



Spotted Wintergreen

(*Chimaphila maculata*) in Ontario

Ontario Recovery Strategy Series

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

February 2010

Natural. Valued. Protected.

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, 2007 (ESA, 2007) 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, 2007, 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, 2007 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, 2007. 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

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DECLARATION

The Ontario Ministry of Natural Resources has led the development of this recovery strategy for the Spotted Wintergreen in accordance with the requirements of the *Endangered Species Act, 2007* (ESA 2007). 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

This recovery strategy outlines the objectives and approaches necessary for the protection and recovery of Ontario populations of Spotted Wintergreen (*Chimaphila maculata*). The strategy is based on a comprehensive review of current and historical population census data and consultations with knowledgeable individuals.

Populations of Spotted Wintergreen occur primarily as distinct colonies composed of few to several individuals. As stems arise from the creeping rhizomes of this plant (Kirk 1987), it is probable that clumps or contiguous groupings of stems actually represent clones or ramets rather than single individuals. In southern Ontario, the plant's flowers generally open in mid-July and are likely pollinated by *Bombus* spp. The morphology of the seeds (small, wingless, tailed and ribbed) suggests that seed dispersal is principally by anemochory (i.e., wind dispersal). Spotted Wintergreen has been reported as having mycorrhizal associations, although the type and nature of the association remains unclear.

The long-term recovery goals for Spotted Wintergreen are to protect and enhance all extant populations to ensure that sustainable levels are established or maintained, and to restore historical populations and establish new populations in appropriate habitat, if deemed feasible. The recovery objectives for this species place greatest emphasis on ensuring the protection of extant populations. To that end, several specific objectives have been identified:

1. Identify and protect habitat for extant populations;
2. Identify and mitigate threats through monitoring and management;
3. Monitor populations regularly to determine trends and habitat conditions;
4. Develop education and stewardship programs for private landowners;
5. Initiate research to fill knowledge gaps;
6. Investigate the feasibility of recovery potential of historic sites or other suitable habitat.

Recovery approaches include the protection of habitat, identification and mitigation of threats to populations through continued monitoring and management, conservation of the genetic pool through gene banking, and experimental micro-propagation.

Many of the recovery activities identified in this recovery strategy are contingent on the outcome of future research initiatives, as basic knowledge of the species' habitat requirements, population biology, and propagation requirements is lacking. The recovery strategy outlines and prioritizes research programs necessary to support the implementation of the identified recovery approaches.

It is recommended that the area to be prescribed as Spotted Wintergreen habitat in a habitat regulation include the area occupied by extant populations and the extent of the vegetation community (based on the Ecological Land Classification (ELC) for southern Ontario) in which it occurs at each site. This will allow for future growth, expansion and migration of these populations.

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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME: Spotted Wintergreen

SCIENTIFIC NAME: *Chimaphila maculata*

SARO List Classification: Endangered

SARO List History: Endangered (2008), Endangered – Regulated (2004)

COSEWIC Assessment History: Endangered (2000)

SARA Schedule 1: Endangered (June 5, 2003)

CONSERVATION STATUS RANKS:

GRANK: G5

NRANK: N1

SRANK: S1

The glossary provides definitions for the abbreviations above.

1.2 Species Description and Biology

Species Description

Spotted Wintergreen (*Chimaphila maculata*) is a small, rhizomatous evergreen herb or sub-shrub. It is similar to Pipsissewa (*Chimaphila umbellata*), and the two share the same habitat, but they differ in that Pipsissewa lacks the conspicuous white stripes along the veins on the upper surface of the leaves (Kirk 1987). Although isolated individuals do occur, large colonies of clones (ramets) may be formed by the growth of shallow, horizontally spreading rhizomes that produce erect shoots. The plant can grow to a height of 50 centimetres high (Flora of North America 2009). Each shoot bears several whorls of smooth leaves and a terminal cluster of one to five white or pinkish fragrant flowers (from Standley et al. 1988, Kirk 1987). The fruit is a roundish capsule up to one centimetre across (Flora of North America 2009).

Species Biology

Populations of Spotted Wintergreen occur primarily as distinct colonies composed of few to several individuals. As stems arise from the creeping rhizomes of this plant (Kirk 1987), it is probable that clumps or contiguous groupings of stems actually represent clones or ramets rather than single individuals, however no research has been undertaken to test this hypothesis.

The pollination biology of Spotted Wintergreen has been examined in one scientific paper by Standley et al. (1988), who studied sympatric populations of Spotted Wintergreen and Pipsissewa in a Massachusetts deciduous forest. This study found that

both species flower for approximately 14 days beginning in early to mid-July and that they are both visited primarily by bumblebees of the genus *Bombus*. Spotted Wintergreen was visited primarily by *Bombus perplexus*, whereas Pipsissewa was visited by *Bombus bimaculatus*, *B. vagans* and *B. perplexus*. Knudsen and Oleson (1993) also found that Pipsissewa was visited exclusively by *Bombus* spp. except that the visitors were exclusively males.

Various field botanists and ecologists have observed that, in southern Ontario, the plant's flowers generally open in mid-July for approximately 17 days and that plants produce abundant seed (Kirk 1987, K. Ursic pers. comm. 2001). These individuals also noted that fruiting occurs in August with the capsule splitting and releasing its seeds, many of which persist in the capsule into the next spring, and that seeds are small (0.4–0.6 mm long, 0.1–0.2 mm wide), wingless, tailed and ribbed (Kirk 1987). The morphology of the seeds suggests that seed dispersal is principally by anemochory (i.e., wind dispersal).

