# COSEWIC
# Assessment and Status Report

on the

# Nodding Pogonia
*Triphora trianthophoros*

**in Canada**


**ENDANGERED**
**2010**

**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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Previous report(s):

COSEWIC. 2000. COSEWIC assessment and update status report on the Nodding Pogonia *Triphora trianthophora* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 9 pp.

White, D.J. 1999. Update COSEWIC status report on the Nodding Pogonia *Triphora trianthophora* in Canada, *in* COSEWIC assessment and update status report on the Nodding Pogonia *Triphora trianthophora* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-9 pp.

Woodliffe, P.A. 1988. COSEWIC status report on the Nodding Pogonia *Triphora trianthophora* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 42 pp.

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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Nodding Pogonia — ©Gary Allen.


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# COSEWIC
# Assessment Summary

**Assessment Summary – November 2010**

**Common name**
Nodding Pogonia

**Scientific name**
*Triphora trianthophoros*

**Status**
Endangered

**Reason for designation**
This small showy orchid of rich woodland soils undergoes variable periods of dormancy. In Canada, this species is known from only two populations in southwestern Ontario, one of which has not been observed in more than 20 years. About 1400 flowering stems were documented at one site in 2008 during a year of high rainfall, in contrast to a decade previously when the Canadian population was documented as consisting of only 50 individuals. Although grazing by deer has been reduced, invasive plants have contributed to a loss in habitat quality and exotic earthworms are likely the cause of the reduction of the organic layer of the forest floor. Chance events could also impact the population.

**Occurrence**
Ontario

**Status history**
Designated Threatened in April 1988. Status re-examined and designated Endangered in April 1999. Status re-examined and confirmed in May 2000 and November 2010.

# COSEWIC
# Executive Summary

## Nodding Pogonia
*Triphora trianthophoros*

### Wildlife species description and significance

Nodding Pogonia (*Triphora trianthophoros*) is a small orchid that persists mainly as an underground rootstock, sending up flowering shoots only in favourable years. It forms colonies through asexual reproduction by small tubers formed from the ends of its fleshy roots. The greenish-purple aerial shoots vary in height from 5 to 31 cm. One to several small, alternate, round clasping leaves are attached on the stem from about midway to the base of the inflorescence. Plants commonly produce three flowers, each subtended by a leafy bract. The corolla consists of a central, lower lip, bearing three greenish crests, and two dorsal petals. The three sepals are white and petal-like. Fruit is an erect green capsule.

The species is of special interest because it depends on mycorrhizal fungi for its nourishment. Its irregular appearance above ground depends on environmental conditions that are not well understood. It is also one of the rarest orchids in Ontario. No recorded traditional Aboriginal uses for this species are known.

### Distribution

Nodding Pogonia occurs in North America from New England westward to southwestern Ontario and Michigan south to Texas and Florida. In Canada, it is found at only two sites, Rondeau Provincial Park (Municipality of Chatham-Kent) and a site on private property (Essex County). The Canadian range of the species extends over an area of only about 62 $km^2$.

### Habitat

The species requires rich, moist, deciduous forest with a deep leaf litter and an abundance of humus. In Canada, it grows in beech-maple forests with a sparse understorey. It tolerates a wide range of soil types and acidity, but requires association with a mycorrhizal fungus, probably from the genus *Rhizoctonia*.

## Biology

Nodding Pogonia is a small and inconspicuous orchid that only shows above ground in late summer when it begins its short flowering period. It derives most of its nourishment from its fungal associates, and it grows above ground only to produce flowers and seeds. If conditions are unfavourable for flowering in a particular year, flowering stems may not be produced. Nodding Pogonia is pollinated by bees in at least two different orders. Production of seed capsules in Nodding Pogonia is generally low. Plants also propagate vegetatively by means of underground tuberoids. Colonies may be long-lived; a New England colony has continuously persisted for over 70 years.

## Population sizes and trends

In 2008, the Canadian population of Nodding Pogonia consisted of 1357 flowering stems, and was located entirely within three subpopulations at Rondeau Provincial Park. The fourth was not seen in 2008. It is likely that this count was conservative. This species is known for its fluctuating number of flowering stems; after an estimated > 95% decline documented in the 1998 update status report, the 2008 count is among the highest ever recorded for the Rondeau population which may be due to ideal growing conditions.

Nodding Pogonia was not found during a 2008 search of the eastern portion of the Essex County site, where plants have not been observed since 1987. However, this species may persist for many decades as a subterranean tuber, and because the condition of the woodlot has not changed substantially, it cannot be presumed that the orchid is extirpated from this site.

## Threats and limiting factors

Invasive plant species such as Japanese Barberry (*Berberis thunbergii*) and Garlic Mustard (*Alliaria petiolata*), as well as exotic earthworms, may threaten Nodding Pogonia. Herbivory by deer, chipmunks and slugs is possible at either site, and is a known threat to other populations in the United States. The single privately owned site could be threatened by a change in land use or management. Trampling of Nodding Pogonia may be a minor threat.

## Protection, status, and ranks

Nodding Pogonia is classified as Endangered under the Ontario *Endangered Species Act, 2007* and is listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA). In Canada, Nodding Pogonia occurs only within a provincial park and at one privately owned woodland. It is globally ranked by NatureServe as vulnerable, and is rare throughout most of its range, especially in adjacent states. It has a national and provincial rank, in Canada, of critically imperilled.

