Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Heart-leaved Plantain (*Plantago cordata*) in Canada

Heart-leaved Plantain

2013

Canada

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PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) 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.

The Minister of the Environment is the competent minister for the recovery of Heart-leaved Plantain and has prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with the Province of Ontario, the Department of National Defence, and the Chippewas of Kettle and Stony Point First Nation.

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 Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of Heart-leaved Plantain 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 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.

ACKNOWLEDGMENTS

The first draft of this recovery strategy was developed by John Ambrose and Jarmo Jalava for the Carolinian Woodlands Recovery Team, with input from Allen Woodliffe and Karen Hartley (Ontario Ministry of Natural Resources) and Kate Hayes (formerly Environment Canada, Canadian Wildlife Service – Ontario (EC, CWS-ON)). The draft strategy was updated by Angela Darwin, Rachel deCatanzaro, and Ken Tuininga (EC, CWS – ON) and Lisa Isaacman (formerly EC, CWS – ON). Madeline Austen, Lesley Dunn, and Marie-Claude Archambault (EC, CWS – ON) reviewed and provided comments and advice during development of this document. Ruben Boles (EC, CWS – National Capital Region), Rick Sherstabetoff, Darryl Damude, Rob Wheeler and Jennifer Rowland (Department of National Defence) also contributed information during the development this recovery strategy. Acknowledgment 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 Aboriginal organizations and individuals, individual citizens, and stakeholders who provided input and/or participated in consultation meetings.

EXECUTIVE SUMMARY

Heart-leaved Plantain (*Plantago cordata*) is a perennial herb that is listed as Endangered on Schedule 1 of the *Species at Risk Act.* It occurs in relatively undisturbed, wet woods often along rocky or gravelly calcareous beds of shallow, slow moving clear streams or wet depressions. In Canada, this species is found where ephemeral creeks flow in the spring, and where moisture is generally always present above or just below the soil surface. The global range originally extended across North America from Minnesota, Michigan, and Ohio to Ontario, south to the southeastern United States, but the species is now extremely localized, with a centre of abundance located in Missouri. The Canadian range has been reduced from seven historic populations to two populations near southern Lake Huron. Less than 5% of the global range of Heart-leaved Plantain occurs in Canada.

Canadian populations of Heart-leaved Plantain are primarily threatened by a reduction in the quality and availability of habitat as a result of nutrient enrichment from agricultural runoff, clearing of riparian vegetation, alteration of the streambed (ditching, draining, and damming), and timber harvesting. They are also threatened by land development, decommissioning activities at the former Camp Ipperwash, invertebrate herbivory (including herbivory from the invasive Gray Garden Slug, *Deroceras reticulatum*), and collection for food and medicinal uses. Heart-leaved Plantain is limited by inherent biological factors (small population size and low reproductive output) and its specialized habitat requirements.

There are unknowns regarding the feasibility of recovery of Heart-leaved Plantain, due in large part to the limited availability of suitable habitat. In keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be feasible. Broad strategies to be taken to address the threats to the survival and recovery of Heart-leaved Plantain are presented in the section on Strategic Direction for Recovery. The population and distribution objective is to maintain the current abundance of Heart-leaved Plantain at known extant populations, and to maintain, or increase where biologically and technically feasible, the current distribution of Heart-leaved Plantain in Canada.

Critical habitat is fully identified within this recovery strategy, based on the best available data. As additional information becomes available, additional critical habitat may be identified where sites meet the critical habitat criteria.

One or more action plans will be completed for Heart-leaved Plantain by December 2017.

RECOVERY FEASIBILITY SUMMARY

Based on the following four criteria outlined in the draft SARA Policies (Government of Canada 2009), there are unknowns regarding the feasibility of recovery of Heart-leaved Plantain. 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 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.**

Yes. There are currently two isolated, extant populations of the species in Ontario. Additionally, populations currently exist in at least 13 U.S. states, including Missouri where the species is considered stable.

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

Unknown. Although limited, suitable habitat is currently available at two known extant, apparently stable populations in Ontario. It is possible that other undiscovered populations or unoccupied patches of suitable habitat may also exist. However, the species uses a very specialized habitat of ephemeral streams and little is known about making additional habitat available. While it may be possible to restore habitat at some degraded historic sites, this would require mitigating a complex variety of upstream and on-site impacts. It is unknown whether sufficient suitable habitat can be restored and maintained to promote recovery beyond maintaining the two extant populations.

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

Yes. Habitat loss and degradation, particularly alteration of hydrology and reduction in water quality resulting from alterations to natural stream courses, removal of riparian areas, intensive agricultural use and other land development, is the primary threat to this species' recovery throughout its current and historic range (Brownell 1998; NatureServe 2010). Techniques to avoid and mitigate these threats are available (e.g., use of agricultural best management practices, protecting riparian and stream habitats).

