Photo: Loyal A. Mehrhoff

Large Whorled Pogonia

(Isotria verticillata) in Ontario

Ontario Recovery Strategy Series

Recovery strategy prepared under the *Endangered Species Act, 2007*

Natural. Valued. Protected.

Ministry of Natural Resources

Ontario

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the Endangered Species Act (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA, a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. There is a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources Species at Risk webpage at: **www.ontario.ca/speciesatrisk**

RECOMMENDED CITATION

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Cette publication hautement spécialisée Recovery strategies prepared under the *Endangered Species Act, 2007*, *n'est disponible qu'en Anglais en vertu du Règlement 411/97 qui en exempte l'application de la Loi sur les services en français. Pour obtenir de l'aide en français, veuillez communiquer avec Pamela Wesley au ministère des Richesses naturelles au 705-755-5217.*

AUTHORS

Judith Jones – Winter Spider Eco-Consulting, Sheguiandah, Ontario
Jarmo Jalava – Consulting Ecologist, Paisley, Ontario
John D. Ambrose – Consultant, Guelph, Ontario

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DECLARATION

The recovery strategy for the Large Whorled Pogonia has been prepared in accordance with the requirements of the *Endangered Species Act,* 2007 (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

RESPONSIBLE JURISDICTIONS

Ontario Ministry of Natural Resources
Environment Canada – Canadian Wildlife Service, Ontario

EXECUTIVE SUMMARY

The Large Whorled Pogonia (*Isotria verticillata*) is an orchid with a single yellowish-green flower above a whorl of leaves. The species requires mycorrhizal fungi in its roots for nourishment. The Large Whorled Pogonia can remain dormant, sometimes being absent for a number of years. The species is listed as endangered under the provincial *Endangered Species Act, 2007* and the federal *Species at Risk Act*.

Canadian locations of Large Whorled Pogonia are all in Carolinian woodland in southwestern Ontario. There are two populations presumed extant, one population possibly extant and one historical population last seen in 1879. The three populations declined steadily from the 1960s to the early 1990s. The last observation of the species in Canada was in 1996 despite some subsequent searches. However the maximum dormancy period for this species is unknown and sites have not been searched in consecutive years; therefore it is premature to presume the species is extirpated.

The habitat of Large Whorled Pogonia generally is moist, deciduous or mixed forest with a semi-open canopy on sandy acidic soil with thick leaf litter and abundant humus.

Human impacts on habitat (land clearing, incompatible forestry practices and trampling) have probably played a significant role in the decline of Large Whorled Pogonia in Canada. Other threats include the effects of fragmentation of woodlands and resulting isolation of small populations and natural processes such as flooding by beaver. As well, exotic earthworms and atmospheric pollutants are potential threats that may alter soil conditions and deleteriously affect the symbiotic mycorrhizal fungi that the orchid requires to survive. Invasive plant species may also be a potential threat.

Determining if any Canadian populations are extant is an urgent knowledge gap.

The recovery goal is to recover and maintain long-term, self-sustaining, viable populations of Large Whorled Pogonia and its habitats within the current and historic range in southern Ontario. Recovery for Large Whorled Pogonia will present a number of challenges. Propagation and re-introduction can be difficult to do with orchids because of the necessary mycorrhizal associations. The objectives toward achieving the recovery goal include the following.

- Determine current status of Large Whorled Pogonia populations in Ontario through inventory of the three known populations, historic reports and other potential habitat.
- Protect and manage habitat to maintain extant populations in Ontario through:
    a. appropriate management of public lands;
    b. appropriate land-use planning for private lands;
    c. stewardship on private lands;
    d. site securement; and
    e. site restoration and rehabilitation.

- Address knowledge gaps relating to the biology, ecology, habitat and threats of Large Whorled Pogonia in Ontario.
- Coordinate recovery activities with other plant species of the draft Carolinian Woodland Plants Recovery Strategy and work towards increasing the amount of high-quality interior moist forest habitat (to enhance the chances of natural dispersal and colonization of new sites).
- Develop educational and outreach materials for naturalists, orchid enthusiasts and the general public highlighting the significance, uniqueness and vulnerability of the species.
- Investigate the feasibility of reintroducing Large Whorled Pogonia to sites where it is deemed extirpated if suitable habitat remains, or to other suitable habitat.

