (Linnaeus) C. Presl), and *Sphagnum* mosses (COSEWIC 2002). For a complete description of vegetation communities at each site see the reports by Brinker (2006) and Catling et al. (2024).

Figure 7. Examples of Branched Bartonia habitat in Ontario. Photos by P.K. Catling.

2.5. Ecology

2.5.1. Life Cycle and Reproduction

Branched Bartonia may be heterotrophic (dependent on soil fungi directly or indirectly for much of its organic nutrient requirements) and derives nourishment from decayed material (Reznicek & Whiting 1976; COSEWIC 2003; Hill 2003; Matthews et al. 2009). It is suspected that the mycorrhizae are probably endomycorrhizal rather than ectomycorrhizal (Hill 2003).

Branched Bartonia is an annual or biennial that reproduces only by seed (COSEWIC 2003; Hill 2003). Flowering period is from late-July through to mid-September. Branched Bartonia can be found flowering into October and it may be possible to find this species in flower until the first frosts occur. Fruiting occurs from late-August to late-October, occasionally into November (Gillett 1959; Higman and Penskar 1996). Little is known about the pollination of Branched Bartonia and it is uncertain if it is pollinated by insects or self-pollinated (Hill 2003). Branched Bartonia has been observed to be visited by moths (MECP 2018). In recent work, surveyors watched Branched Bartonia plants for a total of 20 hours during the day and observed no pollinators (Catling et al 2024). The fruit set of a subset of plants was relatively high (84% of flowers produced fruit with seeds) suggesting pollinators are very effective or abundant, or the species can produce seeds through apomixis or self-pollination (Catling et al. 2024). Conditions required for germination and how long seeds can remain viable in the seed bank are also unknowns (COSEWIC 2003).

2.5.2. Dispersal

Branched Bartonia capsules have many (1000 to 1500) small seeds (average 0.19 mm long x 0.12 mm wide) in each capsule (Gillett 1959, 1963; COSEWIC 2003). Dispersal mechanisms are assumed to include air and water based on the small size (0.2 to 0.3 mm) of the seed (Hill 2003). Production of small seeds to disperse large distances via water or air is expected to increase the opportunity for Branched Bartonia seeds to land in suitable habitat, assuming that suitable sites with fungal associates are scarce and few seeds will reach a suitable area to germinate and mature (Hill 2003). Branched Bartonia typically occurs in patches of plants, suggesting that a portion of the seeds produced fall in close proximity to the parent plant and maintains its occurrence in the approximate same location (i.e., within 10 metres of where it occurred previously) (COSEWIC 2003). Monitoring of 1 m plots at O'Donnell Point showed a drastic decline in abundance (North-South Environmental Inc. 2008). Monitoring surveys in 2022 and 2023 at Austin's Wetland showed Branched Bartonia occupying an entirely new area of the wetland and no stems within the vicinity of the previous record (Catling et al. 2024). These results suggest that in certain years water dispersal may shift the location of occurrence within the wetland.

The abundance of Branched Bartonia along mammal trails and laydown areas also suggests that the small seeds may be dispersed in mammal fur (Catling et al. 2024). However, this theory is based on anecdotal evidence and is unproven.

2.6. Status

Branched Bartonia has a global rank of Secure (S5T5) and ranges from Apparently Secure (S4) to Critically Imperiled (S1) across its range within North America; however, in over half the states it occurs in it has no status rank (NatureServe 2022a). Branched Bartonia occurs in one province (S2 Ontario) and 28 states:

- S1: Maine, Missouri, New Hampshire, New York, Oklahoma, West Virginia
- S2: Delaware
- S2S3: North Carolina
- S3: Indiana, Pennsylvania, Virginia
- S4: Arkansas, New Jersey
- SNR: Alabama, Connecticut, District of Columbia, Florida, Georgia, Illinois, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, Rhode Island, South Carolina, Tennessee, Texas

In Canada, Branched Bartonia has a national rank of Imperiled (N2) (NatureServe 2022a). Branched Bartonia was assessed by COSEWIC as Special Concern in 1992 and Threatened in 2003 (COSEWIC 2003). It is listed as Threatened on Schedule 1 of the *Species at Risk Act* (MECP 2019). In Ontario, Branched Bartonia was accessed by COSARO as Threatened (2003) and is listed on the *ESA, 2007* (Government of Ontario 2007).

2.7. Threats and Limiting Factors

For a detailed description of threats see the COSEWIC status report (COSEWIC 2003) and the recovery strategies (ECCC 2017; MECP 2018).

Due to the dependence on moisture, Branched Bartonia and its habitat would be particularly susceptible to negative impact from hydrological change, including but not limited to encroachment by woody vegetation (Hill 2003; ECCC 2017). Invasive species, such as Glossy Buckthorn *(Frangula alnus* Miller) and Common Reed (*Phragmites australis* (Cavanilles) Trinius ex Steudel subsp. *australis*), are a primary threat to the habitat of Branched Bartonia (COSEWIC 2003; Catling et al. 2024). Glossy Buckthorn is becoming dominant in the habitat of Branched Bartonia at Medeora Lake Road Fen (Catling et al. 2024). Increases in organic nutrients, which promote the growth of robust plants such as cattails (*Typha* spp.) and non-native invasives, likely exacerbate competition threats to this species. The expansion of transportation corridors has the potential to impact certain subpopulations (COSEWIC 2003). The current impact of peat mining, recreational activities, climate change, adjacent

land uses and input of pollutants from roadways or railways are uncertain but expected to be minimal, since many of the subpopulations occur in remote areas. At five sites in Ontario Branched Bartonia occurs in wetlands adjacent to roads or railways (Catling et al. 2024). If these factors cause increase in sediment-laden runoff that carries organic nutrients, or hydrological impacts from impounding or impeding groundwater, they cause indirect impacts to Branched Bartonia habitat.