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

Unknown. The isolation and limited number of pockets that contain suitable habitat are the main factors limiting this species in Canada. Although Heart-leaved Plantain can be directly seeded or propagated from seed and re-established in suitable habitat (NatureServe 2010), knowledge gaps remain related to the specialized habitat requirements and other factors limiting the establishment and distribution of this species.

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1. COSEWIC* SPECIES ASSESSMENT INFORMATION

Date of Assessment: May 2000

Common Name (population): Heart-leaved Plantain

Scientific Name: *Plantago cordata*

COSEWIC Status: Endangered

Reason for Designation: Two remaining populations with narrow habitat tolerance threatened by ongoing habitat degradation.

Canadian Occurrence: Ontario

COSEWIC Status History: Designated Endangered in April 1985. Status re-examined and confirmed Endangered in April 1998 and in May 2000.

* Committee on the Status of Endangered Wildlife in Canada

2. SPECIES STATUS INFORMATION

Although Heart-leaved Plantain (*Plantago cordata*) is globally ranked as Apparently Secure (G4) by NatureServe (2010), the species is considered Critically Imperilled in both Canada (N1) and Ontario (S1). It has been assessed as Endangered within Canada by COSEWIC, and is listed as Endangered on Schedule 1 of the *Species at Risk Act*. It is also listed as Endangered on the Species at Risk in Ontario List under the *Endangered Species Act, 2007*. Less than 5% of its global range occurs in Canada.

In the United States, Heart-leaved Plantain has not been reported in more than 20 years and is possibly extirpated (SH) in the District of Columbia, Florida, Iowa, Kentucky, Maryland and Virginia. It is considered Critically Imperilled (S1) in Alabama, Illinois, Indiana, Michigan, Mississippi, North Carolina, Ohio, Tennessee and Wisconsin, and Imperilled (S2) in Arkansas. It is ranked as Vulnerable (S3) in New York and Georgia, and Vulnerable to Apparently Secure (S3S4) in Missouri. Populations have declined drastically throughout its range except for Missouri, where it appears to be stable (NatureServe 2010).

3. SPECIES INFORMATION

3.1 Species Description

Heart-leaved Plantain is a semi-aquatic[1] perennial herb with fleshy, branching roots and a rosette of basal leaves. The large, distinctive heart-shaped leaves are evident only in the summer (NatureServe 2010), while smaller, narrower leaves are produced in the cooler seasons (Tessene 1969). Small, fleshy flowers grow on the upper 20 cm of the leafless stems. The average number of seed capsules per fruiting stalk at the extant Ontario populations is 86.4 (Brownell 1998). Seed capsules contain dark brown seeds 2.5 to 3.5 mm in length (Brownell 1998).

3.2 Population and Distribution

Historically, the global range of Heart-leaved Plantain extended across North America from Minnesota, Michigan, Ohio, and Ontario, south to the southeastern United States, with occurrences reported in 19 states and 1 province (Brownell 1998). Today, its populations are very localized. There is a centre of abundance in Missouri and several isolated occurrences from eastern New York to northern Florida (Figure 1). Canadian populations are reduced to two extant locations[2] near the southern shore of Lake Huron (Figure 2). Populations at five other locations within Essex County, Lambton County, and Middlesex County are now considered extirpated (NHIC 2006; Table 1).

The extant population at the former Camp Ipperwash in Lambton County can be characterized as two subpopulations (1 and 2) inhabiting adjacent systems of wet linear depressions (intermittent stream bed), situated SE and NW within the property, respectively. The Parkhill population in Middlesex County occurs at the headwaters of an ephemeral stream that is an upper tributary of the Ausable River watershed.

Based on intermittent surveys, the two extant Ontario populations appeared to remain stable between the mid-1980s and late-1990s (Brownell 1998) (Table 1). At the former Camp Ipperwash location, surveys in the early 1990s (MHA 1994; Sutherland et al. 1994) identified two to three subpopulations within what is referred to as Subpopulation 1 above; MHA (1994) estimated the size of Subpopulation 1 to be 5082 plants. Subpopulation 2 was first recorded in 1993 by Sutherland et al. (1994) as a single plant. In 2008/2009, Neegan Burnside (2008, 2009) counted 3850 plants in Subpopulation 1; partial surveys in Subpopulation 2 yielded from 15-47 plants. The population overall at former Camp Ipperwash appears to be well-established and stable (Damude pers. comm. 2010). At the Parkhill location, surveys in 1988 and 1997 identified one subpopulation comprising 3066 and 3200 mature plants, respectively (Brownell 1998). Work completed in 2010 provided a population estimate at Parkhill of between 800 and 1100 mature plants (Jones 2010).

[1] Semi-aquatic: growing or living in or close to water, or carrying out part of its life cycle in water; not fully aquatic.
[2] Location: Defined by COSEWIC (2010) as a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present.