# TECHNICAL SUMMARY

*Triphora trianthophoros*
Nodding Pogonia Triphore penché
Range of occurrence in Canada (province/territory/ocean): Ontario

**Demographic Information**

| | |
|---|---|
| Generation time<br>Average age of parents in the population is unknown, although colonies may be very long-lived (as much as 70 years). | Unknown but possibly decades |
| Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?<br>The number of mature individuals is based on counting flowering shoots as per IUCN/COSEWIC guidelines for species that reproduce sexually and asexually. Although the number of flowering stems counted at Rondeau in 2008 is similar to the large counts in the 1980s, numbers of flowering stems fluctuate and consequently actual trends are difficult to determine. | Unknown |
| Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] | Unknown |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. | Unknown |
| [Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. | Unknown |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. | Unknown |
| Are the causes of the decline clearly reversible and understood and ceased?<br>Decline is unknown due to fluctuating numbers of flowering stems. | N/A |
| Are there extreme fluctuations in number of mature individuals?<br>The appearance of flowering stems undergoes extreme fluctuation; however, the tubers can remain viable for decades. | Unlikely applicable |

**Extent and Occupancy Information**

| | |
|---|---|
| Estimated extent of occurrence<br>The extant subpopulations in Rondeau Prov. Park and the potentially extant site in Essex County form a triangle with an area of about 62 $km^2$. | 62 $km^2$ |
| Index of area of occupancy (IAO)<br>The four Rondeau subpopulations occupy a rectangle of approximately 92,000 $m^2$. The Essex County woodlot is approximately 400 m by 200 m. | 16 $km^2$ (based on 2x2 km grid) |
| Is the total population severely fragmented?<br>The two occurrences are spatially widely separated, have low rates of seed set and low likelihood of recolonization from outside seed sources; also, the small population on private land is of questionable viability in the long term, and may even currently be extirpated. However, of the two populations, the one at Rondeau contains the majority of flowering shoots and occupies more than ½ of the occupied habitat. | Likely not applicable |
| Number of "locations" (as per definition, in relation to threat)<br>Stochastic events, in particular, at the small population on private land and a number of impacts at the larger Rondeau population characterize the locations. The four subpopulations at Rondeau and the questionably viable Essex County population likely represent <5 locations. | Likely <5 |

| | |
|---|---|
| Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?<br>The Essex County site has not been observed for over 20 years. However, limited access to this privately owned site has resulted in a lower search effort, and populations of Nodding Pogonia can be long-lived, so extirpation cannot be assumed. | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?<br>Unknown due to the uncertainty of the continued presence of the species at the Essex County site. | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in number of populations?<br>Unknown due to the uncertainty of the continued presence of the species at the Essex County site. | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in number of locations?<br>Unknown due to the uncertainty of the continued presence of the species at the Essex County site. | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?<br>Habitat quality may be in decline at both sites due to the presence of invasive plant species such as Japanese Barberry and Garlic Mustard, and possibly due to non-native earthworms. | Yes in quality |
| Are there extreme fluctuations in number of populations? | No |
| Are there extreme fluctuations in number of locations (as per definition, in terms of threat)? | No |
| Are there extreme fluctuations in extent of occurrence? | No |
| Are there extreme fluctuations in index of area of occupancy? | No |

**Number of Mature Individuals (in each population) – See Table 1**

| **Population (2008)** | **N Mature Individuals** |
|---|---|
| Rondeau Provincial Park:<br>Essex County:<br>No plants were found in a partial count on the eastern portion of the site in 2008. The western portion of site was not accessed,<br>and the total population at this occurrence is unknown | 1357 flowering stems<br>Unknown |
| Total | 1357 flowering stems |
| For past status reports and during over two decades of plot-based monitoring, flowering stems have been counted for this species as an estimate of population size. The relationship between the number of flowering stems and the number of mature individuals is not known; however, this method of reporting abundance has been maintained for this status report. The formation of flowering clumps may be the result of clusters of tubers originating asexually from one or more plants in close proximity or the result of caching of tubers by squirrels. Because of asexual reproduction by tubers, each flowering stem arising from a tuber represents a mature individual based on IUCN/COSEWIC definition. | |

**Quantitative Analysis**

| | |
|---|---|
| Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]. | Not available |

**Threats (actual or imminent, to populations or habitats)**

| |
|---|
| Invasive plants, exotic earthworms, herbivory, change in land use, stochastic events, low genetic diversity |

**Rescue Effect (immigration from an outside source)**

| | |
|---|---|
| Status of outside population(s)?<br>U.S.: *Very rare (S1 or S2) in adjacent and northern states – Michigan, New York, New Hampshire, Ohio. Nationally not ranked (NNR) in the U.S., although the rounded global status is G3 (vulnerable) because it is rare throughout much of its range (NatureServe, 2010). See Table 2.* | |
| Is immigration known or possible? | Possible but unlikely over the short term. |
| 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 (November 2010) |

**Status and Reasons for Designation**

| **Status:** | **Alpha-numeric code:** |
|---|---|
| Endangered | B1ab(iii)+2ab(iii) |
| **Reasons for designation:**<br>This small showy orchid of rich woodland soils undergoes variable periods of dormancy. In Canada, this species is known from only two populations in southwestern Ontario, one of which has not been observed in more than 20 years. About 1400 flowering stems were documented at one site in 2008 during a year of high rainfall, in contrast to a decade previously when the Canadian population was documented as consisting of only 50 individuals. Although grazing by deer has been reduced, invasive plants have contributed to a loss in habitat quality and exotic earthworms are likely the cause of the reduction of the organic layer of the forest floor. Chance events could also impact the population. | |

**Applicability of Criteria**

| |
|---|
| **Criterion A** (Decline in Total Number of Mature Individuals):<br>Not applicable. Decline unknown as a consequence of fluctuating number of flowering shoots. |
| **Criterion B** (Small Distribution Range and Decline or Fluctuation):<br>Meets Endangered B1ab(iii)+2ab(iii) based on EO and IAO within criterion limits and presence of <5 locations where habitat quality has declined. |
| **Criterion C** (Small and Declining Number of Mature Individuals):<br>Not applicable. Decline unknown as a consequence of fluctuating number of flowering shoots. |
| **Criterion D** (Very Small or Restricted Total Population):<br>Not applicable. Number of flowering shoots (as indicative of mature individuals) exceeds criterion values and threats may not be sufficient to cause a rapid decline in a short period of time. |
| **Criterion E** (Quantitative Analysis): None available. |

