

COSEWIC
Assessment and Update Status Report

on the

Wood-Poppy
Stylophorum diphyllum

in Canada



ENDANGERED
2007

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC Assessment Summary

Assessment Summary – November 2007

Common name

Wood-poppy

Scientific name

Stylophorum diphyllum

Status

Endangered

Reason for designation

A showy perennial herb of Carolinian woodlands restricted to 3 small and highly fragmented populations occupying very limited areas. The habitat is declining in quality due to the presence of invasive plants and habitat disruption due to recreational activities that increase the risk of trampling. Further potential habitat disruption may occur with the expansion of housing development and other commercial activities adjacent to two of the sites. The species is widely available from nurseries but garden-grown plants cultivated in Canada likely originate from U.S. stocks. Cultivated plants are not included in the COSEWIC assessment.

Occurrence

Ontario

Status history

Designated Endangered in April 1993. Status re-examined and confirmed in May 2000 and November 2007. Last assessment based on an update status report.



COSEWIC
Executive Summary

Wood-Poppy
Stylophorum diphyllum

Species information

Wood-poppy (*Stylophorum diphyllum*) is a perennial herb that has yellow or orange sap, a stout rhizome and showy yellow flowers that bloom in early spring. A cluster of 1-4 flowers is produced at the end of an elongated shoot above two or three more-or-less opposite leaves. The flower has four yellow petals that are 2-5 cm in length, and numerous stamens. The woody poppy's fruit is a greyish, oval, hairy capsule that splits by longitudinal clefts into three or four segments. The leaves are mostly basal, have long petioles and are pale underneath. They are deeply divided into five to seven irregular lobes or toothed segments.

Distribution

The distribution of wood-poppy is restricted to northeastern North America, centered in Kentucky and Missouri, but extending as far south as Georgia and Alabama. At the western part of its range, wood-poppy is found in Arkansas, eastern Missouri and Michigan. In Ontario, four historic collections are known from the 1880s, all along the Thames River near London, Ontario. The three extant populations occur near London where they occupy a total area of habitat comprising < 1 ha. The extent of occurrence is 150 km² and the area of occupancy, based on a 1x1 km grid, is 3 km² and based on a 2x2 km grid is 12 km².

Habitat

Wood-poppy is typically found in species-rich woods in forested ravines and slopes, ravine bottoms, along woodland streams, and at the base of bluffs. In Ontario, wood-poppy is at the northern limit of its global range and is found in deciduous forest of till plains, wooded ravines and valley slopes.

Biology

The species is a typical deciduous forest “summer green” herb. It starts growing in mid- to late April, from a short, stocky rhizome. It flowers in May to early June with the seeds dispersed by late June to July. The vegetative parts stay green until late September or early October and then die back. Seeds set readily on flowers that may pollinate themselves or receive pollen from other flowers. Seeds require a cold period of dormancy before they germinate. Plants may flower in their first year, but usually don’t do so in the wild. Once established, plants often survive for 5 or more years. They generally grow in dense stands or clumps, but outlying individuals are observed in the southern Ontario population.

Population sizes and trends

The three known populations of wood-poppy in Canada contained about 255, 250 and 24 mature plants respectively in 2006. The largest known population was partially covered by fill in 1993 and reduced from about 800 plants to about 170. Since then it has increased slightly to about 250 individuals, although this is not based on a detailed census. The other two populations have both increased slightly since 2004, but it is not clear if this is a short-term natural fluctuation or a trend.

Limiting factors and threats

Threats identified for wood-poppy in Canada are habitat destruction and modification, impacts from adjacent development, competition from invasive species, recreation activities and genetic contamination. Wood-poppy has likely never been abundant in Canada, surviving in relative isolation. Recruitment from the nearest population in Michigan and Ohio is unlikely.

Special significance of the species

Wood-poppy in Canada is at the edge of its global range and appears to be genetically distinct from the main population. Apart from some popularity as a garden plant it has no known uses.

Existing protection or other status designations

Wood-poppy is listed as Endangered in Canada (COSEWIC, 2000), and Ontario. The species and its habitat are protected under the *Ontario Endangered Species Act* and the Provincial Policy Statement. Two populations are located on private land, the third in a conservation area. Wood-poppy is also of conservation concern in four other jurisdictions, including Alabama, Arkansas, Georgia, and Virginia. A number of actions have been taken to mitigate risks to the species as the result of actions taken by the Recovery Team established in 1997.



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 (2007)

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

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

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

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



Environment Canada
Canadian Wildlife Service

Environnement Canada
Service canadien de la faune

Canada

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

**Update
COSEWIC Status Report**

on the

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Stylophorum diphyllum

in Canada

2007

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SPECIES INFORMATION

Name and classification

Scientific name: *Stylophorum diphyllum* (Michaux) Nuttall
Synonyms: *Chelidonium diphyllum* Michaux; *Meconopsis diphylla* DC
Common names: wood-poppy, celandine poppy, mock poppy, yellow poppy
Family: Papaveraceae (Poppy Family)
Major plant group: Eudicot flowering plant
Type specimen: Lectotype species: Paris?

Stylophorum diphyllum, the only North American representative of the genus, was originally described by Michaux (1803) as a species of *Chelidonium* and was transferred to *Stylophorum* by Nuttall (1818). Vegetatively it is similar to the Old World species *Chelidonium majus*, and was reunited with *Chelidonium* by Prain (1895).

