

Recovery Strategy for the Round-leaved Greenbrier (*Smilax rotundifolia*), Great Lakes Plains population, in Canada

Round-leaved Greenbrier



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¹ <http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1>

Preface

The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#)² agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Round-leaved Greenbrier, Great Lakes Plains population, and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Ontario Ministry of Natural Resources and Forestry, as per section 39(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Round-leaved Greenbrier, Great Lakes Plains population, and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area³ be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

² <http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2>

³ These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Bird Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgments

Judith Jones (Winter Spider Eco-Consulting) drafted this recovery strategy, with supervision from Lauren Strybos (Canadian Wildlife Service – Ontario). Development of the recovery strategy was facilitated by Judith Girard, Marie-Claude Archambault and Karissa Reischke (Canadian Wildlife Service – Ontario). An earlier version of the document was prepared by Jarmo Jalava and the Carolinian Woodlands Recovery Team in 2007. The following people are gratefully acknowledged for sharing information on this species: John Ambrose (Cercis Consulting), Albert Garofalo (Niagara Falls Nature Club), David Holmes (Long Point Region Conservation Authority), Dan Lebedyk (Essex Region Conservation Authority), Amy Parks (Niagara Region Conservation Authority), and Joyce Sankey (Niagara Falls Nature Club). The recovery strategy benefited from input, review, and suggestions from the following individuals: Ken Corcoran, Angela McConnell, Christina Rohe, John Brett, and Lee Voisin (Canadian Wildlife Service – Ontario), Kim Borg (Canadian Wildlife Service), Eric Snyder, Jay Fitzsimmons, Leanne Jennings, Sam Brinker and Vivian Brownell (Ontario Ministry of Natural Resources and Forestry). Albert Garofalo is thanked for providing photos of Round-leaved Greenbrier.

Acknowledgement and thanks is given to all other parties that provided advice and input used to help inform the development of this recovery strategy including various Indigenous organizations and individuals, individual citizens, and stakeholders who provided input and/or participated in consultation meetings.

Executive Summary

In Canada, Round-leaved Greenbrier (*Smilax rotundifolia*) occurs in Ontario (Great Lakes Plains population) and in southwestern Nova Scotia (Atlantic population). This recovery strategy addresses only the Great Lakes Plains population which is listed as Threatened under both Schedule 1 of SARA and the Ontario *Endangered Species Act 2007* (ESA). The Atlantic population is listed as Not at Risk on Schedule 1 of the *Species at Risk Act* (SARA). NatureServe ranks the species as Vulnerable (N3) in Canada and Imperiled (S2) in Ontario, where it occurs in Essex and Norfolk Counties and in the Niagara Region. There are 16 known extant or presumed extant local populations and one extirpated local population in Ontario.

Round-leaved Greenbrier is a long-lived perennial vine with long stems that climb with tendrils up into trees or form tangles over the ground. At the base, the stems are woody, while above they are armed with stout prickles. The oval- to heart-shaped leaves are alternate and have arching parallel veins. The fruit is a berry eaten by birds and mammals, and dispersed in their droppings.

This genus is dioecious (male and female flowers on separate plants) and both male and female plants must be present for fruit production. Currently, at least four local populations in Ontario are thought to contain only one sex. The factors controlling which sex is expressed and the reason for biased sex ratios are not known. In Ontario, Round-leaved Greenbrier is found in the understory and openings in moist to wet Carolinian forest. These forests have been described as Lowland Red Maple-Mixed Oak Forest or Mixed Oak Forest.

The primary threats to Round-leaved Greenbrier include residential, industrial, and commercial development, high-intensity logging, and alterations to the moisture regime. These threats can be addressed by standard land use planning, habitat stewardship and habitat protection measures. The level of risk posed by invasive species is unknown, but if necessary can be addressed through best management practices (BMPs).

The population and distribution objectives are to: maintain the species' distribution (including any new local populations that are discovered) and to maintain or, where necessary and technically and biologically feasible, increase abundance, at the 16 extant and presumed extant local populations. The broad strategies to be taken to address the threats to the survival and recovery of Round-leaved Greenbrier are presented in the section on Strategic Direction for Recovery (Section 6.2).

Critical habitat is identified as wooded area occupied by Round-leaved Greenbrier, including all contiguous wooded habitat around Round-leaved Greenbrier plants. Critical habitat identified for Round-leaved Greenbrier meets the population and distribution objectives, and a schedule of studies is not included. One or more action plans for Round-leaved Greenbrier will be completed by 2024.

Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, there are unknowns regarding the feasibility of recovery of the Round-leaved Greenbrier, Great Lakes Plains population. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be technically and biologically feasible. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

1. *Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.*

Unknown. It is estimated there are 1000 to 5000 crowns (multi-stemmed clusters) of Round-leaved Greenbrier, Great Lakes Plains population, in Canada. However, it is unknown how many individual plants this represents, because with many stems per crown it can be difficult to distinguish one crown from another. COSEWIC (2007) estimated that there may be fewer than 250 individuals in Canada. Plants of this species are dioecious, meaning that each individual produces either only male or only female flowers at one time. Of the seven local populations for which information on sex status is available, only three are known to have both sexes present, and are therefore capable of sexual reproduction. The other four are thought to contain only a single sex, and are therefore only capable of vegetative reproduction. No seedlings of Round-leaved Greenbrier have been reported in recent surveys (Ambrose 1994; COSEWIC 2007).

2. *Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.*

Yes. The Great Lakes Plains population of Round-leaved Greenbrier is found in Ontario in moist to wet Carolinian forest. While Carolinian forest habitat is limited in Ontario due to historical harvesting, there are still remnant areas of suitable moist to wet forest in regions where Round-leaved Greenbrier occurs. Some are in conservation ownership and are protected from further land conversion. As well, there is additional unoccupied suitable habitat available in some forests where Round-leaved Greenbrier already occurs.

3. *The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.*

Yes. The primary threat to the Great Lakes Plains population of Round-leaved Greenbrier is from habitat loss due to development. This can be curtailed through land use planning and by working with planning authorities, to prevent destruction of this plant's Carolinian forest habitat. Other important threats include high-intensity logging and changes in moisture regimes, which can be mitigated by stewardship and protection of Round-leaved Greenbrier habitat. The level of risk posed by invasive

species is unknown, but if invasive species prove problematic, they can be managed with standard best-management practices (BMPs).

4. *Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.*

Yes. Standard techniques to reduce threats, such as habitat management, stewardship and protection, and the use of land use planning, policy, and outreach and education will help to protect existing local populations and individuals of Round-leaved Greenbrier, Great Lakes Plains population. Researching and implementing measures to establish sexually reproducing local populations will be necessary to improve resilience of the species. This may include augmenting single-sex local populations with individuals of the opposite sex, and researching factors influencing seedling survival.

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2007

Common Name (population): Round-leaved Greenbrier - Great Lakes Plains population

Scientific Name: *Smilax rotundifolia*

COSEWIC Status: Threatened

Reason for Designation: The species is currently known from 13 highly fragmented populations in Ontario's Carolinian Zone. Four populations have been found since the previous COSEWIC assessment due to more extensive surveys, and although no population was lost, habitat declines have occurred. Population size and trend are poorly known due to the clonal nature of the species. Many Ontario populations appear to have plants of only one sex and therefore cannot produce seed. The plants, however, are vigorous, long-lived and resistant to habitat changes.

Canadian Occurrence: Ontario

COSEWIC Status History: Designated Threatened in April 1994. Status re-examined and confirmed in May 2001 and November 2007.

*COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

In Canada, Round-leaved Greenbrier (*Smilax rotundifolia*) occurs in Ontario (the Great Lakes Plains population) and also in southwestern Nova Scotia (the Atlantic population). The Atlantic population is assessed by COSEWIC as Not at Risk⁴ in Canada. Unless otherwise noted, this recovery strategy addresses only the Great Lakes Plains population which is listed as Threatened⁵ on Schedule 1 of the federal *Species at Risk Act* (SARA). Round-leaved Greenbrier is also listed as Threatened⁶ in Ontario under the Ontario *Endangered Species Act, 2007* (ESA), and receives general habitat protection in the province as of June 30, 2013. Globally, the species is listed as Secure (G5) (NatureServe 2015a). In the U.S., this species occurs in 34 states in the eastern and central part of the country. NatureServe (2015a) lists the species as Secure (S5) in all the states where it is given a rank, except Illinois, where it is listed as Vulnerable (S3?⁷). Kartesz (2015) lists the species as 'not rare' throughout its range in the U.S. Appendix A shows NatureServe rankings for Round-leaved Greenbrier throughout its range. It is

⁴ A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.

⁵ A wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

⁶ A species that lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening to lead to its extinction or extirpation.

⁷ ? denotes an inexact numeric rank i.e. rank is believed most likely to be S3, but there is a significant chance the rank is actually S2 or S4 (Master et al. 2012)

estimated that Canada holds less than 5% of the global range of the species (Great Lakes Plains population and Atlantic populations combined).