3. Considerations for Implementing the Protocols

3.1. Protocol Refinement

The survey protocols are based on the review of the available literature on Branched Bartonia, consultation with the various experts who contributed advice and knowledge, and the authors' own experience monitoring various rare plant species, including Branched Bartonia surveys completed in 2007, 2022 and 2023. An adaptive approach is recommended whereby the field protocol is refined and improved as data are collected, especially during the collection of baseline data. It is recommended that individuals who undertake the field work comment on the protocol and indicate where it was difficult to apply and to make suggestions for improvement. In making refinements, it is essential that the overall objectives of consistently monitoring population size, and documenting threats, be adhered to in order to provide sufficient consistency among sites to allow comparison of data and draw conclusions about the status, protection needs and management requirements of the population.

As an annual or biennial species, Branched Bartonia abundance, distribution and location within a site may fluctuate year to year based on the given biotic and abiotic conditions. Little is known about Branched Bartonia life cycle and this protocol should be updated to consider new information as it becomes available.

3.2. Habitat and Species Sensitivity

Sphagnum dominated habitats including fens and bogs are sensitive to trampling and the small delicate Branched Bartonia plants (**Figure 8**) are particularly vulnerable to being overlooked and trampled, especially in the dense vegetation cover of certain fens. This species is small and inconspicuous and may grow under or amongst other vegetation, which obscures the view of it. Trampling impacts can be very persistent in fen habitats; for example, at O'Donnell Point, the trampling impacts of the 2005 monitoring could still be seen in 2007 (North-South Environmental Inc. 2008). Surveyors should avoid stepping on hummocks where possible. If damage to the habitat caused by trampling during surveying is noted, surveys should not be conducted at that site for at least five years to allow the habitat opportunity to recover.

Damage to vegetation and the habitat may become more severe if a path is walked repeatedly, causing the trail to be compacted. Branched Bartonia was frequently found along mammal trails (Catling et al. 2024) suggesting it either may benefit from some level of disturbance or the seeds may be distributed by mammals. It is still highly recommended that human disturbances from surveys be minimized to the greatest extent possible. It is recommended that unless they are following an existing mammal trail, surveyors avoid walking the same path repeatedly so that severity of damage can be minimized. No motorized vehicles (e.g., ATVs) should be utilized within wetland habitats for Branched Bartonia surveys. Compacted trails from foot traffic, snowmobiles and ATVs are already present at some sites where Branched Bartonia occurs (Brinker 2006; Catling et al. 2024), but the presence of this impact should not be used to justify use of motorized vehicles.

Figure 8. Branched Bartonia growing less than 1 cm tall above Sphagnum. Photo by P.K. Catling.

Introduction or spread of invasive species has the potential to threaten Branched Bartonia and its habitat. Measures should be taken to reduce the spread of invasive plant seeds including washing and brushing off mud or attached seeds from clothing, boots, waders and/or field equipment between sites.

Additional SAR flora and fauna may occur in the same habitat as Branched Bartonia. Surveyors should make themselves familiar with these species and minimize potential harm to them. Records of incidental SAR or species of conservation concern (S1-S3) should be reported to Ontario's Natural Heritage Information Centre (see **Section 4.6**).

3.3. Frequency of Survey

Branched Bartonia can be absent or low in abundance in a given year or the plant phenology can shift due to environmental conditions (S. Brinker, pers. comm. 2021). To prove the species is absent at a site, presence/no detection surveys should occur for a minimum of three consecutive years to account for the potential of this species to be overlooked because of its small stature and annual nature. Since Branched Bartonia is annual or biennial species the location where it occurs in a given wetland may change from year to year and it is important to survey more than just the exact location of the previous record.

After baseline data on the abundance of Branched Bartonia in Ontario has been collected, annual monitoring of all known subpopulations will not be necessary. Annual surveys of the entire range of

Branched Bartonia are unrealistic and have the potential to damage the sensitive habitat in which Branched Bartonia occurs. It is recommended that a full inventory of existing subpopulations occurs optimally every five years and at a minimum of once every ten years. However, for long-term studies on trends or to gain additional knowledge of the species, a site or two may be surveyed annually as a representative for the population. Surveying a representative site first in years of a complete inventory may allow surveyors to determine if Branched Bartonia is abundant or scarce that year and provide surveyors with a search image prior to implementing the full inventory. Surveying in years of moderate to high abundance is recommended for the purposes of increasing detection of the species. Years with warm late falls and moderate water levels (i.e., not flooded but not dried out) are expected to be ideal (S. Brinker pers. comm. 2022).

Additional monitoring should occur the year before and at one and three years after any habitat management actions or detrimental human activities (e.g., changes in hydrology, invasive species removal) occur. A full inventory of Branched Bartonia may not be necessary post-management if the goal is to assess abundance of invasive species; however, Branched Bartonia abundance should be noted generally in this case.

3.4. Qualifications of Surveyors

Surveyor experience greatly influences the probability of detection of Branched Bartonia, and surveys completed by inexperienced surveyors can lead to inaccurate results. Even when the species is in bloom or fruiting, Branched Bartonia is very inconspicuous, due to its small size and growth among *Sphagnum* mosses, dense sedges, ferns, shrubs or other vegetation. Surveys for Branched Bartonia should be led by a botanist who understand the species' biology to assist with focusing search efforts to areas with the highest probability of locating the species. It is important that all members of the survey team have a search image for Branched Bartonia and the ability to confidently identify the species. The lead surveyor or each team should also be able to interpret aerial imagery, navigate, record the survey track, geo-reference observations using a Global Positioning System (GPS) unit and classify vegetation communities.

The small inconspicuous nature of Branched Bartonia makes it easy to trample individuals, specifically if they are vegetative or growing under or amongst other vegetation. The importance of caution should be stressed to all surveyors during training.

Lead surveyors and GIS specialists handling the data should have completed the Ontario Natural Heritage Information Centre (NHIC) data sensitivity training.

Surveyors should be familiar with the safety risks within Branched Bartonia habitat and how to prepare for them. Safety concerns include but are not limited to Black Bears, Moose, Massasauga Rattlesnakes, uneven boggy terrain, working in remote areas and working around water.

3.5. Authorization

Surveys or monitoring for Branched Bartonia may require an authorization under the ESA. The Project Lead should contact the responsible biologist in the Ministry of Environment, Conservation and Parks (MECP) district where the survey is to be completed to determine if a permit is required or make an inquiry to SAROntario@ontario.ca. Any permits required for the collection of Branched Bartonia specimens or potential damage to individuals should be acquired prior to commencing fieldwork so that these are already in-hand if collection is needed. Permit applications should be submitted at least five months prior to proposed fieldwork.