## PREFACE

Only two populations are known for Canada, one of which, on two adjoining properties on private land, has not been confirmed for over 20 years. In the previous status report update (White 2000), the number of Nodding Pogonia flowering stems at the Rondeau site was estimated at 50. This represented a decline of >95% from the estimate of around 1500 flowering stems at Rondeau in the late 1980s, when the original status report was published (Woodliffe 1988). However, fieldwork for the current update report was completed during the wet, cool summer of 2008, one of the best flowering seasons in many years, when approximately 1400 flowering stems were counted at the Rondeau site (Woodliffe, pers. comm. 2008). Most of the four Rondeau subpopulations are visited annually, although a complete census is not undertaken every year. Since fieldwork for the last status report was completed in the summer of 1998, the other known Canadian occurrence within a private woodlot in Essex County has been partially surveyed only twice (2000 and 2008), and no plants have been observed there since the late 1980s.

## 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 (2010)

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

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

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

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

Environment Canada | Environnement Canada
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Canada

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

# COSEWIC Status Report

on the

# Nodding Pogonia
*Triphora trianthophoros*

**in Canada**

2010

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## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and classification

Scientific name: *Triphora trianthophoros* (Sw.) Rydb.

Synonym: *Triphora trianthophora* (Sw.) Rydb., *Pogonia trianthophora* (Swartz) Britton, Arethusa trianthophoros Sw.

Common names: Nodding Pogonia; Three Birds Orchid, Triphore penché

Family name: Orchidaceae (orchid family)

Major plant group: Angiosperm (monocot flowering plant)

The spelling of the specific epithet “trianthophora”, as used in previous status reports, has been changed to reflect the correct Greek feminine ending “”-os”. The generic name *Triphora* is a feminine noun derived from the Greek language meaning “bearing three flowers”.

### Morphological description

Nodding Pogonia (Figures 1 and 2) is a small orchid that persists mainly as an underground rootstock, sending up flowering shoots only in favourable years. The greenish-purple aerial shoot varies in height from five to 31 cm. One to several small, alternate round clasping leaves are attached to the stem from about midway to the base of the inflorescence. Plants produce from one to seven white flowers but three are commonly found, each subtended by a leafy bract. Flower parts are in threes; the corolla consists of a central, lower lip, bearing three greenish crests, and two dorsal petals; the three sepals are white and petal-like. The fruit is an erect green capsule. Asexual colony formation occurs through the production of tubers at the ends of its fleshy roots. Additional technical descriptions, botanical keys, and illustrations can be found in Gleason and Cronquist (1991), Voss (1972), and Holmgren (1998).

Figure 1. Clump of mature stems of Nodding Pogonia. Photograph: Copyright P. Allen Woodliffe (with permission).

Figure 2. Nodding Pogonia inflorescence. Photograph: Copyright P. Allen Woodliffe (with permission).

## Population spatial structure and variability

No information on spatial population structure could be found. All Ontario populations are *Triphora trianthophoros* var. *trianthophoros*, which is found throughout the species' range in the eastern United States (Oldham and Brinker 2009). *Triphora trianthophoros* var. *texensis* is endemic to Texas (Brown and Pike 2006). Although orchid seeds are highly mobile, ecological barriers to genetic exchange do exist. The predominant barrier is habitat fragmentation due to extensive tracts of agricultural land. Nodding Pogonia has a low rate of seed capsule production (Williams 1994), and the orchid likely propagates mostly vegetatively (i.e., asexually). It also occurs uncommonly, in fragmented populations across eastern North America (NatureServe 2010).

## Designatable units

Designatable units do not apply for this species, because both populations occur within the Great Lakes Plains Ecological Area recognized by COSEWIC, and there are no morphological or taxonomic differences recognized for populations of Nodding Pogonia within its range in Canada.

## SPECIAL SIGNIFICANCE

Nodding Pogonia is one of the rarest orchids in Ontario. Its irregular appearance above ground appears linked to environmental conditions that are not well understood. No recorded traditional Aboriginal uses for this species are known.

## DISTRIBUTION

### Global range

Nodding Pogonia occurs in North America from New England westward to southwestern Ontario, Michigan and Wisconsin, and south to Texas and Florida (Figure 3). It also ranges into Central America (Luer 1975). The orchid is rare to very rare at the northern end of its range, but is more frequent in the southern and central United States.

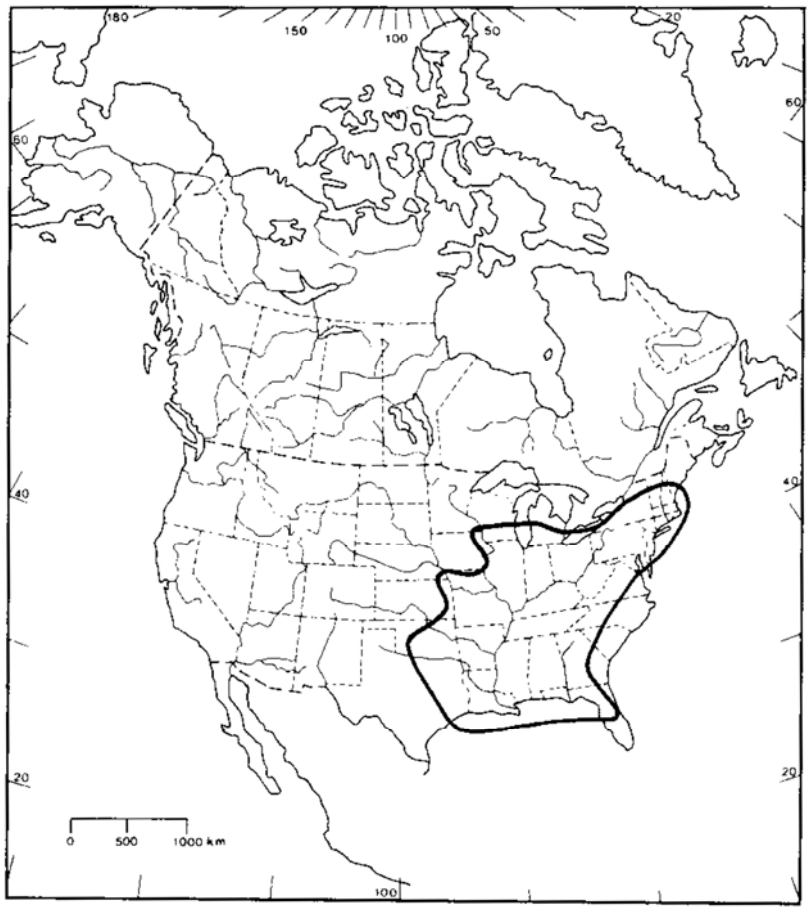


Figure 3. Distribution of Nodding Pogonia in North America (White *et al.* 1982).