3. Species Information

3.1 Species Description

Round-leaved Greenbrier is a perennial⁸ vine that forms crowns⁹ of long stems that climb with tendrils¹⁰ and may grow over shrubs and up into trees to a height of 5 m or more (Holmes 2002) (Figure 1). It may also form tangles of long, branched stems over the ground. It spreads vegetatively¹¹ by growing shoots from rhizomes¹² and stolons¹³. This species is a long-lived plant with stems that become woody at the base and which are armed with stout, flattened greenish prickles (Figure 2). The oval to heart-shaped leaves are alternate¹⁴ and have large arching parallel veins. The plants produce clusters of small (8 to 10 mm diam.), greenish flowers that grow on stalks about 1.5 cm long. Round-leaved Greenbrier is a dioecious plant, meaning that each plant produces only male or female flowers at a given time. In Ontario, flowering occurs from late May to mid-June (Ambrose 1994; COSEWIC 2007). The fruit is a round, blue-black, fleshy berry about 8 mm in size (Holmes 2002).

Round-leaved Greenbrier may be confused in the field with Bristly Greenbrier (*S. tamnoides*), which is the only other woody greenbrier in southern Ontario. Round-leaved Greenbrier may be identified by the widely spaced stout prickles on the stems, which are not bristly (Figure 2); by the stalk of the fruit cluster which is about as long as the leaf stalks but no longer; and by having usually fewer than 12 flowers or fruits in a cluster (Ambrose 1994; Holmes 2002).

⁸ A plant that lives for more than two years.

⁹ A crown is a multi-stemmed cluster that may be considered an "individual" for abundance purposes, but which may or may not be physically separated from other such individuals.

¹⁰ A slender stem-like structure that is used by climbing plants to wrap around or to hook a support. In *Smilax* sp., tendrils develop from a stipule (outgrowths from the leaf base).

¹¹ A form of asexual reproduction where new organisms form without seeds or spores.

¹² A horizontal underground stem which can send out both shoots and roots.

¹³ A stem which grows at the soil surface or just below ground that produce roots and new plants.

¹⁴ Leaves alternate sides along the stem and one leaf grows from each node on the stem.



Figure 1. Climbing habitat of Round-leaved Greenbrier showing a crown of many stems at the base. (Photo: Albert Garofalo).



Figure 2. Stem of Round-leaved Greenbrier showing stout prickles and no smaller bristles.
(Photo: Albert Garofalo).

3.2 Species Population and Distribution

The Great Lakes Plains population of Round-leaved Greenbrier occurs only in southern Ontario in three regions: Essex County, Norfolk County, and in the Niagara Region (COSEWIC 2007) (Figure 3). In addition to this, Soper and Heimburger (1990) report the species as also known from Kent and Middlesex counties. However, reports from these two counties are unsubstantiated as no documented basis for these reports has been found (COSEWIC 2007; Oldham pers. comm. 2016). A specimen from 1895 collected from Morris Township, Huron County is listed in the database of Canadensys (2016) and housed in the herbarium of the University of British Columbia. It is labeled *Smilax rotundifolia*. A digital image of this specimen shows a plant with a bristly stem, no stout prickles, and long stalks to the flower clusters. This appears to be a specimen of Bristly Greenbrier (*Smilax tamnoides*) that has been misidentified (Oldham pers. comm. 2016). There is no evidence that Round-leaved Greenbrier was ever more abundant or widespread in Ontario (COSEWIC 2007).

A list of local Ontario populations and their locations is shown in Table 1. There are a total of 17 known local populations; ten extant, six historical¹⁵ and one extirpated. The extirpated local population, located at Point Pelee (local population # 14, Table 1), is known from a single specimen collected in 1881 (COSEWIC 2007). The six historical local populations have not been confirmed for at least 20 years. However, Round-leaved Greenbrier is a long-lived species (life-span estimated up to at least several decades, and perhaps even centuries; COSEWIC 2007), so a lack of confirmation for 20 years or more does not mean that the species is no longer present, if the habitat it lives in remains suitable. All of the local populations that have been revisited and thoroughly surveyed have proved to be extant (COSEWIC 2007), so there is no evidence of recent extirpation of this species. Best available information indicates that forested habitat remains at the location of each of these local populations, so the six historical local populations are presumed extant for the purposes of this report.

Three local populations listed in Table 1 were not known at the time of the last COSEWIC assessment (COSEWIC 2007). Bowman's Woods West (local population # 15) and Heartland Forest (local population # 16) have been recently discovered by members of the Niagara Falls Nature Club (Garofalo pers. comm. 2016; Sankey pers. comm. 2016). It is likely that these local populations have existed for many years, but have only recently been observed and reported. McLeod Road (local population # 17), has been identified as a historical local population based on Natural Heritage Information Centre (NHIC) records (NHIC 2016). It is possible that additional local populations will be found in the future, but the limited amount of suitable habitat remaining for this species, and high rates of forest loss to urbanization in southern Ontario make it unlikely that a large number of unknown local populations exist in this region.

At the last status assessment, COSEWIC estimated that there are 1000 to 5000 crowns of Round-leaved Greenbrier in Canada. The three local populations found since that assessment are small relative to the variation in this estimate (Table 1, local populations # 15, 16 and 17), so the estimate of 1000 to 5000 crowns continues to be valid. However, it is uncertain how many individuals this may represent because with many stems per crown it can be difficult to distinguish one crown from another. COSEWIC (2007) estimated that there may be fewer than 250 genetically distinct individuals in Canada.

Ambrose (1994) hypothesized that the present Ontario distribution of Round-leaved Greenbrier reflects the likely paths of post-glacial migration of plant species across the two land bridges around Lake Erie, and that the current distribution of Round-leaved Greenbrier as isolated small patches is the result of a single dispersal event or only very few events. Why birds have not dispersed the species over a larger area is not known.

¹⁵ NatureServe (2015b) considers an occurrence (or local population) historical when recent field information verifying continued existence of the occurrence is lacking. In the absence of known disturbance, and with habitat still extant, NatureServe generally recommends a rank of historical for occurrences that have not been confirmed for between 20-40 years (NatureServe 2015b). However, this does not imply that these local populations are extirpated.

No seedlings of Round-leaved Greenbrier have been seen in any surveys from the late 1980s to the present, so gene-flow from the U.S. to the Canadian population is unlikely.

In the U.S., Round-leaved Greenbrier is present from Maine south to Florida and west to Oklahoma and central Texas (Kartesz 2015; NatureServe 2015a). In the greater North American range, there is some discrepancy between the range NatureServe (2015a) shows for this species and the range shown by the Biota of North America Project (BONAP) (Kartesz 2015) and the Flora of North America (FNA) (Holmes 2002); BONAP and the FNA do not show the species as occurring in Iowa, Kansas, Minnesota, or South Dakota, and BONAP does not show it as rare in Illinois. The North American distribution as shown in the FNA was taken as most correct by COSEWIC (2007).

Table 1. Local populations of Round-leaved Greenbrier, Great Lakes Plains population, with last observation, sex status at last observation, and land ownership^A.

Local Population # ^B	Local Population Name	Last Obs.	Status	Sex status at last obs.	Abundance	Land Ownership and Notes
Essex County						
1	Cedar Creek ESA	1984	Historical; presumed extant	Unknown: not flowering or fruiting	20-30 crowns	Private and Essex Region Conservation Authority Not found in 2006, but only partial survey of large area.
2	Catbrier Woods ESA	1990	Historical; presumed extant	Male only	12-16 crowns	Private
3	White Oak Woods ESA	1989	Historical; presumed extant	Male & female: fruiting	~ 50 crowns fruiting	Private
4	Sweetfern Woods ESA	1989	Historical; presumed extant	Male only	~ 60 crowns	Private
5	Blytheswood ESA	2006	Extant	Unknown: not flowering or fruiting; male & female: fruiting in 1982	Dozens of crowns	Private
14	Point Pelee	1881	Extirpated	Extirpated	No info	Extirpated (COSEWIC 2007). Based on a specimen in CAN by Macoun. Never relocated.
Norfolk County						
6	South	2015	Extant	Unknown: not	>100	Long Point

	Walsingham Sand Ridges	2006 1987		flowering or fruiting at any observation	crowns	Region Conservation Authority and private owners.
Niagara Region						
7	Drummond Heights	2013	Extant	Unknown: not flowering or fruiting; Male & female Fruiting in 2006	1 large crowns and 2 smaller crowns	Private
8	Garner Road A Edgewood Woodlot	2013	Extant	Unknown; Female only not fruiting in 2006	Patch 15 x >30 m	City of Niagara Falls
9	Cooks Mills	1989	Historical; presumed extant	Unknown: not flowering or fruiting;	>6 crowns	Private
10	Fenwick	2006	Extant	Unknown: not flowering or fruiting;	"Abundant over 0.7 ha"	Private
11	Lyons Creek North	2007	Extant	Male only	Patch 50 x 5 m with hundreds of stems	Private
12	Woodlawn Park	2013	Extant	Unknown: not flowering or fruiting	Patch 60 x 7 m	City of Welland
13	Garner Road B Fernwood Woodlot	2013	Extant	Unknown: info not reported	Patch 36 x 10 m	City of Niagara Falls
15	Bowman's Woods West	2013	Extant	Unknown: not flowering or fruiting	2 patches, each with 50-100 stems	City of Niagara Falls
16	Heartland Forest	2014	Extant	Unknown: not flowering or fruiting	'Rare'	Private nature centre
17	McCleod Road	1980	Historical; presumed extant	Unknown: info not reported	No info	Private; suitable habitat still present

^A Sources: Kevan et al. (1991); Ambrose (1994); COSEWIC (2007); Garofalo (pers. comm. 2016); Holmes (pers. comm. 2015); Lebedyk (pers. comm. 2016); Niagara Falls Nature Club (unpublished data); Parks (pers. comm. 2016); Sankey (pers. comm. 2016); City of Niagara Falls (2016).

