COSEWIC
Assessment and Status Report

on the

Purple Twayblade
Liparis liliifolia

in Canada

THREATENED
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. 2001. COSEWIC assessment and update status report on the Purple Twayblade *Liparis liliifolia* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 10 pp.

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Purple Twayblade — ©Gary Allen.

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COSEWIC
Assessment Summary

Assessment Summary – November 2010

Common name
Purple Twayblade

Scientific name
Liparis liliifolia

Status
Threatened

Reason for designation
This small inconspicuous orchid extends across southern Ontario to southwestern Quebec as a series of scattered populations. The discovery of several new populations in recent years has extended its known range in Canada. The few individuals present in the majority of the populations and the overall small size of the entire Canadian population places the species at continued risk from chance events.

Occurrence
Ontario, Quebec

Status history
Designated Threatened in April 1989. Status re-examined and designated Endangered in April 1999 and in May 2001. Status re-examined and designated Threatened in November 2010.

COSEWIC
Executive Summary

Purple Twayblade
Liparis liliifolia

Wildlife species description and significance

Purple Twayblade (*Liparis liliifolia*) is a terrestrial perennial orchid whose leafy flowering shoot develops from a bulbous corm. The plant attains a height of about 25 cm. The flowering stalk of five to 33 flowers arises from the centre of two oval to elliptic fleshy leaves. Flowers consist of a prominent, broad violet-mauve lip (10-14 mm long) streaked with a fine network of reddish-purple veins. The two lateral petals are linear to thread-like and greenish to pale purple. Three greenish-white narrowly lanceolate sepals surround the petals. The fruit develops into an erect ellipsoid capsule about 15 mm long.

Because Purple Twayblade is a rare orchid, it is of considerable interest to naturalists and photographers.

Distribution

Purple Twayblade occurs in the United States from New England and Minnesota south to Arkansas and Alabama. The Canadian distribution was previously believed to be limited to southwestern Ontario. However, two new records in the last decade have extended the Canadian range of Purple Twayblade into eastern Ontario and southwestern Quebec. It has also been recently reported on Pelee Island.

Habitat

Purple Twayblade is found in a wide variety of plant communities and soil conditions. Although it is generally found in dry to mesic conditions, it has recently been reported from wetlands in Canada. Canadian occurrences are from open oak woodland and savannah, mixed deciduous forest, shrub thicket, shrub alvar, deciduous swamp, and conifer plantation. The presence of a specific fungal associate may be more important than substrate conditions.

Biology

Purple Twayblade is an early colonizing species found in woodlands and also in a variety of disturbed sites. Plants are self-incompatible and flowers require cross-pollination to produce viable seed. Flowers are pollinated by flies, although the species is not known. As with most orchids, capsules produce a large number of tiny, dust-like seeds that are dispersed by wind and possibly by water. Developing protocorms require association with a mycorrhizal associate in order to survive.

Population sizes and trends

Purple Twayblade has been documented at 23 sites in Canada, four of the populations at these sites are historical and presumed extirpated. Since 1998, the number of populations has increased from around 12 to about 19. This may be due to increased reporting of previously existing populations although it is possible that some of the newly documented populations may be recently established.

Since 1998, it is presumed that only 10-12 populations are extant based on fieldwork in 2007-2009. At six of 13 sites visited in 2008 (#5, #6a, #12a, #13, #17, #18), no plants were observed; at three of these sites (#5, #12a, and #13) the habitat had become overgrown and shaded, or invasive plants had become established. It is assumed that these populations have become extirpated. At one of these sites, part of the population has not been seen in several decades (#6a) and the remaining sub-population (#6b) will likely be destroyed imminently by a housing project. One private site not visited in 2008 (#15) only had two plants in 1986 and none in 1998 and is possibly also extirpated. A formerly large population (#17) had dwindled to just a few plants in 2000 was no longer evident in 2008. A large new population (#18) discovered in 2001 appears to have disappeared after flooding of its habitat by beavers and has not re-appeared subsequent to dam removal.

Since the last status report update, three large populations of 180+ plants have been newly documented (#14, #18, #19). It is uncertain whether these populations have existed for a long time, or if they have been recently established. Most extant sites have fewer than 40 plants.

The Canadian population may consist of only 200-500 plants. This is possibly a conservative estimate, because the species is easily overlooked and some sites have not been recently visited. Based on fieldwork in 2007-2009, ~360 plants were confirmed at 10 sites.

Threats and limiting factors

Threats to Purple Twayblade include housing development and urbanization, invasive species, and potentially small population sizes.

Protection, status, and ranks

COSEWIC assessed this species as Endangered in May 2001. Purple Twayblade is provincially listed as Endangered under Ontario's *Endangered Species Act, 2007* and is listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA). Eleven of nineteen Purple Twayblade occurrences are wholly or partially protected through public or conservation ownership. Of protected sites, two are managed by Ontario Parks, six are in municipal ownership, and three are on properties owned by conservation organizations or universities. The remaining eight occurrences are believed to be on private land.

NatureServe ranks the species as globally secure and nationally imperilled in Canada but secure in the U.S. In Ontario, it is also ranked as imperilled. In Quebec, the species is critically imperilled.

TECHNICAL SUMMARY

Liparis liliifolia
Purple Twayblade — Liparis à feuilles de lis
Range of occurrence in Canada: Ontario, Quebec

Demographic Information

Generation time Time to flowering ranges from 4 to 15 years. Longevity is unknown but generation time is likely >10 years and possibly even as much as 20 years.	Perhaps 10-20 yrs
Is there a continuing decline in number of mature individuals? An apparent population increase is perhaps largely due to an increase in search effort and reporting. A continuing decline is inferred from the loss of >300 mature individuals at population #17 and the presumed extirpation of a number of small populations over the last 20 years. There is also uncertainty as to whether the large population (#18) impacted by flooding will recover. Two sites are also at risk to housing development.	Likely
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]. There is considerable uncertainty in determining a % decline due to a number of sites that could not be visited, the cryptic nature of this species leading to possibly low estimates of total plant numbers, the uncertainty as to the recovery of population #18, and the possibility that the Montreal population represents a recent dispersal event.	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. Too much uncertainty to determine a % value of change.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	41,200 km²
Index of area of occupancy (IAO)	76 km² (based on 2x2 km grid)
Is the total population severely fragmented? More than half of the total Canadian population is contained within two large extant occurrences (#14 & #19) and potentially in a third population (#18) if it recovers.	No
Number of “locations” (as per definition, in relation to threat) Perhaps only 10-12 populations are extant with varying threats; 10-12 locations are estimated.	Possibly 10-12
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No

Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? The apparent increase in the number of newly reported populations is likely due to increased search effort over the last 20 years, but this is not known for certain. The uncertainty of overall loss or gain in the IAO is also compounded by the uncertainty around the number of small populations that could become extirpated.	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of populations? The apparent increase in the number of newly reported populations is likely due to increased search effort over the last 20 years, but this is not known for certain. The uncertainty of overall loss or gain in populations is also compounded by the uncertainty around the number of small populations that could become extirpated.	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of locations? Although some populations have been lost, a series of new populations have been discovered, some of which may have been previously unreported that were overlooked and some may be new. The orchid is a colonizing species.	Unknown
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? A decline in quality and area of suitable habitat is inferred from the spread of invasive plants at two sites and the losses and inferred imminent losses of sites due to development.	Decline in quality and area
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)

Population			N Mature Individuals
All populations except #19 are in southern Ontario. The most recent observation is listed for each population.			
Site	**Number of Plants**	**Year of Obs.**	
1. Pelee Island	27	2008	
2. Black Oak Woods	29	2008	
3. Ojibway Prairie Complex	3	2008	
4. Spring Garden ANSI	4	2008	
5. Reaume Street Prairie	40	1994	
6. LaSalle Woods	2-4	2002	
7. Town of LaSalle TC5-M1	20	2008	~360 (2007-2009) but probably ranges from 200-500
8. Town of LaSalle CH3-M11	14	2008	
9. McAuliffe Woods	40	2009	
10. Canard River	1	2008	
11. Oxley Swamp	4	1986	
12. Cedar Creek	12	1985	
13. Deyo's Woods	10-12	1984	
14. Clear Creek	33+	2008	
15. Lakeshore Woods	2	1986	
16. West Lorne	24	1985	
17. York Region	"a few"	2000	
	>300	1977	

18. Frontenac Provincial Park	313, but estimated at 400-500	2003	
	None	2008	
19. Macdonald Campus, McGill University, Montreal, Quebec	186	2007	
Populations presumed extirpated:			
20. Windsor	>70	1969	
21. Komoka	4	1971	
22. Near Arva	-	1950s	
23. Fort Erie	-	1864	

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	None available

Threats (actual or imminent, to populations or habitats)

Housing development, invasive species, small population size.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? **U.S.:** Not nationally at risk in the United States. Of conservation concern in several states adjacent to Canada (Michigan, S3; New York, S2; Vermont, S1) and especially in New England (Connecticut, S1; New Hampshire, SX; Rhode Island, S1; Vermont, S1). A fairly common species in the southern United States.	
Is immigration known or possible?	Unknown but possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely? Rescue from outside populations is considered possible because orchid seeds are very mobile, and this plant is not a habitat specialist. Purple Twayblade is also present in adjacent American states, and is very common in the southern United States. However, seeds require a specific fungal associate in order to germinate successfully, and for this reason, the likelihood of rescue from outside populations is considered low.	**Possible but likely low**

Current Status

COSEWIC: Threatened (November 2010)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Threatened	C2a(i); D1
Reasons for designation**:** This small inconspicuous orchid extends across southern Ontario to southwestern Quebec as a series of scattered populations. The discovery of several new populations in recent years has extended its known range in Canada. The few individuals present in the majority of the populations and the overall small size of the entire Canadian population places the species at continued risk from chance events.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Level of decline unknown.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Not severely fragmented and locations likely >10 and no extreme fluctuations in population size.
Criterion C (Small and Declining Number of Mature Individuals): Meets Threatened C2a(i) due to inferred decline with no population estimated to contain >1000 mature individuals.
Criterion D (Very Small or Restricted Total Population): Meets Threatened D1 based on the total population being >250 and <1000 mature individuals.
Criterion E (Quantitative Analysis): None conducted.

PREFACE

Since the previous fieldwork in 1998 for the update status report (White, 2001), eight new occurrences of Purple Twayblade have been discovered, resulting in a total of perhaps 10-12 extant populations in 2009. Three of these (#14, #18, and #19) each contained more than one hundred plants when originally documented and are among the largest Canadian populations ever recorded. The current status of population #18 is uncertain, however, due to flooding by beavers in 2004. Removal of the beaver dam has not resulted in recovery of this population to date. These new reports have expanded the Canadian range of Purple Twayblade to include eastern Ontario and western Quebec. It is likely that the apparent increase in both population numbers and range is due in large part to an increased search effort for this inconspicuous plant, but it is also possible that some populations have become established recently.

A number of populations are believed to have become extirpated since the last status report update in 2001. The persistence of population #18 is in question, and the formerly large population #17 has not been observed since 2000, despite two site visits. The status of several other small populations is also uncertain. Habitat quality and area have likely declined at five or more sites. No recent information has been obtained for two populations on private property that have not been observed for over two decades.

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.

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

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Liparis liliifolia

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TABLE OF CONTENTS

List of Figures

List of Tables

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Scientific name*: Liparis liliifolia* (L.) L.C. Richard ex Lindley
Pertinent synonym: *Leptorchis liliifolia* (L.) O. Kuntze
Common names: Purple Twayblade; Lily-leaved Twayblade; Liparis à feuilles de lis
Family name: Orchidaceae (orchid family)
Major plant group: Angiosperm (monocot flowering plant)

Morphological description

Purple Twayblade is a terrestrial perennial orchid arising from a bulbous corm. The plant attains a height of about 25 cm. A flowering stalk of five to 33 flowers arises from the centre of two oval to elliptic fleshy leaves (Figure 1). Flowers consist of a prominent, broad violet-mauve lip (10-14 mm long) streaked with a fine network of reddish-purple veins (Figure 2). The two lateral petals are linear to thread-like and greenish to pale purple. Three greenish-white narrowly lanceolate sepals surround the petals. The fruit develops into an erect ellipsoid capsule 15 mm long.

Figure 1. Purple Twayblade in flower. Photograph: Holly J. Bickerton.

Figure 2. Detail of Purple Twayblade inflorescence. Photograph: P. Allen Woodliffe (with permission).

Population spatial structure and variability

No information on spatial population structure could be found. The seeds of this species are highly mobile and may be dispersed long distances on air currents (Mattrick 2004). No infraspecific taxa are recognized for Purple Twayblade (NatureServe 2009).

Designatable units

No designatable units are recognized. All of the populations occur within the Great Lakes Plains Ecological Area recognized by COSEWIC, and there are no morphological or taxonomic differences recognized for populations of Purple Twayblade in Canada.