Table 1. Summary of Element Occurrences[3] in Ontario

Location	EO Rank[4]	Last Obs.	Population Estimates	Notes
Former Camp Ipperwash (Lambton County; federal land)	A	2010	Subp.1 / Subp.2 1984: obs / - 1989: ~3700 / - 1993: 5082 / 1 2006: obs / obs 2007: - / 15-20 2009: 3850 / 47 2010: obs / obs	Reported in 1984; known previously by Chippewas of Kettle and Stony Point First Nation. Population surveyed in 1989 (Oldham and McLeod 1990). Population size for Subpopulation 1 in 1993 estimated to be 5082. (MHA 1994); may include juveniles. Subpopulation 1 was characterized by MHA (1994) and Sutherland et al. (1994) as 2 and 3 subpopulations, respectively. Subpopulation 2 was first discovered in 1993 and recorded as a single plant (Sutherland et al. 1994). Property inventoried in 2006 by AMEC (2006), who mapped Subpopulation 2 as over 20 dots, though no stem counts were carried out. In 2007/9, 3850 plants (including some juveniles) recorded at Subpopulation 1; two partial surveys were undertaken for Subpopulation 2 (Neegan Burnside 2008, 2009). Both subpopulations confirmed in 2010 (Golder 2010). Maps permitting the placement of recorded occurrences into subpopulations 1 and 2 from 1994, 2006, and 2008/9 given in MHA (1994) and Golder (2010).
Parkhill, Headwaters of Ausable river (Middlesex County; non-federal land)	B	2010	1988: ~3066 1997: ~3200 2010: ~800-1100	Discovered in 1987 (Oldham and McLeod 1990). Little change in population estimates between 1988 and 1997 surveys (Brownell 1998). Population counts updated in 2010 (Jones 2010).
Near Thedford (Lambton County; non-federal land)	X	1967	Extirpated	No plants located in 1984. Stream is now largely cleared of trees, heavily grazed and trampled, and much degraded (NHIC 2006).
Lucan (Middlesex County; non-federal land)	X	1894	Extirpated	Area searched extensively in 1985 with no sign of the species (NHIC 2006).
Glencoe (Middlesex County; non-federal land)	X	1893	Extirpated	Old specimen record. Glencoe area searched by Oldham, Allen and McLeod in 1985; no suitable habitat found (NHIC 2006).
Near Amherstburg (Essex County; non-federal land)	X	1882	Extirpated	Plant not located in 1981, and severe habitat and water quality degradation noted; county-wide deforestation has lead to more severe flooding and scouring of rivers. (Brownell 1983; NHIC 2006).

[3] An Element Occurrence (EO) is identified by the NHIC as an area of land and/or water in which the species is, or was, present.
[4] Rank definitions for EO are: A (Excellent predicted viability); B (Good predicted viability); X (Extirpated) (NHIC 2003).

Location	EO Rank[4]	Last Obs.	Population Estimates	Notes
Near Canard River (Essex County; non-federal land)	X	1863	Extirpated	Some woodlands remain along the Canard River, and most of these have been searched. Water quality of the Canard River and its watershed has been severely degraded; county-wide deforestation has lead to more severe flooding and scouring of rivers (Brownell 1983; NHIC 2006).

Obs. = observation

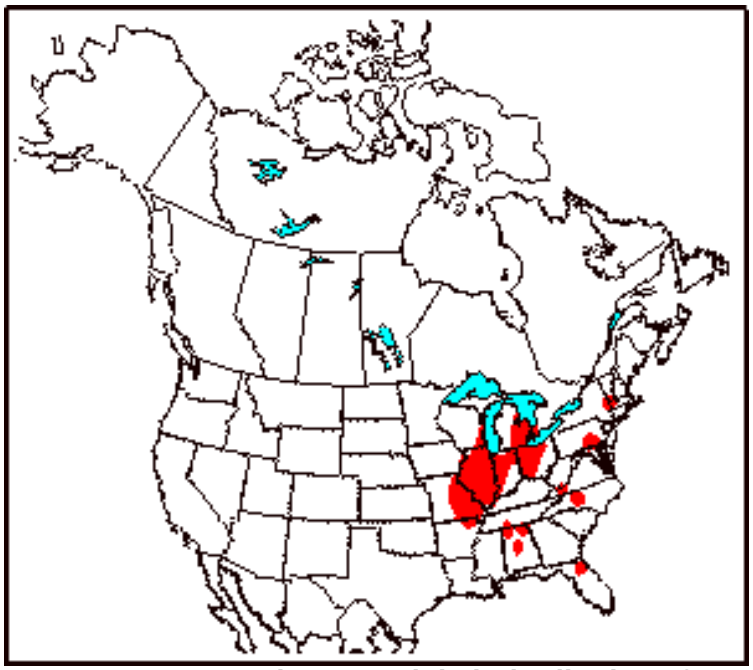

Figure 1. Global Distribution of Heart-leaved Plantain (modified from Argus et al. 1982-1987).