Morphological description

Stylophorum diphyllum is a hairy, perennial herb up to about 40 cm tall, developing a stout rhizome. Stems, sepals, and sometimes leaves, have few to many stout, multicellular hairs. The leaves are pale beneath, mostly basal, with long petioles. They are deeply pinnately divided, almost or quite to the mid-vein, into 5-7 irregular lobed or toothed segments. Flowers are in few-flowered clusters subtended by 2 or 3 more-or-less opposite leaves. The two sepals are hairy and slightly fleshy. The four petals are 2-5 cm long and rich yellow. The stamens are numerous with very slender filaments and oblong anthers. The ovary is densely pubescent, more or less elliptical in shape and narrowed to a long style, which is persistent in the fruit. The fruit is a nodding, greyish-green, soft-bristly, pubescent capsule, splitting by longitudinal clefts into 3 or 4 segments (Gleason, 1952; Ernst, 1962). All parts of the plant have a yellow to orange, bitter-tasting sap. A technical description of the species is given in Gleason and Cronquist (1991).

Line drawings of *Stylophorum diphyllum* leaf and flower are given in Gleason (1952). More detailed anatomical drawings appear in Ernst (1962). A colour plate is given in Boynton (1918). A drawing by Susan A. Reznicek illustrates an article by A.A. Reznicek (1988). Drawings from sketches made in the field by the senior author are given in Figure 1.

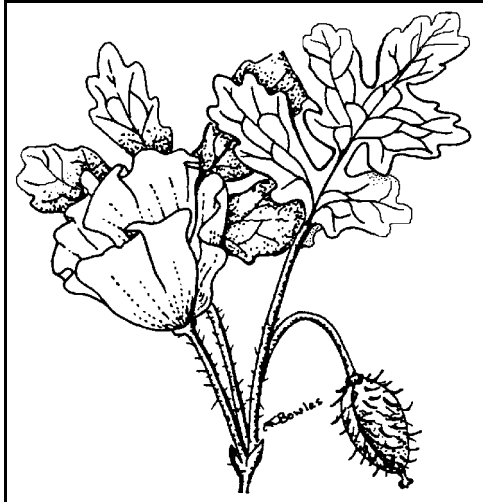


Figure 1. Line drawing of *Stylophorum diphyllum* by Jane Bowles.

During early spring, the large bright yellow flowers of *Stylophorum diphyllum* are distinctive and attract attention from some distance. At this season the pubescence is also very obvious as are the pale backs of the leaves. In its vegetative state *Stylophorum diphyllum* is strikingly similar to the relatively common adventive species from the Old World, *Chelidonium majus* (greater celandine). In *Chelidonium majus* the leaves are all alternate. In *Stylophorum diphyllum* there are one or more basal leaves, with opposite or whorled leaves present on the otherwise naked flowering stem. The flowers of *Chelidonium majus* are much smaller, with narrower petals only about 1 cm long, and glabrous sepals and capsules. The capsule of *Stylophorum diphyllum* is ovoid and bristly-hairy whereas that of *Chelidonium majus* is hairless and linear-cylindric.

Genetic description

Stylophorum diphyllum reproduces sexually and appears to be capable of both outcrossing and selfing. The degree of genetic diversity among and within *Stylophorum diphyllum* populations is being determined through the application of molecular genetic markers. This is a work in progress, but early results suggest variation both within and among Canadian populations and differences between Canadian and U.S. populations (Gharebaghi, 1996; Galbraith, pers. comm., 2005). The distance between populations and the unstable nature of the intervening habitat suggests significant barriers to genetic exchange among populations.

Designatable units

Stylophorum diphyllum in Canada forms a single designatable unit since the populations occur in close proximity and in the same COSEWIC ecological area (Great Lakes Plains).

DISTRIBUTION

Global range

Stylophorum diphyllum is restricted to eastern North America. A general distribution map is given in Figure 2.

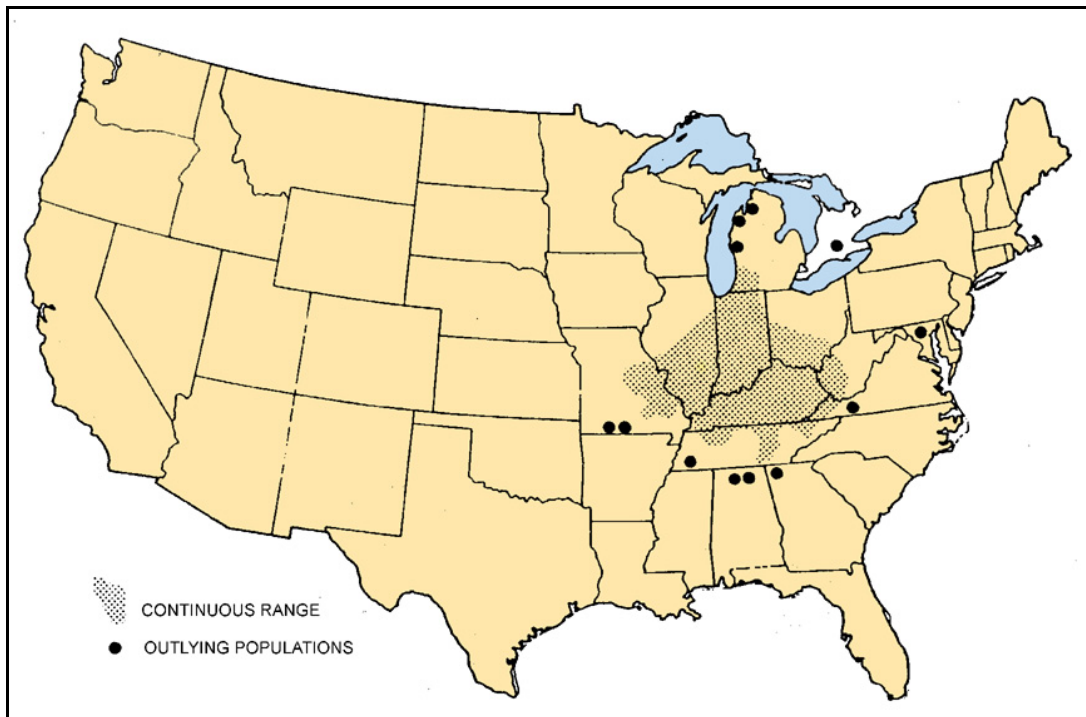


Figure 2. Global distribution of *Stylophorum diphyllum*.