Additional permits may be required from Ontario Parks, Parks Canada Agency, Canadian Wildlife Service or conservation authorities if surveys or monitoring are to be carried out in provincial parks and conservation reserves, national parks, national wildlife areas or conservation areas, respectively. Municipalities should also be contacted for permission to conduct research in municipally owned parks. Reporting requirements associated with these permits may differ and should be followed accordingly.

Permission to carry out work on private property should be obtained from the property owner or manager prior to accessing the property.

4. Standardized Survey Protocol for Inventory and Monitoring

Two survey methods are described below. The presence/no detection survey method (**Section 4.4**) is focused on confirming presence, rapidly documenting site-wide abundance and searching a large area. The long-term monitoring survey method (**Section 4.5**) is more time consuming and captures greater detail including: recording the abundance of patches/individuals, patch size (area) and distribution of stems across the site. Information on records review (**Section 4.1**), survey timing (**Section 4.2**), potential suitable habitat mapping (**Section 4.3**), survey effort and repetition (**Section 4.6**) and reporting (**Section 4.7**) are relevant to both survey types. This protocol is science-based and has been revised through an inventory of Branched Bartonia in Ontario. It is highly recommended that any issues with the survey method be recorded and reported so the protocol can be improved and adapted in the future.

Branched Bartonia individuals may grow under *Sphagnum*, producing multiple branches or stems above the moss. It can be challenging to distinguish individuals without disturbing the habitat. As such the survey protocol records the number of stems above the *Sphagnum* unless it is clearly one individual.

4.1. Records Review

A records review should be carried out prior to undertaking field surveys. Existing occurrence records may help to better scope the field survey or, if extensive recent data is already available for a site, existing records may eliminate the need for a field survey altogether. The absence of occurrence records from an area does not indicate that the species is absent; suitable habitat must be adequately surveyed before concluding that the species is unlikely to be present (see **Section 4.6** for details on survey effort required). The following sources can be consulted for information on distribution and occurrence records within Ontario:

- NDMNRF Natural Heritage Information Centre (NHIC) www.ontario.ca/nhic; e-mail: nhicrequests@ontario.ca
- Local Conservation Authorities www.conservationontario.ca
- Status reports from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); available through the *Species at Risk Act* (SARA) Public Registry www.sararegistry.gc.ca/default.asp
- Other information sources such as, but not limited to species experts, NDMNRF and MECP staff, park staff, municipal staff, conservation focused groups including land trusts, Nature Conservancy of Canada, friends of provincial parks, herbaria, site-related environmental impact or screening reports, landowners, local naturalists, published scientific literature and natural history inventories.

Additionally, recent observations on public biological databases such as iNaturalist and the Global Biodiversity Information Facility may not be included in the NHIC database and inquiring with the observer can determine if the record is associated with a previously known occurrence.

4.2. Survey Timing

This species is most obvious and easily identifiable during its flowering and fruiting period. Surveys should only occur within the flowering period between late August and into early-October. Optimally surveys would be in early to mid-September when the largest number of individuals may be in flower or early blooming individuals have developed fruit. Fruiting begins in late-September and fruiting individuals are more challenging to notice. Later into the fall, all forms of Branched Bartonia phenology can be found with some stems in flower, others fruiting or senesced (Catling et al. 2024).

Surveys may be completed during a variety of weather conditions, but heavy rain, fog or other weather that reduces visibility or increases safety risk should be avoided. Current water levels of the wetland should be considered before surveys are completed as flooding may obscure the view of Branched Bartonia and increase safety risk.

4.3. Potential Suitable Habitat Mapping

Potential suitable habitat mapping for Branched Bartonia has been completed by Glenside Ecological Services Limited (2009) for the Muskoka District (**Figure 9**). North-South Environmental Inc. and Blazing Star have also completed potential suitable habitat mapping for this species in Ontario (**Figure 10**). The Potentially Suitable Habitat mapping that has been completed may be used to identify areas where additional locations may occur and target survey efforts for research purposes, but this mapping should not be used to suggest or confirm absence.

The potential suitable habitat mapping exercise completed by North-South Environmental Inc. and Blazing Star including the Municipality of Muskoka, Parry Sound, and northern Simcoe, used the following datasets:

- MNRF Wetlands [Coverage: Parry Sound & Northern Simcoe]
- Enhanced Wetland Mapping for Muskoka [Coverage: Muskoka]
- Forest Resource Inventory (FRI) Version 2: Nipissing Forest and the French Severn Forest [Coverage: Muskoka and Parry Sound]

Potential suitability was classified for each wetland from 1 (high suitability) to 4 (low/moderate suitability) based on wetland type and the adjacent FRI tree community; adjacent tree communities were modelled as the average of all communities within 100 m of each wetland. The following criteria was used to model the initial potential suitability:

- Class 1: Fens and Bogs with predominantly Black Spruce or Larch
- Class 2: Fens and Bogs with Black Spruce, Larch, or Black Cherry
- Class 3: All other Fens and Bogs
- Class 4: Unevaluated wetlands with predominantly Black Spruce or Larch

This exercise identified a large number of potentially suitable areas and acted as a baseline, which was further refined based on a review of aerial imagery, proximity to existing or historic records and land ownership.

