COSEWIC
Assessment and Update Status Report

on the

Drooping Trillium
Trillium flexipes

in Canada

ENDANGERED
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Drooping Trillium — Photo by Robert Foster.

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COSEWIC
Assessment Summary

Assessment Summary – April 2009

Common name
Drooping Trillium

Scientific name
Trillium flexipes

Status
Endangered

Reason for designation
A showy perennial species currently present at only two small locations in southern Ontario. It has not been found at five additional sites where it was documented historically. This riparian species is at ongoing risk of habitat degradation from the invasion of exotic plants. It is also at risk from recreational activities and the effects of stochastic events due to its small population size.

Occurrence
Ontario

Status history
Designated Endangered in April 1996. Status re-assessed and confirmed in May 2000 and in April 2009.
Last assessment based on an update status report.

COSEWIC
Executive Summary

Drooping Trillium
Trillium flexipes

Species information

Drooping Trillium (*Trillium flexipes*) is a member of the Liliaceae, the lily family. No varieties or subspecies have been formally recognized, but one of the many forms has been named, forma *walpolei*. This reddish or maroon form is likely a hybrid with Red Trillium (*Trillium erectum*). Drooping Trillium can usually be differentiated from other co-occurring *Trillium* species by the absence or near absence of leaf stalks and slightly drooping flowers with large, spreading, white petals and a white, ovoid ovary with prominent stigmas.

Distribution

The historic range of Drooping Trillium includes Ontario and 17 states in the north-central and eastern US. The global maximum extent of occurrence encompasses approximately 850,000 km^2 but its distribution is discontinuous in much of its range. In Canada, it was historically known from seven sites in Ontario within the Carolinian zone. Populations at five of these sites are now believed to be extirpated. The only confirmed extant sites in Canada are along the Sydenham River at Strathroy and along the Thames River in Dunwich Township near Dutton. Its present Extent of Occurrence in Canada is about 7 km^2. Its Index of Area of Occupancy based on a 2x2 km grid is 8 km^2; the actual area of habitat occupied is 0.08 km^2 or 8 ha.

Habitat

Throughout its range, Drooping Trillium is typically found in hardwood forests on mesic, circumneutral soils. Canadian populations are associated with watercourses, usually on better drained microsites on floodplain terraces or adjacent slopes with sandy loam soils. It may benefit from periodic disturbance caused by flooding and the warmer than average microsites along river valleys.

Biology

Drooping Trillium is an herbaceous plant that typically flowers in May and June at Canadian sites. It is a rhizomatous perennial that takes on average 10 years to reach reproductive maturity. Each individual plant has one to several flowering stems. Reproduction is primarily sexual with ants playing a role in short-distance dispersal of seeds. Seeds have double dormancy, requiring two seasons of cold to germinate. Deer may also disperse seeds but can have a negative impact from herbivory.

Population sizes and trends

The species is secure globally, with numerous healthy populations in the US. At the northern periphery of its range in Canada, it has apparently been extirpated at 5 of the 7 known occurrences. Numbers appear to be stable or increasing at the two extant sites. A total of 1465 flower stems were found in 2007, which represents a smaller number of individual plants (perhaps 500-1000), because there are one to several flowering stems per plant. It also excludes a small number of non-flowering individuals.

Limiting factors and threats

Drooping Trillium is at the northern limit of its range in Canada and has restricted habitat preferences. The main historic and current threats to Canadian populations are habitat loss and degradation from urban and agricultural development. Trampling from increasing and incompatible recreational trail use threatens the Strathroy population. Invasive species such as Garlic Mustard and herbivory by White-tailed Deer are also threats.

Special significance of the species

Drooping Trillium has long been the study of amateur and professional botanists and is a component of biodiversity in Canada's Carolinian forest. First Nations peoples used the closely related trillium species for several medicinal purposes.

Existing protection or other status designations

Drooping Trillium has a NatureServe Conservation status G5 (secure). It is also ranked N5 in the US and is ranked as critically imperiled (S1) to common (S5) in its US range. The species is ranked N1 in Canada and S1 in Ontario. It is currently designated as Endangered in both Ontario (*Species at Risk Act*, 2007) and federally under the *Species at Risk Act* (COSEWIC, May 2000). One Canadian population is largely protected within St. Clair Region Conservation Authority land at Strathroy. The other is on private land. A recovery strategy is in the final stages of preparation.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2009)

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

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

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

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

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

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TABLE OF CONTENTS

List of Figures

List of Tables

SPECIES INFORMATION

Name and classification

Scientific name:	*Trillium flexipes* Rafinesque, C.S. 1840. Autikon Botanikon, 33. - U.S.A. (Kentucky; Tennessee).
Synonyms:	*Trillium declinatum* (Gray) Gleason. 1906. *in* Bull. Torr. Bot. Club 33:389; not Raf. 1840. *in* Autikon Botanikon,135.-U.S.A.(Alabama; Florida). *T. gleasonii* Fernald.1932. *In* Rhodora 34:2, 22. *T. erectum* L. var. *declinatum* Gray, as given on page 523 of Gray's Manual, edition 5, in 1867, and prior to the subsequent recognition of the taxon as a species by Gleason in 1906 (*i.e., T. declinatum*) *T. cernuum* var. *declinatum* (Gray) Farwell, as published in 1920 in the Report of the Michigan Academy of Science, Volume 21, page 363 *T. erectum* var. *blandum* Jennison (see also Kartesz and Kartesz 1980; Mitchell 1986).
Common names:	Drooping Trillium (Patrick 1987; Newmaster *et al.* 1998); Bent, Declined, or White Trillium (Patrick 1986a), and occasionally as Nodding Trillium (Mitchell 1986), although the later is more commonly used in reference to *T. cernuum.* French names include trille à pédoncule incliné (used by COSEWIC) and *trille courbe.*
Major plant group:	Monocot flowering plant.

Trillium flexipes has always been assigned to the very distinctive genus *Trillium*, which some (*e.g.*, Farr *et al* .1979; Patrick 1985; Mitchell 1989; Sawkins and McGough 1993) believe should be elevated to its own family (Trilliaceae), instead of being placed in the lily family (Liliaceae). There is also a consensus among botanists that Drooping Trillium represents a distinct species, although this was not always the case. Some difficulty still exists in assigning a given specimen to this species because of the great intra-specific variation and apparent ease with which hybridization occurs (Case 1987). Because of this and the apparent disappearance of the Rafinesque's type specimen, several synonyms have historically been used for *T. flexipes* (see Gray Herbarium Index 1968).

A colour form with red or maroon petals has been formally recognized as *T. flexipes* forma *walpolei* (Farwell) Fernald. According to the Gray Herbarium Index (1968), it was originally published in 1920 in the Report of the Michigan Academy of Science, Volume 2, page 363, as *T. cernuum* var. *declinatum* forma *walpolei* (Farwell). This taxon has been recognized historically in conjunction with the two specific synonyms mentioned above for *T. flexipes,* namely *T. declinatum* forma *walpolei* (Farwell) Friesner and *T. gleasonii* forma *walpolei* (Farwell) Deam. Case (2002) considers it to be a hybrid with *T. erectum.* Farwell also named another colour form of *T. flexipes* that has the typical white petals, but each with a dark reddish-brown blotch at the base, referring to it as forma *billingtonii.* However, Case and Burrows (1962) established that these two forms occurred only where the ranges of *T. flexipes* and *T.*

erectum overlapped, and then only where both species grew in proximity, thus enabling bees to cross-pollinate them. They concluded, therefore, that Farwell's so-called "forms" were not distinct taxa but were actually hybrids (Case and Case 1993). *Trillium flexipes* also hybridizes with *T. cernuum* where they occur sympatrically in Minnesota (Augustine and Frelich 1998; Rogers 1981).