Special significance

As a member of the orchid family, Purple Twayblade is of considerable interest to naturalists and photographers. The species is also of interest because of its rarity. There are no recorded traditional Aboriginal uses for this species known.

DISTRIBUTION

Global range

Purple Twayblade is restricted to North America, and is a common species throughout the eastern and mid-western United States. It extends from southern Ontario and Quebec, eastward to New England, westward to Minnesota and southward to the upland regions of Georgia and Alabama (Figure 3).

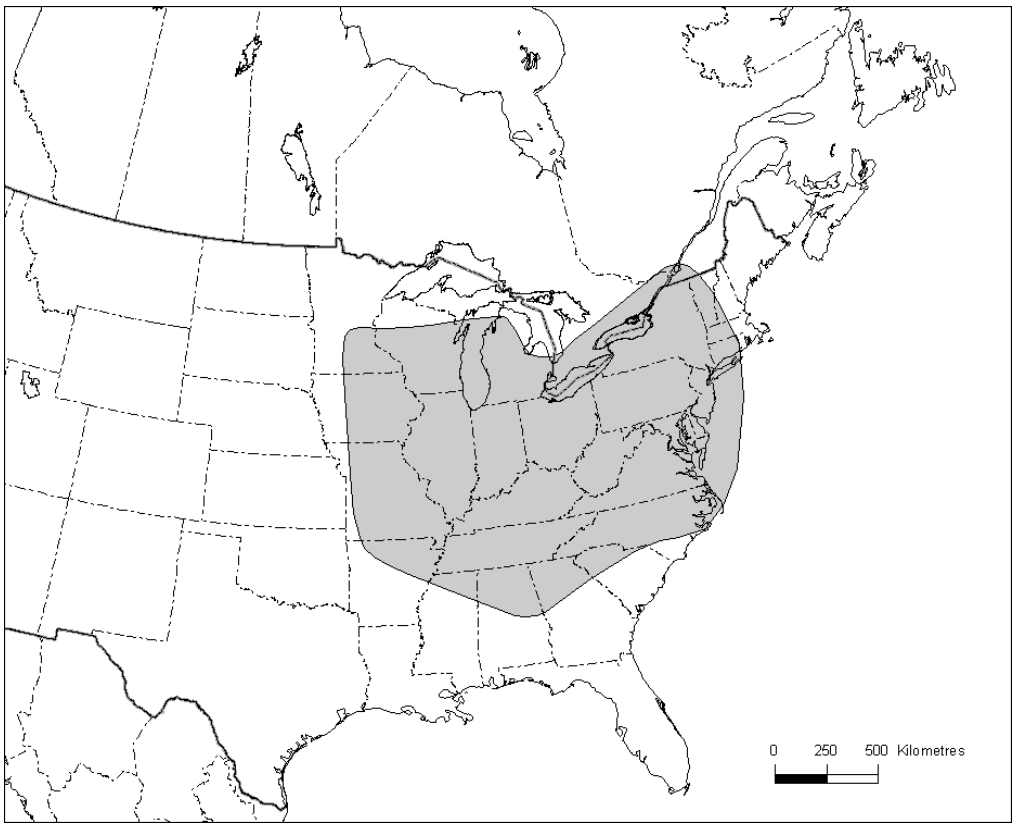

Figure 3. North American distribution of Purple Twayblade (adapted from Allen, 1989).

Canadian range

The species has been known to occur in Canada since 1864 (Whiting and Catling, 1986). The majority of the species' Canadian populations are found in southwestern Ontario where it is found in Essex and Elgin Counties, in the Regional Municipality of Chatham-Kent and in York Region (Figure 4). Since 1998 fieldwork for the last status report (White 2001), eight new sites for this species have been reported, including one relatively large population in Frontenac County (near Kingston, Ontario) and another near Montreal, Quebec. Both of these large populations are several hundred kilometres from the nearest known, but now extirpated, Canadian occurrence in York Region. It is possible and even likely that many of these populations existed previously, but have only recently been discovered.