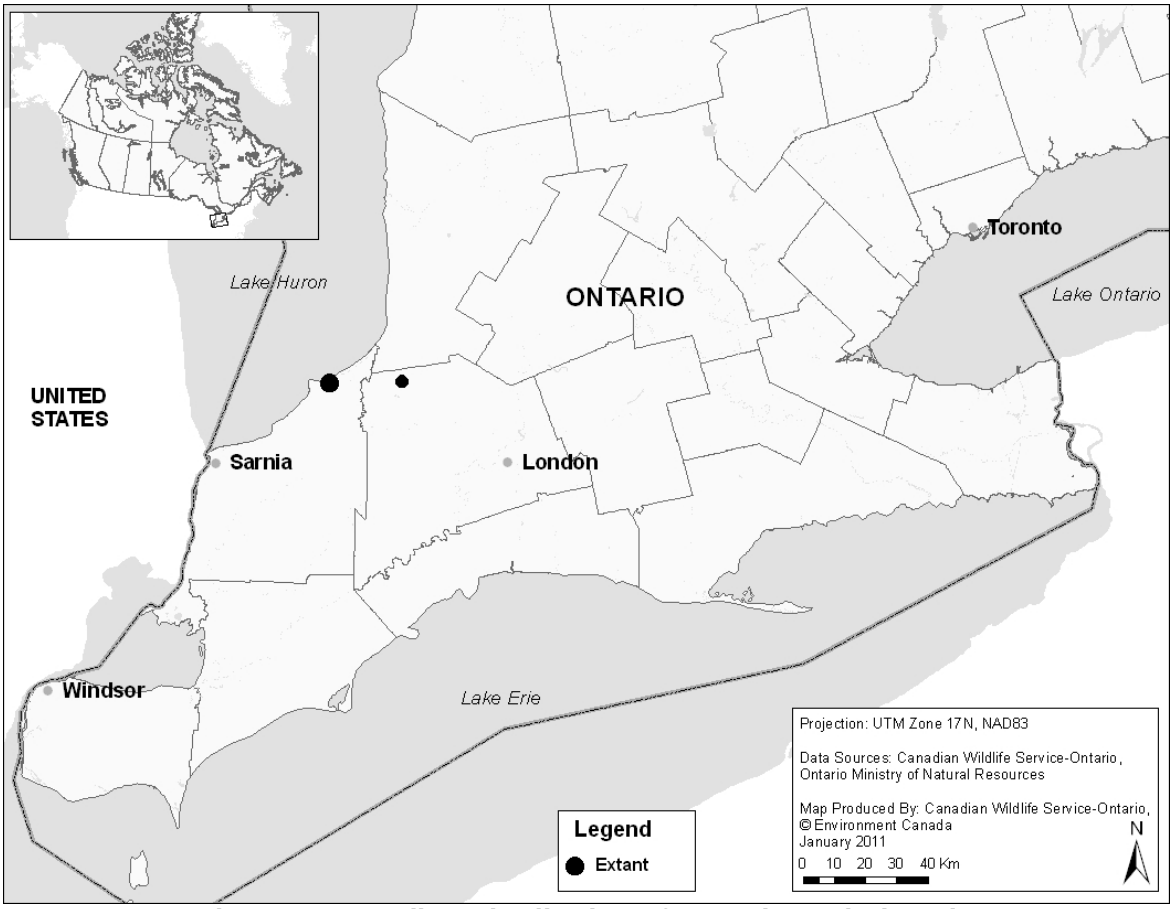

Figure 2. Canadian Distribution of Heart-leaved Plantain

3.3 Needs of the Heart-leaved Plantain

Heart-leaved Plantain occurs in relatively undisturbed wet woods, often along rocky or gravelly calcareous beds of shallow, slow moving clear streams. In Ontario, populations are found where ephemeral creeks flow in the spring. Moisture is generally always present above or just below the soil surface. The soil in which the former Camp Ipperwash (Lambton County) population grows is clay loam (Brownell 1998), while the Parkhill population grows in soil described as "moist black muck" (NHIC 2006).

The dominant trees where the two extant Ontario populations are found include Sugar Maple (*Acer saccharum*), Silver Maple (*Acer saccharinum*), Red Maple (*Acer rubrum*), Blue-beech (*Carpinus caroliniana*), Shagbark Hickory (*Carya ovata*), White Ash (*Fraxinus americana*), Black Ash (*F. nigra*) and Basswood (*Tilia americana*) (Brownell 1998). Heart-leaved Plantain is usually found with herb associates Swamp Buttercup (*Ranunculus hispidus* var. *caricetorum*), Poison Ivy (*Toxicodendron rydbergii*), Water Pimpernel (*Samolus valerandi*) and Fowl Manna Grass (*Glyceria striata*) (Brownell 1998), but generally occupies areas where other ground vegetation is sparse.

Day length and temperature determine the timing of leafing and flowering (Tessene 1969). In Ontario, Heart-leaved Plantain blooms in mid-April (Brownell 1998). Flowers are normally wind-pollinated, yet are capable of self-pollination. New plants are also capable of sprouting from the roots of a parent plant (Brownell 1998). Seeds, released in early summer, are highly buoyant and adhere to floating objects while they are dispersed within the streambed (Brownell 1998). The majority of seeds fall in close proximity to parent plants, where they have only a few months to germinate after drying (Tessene 1969; Stromberg et al. 1983; Brownell 1998).