Morphological description

*Trillium flexipe*s is 15 to 60 cm tall and emerges from a horizontal underground rhizome. The rhizome is an elongated, thick and fleshy generally unbranched subterranean structure that produces a terminal bud from which the single scape is produced. Buds can also form at axils of the rhizome (Case 2002). A single plant may have one or more sturdy above-ground stems (technically scapes) that are surmounted by a whorl of three sessile, green, leaf-like bracts attached to its short rhizome. These bracts function in photosynthesis and are structurally similar to leaves and many authors refer to them as leaves. They are up to 20 cm long and broad, abruptly acuminate, and narrowed from near the middle to the base. Not all stems or individuals bear flowers, and without digging up the rhizome, it may be difficult to discriminate an individual plant from adjacent ones.

On flowering stems, the peduncle is 3 to 12 cm long, straight, and can be erect, horizontal or recurved. The majority of plants have their flowers below the height of the leaves. Sepals are lanceolate and about equal in length to the petals. The petals are normally white but can be reddish or maroon in forma *walpolei* (Farwell) Fernald. Petals are usually obtuse, from 2 to 5 cm in length, and spreading but not usually recurved (Figure 1). Filaments are short and almost always 2 mm long, while anthers are from 6 to 15 mm in length, are 2 to 5 times as long as the filaments, and are white to creamy in colour. The ovary is white or pale to pink in colour, ovoid, sharply 6-angled, and broader at the base with prominent, coarse stigmas. It often has a stale or musty fragrance. Fruits are berrylike, rosy red to purplish, 2–3.5 × 1–3 cm, fragrant and very juicy at maturity (Case 2002). For more detailed descriptions see Fernald (1950), Patrick (1986a, 1986b), Gleason and Cronquist (1991) and Young (1994).

Figure 1. *Trillium flexipes* at Strathroy, May 2007 (photo by Robert Foster).

The only similar plants with which *T. flexipes* might be confused are other *Trillium* species. Plants of the Elgin County population were previously misidentified as *T. cernuum.* The key characters for separating *T. flexipes* from *T. cernuum* and *T. erectum* are summarized in Table 1. Plants of the Strathroy population of *T. flexipes* (especially those with maroon-coloured petals) are most likely to be confused with *T. erectum,* which also occurs at this site. Vegetatively, these two species are more similar to each other than to *T. cernuum.*

Table 1. Distinguishing morphological features of *Trillium flexipes*, *T. cernuum* and *T. erectum* (Case 2002, Patrick 1986a, 1986b).

Species	*Trillium flexipes*	*Trillium erectum*	*Trillium cernuum*
Leaves	Sessile	Sessile	Short petiole
Anthers	Longer than filaments, cream-coloured	Equaling filaments; dark maroon	Equaling filaments; pink
Pedicel	Horizontal to erect	Horizontal to erect	Declined below leaves
Ovary	White, ovoid, strongly angled	Purple-black to maroon, subglobose	White, ovoid
Petals	Spreading; up to 5 cm long and 3.5 cm broad	Spreading; 1.5 to 5 cm long and 1 to 3 cm broad	Recurved between sepals; maximum of 2.5 cm long and 9 mm broad

Genetic description

No genetic studies of Canadian populations of *Trillium flexipes* have been published to date. Northern populations of closely related *T. erectum* tend to have less genetic diversity than southern populations, likely as a result of historical patterns of post-glacial dispersal (Griffin and Barrett 2004). There is presumably little or no gene flow between populations in Ontario or with populations to the south in the United States. The two extant Ontario sites are 27 km apart, which is greater than the expected foraging distance of its insect pollinators or seed dispersers. All seven historic and extant Ontario sites are separated by a maximum of 350 km between Niagara Glen in the northeast and Amherstburg to the southwest.

Designatable units

A single designatable unit is recognized for this widespread eastern North American species because of its very restricted range in Canada within a single COSEWIC ecological area (Carolinian).

DISTRIBUTION

Global range

The main range of *Trillium flexipes* runs west from western New York State through to southeastern Minnesota, south to northern Mississippi and east to northwestern Georgia (Figure 2). A disjunct population also occurs in the Susquehanna River drainage of Maryland and Pennsylvania on the eastern seaboard (Patrick 1986a; Argus and Pryer 1990). Reports from South Dakota are unconfirmed (Ode 2007). It is extant in Ontario and 17 states but its distribution is discontinuous and localized (Figure 2). The global maximum extent of occurrence encompasses approximately 850,000 km^2 based on Case (2002). The proportion of the global range and population size in Canada is less than 1%. There are large areas of unsuitable habitat within this range where the species does not occur.

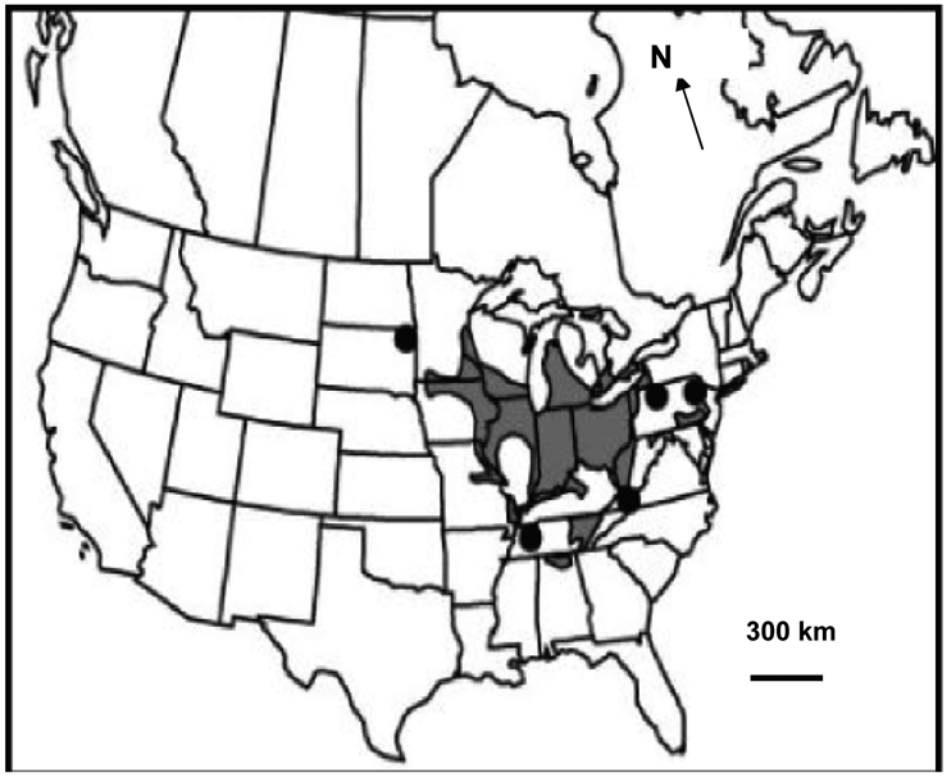

Figure 2. Distribution of *Trillium flexipes* in North America (Case 2002).