Spotted Wintergreen has been reported as having endotrophic mycorrhizal associations (i.e., with fungal filaments that may penetrate the plant cells), although the type and nature of the association remains unclear, and the fungal associates remain unknown. Boullard and Ferchau (1962) describe a mycorrhizal association of the ericoid type on root samples of Spotted Wintergreen collected from North Carolina, West Virginia, New York, New Hampshire and interestingly, Ripples, New Brunswick. However, given that Spotted Wintergreen has never been reported in New Brunswick prior or subsequent to Boullard and Ferchau's (1962) publication, and that this location is outside of the plant's known range, it places their plant identification(s) into question.

1.3 Distribution, Abundance and Population Trends

Global Range

Spotted Wintergreen occurs naturally in eastern North America, Mexico and Central America. Its range in eastern North America is from southern Michigan and Ontario to southern New Hampshire and Maine, south to Mississippi and northern Florida (Figure 1). The western limits appear to be western Kentucky and Tennessee, and eastern Illinois. Its southern range is from Central America, through Mexico to Arizona. However, available information limits a detailed analysis of the global abundance of this species.

The global conservation status rank for Spotted Wintergreen is G5, which is considered secure (NatureServe 2009). NatureServe also applies conservation status ranks at the national (N) and sub-national (S) (i.e., state or provincial) level. In Canada, Spotted Wintergreen is ranked N1 (critically imperilled), and is listed as endangered federally under the *Species at Risk Act* and provincially on the Species at Risk in Ontario (SARO) List. Spotted Wintergreen is considered secure (S5) in the United States, but within the U.S., Spotted Wintergreen is considered critically imperilled (S1) in Illinois, and imperilled (S2) in Vermont, Maine, and Mississippi (NatureServe 2009). Furthermore, the species

is legally protected in Illinois and Maine, where it has been designated as endangered, and in New York, where it is considered exploitably vulnerable (USDA, NRCS 2009).

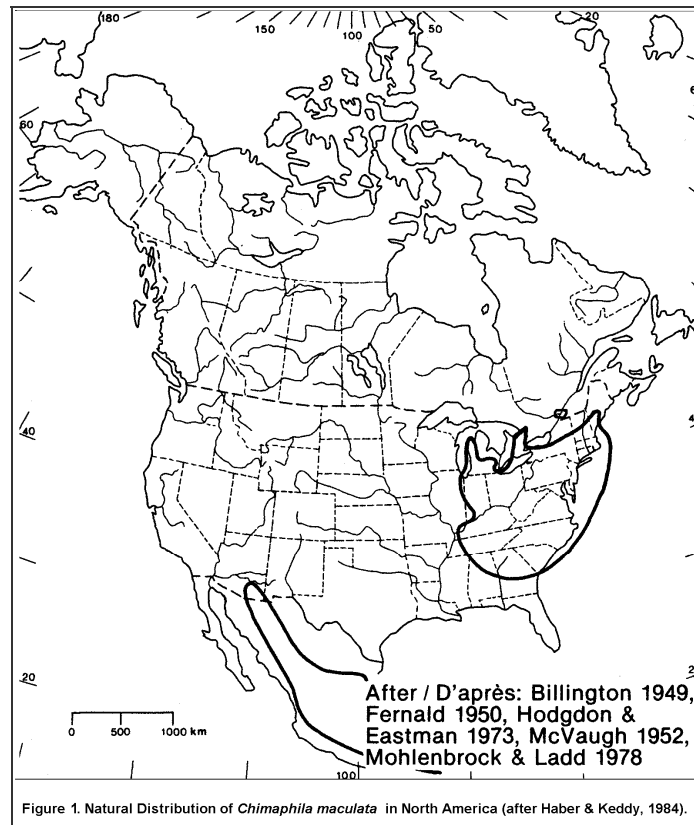


Figure 1. Distribution of Spotted Wintergreen in North America (after Haber and Keddy, 1984)

Canadian Range

The current extant distribution of Spotted Wintergreen in Canada is restricted to a few locations in Ontario (Figure 2) that support an estimated 2,700 stems. Historically, Spotted Wintergreen was more widely distributed throughout southwestern and south central Ontario; however, it has since been extirpated from Simcoe Kent, Middlesex and York Counties, Hamilton-Wentworth Region and the District of Muskoka. In Quebec, a single population was discovered in 1992 at Parc d'Oka in Deux-Montagnes County in the southwestern part of the province (Jacobs 2001), and is now presumed extirpated there.