3.4 Biological Limiting Factors

Heart-leaved Plantain is limited by its specialized habitat requirements and the dynamic nature of its ephemeral creek habitat. When this species occurs in habitat islands within a fragmented landscape as the Ontario populations do, their ability to disperse and colonize new locations is limited. The ability to colonize new locations is further restricted by the fact that seeds are normally dispersed by water in small, ephemeral, slow-moving streams, which in themselves are sparsely-distributed on the landscape. Relatively small, geographically-isolated populations are prone to loss of genetic diversity and are at greater risk of being extirpated by stochastic events. A genetic study with samples from six states and Ontario found that there is very little genetic variation in the species, suggesting that genetic bottlenecks and founder effects have resulted from population crashes (Brownell 1998).

Heart-leaved Plantain has the lowest reproductive output of all plantain species (NatureServe 2010). Seedling mortality is high, and the dependence on the same mature individuals to reproduce each year places the species in a vulnerable position; adult plants can withstand stress (e.g., stream draining, pollution) for short periods, but if stressors persist for several seasons, the adult population will not reproduce and will eventually be extirpated (Tessene 1969; NatureServe 2010).

4. THREATS

Threats to the Canadian populations of Heart-leaved Plantain are listed in order of priority, from the most to least serious, based on existing information and knowledge and with a focus on the extant populations (Table 2). However, it is likely that this information will change as greater understanding is gained about the threats to extant populations and factors that led to the extirpation of historic populations.

4.1 Threat Assessment

Table 2. Threat Assessment Table

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Habitat Loss and Degradation*						
Nutrient-loading from agricultural run-off	High (Parkhill) / Medium (former Camp Ipperwash)	Widespread	Historic/ Current	Continuous / Seasonal	Unknown	High
Removal of riparian vegetation	High (Parkhill) / Low (former Camp Ipperwash)	Widespread	Historic/ Current	Recurrent	High	High
Timber harvesting	High (Parkhill) / Low (former Camp Ipperwash)	Widespread	Historic/ Current	Recurrent	Medium–high	Medium–high
Ditching, draining, and damming	Medium (Parkhill) / Low (former Camp Ipperwash)	Widespread	Historic/ Current	Recurrent	Medium	High
Detection and removal of unexploded explosive ordnances[5] (former Camp Ipperwash)	Medium (former Camp Ipperwash)	Localized	Anticipated	One-time	High	Low

[5] Unexploded explosive ordnances are a by-product of live fire training, consisting of munitions that have been primed, fuzed, armed or otherwise prepared for action, and that have been fired, dropped, launched or placed in a manner that constitutes a hazard to people, operations, or installations, and remains unexploded by malfunction or for any other reason (DND 2011).

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Land development (Agricultural)	Low (Parkhill)	Localized	Historic/ Current	Recurrent	High	High
Natural Processes or Activities*						
Invertebrate herbivory	Medium	Widespread	Unknown	Continuous	Unknown	Low
Exotic, Invasive, or Introduced Species*						
Gray Garden Slug (*Deroceras reticulatum*)	Medium (former Camp Ipperwash) / Unknown (Parkhill)	Unknown	Historic/ Current	Continuous	Unknown	Medium
Consumptive Use*						
Harvesting for food / medicinal uses	Medium (former Camp Ipperwash) / Low (Parkhill)	Widespread	Unknown	Continuous	Unknown	Low

[1] *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).*
[2] *Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).*
[3] *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).*
** Threats are listed in decreasing level of significance.*

4.2 Description of Threats

Throughout its North American range, the major threats to Heart-leaved Plantain have been cited as habitat degradation resulting from upstream impacts (e.g., clearing of riparian vegetation, industrial, agricultural and domestic run-off), and alterations to stream flow (Brownell 1998; CPC 2006; NatureServe 2010). In the case of the two extant Ontario populations, water flow appears to originate primarily from local snow-melt and rainfall. This suggests that the main threats to these populations would be alterations to local stream and riparian habitat, as well as alterations to woodlands in the immediate vicinity.

Nutrient Loading from Agricultural Run-off
At the Parkhill population, some runoff from an adjacent agricultural field may occur, particularly in spring and following heavy rains. Similarly, one of the subpopulations at the former Camp Ipperwash appears to be impacted by drainage from an upstream agricultural field (Jalava and Ambrose 2010). The resulting nutrient loading could lead to eutrophication and algal blooms that trap seeds and kill seedlings (Stromberg et al. 1983; Brownell 1998).