The maximum length of dormancy for this species is not known, so as a precautionary principle a habitat prescription should be made for the populations presumed or possibly extant until their status can be clarified.

It is suggested that the area to be prescribed as habitat should be the Ecological Land Classification (ELC) vegetation type around the three documented populations plus any contiguous area of deciduous or mixed forest cover that has >10 cm of duff and humus and soil pH of 4.0 to 5.5. If the plants reappear in any given year and it becomes possible to fill knowledge gaps, these parameters can be further refined.

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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME: Large Whorled Pogonia
SCIENTIFIC NAME: *Isotria verticillata*
SARO List Classification: Endangered
SARO List History: Endangered (2008), Endangered – Regulated (2004)
COSEWIC Assessment History: Endangered (2000)
SARA Schedule 1: Endangered
CONSERVATION STATUS RANKINGS: GRANK: G5 NRANK: N1 SRANK: S1

The glossary provides definitions for technical terms, including the abbreviations above.

1.2 Species Description and Biology

Species Description

Large Whorled Pogonia is an orchid with a single yellowish-green flower with narrow purplish sepals growing just above a whorl of five or six green leaves. The leaves measure approximately nine centimetres long by five centimetres wide. The sepals are much longer than the petals (White 1998) and the flower has a sweet, delicate fragrance. It can attain a maximum height of 30 cm and has a stem that is often purplish (White 1998). The fruit measures 25 mm by 7 mm (Environment Canada 2008).

Species Biology

Large Whorled Pogonia reproduces primarily through vegetative shoots. A single clone is capable of producing up to 300 individual shoots (ramets) (Mehrhoff and Homoya 2002). In Canada, the plants flower in late May or early June, and bees are the main pollinators (Mehrhoff, 1983). The fruit is a dry capsule with fine seeds which are dispersed by wind (Environment Canada 2008). Like many other orchids, Large Whorled Pogonia plants require mycorrhizal fungi for nourishment (Hill 2007). The relationship between orchids and their associated mycorrhizae is normally symbiotic, and one can usually not survive without the other.

This species may remain dormant during unfavourable conditions and can be absent for several years at a time if conditions required to produce flowers and seeds are not met.

A year or even several without flowering plants does not necessarily indicate that the species is extirpated (Hill 2007).

1.3 Distribution, Abundance and Population Trends

Large Whorled Pogonia (Figure 1) occurs in eastern North America, from New England, southwestern Ontario and Michigan south to Texas and Georgia (Klinkenberg 1986, White 1998). In Canada it is restricted to extreme southwestern Ontario (Middlesex, Oxford and Norfolk counties) (Figure 2). Less than one percent of its global range is in Canada.

Large Whorled Pogonia is globally ranked as G5 (secure), nationally in the United States as N5 (secure) and nationally in Canada as N1 (critically imperilled). In Ontario, it is ranked critically imperilled (S1). According to NatureServe (2009), the species is listed as:

- critically imperilled (S1) in Florida, Illinois, Missouri, New Hampshire, Oklahoma, and Texas;
- imperilled (S2) in Alabama, Delaware, Michigan, North Carolina, and Vermont;
- vulnerable (S3) in Connecticut, Georgia, Indiana, Louisiana, Massachusetts, Mississippi, New York, and Rhode Island;
- extirpated (SX) in Maine; and
- secure or Not Ranked (S4, S5, SNR) in Arkansas, District of Columbia, Kentucky, Maryland, New Jersey, Ohio, Pennsylvania, and South Carolina, Tennessee, Virginia, and West Virginia.

In Ontario, a total of four populations have been recorded. Two populations have not been seen since 1990 and 1996 but are still presumed extant. A third population was seriously affected by flooding but may possibly still have some portion extant. The fourth population is an historical record of a population last seen in 1879 (Table 1). For the three populations that may be extant, dramatic declines since the 1960s have been observed.

Due to the long dormancy periods possible for this species, these populations cannot yet be presumed extirpated, especially since they have not been searched for on a consistent, annual basis to see if the plants have appeared above ground. The related species Small Whorled Pogonia (*Isotria medioloides*) is known to be able to be dormant for up to 20 years but the Large Whorled Pogonia probably does not remain dormant for as long (Woodliffe pers. comm. 2009).