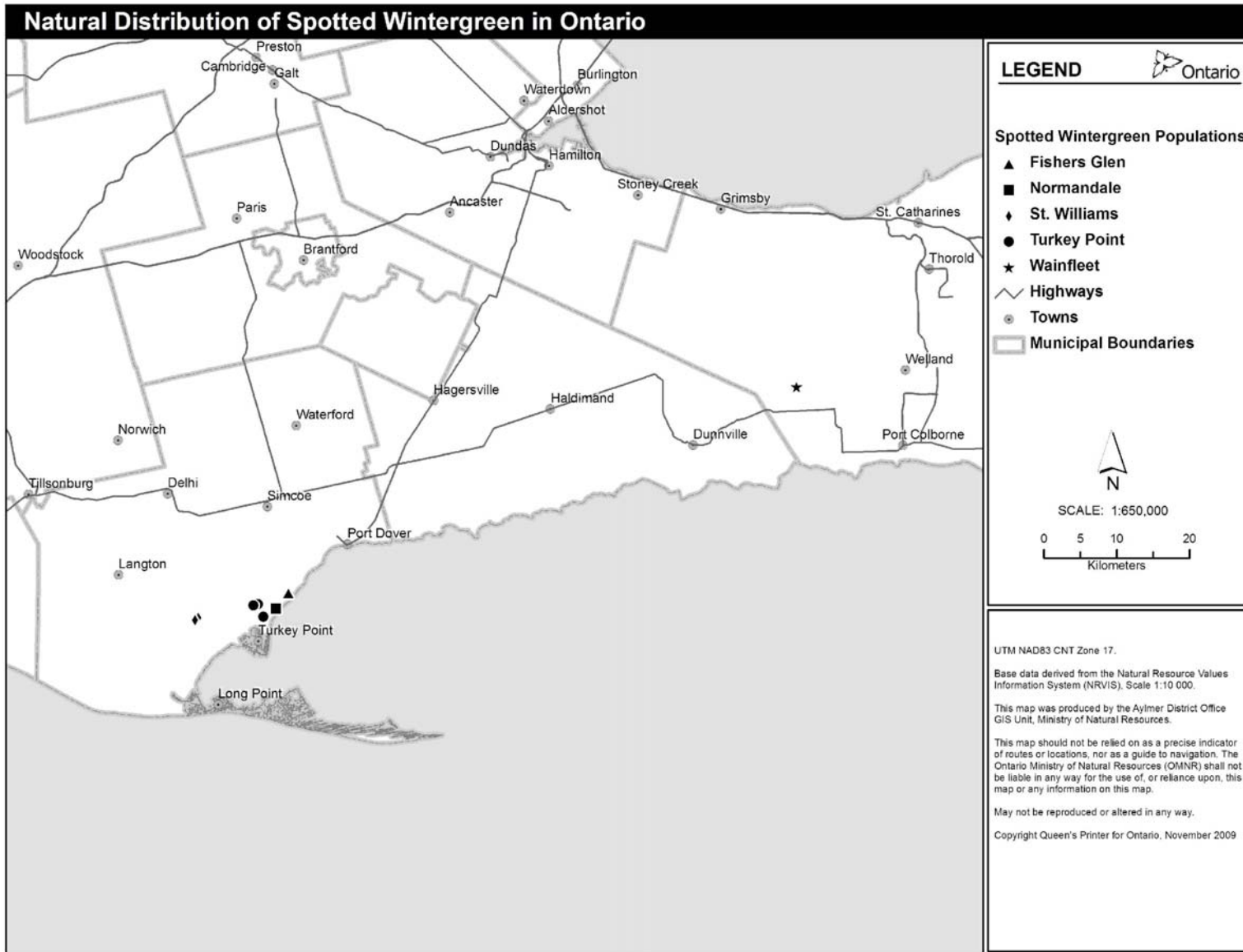


Figure 2. Current distribution of Spotted Wintergreen in Ontario

An estimated 11 populations have been extirpated from a total of 16 known occurrences in Ontario. Populations are considered to be independent if separated by one kilometre or more of inappropriate habitat, and groupings of plants separated by less than one kilometre are considered sub-populations (Natural Heritage Information Centre 2001).

There are insufficient data available on extant populations to estimate long-term trends in population size for this species. Inconsistent methodology in population estimation and delineation of sub-populations as well as a lack of reliable data have made it equally difficult to estimate short-term trends for some extant populations.

Table 1. Estimated abundance of Spotted Wintergreen in Ontario

County/Region	Population Name	Year of Last Survey	Approximate Number of Stems
Norfolk	St. Williams	2007	1923
Norfolk	Turkey Point	2009	591
Norfolk	Normandale	2005	165
Norfolk	Fishers Glen	2007	51
Niagara	Wainfleet	2007	7

In recent years, three populations have had notable increases in abundance, one population has had a marginal increase in abundance, and one additional population was recently discovered. In Norfolk County, a sub-population at the St. Williams site increased from 41 stems in 1985 to 1923 stems in 2007; similarly, the Normandale population increased from 10–15 stems in 1996 to 165 stems in 2005; seven new sub-populations have been discovered since 2004 at the Turkey Point site, bringing the estimated population for this site up to 591 in 2009, compared to 61 in 2008. The Fisher’s Glen population increased from 23 stems in 2000 to 51 stems in 2007. A new population was recently discovered in the Township of Wainfleet, Regional Municipality of Niagara.

1.4 Habitat Needs

The key habitat attributes for Spotted Wintergreen, detailed below, include:

- association with dry to fresh oak-pine or oak dominated woodlands;
- limited competition with other groundcover species;
- partial shade;
- slightly acidic surface soil conditions (soil pH 4.2 to 6.0);
- well-drained soils (especially sandy soils) and sites;
- nutrient-poor soil conditions;
- moderated climate.

Spotted Wintergreen typically occurs in dry oak-pine mixed forest and dry woodland habitats (M. Gartshore pers. comm. 2001). Recent and available field observations have confirmed that Spotted Wintergreen is a woodland understory species typically

associated with dry–fresh oak and oak–pine mixed forests and woodlands. Ecological Land Classification (ELC) ecosites (Lee et al. 1998) for extant populations are CUP3, FOD1, FOD8, FOD9, or FOM2 (Table 2). These communities typically have semi-closed canopy conditions. The semi-open conditions of the vegetation communities in Ontario are a result of past disturbance, and will likely require further disturbance in the future to maintain suitable conditions for Spotted Wintergreen (A. Woodliffe pers. comm. 2006). The associated communities are characterised by an overstorey of White Pine (*Pinus strobus*), Red Oak (*Quercus rubra*), Black Oak (*Quercus velutina*) and American Beech (*Fagus grandifolia*), an understorey of Round-leaved Dogwood (*Cornus rugosa*), Pipsissewa and Witch Hazel (*Hamamelis virginiana*), and a groundcover layer of False Lily-of-the-Valley (*Maianthemum canadense*), Bracken Fern (*Pteridium aquilinum*) and Wild Sarsaparilla (*Aralia nudicaulis*) (T. Farrell pers. comm. 2001). Table 3 includes a summary of species noted in habitats occupied by Spotted Wintergreen for North America.