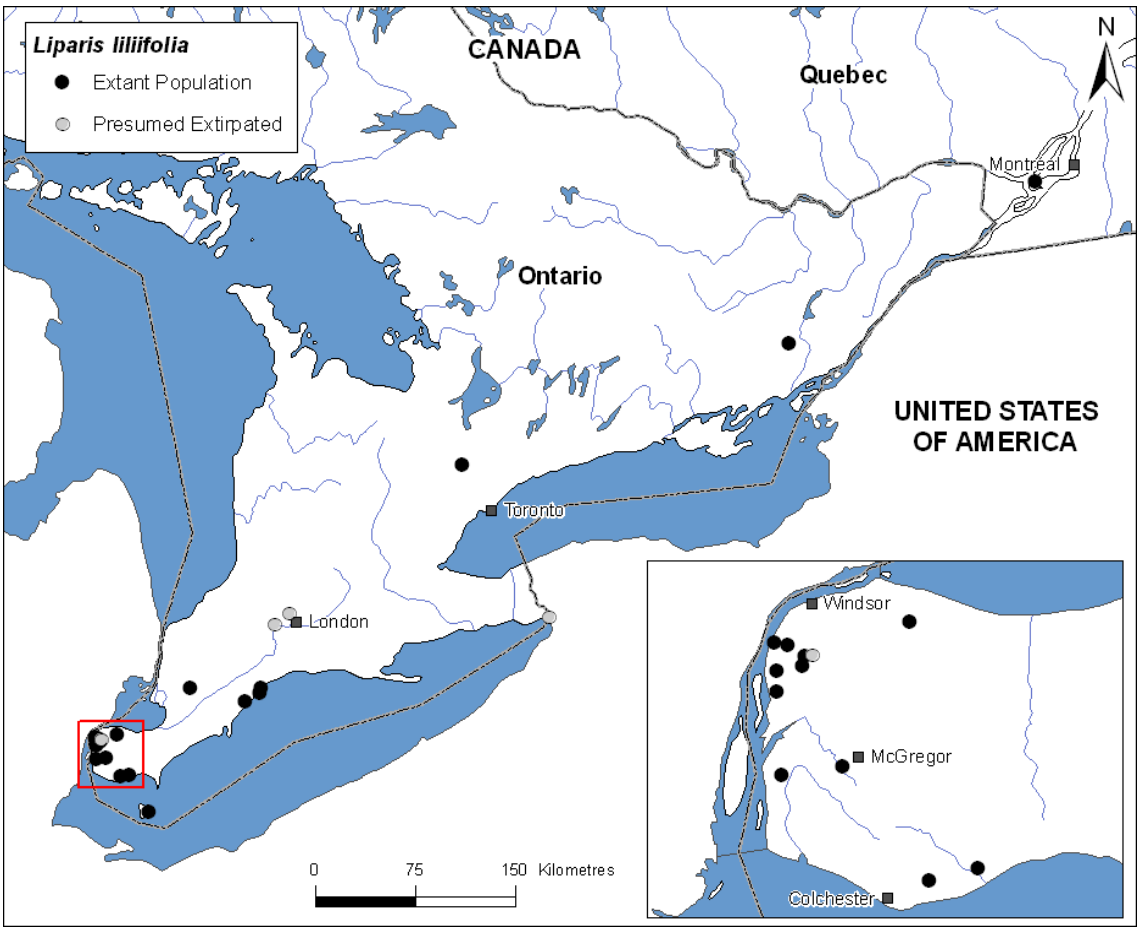

Figure 4. Distribution of Purple Twayblade occurrences in Canada. Only the historic populations that have not been relocated have been mapped as extirpated. A number of other more recent populations are likely also extirpated.

The total extent of occurrence in Canada, based on a minimum convex polygon, is ~41,200 km^2. The total number of one kilometre grid squares occupied by known Purple Twayblade occurrences is 19, for a total index of area of occupancy of 19 km^2. This value includes four populations that may be extirpated, and another two about which nothing is known. The number of 2x2 km grid squares occupied is 19, for a total index of area of occupancy of 76 km^2. The area of occupancy estimated from site observations during fieldwork in 2007-2009 is <1 km^2. The Canadian populations occupy less than 10% of the global range of the species (Brodribb and Oldham 2000).

Search effort

During June and July of 2008, fieldwork was conducted at 14 of 19 assumed extant occurrences by 15 individuals, with approximately 35 person-hours of search time. The Quebec occurrence was searched in 2007 by two people, over approximately three days. One occurrence was first discovered in spring 2009.

Three extant occurrences were not visited between 2007 and 2009, and no new information was obtained for this update status report. Two of these occurrences are privately owned and landowners could not be located to obtain permission. Oxley Swamp was not visited because it has been searched twice unsuccessfully in the last several years by experienced botanists, and habitat was regarded as no longer suitable for this species (G. Buck, pers. comm. 2008).

Purple Twayblade can be difficult to see even in full flower, and may grow underneath understorey vegetation. A failure to locate this orchid, even with significant search effort by knowledgeable individuals, does not necessarily indicate that plants are absent.

Over the past decades, much of Purple Twayblade's oak savannah habitat in southwestern Ontario has been intensively surveyed. However, the species may also colonize plant communities that are perceived as poorer in quality, including shrub thickets, conifer plantations, and disturbed areas, and few of these have been well searched for the species. Occurrences in swamps, a new habitat type for Canada, have been found recently in eastern Ontario and western Quebec at sites that also represent significant range extensions. As such, large areas of privately owned, potentially suitable habitat exist in those regions.

HABITAT

Habitat requirements

Purple Twayblade is found in a wide variety of plant communities. Within its core range in the United States, it has been reported from old fields, shrub thickets, disturbed woodlands, coniferous plantations, rich hardwood forests, moist floodplain woods, and sand ridges in prairie (Sheviak 1974; Case 1987). In Ontario, it has been recorded in many types of habitat, including open oak woodland and savannah, mixed deciduous forest, shrub thicket, shrub alvar, deciduous swamp, and conifer plantation (Allen 1989; White 2001; Buck and Dobbyn 2002; Ambrose *et al*. 2004; White 2008).

Purple Twayblade favours xeric to mesic drainage conditions (Sheviak 1974), but it can also tolerate wet conditions (Mattrick, 2004). Canadian populations are mainly on upland sites, with the exception of the Frontenac Provincial Park occurrence in a deciduous swamp (White 2008), and the Montreal occurrence in a mixed deciduous – hemlock swamp (A. Godbout, pers. comm. 2010). Lowland sites are also known infrequently from the United States (Sheviak 1974); several sites in New York and Vermont have been documented from deciduous swamp habitats (Mattrick 2004).

Purple Twayblade generally occurs in open to semi-open canopy cover. However, it is occasionally present in forests with dense canopies (Sheviak 1974; Homoya 1993). It can sometimes be found in disturbed areas such as second-growth stands, plantations, and woodlands where canopies have been thinned. Populations appear to decline in both numbers and reproductive success as sites become more densely shaded (Sheviak 1974).

Purple Twayblade also exhibits a wide tolerance of soil conditions, colonizing soils ranging from sands to silt loams and probably clay loams (Sheviak 1974). The species prefers mildly acidic soils (pH 4.5. to 6.6), but can tolerate a range of conditions from strongly acidic to neutral soils (Sheviak 1974; Smith 1993). Recent research suggests that the presence of a specific fungal associate may be more important than substrate conditions (Mattrick 2004).

Habitat trends

Trends in the quality and quantity of Purple Twayblade habitat are difficult to estimate, mainly because this species continues to be reported from new sites, and from plant communities from which it has not previously been documented. It seems likely that this reflects an increased search effort and reporting, rather than significant changes in habitat availability or population. However, Purple Twayblade is also recognized as a colonizing species that is able to establish, sometimes with very large populations, in many habitat types, and perhaps especially where sites have been disturbed (Sheviak 1974).

Four historic populations of a total of 23 documented Canadian occurrences have been reported to be extirpated (sites 20-23, Table 1), probably due to a combination of habitat loss, an increase in canopy cover due natural succession, and pesticide use (Allen, 1989). Since fieldwork for the last status report update in 1998 (White 2001), none of the habitat of the remaining nineteen occurrences is believed to have been destroyed, although at least two populations in the town of LaSalle are under development pressure (P. Pratt, pers. comm. 2008; G. Waldron, pers. comm. 2009).

Table 1. Summary of Purple Twayblade occurrences.