Figure 1. Global Distribution of Large Whorled Pogonia (shaded area and outlying dots) (FNA 2005)

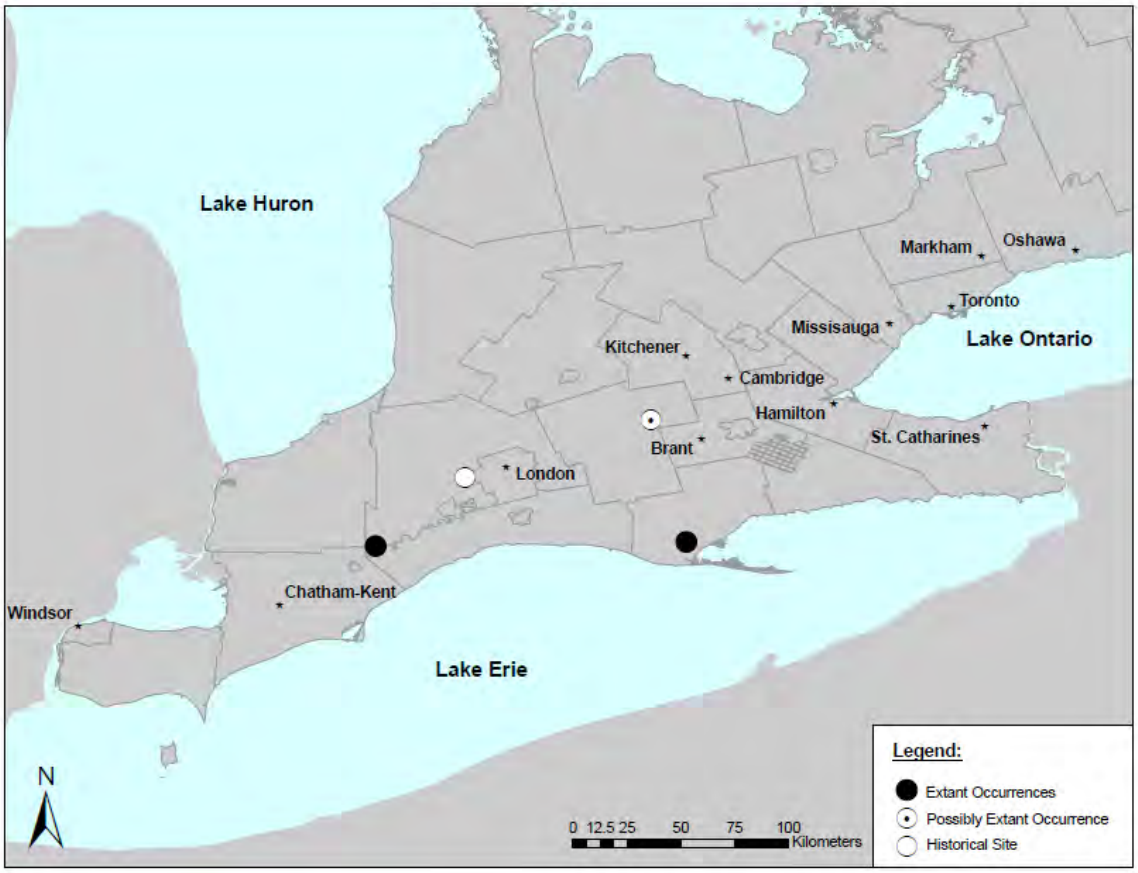

Figure 2. Distribution of Large Whorled Pogonia in Ontario. Black dots—populations presumed extant; grey dot—population possibly extant; white dot—historical site presumed extirpated.

Table 1. Populations of Large Whorled Pogonia with most recent observation data.