Table 2. Ecological Land Classification (ELC) Codes for sites that support extant populations* of Spotted Wintergreen in Ontario

Site Name	ELC Community (ELC Code)
St. Williams	Red Pine Coniferous Plantation Type (CUP3-1)
	Fresh – Moist Poplar Deciduous Forest Type (FOD8-1)
	Fresh – Moist Poplar Deciduous Forest Type (FOD8-1)
Turkey Point	White Pine Coniferous Plantation Type (CUP3-2)
	Dry – Fresh Black Oak Deciduous Forest Type (FOD1-3)
	Red Pine Coniferous Plantation Type (CUP3-1)
	White Pine Coniferous Plantation Type (CUP3-2)
	Fresh – Moist Poplar Deciduous Forest Type (FOD8-1)
Normandale	Dry - Fresh White Pine – Oak Mixed Forest Type (FOM2-1)
Fishers Glen	Dry - Fresh White Pine – Oak Mixed Forest Type (FOM2-1)
Wainfleet	Fresh – Moist Oak – Maple Deciduous Forest Type (FOD9-2)

* For the purposes of this recovery strategy, populations are considered to be independent if separated by one kilometre or more, and that groupings of plants separated by less than one kilometre are considered sub-populations.

Table 3. Summary of species noted in habitats occupied by Spotted Wintergreen either currently or historically, as described in the available sources for North America

Site Location	Dominant Overstorey	Dominant Understorey	Noted Groundcover
St. Williams, (Kirk 1987)	Black Oak (<i>Quercus velutina</i>), White Oak (<i>Q. alba</i>), Eastern White Pine (<i>Pinus strobus</i>)	Witch Hazel (<i>Hamamelis virginiana</i>), Maple-leaved Viburnum (<i>Viburnum acerifolium</i>), Black Cherry (<i>Prunus serotina</i>)	Bracken Fern (<i>Pteridium aquilinum</i>), Pennsylvania Sedge (<i>Carex pensylvanica</i>), False Solomon's Seal (<i>Maianthemum racemosum</i>), Shinleaf (<i>Pyrola elliptica</i>), Indian Pipe (<i>Monotropa uniflora</i>), Pale Blueberry (<i>Vaccinium pallidum</i>), Pipsissewa (<i>C. umbellata</i>)
Wasaga Beach, (extirpated) (Kirk 1987)	Large-toothed Aspen (<i>Populus grandidentata</i>), Red Oak (<i>Q. rubra</i>), Eastern White Pine		
Wellesley, Massachusetts (Standley et al. 1988)	Red Oak, White Oak, Pignut Hickory (<i>Carya glabra</i>), Shagbark Hickory (<i>Carya ovata</i>), Red Maple (<i>Acer rubrum</i>), Eastern White Pine	Low Sweet Blueberry (<i>Vaccinium angustifolium</i>), Mountain Laurel (<i>Kalmia latifolia</i>), Sheep Laurel (<i>Kalmia angustifolia</i>), Black Huckleberry (<i>Gaylussacia baccata</i>), Nannyberry (<i>Viburnum lentago</i>), Maple-leaved Viburnum	Bracken Fern, False Lily-of-the-Valley (<i>Maianthemum canadense</i>), Shinleaf, Indian Pipe, Pink Ladyslipper (<i>Cypripedium acaule</i>), Sessile-leaved Bellwort (<i>Uvularia sessilifolia</i>), Wintergreen (<i>Gaultheria procumbens</i>), Pipsissewa
Norridgerock, Maine (Eastman 1976)	Red Oak, Eastern White Pine, American Beech (<i>Fagus grandifolia</i>)	Round-leaved Dogwood (<i>Cornus rugosa</i>)	Running Club-moss (<i>Lycopodium clavatum</i>), Bracken Fern, Pennsylvania Sedge, False Lily-of-the-Valley, Wild Sarsaparilla (<i>Aralia nudicaulis</i>), Green Shin-leaf (<i>Pyrola chlorantha</i>), Pipsissewa, Ram's Head Lady Slipper (<i>Cypripedium arietinum</i>), Hooker's Orchid (<i>Plantanthera hookeri</i>), Showy Orchis (<i>Galearis spectabilis</i>)
Peaked Mountain, Hiram, Maine (Eastman 1976)	Red Oak, White Birch (<i>Betula papyrifera</i>), American Beech	Witch Hazel, Maple-leaved Viburnum	
Lusk Creek, Illinois (Jones and Fralish 1974)	Black Oak, White Oak, Scarlet Oak (<i>Q. coccinea</i>), Hickory (<i>Carya</i> spp.)		False Dandelion (<i>Krigia biflora</i>), Dittany (<i>Cumila origanoides</i>), Solomon's Seal (<i>Polygonatum biflorum</i>), False foxglove (<i>Aureolaria flava</i>), Wild Licorice (<i>Galium circaezans</i>)

As White (1998) pointed out, all extant sites in Ontario are close to large bodies of water and the moderating effect on the climate may be an important factor. Kirk (1987) provided site-specific information with respect to climate at the St. Williams site, and mentions the moderating effect of Lake Erie and Georgian Bay as a factor at the St. Williams site and (former) Wasaga beach sites respectively.