^B Site numbers correspond to numbers in COSEWIC (2007) except for numbers 15, 16, and 17 which were not mentioned in the report.

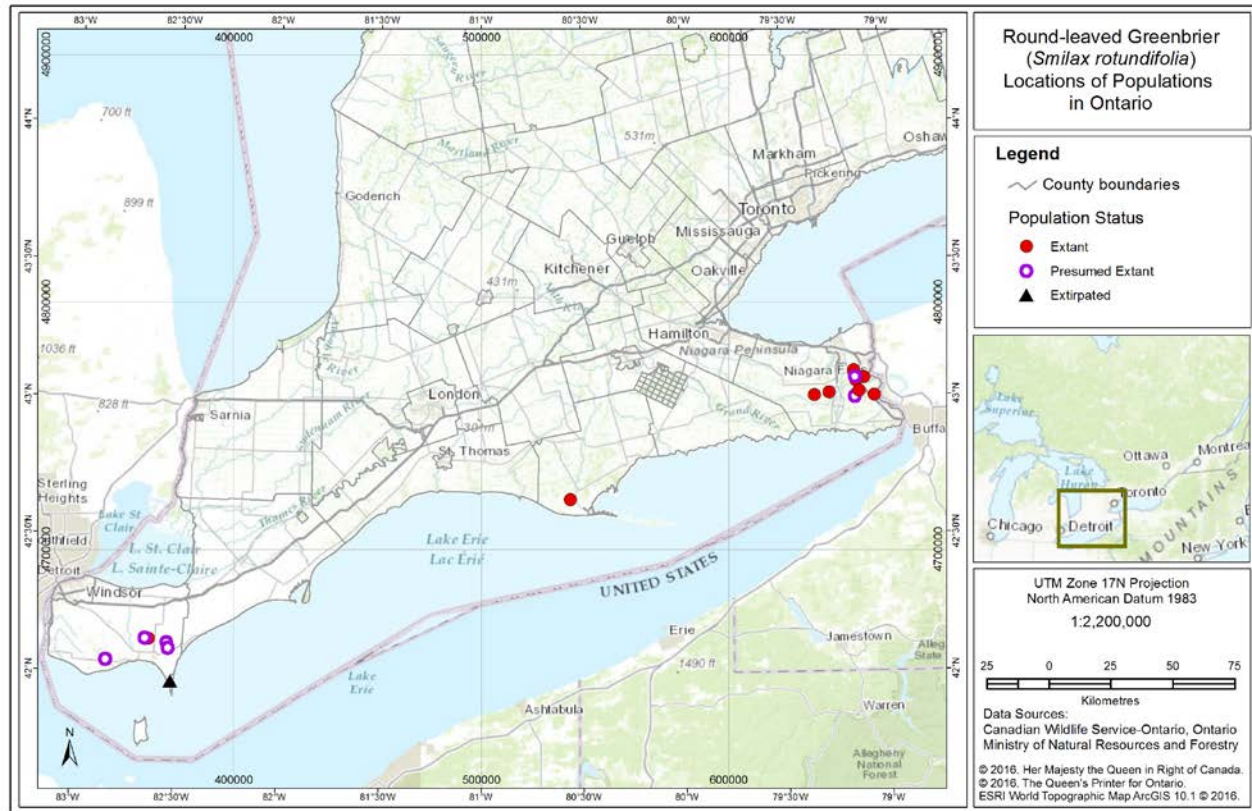


Figure 3. Distribution of Round-leaved Greenbrier local populations in Ontario.

3.3 Needs of the Round-leaved Greenbrier

Habitat Needs

In Ontario, Round-leaved Greenbrier is found in moist to wet Carolinian forest, often on sandy soil (Ambrose 1994), in areas just slightly drier than what would be considered swamp, in seasonally but not perpetually flooded ground (Ambrose pers. comm. 2015). The species inhabits both forest understory and forest openings. In Essex County, forests where Round-leaved Greenbrier occurs have been described as Lowland Red Maple-Mixed Oak Forest, or wetter and lower parts of Mixed Oak Forest dominated by Pin Oak (*Quercus palustris*) and Swamp White Oak (*Q. bicolor*) (ERCA 1994).

The associated tree and shrub species reported in Round-leaved Greenbrier habitat are shown in Table 2. In addition, Round-leaved Greenbrier is found associated with many other rare and at-risk Carolinian plants which require specific habitats. Rare associates are shown in Appendix B.

In its greater habitat in the U.S., Round-leaved Greenbrier grows in a variety of dry-moist habitats, including mature Oak Forest and Mixed-Oak Forest, openings in Oak Forest, riparian woods, borders, hedgerows, thickets, old fields and dunes (Brewer et al. 1973; Smith 1974; Voss 1972; Holmes 2002; Abrams and Hayes 2008). It has been described both as an early-successional species which gets established in open conditions and persists as an understory species as forest reclaims the site (Smith 1974), and as a super dominant understory species in a mature (140-year old) mixed-oak coastal plain forest (Abrams and Hayes 2008). Smith (1974) notes that Round-leaved Greenbrier tolerates 70 to 80% shade but matures more rapidly and produces more fruit in forest edge and open situations, and COSEWIC (2007) suggests that forest openings may be required for seedling establishment. However, Carter and Teramura (1998) found that this species can develop the ability to efficiently photosynthesize under low light conditions. Taken together, this suggests that Round-leaved Greenbrier has the potential to be highly adaptable, and grow in a wide-range of successional stages and under a variety of canopy cover conditions.

Although Round-leaved Greenbrier has been reported from dry sites in the U.S. (e.g. Voss 1972; Holmes 2002), it seems to benefit from moist soils in many situations. For example, a study of open habitats in Connecticut found Round-leaved Greenbrier grew significantly faster in moister habitats (Niering and Goodwin 1974). Similarly, Smith (1974) suggests that wetter soils may compensate for slower growth in shaded conditions relative to open conditions. COSEWIC (2007) attributed the slow growth on drier sites to drought stress and to impacts from browsing. Cobb et al. (2007) point out the importance of moisture to recovery from the freeze-thaw cycle experienced during winter. Vines including *Smilax* spp. have relatively large xylems¹⁶, which are susceptible to embolisms¹⁷ when frozen. Cobb et al. (2007) showed that Round-leaved Greenbrier

¹⁶ Plant tissue that carries water and minerals from the roots to the leaves and gives support to the stem or trunk.

¹⁷ Air bubbles formed in the xylem during freezing conditions.

was able to recover completely from this phenomenon in spring, because it can generate high root pressure¹⁸. This requires sufficient soil moisture to support the high root pressure. Cobb et al. (2007) suggest that Round-leaved Greenbrier favors wetter habitats in New England (near the northern edge of the species' range) in order to support the high root pressure needed to repair embolism damage in the spring. Therefore, moist soil conditions may be particularly important to Round-leaved Greenbrier in the northern part of its range (including Ontario), where it is exposed to harsh winters, and particularly in spring as it recovers from damage caused during the winter.

Round-leaved Greenbrier appears to tolerate moderate disturbance in its habitat. For example, on lands owned by Long Point Region Conservation Authority (LPRCA), Round-leaved Greenbrier plants are found mainly in areas where canopy openings were created in the late 1980s for a study of different logging treatments (Reader and Bricker 1992; Holmes pers. comm. 2015). In addition, in Michigan, Round-leaved Greenbrier occurs in oak openings (Brewer et al. 1973), which are the result of some type of natural disturbance, usually fire (Kost et al. 2007). Round-leaved Greenbrier may need some disturbance of the ground or litter layer for seedling establishment (Ambrose 1994). The exact thresholds of tolerance to disturbance are not known.

Biological Needs

This species is dioecious, with male and female flowers on separate plants. As with all dioecious plants, Round-leaved Greenbrier is an obligate out-crosser, meaning that it must mate with another individual, and self-fertilization does not occur (Kevan et al. 1991). Therefore both male and female plants must be present for sexual reproduction to be possible. Of the seven local populations for which sex has been recorded, three have been observed to contain both male and female plants, three contained only male plants and one only female plants (Table 1), suggesting that sexual reproduction is not likely to be occurring in at least four local Ontario populations.

There are many reasons why both male and female plants may not be present in a single local population. In plants, sex is not necessarily a fixed, genetically-controlled trait. For example, many dioecious species are known to change sex when triggered by certain environmental conditions (such as particular levels of light, temperature, moisture, soil nutrients, etc.) or physical trauma (for example damage from insects or browsing), and some perennial species also change sex as they get older (Freeman et al. 1980). Fragmentation of the landscape, resulting in changes in environmental conditions has been linked to biased sex ratios in another dioecious species, Chinese Pistache (*Pistacia chinensis*, Yu and Lu 2011). In a related species, Carrion Flower (*Smilax herbacea*), Sawyer and Anderson (1998) suggested female mortality was the main reason for male-biased sex ratios.