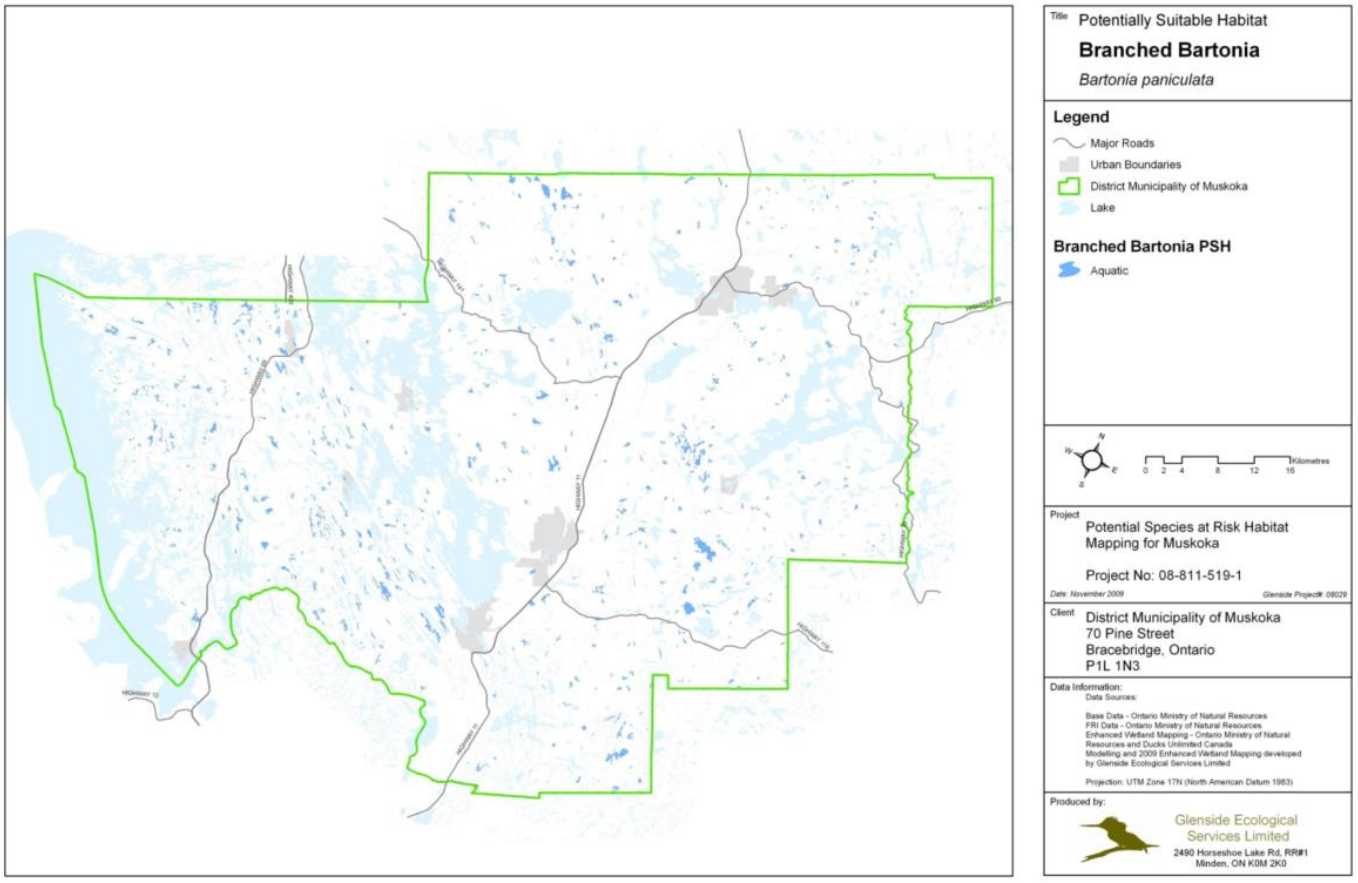

Figure 9. Potentially suitable habitat for Branched Bartonia in Muskoka District (Glenside Ecological Services Limited 2009)