Location	Status	Last Observation	Year of Survey	Flowering Plants	Vegetative Plants	Notes
Middlesex County, Skunk's Misery	Unknown Presumed extant	1996	1989 1993 1996 1997	0 0 0 0	9 1 1 0	A maximum of nine plants observed since initial discovery in 1984; flowering plants never observed. Not found during 1997 search (White 1998). Private land.
Norfolk County, Backus Woods	Unknown Presumed extant	1990	1965 1966 1969 1971 1980 1982 1983 1984 1987 1989 1990 1997 2008	6 ? 6-8 12 2 0 0 0 0 0 0 0 0	24 43? ? 28 23 20 19 17 11 3 2 0 0	Rare; confined to a single colony. Not seen since 1990, despite the fact that the colony is easy to locate and several people have searched for it (White 1998). Owned by Nature Conservancy Canada. Suitable (but apparently unoccupied) habitat also present, so species may have been overlooked there.
Oxford County, Fowler's Pond	Unknown Possibly still extant	1990	1985 1986 1987 1989 1990 1996 1997	4 2 1 0 0 0 0	40 70 105 41 >20 0 0	Apparently eliminated by beaver flooding of nearby pond. Formerly Ontario's largest known population. Provincial Wildlife Area owned and managed by Ontario Ministry of Natural Resources.
Middlesex Co Komoka Swamp	Historical	1879				Documented in 1879 by W.E. Saunders. In 1941 he reported the species as absent in the London area after 1879 (Whiting and Catling 1986).

1.4 Habitat Needs

Large Whorled Pogonia generally requires moist deciduous or mixed forest with a semi-open canopy on sandy soil, a thick leaf litter and abundant humus (White 1998). In the United States the species is also found in seepage zones and successional bogs with *Sphagnum* and other species that prefer acidic soils. Other descriptions (Hill 2007; Michigan Natural Features Inventory 2007; House 1906) report the habitat as the drier parts of low oak and Red Maple (*Acer rubrum*) forest and in seasonally inundated, acidic hardwood swamps with hummocky ground. Acidic soils are essential, with the species being found in soils with a pH range of between 4.2 and 5.1 (FNA 2006).

At Backus Woods the species occurs in a closed-canopy, sandy, dry-mesic forest dominated by Red Maple with scattered White Oak (*Quercus alba*) and Red Oak (*Quercus rubra*). Dominant shrubs at the site include Maple-leaved Viburnum

(*Viburnum acerifolium*), Lowbush Blueberry (*Vaccinium angustifolium*) and Smooth Serviceberry (*Amelanchier laevis* ssp. *arborea*), while dominant herbs include Canada Mayflower (*Maianthemum canadense*), Indian Cucumber-root (*Medeola virginiana*), Starflower (*Trientalis borealis*), False Solomon's-seal (*Maianthemum racemosum*) and Lance-leaved Wild-licorice (*Galium lanceolatum*) (NHIC 2011).

1.5 Limiting Factors

The three populations of Large Whorled Pogonia are isolated and small, so the species is at risk of being destroyed by stochastic events such as major storms, drought or wildfire. A single event could remove an entire population. Loss of genetic diversity is another concern for species occurring in such small, geographically isolated populations.

Large Whorled Pogonia, like several other rare orchid species in Ontario, only grows above ground in years with conditions favourable to the production of flowers and seeds. The reproductive biology of this species is highly specialized and requires coinciding factors: favourable conditions for the plant to invest energy in producing flowers; insect pollinators to produce a seed set; wind dispersal of seeds; and contact of the seeds with a specific fungus species in order for germination to take place. These intricacies limit the species because if one factor is lacking it can affect the entire chain of events necessary for reproductive success and perpetuation of populations. In addition only a small percentage of the population normally flowers in any given year, and some years no flowers at all may be produced (Hill 2007).

Large Whorled Pogonia is normally pollinated by solitary bees of the Andrenidae, Anthophoridae and Halictidae families. These bees are wide-ranging and visit a large number of spring and early summer flowers (Mehrhoff, 1983). Large Whorled Pogonia is also self-compatible but does not frequently self-pollinate, unlike the related Small Whorled Pogonia. Thus, pollinators are required. In addition, the pollen in this species is a mass rather than a single pollinia, meaning that more than one insect may receive pollen from a single flower (Mehrhoff 1983). Despite this, field studies in North Carolina (Mehrhoff, 1983) found that only 21% of the plants studied received successful pollination. Furthermore, only six percent of flowers produced mature capsules, the majority either aborting or being destroyed by other factors. Even in experimentally hand-pollinated flowers, capsule loss was high. The Small Whorled Pogonia was found to have a pollination rate of 83% but despite a better pollination rate it is also a very rare species.