This map is based on distribution information provided by individual state authorities and other records from herbarium specimens and the literature (Bowles and Oldham, 1993). Fernald (1950) gives the range as western Pennsylvania to Wisconsin, south to southwestern Virginia, Tennessee and Missouri, but no herbarium records exist confirming the existence of *Stylophorum diphyllum* in Wisconsin (Wisconsin SH, 2006). The inclusion of Pennsylvania in the range appears to be based on a single specimen, probably from western Pennsylvania, but lacking precise location information, and on unconfirmed reports of the species in Allegheny County (Buker and Thompson, 1986). Three locations of the species are currently known for Pennsylvania, but none are in natural settings and Buker and Thompson (1986) could not confirm its current or historical native occurrence there.

Canadian range

Stylophorum diphyllum is known from three extant locations near London, Ontario at the northern limit of the Eastern Deciduous Forest Region or Carolinian Zone in Ontario (Figure 3).

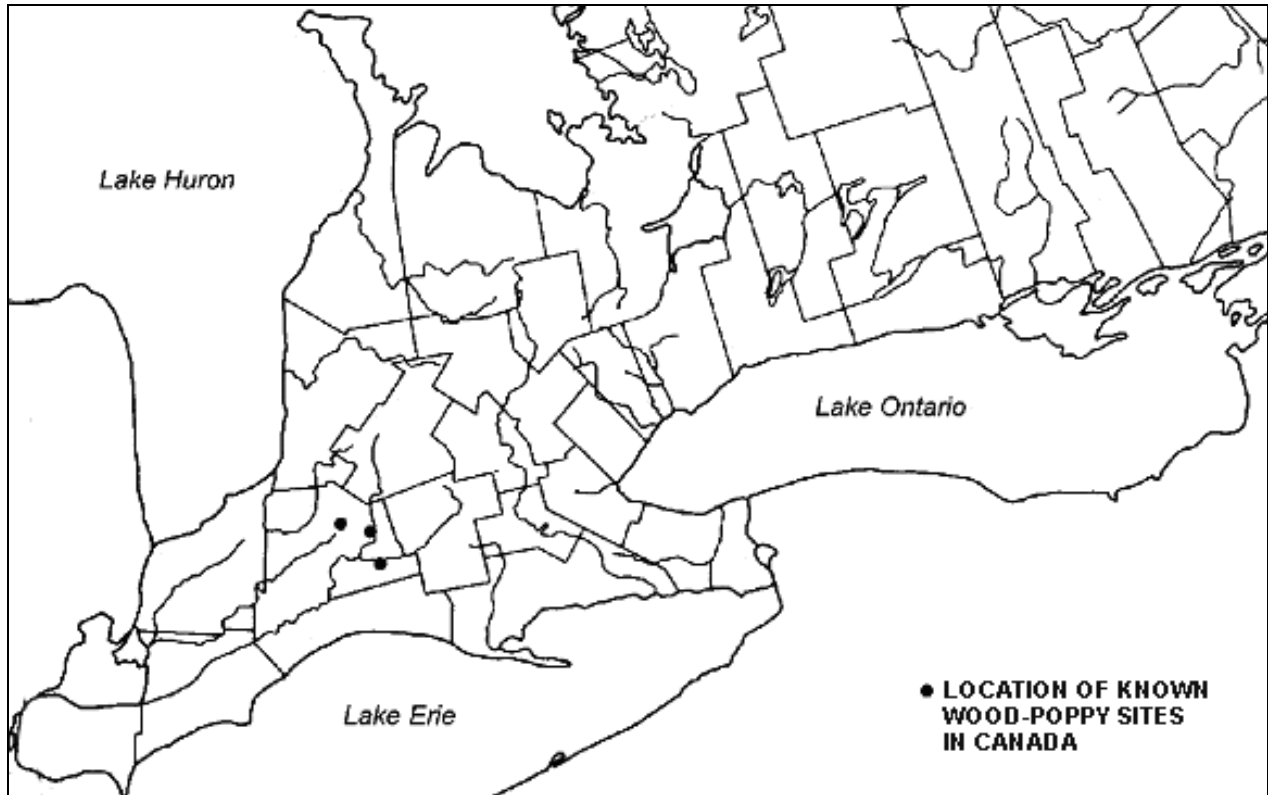


Figure 3. Distribution of *Stylophorum diphyllum* in Ontario.

It appears always to have been very rare in Canada. All historic records are from the same region. The Canadian range makes up less than 1% of the global distribution.

Only four historic collections are known. The three extant populations (Ilderton, Fanshawe, London) are from near Plover Mills, Middlesex County. For one of the historic records, the only locality given is "Thames River". Because of the vague locality information given for these historic records, it is uncertain as to which, if any, of the extant populations these refer to. Until 1987 no collections had been made since 1889. Keddy (1987) assumed the species to be extirpated from Ontario. Phipps (pers. comm. 1993) reported seeing a small clump of *Stylophorum diphyllum* with flowers near Ilderton, Ontario, in 1972. Dufton (pers. comm. 1993) photographed a population near Fanshawe, Ontario, also in the early 1970s. A copy of this photograph is deposited in the University of Western Ontario (UWO) Herbarium. In 1987, *Stylophorum diphyllum* was discovered by David Stephenson on a small tributary of the Thames River near London, Ontario

(Stephenson, 1987). In 1994 the senior author and Marjory Dufton rediscovered the population near Fanshawe, and in 1996 the senior author and James Phipps rediscovered the population near Ilderton.