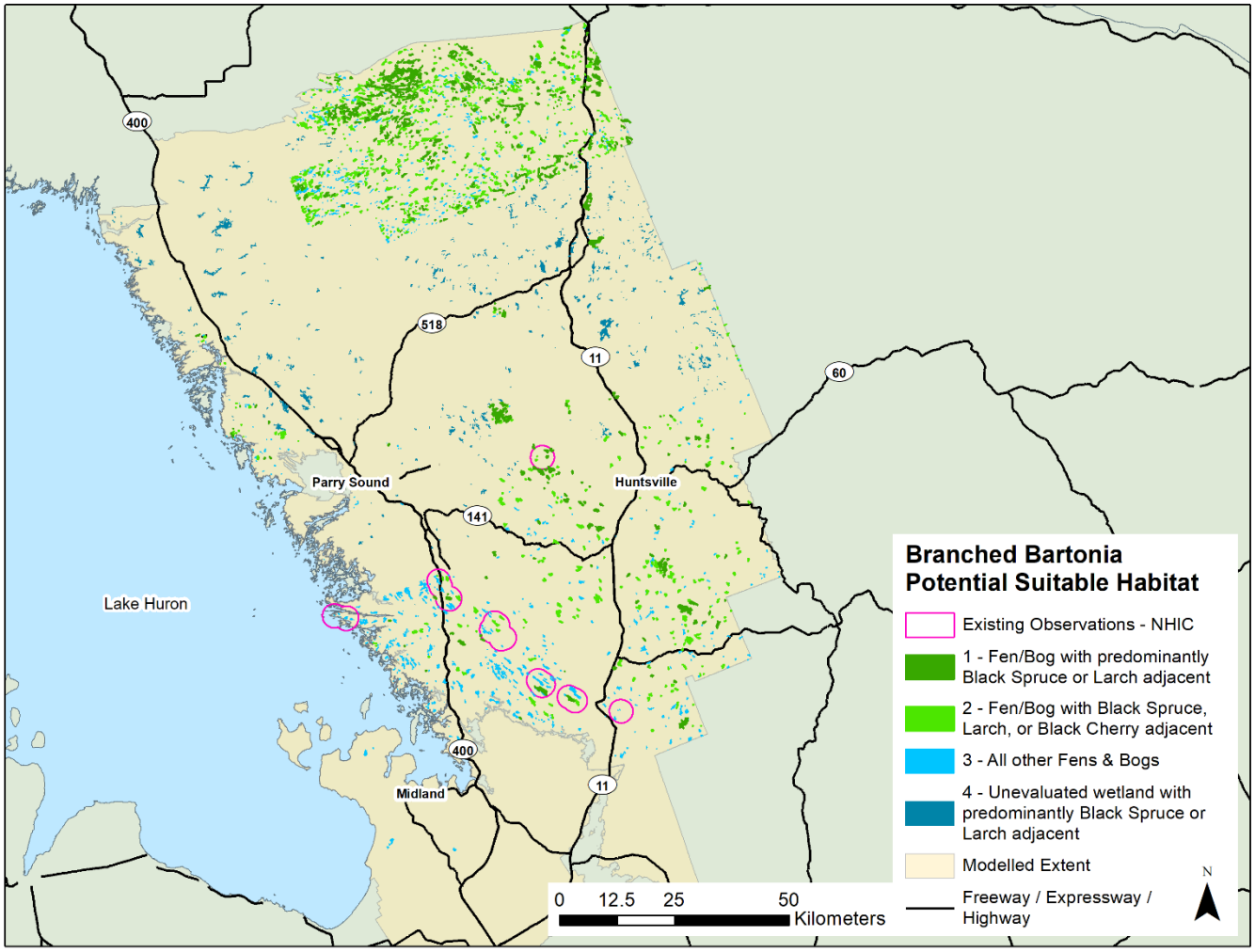

Figure 10. Potentially suitable habitat mapping for Branched Bartonia in Ontario completed by North-South Environmental Inc. and Blazing Star in 2022.

4.4. Presence/No Detection Surveys

Branched Bartonia typically grows in clusters of individuals but may be sparsely distributed within a particular area of a site. The aim of presence/no detection surveys is to determine if Branched Bartonia is present or absent within a given area. Branched Bartonia is restricted to fens and bogs so only wetland communities need to be surveyed. Due to the sensitivity of the habitat a formal transect method covering the entirety of the area is not recommended; however, a systematic approach to a targeted search (e.g., starting on one side and making your way across the suitable habitat) is recommended to avoid undue trampling.

4.4.1. Method

A systematic controlled intuitive search method should be used to survey or monitor Branched Bartonia. This method of intuitive search requires that the surveyor(s) be very familiar with plant identification, have a search image for Branched Bartonia's growth habit and knowledge of the various habitat and microhabitat preferences of this species. Surveyors completing a controlled intuitive search should walk through the areas of potentially suitable habitat and target the areas that appear most optimal for Branched Bartonia. Typically, this includes large open areas dominated by *Sphagnum* and with sparse cover of tall woody species. Hummocks, edges of mammal trails, and edges of depressions should be searched. However, the plant can occur on flat open sphagnum mats, under small clumps of shrubs or trees or growing at the base of dense ferns or sedges. It is best to look everywhere as you walk between the most optimal areas.

It is recommended that the targeted search be completed somewhat systematically to reduce impacts of trampling and minimize overlap between surveyors. The survey route should be recorded with GPS track log or comparably accurate track log for data collection programs on tablets/cellphones (e.g., ArcGIS Field Maps, etc.). If multiple surveyors are present, they should either divide the area in subsections assigned to each individual, walk through the habitat a few metres apart at a similar pace or start at opposite ends of the suitable habitat and work inward to avoid overlap and excessive trampling. Surveyors should remain in contact (and optimally within sight) during the survey for safety and to better ensure that effort is not duplicated. Surveyors should scan for Branched Bartonia on either side of them and in front of them as they walk.

When Branched Bartonia is located the immediate (within 5 to 10 m) area where it was found should be searched more thoroughly to find additional stems. A clicker counter should be used to record the total number of stems at the site. A polygon should be recorded around the area where Branched Bartonia occurs at the site by recording the coordinates of the outermost occurrences. If distinctly separate areas of the site have Branched Bartonia (e.g., most northern and most southern end of a wetland but not anywhere in between), separate polygons should be recorded. A high accuracy GPS unit is recommended.

Site name, site location, a general habitat description and a description of observed or potential threats should be recorded for each wetland where Branched Bartonia surveys occur. A data sheet has been provided in **Appendix 1**. Surveyors should use this datasheet as a guideline for the minimum amount of data to collect; however, the datasheet may be revised to include additional data for specific survey needs or may be used to develop a digital data collected platform. Survey results, regardless of a positive or negative result, should be reported as outlined in **Section 4.7**.

4.5. Long-term Monitoring

Long-term monitoring tracks the abundance and distribution of Branched Bartonia stems at a site. Any inventory that completes a thorough search of one or more Branched Bartiona subpopulations and collects data consistent with this methodology should be considered part of long-term monitoring.

Long-term monitoring is necessary to observe population trends and can be particularly challenging to implement for annual/biennial species that may have variable abundance, distribution and location from year to year. Long-term monitoring is more intensive and costly but is necessary to improve our knowledge of the species life history and demographics. Long-term monitoring is necessary to assess the need for management actions as well as to determine their success. Data collected can include population abundance, individual health (or a representation of health such as plant height or number of flowers), pollinators, reproductive success, habitat condition and threats. Initial surveys for the species should follow the detection protocol outlined in **Section 4.4**.

A complete search of the site to locate additional individuals/patches should occur at least once every ten years but monitoring within the ten-year period may focus on the area of previous record.

4.5.1. Method

Long-term monitoring of sites with existing records of Branched Bartonia goes beyond counting site wide abundance. The goal of long-term monitoring is collecting data in a repeatable manner and standardizing it so it can be compared over time.

To collect abundance data a systematic controlled intuitive search should be used. As with the presence/no detection surveys, all surveyors mush be familiar with the species and its habitats. It is still recommended that the targeted search be completed somewhat systematically to reduce impacts of trampling and minimize overlap between surveyors. The survey route must be recorded with GPS track log or comparably accurate track log for data collection programs on tablets/cellphones (e.g., ArcGIS Field Maps, etc.). If multiple surveyors are present, they should either, divide the area in subsections assigned to each individual, walk through the habitat a few metres apart at a similar pace or start at opposite ends of the suitable habitat and work inward to avoid overlap and excessive trampling. Surveyors should remain in contact (and optimally within sight) during the survey for safety and to better ensure that effort is not duplicated. Surveyors should scan for Branched Bartonia on either side and in front of them as they walk.