As noted above, the Large Whorled Pogonia requires soils with a pH between 4.2 and 5.1 and there is a general paucity of Carolinian forest habitat with suitably acidic substrate in Southwestern Ontario (White 1998).

1.6 Threats to Survival and Recovery

Observed Threats

Habitat Loss or Degradation

Habitat loss and degradation are likely the primary past and present threats to the Large Whorled Pogonia (White 1998) and to many of the other species at risk in the Carolinian woodlands. Clearing of forests for development may eliminate habitat altogether and cause local extinctions. Forest management and development can result in excessive drying of the humus layer that the species needs for survival.

Fragmentation and Isolation

The clearing of forests has created a fragmented landscape of isolated woodlots separated by great distances. This has resulted in reduced dispersal ability and increased genetic isolation for woodland plants.

Natural Processes

Because there are so few (if any) extant populations of Large Whorled Pogonia in Ontario, the species is at considerable risk of extirpation due to natural processes such as drought, flooding or wildfire. Opening of the forest canopy by windstorms may result in drying of the critical humus layer. Flooding by beaver has eliminated the habitat of the Fowler's Pond occurrence which was once the largest population in the province. More robust populations would normally be able to rebound from such impacts.

Trampling by Pedestrians

Trampling of habitat by people looking for this species may cause soil compaction, direct damage to plants and introduction of exotic or invasive plant species (below).

Potential Threats

Exotic and Invasive Species

Exotic earthworms reduce duff and humus layers as well as fungal diversity (Baxter et al. 1999; Muratake 2003, Bohlen et al. 2004). All of these are necessary for the survival of Large Whorled Pogonia, so the presence of exotic earthworms may be an important potential threat. The impacts on the greater forest ecosystems of eastern North America are still being studied (e.g., Hale et al. 2006) but the effects of exotic earthworms appear to be wide-spread and potentially devastating for understory forest communities.

Garlic Mustard (*Alliaria petiolata*) is an exotic invasive plant that produces chemicals in the soil that inhibit the growth of other plants and mycorrhizal fungi. The effects of Garlic Mustard on Large Whorled Pogonia have not been studied, but Garlic Mustard is present in most woodlots in southern Ontario and may be a potential threat. Other exotic or invasive plant species are also a potential threat as they can out-compete native plants for space and resources.

Pollution
Air- and precipitation-borne pollution, leading to soil acidification and nutrient loading (increases in available nitrogen) has been shown to alter the diversity and species composition of forest mycorrhizal fungi (Arnolds 1991; Peter et al. 2001). Pollution may therefore be a potential threat to Large Whorled Pogonia if it reduces the availability of the mycorrhizal fungi required by the orchid.

1.7 Knowledge Gaps

Knowledge gaps may limit the successful recovery of Large Whorled Pogonia.

Knowledge gaps that require field work are:

- current status of population and habitat conditions at the historical site;
- current status of extant populations (if any);
- whether other areas of suitable habitat exist that could support the species; and
- detailed standardized (ecological land classification or ELC) documentation and mapping of the forest communities of the extant occurrences to guide habitat protection.

To mitigate or eliminate threats, a better understanding is needed of:

- the specific mycorrhizal associations required by Large Whorled Pogonia;
- the impacts of air and water-borne nutrient loading on the species;
- the impacts of exotic earthworms, including which species are of most concern; and
- the ecological requirements of pollinators needed by Large Whorled Pogonia.

Data on the biological and ecological needs of the species is needed to guide site management, stewardship and potential reintroduction efforts.

1.8 Recovery Actions Completed or Underway

Recovery of Large Whorled Pogonia is being planned as part of work on the Carolinian woodlands ecosystem to improve the integrity of the landscape where a number of species at risk occur. So far, no actions have been taken specifically for Large Whorled Pogonia; however such actions could be incorporated as a part of ecosystem recovery planning which is currently underway.

All three populations of Large Whorled Pogonia were surveyed regularly until the late 1990s. The Backus Woods site had recently been acquired by the Nature Conservancy of Canada (NCC) and will have management planning with NCC's adjacent properties at that site (Crosthwaite pers. comm. 2011). Fowler's Pond is managed as a Provincial

Wildlife Area by the Ontario Ministry of Natural Resources. No recent management planning has been done for this site. A third site, Skunk's Misery, is owned by a church congregation that knows of this species and supports conservation activity.