Round-leaved Greenbrier is dependent on pollination by insects, because its pollen is linked together by strands of viscin a natural sticky substance, which prevents the pollen being carried by the wind. The most likely pollinators are mosquitoes, although small

¹⁸ the ability to pull water into the roots and up the xylem, repairing the embolisms.

flies, small bees and bumble bees may also be important (Kevan et al. 1991). However, in 50 person-hours of observations, only three insects (two mosquitoes and a bumblebee) were observed to land on female Round-leaved Greenbrier flowers, and none were observed on male flowers (Kevan et al. 1991). In addition, even in a mixed-sex local population, artificial pollination increased fruit size and number of seeds compared to flowers allowed to reproduce naturally, suggesting a lack of effective natural pollination (Kevan et al. 1991).

The fruit of Round-leaved Greenbrier is a fleshy berry (5-8 mm in diameter) that is eaten by birds and mammals. The seeds pass through the gut and are dispersed in droppings. As a result, dispersal distances may be large, and seeds may not necessarily fall in locations suitable for growth. Fruit ripen in September to November (Greenberg and Walter 2010). In a study in the southern Appalachian mountains, Round-leaved Greenbrier produced fewer fruit than other native and non-native plants fruiting at the same time, and a significantly lower proportion of fruit were removed over the winter by birds and animals from Round-leaved Greenbrier than from other plants (Greenberg and Walter 2010), suggesting seed dispersal may be limited in this species, relative to other plants producing fruit at the same time of year.

Round-leaved Greenbrier is browsed by wildlife and cattle; of 73 species studied in eastern Texas hardwood forest, greenbriers (*Smilax* sp.) were among the most heavily grazed (Goodrum 1977). However, this group is very tolerant to browsing, because the rhizomes produce new shoots annually. Goodrum (1977) estimated that 50-60% of annual growth of greenbriers can be eaten without mortality of the roots.

The maximum life span of Round-leaved Greenbrier is not known, but the woody bases of the stems suggest a longer life span than that of smaller, herbaceous greenbrier species. In addition, the rhizomes can persist for years, even after the above-ground part of the plant has been removed (for example by fire or other disturbance; Goodrum 1977). COSEWIC (2007) presumed an age of at least several decades for well-developed individuals.

Relatively little is known about propagation of greenbriers (genus *Smilax*), including Round-leaved Greenbrier (Luna 2012). Seedling growth in the first year may be quite slow for this species, as plants invest more in growing underground storage organs than in above ground growth (reviewed by Luna 2012). Vegetative propagation using the tubers or rhizomes may be possible (reviewed by Luna 2012), but more research on all aspects of propagation is needed.

Table 2. Associated tree and shrub species reported in Round-leaved Greenbrier habitat in order of frequency (Smith 1974; Ambrose 1994; ERCA 1994).

English Name	Scientific Name
Common associates	
Red Maple	<i>Acer rubrum</i>
Red Oak	<i>Quercus rubra</i>
Pin Oak*	<i>Quercus palustris</i>
American Hornbeam	<i>Carpinus caroliniana</i>
White Ash*	<i>Fraxinus americana</i>
Sassafras	<i>Sassafras albidum</i>
White Oak	<i>Quercus alba</i>
American Witch-hazel	<i>Hamamelis virginiana</i>
Black Gum*	<i>Nyssa sylvatica</i>
Occasional associates	
Red Ash*	<i>Fraxinus pennsylvanica</i>
Slippery Elm	<i>Ulmus rubra</i>
Swamp White Oak	<i>Quercus bicolor</i>
Sugar Maple	<i>Acer saccharum</i>
Silver Maple	<i>Acer saccharinum</i>
American Beech*	<i>Fagus grandifolia</i>
Maple-leaved Viburnum	<i>Viburnum acerifolium</i>
Eastern Flowering Dogwood*	<i>Cornus florida</i>
American Chestnut*	<i>Castanea dentata</i>

* Species marked with an asterisk are rare or at risk in Ontario, or have declined due to insect infestation, and may no longer be present in the habitat in 2016.

4. Threats

According to COSEWIC (2007) Round-leaved Greenbrier is threatened by habitat loss and modification due to housing development and deer browse. Additional potential threats may be presumed based on threats linked to the biology of Round-leaved Greenbrier, and threats reported for other species at risk (SAR) plants that use Carolinian forest habitats, including high-intensity logging and invasive species. All of these threats may be compounded by natural limitations (discussed at the end of this section), especially existence of single sex local populations and lack of pollinators. Overall, a general stress is the remaining small habitat size in a patchy distribution of isolated woodlots surrounded by agricultural and urban land uses.

4.1 Threat Assessment

Table 3. Threat Assessment Table

Threat	Level of Concern ^a	Extent	Occurrence	Frequency	Severity ^b	Causal Certainty ^c
Habitat Loss or Degradation						
Residential, industrial and commercial development	High	Widespread	Current	Recurrent	Moderate/High	High
High-intensity logging	Medium	Localized	Current	Recurrent	Moderate	Medium
Exotic, Invasive, and Introduced Species						
Invasive species	Unknown	Widespread	Current	Continuous	Unknown	Low
Disturbance or Harm						
Inappropriate recreational vehicle use	Low	Localized	Current	Continuous	Low	Low
Deer browse	Low	Localized	Historic/Unknown	Recurrent	Low	High
Changes in Ecological Dynamics						
Alteration of the moisture regime	Medium	Unknown	Current	One-time	Unknown	Medium

^a Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table.

^b Severity: reflects the population-level effect (high: very large population-level effect, moderate, low, unknown).

^c Causal certainty: reflects the degree of evidence that is known for the threat (high: available evidence strongly links the threat to stresses on population viability; medium: there is a correlation between the threat and population viability e.g. expert opinion; low: the threat is assumed or plausible).

4.2 Description of Threats

Threats are addressed in order of level of concern.

Residential, industrial and commercial development

Urban development is occurring rapidly in southern Ontario. One site in the Niagara Region was listed by COSEWIC (2007) as being slated for development (local population # 13, recorded as extant in 2013). The woodlots containing local populations # 7 and # 12 have reduced in size due to road construction and residential development (COSEWIC 2007; Sankey pers. comm. 2016). Development pressure continues to be

high in that region, and remaining forest patches are commonly used for new residential subdivisions. Twelve of the forest patches that provide habitat for local populations are at least partly privately owned (Table 1), and therefore potentially vulnerable to development. Nevertheless, 11 of the forest patches have some or all of the land in a protective land use designation (section 6.1, Table 1), which may offset the risk of development.

Loss of habitat was a large threat historically when most forest was converted to agricultural use, resulting in the present-day fragmentation and scarcity of Carolinian forest habitat. The remaining Carolinian forest habitat is now very limited. In addition, because Round-leaved Greenbrier requires plants of the opposite sex to reproduce, if only one sex is present, the isolated nature of habitat fragments may be a serious problem. Additional habitat loss may further increase the distances between habitat patches, thus further reducing the likelihood of successful reproduction.

High-intensity Logging

Round-leaved Greenbrier is a long-lived woody species able to tolerate some disturbance in its habitat. At one site, it is associated with openings in the canopy made by moderate forest management activities (Holmes pers. comm. 2015). Therefore, small-scale, selective cutting of trees may not be harmful. However, high-intensity logging may degrade or destroy habitat if it opens the canopy enough to change the moisture regime, and machinery may also directly damage Round-leaved Greenbrier plants. In addition, there could be a cumulative effect from repeated small-scale operations over a number of years. Whether there is active logging in areas with Round-leaved Greenbrier is unknown as the most recent systematic field work was done in 2006, and at that time only about half of the sites were surveyed.

Alteration of the Moisture Regime

Ambrose (1994) lists alteration of drainage patterns through human activities as one of the main threats to Round-leaved Greenbrier at the time of that report. Soil moisture may be particularly important in spring when plants are recovering from the freeze-thaw cycle endured over the winter (Cobb et al. 2007). In addition to development and logging, other human activities both inside and outside forest patches may also change soil moisture levels in Round-leaved Greenbrier habitat. These include ditching ground, changing creek flow, creating berms, or any activity that changes soil or slope around Round-leaved Greenbrier.

Inappropriate Use of Recreational Vehicles

Off-trail use of recreational vehicles (e.g. all-terrain vehicles, ATVs), is a problem on some LPRCA lands and is known to threaten other forest SAR (Holmes pers. comm. 2015). Recreational vehicle use can churn up moist soils, cause ruts, and bring in introduced or invasive non-native species. Any of these results could potentially make habitat unsuitable for Round-leaved Greenbrier.

Deer Browse

Part of one local population (# 4, Table 1) was listed by COSEWIC (2007) as being within a deer enclosure. This local population was subject to excessive pressure from browsing (COSEWIC 2007). While Round-leaved Greenbrier can withstand high levels of browsing (Goodrum 1977), it is likely that this intense browsing pressure from artificially high densities of deer is damaging. It is unknown whether the enclosure is still in place.

Invasive species

Invasive species have not been mentioned as a threat to Round-leaved Greenbrier (Ambrose 1994; COSEWIC 2007), but many invasives are now much more widespread than they were when the COSEWIC report was written. For example, Garlic Mustard (*Alliaria petiolata*), Glossy Buckthorn (*Frangula alnus*), and Tartarian Honeysuckle (*Lonicera tatarica*) are shade-tolerant and able to colonize and take over forest understory areas, and may compete with Round-leaved Greenbrier for space, nutrients or other biological needs (OMNRF 2012). Garlic Mustard in particular may have allelopathic¹⁹ effects (OMNRF 2012). The effects of invasive species on Round-leaved Greenbrier are unknown but are listed here as a potential threat.