Information on microsite preferences for Spotted Wintergreen is limited. The plant appears to have a relatively narrow pH range. Standley et al. (1988) recorded soil pH values of 4.2 to 4.6 at a Spotted Wintergreen site in Massachusetts. Other studies report that the species prefers an average soil pH below 7 (Eastman 1976, Kirk 1987), but actual soil sampling at any of the Ontario sites has yet to be conducted. Interestingly, Kirk (1987) noted that based on field observations, Spotted Wintergreen differs from its close relative *Pipsissewa* in that it is unable to tolerate the higher acidity found in pure pine stands created by dense layers of needle duff, and appears to prefer mixed oak-pine woodlands.

The plant tends to occur on sandy soils that are essentially stone-free with low organic content, having good drainage and nutrient poor status (Kirk 1987). The Ontario populations of Spotted Wintergreen occur on relict sand dunes (A. Woodliffe pers. comm. 2006). Kirk (1987) also noted that the plant appears to prefer insolated sites (i.e., sites with some sun exposure) lacking soil moisture extremes. However, no quantitative assessment of the habitat conditions for this species has been undertaken to date.

1.5 Limiting Factors

Reproductive Biology

Although aspects of the reproductive biology of Spotted Wintergreen may be limiting factors, there has been far too little study on the subject to draw any definitive conclusions. Standley et al. (1988) point out that having a limited number of shared pollinators, as is the case with Spotted Wintergreen, can reduce aspects of plant fitness (e.g., reduced seed set, production of infertile hybrids, reduced floral visitation). They acknowledge that their results do not allow testing of these hypotheses and that further study is required. Further scientific research is also required to determine whether seed dispersal is a limiting factor.

It is also possible that lack of sexual reproduction of Ontario populations may represent a potential limiting factor for Spotted Wintergreen. Unfortunately, the only scientific reports on this topic for this genus deal with *Pipsissewa* (Barrett and Helenurm 1988a, b). These studies found that *Pipsissewa* exhibited mostly clonal growth and, like many boreal forest herbs, was limited in fruit-set production by pollen limitation and predation of developing fruit. However, further research into modes and mechanisms of reproduction in Spotted Wintergreen are required to determine if this holds true for this species as well.

Spotted Wintergreen is capable of reproducing either clonally or by seed (Standley et al. 1988). Clones may consist of few to several hundred stems (ramets), and therefore, a population consisting of several hundred stems may represent only one to several individuals. However, determining the precise number of clones or individuals within a large and/or tightly spaced population requires excavation or genetic analysis that has not been completed for a population of Spotted Wintergreen. Although the Ontario populations do appear to flower and produce seed regularly, it has been hypothesized that low seed viability and dispersal must be limiting intrinsic factors to population growth, given that unoccupied suitable habitats are readily available at most extant sites (Kirk 1987). However, once again, additional scientific research is required to confirm this hypothesis.

Mycorrhizal Associations

The mycorrhizal status of Spotted Wintergreen may also present a limiting factor if mycorrhizae are required for survival, and its fungal associates are uncommon. Some studies of the mycorrhizae of Spotted Wintergreen are questionable, as discussed in section 1.2. Nonetheless, it seems likely that Spotted Wintergreen has a mycorrhizal association to some degree, since other species of this genus display various types of mycorrhizal associations (Largent et al. 1980, Boullard and Ferchau 1962, Henderson 1919).

Soil Requirements

Spotted Wintergreen occurs on well-drained slightly acidic sandy soils and is typically associated with dry–fresh oak and oak pine forest communities. Research at the Hazelwood Botanical Preserve in Ohio indicated that a soil pH in excess of seven would exclude Spotted Wintergreen. Given the predominance of alkaline soils in southern Ontario, Spotted Wintergreen’s preference for slightly acidic soils may represent another limiting factor for this species, although even on generally basic soils, surface reactions may be acidic. No Spotted Wintergreen sites in Ontario have been tested to determine soil pH; therefore, it is difficult to evaluate the degree to which soil type is limiting.

Population Isolation

Habitat for Spotted Wintergreen is fragmented, resulting in isolated populations, restricted gene flow and reduced genetic diversity. Poor genetic exchange within and among populations can reduce overall species fitness. Not enough is known about the population biology of the species to determine the minimum habitat size or number of individuals necessary to support a viable population.

1.6 Threats to Survival and Recovery

Forest Management

Current land uses and activities can potentially conflict with conservation of the species. Such activities could include: a commercial tree nursery, a logging road related to silvicultural operations, use and/or maintenance of an irrigation line, and prescribed

burning for management of other species. These activities could result in canopy removal, alteration of species composition of associated plant communities, soil compaction, or could provide a vector for the introduction of invasive species. Habitat changes associated with the conversion of open dunes, savannas and woodlands to pine plantations and increased levels of anthropogenic disturbance may have contributed to the loss of extirpated populations. In a recent survey report of the Wasaga Beach Provincial Park sites by Bowles (2001), Dr. A. Reznicek has remarked on the extent of canopy closure that has occurred in the plantations over the past 25 years due to better fire suppression.

Competition with Other Plant Species

Although Pipsissewa shares Spotted Wintergreen's range and habitat, even at a microsite level, it is unclear whether it poses any kind of competition threat (Standley et al. 1988). Presumably, invasive species would also be a potential threat, although this threat has not been confirmed at any of the extant sites. Disturbance due to recreational trails and tree harvesting could provide a vector for the introduction of invasive species.