	Population/site	Original record	Last obs.	1989 Report (Allen)	2001 Report (White)	Most recent records
1	Pelee Island – Shaughnessy Cohen Nature Reserve	J. Ambrose and G. Waldron (2002)	2008	-	-	21 (2002); 27 (2008, J. Ambrose and G. Waldron)
2	Black Oak Woods ESA (Ojibway Parkway – North)	P. Catling and S. McKay (1975)	2008	>=40 (1975?)1 (1985)	2 (1990)	29 (2008, H. Bickerton)
3	Ojibway Prairie Complex (including Tallgrass Heritage Area)	P. Pratt (1975)	2008	5 (1985)	7 (1989)	6 (2008, A. Woodliffe)

	Population/site	Original record	Last obs.	1989 Report (Allen)	2001 Report (White)	Most recent records
4	Spring Garden ANSI	M. Oldham (1994)	2008	-	~20 (1994)	4 (2008, H. Bickerton)
5	Reaume Street Prairie	M. Oldham (1997)	1997	-	~40 (1997)	0 (2008, H. Bickerton)
6a	LaSalle Woods (Sandwich West Woodlot)	J. Johnson (1979)	1979	2 (1979)	-	0 (2008, H. Bickerton)
6b		T. Preney (2002)	2002	-	-	2-4 (2002), Not visited in 2008
7	Town of LaSalle Candidate Natural Heritage Area TC5/M1	G. Waldron (2008)	2008	-	-	20 (2008, G. Waldron)
8	Town of LaSalle Candidate Natural Heritage Area CH3-M11	G. Waldron (2008)	2008	-	-	14 (2008, G. Waldron)
9	McAuliffe Woods Conservation Area	G. Waldron (2009)	2009	-	-	~40 (2009, G. Waldron)
10	Canard River, Mitchell Property	G. Waldron (2007)	2008	-	-	1 (2008, G. Waldron, K. Oliver, H. Bickerton)
11	Oxley Poison Sumac Swamp	G. Allen and M. Oldham (1985)	1986	4 (1986)	-	0 (G. Buck, H. Arnold, 2005, 2006); Not visited in 2008
12a	Cedar Creek – North	M. Oldham (1984)	1985	12 (1985)	0 (1998)	0 (2008, H. Bickerton)
12b	Cedar Creek – South	W. Botham (1973)	1982	~12 (1982)	-	Not visited in 2008
13	Deyo's Woods	R. Brown (1983)	1984	19 (1983); 25 (1984)	10-12 (1997)	0 (2008, R. Brown and H. Bickerton)
14	Clear Creek	G. Buck (2001)	2008	-	-	253 (2001); 33+ (partial count, 2008, S. Dobbyn and J. Hoare)
15	Lakeshore Woods, near New Glasgow	A. Wormington (1986)	1986	2 (1986)	0 (1998)	Not visited in 2008
16	West Lorne, Allan Craig Woods (near Eagle)	A. Craig (1974)	1985	24 (1985)	0 (1998)	Not visited in 2008
17	York Region, Happy Valley Forests	R. Tasker (1977)	2000	>300 (1977); 34 (1985)	191 (1989)	"a few" (2000) 0 (2001, 2008, H. Bickerton, G. Varrin, A. Godfrey, M. Hubert)

	Population/site	Original record	Last obs.	1989 Report (Allen)	2001 Report (White)	Most recent records
18	Frontenac Provincial Park	T. Marsh (2001)	2003	-	-	313 (2003; but estimated at 400-500); 0 (2008, C. Brdar, M. Sly, B. Beveridge, H. Bickerton)
19	Montreal: Morgan Arboretum, Macdonald Campus, McGill University	F. Coursol (2004); A. Godbout (2006, 2007)	2004	-	-	186 (2007, A. Godbout)
20	Windsor (Behind Health Lab)	1968 (J. Wilson)	> 70 (1969)	-	-	Presumed extirpated (Allen, 1989) - converted to manicured parkland
21	Komoka	1946 (J. Higgins)	83 (1962); 4 (1971); 0 (1983)	-	-	Presumed extirpated (Allen, 1989)
22	Near Arva (London area)	1940s (J. Higgins)	1950s	-	-	Presumed extirpated; converted to agriculture (Allen, 1989)
23	Fort Erie	1864 (Day)	1864	-	-	Considered extirpated (Allen, 1989)
	TOTAL (Est'd)			No est-imate	50 (White, 2001)	~360 (2007-9) but probably ranges 200-500 in any one year

Sources: Allen, 1989 ; White, 2001; NHIC, 2008.

At four of the remaining 19 occurrences (see above), habitat may have become unsuitable for Purple Twayblade where the species has not been found recently, despite searching (Table 1). This may be due to natural succession (Oxley Swamp, #11; Cedar Creek North, #12a), the presence of invasive or aggressive species (Cedar Creek North, #12a; Deyo's Woods, #13), or encroaching development (Happy Valley, #17). Habitat at one site (Frontenac Provincial Park, #18) was flooded by a beaver (*Castor canadensis*) dam, and a portion of this site remained flooded following dam removal. Three additional sites where the species has not been observed in at least two decades (West Lorne, #16; Lakeshore Woods, #15; and one Cedar Creek sub-population, #12b) are privately owned and were not visited in 2008. Habitat quality at these sites is unknown.

Moderate and high quality Black Oak savannah and woodland has been maintained in the Windsor-LaSalle area, due in part to land acquisition and in some cases, prescribed burning. Purple Twayblade also continues to be found at new locations and in new plant communities in southwestern Ontario (Pelee Island, Town of LaSalle, and near the Canard River in Essex County). In the Windsor-Essex area, remaining natural areas are few, and many continue to be converted to other land uses, especially housing and agricultural development. For a colonizing orchid, maintaining a supply of potentially suitable natural areas may be as important as maintaining existing habitat.

Since the last status report (White 2001), new occurrences in eastern Ontario and western Quebec (Frontenac Park, #18; Montreal, #19) have extended the known range in Canada by several hundred kilometres to the northeast. These occurrences likely existed for some time, and as such, do not represent a recent expansion of the range. The habitats of populations in eastern Ontario and western Quebec suggest that deciduous and mixed swamps may also provide suitable sites. These plant communities are common to abundant in southeastern Ontario and western Quebec, and most are on private land that has not been intensively surveyed.

In many parts of the northeastern United States, however, available Purple Twayblade habitat is likely decreasing in both quality and extent (Brodribb and Oldham 2000). In a geographic analysis of regional records, Farnsworth and Ogurcak (2006) found that 83.6% of New England occurrences of Purple Twayblade had been lost since documentation began.

BIOLOGY

Life cycle and reproduction

Purple Twayblade is a perennial species with broad basal leaves emerging from a corm (roundish underground stem) in spring. In Ontario, flowering occurs between late May and mid-July, and flowers are generally at their peak through the middle of June. Even small colonies typically consist of both flowering and non-flowering individuals in a given year. Plants can reach reproductive maturity within four years (Mrvicka 1990, cited in Mattrick 2004), but may take up to fifteen years (Rasmussen 1995). An average generation time of about 10-20 years has been assumed for assessment purposes.