The Extent of Occurrence (EO) in Ontario was calculated by drawing a perimeter connecting the three sites and calculating the area using a Geographic Information System (GIS) computer program. The EO is about 150 km². The total area actually occupied by the populations, calculated by drawing a perimeter line around each population mapped into GIS, is <1 ha., with the three sites contributing 0.48 ha, 0.45 ha and 19.5 m². Using a 1 km² grid overlay, the Area of Occupancy (AO), based on COSEWIC criteria, would occupy 3 km² and based on a 2x2 km grid would occupy 12 km².

HABITAT

Habitat requirements

Stylophorum diphyllum is typically a plant of rich forests. Habitat information on herbarium specimens collected throughout its range includes species-rich woods, forested ravines and slopes, woodland streams, ravine bottoms and bases of bluffs. Most collections appear to be from ravines and slopes, but this may be an artefact of the distribution patterns of remnant woodlots on land unsuitable for agriculture. More specific habitat annotations providing information on edaphic conditions includes "rich damp beech woods", "rich limestone woods", "limestone slopes and terraces", "moist rich woods", "mesic slopes" and "loamy sand beech-maple woods". Additional descriptions provided by Kiger (1997) include thickets, cedar barrens, shaded dunes and occasionally in fields, often on slopes, in loam or sand.

In Ontario all three sites are in rich, mesic, mixed deciduous woodland on calcareous glacial till deposits of loamy clay. Two sites (London and Fanshawe) are on the slopes of the Thames River, while the third (Ilderton) is on a level till plain well away from any water-course. At London and Ilderton outlying plants are present on disturbed areas (fill and drainage spoils respectively) adjacent to the main population. In natural settings *Stylophorum diphyllum* usually grows in full shade, but cultivated plants flourish in partial sun (personal observation). Habitat that appears suitable for *Stylophorum diphyllum* appears to be much more widespread and extensive, even locally, than the species itself.

The canopy trees at the Ontario populations of *Stylophorum diphyllum* include sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), American beech (*Fagus grandifolia*), black cherry (*Prunus serotina*) and hackberry (*Celtis occidentalis*). The largest trees are about 40 cm diameter at breast height. The shrub layer is open to closed, predominantly choke cherry (*Prunus virginiana*) and saplings of the canopy trees. Where it exists, *Stylophorum diphyllum* often forms the dominant groundcover species, the closest neighbour to it tending to be other *Stylophorum diphyllum* individuals.

Otherwise, associated ground layer species include many of the normal suite of rich woodland species such as blue cohosh (*Caulophyllum thalictroides*), Virginia waterleaf (*Hydrophyllum virginianum*), Canada waterleaf (*H. canadense*), yellow trout-lily (*Erythronium americanum*), wild ginger (*Asarum canadense*), zigzag goldenrod (*Solidago flexicaulis*), bottle-brush grass (*Elymus hystrix*), spotted jewel-weed (*Impatiens capensis*), false Solomon's seal (*Maianthemum racemosum*) and Jack-in-the-pulpit (*Arisaema triphyllum*). The exotic invasive species garlic mustard (*Alliaria petiolata*) is also present at two sites (Bowles, unpublished data).

Habitat trends

Heavy logging followed by burial by fill at the London site reduced a large section of the known habitat of *Stylophorum diphyllum* in 1993. Since then the remnant population has expanded slightly. Erosion and deposition in the creek valley and at the edge of the fill affects local outlying individuals during some storm events. Opening of the canopy by logging and the death of trees affected by fill operations has been followed by dense growth of saplings. It is unclear what the overall effects of these changes in canopy cover have been.

At Fanshawe, many of the trees around the *Stylophorum diphyllum* site have died in the last 5 years. This has created both openings in the canopy and a considerable amount of coarse woody debris. Understorey shrub growth (mainly *Prunus virginiana*) has increased and may be shading out the original stand. *Alliaria petiolata* is abundant at this site, but it appears to have diminished slightly in the immediate area of the *Stylophorum diphyllum* possibly due to mitigating actions to remove rosettes of the invasive near the wood-poppy plants. These changes in the habitat may also have affected seed predator (mice) and disperser (ant) populations, shade, competition, soil processes and mycorrhizae. In the last two years recruitment has suddenly increased at this site.

At Ilderton the population is at the edge of an active sugar bush. Apart from construction of an adjacent municipal drain the site management has changed very little over the last 30 years. The drain spoil has created recruitment sites for *Stylophorum diphyllum*.

Habitat protection/ownership

The London and Ilderton sites are privately owned. The London site is within the 30-year growth boundary for the City of London and development is occurring in the neighbourhood. A Community Plan is being prepared for the area that must provide some degree of setback to protect the population. However, the presence of residential development in the area is likely to lead to increased disturbance and recreation pressure at this site as well as to a potential increase in exotic competitors.

The Ilderton site is part of a large, well established commercial sugar bush operation. The landowners are aware that *Stylophorum diphyllum* is present and have no plans at present for any land use change that might affect the population. Management and construction operations on the drain could affect some plants.

The Fanshawe population is in a Conservation Area owned and managed by Upper Thames River Conservation Authority (UTRCA). The Conservation Authority is aware of the presence of *Stylophorum diphyllum* on the property and has managed the site to help protect the plants by re-routing a trail and installing signage.

BIOLOGY

Life cycle and reproduction

Stylophorum diphyllum is a polycarpic perennial. Each plant produces one to several flowering stems. The maximum number of stems counted on a single individual is 19, the average 8.3. The number of flowering stems is strongly correlated with the size of the plant measured by the spread of the canopy. *Ex situ* plants can flower in their first year, but in the wild no flowering was detected on plants with a canopy spread of <20 cm (Bowles, 1997). Plants grown in *ex situ* plantings or tagged in the wild will flower annually, but begin to decline and show dieback in the centre of the root crown after 4-5 years. Flowering is indeterminate, but peak flowering occurs over a period of about 10 days in mid-late May. Usually each stem produces 1-4 flowers, but additional flowers and even flowering stems can be produced after the peak season and into the fall. This is much more common in *ex situ* populations than in the wild. The average number of full seeds produced per capsule was 39, with a range of 0 to 99. Consequently, an average-sized plant can produce over 1000 seeds per year.