Trampling/Soil Compaction

Any activity that would result in trampling could potentially harm the species. Spotted Wintergreen prefers undisturbed soils, and any activities that result in soil disturbance or compaction could be detrimental (NatureServe 2009). Kirk (1987) comments that the site of the extirpated population from near the town of Simcoe, Norfolk County, was a small woodlot that had experienced extensive disturbance from all-terrain vehicles (ATVs), possibly contributing to the elimination of the species at that location. Several sites have recreational trails for hiking, walking, snowshoeing, and ATV use, all of which have a potential to result in trampling and soil compaction. The effects of these activities are unknown, but could affect populations by altering habitat conditions or destroying plants.

Waste Disposal

Waste disposal is a threat at the Wainfleet site. When the site was surveyed, a few old car parts were found near the site (T. Staton pers. comm. 2009). If additional scrap is accidentally deposited directly on top of the plants, the entire population could be eliminated due to the very limited extent of this site.

Collecting

Although White (1988) reported human threats from collecting on one occasion, the threat is currently considered to be low. Populations are primarily located in moderately low traffic areas and knowledge of the species' whereabouts is limited. No empirical evidence of the above noted threats has been collected to date.

Animal Foraging

There are no documented natural browsers for this species, but the Woodland Vole (*Pitymys pinetorum*), which is a special concern species on the SARO List, has a range, distribution, and habitat similar to Spotted Wintergreen and is suspected to forage on the rhizomes of this species. This constitutes a potential threat, but conversely could

benefit Spotted Wintergreen by assisting in its dispersal (M. Gartshore pers. comm. 2001), thus the role of small mammals needs to be clarified through further research.

Foraging activities of Wild Turkey (*Meleagris gallopavo*) have caused significant forest floor disturbance at the St Williams site, where Wild Turkeys gather in high concentrations, particularly during the winter (Gould 2001). Scratching and uprooting behaviour of turkeys might potentially damage rhizomes of Spotted Wintergreen and create openings in the groundcover where invasive species could colonize. The actual impact of this activity is currently unknown.

Table 4 provides a summary of an evaluation of human threats to individual populations and categorizes the threats based on their source, type, spatial and temporal extent, as well as the certainty that the threat is currently affecting the population. Natural threats (animal foraging and competition) occur at all sites.

Table 4. Evaluation of threats to Spotted Wintergreen

Population	Source of Threat	Temporal Extent	Certainty
St. Williams	Trampling/Soil Compaction*	Ongoing	probable
	Forest Management**	Occasional	speculative
	Collecting	Short-term	confirmed
Turkey Point	Trampling/Soil Compaction*	Ongoing	probable
	Forest Management**	Occasional	speculative
	Collecting	Short-term	speculative
Normandale	Forest Management**	Occasional	speculative
	Collecting	Short-term	speculative
Fishers Glen	Forest Management**	Occasional	speculative
	Collecting	Short-term	speculative
Wainfleet	Trampling/Soil Compaction*	Ongoing	probable
	Forest Management**	Occasional	speculative
	Waste Disposal	Ongoing	probable

* Trampling/Soil Compaction includes use of trails for ATV riding, walking, etc.

** Forest management activities include logging, pesticide/herbicide use for silviculture, and maintenance of logging roads.

1.7 Knowledge Gaps

Based on a review of the literature it is clear that the available information on Spotted Wintergreen is very limited. Additional research is required to obtain knowledge that will contribute to the protection and recovery of this species. Basic research needs for the species are listed below in order of importance:

1. Census and verification of all extant populations using standardized, objective and repeatable methods.

2. Research into feasibility of gene banking material from vulnerable populations, survey of genotypic diversity, species propagation and translocation.
3. Research into the population and reproductive biology of this species.
4. Research into the specific habitat requirements of this species.
5. Research potential threats to populations of this species.

Survey Requirements

Reliable, accurate, and current census information on populations of Spotted Wintergreen in Ontario is incomplete or lacking. Inconsistencies in naming and geographical referencing of populations and sub-populations have prevented detailed comparative analyses of population trends. Information collection needs to be standardized to reflect reliable baseline data, from which future recovery actions will be developed.

Biological / Ecological Research Requirements

At present, the population biology, genetics and ecology of Spotted Wintergreen are not well understood. Information on the genetic variability within and among populations is necessary to assess population viability. A population viability assessment (PVA) is necessary to more precisely define the population and habitat size thresholds necessary to achieve self-sustaining populations of this species. Understanding the minimum viable population is essential in guiding recovery actions.

Aspects of the reproduction of Spotted Wintergreen that remain unclear are: the primary mode of reproduction (whether clonal or sexual), the relative importance of its pollination biology, and the role of pollinators. Furthermore, there has been little research into characterizing habitat conditions and requirements for the species, including the nature of its mycorrhizal associations and soil pH requirements specific to southern Ontario. Additional research is required in all these fields.

Threat Clarification Research Requirements

At present, there is no research that directly examines natural and human threats to this species. Most of the threats to this species are speculative and require further research to ascertain their potential impact. All potential threats to Spotted Wintergreen should be investigated empirically and weighted against limiting factors, such as potentially low seed viability or specific affinities for particular habitats. It is critical to have good empirical data available to guide the development of appropriate threat mitigation activities.

Despite the knowledge gaps, priority recovery approaches that could benefit the species should be implemented immediately.

1.8 Recovery Actions Completed or Underway

Recovery actions for Spotted Wintergreen that are complete or currently underway include:

- Population census and habitat monitoring for some sub-populations has been completed up to 2009;
- Ecological Land Classification designations/mapping to support the delineation of the area recommended to be prescribed as habitat in a habitat regulation has been completed for most sub-populations
- Conservation Land Tax Incentive Program mapping was completed in 2001 for some sub-populations;
- Habitat management on public lands is on-going as necessary (e.g., creation of Species at Risk signage at St. Williams Conservation Reserve, forest management advice);
- Education and stewardship with private landowners is on-going as necessary (e.g., forest management advice).