Flowers have a broad, translucent purple lip and an anther column, underneath which insect pollinators pass to gather nectar at the flower's base (Mohlenbrock 1970). Although most orchids are pollinated by bees, Purple Twayblade is pollinated by flies (Dipterans) (Christensen 1994). In contrast to bees, flies are poor pollinators, and may visit flowers many times without successful pollination (Mattrick 2004). It is not known conclusively which species is (or are) responsible for pollination; however, flies in the large group Sarcophagidae (the flesh flies) have been observed on Purple Twayblade flowers and probably contribute to pollination (Christensen 1994).

Unlike many orchids, Purple Twayblade is self-incompatible, meaning that flowers require cross-pollination to produce viable seed (Whigham *et al*. 2002 cited in Mattrick 2004). Hybrids of Purple Twayblade have not been reported, although a green-flowered form (*forma viridiflora* Wadmond) has been observed in Indiana (Sheviak 1974; Homoya 1993).

As in other orchids, the tiny seeds produced carry few nutrients to assist in germination. At germination, many orchids are colonized by mycorrhizal fungi, which provide nutrients to the developing protocorm. Developing orchids are often dependent on associated fungi for all nutrition (McCormick *et al*. 2006). Inoculation experiments suggest that Purple Twayblade may require association with fungi in the genus *Rhizoctonia*. Seeds have been found to persist in soil for up to four years (Whigham *et al*. 2002, cited in Mattrick 2004).

Physiology and adaptability

Purple Twayblade appears to be somewhat adaptable to changing environmental conditions. The species has a wide habitat tolerance across its range in eastern North America and it displays a pioneering ability to colonize recently disturbed areas (Sheviak, 1974). For example, in Illinois, it is known as a colonizer of open dry sites and windthrows, and Sheviak (1974) observes that after becoming established in an area, populations can rapidly increase to hundreds of plants. In some habitats, it may be dependent upon disturbance that maintains its preferred open conditions (*e.g*., canopy opening by windstorms, grazing, brush cutting) to persist. As canopy cover increases and more forested conditions develop, large colonies of Purple Twayblade may decrease to only a few individuals (Sheviak 1974).

Cultivation *in vitro* has been reported with reasonable success, provided that seeds are inoculated with an appropriate fungal associate (Mattrick 2004). It appears less likely that germinated seeds or transplants from native populations can survive in natural settings. In the 1980s, seeds from the Happy Valley (York Region) population were successfully germinated at the University of Guelph, but one-year-old protocorms did not transfer to soil (Allen 1989). Some successful transplants from natural populations are known in Canada. However, transplant success in Canada appears to be mixed, with several attempts failing to survive beyond a few seasons (Allen 1989).

Dispersal

Orchids produce a large number of dust-like seeds that may be transported long distances on air currents (Dressler 1981). This is likely the method of seed dispersal used by Purple Twayblade, although it has been suggested that seeds may be locally dispersed by water (especially in swamp habitats) or by melting snow (Mattrick 2004). At some forested sites, the presence of this diminutive species underneath other plants in the herb and shrub layers may reduce the quantity of seeds that are able to travel any sizable distance from source plants. Dispersal may be less impeded in shrubby thicket, alvar, open savannah, and plantation sites.

The actual dispersal distances for the tiny, less than 1 mm in length, seeds of Purple Twayblade are not known. On the other hand, studies of spore dispersal distances for some mosses, such as that of the common *Atrichum angustatum* of eastern North America found on light sterile soils in sites as open areas along roadsides or mounds in open woods, provide some insight into the dispersal of tiny propagules such as spores. Up to 98% of spores from some colonies of this moss travel no further than 2 m from the colony (Stoneburner *et al.* 1992). Considering that *Liparis* seeds are roughly 10 times the size of these moss spores and the plants are at most only about 25 cm tall, one could surmise that a large proportion of *Liparis* seeds likely do not disperse any great distance from the parent plant. Additionally, the seeds would require a mycorrhizal association with a compatible fungus. Such colonizing events likely occur only sporadically. It is possible, however, that the relatively recent discovery of the McGill University population may reflect a recent establishment and spread of the species eastward in Canada. However, its presence in a mixed hemlock swamp may also indicate that the habitat had not been searched adequately for this inconspicuous orchid.

Interspecific interactions

Herbivory on Canadian populations of Purple Twayblade has not been observed during recent fieldwork (H. Bickerton pers. obs.) or previously documented. White-tailed Deer (*Odocoileus virginianus*), rabbits (*Sylvilagus* sp.), and wild turkeys (*Meleagris gallopavo)* have been observed browsing on Purple Twayblade at New England sites (Mattrick 2004). In Connecticut, many extant sites are reportedly threatened to the point of extirpation by deer browsing in areas with high populations of White-tailed Deer (Brodribb and Oldham 2000).

POPULATION SIZES AND TRENDS

Sampling effort and methods

Where possible, sites were searched with (or by) individuals familiar with the orchid's exact location. Otherwise, previously documented sites were searched using available geographic coordinates and habitat descriptions. When plants were found, individuals were counted, and reproductive status was recorded.

Abundance

Based on surveys in 2007-2009, the total population of Purple Twayblade in Canada is conservatively estimated at between 200 and 500 plants (Table 1). This is believed to be a conservative estimate for several reasons. First, some sites have not been visited in many years and plants may still persist there. Second, this species is obscure and is probably underreported. Third, like many orchids, Purple Twayblade may remain dormant and not be visible in seasons of drought (White 2001). A detailed rationale for this estimate follows.

The Montreal population was last counted in 2007, when 186 plants were observed. The population was present in the spring of 2009 but individual plants were not counted; complete counts are made only every few years in order to minimize disturbance (A. Godbout, pers. comm. 2009).

In 2008, 134 plants were counted at 8 sites over the flowering season. Of these, 23 were flowering, 14 were in fruit, and 64 were in a vegetative state (reproductive status not recorded for 33 plants). This ratio of flowering and fruiting plants to vegetative plants is not unexpected for this species, as populations typically contain a large percentage of non-reproductive individuals (Mattrick 2004).

In the spring of 2009, an additional population of about 40 plants was discovered in the Town of Tecumseh (#9, McAuliffe Woods Conservation Area; Table 1).

A composite count for 2007-2009 is ~360 plants (186 plants (2007), 134 (2008), and 40 (2009), all at different sites). An upper limit of 500 is considered reasonable, since the 2008 Clear Creek population was partially counted, and could be higher given the original number of plants found here (253 in 2001). If the Frontenac Provincial Park population recovers (313 plants in 2003), the total Canadian population could be higher than 500.