## Canadian range

Nodding Pogonia has been known from Canada since 1950 (Zavitz and Gaiser 1956). It only occurs at two sites in southwestern Ontario (Figure 4). One occurrence, consisting of four known subpopulations, is within Rondeau Provincial Park (Municipality of Chatham-Kent). The other is in an Environmentally Significant Area, the Hillman Three Birds Woodlot located on private property (Essex County). The two occurrences are approximately 62 km apart. New Canadian locations for this species have not been discovered since 1966, despite extensive botanical work in southwestern Ontario. However, it is easily overlooked, due to its small size, inconspicuous flowers, late and exceedingly short flowering period, and its irregular abundance even at known sites. It is possible that as yet undiscovered populations occur elsewhere in southwestern Ontario.

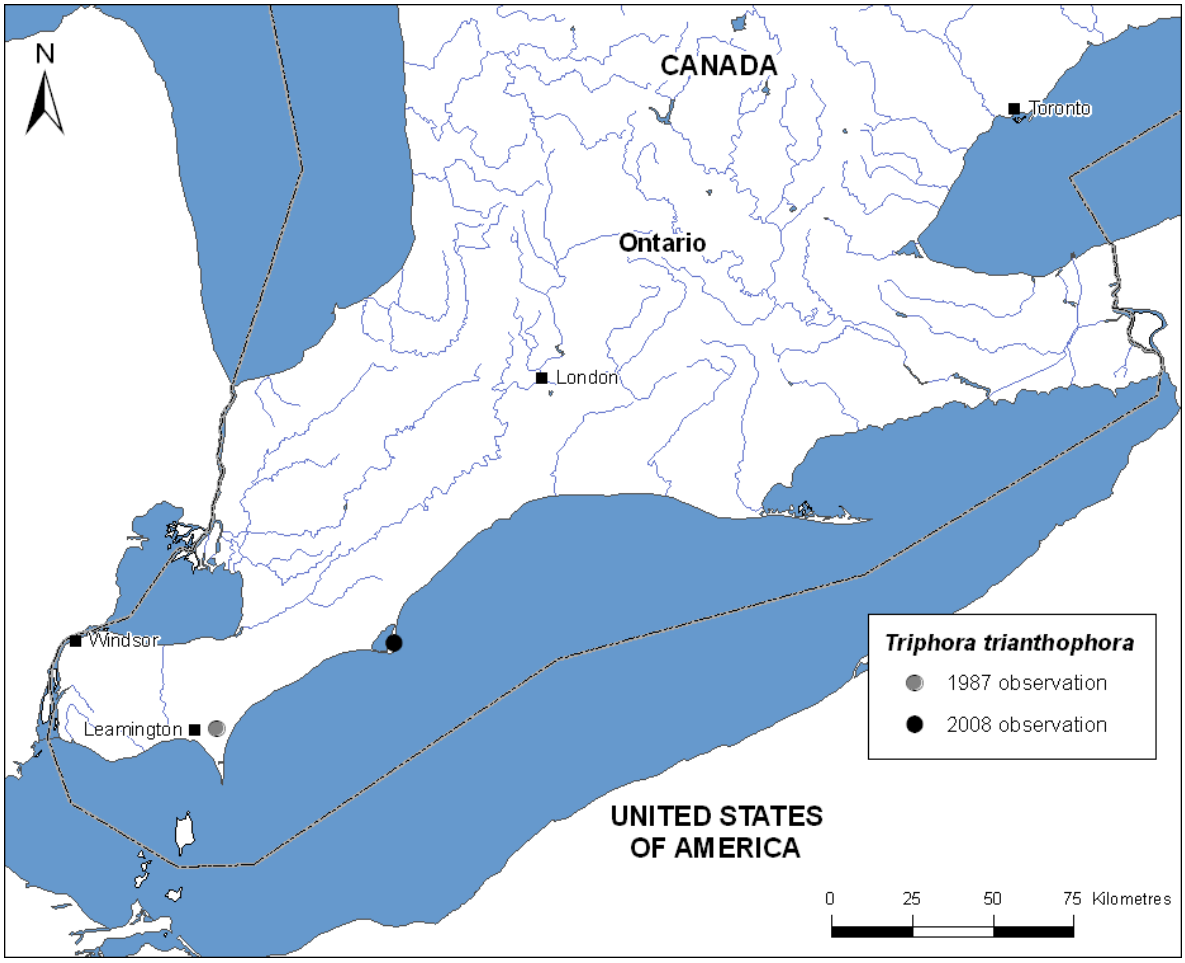


Figure 4. Distribution of Nodding Pogonia in Canada (courtesy of COSEWIC secretariat).