When Branched Bartonia is located the immediate (within 5 to 10 m) area where it was found should be searched more thoroughly to find additional individuals. In contrast with the presence/no detection survey method, long-term monitoring records location and abundance of each patch of Branched Bartonia within the site. A clicker counter should be used to record the number of stems in each patch (all stems occurring within 10 m of the nearest plant). GPS co-ordinates, abundance and patch size should be recorded separately for each individual/patch separated by 10 m or more. Where Branched Bartonia occurs consistently over a large area (greater than 10 x 10 m) the polygon should be recorded as the coordinates of the outermost stems. The centroid of the patch or waypoint of isolated stems should be recorded on the datasheet so that the data collected can be related to the correct polygon. A high accuracy GPS unit is required.

Mapping of long-term monitoring data should illustrate abundance and distribution across the site to show changes in abundance, plant density and location over time. To standardize the data across time a variety of data should be calculated and reported including the size of occupied area (m^2), the total abundance at the site, the number of stems divided by wetland area, the number of stems divided by survey track length and number of stems located per person hour should be calculated and reported. These calculations are meant to standardize the data so that it is comparable over time and accounts for variables including survey effort (duration and distance).

Site name, site location, a detailed habitat description according to Ecological Land Classification methods and a description of observed or potential threats should be recorded for each wetland. A data sheet has been provided in **Appendix 2**. Surveyors should use this datasheet as a guideline for the minimum amount of data to collect; however, the datasheet may be revised to include additional data for specific survey needs or may be used to develop a digital data collected platform. Survey results, regardless of a positive or negative result, should be reported as outlined in **Section 4.7**.

4.5.1.1. Permanent Marking

Branched Bartonia is an annual species and individuals may not appear in the same exact locations. Permanently marking individuals is not necessary or useful. However, a permanent marker (e.g., pigtail stakes with a numbered tag and flagging tape, or flagging tape in a shrub or tree) can be placed at the at the centroid of the occurrence or centroid of the patch with highest abundance to aid surveyors in relocating the area of suitable habitat, the general location where Branched Bartonia has occurred and/or photo monitoring locations (**Figure 11**). To avoid excessive markers in the habitat, surveyors should consider not permanently marking additional patches or isolated individuals. The location of the permanent marker should be recorded using a high accuracy GPS device.

Figure 11. Examples of pigtail stakes marking Branched Bartonia patches. Photos by P.K. Catling.

4.5.1.2. Temporary Marking

Temporary marking may be desired for a particular study where repeated visits to the site are necessary (e.g., fruit set or seed set study, pollination study, etc.). Temporary marking is time consuming but can be beneficial for ensuring individuals are not trampled or missed during counting. Temporary marking can also be used with a photographic record to document plant distribution within the habitat. Seeing the distribution of markers within the habitat will give the surveyor an understanding of the distribution and microhabitat preferences. Once all individuals have been marked, photos should be taken of the area where Branched Bartonia occurs looking in every compass direction from the centroid of the patch so that changes in abundance and distribution can be documented over time.

If temporary marking is desired, all Branched Bartonia individuals or a subset of individuals may be temporarily marked as they are located (see example in **Figure 12**). Temporary markers (e.g., thin survey flags) should be placed approximately four centimeters away from the base of each plant to prevent damage to it. Temporary markers must be removed during the final site visit of the monitoring program and not left overwinter. Temporary marking may not be ideal for sites with high abundance.

Figure 12. Branched Bartonia stems temporarily marked with survey flags. Photo by P.K. Catling.

4.5.2. Associated Plant Community

The Ecological Land Classification system for southern Ontario's vegetation community description framework should be used to describe the associated plant community (e.g., Lee et al. 1998). For each community in which Branched Bartonia is present, the ELC community boundary should be mapped, and the dominant species and cover of each vegetation layer should be recorded. Indicators of rich fen (see Harris et al. 1996), that help to classify the fen's nutrient enrichment, should particularly be recorded as it is important to monitor changes such as enrichment within the habitat. It is also important to record indicator species of marsh, that may indicate an increase in organic nutrients such as nitrogen. Changes in the surrounding community that could contribute to changes in hydrology or nutrients (such as residential housing, roads or other development) should also be recorded.

Species considered invasive in Ontario based on Weediness Index[1], exotic status (SE5) in the NHIC Database[2] or other invasive species list[3], should be noted. The abundance of all invasive species in the area of suitable habitat should be estimated (1 = 1-2 plants, 2 = 3-5, 3 = 6-20, 4 = 21-50, 5 = 51-100, 6 = 100+) and distribution described (L=localized, O=occasional, P=scattered patches, W=widespread). Location of invasive species should be recorded using a GPS or tablet. Polygons of larger patches of invasive species may be delineated. Proximity to Branched Bartonia should be noted.

4.5.3. Evaluating Threats

All threats to the habitat and species in and adjacent to the area of occurrence should be noted and described in sufficient detail to facilitate threat ranking according to the COSEWIC guidelines for evaluating threats (COSEWIC 2012). Lead surveyors should review pages 9-12 of the COSEWIC guidelines for threats classification to become familiar with this ranking system (COSEWIC 2012). Where possible, the location and extent of threats should be mapped using a GPS or tablet. Where threats are not mappable (e.g., changes in hydrology, widespread distribution of an invasive plant species, evidence of widespread herbivory), they should be described. Adjacent land-uses should also be described.

4.6. Survey Effort and Repetition

Survey effort will be directly related to the amount of suitable habitat present at a site, the visibility within the vegetation community present and the abundance of Branched Bartonia. Branched Bartonia is very small and may be overlooked even when in bloom. Vegetation communities with a higher abundance of shrubs, ferns and sedges can be expected to take longer to survey due to poorer visibility.

A slow walking pace (<4 km per hour) should be employed during surveys to optimize chances of noticing this species. For example, a site like Mac Tier Fen, which is a 42.4 ha wetland (not all of which is suitable for Branched Bartonia) may take approximately 17 km to walk all the potentially suitable habitat. This means the Mac Tier Fen site would take between 8.5 and 4.5 hours to survey if the goal is simply to detect and record Branched Bartonia and surveyors walk a consistent pace of between 2 to 4 km per hour. However, recording data causes surveyors to stop frequently and this site can take two full days to completely monitor since there is a fairly high abundance of Branched Bartonia.