2.0 RECOVERY

2.1 Recovery Goal

The recovery goal is to recover and maintain long-term self-sustaining viable populations of Large Whorled Pogonia and its habitats within the current and historic range in southern Ontario.

2.2 Protection and Recovery Objectives

Table 2. Protection and recovery objectives

No.	Protection or Recovery Objective
1	Determine current status of Large Whorled Pogonia populations in Ontario through inventory of the three known populations, historic reports and other potential habitat.
2	Protect and manage habitat to maintain extant populations in Ontario through: a) appropriate management of public lands; b) appropriate land-use planning for private lands; c) stewardship on private lands; d) securing sites ; and e) site restoration and rehabilitation.
3	Address knowledge gaps relating to the biology, ecology, habitat and threats of Large Whorled Pogonia in Ontario.
4	Coordinate recovery activities with other plant species of the draft Carolinian Woodland Plants Recovery Strategy and work towards increasing the amount of high-quality interior moist forest habitat (to enhance the chances of natural dispersal and colonization of new sites).
5	Develop educational and outreach materials for naturalists, orchid enthusiasts and the general public highlighting the significance, uniqueness and vulnerability of the species.
6	Investigate the feasibility of reintroducing Large Whorled Pogonia to sites where it is deemed extirpated if suitable habitat remains or to other suitable habitat.

2.3 Approaches to Recovery

Table 3. Approaches to recovery of Large Whorled Pogonia in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
1. Determine current status of Large Whorled Pogonia populations in Ontario through inventory of the three recently extant populations, historic reports and other potential habitat.				
Critical	Short-term	Inventory, Monitoring and Assessment	**1.1** Conduct population counts of extant populations (if any); characterize habitat (including ELC mapping); rigorously assess threats present, especially exotic earthworms and Garlic Mustard.	• Any or all threats. By gaining insight into causes of declines, specific problems can then be addressed.
Critical	Short-term	Inventory, Monitoring and Assessment	**1.2** Inventory sites of historic reports	• Any or all threats. By gaining insight into causes of declines, specific problems can then be addressed.
Necessary	On-going	Inventory, Monitoring and Assessment	**1.3** Identify and survey additional sites with suitable habitat.	• Any or all threats. By gaining insight into causes of declines, specific problems can then be addressed.
2. Protect and manage habitat to maintain extant populations in Ontario through: a) appropriate management of public lands; b) appropriate land-use planning and stewardship for private lands; c) securing sites; and d) site restoration and rehabilitation.				
Critical	Short-term	Management	**2.1** Minimize beaver impacts at Fowler's Ponds through dam management.	• Natural Processes
Critical	Short-term	Management	**2.2** Post signs at public land occurrences indicating habitat sensitivity.	• Trampling
Critical	Short-term	Management	**2.3** Examine current land use and management practices and identify any positive and/or negative impacts.	• Habitat Degradation; Potential to address other threats

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	On-going	Communications	**2.4** Discuss Skunk's Misery site and other potential habitat areas on private land with municipal planners.	• Habitat loss
Necessary	Short-term	Stewardship; Management	**2.5** Develop species-specific management recommendations and provide to landowners and land managers.	• Habitat loss; Habitat degradation; Other threats
Necessary	Short-term	Management	**2.6** Review and update existing management plans for public lands to ensure they include considerations for protection of the species.	• Habitat Degradation
Beneficial	Long-term	Protection	**2.7** Secure key sites through easements or purchase.	• Habitat loss; Potential to address other threats;
3. Address knowledge gaps relating to the biology, ecology, habitat and threats of Large Whorled Pogonia in Ontario.				
Critical	Short-term	Research	**3.1** Engage academic community to participate in researching knowledge gaps.	• Any or all threats
Critical	Short-term	Research	**3.2** Investigate causes of extirpation from historic sites.	• Any or all threats
Critical	Short-term	Research	**3.3** Conduct population viability analysis.	• Fragmentation and isolation; any other threats.
Necessary	On-going	Research	**3.4** Research mycorrhizal relationships of the species.	• Habitat degradation
Necessary	On-going	Research	**3.5** Research impacts of air pollution (e.g., NO_2) on the species.	• Pollution
Necessary	On-going	Research	**3.6** Research pollination and long range dispersal mechanisms.	• Fragmentation and Isolation
Beneficial	Long-term	Research	**3.7** Based on 3.4, investigate ways to propagate Large Whorled Pogonia for reintroduction.	• Any or all threats by being able to counteract declines