It should be noted that the origin of the Rondeau occurrence is unclear. Four clumps from the Essex County site were transplanted at a site in Rondeau Provincial Park in 1956. By 1960, these plants had disappeared. In 1966, a small population was discovered about one km from the site of the original transplants, and additional subpopulations were found over the next two seasons. It is not known whether any or all of the four subpopulations now known were native to Rondeau Provincial Park, or resulted from the 1956 transplants (Woodliffe 1988). Each of the subpopulations is a minimum of one km from the transplant site. Even if the four subpopulations had resulted from the transplants, although this seems highly improbable, the Rondeau Provincial Park population still qualifies for COSEWIC assessment purposes because it is within the natural range of the species. The Rondeau Provincial Park occurrence is less than 100 km from the population in Essex County and the North American range of the species extends considerably further northward in the northeastern states than the species' occurrence at Rondeau Provincial Park. As well, the plants originated from a native source.

The total extent of occurrence (EO) in Canada is estimated to be about 62 $km^2$ based on the area encompassed in a triangle including the subpopulations in Rondeau Provincial Park and the potentially extant site in Essex County. The total number of one km grid squares occupied by Nodding Pogonia at Rondeau Provincial Park is eight, and in Essex County is one, for a total index of area of occupancy (IAO) of nine $km^2$. The number of two km grid squares occupied is three at Rondeau Provincial Park and one at the Essex County site, for a total IAO of four grid units (16 $km^2$). The Canadian populations occupy less than 1% of the global range of the species.

## HABITAT

### Habitat requirements

Nodding Pogonia is a species of rich, mesic, mixed hardwood forests. In the northeastern United States, Nodding Pogonia is closely associated with mature stands of American Beech (*Fagus grandifolia*) (Brackley 1985; Keenan 1992). In Canada, it grows in rich, moist beech-maple forests with a deep humus layer. The forest understorey is usually relatively open in areas where Nodding Pogonia is found, with few herbaceous species growing nearby (Figure 5). Associated plants at both sites are well described in Woodliffe (1988). Although seemingly suitable forest habitats occur much more widely within the Carolinian Zone of southwestern Ontario, no other occurrences of this orchid have been found over many decades of plant surveys conducted in the region.

Figure 5. Nodding Pogonia habitat at Rondeau Provincial Park. Photograph: Holly J. Bickerton.

Nodding Pogonia requires compatible fungal associates for nourishment throughout its life cycle. Because of its frequent association with American Beech, Williams (1994) hypothesized that the orchid may receive nutrients and photosynthates from beech trees via soil fungi that are connected to both beech trees and the orchid. Deep leaf litter may help to support a mycorrhizal fungus within the leaf mould (Brackley 1985). Nodding Pogonia occurs in a variety of soil types, but is most commonly found in soils with high organic matter. In Canada, the Essex County occurrence is found in the Essex Clay Plain, within Berrien Sand in the Brookston Clay Sand spot phase, and at the Rondeau Provincial Park site, the orchid occurs on the tops and sides of low sand ridges of the Erie Spit formation (Chapman and Putnam 1984, cited in Woodliffe 1988). Nodding Pogonia generally prefers acidic conditions, but can tolerate neutral to calcareous soils. At three Michigan sites, pH values ranged from 4.65 to 7.35 (Medley 1979, cited in Woodliffe 1988).

Although Nodding Pogonia appears to favour mesic sites, it also grows in floodplain forests, borders of swamps, sphagnum bogs, and on sandy flats (Case 1987; Sheviak 1974; Homoya 1993). It appears to require a steady supply of moisture throughout the season; drought may reduce or eliminate flowering in a season (White 2000).

Nodding Pogonia is highly shade tolerant, perhaps because it does not rely to any great extent on photosynthesis to obtain nutrients. It typically flowers under the very low light conditions present under a full canopy in a late successional forest, when most forest plants have finished flowering (Williams 1994).

### Habitat trends

Habitat of Nodding Pogonia at Rondeau Provincial Park has recovered from excessive grazing by White-tailed Deer (*Odocoileus virginianus*). White-tailed Deer numbers have been reduced through managed culls since the mid-1990s, and although the understorey remains quite open, it is gradually filling in as grazing pressure is reduced. The exotic Japanese Barberry (*Berberis thunbergii*), is widely distributed throughout the park and has been present for decades. Whether there has been a change in abundance subsequent to the deer culls is unknown but it is seemingly more abundant at one subpopulation. This spiny shrub is not palatable to deer and likely was not impacted by the local deer population. Human disturbance has not been seen at any of the four subpopulations; however, tree falls have been a common occurrence within the park.

The eastern half of the Essex County site is no longer heavily grazed by horses as reported in Woodliffe (1988), and a sparse native understorey has returned. Scattered Garlic Mustard (*Alliaria petiolata*) seedlings are present in the area where Nodding Pogonia was recorded in the 1980s. The leaf litter here appeared sparser than in healthy mature forests, with many patches of bare soil present. Mature deciduous woodland remains on the western half of the property, where the majority of the population was last observed in the 1980s. The western portion of the property was not visited in 2008.

## BIOLOGY

Nodding Pogonia is a small, inconspicuous plant that only shows above ground in late summer when it is about to begin its short flowering period. If conditions are unfavourable for flowering in a particular year, few, if any, stems are produced (Woodliffe 1988). This could cause the orchid to be missed by those trying to find the species. Additional publications on U.S. populations that provide some insight into the biology of the species include those of Williams (1998) and Dister (2006).

## Life cycle and reproduction

Nodding Pogonia is able to persist underground in a tuberous condition for many years at a time (Lownes 1920; Morris and Eames 1929; Luer 1975). Nodding Pogonia has been referred to as a semi-saprophyte (Case 1987), because of its ability to obtain nutrients primarily from its association with subterranean fungi. Consequently, it grows above ground for a short time, only to produce flowers and seeds. The flowering stalk does contain chlorophyll and likely provides photosynthate that may be important in providing additional energy for flowering and seed set. Flowering stems may appear abundantly one year, and be virtually absent the next (Williams 1994). Williams (1994) observed in a Massachusetts population that most plants did not form flowering shoots but remained in the leaf litter as thickened underground storage structures, or "tuberoids". Although the species of its mycorrhizal associate is unknown, it is relegated to the genus *Rhizoctonia*, a genus that includes the asexual forms of mycorrhizal fungal associates, until it can be determined more specifically (Roberts 1999).