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[1] Oldham et al. 1995. Floristic Quality Assessment System for Southern Ontario. Natural Heritage Information Centre, Ontario Ministry of Natural resources. Peterborough, ON. 17pp.
[2] NHIC Database Available at: https://www.ontario.ca/page/get-natural-heritage-information
[3] Such as those developed by conservation authorities: CVC Invasive Species Lists and Factsheets https://cvc.ca/wp-content/uploads/2012/09/cvc-appendix-landowners-guide-to-invasives.pdf

It is important to consider the goal of the survey when budgeting and planning site visits. If it is a potentially suitable site with no previous records, it may be worth taking the time to fully survey the site as Branched Bartonia can be present in small inclusions within larger wetland areas (Catling et al. 2024). If the goal of monitoring is to confirm that Branched Bartonia is still present without specific regard for abundance, then surveys can be completed more rapidly. If the desire is to monitor abundance over time the site should be surveyed completely according to the long-term monitoring protocol.

It is uncertain if Branched Bartonia can persist in the seed bank and germinate when conditions become favourable. The absence of Branched Bartonia individuals in one year is not sufficient to conclude that the species is absent from a site. If the purpose of the survey is to assess presence due to potential impact to the species, a minimum of three consecutive years of surveys with negative results should be used to increase the probability that Branched Bartonia is absent from the survey area. Negative search results from this type of survey should not be used to indicate absence at the site unless the search effort is sufficient to cover the entirety of the site, surveyors are experienced, **and** the surveys have been completed for multiple consecutive years.

4.7. Reporting

Datasheets for consistent surveying have been provided in **Appendix 1** (presence/no-detection survey) and **Appendix 2** (long-term monitoring survey). Branched Bartonia records and incidental observations of other SAR or other provincially tracked species encountered during surveys should be reported to NHIC.[4] The NHIC is Ontario's conservation data centre and maintains the provincial record of Ontario's rare animals, plants and plant communities. Information regarding the absence of Branched Bartonia at a site is important as well and should also be submitted to the NHIC. Data should be submitted in digital format (e.g., spreadsheet or shape files with associated tabular data) as per the instructions on NHIC's website.[5] The local OMNRF/OMECP office should also be provided with a copy of the data submitted to NHIC.

If survey work is completed within a provincial park or conservation reserve, reporting requirements will be defined in the authorization to conduct the work. Additional reporting required by MECP, NCC, conservation authorities and/or municipalities should follow requirements of these individual permits. Landowners or managers should be made aware of Branched Bartonia on their property to promote its preservation. Reporting requirements or expectations for work completed on First Nations land should be established in consultation with the band council and any protocols for data

[4] www.ontario.ca/nhic
[5] https://www.ontario.ca/page/report-rare-species-animals-and-plants

transfer and use of data are to be followed. Distribution of data collected from First Nations lands is at the discretion of the band.

The following should be recorded and reported for each Branched Bartonia survey regardless of positive or negative results:

- time and date of survey,
- name of surveyor(s),
- contact information of lead surveyor,
- a summary of surveyor(s) qualifications,
- location description and directions,
- GPS tracks for each surveyor,
- shapefiles or other digital data associated with mapping,
- type of GPS unit used and its range of accuracy,
- start and end time of the survey,
- survey effort (duration, number of surveyors and area covered) for each site,
- photos of the habitat,
- a statement on habitat suitability (i.e., are there threats impacting suitability, has habitat changed and influenced presence of branched Bartonia, etc.),
- an assessment of whether additional surveys are warranted and a detailed description or mapping of areas where future surveys should be focused, and
- survey results (positive, negative, number of stems, etc.).

The following should be reported for each Branched Bartonia subpopulation located:

- map of the area of occurrence and survey tracks,
- coordinates, type and tag numbers of permanent markers, if implemented,
- photos and coordinates of photo monitoring station, if implemented,
- photographic vouchers of each occurrence including vital identification features and habitat photos,
- count of total stems at the site,
- count of stems in each patch (only for long-term monitoring),
- number of stems divided by wetland area,
- scans of datasheets or digital data files if collected via tablet,
- vegetation community description according to Ecological Land Classification; and
- a description and locations of observed or potential threats.

The following should be reported where long-term monitoring is implemented:

- waypoint(s) of patch centroids and individual locations waypoint(s),
- map of patch polygon(s) and individual locations with abundance,

- count of stems in each patch,
- number of stems divided by the wetland area,
- number of stems divided by survey track length, and
- number of stems located per person hour.

4.7.1. Voucher Specimens

Conservation of SAR plants should be of primary concern when considering collecting; however, it is also important to ensure new locations are verifiable and supported by sufficient data, such as voucher specimens, and confirmed by experts. Permits under the ESA are required for the collection of Branched Bartonia and it is recommended that the Project Lead acquire the appropriate permits for collection prior to completing presence/ no detection surveys in case collection is required. Photos that clearly document all the identification features may be submitted to NHIC or herbaria as an alternative to collection of a voucher specimen. If identification is in doubt, photo evidence documenting all identification characteristics should be taken and sent to experts for confirmation.

To prevent over-collection of this species, voucher specimens should only be considered at sites with no previous records. At sites where Branched Bartonia has not been previously recorded, a voucher specimen may be considered depending on the abundance of the occurrence. If less than twenty plants occur at a site, extensive georeferenced photo evidence should be taken in place of voucher specimens. If the number of plants is between twenty to fifty, a voucher specimen may include one individual. If more than fifty plants occur at a site, voucher specimens may optionally include a few individual plants.

Voucher specimens should be submitted to an herbarium with the following information provided:

- collector name,
- identifier name,
- collection date,
- location in GPS coordinates,
- location description,
- details on abundance, and
- a general habitat description including associate species.

Material collected from different individuals should be kept separate and submitted as separate collections. A recommended datasheet to fill out for collecting voucher specimens is provided in **Appendix 3**. This should be considered a baseline for the minimum data collected and may be modified to suit digital formats or for the collection of additional data.