Canadian range

Trillium flexipes extends into Canada along the northeastern border of its range only within the Carolinian Zone of southwestern Ontario along the northern side of Lake Erie (Figure 3). In Canada, *Trillium flexipes* was known historically from seven sites, but is thought to persist only at two locations, Strathroy and Dunwich (Figure 3, Table 2). The Strathroy site was first discovered in 1898, but it was not until 1989 that the population was rediscovered by Muriel Andreae and subsequently a specimen was collected by D. Martin (Bowles pers. comm. 2008). Both the typical white *T. flexipes* and the reddish *walpolei* form are present at this site. *Trillium flexipes* was discovered at the Dunwich site in 1993 by D. McLeod and M. Oldham during fieldwork for the original COSEWIC status report. *Trillium flexipes* has not been relocated at any of the other historic sites since the original collections and it is extirpated or presumed extirpated at those locations (Table 2).

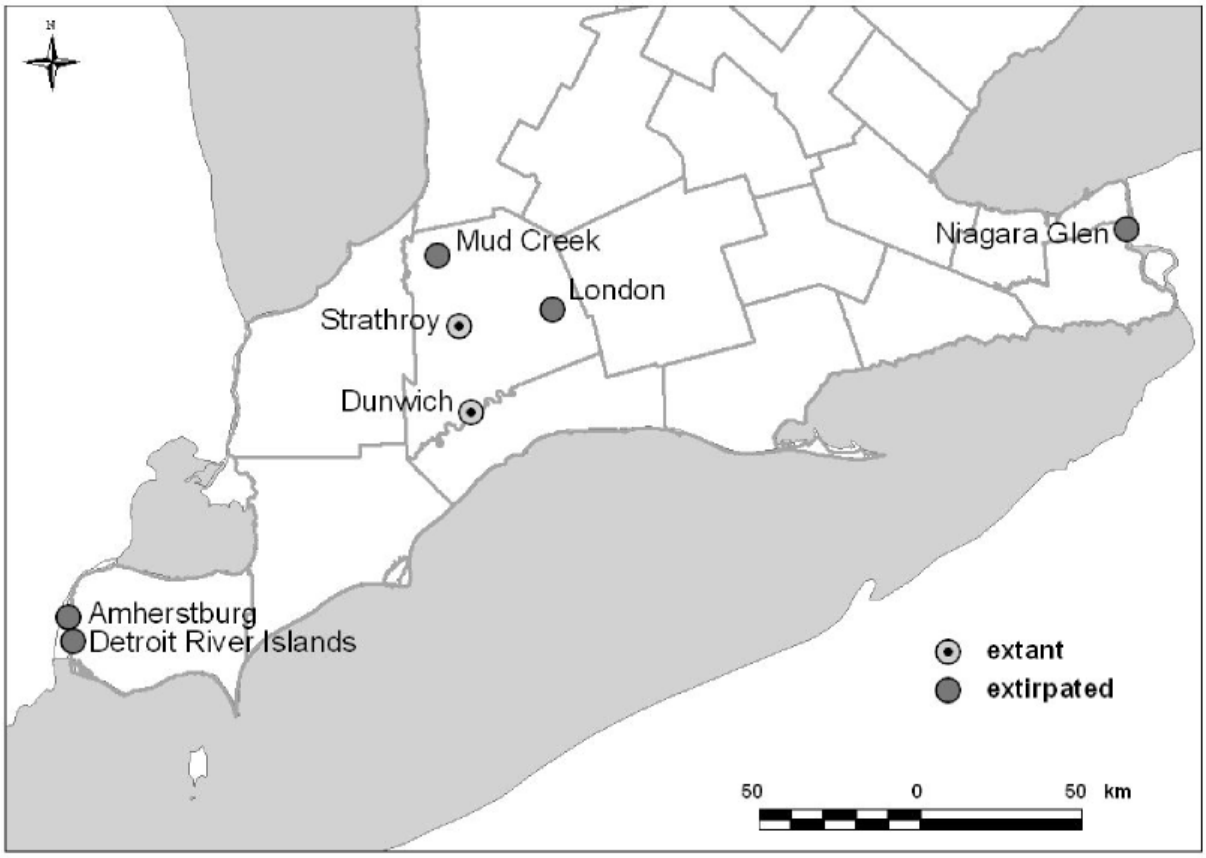

Figure 3. Distribution of *Trillium flexipes* in Canada (Patrick 1986).

Table 2. Location of known historical and extant populations of *Trillium flexipes* in Canada.

Site	County / Region	1st Collector	Voucher*	Date	Current Status
Amherstburg, Malden Township	Essex	Maclagan?	E	1848	extirpated?
Islands of Detroit River	Essex	Maclagan	E	1849	extirpated?
North branch of Thames River near London	Middlesex	Millman & Burgess	TRT, MTMG	1881	extirpated
Mud Creek flats near Parkhill, McGillivray Township	Middlesex	Dearness	DAO	1892	extirpated?
Sydenham River at Strathroy	Middlesex	Smith	DAO	1898	extant
Niagara Glen, Stamford Township	Niagara Region	Shields & Miller	TRT	1950	extirpated?
NW of Dutton, Dunwich Township	Elgin	McLeod & Oldham	UWO	1993	extant

DAO = Agriculture and Agri-Food Canada Herbarium, Ottawa; E = Royal Botanic Garden Herbarium, Edinburgh; MTMG = McGill University Herbarium, Montreal; TRT = Royal Ontario Museum Herbarium, Toronto; UWO = University of Western Ontario Herbarium, London.

The specimen from the Niagara Glen site shows some evidence of past introgression with *T. erectum* and the population probably no longer persists (Patrick 1987). A collection from the Thames River near London on May 14, 1993, by M.J. Oldham, at first suspected of being *Trillium flexipes,* was subsequently determined to be *T. cernuum* (Patrick 1994).

Trillium flexipes is at the northern limit of its global range in Canada, and all known Canadian sites are within the Mixedwoods Plain Ecozone (Environment Canada 2007), and more specifically the Niagara Section of the Deciduous Forest Region (Rowe 1972),often called the Carolinian Zone. Canadian occurrences likely reflect post-glacial dispersal along river valleys that provided warm microclimates, sandy alluvial soils, and associated overstorey vegetation (Gleason 1952). This migration into Canada appears to have occurred through either the Niagara Peninsula from northwestern New York State and/or from southern Michigan at the western end of Lake Erie, and would have begun approximately 8000 years ago after the retreat of the Ontario Lobe of the Wisconsin Ice Cap (Chapman and Putnam 1984).