In Canada, Nodding Pogonia appears above ground in late July to early August. It can develop rapidly, approaching blooming size within a week. Peak flowering occurs in mid-August. Bud development may take a week or more. A drop in night temperature, usually of a few degrees, triggers flowering. Buds open by mid-morning, forty-eight hours following the nighttime temperature drop. Flowers usually remain open for pollination for only a few hours, and collapse by evening of the same day (Keenan, 1992). Most plants produce between one and three flowers over the course of the season, although as many as seven flowers have been observed at Rondeau (Woodliffe, pers. comm. 2009). Williams (1994) reported a large percentage of bud loss in a six-year study of a Massachusetts population, due to bud drop, and herbivory.

Colonies of Nodding Pogonia usually develop and flower synchronously, which may increase their chances of cross-pollination (Luer 1975). Following the first flowering, further flowering buds may develop and the flowering process may be repeated two or three times through the short season. Flowering at Canadian sites occurs generally between late July and early September, although at Rondeau Provincial Park, flowers have been observed in late September (Woodliffe 1988).

Bees are likely the primary pollinators of Nodding Pogonia. It appears that a number of species are capable of pollinating flowers. Pollinators collected in 1984 at the Rondeau population were identified as parasitic bees in the family Halictidae, specifically *Dialictus abanci*, *D. oblongus* and *D. philanthanus* (Woodliffe 1988). Studies of Nodding Pogonia in Michigan have shown the primary pollinators to be sweat bees and small carpenter bees (Xylacopidae) (Medley 1979 cited in Woodliffe 1988). Williams (1994) also observed pollination by a small species of bumblebee (*Bombus* sp.; Apidae) and a slender bee likely belonging to the genus *Hylaeus* (Colletidae).

Perhaps due to its extremely limited availability to pollinators, Nodding Pogonia rarely sets seed capsules (Keenan 1992; Williams 1994). In Massachusetts, studies over five years showed that fewer than five percent of buds produced capsules. When seed capsules were produced, most ripened to maturity (Williams 1994). As with most orchids, each capsule may produce many tiny seeds, and so the low rate of capsule set may not necessarily be limiting. In contrast, in some years, such as in 2009, the percent capsule formation noted at the Rondeau National Park site appeared to be much higher based on field notes recorded for part of the population (Woodliffe, pers. comm. 2010).

Little is known about seedling establishment. As with most orchids, the tiny seeds contain few nutrient resources of their own, and germinate and develop successfully only after they have been infected by a compatible fungal endophyte (Anderson 1994). Seedling establishment rates are possibly low due to the need for a compatible fungal associate.

No data are available on generation time (i.e., the average age of reproducing adults), or even of the age at which plants reach reproductive maturity. Nodding Pogonia reproduces vegetatively by the production of new, secondary tuberoids from the plant's primary tuberoid (Williams 1994) and likely relies heavily on this method of reproduction, given the relatively large numbers of non-flowering tuberoids that may be present. Colonies may be long-lived. One New England colony has been observed consistently for at least 70 years (Keenan 1998, cited in Ramstetter 2001).

**Physiology and adaptability**

Associated with mature maple-beech forests and soils of high organic content, Nodding Pogonia appears to have a low ability to adapt to environmental change. It is believed to be susceptible to changes in canopy cover and other alterations to light and moisture regimes, such as those resulting from timber harvesting (Ramstetter 2001).

It does not appear that Nodding Pogonia has been successfully cultivated from seed and transplanted to survive in natural conditions. Anderson (1994) successfully germinated seeds in culture, producing rhizomes/roots with small tubers and shoots, but suggested that protocorm transplants to soil would need to be infected with fungus isolated from a naturally growing plant. However, successful transplants of mature individuals from natural populations have been reported (Morris and Eames 1929).

### Dispersal

Most orchids produce minute seeds that are well-suited for long-distance wind dispersal (Dressler 1981). However, there is no published information available on patterns or distances of seed dispersal for Nodding Pogonia. The lack of new occurrences of this species in Ontario in the past decades likely reflects the difficulty in establishment of such colonies as well as their discovery based on their life history characteristics.

The application of severe fragmentation, as per IUCN/COSEWIC definition, for the two populations of Nodding Pogonia is uncertain. The two sites are separated by 62 km, have low rates of seed capsule maturation and low probability of recolonization from outside seed sources reflects their discreteness. However, the small population on private land is of questionable viability in the long term. However, of the two populations, the one at Rondeau contains the majority of flowering shoots and occupies more than one half the occupied habitat.

### Interspecific interactions

Evidence of deer browsing was noted on a clump of Nodding Pogonia at Rondeau in 1986, removing all flowers and eliminating seed production for the entire clump. Herbivory by slugs, insects, rodents, and deer have also been observed elsewhere (Ramstetter 2001). In Massachusetts, Williams (1994) observed destructive herbivory of Nodding Pogonia buds and stems by slugs. Entire clumps of flowering stems and underground tuberoids may also be consumed or destroyed by rodents, especially chipmunks (*Tamias striatus*) (Keenan 1992; Williams 1994). Herbivory may constitute a significant cause of bud loss in young plants (Williams 1994).

## POPULATION SIZES AND TRENDS

### Sampling effort and methods

Between August 14 and August 24, 2008, both sites from which Nodding Pogonia has been documented in Ontario were searched by four individuals, with approximately 34 person-hours of search time. Allen Woodliffe, who has visited both sites, accompanied Holly Bickerton to both. Only three of the four subpopulations in Rondeau Provincial Park were documented in 2008. The fourth could not be located. Only the eastern portion of the Essex County site was visited because permission was not obtained to access the entire woodland. Where plants were found, flowering stems were counted or, in the case of very large clumps, estimated.