Ontario Ministry of Natural Resources staff last performed a complete census of all Norfolk County populations in April and May of 2005, and only some sub-populations from 2006 and 2008. Niagara Peninsula Conservation Authority staff completed a census of the Wainfleet population in 2007. A consultant surveyed some sub-populations at Turkey Point in 2009.

Some of the actions being taken to implement the federal Tallgrass Communities of Southern Ontario Recovery Plan focus on conservation of prairies, savanna and woodland vegetation communities. These actions may also provide habitat for Spotted Wintergreen populations. That recovery plan involves the identification of prairie related sites and a landowner contact program that began in the summer of 2001, and may reveal additional information about Spotted Wintergreen.

2.0 RECOVERY

2.1 Recovery Goals

The long-term recovery goals for Spotted Wintergreen are to protect and enhance all extant populations to ensure that sustainable levels are established or maintained, and to restore historical populations and establish new populations in appropriate habitat, if deemed feasible.

2.2 Protection and Recovery Objectives

The recovery objectives for this species place greatest emphasis on ensuring the protection of extant populations. To that end, several specific objectives have been identified (Table 5).

Table 5. Protection and recovery objectives

No.	Protection or Recovery Objective
1	Identify and protect habitat for extant populations
2	Identify and mitigate threats through monitoring and management
3	Monitor populations regularly to determine trends and habitat conditions
4	Develop education and stewardship programs for private landowners
5	Initiate research to fill knowledge gaps
6	Investigate the feasibility of recovery potential of historic sites or other suitable habitat

2.3 Approaches to Recovery

Table 6. Approaches to recovery of the Spotted Wintergreen in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
1. Identification and protection of habitat for extant populations				
Critical	Short-term	Protection	1.1 Identify area required to protect extant populations <ul style="list-style-type: none"> – Identify key habitat features – Delineate area to be prescribed as Spotted Wintergreen habitat in a habitat regulation 	<ul style="list-style-type: none"> • Habitat Requirements
Critical	Short-term	Protection	1.2 Habitat Protection <ul style="list-style-type: none"> – Protect habitat of extant populations through land acquisition or other mechanisms 	<ul style="list-style-type: none"> • Forest Management, Trampling/Soil Compaction
2. Identification and mitigation of threats through monitoring and management				
Necessary	Long-term	Protection, Management	2.1 Management on public lands <ul style="list-style-type: none"> – Work with land managers to develop management plans – Implement actions to reduce site-specific threats on an as-needed basis 	<ul style="list-style-type: none"> • Forest Management, Trampling/Soil Compaction
Critical	Long-term	Inventory, Monitoring and Assessment, Research	2.2 Threat Clarification, Reduction and Mitigation <ul style="list-style-type: none"> – Conduct research to quantify and evaluate potential threats – Develop approaches to mitigate threats 	<ul style="list-style-type: none"> • All Threats
Necessary	Long-term	Management, Research	2.3 Habitat Management <ul style="list-style-type: none"> – Develop approaches for habitat management based on research and monitoring 	<ul style="list-style-type: none"> • Habitat Disturbance

Recovery Strategy for the Spotted Wintergreen in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
3. Regular monitoring of population trends and habitat conditions				
Necessary	On-going	Inventory, Monitoring and Assessment	3.1 Population Census <ul style="list-style-type: none"> – Conduct an inventory of extant populations on an annual basis using standardized inventory methods 	<ul style="list-style-type: none"> • Survey Requirements
Necessary	On-going	Inventory, Monitoring and Assessment	3.2 Habitat Monitoring <ul style="list-style-type: none"> – Monitor general habitat conditions of extant populations annually 	<ul style="list-style-type: none"> • Competition, Natural and Anthropogenic Disturbance
4. Development of supportive education and stewardship programs for private land				
Necessary	On-going	Stewardship	4.1 Education and Stewardship <ul style="list-style-type: none"> – Provide information and resources (e.g., fact sheets) to private landowners, property managers and other stakeholders for the purposes of assisting recovery efforts 	<ul style="list-style-type: none"> • Forest Management, Trampling/Soil Compaction, Collecting
5. Initiate research to fill knowledge gaps				
Necessary	Long-term	Research	5.1 Species Ecology and Habitat Research <ul style="list-style-type: none"> – Initiate research programs to characterize species ecology (e.g., role of fire) – Initiate research programs to characterize habitat requirements (e.g., nutrient, pH, soil texture, moisture regime, light levels, temperature, soils, mycorrhizal associations,) 	<ul style="list-style-type: none"> • Reproductive Biology, Habitat Requirements, Competition
Necessary	Long-term	Research	5.2 Population Biology and Genetics Research <ul style="list-style-type: none"> – Initiate research on population biology, in particular pollination, dispersal and seed viability – Conduct genetic analysis and minimum viable population size for comparison across Ontario habitats 	<ul style="list-style-type: none"> • Reproductive Biology

Recovery Strategy for the Spotted Wintergreen in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Long-term	Research	5.3 Genetic Conservation <ul style="list-style-type: none"> – Collect seed and/or tissue culture from extant populations and deposit with a gene bank repository for long-term storage and analysis of genetic variability among populations 	<ul style="list-style-type: none"> • Reproductive Biology
Necessary	Long-term	Research	5.4 Plant Propagation Research <ul style="list-style-type: none"> – Initiate experimental micro-propagation trials from seed or tissue culture sources – Genetic variability and potential out crossing trial should be attempted if genetics research suggests gene transfer is a limiting factor 	<ul style="list-style-type: none"> • Reproductive Biology
6. Initiate research on species conservation, including recovery potential of historic or other suitable sites				
Necessary	Long-term	Research	6.1 Species Reintroduction and Restoration Research <ul style="list-style-type: none"> – Evaluate feasibility of restoring historical populations and establishing additional populations in suitable habitat 	<ul style="list-style-type: none"> • Reproductive Biology, Population Isolation