Stylophorum diphyllum follows a phenological pattern exhibited by many “summer green” deciduous forest herbs. Vegetative growth is apparent in mid- to late April in southern Ontario, and by late May or early June flowering is completed. The leaves remain photosynthetically active until early fall, by which time the fruits have disintegrated and the seeds dispersed.

Flowering dates of herbarium specimens housed at University of Michigan Herbarium (MICH) show the expected relationship with latitude. The earliest date on a flowering specimen was April 11 from Cheatam County, Tennessee (Latitude approximately 36°10'N) and the latest date was June 18 on a specimen from Antrim County, Michigan (Latitude approximately 45° N). Lindsey and Newman (1956) reported a 30-day range in first flower date with a 30-day growth period, a temperature threshold of 10°C and a sum of about 1150 degree hours required for flowering. In Canada the first flowering date is usually in the first or second week of May (Bowles, unpublished data).

The seeds of *Stylophorum diphyllum* have a fleshy, white, oily endosperm and rudimentary embryo. In germination studies, Baskin and Baskin (1984) found that most seeds germinated in the spring following production. The pattern of dormancy was quite complex involving both morphological and physiological mechanisms. Seeds with undeveloped embryos are classed as morphologically dormant while those with physiological inhibition are classed as physiologically dormant. A combined morpho-physiological dormancy appears to be present in *Stylophorum diphyllum*. Temperatures of 5°C were required for embryo growth prior to germination.

In 1998, seeds of Canadian populations that were air dried and kept in a refrigerator at 3°C from June to October and then overwintered outside in flats in a cold frame had a germination rate of over 80% the following year. Subsequent attempts to germinate seeds using a similar method have not been successful, and no germination has been detected in seeds planted in marked locations at the *Stylophorum* sites (Bowles, unpublished data).

Predation and disease

A limited amount of browse has been observed on wild plants. Usually capsules are removed, either by white-tailed deer (*Odocoileus virginianus*) or by woodchucks (*Marmota monax*). The acrid yellow sap probably deters many potential predators. Very little browsing by invertebrates (such as insects and molluscs) has been observed in wild plants. Most mortality in adult plants appears to follow softening and rotting from the centre of the root crown. It is not known whether this is a disease or simply decay that follows senescence in older plants. Seeds are also eaten by mice.

Dispersal/migration

The seeds of *Stylophorum diphyllum* are about 2 mm long and 1.5 mm wide with a carunculate aril (Gunn and Seldin, 1976; Gunn, 1980) believed to be an adaptation to dispersal by ants (Nordhagen, 1959). The seeds have a fleshy, white, oily endosperm (Figure 5). In ant-dispersed species the ants are attracted to the fatty acids in the elaiosome and typically carry the seeds back to the colony where the oil-rich organ is removed and the seed discarded. Seeds placed on a concrete path in a garden were removed by ants in less than 1 minute (Bowles, personal observation). At the London site 79% of 600 seeds placed out on small trays had been removed within 24 hours. When half the seeds were covered with wire mesh cage to prevent predation by rodents, 25-33% of the protected seeds were removed at the London site, but at Fanshawe no protected seeds were removed. This suggests that ants were not present at Fanshawe, or were not collecting the seeds, which could explain the very low recruitment rates at this site during that period. Unprotected seeds at Fanshawe were apparently mostly eaten by mice. Mice droppings containing the seed coats were found on the trays used for the experiment (Bowles 2000).

Adaptability

Although the flowers of *Stylophorum diphyllum* are large, showy, and are visited by insects, Elrod (1904) found that seed set was normal in flowers isolated from insects.

According to Baskin and Baskin (1984), *Stylophorum diphyllum* does not reproduce vegetatively, although spread of individual plants does occur by rhizome growth. However, rhizomes are very short and stocky, and spread of individual plants is very limited.

Baskin and Baskin (1984) suggest that germination, like that in *Stylophorum diphyllum*, which requires a cold stratification period, is adaptive for deciduous forest herbs because it allows seedlings to avoid the extreme winter temperatures, but to take advantage of the vernal light phase before canopy closure.

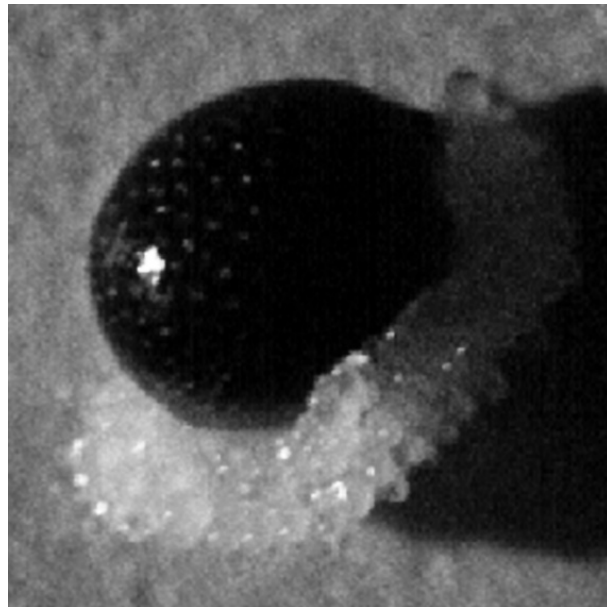


Figure 4. Photograph of *Stylophorum diphyllum* seed, showing the fatty elaiosome of translucent cells.