The majority of occurrences are small (under 40 plants). Among the new records from the past decade, only three sites have been reported to have more than 100 plants: #14, Clear Creek; #18, Frontenac Provincial Park; #19, McGill University (Table 1). The York Region population was virtually extirpated by 2000. Whether these large, newly reported populations represent recently established populations is also not known. It is plausible that these relatively large populations existed previously, but had not been found in past surveys. Under some circumstances, newly established populations of Purple Twayblade may increase in size to thousands of individuals, as reported by Case (1987) for a site at the University of Wisconsin arboretum, but then decline when the site becomes densely shaded.

Although most of the extant populations consist of only a small number of individuals, the Quebec population is larger than the total of all of the smaller populations in Ontario. In addition, if the Frontenac Provincial Park population recovers to former numbers, these two populations represent considerably more than one half of the mature individuals and possibly occupy more than one half of the area of the total Canadian population. Consequently, the species is not severely fragmented.

Fluctuations and trends

When the original status report was written, Purple Twayblade was known from 11 sites in southern Ontario, with one population of 191 plants, but most containing only a few plants (Allen 1989). In 1998, there were 12 populations believed to be extant, with a total of perhaps 50 plants in Canada (White 2001).

Between 2007 and 2009, the total Canadian population contained about 200-500 plants. Of the 19 populations that had been presumed to be extant, four (#11, #12, #13, #17) may no longer persist. This is based on the absence of plants in 2008 and/or in recent years, combined with a reduction in habitat quality. Three of the populations first reported in the last decade are among the largest documented in Canada. Four new smaller populations have also been reported from the Windsor-Essex area, and one from Pelee Island (Table 1).

An apparent increase in overall population size and number of occurrences should be interpreted cautiously. It is likely that several of the recently reported populations may be the result of an increased search effort, especially in Windsor-Essex, by botanists familiar with the species. The species may have been underreported in the past, as it can escape detection even by those familiar with it. Cool, wet conditions in 2008 may also have contributed to favourable counts.

A number of populations likely have become extirpated since 1998. A sub-population of the LaSalle Woods (#6b) occurrence will likely be lost imminently to a housing development (P. Pratt, pers. comm. 2008). The second sub-population in the LaSalle Woods area (#6a) has not been observed since 1979 (J. Johnson), although suitable habitat remains in good condition, and has now been purchased by the Town of LaSalle.

The largest known Canadian population in Frontenac Provincial Park (#18) contained at least 313 plants in 2003, and perhaps as many 400-500 (White, 2008). Most of the habitat appears to be recovering after being submerged in 2004 by a beaver pond. After the beaver dam was removed a small portion of the site remained flooded in 2008 (M. Sly, pers. comm. 2008). No plants were observed in 2007 or 2008, and the site continues to be closely monitored by Ontario Parks (C. Brdar, pers. comm. 2008).

Plants were last observed at Deyo's Woods (#13) in 1997 (White 2001). Both sub-populations were visited in 2008 by Ross Brown and H. Bickerton and no plants were observed. Understorey vegetation had become overgrown where the plants had previously occurred, and this area may no longer be suitable for Purple Twayblade.

Although Oxley Swamp (#11) has been surveyed at least twice in recent years, Purple Twayblade has not been observed at this site since the mid-1980s. Early successional habitat has matured and may no longer be suitable (G. Buck, pers. comm. 2008).

Two small sub-populations were documented at Cedar Creek in 1980s. The northern occurrence (#12a) of 12 plants (Allen 1989) was not observed in 2001 or 2008. The previously grazed understorey appeared overgrown in comparison to previous habitat descriptions, and this sub-population may no longer exist. A second sub-population on the southern shore of Cedar Creek (#12b) has not been observed since 1982.

The occurrences at Lakeshore Woods (#15) and West Lorne (#16) have not been observed since the mid-1980s. Both areas were searched unsuccessfully by David J. White during fieldwork in 1998, although the season was very dry (White 2001). These areas were not visited in 2008 because private landowners could not be identified.

Finally, the Happy Valley population in York Region (#17) is likely extirpated. When first documented in 1977, it was the largest known Canadian population, at over 300 plants. Subsequent population counts have steadily declined, to 191 in 1989 (Allen 1989), to only “a few” in 2000. Search efforts in 2001 and 2008 did not yield any plants.

Overall, although a decline in mature individuals may have occurred, the degree of that decline cannot be determined with any certainty. A series of populations have likely become extirpated, including one large one (#17) and possibly a second large population at Frontenac Provincial Park (#18) but new small populations have been discovered through intensive search efforts. The species is also known to colonize diverse habitats and may be more common than reported, especially considering the broader range of occurrence as now understood due to the recent discoveries in southeastern Ontario and western Quebec.

Rescue effect

It is possible that Purple Twayblade could be reintroduced from populations within the United States, but perhaps only after a considerable period of time. Purple Twayblade is a colonizing species, especially of disturbed sites with open canopies (Sheviak 1974); its seeds are tiny and wind-dispersed, sometimes being carried over long distances (Sheviak 1990). However, as discussed under dispersal of seeds, it is likely only a small proportion of seeds travel great distances and these then must form mycorrhizal associations to develop into seedlings.

The species is also more common in some nearby American states (*e.g.*, Ohio, Indiana). It appears that the Purple Twayblade population may be increasing (or increasingly reported) in neighbouring Michigan, with a new population reported from Charlevoix County (northern Michigan) in 1990 (A. Reznicek, pers. comm. 2009), further north than previously documented. No clear changes in abundance or range have been observed in New York or Vermont (S. Young, pers. comm. 2009; B. Popp, pers. comm. 2009).

THREATS AND LIMITING FACTORS

Succession

Purple Twayblade is a colonizing species of successional and disturbed habitats, and appears to decline at sites when they become too densely shaded. At several sites (Deyo's Woods, #13; Cedar Creek, #12; a portion of the Ojibway Prairie Complex, #3; Oxley Swamp, #11; and the Reaume Street Prairie, #5), previously open understories are becoming denser and overgrown.

Housing development and urbanization

The threat of habitat destruction due to urbanization is highest in the Windsor-LaSalle area, where several Purple Twayblade occurrences are concentrated in small remnants within a developing urban area. One privately owned site has been approved for housing development, and another is under development pressure (P. Pratt, pers. comm. 2008; G. Waldron, pers. comm. 2009). Over the years, some habitat has likely been lost to landscaping at the Happy Valley site, which is immediately adjacent to a private home (Allen 1988).