## Abundance

Estimating numbers of mature individuals is difficult for this species, because there are no known methods available to determine the genetic limits to individual mature plants. Flowering stems that appear above ground in large clumps may or may not represent a single genetic individual (i.e., genet). In previous status reports and in monitoring data from at least two decades (A. Woodliffe, pers. comm. 2008), the number of individual flowering stems has been used to report abundance. This method of reporting abundance has been maintained in this status report. However, it is not well understood how the number of flowering stems relates to the number of mature individuals at a site. Each flowering stalk and its tuber must be counted as a mature individual based on IUCN/COSEWIC guidelines for species that also produce asexual progeny that can live independently. Flowering clumps of Nodding Pogonia may be the result of growth from tubers of one or more plants in close proximity or as a consequence of caching of tubers by squirrels (A. Woodliffe, pers. comm. 2010). Such clusters, therefore, cannot be assumed to represent a single individual for assessment purposes. A summary of population sizes is provided in Table 1.

**Table 1. Summary of population reports and number of flowering stalks.**

| . | Location | Original record | Last Observation | 1988 Report (Woodliffe) | 1998 Report (White) | Most recent records |
|---|---|---|---|---|---|---|
| 1 | Rondeau Provincial Park | Ussher (1966) | 2008 | ~1500 (1986, A. Woodliffe) | ~50 (1998, estimate by D.J. White) | 1357 (2008, A. Woodliffe, H. Bickerton *et al*.)<br>126 (2009 partial data, recorded at the main subpop. viz. 69 in 2008 at same site, A. Woodliffe) |
| 2 | Hillman area, Mersea Township, Essex County | Zavitz (1950) | 1987 | 12 (1950, C. Zavitz),188 (1967, R. Whiting),<br>22 (1985, W. Botham)<br>"less than a dozen" (1987) | 0 (1998, D.J. White) | 0 (2000, D. Jacobs, partial survey)<br>0 (2008, A. Woodliffe, H. Bickerton) |
| | **TOTAL** | | | | | 1357 stems (2008) |

In 2008, 1357 flowering stems were counted, all located within three subpopulations at Rondeau Provincial Park. The fourth was not observed in 2008. It is likely that this count is conservative, given the obscure nature of this orchid. The 2008 count of flowering stems is among the highest ever documented for the population at Rondeau (A. Woodliffe, pers. comm. 2008). This may be a result of a cool, wet summer that presented ideal growing conditions, combined with an increased search effort in advance of the update status report.

Nodding Pogonia was not found in the eastern half of the Essex County site, historically an area with fewer plants. The western portion was not visited in 2008.

**Fluctuations and trends**

Nodding Pogonia is well known for its large fluctuations in above-ground flowering stems, which make trends very difficult to assess (Keenan 1992). Such apparent fluctuations have been observed by annual monitoring of plots at Rondeau Provincial Park conducted by Allen Woodliffe over two decades.

The Rondeau population was discovered in 1966, when it supported several clumps of 10-15 flowering stems each (Woodliffe 1988). Between the time of its discovery and the writing of the original status report, the Rondeau survey count increased to almost 1500 flowering stems, scattered in clumps of various sizes across three subpopulations (Woodliffe 1988). By 1998, only 50 flowering stems were counted at Rondeau Provincial Park—a reported decline estimated at about 95% (White 2000). In view of the widely fluctuating stem counts, the total count of 1357 flowering stems in the 2008 field season at Rondeau likely should not be taken to represent a stable condition for the Canadian population.

The Essex County site has not been visited as regularly. Despite searches in 1998 (D.J. White, partial survey) and 2000 (D. Jacobs and A. Woodliffe, partial survey), Nodding Pogonia has not been observed there since 1987, although the habitat has not changed substantially. Compared with previous reports of heavy grazing (Woodliffe 1988), abundant litter, and access to the woodlot by cars and trucks (Whiting 1968), site conditions may even have improved over the past decades. Surveys in July of 1998 were undertaken during a very dry period. It is still possible that Nodding Pogonia is present at this site, because it may persist as an underground tuberoid for long periods of time, even when flowering stems are absent. One occurrence of Nodding Pogonia at a well-botanized South Carolina site was reportedly last observed in 1850 and subsequently rediscovered in 1975, after an apparent “absence” of 125 years (Porcher 1977).

## Rescue effect

Even though orchid seeds are reportedly highly mobile, it is unlikely that re-establishment of Nodding Pogonia in Ontario could occur naturally from populations in the United States, in the event that it was extirpated from Canada, for the following reasons: the species is very rare in all states adjacent to Ontario, including New York, Pennsylvania, Ohio, Michigan, and Wisconsin (Table 2); successful production of seed capsules is low; extant populations probably persist mainly by vegetative reproduction; and Nodding Pogonia requires specific habitat conditions and the presence of compatible soil fungi. Despite relatively intensive botanical surveying in southwestern Ontario, no new populations of this species have been discovered in over 40 years.

**Table 2. Summary of S-Ranks for Nodding Pogonia (*Triphora trianthophoros*).**

| State or Province | SRank[1] | State/Provincial Listing (if any) |
|---|---|---|
| Alabama | SNR | |
| Arkansas | SNR | |
| Connecticut | S1 | SC |
| Delaware | S1 | END |
| District of Columbia | SH | |
| Florida | S3 | |
| Georgia | S2? | |
| Illinois | S3? | |
| Indiana | SNR | |
| Iowa | S3 | THR |
| Kansas | S1 | |
| Kentucky | SNR | THR |
| Louisiana | S2 | |
| Maine | S1 | THR |
| Maryland | S1 | END |
| Massachusetts | S1 | END |
| Michigan | S1 | THR |
| Mississippi | S2S3 | |
| Missouri | SNR | |
| Nebraska | S1 | END |
| New Hampshire | S2 | THR |
| New Jersey | S1 | END |
| New York | S2 | END |
| North Carolina | S2? | |
| Ohio | S2 | THR |
| Oklahoma | S2S3 | |
| Pennsylvania | SH | |
| South Carolina | S2 | SC |
| Tennessee | SNR | |
| Texas | SNR | |
| Vermont | S1 | THR |
| Virginia | S1 | END |
| West Virginia | S2 | |
| Wisconsin | S2 | SC |

Source: NatureServe, 2010; Ramstetter, 2001.