Other Factors

The Emerald Ash Borer (*Agrilus planipennis* or EAB) has been documented as a threat to species of Carolinian forests that have a high ash component (Environment Canada 2016). Die-back of ash trees was not mentioned by COSEWIC (2007) as a threat to Round-leaved Greenbrier, but EAB has been spreading rapidly and is present throughout southern Ontario and Quebec (Canadian Food Inspection Agency 2015). The loss of ash and opening of the canopy are likely to have strong impacts on many Carolinian species, but the direct implications to Round-leaved Greenbrier are unknown, and oaks and maples are more important canopy associates for Round-leaved Greenbrier than ash. The opening of the canopy through loss of ash could negatively impact Round-leaved Greenbrier, if loss is extensive enough to impact soil moisture regime, or may even have positive effects through increase in light levels.

4.3 Natural Limitations

Of seven local populations for which information on plant sex are available, four contained only single sex plants (three contained only male plants and one only female), meaning these local populations can only reproduce vegetatively, not sexually. This leads to reduced genetic variability in both local and total populations, which may be detrimental to the long-term survival of the species in Canada. It is unknown why these local populations contain only one sex, or whether environmental conditions are limiting the expression of either male or female plants in these local populations.

Round-leaved Greenbrier may suffer from limited pollinators. In 50 person-hours of observations, only three insects (two mosquitoes and a bumblebee) were observed to

¹⁹ Allelopathic plants secrete toxins or other chemicals into the soil, affecting the growth of neighbouring species.

land on female Round-leaved Greenbrier flowers, and none were observed on male flowers (Kevan et al. 1991). In addition, when hand-pollinated flowers were compared with flowers left to be pollinated naturally, fruit size was smaller and there were fewer seeds in the flowers left alone, showing a lack of effective natural pollination (Kevan et al. 1991). It is not clear why there may be a lack of pollinators, or if a particular insect group may be missing from Round-leaved Greenbrier habitat. However, loss of Carolinian forest cover in Ontario has been shown to cause a reduction of bee species richness and abundance, and to correlate to reduced seed set in at least two self-incompatible plant species (Taki et al. 2007; 2008). In addition, in Canada and globally many insect populations are declining (especially bees) due to loss of habitat and food sources, diseases, pests, and pesticide exposure (Health Canada 2015). It is currently unknown what impact the decline in pollinator populations may have on Round-leaved Greenbrier.

5. Population and Distribution Objectives

The population and distribution objectives for Round-leaved Greenbrier, Great Lakes Plains population, are:

- Maintain the species' distribution (including any new local populations that are discovered);
- Maintain or, where necessary and technically and biologically feasible, increase abundance at the 16 extant and presumed extant local populations.

Round-leaved Greenbrier is a robust and long-lived plant, with a range of habitat tolerances within moist forest. There is no evidence for recent extirpation of local populations, where forested habitat remains (see section 3.2) and best available information indicates that forested habitat remains at the location of each of the historical local populations. Therefore, the six local historical populations are presumed extant for the purposes of this recovery strategy.

Due to uncertainty about the abundance of individual plants (COSEWIC 2007) and lack of recent information about a number of local populations (Table 1), setting quantitative abundance objectives is not possible at this time. There is no indication that Round-leaved Greenbrier was ever more widespread in Ontario than its current distribution. Therefore, the recovery objectives aim to maintain the existing distribution and abundance of local populations. If any new local populations are discovered (for example, three additional local populations have been discovered since the 2007 COSEWIC assessment), these should also be maintained.

Even if the distribution and abundance of Round-leaved Greenbrier is maintained, the long-term resilience of the species is not ensured as several local populations have low abundance (e.g. # 7, Drummond Heights, # 9 Cooks Mills; Table 1) and it is possible that the majority of the population is currently reproducing vegetatively. This is supported by the existence of single-sex local populations (four of seven local

populations where sex-ratio is known), and by the lack of observations of seedlings in any recent surveys. In the absence of sexual reproduction, genetic diversity is likely to decline, increasing the risk of inbreeding and reducing the ability of the species to recover from perturbations. Establishing sexually reproducing local populations by augmenting existing single-sex local populations with individuals of the opposite sex, if biologically or technically feasible, and researching factors that promote seedling production and survival may both help to increase abundance at existing local populations.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

Eleven local populations have some or all of the land in a conservation land use designation. On lands owned by Long Point Region Conservation Authority, Round-leaved Greenbrier is located in some areas that are working forest with active logging operations. These areas are surveyed prior to work commencing, and a buffer is established around the species to protect it (Holmes pers. comm. 2015).

6.2 Strategic Direction for Recovery

Table 4. Recovery Planning Table

Threat or Limitation	Priority ^a	Broad Strategy to Recovery	General Description of Research and Management Approaches
Knowledge gaps	High	Surveys and monitoring	<ul style="list-style-type: none"> Survey local populations that have not been confirmed recently for population status and any new threats. Confirm reproductive status and population size of all local populations. Develop and implement a long-term monitoring protocol.
Low rate of seedling establishment; single-sex local populations	High	Research and management	<ul style="list-style-type: none"> Assess threats and site conditions to determine need and feasibility for augmenting single-sex local populations with individuals of the opposite sex. Where feasible and necessary, implement measures to augment single-sex local populations. Monitor local populations for seedling production; investigate factors that promote seedling germination, growth and survival. Where feasible and necessary, implement actions to increase seedling production and survival in mixed-sex local populations.
Development; Alteration of the moisture regime	High	Land use policy and planning;	<ul style="list-style-type: none"> Ensure county and municipal or other planning authorities are aware of locations of all Round-leaved Greenbrier local populations and the types of activities that constitute threats.
Development	High	Habitat protection; Partnerships	<ul style="list-style-type: none"> Support protection, stewardship and restoration of Carolinian forest and associated habitats, as well as land use planning in Carolinian Canada.
Development, high-intensity logging, alteration of the moisture regime	High	Outreach and education	<ul style="list-style-type: none"> Contact owners of all public and private lands supporting Round-leaved Greenbrier. Provide information about identifying and protecting the species and what activities are threats.
Knowledge gaps	High	Research on natural limitations	<ul style="list-style-type: none"> Study factors that determine whether plants flower male or female. Study pollinators of Round-leaved Greenbrier to see which are effective and if any are limited.
Inappropriate use of recreational vehicles	Low	Outreach and education	<ul style="list-style-type: none"> Promote responsible recreational vehicle use including staying on trails, and information on identifying and avoiding SAR.

Invasive species, deer browse, EAB	Low	Monitoring; Habitat management	<ul style="list-style-type: none">• Monitor local populations for presence of invasive species. Where necessary, control invasive species in immediate habitat areas following best management practices (BMPs) established for control.• Monitor local populations for damage from deer browse. Where necessary implement measures to protect plants from deer browse• Monitor whether forest changes due to EAB are causing impacts.
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¹ "Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.

7. Critical Habitat

7.1 Identification of the Species' Critical Habitat

Section 41(1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. Under section 2(1) of SARA, critical habitat is "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

This federal recovery strategy identifies critical habitat for Round-leaved Greenbrier (Great Lakes Plains population) in Canada to the extent possible, based on the best available information as of February 2016. Critical habitat is identified for all existing local populations²⁰ of Round-leaved Greenbrier in Ontario (Figures 4, 5, and 6; Table 5), and is sufficient to meet the population and distribution objectives; therefore a schedule of studies is not required. Additional critical habitat may be added in the future if new or additional information supports the inclusion of areas beyond those currently identified (e.g., new local populations are found or existing local populations expand into adjacent areas).

Critical habitat identification for Round-leaved Greenbrier (Great Lakes Plains population) is based on two criteria: habitat occupancy and habitat suitability.

7.1.1 Habitat Occupancy

The habitat occupancy criterion refers to areas of suitable habitat where there is a reasonable degree of certainty of current use by the species.

Habitat is considered occupied when:

- At least one Round-leaved Greenbrier stem has been observed, and
- The location has not been classified as extirpated²¹.

Habitat occupancy is based on occurrence reports available for all local populations from the NHIC and COSEWIC, as well as other project based data reports (Garofalo pers. comm. 2016; Parks pers. comm. 2016; Sankey pers. comm. 2016). Within Ontario, Round-leaved Greenbrier is reported from ten extant and six historical local populations. Due to the robustness and longevity of Round-leaved Greenbrier (up to at least several decades, and perhaps even centuries; COSEWIC 2007), historical local populations with existing suitable habitat where the species has not been recently

²⁰ This includes all local populations that have not been classified as extirpated by the Natural Heritage Information Centre (NHIC) and Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

²¹ Extirpation could be determined by updated COSEWIC assessment, NHIC, or through project based data reports.

surveyed are presumed to be extant and considered occupied. If new observations become available for additional local populations, they may be considered for the identification of additional critical habitat in future action plans or recovery strategies.

Habitat occupancy is therefore presumed as extant for all non-extirpated local populations listed in Table 1 as of February 2016.