Timber Harvesting and Removal of Riparian Vegetation
Some types of timber harvesting (particularly clear-cutting or heavy selective logging that does not maintain a minimum 75% canopy cover) and removal of riparian vegetation can result in higher stream temperatures, increased erosion, and siltation, which can cause mortality of adult plants and prevent seedling establishment (NatureServe 2010). Additionally, the high levels of runoff from deforested areas increases the frequency and intensity of flooding and scouring of the stream bed, which can lead to shredding and uprooting of plants (Meagher et al. 1978). Seedlings are especially susceptible to uprooting during floods (NatureServe 2010).

At the two historic locations in Essex County, county-wide deforestation has lead to more severe flooding and scouring of rivers, and water quality degradation, and likely contributed to the decline of Heart-leaved Plantain (Brownell 1983; NHIC 2006).

Ditching, Draining, and Damming
Alterations to streamflow caused by ditching, draining, and damming, can reduce the natural water level fluctuations to which Heart-leaved Plantain is adapted. This can leave the plants susceptible to being crowded out by newly-established vegetation (NatureServe 2010). Localized signs of such alterations were observed at the Parkhill site in 1989 (Oldham and McLeod 1990).

Detection and Removal of Unexploded Explosive Ordnance
On the former Camp Ipperwash site, currently owned and managed by the Department of National Defence (DND), there is some concern for potential disturbance of Heart-leaved Plantain during upcoming decommissioning activities. Studies are currently underway to delineate areas where munitions (unexploded explosive ordnances) and species at risk occur, and to evaluate next steps for decommissioning the site safely and protecting species at risk, including Heart-leaved Plantain. Environment Canada is working closely with DND and the Kettle and Stony Point First Nation to protect species at risk. It is not known at this stage whether or not decommissioning activities will impact Heart-leaved Plantain and, if so, what mitigation measures will be taken to protect the species on the site.

Invertebrate Herbivory
Invertebrate herbivory (by slugs, snails, weevils, caterpillars and beetle larvae) on Heart-leaved Plantain is common, and many plants in Ontario have been found with holes in the leaves, or with leaves severed at the petiole (MHA 1994; NatureServe 2010). This likely contributes to the high rates of seedling mortality in this species.

Gray Garden Slug (*Deroceras reticulatum*)
In addition to native herbivores, the introduced Gray Garden Slug is considered to be a significant threat to Heart-leaved Plantain, causing damage through grazing on the leaves of mature plants and seedlings (MHA 1994; AMEC 2006). In recent surveys at the former Camp Ipperwash, although evidence of herbivory was noted on some plants, the slug itself was not found (AMEC 2006). Further surveys are warranted at both extant sites to confirm the slug's presence and to document its impact on Heart-leaved Plantain.

Harvesting for Food/ Medicinal Purposes
In Ontario, this species (also known as "hollowroot") has historically been collected by Aboriginal peoples for food and medicinal uses (NatureServe 2010).

Land Development (Agricultural)
Land development, especially for agriculture, has contributed to the decline of the Heart-leaved Plantain in Canada, by causing on-site habitat loss and isolation of populations (Brownell 1998).

Though not currently a threat to extant populations in Canada, cattle grazing and trampling on lands developed for agriculture is thought to have caused the extirpation of one historic population near Thedford, and has rendered some wet wood habitat in the vicinity of the extant Parkhill site unsuitable for colonization (Brownell 1998).

5. POPULATION AND DISTRIBUTION OBJECTIVES

The population and distribution objectives are to maintain the current abundance of Heart-leaved Plantain at known extant populations and throughout its current distribution, and to maintain or increase the current distribution of Heart-leaved Plantain in Canada where biologically and technically feasible. The Canadian distribution of Heart-leaved Plantain is very restricted, occurring at the northern edge of its range. It is unknown whether sufficient suitable habitat can be restored and maintained to promote recovery beyond maintaining the two extant populations. Five additional populations of this species were known in Canada in the past, but have not been seen in over 40 years. Given the extent of land conversion within the historic range of Heart-leaved Plantain in Canada, opportunities for re-establishment of historic populations are currently believed to be very limited, but require further investigation.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Currently Underway

- Periodic surveys of the two extant populations have been undertaken in Ontario. Survey results are presented in the COSEWIC status report (Brownell 1998) and more recent data are presented in Section 3.2 of this recovery strategy. The most recent inventories were at the former Camp Ipperwash site in 2008/2009 (Neegan Burnside 2009) and at the Parkhill site in 2010 (Jones 2010).
- A management plan for Heart-leaved Plantain at former Camp Ipperwash was prepared in 1993 (MHA 1994; NHIC 2006).
- Mapping of the Parkhill population as part of the Conservation Land Tax Incentive Program was undertaken in 1998 by the Ontario Ministry of Natural Resources.

- A Conservation Action Plan (CAP) for the Ausable River – Kettle Point to Pinery area has been produced (Jalava et al. 2010). The CAP lists Heart-leaved Plantain as one of its biodiversity conservation targets, and the objectives include filling knowledge gaps regarding Heart-leaved Plantain.
- A Recovery Strategy for the Heart-leaved Plantain (*Plantago cordata*) in Ontario has been developed (Jalava and Ambrose 2012).