POPULATION SIZES AND TRENDS

Search effort

Historical records suggest that *Stylophorum diphyllum* was very rare in Ontario, even before the habitat destruction that followed European settlement. Nearly a century elapsed between the sparse earliest records and more recent discoveries. The striking appearance of the species in early spring makes it unlikely that it has been seriously overlooked. Sites within the known historic range are quite well botanized.

Since 1987, the senior author has made searches in the known historic range of *Stylophorum diphyllum*, with additional searches by Brinker, Oldham and Stephenson. Early (1947) air photographs were used to concentrate areas of search by identifying sites within the known historic range that had mature trees in 1947, and may have had continuous tree cover. Candidate sites were walked during the flowering season. Search time accumulates to more than 70 person-hours.

The only known populations of *Stylophorum diphyllum* in Canada are at least 15 km apart and some 200 km from the nearest wild populations of the species in the United States. Each Canadian population consists of a few to several hundred closely spaced plants with a few outlying clumps and individuals. The London and Ilderton populations are spread over an area of 100-150 m² with outliers up to 40 m and 150 m away respectively. The Fanshawe population is much smaller. Until 2005 it consisted of between 5-8 mature plants in an area of less than 1 m². During 2005 there was some recruitment and in 2006 all of the original plants had died, but 24 new plants were censused in an area of about 19.5 m².

Abundance

Descriptions of population sizes at the three known sites in 2006 are given below. All three sites have experienced an increase in population numbers in the last 2-3 years, but this may represent short-term natural fluctuations in response to weather or other factors rather than a trend of increasing population.

London

This site, discovered in 1987, is now in the City of London. The original population size was estimated to consist of about 740 individuals in the main patch, approximately 10 x 15 m in size, with a few smaller stands and isolated individuals, bringing the total to about 800 plants (Bowles, 1997). The report of 5000 individuals (Gosnell and Stephenson, 1996) is considered erroneous because of the way that individuals were recognized and density counts were multiplied up over the stand area.

In 1993 logging and filling occurred at the site and the main population was buried. Gosnell and Stephenson (1996) considered the population to be reduced to about 160 remaining plants in 6 stands, plus some additional recruitment.

In 1997 a more thorough mapping and population census revealed approximately 235 mature plants and about 50 recruits. Problems confounding counting individual plants at this site include a clumped distribution of multi-stemmed individuals and very steep slopes.

The population was monitored through 1997-2005, although another detailed census was not done. Populations in individual stands remained more or less stable at about 250 plants, with some recruitment and some turnover. In 2006 landowner permission to access the site for a more accurate census was denied.

Fanshawe

This site was rediscovered in 1994 when it consisted of a small patch about 1.5 m across containing about 8 individuals. Several of these plants died, apparently from crown rot, over the next 10 years. No recruitment was seen until 2005. In 2006 none of the original plants remained, but 24 additional recruits were mapped over an area of about 5 x 6 m.

Ilderton

This site was rediscovered in 1996, when it consisted of approximately 140 individuals in the main patch, with an additional 20 outlying individuals. When the site was surveyed in 2006 the main stand consisted of 180 plants, two additional loose patches of about 35 and 28 individuals respectively, and a number of outlying plants totalling about 255 individuals. An additional survey in May 2006 located two additional stands, of 5 and 12 individuals respectively, separated by about 150 m from the main site. Thus the population appears to have increased slightly over this time.

Rescue effect

Recruitment of plants from the next nearest population in Michigan and Ohio is unlikely. The distances are large, and the intervening territory includes extensive areas of unsuitable habitat including agricultural and urban land as well as significant stretches of water (Lake Erie, Lake St. Clair and the St. Clair and Detroit Rivers). The species appears to be locally dispersed by ants, and no long-distance dispersers are known. The continued existence of *Stylophorum diphyllum* in Canada depends, therefore, on the maintenance of the three known populations.

LIMITING FACTORS AND THREATS

Habitat destruction and modification

Habitat destruction (by fill) was a major cause of population decline in 1994 at the London population. This was a “once only” disturbance, but lingering effects include erosion, sedimentation, and change in the woody species strata as dead and dying trees are replaced by saplings. There has also been an increase in weedy species that may be competing with the *Stylophorum* plants.

The Ilderton population is at the edge of an active sugar bush and adjacent to a municipal drain. Some activities in the sugar bush, such as logging or creating access roads could damage the population. Several outlying plants have established on the spoil from the drain. Future management of the drain would likely affect these individuals.

Development

The London population is now within the City of London, and it will only be a matter of time before the adjacent lands are converted for residential development. Although *Stylophorum diphyllum* and its habitat are protected under the Ontario *Endangered Species Act* (ESA) and the Provincial Policy Statement (PPS), some plants are growing very close to the edge of the woodland. Adjacent development is certain to have some effects on the site, through increased levels of trampling, increase in invasive species and other disturbances. Due to the very steep slopes at the site, any human traffic poses a threat. Traversing, climbing or descending the slopes is very difficult, and damage to the substrate and to plants growing on the slope is almost inevitable.

Invasive species

Alliaria petiolata is abundant at Fanshawe, and may compete directly with *Stylophorum* plants, especially seedlings. Rosettes close to established plants have been removed each spring as part of recovery activities. Disturbance from pulling garlic mustard here may have created germination sites for *Stylophorum* seedlings. The number of garlic mustard plants appears to have decreased in 2006. At the London and Ilderton populations, garlic mustard is increasing.

Japanese knotweed (*Polygonum cuspidatum*) is present at the London site and has been treated to control its spread, but it is not yet eradicated. Herb Robert (*Geranium robertianum*) is also of concern at this site because large numbers of seedlings have been noted under and around mature *Stylophorum* plants, and could be in competition with *Stylophorum* seedlings.

Seed predation

Seed predation has been observed, both through browsing of capsules by white-tailed deer and woodchucks, and of fallen seeds by mice. Browsing appears to be limited and is not likely to be a significant limiting factor at the London or Ilderton populations. Conversely, seed predation by mice at Fanshawe, where the population is quite small, may be a significant limiting factor affecting recruitment (Bowles, 2000).