The maximum extent of occurrence (EO) in Canada is about 7 km^2 based on a long narrow polygon encompassing the Strathroy and Dunwich sites (0.3 km wide x 27 km long); this includes a large amount of unsuitable habitat between the two localities. The Index of Area of Occupancy based on 2x2 km grid cells is 8 km^2 and 2 km^2 based on a 1x1 km grid; the actual area occupied by *Trillium flexipes* in Canada is 0.08 km^2 or 8 ha.

HABITAT

Habitat requirements

In Canada, *Trillium flexipes* is an understorey, perennial herb of forested, mesic to wet-mesic floodplain terraces and slopes adjacent to rivers or other watercourses on circumneutral, sandy loam soils. All Ontario populations except perhaps the Amherstburg site are associated with watercourses suggesting that fluvial processes are responsible for creating and maintaining a suitable habitat. It is able to tolerate, or even possibly benefit from some periodic disturbance of a site caused by annual flooding and sediment deposition within the floodplain of a watercourse. *Trillium flexipes* apparently requires circumneutral, sandy loam soils and the drainage provided by slightly elevated floodplain terraces and slopes above the local seepage zone. These topographic features within a riverine system also typically have the long-term stability that allows establishment of the forest community required by *Trillium flexipes.* The warmer climate prevailing within the Carolinian Zone, augmented by warmer, site-specific microclimates, appears to be a requirement as well.

Trillium flexipes prefers better drained, circumneutral soils (Patrick 1994). The old London and the extant Strathroy populations are located in spillway and sand plain areas within the Caradoc Sand Plains and London Annex physiographic region. The extant Dunwich population occurs in a narrow strip of sand plain that connects the Caradoc Sand Plains to the Bothwell Sand Plains via the Thames River corridor (Chapman and Putnam, 1984). The historical Parkhill population on Mud Creek occurs within a bevelled till plain area of the Huron Slope physiographic region, while the Detroit River and Amherstburg historical populations are most likely within the clay plain portion of the St. Clair Clay Plains region.

The Strathroy site contains a large more or less continuous population growing in sandy loam of a relatively flat to undulating floodplain of bottomland forest along the Sydenham River. *Trillium flexipes* favours the slightly higher elevations of better drained microsites on the floodplain. Upstream of the *T. flexipes* population, a transition to deciduous swamp on muck soils occurs where the ground cover is dominated by Skunk Cabbage (*Symplocarpus foetidus*), and *T. flexipes* gives way to *T. erectum* and *T. grandiflorum* along well-drained adjacent slopes. The Dunwich population occurs in loamy sand of a relatively steep (30° to 45°), northeasterly-facing slope along the south side of the Thames River. In contrast, this population is not subject to annual spring flooding and has a mesic moisture regime because the plants occur above the zone of permanent groundwater seepage.

Trillium flexipes depends upon the open canopy state of a deciduous forest in the spring for early growth and flowering. Both the Strathroy and Dunwich sites have mature deciduous forest with 75 to 100% canopy closure when fully leafed out. Dominants at Strathroy are Silver Maple (*Acer saccharinum*), Manitoba Maple (*A. negundo*), Sugar Maple (*A. saccharum*), White Ash (*Fraxinus americana*), and Basswood (*Tilia americana*), whereas at Dunwich the main tree species are Hackberry (*Celtis*

occidentalis), American Elm (*Ulmus americana*), American Beech (*Fagus grandifolia*), Blue Ash (*Fraxinus quadrangulata*), Black Maple (*Acer nigrum*), Slippery Elm (*U. rubra*) and White Ash (*Fraxinus americana*). At Strathroy, the shrub layer varies from a rather open situation with only a few scattered shrubs and saplings to areas where more densely concentrated patches occur. Common associates include Gray Dogwood (*Cornus racemosa*), Witch-hazel (*Hamamelis virginiana*), Chokecherry (*Prunus virginiana*) and introduced honeysuckles (*Lonicera* spp.). Understory plants are dominated by Ostrich Fern (*Matteuccia struthiopteris*), Garlic Mustard (*Alliaria petiolata*), Wild Ginger (*Asarum canadense*), and Jack-in-the-pulpit (*Arisaema triphyllum*). At Dunwich, the shrub layer is much sparser, mainly sapling regeneration of the canopy species, and the most common ground cover species are White Baneberry (*Actaea pachypoda*), Garlic Mustard, Jack-in-the-pulpit, Jewelweed (*Impatiens capensis*), False Solomon's Seal (*Maianthemum racemosum*), May-apple (*Podophyllum peltatum*), and Bluestem Goldenrod (*Solidago caesia*).

Habitat trends

Clearing and alteration of riverine woodlands for development and recreational purposes has been widespread and ongoing throughout the historical Canadian range of *Trillium flexipes.* Habitat destruction is the probable cause for the loss of the former London population and likely the two Essex County populations, because there has been a high level of ongoing development in that area during the past 150 years. However, the lack of specific location information for the Essex sites makes it difficult to draw any hard conclusions. The Mud Creek population may have fared better because there appears to have been little, if any, alteration of the main valley of the creek for some distance upstream of the Parkhill Conservation Area reservoir.

The Strathroy site along the Sydenham River has undergone some timber harvesting in the past, but it appears to have remained relatively unchanged since the initial discovery of this population almost 100 years ago. Its bottomland location within a small floodplain probably made it undesirable for agricultural use. However, some *Trillium flexipes* habitat was lost for the development of a golf course. Selective logging of large diameter trees, mainly ash, occurred at the Dunwich site in 2003. Timber harvesting may have also occurred at this site prior to the MNR's 1970 *Woodlot Improvement Act* agreement with the landowner. Agricultural tillage on the adjacent upland area may also contribute to some nutrient enrichment of this site.

Habitat protection/ownership

The vast majority of the Strathroy population of *Trillium flexipes* occurs within the Strathroy Conservation Area, which is owned and managed by the St. Clair Region Conservation Authority. A small number (<10) of plants are scattered in less than 1 ha of forest on adjacent private land at a golf course. The Dunwich population is on privately owned land. From 1970 to 1984 the landowner had an agreement with the Ontario Ministry of Natural Resources (OMNR) under the *Woodlands Improvement Act* (W.I.A.) to manage the forested portion of the property. However, the forested slopes of

the river valley where *Trillium flexipes* is located were designated in the MNR's management plan as "protected forest" and so were not subject to any alteration during the agreement period (COSEWIC 2000).

Both Essex County historical sites, as well as the London, Middlesex County location where the population is now considered to be extirpated, are probably under private ownership, although it is not possible to say with certainty because the precise localities are unknown. The historical Mud Creek Flats (McGillivray Township) site is either privately or publicly owned, because a relatively long stretch of the cited "Mud Creek flats" location, which appears to contain suitable habitat, is currently within the Parkhill Conservation Area, which is owned and managed by the Ausable Bayfield Conservation Authority. The Niagara Glen site is owned and managed by the Niagara Parks Commission.