7.1.2 Habitat Suitability

Habitat suitability relates to areas possessing a specific set of biophysical attributes that can support individuals of the species in carrying out essential aspects of their life cycle. At existing local populations in Ontario, Round-leaved Greenbrier is typically found growing in Carolinian forests with a variety of habitat types dominated by Red Maple (*Acer rubrum*) and Pin Oak (*Quercus palustris*), in combination with several other overstorey species including but not limited to Red Oak (*Quercus rubra*), American Hornbeam (*Carpinus caroliniana*), White Ash (*Fraxinus americana*), Sassafras (*Sassafras albidum*), White Oak (*Quercus alba*), American Witch-hazel (*Hamamelis virginiana*), or Black Gum (*Nyssa sylvatica*) (ERCA 1994; COSEWIC 2007).

The biophysical attributes, which capture the characteristics required by the species to carry out its life processes, include:

- Moist to wet wooded habitat often with sandy soils
 - Slightly drier than what would be considered swamp, typically in seasonally but not perpetually flooded grounds (Ambrose pers. comm. 2015)

Based on the best available information, suitable habitat for Round-leaved Greenbrier is currently defined as the extent of the biophysical attributes where Round-leaved Greenbrier exists in Ontario. Further detail is provided below.

Due to the range of forested habitat that Round-leaved Greenbrier can occupy, suitable habitat for Round-leaved Greenbrier in Ontario is best captured using the OMNRF (2014) wooded area boundary. This framework provides an approach to the interpretation and delineation of woody vegetation boundaries according to Ontario Base Mapping standards to identify wooded areas in Southern Ontario²². The wooded area identified includes the areas occupied by the species and the extended surrounding areas that provide suitable habitat conditions (e.g. moisture regime, open to closed canopy) to carry out essential life processes for the species and should allow for natural processes related to population dynamics and reproduction (e.g. dispersal and pollination) to occur.

²² The wooded area boundary is intended to depict area covered by trees in Province of Ontario. It includes areas of trees and shrubs at least 2 m in height and 60% canopy cover with a minimum mapping unit of 0.25 ha, and excludes hedgerows and plantations (OMNRF 2014).

The entire contiguous forest patch around the plant, as defined by the wooded area boundary, is considered critical habitat. This allows for growth of existing plants and an increase in abundance of plants, as outlined in the population and distribution objectives, and acts to maintain the microhabitat conditions for the plant, along with the functional integrity of the forest. Maintaining the functional integrity of the forest will help to maintain the soil moisture regime essential to this species, as well as promoting the abundance of insect pollinators for Round-leaved Greenbrier (COSEWIC 2007; Taki et al. 2007), as limited pollinators may be a factor in lack of sexual reproduction (Kevan et al. 1991).

Human-made structures (e.g., maintained roadways, buildings) do not possess the biophysical attributes of suitable habitat or assist in the maintenance of natural processes and are therefore not identified as critical habitat.

7.1.3 Application of Criteria to Identify Critical Habitat for Round-leaved Greenbrier

Critical habitat for Round-leaved Greenbrier is identified as the extent of suitable habitat (section 7.1.2) where the habitat occupancy criteria is met (section 7.1.1).

In Ontario, as noted above, suitable habitat for Round-leaved Greenbrier is most appropriately identified with wooded area boundaries. Critical habitat is located within these boundaries where the biophysical attributes described in section 7.1.2 are found and where the occupancy criterion is met (section 7.1.1).

Application of the critical habitat criteria above to the best available information identifies critical habitat for 16 local populations of Round-leaved Greenbrier, Great Lakes Plains population in Canada (see Figures 4, 5, and 6; Table 5). The critical habitat identified is considered a full identification of critical habitat and is sufficient to meet the population and distribution objectives for Round-leaved Greenbrier.

Critical habitat identified for Round-leaved Greenbrier is presented using 1 x 1 km UTM grid squares. The UTM grid squares presented in Figure 4, Figure 5, and Figure 6 are part of a standardized grid system that indicates the general geographic areas containing critical habitat, which can be used for land use planning and/or environmental assessment purposes. In addition to providing these benefits, the 1 x 1 km UTM grid respects data-sharing agreements with the province of Ontario. Critical habitat within each grid square occurs where the description of habitat occupancy (section 7.1.1) and habitat suitability (section 7.1.2) are met. More detailed information on critical habitat to support protection of the species and its habitat may be requested on a need-to-know basis by contacting Environment and Climate Change Canada – Canadian Wildlife Service at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

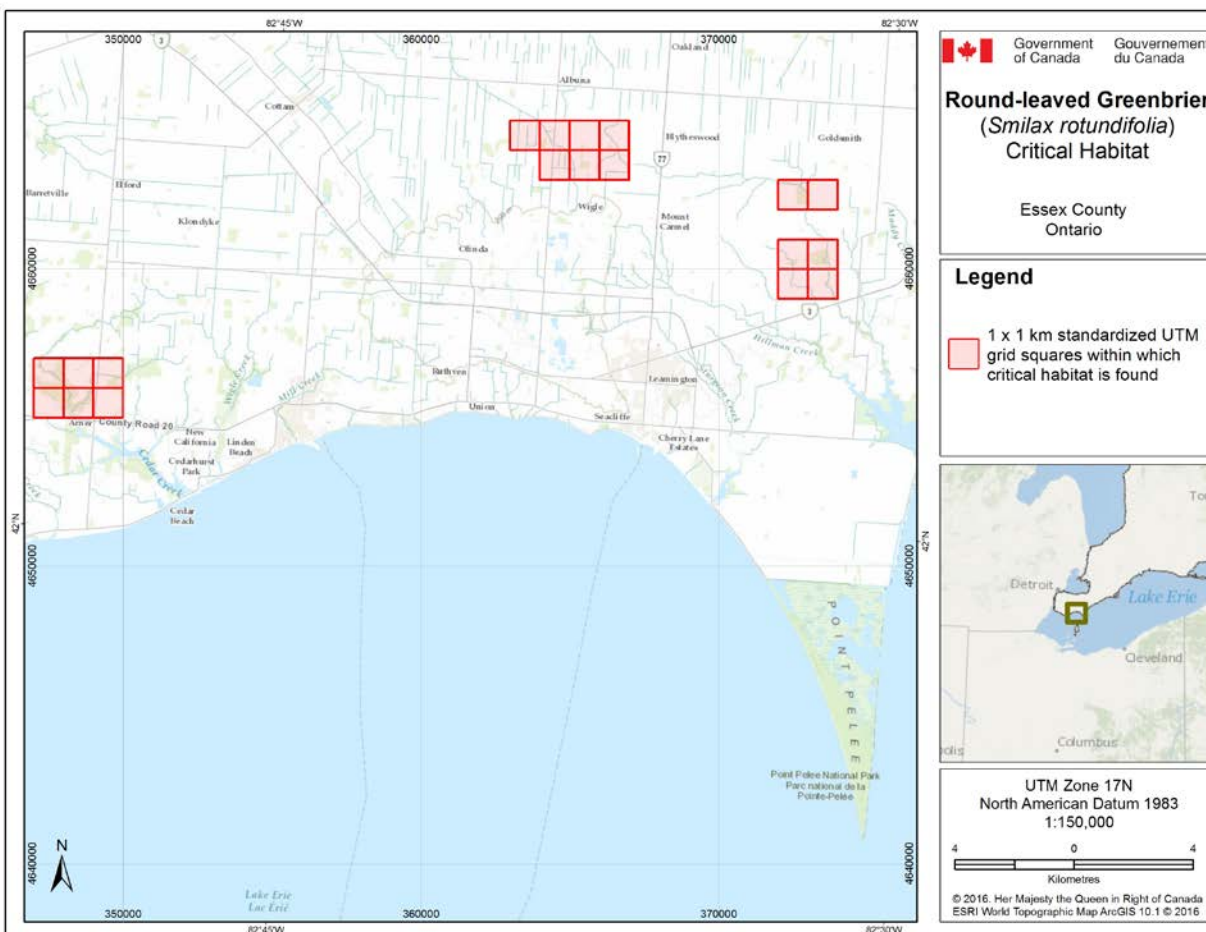


Figure 4. Grid squares identified as containing critical habitat for Round-leaved Greenbrier in Essex County, Ontario. Critical habitat for Round-leaved Greenbrier occurs within these 1 x 1 km standardized UTM grid squares (red shaded squares), where the description of habitat suitability (section 7.1.2) and habitat occupancy (section 7.1.1) are met.