Trespass and recreation

The London population is in an area where there is a high level of off-road bicycle traffic. Unauthorized trails are created from time to time and some of these are close to the *Stylophorum* stand.

At Fanshawe a trail close to the population was relocated in 1998 and the threat from trampling has diminished.

Genetic contamination

Stylophorum diphyllum is an attractive plant and is sold in garden stores in southern Ontario. The origin of this commercial stock is unknown, but is most certainly not Canadian. Knowing the plant is native, some well-meaning enthusiasts have introduced the plants into ravines and other natural areas. Records are not usually kept of these endeavours. Preliminary results from genetic analysis (Galbraith, 2005, pers. comm.) show that Canadian populations may be genetically distinct from American populations. Not only could Canadian plants be genetically contaminated by American stock, but there is a real possibility that recovery, rather than introduction, may be hard to track because native and non-native populations may be indistinguishable in appearance.

Other natural or human-made factors

Because of the striking appearance of *Stylophorum diphyllum*, especially in flower, there are potential threats from wildflower gardening enthusiasts, either transplanting individual plants or collecting seeds, and from photographers or naturalists trampling the populations.

SPECIAL SIGNIFICANCE OF THE SPECIES

The conspicuous, fleshy, oily, carunculate aril or elaiosome that forms a fringe on seeds of *Stylophorum diphyllum* appears to be attractive to ants (Gates, 1943; Nordhagen, 1959, Bowles, personal observation). The elaiosome of *Stylophorum diphyllum* was tested for total lipid content and found to be very rich in total lipids with the following make-up of fatty acids: palmitic acid 48%, oleic acid 41.9%, linoleic acid 5.2%, palioleic acid 1.9% and stearic acid 1.7% (Draper, pers. comm. 1997). Field experiments have shown that *Stylophorum* seeds are taken by ants, but are also predated by mice. Snails or slugs also sometimes remove the elaiosome (Bowles, unpublished data).

In general, members of the Papaveraceae are rich in alkaloids, some of which are important narcotics with both medicinal and poisonous properties (Ernst, 1962). The acrid sap which usually darkens on drying is an important characteristic of the family. According to Gunn and Seldin (1976) the root stocks and saffron-coloured juice of *Stylophorum diphyllum* have no recorded uses. Moerman (1998) does not list any native American ethnobotanical uses of *Stylophorum*.

The showy flowers of *Stylophorum* have attracted some attention as an ornamental plant. Once established, the plant does well in cultivation in shaded flower gardens, abundantly self-seeding to produce large stands. It was introduced to Europe as an ornamental in 1854 (Boynton, 1918) and is available in nurseries in southern Ontario.

Stylophorum diphyllum in Canada forms disjunct populations at the northern limit of its range. A number of other species found in southern Ontario have a similar distribution. Populations at the edge of a species range that are genetically distinct are important to the diversity of the species.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Stylophorum diphyllum is currently listed as a regulated Endangered Species in Ontario, and Endangered in Canada (COSEWIC, 2000). It is protected under the Ontario *Endangered Species Act* and is listed on Schedule 1 of the federal *Species at Risk Act*. It is also the subject of a recovery strategy (Bowles, 2007). The initial recovery team was established in 1997. Over the course of the following seven years, a number of actions have resulted in a better understanding of the species in Canada and in mitigating risks to the species: new surveys have discovered one new population; two *ex situ* populations were established; further information on the biology of the species has been compiled; seed predation has been clarified through *in situ* experiments; invasive garlic mustard rosettes were removed from the immediate vicinity of wood-poppy plants at the Fanshawe population; critical habitat has been identified.

The conservation status of *Stylophorum diphyllum* in jurisdictions of the United States is given in Table 1:

| Status | Jurisdiction | Source |
|----------------------------|--|----------------------|
| S1 Critically imperilled | Alabama | (Alabama NHP, 2006) |
| | Georgia | (Georgia DNR, 2006) |
| S2 Imperilled | Virginia | (Virginia DCR, 2006) |
| S3 rare | Arkansas | (Arkansas NHC, 2006) |
| S4 Apparently secure | West Virginia | (NatureServe, 2006) |
| S5 Secure | Kentucky | (NatureServe, 2006) |
| Exotic | Delaware, Maryland | (NatureServe, 2006) |
| Not ranked or under review | Illinois, Indiana, Ohio, Michigan, Missouri, Tennessee, Wisconsin | (NatureServe, 2006) |

TECHNICAL SUMMARY

Stylophorum diphyllum

Wood-poppy

Stylophore à deux feuilles

Range of Occurrence in Canada: southern Ontario

Extent and Area Information

| | |
|---|--|
| • <i>Extent of occurrence (EO)(km²)</i> | 150 km ² |
| • <i>Specify trend in EO</i> | stable |
| • <i>Are there extreme fluctuations in EO?</i> | no |
| • <i>Area of occupancy (AO)</i> [Actual area occupied by the three populations is <1 ha] | 3 km ² based on a 1x1 km grid overlay and 12 km ² based on a 2x2 km grid |
| • <i>Specify trend in AO</i> | decline |
| • <i>Are there extreme fluctuations in AO?</i> | no |
| • <i>Number of known or inferred current locations</i> | 3 |
| • <i>Specify trend in #</i> | stable |
| • <i>Are there extreme fluctuations in number of locations?</i> | no |
| • <i>Specify trend in area, extent or quality of habitat</i> | decline |