BIOLOGY

Life cycle and reproduction

Throughout its range, *Trillium flexipes* flowers from April to June (Fernald 1950), but at the northern limit of its range in Ontario, the peak blooming period typically occurs during the second week of May and extends to the beginning of June, depending on the climatic conditions of any given year (McLeod 1996). It is a rhizomatous perennial that can take up to 10 years to flower from seed (Ohara 1989) and can potentially live for several decades. The short fleshy rhizome can produce additional shoots from axillary buds. Such additional shoots from the same rhizome are likely best interpreted as representing additional “branches” of a single plant and not as clonal growth because such axillary shoots do not become independent plants reproducing separately as sexually or asexually reproducing individuals.

Trillium flexipes depends mostly on seeds for recruitment (Ohara 1989). The flowers of *Trillium flexipes* have both stamens and a pistil and reproduce sexually. However, the mating systems of declinate-flowered trilliums such as *T. flexipes* are not well understood (Ohara and Utech 1988). As with *T. grandiflorum* and *T. erectum* (Chimielewski and Ringius 1987), *Trillium flexipes* is likely both cross-pollinated (xenogamous) and self-pollinating (autogamous), with the latter predominant. Its relatively low fertilization rate (34%) suggests that *Trillium flexipes* has a low self-compatibility combined with inefficient outbreeding pollination systems (Ohara 1989). However, the average production of approximately 44 seeds per flower is the second highest known for eastern North American pedicellate trillium species (Ohara 1989).

Trillium flexipes has double dormancy, in which two seasons of cold are required for germination of seeds (Pringle 1984). In the first year, only roots develop from the seed and it is not until the second year that cotyledons emerge above-ground (Ohara 1989). Germination rates are unknown but clumps of seedlings near the parent plants of several trillium species suggest that under natural conditions the seeds are quite viable

with a good number of them actually germinating (Kawano *et al.*, 1992; Ohara and Higashi 1987). Abiotic factors necessary for seedling development are generally those required by the mature plants.

Herbivory

Browsing by White-tailed Deer (*Odocoileus virginianus*) or possibly Woodchucks (*Marmota monax*) would be detrimental to survival of *Trillium flexipes* if it occurred prior to maturation of the capsules but could aid in dispersal of mature seeds (Augustine and Frelich 1998). Known insect predators of the reproductive organs of *Trillium flexipes* include larvae of two tortrix moth species (Tortricidae) that occur throughout its range in Ontario (Covell 1984; Davis 1981). No evidence of such predation has been found at the two extant Ontario populations. This type of predation effectively destroys all ovules of a given flower and represents mortality at a very early stage of reproduction.

Physiology

The species' occurrence in deciduous woodlands where a change from an open spring canopy to a relatively closed summer canopy prevails, suggests the need for the resultant seasonal variation in light levels at all life stages. The open spring and more closed summer canopy conditions at both extant sites indicate that the species is dependent upon a fairly high light intensity during the early stages of growth and the flowering period. However, this requirement appears to diminish as the canopy leafs out because fruit maturation and photosynthesis continue well into mid-summer. An overstorey canopy with some openings may provide optimal conditions for growth compared to forests with complete canopy closure.

Dispersal

Short-range dispersal of *Trillium flexipes* seeds depends upon ants that are attracted to the oil-containing seed appendage or elaiosome (Berg 1958; Ohara and Higashi 1987). Seedling mortality is reduced by the relatively short-distance dispersal of seeds by ants because it reduces competition between seedlings that would otherwise germinate in clumps near the parent plant (Higashi *et al.*, 1989). In two Japanese trillium species, over half of the many-seeded fruits initially fall within just 20 cm of the parent (Higashi *et al.* 1989) but ants dispersed 15% of the total number of seeds up to a distance of 3.3 m (Ohara and Higashi 1987). Nocturnal ground beetles partially or completely consumed the elaiosomes of 85% of seeds rendering them unattractive to ants, and thereby resulting in a clumped distribution of seedlings near fertile plants. It is quite probable that a similar situation prevails for *Trillium flexipes* in North America.

Small mammals are not attracted to Japanese trillium seeds (Ohara and Hagashi 1987) and are therefore unlikely to be dispersal agents for *Trillium flexipes.* Seed dispersal does occur, however, as a result of herbivory of mature trillium by White-tailed Deer. McLeod (1996) has observed where the leaf whorls and flowers or capsules of trillium were stripped by deer, leaving behind only the bare stalks. Provided the seed

survives passage through the animal's digestive tract and is voided in suitable habitat, the species could be spread for considerable distances by this means.

The production of multiple asexual or flowering shoots on individual rhizomes results primarily in the increase in number of aerial shoots and the density of shoots within a population and does not serve as a means of dispersal.

Interspecific interactions

Although *Trillium flexipes* is largely self-pollinated, its declining peduncle at anthesis and long exserted stamens suggest that bumblebees (*Bombus* spp.) and some butterflies could visit and forage the hanging flowers as potential pollinators (Kawano *et al.* 1992). Two Japanese species of trillium with white petals are frequently visited by flies and beetles and they do not appear to be wind-pollinated (Ohara *et al.* 1990).

Disease organisms are also known to cause mortality in trillium species. The bacterium *Mycoplasmas* is best known for causing the various degrees of petal greening and bizarre distortions of plant parts in *T. grandiflorum,* and is thought to be spread by leaf hoppers (Gad and Cruise 1974; Case and Case 1993). Seedlings, juveniles and mature plants of all trillium species are known to be considerably weakened by a *Botrytis* fungus that attacks the leaves (Case and Case 1993), destroying their photosynthetic capabilities. The entire above-ground portion of some plants may be killed in a given year resulting in a reduction in the number of blooms produced the following season. Lilies are strong carriers of this fungus (Case and Case 1993) and Michigan Lily (*Lilium michiganense*), as well as several other members of the lily family (*e.g.*, False Solomon's Seal, Starry False Solomon's Seal (*Maianthemum stellata*), Hairy Solomon's Seal (*Polygonatum pubescens*), and Large-flowered Bellwort (*Uvularia grandiflora*)), are associates of *Trillium flexipes* at both extant sites.

Hybridization of *Trillium flexipes* with *T. erectum* and *T. grandiflorum* has been observed in natural populations as well as achieved artificially in a horticultural setting (Case and Case 1993).

Trillium flexipes has a mutualistic association with vesicular-arbuscular mycorrhizal (VAM) fungi, which makes nutrients such as phosphorus more available to the roots of host trillium plants particularly during the spring (DeMars and Boerner 1995).

Adaptability

The apparent disappearance of *Trillium flexipes* from most Canadian sites suggests that it is unable to adapt to the pressures of habitat change. The species is fragile due to its limited habitat preference. The apparent increase in the number of plants at Dunwich suggests they are able to tolerate selective logging. The occurrence of robust *Trillium flexipes* along the edge of the hiking trail at the Strathroy site suggests that these plants may benefit from increased light levels and/or decreased competition associated with the trail. However, they are also more likely to be trampled.

Trillium flexipes have been cultivated successfully in wildflower gardens (Case 1988). However, gardeners usually prefer to transplant stock from local populations because of the slow and difficult process of growing trilliums from seed due to double dormancy. A few plants grown from seeds of plants from the Strathroy population are being cultivated at the University of Western Ontario with a view to maintaining an *ex situ* population (Andreae 2007a).

POPULATION SIZES AND TRENDS

Search effort

Surveys for *Trillium flexipes* are best timed to coincide with flowering due to the difficulty in discriminating sterile individuals from other similar-looking trillium species.