Invasive species

Invasive species are present at several sites, and probably threaten this species. Garlic Mustard (*Alliaria petiolata*) is abundant in former Purple Twayblade habitat in Deyo's Woods and it is also present at the Canard River site. It is one of the most invasive species present in southern Ontario. Scots Pine (*Pinus sylvestris*) is abundant and European Buckthorn (*Rhamnus cathartica*) is present in areas of the Reaume Street Prairie where Purple Twayblade has previously been documented (H. Bickerton pers. obs.).

On the other hand, Purple Twayblade has been reported in areas dominated by non-native species such as Black Locust (*Robinia pseudoacacia*), Multiflora Rose (*Rosa multiflora*), and also in raspberry thickets and conifer plantations (Sheviak 1974; Case, 1987; White, 2001; G. Waldron, pers. comm. 2009; M. Penskar, pers. comm. 2009).

Flooding by beavers

The Frontenac Provincial Park occurrence last reported in 2003 was flooded by a beaver dam in the following year (C. Brdar, pers. comm. 2008). The dam has since been removed. However, beavers are still active in the area and one area of formerly occupied habitat remained flooded in 2008. Purple Twayblade has not reappeared and is now possibly extirpated from the site. Such stochastic flooding events are natural impacts that, as in this case where a large population appears to have been destroyed, may represent a limiting factor that, overall, reduces the reproductive and dispersal potential of the species.

Small population size

Most Canadian populations are small, containing fewer than forty plants, and this is considered to be a limiting factor for several reasons. First, Purple Twayblade is self-incompatible, and hand-pollination experiments have demonstrated that plants in close proximity to one another are much less likely to produce viable seed than those from a more distant location (Whigham and O'Neill 1991, cited in Mattrick 2004). There is evidence of severe inbreeding depression from small, isolated populations in Maryland, and inbreeding depression is considered to be a threat to the taxon in New England (Mattrick 2004). Finally, small populations are also more likely to be vulnerable to stochastic events.

Other threats

Although other threats to this species have been identified in the past (Allen 1989; White 2001), these are not currently regarded as constituting significant threats to Canadian populations. For example, Purple Twayblade is not a showy orchid species, and is not likely to be threatened by collection, trampling, or soil compaction.

Threat-based delineation of locations

In 2008, the number of extant and possibly viable populations are inferred to be about 10-12 based on uncertainties of actual loss or persistence of some populations and viability of others. Four populations out of 19 sites originally considered to be extant (Allen 1988) had seemingly become extirpated by 2008 through successional changes in habitat (#11, #12, #13) or to housing development (#17). In addition, a few populations/subpopulations that were visited in 2008 that had no plants (#5, #6a, #12a, #13) and originally only had a few plants that were subsequently absent when surveyed more than 10 years ago are possibly also extirpated. Three populations (#3, #4, #10) that were visited in 2008 had fewer than 10 plants ever present are questionably viable. Several sites could not be surveyed due to lack of permission for entry.

The number of locations as defined by COSEWIC is determined on the basis of the most severe threats affecting each population or portions of extant populations. The number of locations, for assessment purposes, is here considered to be equated to the number of populations (10-12) that are assumed to be extant. The various threats, especially successional changes to the habitat, have been the cause of the loss and/or decline of the majority of the known occurrences. Habitat succession exacerbated by the spread of invasive species will continue to be an important threat to most extant populations. It is recognized, however, that in view of the colonizing nature of this species, this orchid must be adapted to natural habitat changes. In spite of such adaptation and the discovery of new populations since the original report (Allan 1989), a decline in known populations has occurred. Development pressures are currently impacting two sites in the Windsor-LaSalle area, and most of the extant populations are impacted by the low numbers of individuals that likely make them highly vulnerable to stochastic events. Even large populations such as that at Frontenac Provincial Park can be severely impacted by events such as flooding of habitat by beavers.

PROTECTION, STATUS, AND RANKS

Legal protection and status

Purple Twayblade is provincially listed as Endangered under Ontario's *Endangered Species Act, 2007* and is listed as Endangered on Schedule 1 of the federal *Species at Risk Act* (SARA). COSEWIC assessed this species as Endangered in May 2001.

Non-legal status and ranks

NatureServe (2009) ranks Purple Twayblade as G5 globally (Secure). Its national rank for Canada is N2 (Imperilled) and in the United States N5 (Secure). It is ranked S2 (Imperilled) in Ontario (Oldham and Brinker 2009). In Quebec, the species is ranked S1 (Critically Imperilled; Centre de données sur le patrimoine naturel du Québec, 2008). Purple Twayblade has been documented in 30 American states, and has a conservation ranking of S3 (Vulnerable), S2 (Imperilled), S1 (Critically Imperilled), or SX (Presumed Extirpated) in 15 states, mainly along the northern and southern edges of its core range in the United States (Table 2).

Table 2. Conservation status and ranks for Purple Twayblade.

State/Province	S-Rank1	State Legislation (if any)
Alabama	S1	
Arkansas	SNR	
Connecticut	S1	END
District of Columbia	SNR	
Delaware	S2	
Georgia	S3	
Iowa	S3	
Illinois	S3S4	
Indiana	SNR	
Kentucky	S4	
Maryland	S2S3	
Massachusetts	S2	
Michigan	S3	
Minnesota	SNR	
Missouri	SNR	
North Carolina	S3	
New Hampshire	SX	
New Jersey	S3S4	
New York	S1	
Ohio	SNR	
Oklahoma	S1	
Ontario	S2	
Pennsylvania	SNR	
Quebec	S1	
Rhode Island	S1	
South Carolina	S1	

[1] S1: Critically Imperilled; S2: Imperilled; S3: Vulnerable; S4: Apparently Secure; S5: Secure; SX: Presumed Extirpated; SU: Unrankable; SNR: Not Ranked (NatureServe, 2009)

State/Province	S-Rank1	State Legislation (if any)
Tennessee	SNR	
Virginia	S5	
Vermont	S1	
Wisconsin	SNR	
West Virginia	S5	

Habitat protection and ownership

Habitat protection of Purple Twayblade through procurement of land for conservation has increased in the past decade, due in part to land purchases by the City of Windsor, the Town of LaSalle, and the Nature Conservancy of Canada. Of the nineteen occurrences known (excluding the four historic sites), eleven are now entirely or mostly owned by government or by conservation agencies and by a university. In fieldwork carried out from 2007 to 2009, Purple Twayblade was found at several of these protected sites, in two cases having persisted for over 20 years. The species is not known to occur on any federal lands in Canada.

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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 *Liparis liliifolia* were examined during the preparation of this report.