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
4. Coordinate recovery activities with other plant species of the Carolinian Woodland Plants Recovery Strategy and work towards increasing the amount of high-quality interior moist forest habitat (to enhance the chances of natural dispersal and colonization of new sites).				
Critical	Short-term	Inventory, Monitoring and Assessment	**4.1** Develop monitoring protocol for Large Whorled Pogonia.	• Any or all threats. By gaining insight into causes of declines specific problems can then be addressed.
Critical	Short-term	Inventory, Monitoring and Assessment	**4.2** Apply monitoring protocol in association with monitoring other priority species of the overall draft Carolinian Woodlands Recovery Strategy.	• Any or all threats. By gaining insight into causes of declines specific problems can then be addressed.
5. Conduct outreach to naturalists, orchid enthusiasts and the public on the significance, uniqueness and vulnerability of the species.				
Beneficial	Long-term	Education & Outreach	**5.1** Educate orchid enthusiasts and naturalists on the impacts of visiting and trampling populations and of collecting.	• Trampling
Beneficial	Long-term	Education & Outreach	**5.2** Establishing a working relationship with orchid enthusiasts to facilitate propagation and appropriate repatriation if feasible.	• Any or all threats by increasing population size and thus resilience to extirpation
6. Pending research results (3.4, 3.7) investigate the feasibility of reintroducing Large Whorled Pogonia to suitable historic sites.				
Beneficial	Long-term	Management	**6.1** Based on assessments of threats, studies of the species' biology and ecology and population viability analysis, determine the feasibility and necessity of reintroduction.	• Any or all threats by increasing population size and thus resilience to extirpation
Beneficial	Long-term	Management	**6.2** Reintroduce species to historic or other suitable sites if deemed feasible.	• Any or all threats by increasing population size and thus resilience to extirpation

Narrative to Support Approaches to Recovery

The first step is to obtain up-to-date information on the status of the species. Because the species has the ability to remain dormant, gathering the necessary data may require visiting the sites several years in a row. Information is urgently needed on population size and demographic structure, habitat characteristics and condition, and threats in order to prioritize recovery activities. The two sites presumed to be extant have not been formally surveyed in over five years, and the historic Middlesex site should also be thoroughly searched. The presence or absence of exotic earthworms and sampling of the duff should be undertaken in concert with inventory. Once the status of the species is verified, recovery steps can proceed.

There is extant habitat that appears to match that of known sites, both on the Norfolk and the Bothwell sand plains. Colonization of new sites should be possible where suitable habitat conditions including appropriate fungal species are present. However, in general, very little forest habitat with acidic soils remains in extreme southwestern Ontario and much of it may in fact be negatively impacted by earthworm activity or other unknown factors. Landscape-level habitat restoration efforts, conducted in association with other Carolinian woodland species at risk, are needed. Habitat restoration will be a long process, but some progress should be evident within one decade. Locally, buffering of existing sites will increase the amount of interior forest. At a landscape level, efforts to re-establish more extensive and better-connected forests will aid in recovery of this and many other imperiled species of the Carolinian woodlands.

Recovery may require establishing new populations through reintroduction. Little is known about the species regeneration in situ, other than its need for mycorrhizal associations for nutrition. Because of these associations, propagating native orchids for potential restoration planting is often very difficult. Attempts to grow and transplant Large Whorled Pogonia have met with little success so far (ROM, 2009), and thus the protocol requires further study. Therefore, reintroduction of the Large Whorled Pogonia is probably best delayed until the knowledge gap on mycorrhizal relationships is better understood.

Many of the recovery steps suggested in this strategy should be accomplished in coordination with steps being planned for other Carolinian woodland species at risk in existing and developing parallel strategies. Examples of multi-species steps could include development of Beneficial Management Practices for woodlands, municipal natural heritage systems mapping and protection legislation, activities of conservation authorities and working with stewardship councils.