In over 100 years since their initial discovery at the Amherstburg, Detroit River, Thames River, and McGillivary Township sites, no *Trillium flexipes* have been reported at these sites, despite significant search effort by qualified botanists. The Thames River site near London has been intensively botanized within the past decade, often in conjunction with development proposals. The McGillivary and London sites were unsuccessfully searched in May 1993 by D. McLeod and M. Oldham during the preparation of the original COSEWIC status report. During 2006, a detailed botanical inventory targeting Species At Risk was conducted at Niagara Glen during the appropriate flowering season by M. Oldham, but no *T. flexipes* were found.

The Strathroy site was visited in May 1990, 1991, 1993, and 1994 by D. McLeod and/or M. Oldham. It has been monitored semi-annually since 1990 by M. Andreae of the St. Clair Conservation Authority. Six person-days of fieldwork were conducted at the Strathroy site from May 13-16, 2007 by Harris and Foster for the preparation of this update report. The main population was visited with M. Andreae and additional extensive surveys were made off-trail to determine the extent of the population. The Dunwich population was visited on June 7, 1993 by several botanists including D. McLeod and M. Oldham. Two person-days of fieldwork were conducted in May 2007 by Foster and Harris. The site was visited with the landowner and additional surveys were conducted adjacent to the main population to determine its extent.

Abundance

Precise abundance measures for the two extant Canadian *Trillium flexipes* populations are difficult to obtain because individual plants may have one to several flowering or sterile stems arising from a single rhizome, and therefore stem counts overestimate the actual number of plants. Sterile individuals that are less conspicuous and easily overlooked or confused with other trillium species are presumably immature plants that should not be included in counts of “mature individuals”. Without destructive sampling, the best index of abundance and reproductive potential is probably the number of flowering stems. The number of actual mature plants, however, may be

approximately half the number of flowering stems counted (Foster and Harris pers. obs.).

The most recent comprehensive survey of the Strathroy site (Harris and Foster 2007) found 1012 flowering stems (Table 3). The total population encompassed 8.0 ha in 2007; with the larger population of 1012 shoots mainly present within a 4.9 ha area of floodplain forest out of a total area of 7.1 ha occupied on the north side of the Sydenham River (erroneously reported as the sound side by COSEWIC 2000). The smaller population of 453 shoots primarily occupied an area of 0.7 ha out of a total area for the population of 0.9 ha. The increase of the population's areal extent is largely due to the re-discovery in 2007 of an outlier group of plants to the southwest of the main population that had been observed there from 1990 to 1993 (Andreae 2007b). The density of flowering plants of the main population (excluding the outlier clump) was approximately 0.02/m^2 in both 1993 and 2007. The densest concentration of plants and those showing the greatest vigour occur adjacent to a hiking trail through the floodplain forest.

Table 3. Summary of abundance estimates for extant populations of *Trillium flexipes* in Canada (Andreae 2007a; COSEWIC 2000; Harris and Foster 2007).

Location	Observers	Date	# Trillium stems		Area Occupied (ha)	Survey Notes
			Flowering	Non-flowering		
Strathroy	MA	May 15, 1990	293			30 min. survey
	MA	May 15, 1991	332 combined			from path only
	MA	May 18, 1993	466 combined			
	DM	May 16, 1994	500	>500	3.0	
	MA	May 22, 2002	97 combined			incomplete survey
	MA	May 16, 2003	330	28		mainly from path
	MA	May 13, 2005	262 combined			
	AGH, RFF	May 13, 2007	1012	105	7.1	
	MA	May 16, 2007	428	44		
Dunwich	DM, MJO, FS, LS	1993	75	some	0.1	
	AGH, RFF	May 17, 2007	453	14	0.9	

AGH = Allan G. Harris; DM = Dave McLeod; FS = Fred Simpson; LS=Lorne Spicer; MA = Muriel Andreae; MJO = Michael J. Oldham; RFF=Robert F. Foster

In 1993, approximately 75 flowering plants (stems) were found along a 100-metre stretch on the south bank of the Thames River northwest of Dutton in Dunwich Township. The plants occupied a 10 m-wide band approximately two-thirds the way up a 100-metre forested slope (COSEWIC 2000). In 2007, a total of 453 flowering stems was found along 250 metres of hillside in a 20-30 m wide band. *Trillium flexipes* were present as scattered individuals but in also dense patches where it was the dominant ground cover. The total area occupied was 0.9 ha, with the main population covering 0.7 ha. A lone individual was found 90 m along the riverbank from the main population mixed in with *T. grandiflorum* and *T. erectum.* The mean density of plants (excluding

the outlier individual) was virtually unchanged with 0.07/m^2 in 2007 compared to 0.075/m^2 in 1993.

Fluctuations and trends

Since 1989 the number of flowering stems at Strathroy has apparently doubled. The apparent increase in 2007 may be the result of greater survey effort/efficiency, maturation of sterile individuals from 1993, and/or natural variation. Visibility of plants varies with weather and phenology of taller associates such as Ostrich Ferns and Garlic Mustard (Andreae 2007b). If McLeod's 1994 estimates are correct (Table 3), there may have been a recent decline in the number and proportion (relative to flowering plants) of non-flowering individuals. McLeod observed that the population in 1994 consisted of "more than 500 flowering plants [stems] plus an even greater but undetermined number of sterile plants [stems]" (COSEWIC 2000), although elsewhere in the report he states that there are "some" sterile individuals at the Strathroy site. Both surveys in 2007 showed far fewer sterile individuals (44 and 105), which could indicate declining recruitment, because *Trillium flexipes* take at least 10 years to mature on average (Ohara 1989). Some of the variation among years may be due to environmental effects. For example, Andreae (2007a) noticed that there were fewer *Trillium flexipes* in flower in 2003, likely due to drought conditions in 2002. Nonetheless, the habitat remains relatively undisturbed apart from invasive species and the population is quite large, containing both immature and mature flowering plants. Hybridization with *T. erectum* at this site may also confuse interpretation of population trends.

The number of flowering *Trillium flexipes* observed at the Dunwich site increased from 75 in 1993 to 453 in 2007. "Some" non-flowering plants [stems] were present in 1993 (McLeod 1996) and at least 14 were observed in 2007 (sterile individuals were difficult to distinguish from other co-occurring *Trillium* species). The apparent increase in population size is unlikely due to more intensive or efficient survey effort because the population is restricted to a small, sloping area and the flowering plants are relatively easy to find and identify. The increase may be the result of maturation of sterile individuals from 1993 or natural variation in numbers, but partial opening of the canopy or other effects from selective logging may have played a role.

The historical sites are presumed extirpated, but no surveys are known to have been conducted since the original COSEWIC status report. The habitat at the McGillivray Township site appeared to be relatively intact in the mid-1990s and so holds the most promise for eventual rediscovery of the population. Given the long generation time of *Trillium flexipes,* there has been neither adequate time nor rigorous enough monitoring of either extant population since their recent discovery (or rediscovery) to determine if they are in expansion or decline.