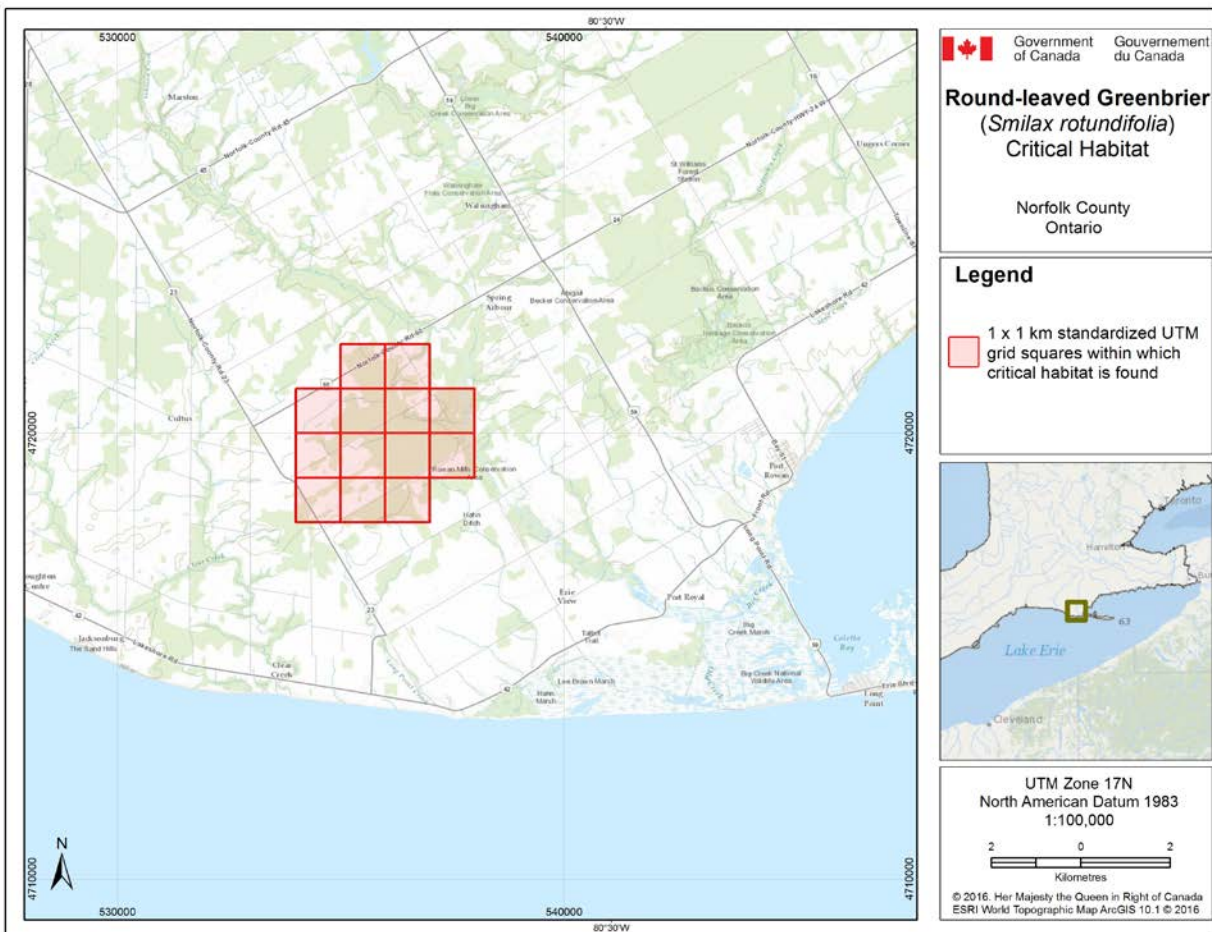


Figure 5. Grid squares identified as containing critical habitat for Round-leaved Greenbrier in Norfolk County, Ontario. Critical habitat for Round-leaved Greenbrier occurs within these 1 x 1 km standardized UTM grid squares (red shaded squares), where the description of habitat suitability (section 7.1.2) and habitat occupancy (section 7.1.1) are met.

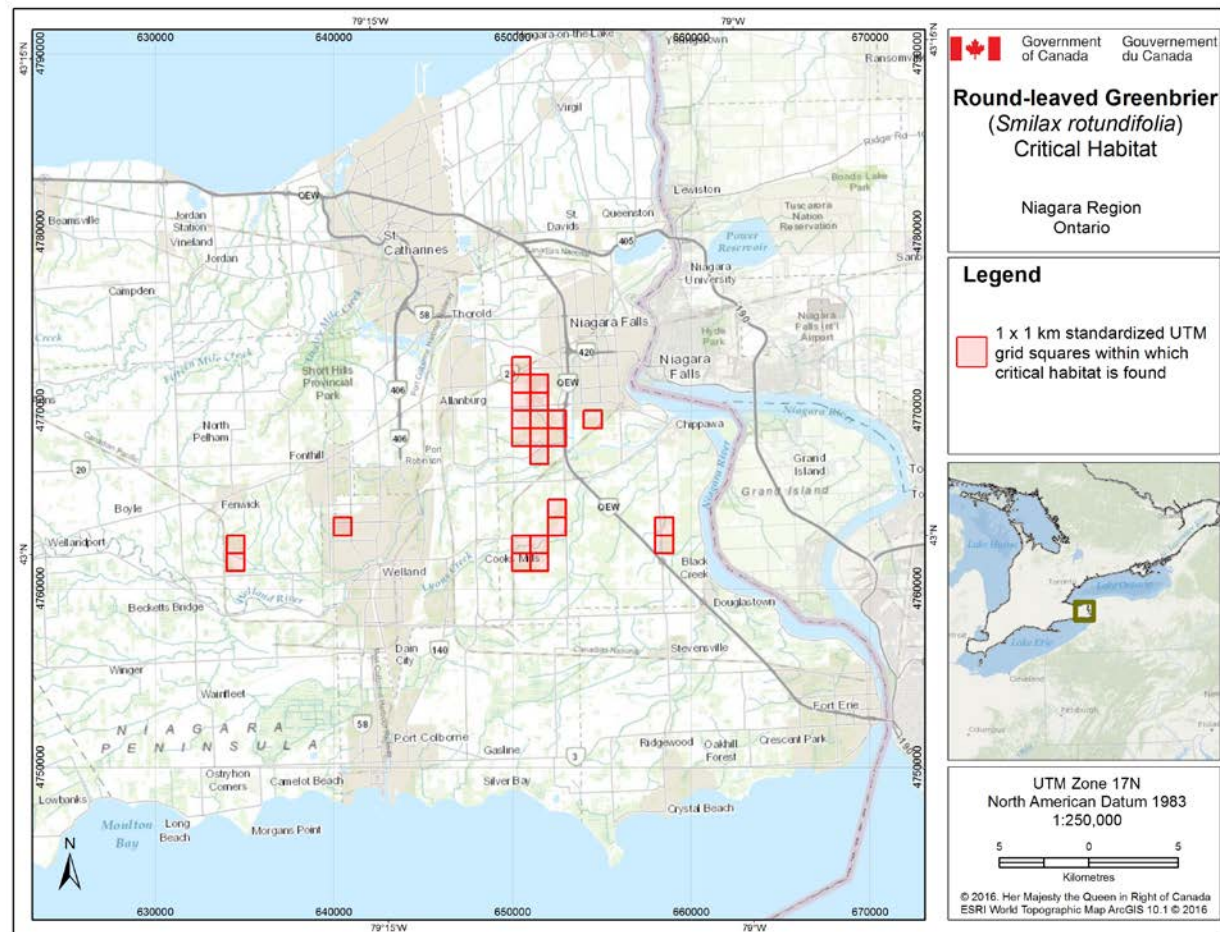


Figure 6. Grid squares identified as containing critical habitat for Round-leaved Greenbrier in Niagara region, Ontario. Critical habitat for Round-leaved Greenbrier occurs within these 1 x 1 km standardized UTM grid squares (red shaded squares), where the description of habitat suitability (section 7.1.2) and habitat occupancy (section 7.1.1) are met.

Table 5. Grid squares that contain critical habitat for Round-leaved Greenbrier in Ontario. Critical habitat for Round-leaved Greenbrier occurs within these 1 x 1 km UTM grid squares where the description of habitat suitability (section 7.1.2) and habitat occupancy (section 7.1.1) are met.

Local Population #	1 x 1 km Standardized UTM grid square ID ^a	UTM Grid Square Coordinates ^b		Land Tenure ^c
		Easting	Northing	
1	17TLG4575	347000	4655000	Non-federal Land
	17TLG4576	347000	4656000	
	17TLG4585	348000	4655000	
	17TLG4586	348000	4656000	
	17TLG4595	349000	4655000	
	17TLG4596	349000	4656000	
2	17TLG6634	363000	4664000	Non-federal Land
	17TLG6643	364000	4663000	
	17TLG6644	364000	4664000	
3	17TLG7529	372000	4659000	Non-federal Land
	17TLG7539	373000	4659000	
	17TLG7620	372000	4660000	
	17TLG7630	373000	4660000	
4	17TLG7622	372000	4662000	Non-federal Land
	17TLG7632	373000	4662000	
5	17TLG6653	365000	4663000	Non-federal Land
	17TLG6654	365000	4664000	
	17TLG6663	366000	4663000	
	17TLG6664	366000	4664000	
6	17TNH3148	534000	4718000	Non-federal Land
	17TNH3149	534000	4719000	
	17TNH3158	535000	4718000	
	17TNH3159	535000	4719000	
	17TNH3168	536000	4718000	
	17TNH3169	536000	4719000	
	17TNH3179	537000	4719000	
	17TNH3240	534000	4720000	
	17TNH3250	535000	4720000	
	17TNH3251	535000	4721000	
	17TNH3260	536000	4720000	
	17TNH3261	536000	4721000	
	17TNH3270	537000	4720000	
7	17TPH5649	654000	4769000	Non-federal Land
8	17TPH5701	650000	4771000	Non-federal Land
	17TPH5711	651000	4771000	

9	17TPH5601 17TPH5602 17TPH5611 17TPH5612	650000 650000 651000 651000	4761000 4762000 4761000 4762000	Non-federal Land
10	17TPH3641 17TPH3642	634000 634000	4761000 4762000	Non-federal Land
11	17TPH5623 17TPH5624	652000 652000	4763000 4764000	Non-federal Land
12	17TPH4603	640000	4763000	Non-federal Land
13	17TPH5702	650000	4772000	Non-federal Land
15	17TPH5682 17TPH5683	658000 658000	4762000 4763000	Non-federal Land
16	17TPH5608 17TPH5617 17TPH5618 17TPH5619 17TPH5628 17TPH5629	650000 651000 651000 651000 652000 652000	4768000 4767000 4768000 4769000 4768000 4769000	Non-federal Land
17	17TPH5609 17TPH5619 17TPH5700 17TPH5710	650000 651000 650000 651000	4769000 4769000 4770000 4770000	Non-federal Land

^a Based on the standard UTM Military Grid Reference System (see <http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789>), where the first 2 digits and letter represent the UTM Zone, the following 2 letters indicate the 100 x 100 km standardized UTM grid, followed by 2 digits to represent the 10 x 10 km Standardized UTM, and the last 2 digits indicate the 1 x 1 km standardized UTM grid containing all or a portion of the critical habitat unit. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See <http://www.bsc-eoc.org/> for more information on breeding bird atlases).