2.4 Performance Measures

- All sites have been searched in five consecutive years and presence or absence of the species as well as basic information on habitat characteristics and visible threats has been documented by fall 2016. (Steps 1.1, 1.2, 1.3)

- Management of sites on public lands has been reviewed with appropriate agencies, including need for dam regulation and signage where appropriate by fall 2016. (Steps 2.1, 2.2, 2.3)

- As a precautionary measure, during the time in which the status of the species is being confirmed, there is no increase in anthropogenic disturbance in the habitat, such as from logging or development (as determined from data in #1). Other threats, such as those from exotic species and air pollution, will be addressed pending research outcomes.

- The Skunk's Misery site and potential habitat sites are discussed with land managers, planners, and landowners (Step 2.4) beginning in 2014 and management planning has been updated (steps 2.5, 2.6) by 2016.

- Other recovery steps, especially monitoring, doing a population viability analysis and addressing knowledge gaps, will be undertaken pending the outcome of the inventory to determine the status of the species.

2.5 Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the authors will be one of many sources considered by the Minister when developing the habitat regulation for this species.

In establishing the area to be prescribed as habitat in a regulation, two factors need to be considered.

First, in the time that Large Whorled Pogonia has been documented in Ontario, the species has been known to occur in several different ELC vegetation types. It has also been observed to be absent for a few years and then to crop up 100 m away in a different ELC vegetation type (Woodliffe pers. comm. 2009). Therefore, ELC type is not a hard and fast defining characteristic of habitat but rather is a broad guide to suitability.

Second, the maximum length of dormancy for this species is not known. The locations of this species have not been searched on a consistent annual basis so it is possible that the plants may have appeared and returned to dormancy without any documentation. Given this, a precautionary principle should be applied and a habitat prescription should be made for the populations presumed or possibly extant until their status is clarified.

It is suggested that the boundary of habitat will best be determined in the field and will require completion of recovery step 1.1 first. However, it is suggested that the area to be prescribed as habitat should be the ELC vegetation type around the three documented populations and any additional contiguous forest where conditions are suitable.

For example, this prescription would describe the ELC vegetation type polygon (probably variations of Red Maple-Red Oak deciduous forest) plus any contiguous forested area (of any type) that has more than10 cm of duff and humus and soil pH of 4.0 to 5.5. If the plants reappear in any given year and it becomes possible to fill knowledge gaps, these parameters can be further refined.

GLOSSARY

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee responsible for assessing and classifying species at risk in Canada.

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

Conservation status rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

1 = critically imperiled
2 = imperiled
3 = vulnerable
4 = apparently secure
5 = secure

Endangered Species Act, 2007 (ESA): The provincial legislation that provides protection to species at risk in Ontario.

Endangered (under COSEWIC and SARA): A wildlife species facing imminent extirpation or extinction.

Endangered (under COSSARO): A species that lives in the wild in Ontario but is facing imminent extinction or extirpation.

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This act establishes Schedule 1 as the legal list of wildlife species at risk to which the SARA provisions apply. Schedules 2 and 3 contain lists of species that at the time the act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

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RECOVERY STRATEGY DEVELOPMENT TEAM MEMBERS

Table 4. Recovery strategy development team members

NAME	AFFILIATION and LOCATION
The recovery strategy was developed by Jarmo Jalava, Judith Jones and John Ambrose under the direction of the following Recovery Team members:	
Dawn Bazely	York University
Jane Bowles	University of Western Ontario
Barb Boysen	Ontario Ministry of Natural Resources
Dawn Burke	Ontario Ministry of Natural Resources
Peter Carson	Private consultant
Ken Elliott	Ontario Ministry of Natural Resources
Mary Gartshore	Private consultant
Karen Hartley	Ontario Ministry of Natural Resources
Steve Hounsell	Ontario Power Generation
Donald Kirk	Ontario Ministry of Natural Resources
Daniel Kraus	Nature Conservancy of Canada
Nikki May	Carolinian Canada
Gordon Nelson	Conservation organization (NGO)
Michael Peppard	Conservation organization (NGO)
Bernie Solymar	Private consultant
Tara Tchir	Regional Government
Kara Vlasman	Ontario Ministry of Natural Resources
Allen Woodliffe	Ontario Ministry of Natural Resources