Rescue effect

Given its habitat specificity and distance from other populations in the United States, it is unlikely that localized extirpations at the periphery of the range in Ontario

will be recolonized from US populations. Genetic exchange between Canadian and US populations is probably very infrequent given the distances.

LIMITING FACTORS AND THREATS

The greatest historic and current threat to *Trillium flexipes* populations in Canada is the loss and degradation of habitat. Habitat loss due to expanding urban development likely caused the extirpation of the historical populations at London and the two Essex County sites. The threat of development is greatly reduced at extant sites because of endangered species legislation and because most of the Strathroy site is on conservation authority land. Although both sites remain relatively undisturbed, they have probably undergone some habitat modification in the past.

Habitat degradation from a number of agents is probably the greatest threat to the extant populations. The relatively small area occupied by Dunwich population renders it particularly vulnerable to habitat loss or degradation. The site was logged prior to the 1970s, which resulted in a more open canopy (approximately 75% closure). The lack of historical data for the trillium at this site makes it impossible to assess the impact however. Selective logging by the private landowner occurred at this site in 2006. Cable skidders were apparently used to minimize site disturbance. Although the short and long-term impacts on *Trillium flexipes* are as yet unknown, this population increased from 75 to 453 stems since 1993. In Alabama, *T. flexipes* plants appear to survive selective timber removal fairly well, but not clearcuts (Schotz 2007).

If too much of the overstorey is removed at either extant site due to logging, forest pests, beaver activity, or natural succession, it could negatively impact shade-tolerant trillium by opening up the site to early successional species such as Meadow Rue (*Thalictricum* spp.) or invasive species such as Garlic Mustard. These species thrive in more open sunlight and crowd out the less competitive trillium, as appears to be the case in some portions of the Strathroy site where past logging practices or fallen trees have created larger openings in the canopy. Garlic Mustard, exotic honeysuckles (*e.g.*, *Lonicera maackii*), and other invasive species are a threat to populations elsewhere in its range including Ohio (Gardner 2007) and Missouri (Smith 2007).

The relationship between invasive species, trilliums, and their environment is complex and poorly understood. At Strathroy, non-native honeysuckles (*Lonicera* spp.) are abundant on well-drained floodplain levées that are also suitable habitat for *Trillium flexipes.* Although honeysuckles often overtop trillium on these microsites, trillium are able to persist underneath because they flower before the honeysuckles leaf out, and the dense shade under the honeysuckles later in the season may help exclude competing vegetation. The steep, north-facing aspect at the Dunwich site may prevent excessive exposure to sunlight even with selective logging. Increased competition for ecological resources and possible allelopathy from Garlic Mustard and alien plant species is a threat even in the absence of logging.

Since the Strathroy site became a publicly-owned Conservation Area, a hiking trail

network has been constructed through the area in order to promote recreational use. Where the trail passes directly through the population, inadvertent damage to trailside plants has occurred from trampling by hikers, mountain bikers, and dog-walkers, particularly with dogs running off-leash (Andreae 2007b). Unauthorized use of the trail network by all-terrain vehicles does considerable damage because ATVs are too wide for the trail and often leave a continuous swath of crushed vegetation along the margins. The growth of the Town of Strathroy is resulting in greater recreational use of the Conservation Area, putting additional pressure on the trillium population unless mitigative measures are implemented.

Natural processes could pose a potential threat to both extant *Trillium flexipes* populations, particularly at the Dunwich site, which is vulnerable to stochastic processes due to its very small size. In 2007, the leaves and flowers of a small number of plants had been browsed at the Strathroy site, presumably by deer. Deer effects on individual trillium are severe, because one bite can remove all leaves and flowers or fruit, and no regrowth will occur during that growing season (Augustine and Frelich 1998). Although individual plants are resilient to deer grazing over the short term (1-2 years), the cumulative effects of herbivory over several growing seasons could cause long-term reductions in reproductive success (Augustine and Frelich 1998). Herbivory from White-tailed Deer negatively impacts *T. flexipes* populations in some parts of Indiana (Homoya 2007) and is a major threat in Ohio (Gardner 2007). Increased herbivory by deer could represent a threat at either Ontario site, particularly if widespread or recurring, or if combined with other threats or catastrophic events such as storms.

SPECIAL SIGNIFICANCE OF THE SPECIES

Trillium flexipes add to the biodiversity of Carolinian forests in Canada, which are themselves a threatened component of our natural heritage. Three provincially rare plant species are associated with the extant *Trillium flexipes* populations (Argus *et al.* 1982 -1987). Green Dragon (*Arisaema dracontium*) and hairy-fruited sedge (*Carex trichocarpa*) are present at Strathroy, while Blue Ash (*Fraxinus quadrangulata*) occurs at the Dunwich Township site. Blue Ash is officially recognized as a species of Special Concern in Ontario (Thompson 1993) and Canada (White and Oldham 2000), as is Green Dragon (Gauvin 1983).

Trillium flexipes have long been the study of amateur and professional botanists and are a useful model for the study of ecology and evolution, particularly hybridization. First Nations peoples used the closely related *Trillium erectum* for several medicinal purposes because the root contains steroids (Foster and Duke 1990).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Trillium flexipes is considered secure globally or G5 (NatureServe 2007) and is therefore not listed by the IUCN or CITES. It is ranked N5 or secure in the United States and is not on the US Endangered Species list. However, the *Lacey Act* does prohibit the transfer of any trillium species across the border of any state if the plant has been collected in contravention of a state endangered species law, as would be the case in Maryland where *T. flexipes* is protected under such a law (Sawkins and McGough 1993). It is ranked SH in one state, S1 in seven states, S2 in two states, and S2S3, S3, or S3S4 in three other states (Table 4).

Table 4. State / Provincial ranks for *Trillium flexipes* (NatureServe 2007 with updates from state Conservation Data Centres).

State / Province	Rank	Notes
Ontario	S1	known from 2 extant occurrences
Alabama	S2S3	19 known occurrences in mountainous northern AL; probably much more common than records suggest;
Arkansas	S1	2 known populations, one with several thousand plants; other populations in rugged areas of the Ozarks could exist
Delaware	?	ranked as SNR (Natureserve 2007) and reported from DE in Case (2002), but apparently never recorded from the state (McAvoy 2007)
Georgia	S1	
Illinois	S3S4	
Indiana	SNR	found in most mesic forests, especially in the southern counties; would be S4S5 if ranked
Iowa	S3	common in the NE part of the state and rare elsewhere
Kentucky	S5	widely distributed
Maryland	S1	
Michigan	SNR	
Minnesota	SNR	
Missouri	SNR	known from mesic forests in 12 eastern counties; would likely be S3S4 if ranked
Mississippi	S1	5 populations in extreme NE
North Carolina	SH	only 2 known occurrences, none seen since 1959 and may be SX
New York	S1	2 extant and 4 other historical occurrences
Ohio	SNR	widespread in rich, mesic deciduous forest and probably occurs in all 88 counties; would be S5 if ranked
Pennsylvania	S2	
South Dakota	?	status uncertain; listed for SD in Case (2002) but no specimen could be located and extremely limited potential habitat left.
Tennessee	SNR	frequent in rich woods on limestone hillsides
Virginia	S1	
West Virginia	S2	
Wisconsin	SNR	fairly common in southern part of state

In Canada, *Trillium flexipes* is ranked N1. It was designated Endangered in Canada by COSEWIC in April 1996, and its status re-assessed and confirmed in May 2000. *Trillium flexipes* is listed as endangered under the federal *Species at Risk Act* (SARA) but this does not confer protection because the extant populations do not occur on federal lands. A recovery strategy is being prepared in consultation with the Carolinian Woodlands Recovery Team and is in the final stages of preparation. *Trillium flexipes* is also regulated as endangered under Ontario's recently revised *Endangered Species Act*, 2007 which prohibits harming or killing the species or damaging or destroying the habitat upon which it depends directly or indirectly. The Provincial Policy Statement of the *Planning Act* of Ontario also prohibits development and site alteration in the significant habitat of endangered species. *Trillium flexipes* at the Strathroy site will likely benefit from habitat restoration efforts undertaken as part of the National Recovery Strategy for Species at Risk in the Sydenham River: An Ecosystem Approach (Dextrase *et al.* 2003).