5. Glossary

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee established under section 14 of the *Species at Risk Act* that is responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act*, 2007 that is responsible for assessing and classifying species at risk in Ontario

Conservation Ranks- Conservation ranks are designations assigned by NatureServe or local scientists to define how rare a species or ecological community is on the global, national, provincial and local levels. Ranks are determined by NatureServe (NatureServe 2022) and, in the case of Ontario's S-rank, by Ontario's Natural Heritage Information Centre (NHIC 2021). The conservation status of a species or ecosystem is designated by a number from 1 to 5 or the letter(s) X, H or NR, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

- X Presumed Extinct (species) – Not located despite intensive searches and virtually no likelihood of rediscovery. Presumed Eliminated (ecosystems, i.e., ecological communities and systems) – Eliminated throughout its range, due to loss of key dominant and characteristic taxa and/or elimination of the sites and ecological processes on which the type depends.
- H Possibly Extinct (species) or Possibly Eliminated (ecosystems) – Known from only historical occurrences but still some hope of rediscovery. Examples of evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct or eliminated throughout its range.
- 1 Critically Imperiled – At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
- 2 Imperiled – At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
- 3 Vulnerable – At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
- 4 Apparently Secure – At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.

- 5 Secure – At very low risk or extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
- NR Not yet ranked- This species has not yet been evaluated.

Local conservation ranks assigned by a municipality, region or conservation authority may differ from the above.

6. List of Abbreviations

COSEWIC: Committee on the Status of Endangered Wildlife in Canada
COSSARO: Committee on the Status of Species at Risk in Ontario
ECCC: Environment and Climate Change Canada
ESA: Ontario's *Endangered Species Act, 2007*
MECP: Ministry of the Environment, Conservation and Parks
MNRF: Ministry of Natural Resources and Forestry
NCC: Nature Conservancy of Canada
SARA: Canada's *Species at Risk Act*
SARO List: Species at Risk in Ontario List

7. Authorities Consulted

Bakowsky, Wasyl. Ecologist. Natural Heritage Information Centre, Ministry of Northern Development, Mines, Natural Resources and Forestry, Peterborough, Ontario. Email correspondence with P.K. Catling on April 5, 2022.

Brinker, Sam. Botanist, Natural Heritage Information Centre, Ministry of Northern Development, Mines, Natural Resources and Forestry, Peterborough, Ontario. Video call correspondence with P.K. Catling on May 9, 2022.

Brownell, Vivian. Retired Species at Risk Biologist, Ministry of Northern Development, Mines, Natural Resources and Forestry, Peterborough, Ontario. Phone call with P.K. Catling on April 8, 2022.

Rouse, Jeremy. District Biologist, Ministry of Northern Development, Mines, Natural Resources and Forestry, Parry Sound, Ontario. Video call correspondence with P.K. Catling on April 4, 2022.

8. Collections Examined

Vascan [6] and GBIF[7] were searched for digitized herbarium specimens from Ontario. No herbarium specimens had digitized photos and records were assumed to be correctly identified. Data from the following was examined and are assumed to be included in existing subpopulation records as no location data is provided in the digital record.

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[6] https://www.canadensys.net/occurrence/search?taxonKey=7221890
[7] https://www.gbif.org/occurrence/map?country=CA&dataset_key=50c9509d-22c7-4a22-a47d-8c48425ef4a7&dataset_key=0348540a-e644-4496-89d3-c257da9ad776&dataset_key=1e61b812-b2ec-43d0-bdbb-8534a761f74c&taxon_key=7221890

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APPENDIX 1 | Presence/ No Detection Data Sheet

Branched Bartonia: Survey Data Form

DATE _____ **SURVEYOR (S)** _____

SITE NAME _____

COUNTY/DISTRICT _____

NEAREST TOWN/CITY _____ **START TIME**_____ **END TIME** _____

CENTROID_____ **TOTAL TIME** _____ **PERSON HOURS** _____

GPS UNIT _____ **GPS ACCURACY**_____M

LOCATION DESCRIPTION

_____

_____

_____

SURVEY TYPE ☐ Monitoring of previous occurrence ☐ Search of suitable habitat

WAS BRANCHED BARTONIA LOCATED? ☐ Yes ☐ No **ABUNDANCE** _____

BRANCHED BARTONIA AREA OF OCCURRENCE _____M^2 **CENTROID** _____

SEARCH EFFORT COMMENTS:

_____

_____

_____

HABITAT DESCRIPTION:

_____

_____

_____

_____

_____

_____

OTHER SAR/ SPECIES OF CONSERVATION CONCERN:

SPECIES	COORDINATS	ABUNDANCE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

INVASIVE SPECIES:

SPECIES	COORDINATS	ABUNDANCE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

SITE NOTES (MANAGEMENT, THREATS, ETC.):

_____

_____

_____

_____

APPENDIX 2 | Long-term Monitoring Data Sheets

Branched Bartonia: Survey Data Form

DATE _____ **SURVEYOR (S)** _____

SITE NAME _____

COUNTY/DISTRICT _____

NEAREST TOWN/CITY _____ **START TIME**_____ **END TIME** _____

CENTROID_____ **TOTAL TIME** _____ **PERSON HOURS** _____

GPS UNIT _____ **GPS ACCURACY**_____M

LOCATION DESCRIPTION

_____

_____

_____

SURVEY TYPE ☐ Monitoring of previous occurrence ☐ Search of suitable habitat

WAS BRANCHED BARTONIA LOCATED? ☐ Yes ☐ No **ABUNDANCE** _____

BRANCHED BARTONIA AREA OF OCCURRENCE _____M^2 **CENTROID** _____

SEARCH EFFORT COMMENTS:

_____

_____

_____

HABITAT DESCRIPTION:

_____

_____

_____

_____

_____

_____

OTHER SAR/ SPECIES OF CONSERVATION CONCERN:

SPECIES	COORDINATS	ABUNDANCE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

INVASIVE SPECIES:

SPECIES	COORDINATS	ABUNDANCE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

SITE NOTES (MANAGEMENT, THREATS, ETC.):

_____

_____

_____

_____

Branched Bartonia: Monitoring Data Form

DATE ________________________________ **SITE NAME** ____

SURVEYOR (S) ____ ____

INDIVIDUAL/PATCH LOCATIONS

WAYPOINT #	EASTING	NORTHING	TOTAL # STEMS	PATCH SIZE (M^2)	NOTES (INDICATION OF POOR HEALTH, INSECTS, ETC.)

NOTES

APPENDIX 3 | Voucher Specimen Data Sheet