6.2 Strategic Direction for Recovery

Table 3. Recovery Planning Table

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Knowledge of the status of populations and habitat	High	• Species and Habitat Surveys and Monitoring	• Develop a monitoring protocol and monitor extant populations at regular intervals; • Identify and survey areas with suitable habitat, particularly where it occurs near extant or historic populations; • At all extant and potential sites, characterize habitat and clarify threats.
All threats in habitat loss and degradation category; Harvesting for food/ medicinal uses	High	• Habitat Protection, Management, and Stewardship; • Outreach, Education, and Communication	• To the extent possible, protect habitat through existing legislation and policies, landowner stewardship, and through the development of Beneficial Management Practices (BMPs) for upstream activities and encourage awareness of the species and the transfer of Traditional Ecological Knowledge; • Work with DND to minimize damage to Heart-leaved Plantain habitat during decommissioning, and work with the Chippewas of Kettle and Stony Point First Nation to manage habitat for Heart-leaved Plantain and to develop appropriate land-use planning and stewardship for the population on the former Camp Ipperwash; • Work with municipalities, conservation authorities, the Province of Ontario, and landowners to develop appropriate land-use planning and stewardship as necessary.

All threats in habitat loss and degradation category	High	• Investigate Feasibility of Reintroduction	Work with the Province of Ontario to: • Determine feasibility of restoration or rehabilitation of habitat at historic occurrences; • Understand causes of extirpation to protect current sites; • Investigate feasibility of reintroduction; • Restore habitats and reintroduce the species to historic locations, if deemed necessary and feasible
Knowledge gaps; Gray Garden Slug	Medium	• Coordination and Research	Engage academic community to investigate, for example: • requirements for dispersal and seedling establishment; • methods of propagation and reintroduction; • management techniques for Gray Garden Slug.

7. CRITICAL HABITAT

7.1 Identification of the Species' Critical Habitat

Critical habitat for Heart-leaved Plantain is fully identified in this recovery strategy, using the best available information. Additional critical habitat may be identified across the range of the species as more information becomes available.

Critical habitat for Heart-leaved Plantain is identified as the extent of contiguous suitable habitat (Section 7.1.1) within the site boundary as per the Site Occupancy Criterion (Section 7.1.2).

7.1.1 Suitable Habitat

Heart-leaved Plantain requires a moist and a stable substrate for seed germination, seedling establishment, and the survival of young plants. The species has a very narrow habitat preference, found in the riparian areas of slow moving streams or wet depressions shaded by forest. In Ontario, Heart-leaved Plantain's habitat characteristics are as follows:

- wet to moist soils of wet depressions or where ephemeral creeks flow in the spring and during heavy rains, where, at other times of the year, the ground may be barely moist, and,
- forested sites, with a minimum of 75% tree canopy closure, dominated by trees including Sugar Maple, Silver Maple, Red Maple, Blue-beech, Shagbark Hickory, White Ash, Black Ash and Basswood (Brownell 1998).

Heart-leaved Plantain is generally thought to be an edge species, as it tends to occupy riparian areas on woodland or forest edges. However, the species requires a closed canopy (75% or greater) in forested habitats (Hill 2007); habitats more closely resembling forest interior habitat than forest edge habitat. Plants exposed to direct sun wilt quickly and die as they have a weak root system and direct sun tends to remove more water from the plants than they can take up (Hill 2007). Maintaining the forest interior conditions around the plant is important to maintaining the suitable micro-environment critical to species persistence.

Recent field work has shown that unoccupied suitable habitat tends to be near the existing population, and, in some cases, immediately adjacent to these populations (Jones 2010). Searches of the surrounding forested area did not reveal additional unoccupied suitable habitat (Jones 2010), however, the forest area immediately adjacent to the occupied area forms the structure of the suitable forest habitat and is necessary to maintain an interior forest environment. At present, it is not clear at what distance from the forest edge physical and/or biological processes begin to negatively affect Heart-leaved Plantain. Studies on micro-environmental gradients at habitat edges, i.e., light, temperature, litter moisture (Matlack 1993), and of edge effects on plants, as evidenced by changes in plant community structure and composition (Fraver 1994), have shown that edge effects could be detected up to 50 m into habitat fragments. As such, a minimum 50 m distance from any Heart-leaved Plantain plant to the forest edge is appropriate to ensure the necessary forest interior habitat is included and to help maintain suitable biophysical processes.

7.1.2 Site Occupancy

Site Occupancy Criterion: The site occupancy criterion defines an occupied site as a site where Heart-leaved Plantain has been observed for any single year since 2006.

A site is defined by a boundary drawn at a radial distance of 50 m around a known observation of Heart-leaved Plantain meeting the site occupancy criterion. An observation may be represented by a point (representing a single plant or a location where there are multiple plants) or a polygon (collected as boundary points around the outer edge of a larger population). The 50 m distance is applied to each observation, with spatially overlapping areas merged together to form larger sites. In cases where observations are represented by a polygon, the 50 m distance is applied to the outer edge of the polygon.