TECHNICAL SUMMARY

Trillium flexipes
Trillium Drooping Trillium — Trille à pédoncule incliné
Range of Occurrence in Canada: Ontario

Demographic Information

Generation time (average age of parents in the population)	>10 yrs
Observed percent reduction in total number of mature individuals over the last 10 years.	No decline
Projected percent reduction in total number of mature individuals over the next 10 years.	N/a
Observed percent reduction in total number of mature individuals over any 10 years period, over a time period including both the past and the future.	N/a
Are the causes of the decline clearly reversible?	N/a
Are the causes of the decline understood?	N/a
Have the causes of the decline ceased?	N/a
Observed trend in number of populations 5 of 7 populations lost historically	Stable
Are there extreme fluctuations in number of mature individuals?	No
Are there extreme fluctuations in number of populations?	No
Is the total population severely fragmented? Perhaps not based strictly on IUCN definition but there are only 2 populations that are widely separated, with the larger having most plants of a total of ~1012 shoots within a 4.9 ha area; the smaller population has only 453 shoots occupying primarily an area of 0.7 ha with abundant invasive plants of Garlic Mustard present that could severely impact this small population and affect its viability.	No

Number of mature individuals in each population

Population	**N Mature Individuals**
Strathroy	1012
Dunwich	453
Total (These represent a much smaller number of individual plants)	<1500 flowering shoots
Number of populations (locations)	2

Extent and Area Information

Estimated extent of occurrence (km²) Maximum EO is ~7km square based on a narrow polygon (0.3 km x 27 km long between the two locations but this includes mainly unsuitable habitat with the actual EO of the two separate linear riparian habitats comprising an EO << 1 km square.	<7 km²
Observed trend in extent of occurrence Presently stable but a significant decline historically with losses of 5 populations.	Stable
Are there extreme fluctuations in extent of occurrence?	No
Estimated area of occupancy (km²) Actual area occupied is ~0.08 km square.	8 based on a 2x2 km grid and 2 based on a 1x1 km grid
Observed trend in area of occupancy	Stable
Are there extreme fluctuations in area of occupancy?	No

Is the extent of occurrence or area of occupancy severely fragmented? Perhaps not but depends on the interpretation of the IUCN definition. There are only 2 small sites with relatively small populations separated by considerable distance and the long-term viability of the smaller population is perhaps questionable considering the presence of the highly invasive Garlic Mustard.	No
Number of current locations	2
Trend in number of locations Presently stable but historic losses of 5 populations at 5 locations.	Stable
Are there extreme fluctuations in number of locations?	No
Trend in area or quality of habitat Seriously invasive plants are present, recreational trail and associated activities are present and change in canopy has altered habitat.	Decline in quality

Quantitative Analysis

	None available

Threats (actual or imminent, to populations or habitats)

Invasive species, particularly Garlic Mustard, and herbivory from deer are threats at both sites, although the severity is unknown. Trampling from recreational activities is a threat at the Strathroy site. Agricultural/ residential development and associated forest clearing are potential threats at the Dunwich site.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: Widespread in USA	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Unknown
Is there sufficient habitat for immigrants in Canada?	Unknown
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Endangered (April 2009)

Additional Sources of Information: None

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ab(iii)+2ab(iii)

Reasons for designation:

A showy perennial species currently present at only two small locations in southern Ontario. It has not been found at five additional sites where it was documented historically. This riparian species is at on-going risk of habitat degradation from the invasion of exotic plants. It is also at risk from recreational activities and the effects of stochastic events due to its small population size.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable because population decline has not been documented.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(iii)+2ab(iii). EO and IAO are below critical limits and only 2 extant populations are known with a decline in the quality of habitat based on the spread of invasive species and impacts from recreational activities.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable due to uncertainty of continuing decline in mature individuals.
Criterion D (Very Small Population or Restricted Distribution): Meets Threatened D2 based on the presence of only 2 populations with ongoing impacts to habitat quality and the likely impacts to the decline of the smaller population due to the presence of a highly invasive exotic plant.
Criterion E (Quantitative Analysis): None available.

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Three anonymous reviewers commented on an earlier draft of the report.

Authorities contacted

The following authorities were contacted for the original COSEWIC status report and/or its 2007 update:

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Robert Foster is co-founder and principal of Northern Bioscience, an ecological consulting firm offering professional consulting services supporting ecosystem management, planning, and research. Dr. Foster has a B.Sc. in Biology from Lakehead University and a D. Phil in Zoology from the University of Oxford. Rob has worked as an ecologist in Ontario for over 15 years, and has authored or co-authored COSEWIC status reports on the Rapids Clubtail and Green Patterned Tiger Beetle, as well as recovery plans for rare plants, lichens, and odonates.

Allan Harris is a biologist with over 20 years experience in northern Ontario. He has a B.Sc. in Wildlife Biology from the University of Guelph and an M.Sc. in Biology from Lakehead University. After spending seven years as a biologist with Ontario Ministry of Natural Resources, he co-founded Northern Bioscience, an ecological consulting company based in Thunder Bay, Ontario. Al has authored or co-authored dozens of scientific papers, technical reports, and popular articles, including COSEWIC status reports for Small-flowered Lipocarpha, Rapids Clubtail and Patterned Green Tiger Beetle. Al also authored Ontario's provincial status report for Woodland Caribou, and has authored or co-authored national and provincial recovery strategies for vascular plants and birds.

COLLECTIONS EXAMINED

During research for the Atlas of the Rare Vascular Plants of Ontario in 1986, T.S. Patrick searched the major herbaria where Ontario specimens of *Trillium flexipes* might be expected. Specimens were located at Agriculture Canada (DAO) - 3, the University of Edinburgh (E) - 2, McGill University in Montreal (MTMG) - 4, and the University of Toronto (TRT) -1. In addition, the University of Michigan (MICH), the University of Guelph (OAC), the University of Western Ontario (UWO) and the Wilfred Laurier University (WLU) herbaria were consulted for the preparation of the original COSEWIC status report (McLeod 1996), as was the personal herbarium of M.J. Oldham, which is housed at the Natural Heritage Information Centre in Peterborough, Ontario.