Narrative to Support Approaches to Recovery

Recovery efforts require close coordination with recovery actions for other species of concern in the area since the plant shares its habitat with other threatened and/or endangered species. For example, controlled burns are used as a management tool for Virginia Goat's-rue (*Tephrosia virginiana*, endangered both provincially and federally) and Bird's-foot Violet (*Viola pedata*, endangered provincially and federally), which could have a potential impact on Spotted Wintergreen populations. Consideration should be given to initiating recovery actions that would benefit multiple species, particularly in the Norfolk County area.

Spotted Wintergreen is known to be difficult to propagate artificially and immediate recovery efforts should focus on working with populations *in situ* before attempting to grow the plant *in vitro* (Duncan and Kartesz 1981). Cullina (2000) reports complete lack of success in germinating the seed, possibly due to the need for fungal associates; however, Cullina states that Spotted Wintergreen is easily propagated from cuttings taken in midsummer. The Plants for a Future website (2009) suggests using soil from the collection site (because of presumed mycorrhizal associations) and minimizing root disturbance as much as possible during transplantation. They also recommend using a moist sphagnum substrate. The noted sensitivity of the root systems may explain why the plant may be susceptible to anthropogenic disturbances such as trampling or ATV use.

The highest research priority and level of recovery effort should be directed toward the largest populations (St. Williams, Turkey Point, and Normandale), which appear to be viable and expanding. These populations could serve as living laboratories in which to research the population biology, habitat requirements, propagation and gene banking potential for future population augmentation or re-introduction programs.

The population at Fishers Glen is also showing some expansion, but much more slowly. For this smaller population, as well as the newly discovered Wainfleet population, emphasis should be placed on monitoring and assessment of habitat conditions and threats. Based on current limited understanding of the population biology and habitat requirements of this species, it is unlikely that the recommended approaches could be effectively implemented over the short term for these populations. A long-term approach could implement recommendations derived from research on the larger populations, to attempt to improve survival and re-establishment.

2.4 Performance Measures

The success of recovery efforts can be measured through ongoing monitoring of populations and threats, assessment of habitat conditions and evaluating the status and progress of the specified research, management, stewardship and education programs (Table 7). Performance measures should be based on the extent to which goals and objectives have been met.

Table 7. Performance measures for the recovery of Spotted Wintergreen

Objective	Performance Measure
1. Identification and protection of habitat for extant populations	<ul style="list-style-type: none"> • Key areas and habitat features delineated for all populations • All habitat protected under the ESA 2007 and through land acquisition
2. Identification and mitigation of threats through monitoring and management	<ul style="list-style-type: none"> • Approaches for managing Spotted Wintergreen habitat and mitigating threats developed • Threats mitigated as necessary to achieve recovery goal
3. Regular monitoring of population trends and habitat conditions	<ul style="list-style-type: none"> • Standardized inventory techniques developed • Population census conducted at all sites • Habitat of extant populations monitored annually
4. Development of supportive education and stewardship programs for private land	<ul style="list-style-type: none"> • Landowners, property managers and stakeholders provided with information on Spotted Wintergreen
5. Initiate research to fill knowledge gaps	<ul style="list-style-type: none"> • Source funding secured for specified research programs • Information gathered regarding species and population biology, ecology and habitat requirements • Gene conservation measures implemented
6. Initiate research on species conservation, including recovery potential of historic or other suitable sites	<ul style="list-style-type: none"> • Recovery potential of historic sites investigated

2.5 Area for Consideration in Developing a Habitat Regulation

Under the ESA 2007, 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 recovery team will be one of many sources considered by the Minister when developing the habitat regulation for this species.

The minimum area that should be prescribed as habitat in a habitat regulation for Spotted Wintergreen should include the area occupied by all extant populations and the surrounding extent of the vegetation community (based on the ELC for Southern Ontario) in which it occurs. Additional setbacks may be required for specific activities to protect against direct or indirect threats. This allows for future growth, expansion and migration of these populations and is consistent with provincial habitat mapping guidelines for the Conservation Land Tax Incentive Program (Ontario Ministry of Natural Resources 1998). Known Ecological Land Classifications for extant sites are described in section 1.4, Table 2. These boundaries should be refined as more information is gained on the factors that may influence habitat suitability and quality.

In Ontario, the current occupied habitats are restricted to the southwestern part of the province. However, historical records for Ontario indicate that, given the appropriate site conditions, Spotted Wintergreen has established itself throughout southern Ontario and as far north as Muskoka District. Consequently, potential habitats, after further study, may include historical locations within the species' range as well.

Habitat that is not currently occupied by the species, or not currently known to be occupied, may also be required for recovery of the species. Before suitable habitat for reintroduction can be identified (including historic sites), further research is necessary to define optimum habitat attributes. Potential recovery areas would include sites within the species' range that exhibit many of the key habitat attributes listed in section 1.4. Presumably a natural site with these attributes would also support the fungal species that may be required to establish the appropriate mycorrhizal associations with the plant. In addition, given the plant's potential sensitivity to trampling and ATV use, it would be advisable to select locations where these activities are restricted.

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 sub-national (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 2007): The provincial legislation that provides protection to species at risk in Ontario.

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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APPENDIX 1. Additional Resources on Spotted Wintergreen

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