^b The listed coordinates are a cartographic representation of where critical habitat can be found, presented as the southwest corner of the 1 x 1 km standardized UTM grid square that is the critical habitat unit. The coordinates are provided as a general location only.

^c Land tenure is provided as an approximation of the types of land ownership that exist at the critical habitat units and should be used for guidance purposes only. Accurate land tenure will require cross referencing critical habitat boundaries with surveyed land parcel information.

7.2 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat was degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single activity or multiple activities at one point in time or from the cumulative effects of one or more activities over time. It should be noted that not all activities that occur in or near critical habitat are likely to cause its destruction. Activities described in Table 6 are examples of those likely to cause destruction of critical habitat for the species; however, destructive activities are not necessarily limited to those listed.

Table 6: Activities likely to result in the destruction of critical habitat.

Description of Activity	Description of Effect (biophysical attribute or other)
Conversion of wooded habitats to other land uses, including development or clearing of forest for other purposes	Clearing or removal of forest will result in direct destruction of forest habitat on which Round-leaved Greenbrier relies.
Activities resulting in changes to moisture regimes within critical habitat, (e.g. creation or blockage of ditches, draining of land for farming or development) or changes to the slope around Round-leaved Greenbrier plants (e.g. digging around plants)	Changes to the moisture regime (either direct changes, or indirect changes related to changes in slope) may degrade habitat for adult plants, and may limit seedling survival. Activities that result in changes to moisture regime may occur inside or outside of critical habitat. There is no known threshold for this activity.
Logging more than 33% of the canopy tree basal area ²³ at one time, or enough to cause drying of soil moisture	Logging can result in reductions in soil moisture which will degrade habitat for Round-leaved Greenbrier. Creation of extensive canopy openings through logging may also degrade habitat.
Heavy grazing deer or livestock in critical habitat (e.g. penning of deer in critical habitat, or pasturing of livestock in critical habitat).	Grazing animals may trample ground, introduce inappropriate nutrients, and alter natural associate species composition
Activities that cause rutting, soil compaction or erosion (e.g. use of heavy equipment, off-trail use of recreational vehicles).	These activities can degrade habitat by making soil conditions unsuitable for seedling survival. In addition, invasive species can be introduced by equipment or vehicles used in critical habitat.

Logging may not necessarily destroy critical habitat depending on the intensity of the operation. One local population of Round-leaved Greenbrier is found associated with forest openings from old logging operations, so some types of light disturbance may possibly be beneficial to the species. However, logging must not open the canopy to the extent that soil moisture is altered. The intensity of logging that would cause such a

²³ Basal area is the cross-sectional area of a tree stem measured at breast height (1.4 m). Canopy basal area is defined here as the sum of basal area for all trees with a diameter at breast height of more than 5 cm, in a plot, divided by the area of the plot (Reader and Bricker 1992).

change may differ in different situations depending on proximity of water bodies, soil type, and other factors.

Reader and Bricker (1992) studied the response of five shade-tolerant understory herbs to different standard logging treatments in Carolinian deciduous forest. The study was done in an area where Round-leaved Greenbrier was present although it was not one of the species studied. They found that four of the five species studied responded favourably to logging treatments of 33% of canopy tree basal area or less and canopy openings of 0.53 ha (circles with 13 m radius), but that all five responded negatively to openings of larger size. Given its growth in forest openings, Round-leaved Greenbrier may tolerate greater canopy opening. However, as a precautionary measure, logging more than 33% of basal area or creating openings with greater than 13 m radius is considered destructive to critical habitat unless new evidence shows otherwise.

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

- Species distribution (including any newly discovered local populations) is maintained;
- Abundance is maintained at the 16 extant and presumed extant local populations;
- Where necessary and technically and biologically feasible, abundance is increased.

9. Statement on Action Plans

One or more action plans will be completed by December 31, 2024.

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Appendix A: Conservation ranks of Round-leaved Greenbrier in Canada and the United States (NatureServe 2015a).

Global (G) Rank	National (N) Ranks	Sub-national (S) Ranks
G5	Canada: N3	Nova Scotia (S3), Ontario (S2)
	United States: N5	Alabama (SNR), Arkansas (SNR), Connecticut (SNR), Delaware (S5), District of Columbia (S5), Florida (SNR), Georgia (SNR), Illinois (S3?), Indiana (SNR), Iowa (SNR), Kansas (SNR), Kentucky (S5), Louisiana (SNR), Maine (SNR), Maryland (SNR), Massachusetts (SNR), Michigan (SNR), Minnesota (SNR), Mississippi (SNR), Missouri (SNR), New Hampshire (SNR), New Jersey (S5), New York (S5), North Carolina (S5), Ohio (SNR), Oklahoma (SNR), Pennsylvania (SNR), Rhode Island (SNR), South Carolina (SNR), South Dakota (SNR), Tennessee (SNR), Texas (SNR), Virginia (S5), West Virginia (S5)

Rank Definitions (Master et al. 2012)

S1: Critically Imperilled: At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.

S2: Imperilled: At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.

N3/S3: Vulnerable: At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

S4: Apparently Secure: At a fairly low risk of extirpation in the jurisdiction 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.

S5: Secure/Apparently Secure: At no risk to fairly low risk of extirpation in the jurisdiction due to an extensive to very extensive range, abundant populations or occurrences, with little to some concern as a result of local recent declines, threats or other factors.

G5/N5/S5: Secure: At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.

SNR: Unranked: Conservation status not yet assessed

U: Unrankable: Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

?: Inexact numeric rank: The addition of a ? qualifier to a 1–5 conservation status rank denotes that the assigned rank is imprecise.

Appendix B: Rare or at-risk associates of Round-leaved Greenbrier (COSEWIC 2007).

English Name	Latin Name	Status	Habitat ^a
American Chestnut	<i>Castanea dentata</i>	Endangered	Forest, especially with oaks
Eastern Flowering Dogwood	<i>Cornus florida</i>	Endangered	Dry to rich deciduous (usually oak) forest
Butternut	<i>Juglans cinerea</i>	Endangered	Stream banks, swamps, upland forest
Green Dragon	<i>Arisaema dracontium</i>	Special Concern	Moist forest, river banks, flood plain
Squarrose Sedge	<i>Carex squarrosa</i>	S2	Moist forest openings, fields, ditches
Round-leaved Tick-trefoil	<i>Desmodium rotundifolium</i>	S2	Oak forests, dry thickets
Pignut Hickory	<i>Carya glabra</i>	S3	Upland sandy forest associated with oaks
Shellbark Hickory	<i>C. laciniosa</i>	S3	Rich floodplain forest, river banks
Black Gum	<i>Nyssa sylvatica</i>	S3	Dry-moist forest, acid or sandy, soils
White Wood Aster ^b	<i>Eurybia divaricata</i>	S2	Dry-moist deciduous woodlands with well-drained soils and relatively open canopies. ^c

Rank Definitions (Master et al. 2012)

S2: Imperilled: At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.

S3: Vulnerable: At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

^a Habitat descriptions from Reznicek et al. (2011), unless otherwise stated

^b White Wood Aster was not included as an associate in COSEWIC (2007), but occurs in two sites listed in Table 1 (unpublished information), so has been added to this table

^c Habitat description from COSEWIC (2002).

Appendix C: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the [*Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*](#)²⁴. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the [*Federal Sustainable Development Strategy*](#)'s²⁵ (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Almost all recovery steps suggested for Round-leaved Greenbrier involve actions that will not be done directly in the habitat and thus will not negatively affect other species. For example, using planning and policy to prevent site alteration, conducting research and monitoring, doing outreach, and protecting Carolinian habitats to allow ecological processes to function naturally, are all "hands-off" types of actions. All are expected to be beneficial for native species found in the same areas as Round-leaved Greenbrier. Promoting responsible recreational vehicle use and controlling invasive species are also expected to be only beneficial to native species present with Round-leaved Greenbrier.

If future research shows a need for some type of habitat management to create conditions favourable to seedling production and survival, a separate assessment process may be needed to determine whether the work proposed would have an effect on the environment or other species. It is not known at this time whether such work is needed or what it would entail, so the environmental considerations specific to that work must be left until these knowledge gaps are filled.

²⁴ www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1

²⁵ www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1