[1] S1: Critically Imperiled; S2: Imperiled; S3: Vulnerable; S4: Apparently Secure; S5: Secure; SH: Historical; SX: Presumed Extirpated; SNR: Not Ranked (NatureServe, 2010).

## THREATS AND LIMITING FACTORS

Above all, Nodding Pogonia is at risk because it occurs at most at only two isolated sites in Canada. Single events such as storms or drought could significantly reduce or even destroy an entire population. In New England, low genetic diversity is considered to be a threat, because populations are small and probably rely on asexual reproduction (Ramstetter 2001).

Invasive species are present at both Canadian sites. Although it has been present for many years at the Rondeau site, Japanese Barberry appears to be increasing and may threaten at least one subpopulation. Control of this species at the main site was initiated in 2010, but the species is widespread throughout the park and could re-establish at the site if control is not maintained. Garlic Mustard seedlings are present in the eastern portion of the Essex county site. Exotic earthworms may present a threat at the Essex site. Earthworms have been shown to reduce the duff layer and fungal diversity, which could harm Nodding Pogonia, and may also impact plant species richness, nutrient availability and modify soil characteristics (Hale *et al*. 2008, 2005; Holdsworth *et al*. 2007; Muratake 2003). Earthworm populations were not surveyed at the Essex site, but leaf litter appeared shallow, and several patches of bare soil were observed at the location where the orchid has been observed in the past. Earthworms may also threaten the populations at Rondeau, where there is a reduced litter layer and large patches of exposed soil on the tops of several sand ridges (Woodliffe, pers. comm., 2009).

Herbivory is a possible threat at either site. Grazing by deer was reported at Rondeau (Woodliffe 1988), although browsed Nodding Pogonia plants have not been observed there since deer population control began at Rondeau in the mid-1990s (A. Woodliffe, pers comm., 2009). Herbivory by chipmunks and slugs has also been destructive at populations in the United States (Williams 1994). Stem damage has recently been observed on plants at Rondeau, but the cause is not known (A. Woodliffe, pers. comm. 2009).

Although the Essex County woodland still persists, and both current landowners intend to maintain the existing woodland, land ownership, use and management may change without additional protection through stewardship.

Trampling is a possible threat at either site, mainly because the species is diminutive, easily overlooked and can be very easily trampled, even when monitoring plants. However, neither population is easily accessible to the public, and trampling and unlawful collection of this rare orchid is probably not a significant threat.

## PROTECTION, STATUS, AND RANKS

### Legal protection and status

Nodding Pogonia is regulated as Endangered under the Ontario *Endangered Species Act, 2007* and is listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA). Legislative protection for the Rondeau population is also provided through Ontario's *Provincial Parks and Conservation Reserves Act* (2006).

### Non-legal status and ranks

Nodding Pogonia is globally ranked G3G4, but has been given a "rounded" global status of G3 (Vulnerable) because it is uncommon throughout its North American range (NatureServe 2010). In Canada, Nodding Pogonia is nationally ranked N1 (Critically Imperilled). It is has been assigned a rank of S1 (Critically Imperilled) in Ontario (Oldham and Brinker, 2009). In the United States, the species may be extirpated in two states, and is ranked S1 or S2 (Imperilled to Critically Imperilled) and S2S3 in 22 of 34 states where it has been documented (NatureServe 2010; Table 2). It is also listed as Endangered, Threatened or Special Concern in 15 American states (Ramstetter 2001).

### Habitat protection and ownership

Of the two known Canadian occurrences, one is protected through provincial ownership and management at Rondeau Provincial Park. The Essex County site, within the Hillman Three-Birds Woodlot, is divided into two properties, both privately owned. The woodlot is designated as an Environmentally Significant Area by the Essex Region Conservation Authority (Ambrose and Jalava 2007). Increased protection of both properties through stewardship or ownership could help to conserve this species, if it is still present here. This has been identified as a high priority in a draft recovery strategy for the species (Oldham 1983, Ambrose and Jalava 2007).

Due to the wide distribution of Nodding Pogonia across eastern North America, it is not possible to estimate the extent of its global range that is in protected areas such as national or provincial parks. In Ontario, the Rondeau Provincial Park site is managed by Ontario Parks, and the species occurs in a Nature Reserve Zone. The second site is on private property. The species is not known to occur on any federal lands in Canada

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Allen Woodliffe, District Ecologist, Aylmer District, Ontario Ministry of Natural Resources (OMNR), Chatham, ON.

Mike Oldham, Botanist, Natural Heritage Information Centre, OMNR, Peterborough, ON.

Sandy Dobbyn, Zone Ecologist, Southwest Zone, Ontario Parks, London, ON.

Jeff Robinson, CWS-Ontario Protected Areas Unit, London, ON.

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## BIOGRAPHICAL SUMMARY OF REPORT WRITER

Holly J. Bickerton holds a B.A.Sc. from McMaster University and a Masters of Environmental Studies from York University. She has over ten years of experience in field ecology. From 2000 to 2003, Holly worked in South Australia for the Nature Conservation Society of South Australia and for the state government, where she participated in several flora and fauna inventories, and authored a nomination for a threatened ecological community. Upon returning to Ontario in 2003, Holly worked for three years as a Species at Risk Biologist with the Ontario Ministry of Natural Resources. She lives in Ottawa and is self-employed as a consulting ecologist, conducting flora and fauna inventories, vegetation mapping, invasive species assessments, ecological and species-at-risk monitoring, as well as policy research and writing. Holly has authored one other COSEWIC Update Status Report, and Recovery Strategies for seven Canadian species at risk.

## COLLECTIONS EXAMINED

No herbarium collections of *Triphora trianthophoros* were examined during the preparation of this report.