Population Information

| | |
|--|--|
| • <i>Generation time (average age of parents in the population)</i> | 5 years |
| • <i>Number of mature individuals</i> | ~ 530 |
| • <i>Total population trend:</i> | Major decrease followed by stable or slight increase |
| • <i>% decline over the last/next 10 years or 3 generations.</i> | ~35% |
| • <i>Are there extreme fluctuations in number of mature individuals?</i> | no |
| • <i>Is the total population severely fragmented?</i> | yes |
| • <i>Specify trend in number of populations</i> | stable |
| • <i>Are there extreme fluctuations in number of populations?</i> | no |
| • <i>List populations with number of mature individuals in each:</i> | London: ~250 Fanshawe: 24 Ilderton: 255 |

Threats (actual or imminent threats to populations or habitats)

| |
|---|
| 1. Habitat destruction and modification |
| 2. Development |
| 3. Invasive species |
| 4. Seed predation |
| 5. Trespass and recreation |
| 6. Genetic contamination |
| 7. Trampling |
| 8. Collection |

Rescue Effect (immigration from an outside source)

| | |
|--|--------------------------|
| • <i>Status of outside population(s)?</i> USA: [other jurisdictions or agencies] | See Table 1 |
| • <i>Is immigration known or possible?</i> | not known, very unlikely |
| • <i>Would immigrants be adapted to survive in Canada?</i> | yes |

| | |
|--|-----|
| • <i>Is there sufficient habitat for immigrants in Canada?</i> | yes |
| • <i>Is rescue from outside populations likely?</i> | no |

Quantitative Analysis

| |
|-----|
| n/a |
|-----|

Current Status

| |
|---|
| COSEWIC: Endangered (2000, 2007) MNR: Endangered |
|---|

Status and Reasons for Designation

| | |
|---|---|
| Status: Endangered | Alpha-numeric code: Endangered B1ab(iii)+2ab(iii) |
| Reasons for Designation: A showy perennial herb of Carolinian woodlands restricted to 3 small and highly fragmented populations occupying very limited areas. The habitat is declining in quality due to the presence of invasive plants and habitat disruption due to recreational activities that increase the risk of trampling. Further potential habitat disruption may occur with the expansion of housing development and other commercial activities adjacent to two of the sites. The species is widely available from nurseries but garden-grown plants cultivated in Canada likely originate from U.S. stocks. Cultivated plants are not included in the COSEWIC assessment. | |

Applicability of Criteria

| |
|--|
| Criterion A (Declining Total Population): Threatened A2ace A 35% decline in populations in under 3 generations and continuing decline in habitat quality with ongoing threats from invasive exotic plants and other factors. |
| Criterion B (Small Distribution, and Decline or Fluctuation): Endangered B1ab(iii)+2ab(iii) EO and AO below limits for endangered and only 3 severely fragmented locations with continuing decline in quality of the habitat. |
| Criterion C (Small Total Population Size and Decline): Threatened C2a(i) No population with >1000 mature individuals but nearly meeting endangered with only 1 population barely exceeding 250 mature individuals. |
| Criterion D (Very Small Population or Restricted Distribution): Threatened D1+2 <1000 mature individuals and only 3 populations with an AO <20 km ² . |
| Criterion E (Quantitative Analysis): None available. |

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The following people have knowledge of extant and historic populations of *Stylophorum diphyllum* and have assisted with the studies on wood-poppy or searches for additional populations.

- Michael J. Oldham, Botanist, Natural Heritage Information Centre, Peterborough, Ontario, original status report author, knowledgeable about the flora of Middlesex County.
- David Galbraith, Conservation and Research, Royal Botanical Gardens, Hamilton, Ontario, genetic studies on *Stylophorum diphyllum*, established *ex situ* population at Royal Botanical Gardens.
- David Stephenson, Consultant, Natural Resources Solutions, Guelph, Ontario, discovered London population of *Stylophorum diphyllum* in 1987, conducted life science inventory of *Stylophorum* site in 1987.
- Marjory Dufton, Naturalist, London, Ontario discovered and photographed Fanshawe population of *Stylophorum diphyllum* in the early 1970s.
- James B. Phipps, Professor Emeritus, Department of Biology, University of Western Ontario, London, Ontario discovered Ilderton population of *Stylophorum diphyllum* in 1972.
- Brenda Gallagher, Technician, Upper Thames Conservation Authority, London, Ontario knowledgeable about the London and Ilderton populations.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

J. Bowles

Jane M. Bowles received her PhD from the University of Western Ontario in 1980. She has over 25 years of experience as freelance ecologist in southern Ontario, doing life science inventories, pursuing research in conservation ecology and working with species at risk. She has been conducting research studies and recovery activities on *Stylophorum diphyllum* since 1997 and is author of the Recovery Strategy. She has been a member of the Vascular Plant Specialist Sub-Committee of COSEWIC since 2002 and a member of COSSARO since 2006. She also sits on the Recovery Teams for wood-poppy, Lake Huron Dune Grasslands/Pitcher's thistle, Tallgrass, Carolinian Woodlands and Walpole Island First Nation. She is an Adjunct Professor at the University of Western Ontario where she has also been Curator of the Herbarium and Director of the Sherwood Fox Arboretum since 1995.

S. Brinker

Samuel R. Brinker received a Bachelor of Environmental Studies (BES) from the University of Waterloo. He has over 8 years of experience researching species at risk and evaluating natural areas. Sam began field surveys as an inventory biologist conducting a Natural Areas Inventory in the City of Hamilton. Since then he has held a number of positions for Ontario Parks and the Ontario Ministry of Natural Resources as a park naturalist, and more recently as a species at risk biologist. Sam is currently a consulting ecologist, where he conducts species at risk assessments for a range of vascular plant and reptile species, as well as wetland and life science inventories in parks and protected areas. He also sits on the Recovery Team for branched bartonia (*Bartonia paniculata* ssp. *paniculata*), and has been involved in the development of the eastern prickly-pear cactus – Lake Erie Sand Spit Savanna Ecosystem Recovery Strategy.

COLLECTIONS EXAMINED

No herbarium collections were examined for this update report.