Information from 2006-2010 is used in this document to determine the habitat meeting the site occupancy criterion. During this time period, surveys were completed for both the former Camp Ipperwash and Parkhill populations. These surveys included extensive searches for Heart-leaved Plantain and all occupied areas within these extant populations are now believed to be identified. These surveys comprise the best available information upon which to base the identification of critical habitat.

7.1.3 Application of Heart-leaved Plantain Critical Habitat Criteria

Critical habitat for Heart-leaved Plantain is identified as the extent of contiguous suitable habitat (Section 7.1.1) within the site boundary as per the Site Occupancy Criterion (Section 7.1.2).

In order to maintain moisture regimes, allow natural processes to occur, and to protect the surrounding trees as a shaded, interior forest-like environment, the habitat within a radial distance of up to 50 m from a Heart-leaved Plantain plant occurring in suitable habitat is identified as critical habitat. If a distinct forest edge (e.g., change to agricultural lands or roads) occurs prior to the end of the 50 m radial distance, critical habitat ends at the hard edge. If a non-suitable forest edge (e.g., early successional forest with <75% cover) occurs prior to the end of the 50 m radial distance, critical habitat ends at the boundary of suitable forest. However, these areas should be considered for their restoration potential to aid in providing the necessary conditions for Heart-leaved Plantain. A distance of 50 m was chosen as a minimum critical function zone distance; that is, a threshold habitat fragment size required for maintaining constituent microhabitat properties for a species (e.g., light, temperature, litter moisture, humidity levels necessary for survival). Existing research provides a logical basis for including a minimum critical function zone distance of 50 m to ensure that microhabitat properties for rare plant species occurrences are maintained, such as for Heart-leaved Plantain (Matlack 1993; Fraver 1994; Forman and Alexander 1998). Where it does not currently exist, 50 m of suitable forest habitat should be a minimum target to protect the habitat of individual plants.

Application of the critical habitat criteria to available information identifies six sites at the former Camp Ipperwash population[6] and one site at the Parkhill population as critical habitat for Heart-leaved Plantain in Canada (Appendix B). It is important to note that the centroids presented represent the site polygon, and not the extent or boundaries of the critical habitat itself. As additional information becomes available, critical habitat identification may be refined or sites meeting critical habitat criteria may be added.

Appendix B, containing the coordinates of the centroids of critical habitat for Heart-leaved Plantain has been removed from the public document to protect the species and its habitat. Disclosing the location not only puts the plant at considerable risk from inadvertent trampling by visitors wishing to view the rare plant, but also increases the potential for collection.

7.2 Activities Likely to Result in the Destruction 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 (Government of Canada 2009).

Activities that are likely to result in the destruction of critical habitat include but are not limited to the following:

- Land development for agriculture and timber harvesting or other similar activities that lead to direct removal of habitat;
- Timber harvesting that reduces the forest canopy cover below 75% closure that leads to exposure to direct sunlight causing wilting and mortality;
- Activities (e.g., cattle grazing) that disturb the substrate and/or result in soil compaction or trampling, thereby preventing seedling establishment or causing plant mortality;
- Activities within the watershed (e.g., removal of riparian vegetation or timber harvesting) that cause erosion and siltation, thereby altering water quality and abiotic habitat that can increase plant mortality and prevention of seedling establishment;
- Changes to upstream activities (e.g., agricultural draining or non-point source pollution) that lead to downstream nutrient enrichment and eutrophication that can result in algal blooms that trap seeds and cause seedling mortality;
- Activities that affect the hydrologic regime (e.g., channelling or ditching). This can lead to scouring of the streambed and establishment of other vegetation that may change habitat characteristics to the point where Heart-leaved Plantain would not have space to grow.

[6] Three sites at the former Camp Ipperwash subpopulation 1 and three sites at the former Camp Ipperwash subpopulation 2.

8. MEASURING PROGRESS

The performance indicator presented below provides a way to define and measure progress toward achieving the population and distribution objectives for this species.

Every five years, success of recovery strategy implementation will be measured against the following performance indicators:

- the current level of abundance in Canada has not decreased, and
- the current distribution in Canada has not decreased.

9. STATEMENT ON ACTION PLANS

One or more action plans will be posted on the SAR Public Registry for Heart-leaved Plantain by December 2017.

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11. PERSONAL COMMUNICATIONS

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APPENDIX A: 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*. 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.

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.

This recovery strategy will clearly benefit the environment by promoting the recovery of Heart-leaved Plantain. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. None of the approaches identified in this strategy are expected to negatively impact other species at risk in Ontario. It is anticipated that some of the proposed broad strategies should benefit other floral and faunal species at risk known or suspected to occur in the area. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the document in particular: Needs of Heart-leaved Plantain; Strategic Direction for Recovery.

APPENDIX B: CENTROIDS OF CRITICAL HABITAT

This appendix has been removed from the document posted on the Public Registry.