

Recovery Strategy for the Goldenseal (*Hydrastis canadensis*) in Canada

Goldenseal



2020



Government
of Canada

Gouvernement
du Canada

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the [Species at Risk \(SAR\) Public Registry](#)¹.

Cover illustration: Goldenseal in flower. © Adrienne Sinclair

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¹ www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

RECOVERY STRATEGY FOR THE GOLDENSEAL (*Hydrastis canadensis*) IN CANADA

2020

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of Ontario has given permission to the Government of Canada to adopt the *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario* (Part 2) and the *Goldenseal – Government Response Statement* (Part 3) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Goldenseal in Canada consists of three parts:

Part 1 – Federal Addition to the *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario*, prepared by D.W. Jolly for the Ontario Ministry of Natural Resources and Forestry.

Part 3 – *Goldenseal – Ontario Government Response Statement*, prepared by the Ontario Ministry of Natural Resources and Forestry.

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Part 2 – *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario*, prepared by D.W. Jolly for the Ontario Ministry of Natural Resources and Forestry.

Part 3 – *Goldenseal – Ontario Government Response Statement*, prepared by the Ontario Ministry of Natural Resources and Forestry

Part 1 – Federal Addition to the *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario*, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#)² agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Goldenseal and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Province of Ontario, as per section 39(1) of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Ontario Ministry of Natural Resources and Forestry led the development of the attached recovery strategy for the Goldenseal (Part 2) in cooperation with Environment and Climate Change Canada (ECCC). The Province of Ontario also led the development of the attached Government Response Statement (Part 3), which is the Ontario Government's policy response to its provincial recovery strategy and summarizes the prioritized actions that the Ontario government intends to take and support.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by ECCC, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Goldenseal and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by ECCC and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

² www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area³ be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

³ These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgements

The Federal Addition to the *Recovery Strategy for the Goldenseal* (*Hydrastis canadensis*) in Ontario (Part 1) was prepared by Karolyne Pickett and Angela Darwin (ECCC, Canadian Wildlife Service – Ontario). Initial drafts were prepared by Holly Bickerton, Consulting Ecologist, Ottawa and Lee Voisin (ECCC, Canadian Wildlife Service – Ontario). Many thanks to the landowners in southwestern Ontario who permitted property access, resulting in updated information on Goldenseal in Canada. Staff at the Ausable – Bayfield Conservation Authority, the Essex Region Conservation Authority, and Ontario Parks provided information and/or assisted with fieldwork. The Federal Addition benefited from input, review, and suggestions from the following individuals and organizations: Krista Holmes, Judith Girard, Burke Korol, Kim Borg, Ken Corcoran, and Elizabeth Rezek (ECCC); Michael Oldham, Martina Furrer, Jay Fitzsimmons, Leanne Jennings, Fiona McGuinness, and Glenn Desy (Ontario Ministry of Natural Resources and Forestry).

Acknowledgement and thanks is given to all other parties that provided advice and input used to help inform the development of this recovery strategy, including Indigenous organizations and individuals who provided input and participated in consultation meetings.

Additions and Modifications to the Adopted Document

The following sections have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario* (Part 2 of this document, referred to henceforth as “the provincial recovery strategy”) and/or to provide updated or additional information.

ECCC is adopting the Ontario recovery strategy (Part 2) with the exception of section 2.0, Recovery. Part 1, section 4 provides updated information on the threats to Goldenseal identified in Part 2 section 1.5. Table 1 under Part 1, section 5 replaces the information presented in Table 1 of Part 2. In place of Part 2 section 2.0, ECCC has established a population and distribution objective and performance indicators, and is adopting the Government of Ontario’s government-led and government-supported actions of the *Goldenseal – Ontario Government Response Statement* (Part 3) as the broad strategies and general approaches to meet the population and distribution objective.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery strategy referring to protection of the species’ habitat may not directly correspond to federal requirements with respect to critical habitat. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

1. Recovery Feasibility Summary

Based on the following four criteria that ECCC uses to establish recovery feasibility, the recovery of Goldenseal has been deemed technically and biologically feasible.

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. During field surveys of nine populations conducted in 2014-15 in southern Ontario, Bickerton and Sinclair (2016) and Jolly (2016b) counted a total of 73,794 Goldenseal stems occurring in the wild. Mature plants capable of reproduction, as evidenced by the presence of flowers and/or fruiting stems, were present at all sites. When taking into account the differing counting methodologies employed in the two studies, and the fact that each individual plant may consist of one to eight stems (Jolly 2016a), the number of individuals of Goldenseal in Canada is estimated to be at least 32,500. This number represents a minimum total abundance for individuals of the species given that not all extant and historical populations (see Table 1) were surveyed during the above studies.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. Generally speaking, Goldenseal occurs in upland and lowland deciduous woodlands and forests in southern Ontario, and despite the loss of more than 90% of these habitats since European settlement (Larson et al. 1999), the Sugar Maple dominated deciduous forests in which the species most often occurs are nevertheless ranked S5 (Secure)⁴ in Ontario (NHIC 2013). The rarity of Goldenseal is atypical for a species with such a broad overall distribution (McGraw et al. 2003, Sanders 2004). If Goldenseal has specific environmental requirements, they have not been uncovered thus far (McGraw et al. 2003). Alternatively, the absence of the species in apparently suitable habitat (Sinclair and Catling 2000a) could be due to past harvesting of the species, or limited seed dispersal in the now highly fragmented landscape of southern Ontario. Based on the best available information at this time, habitat is not considered to be a limiting factor for the species.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. The primary threats to the species include logging, harvesting of wild Goldenseal, and trampling (see Part 1, section 4; Part 2, section 1.5). Threats from logging can be avoided or mitigated through the development of forest management plans for properties where landowners wish to harvest some trees. A survey of 21 locations where Goldenseal occurred found that the canopy cover was 65% on average (Sinclair and Catling 2001). Consistent with this finding, the majority of Goldenseal-occupied habitats surveyed by Bickerton and Sinclair (2016) and Jolly (2016b) were categorized as forest, which is defined as greater than 60% canopy cover (Lee et al. 1998). These findings suggest that the average Goldenseal population can persist in habitats with at least 65% canopy cover, and would allow for some tree harvesting as long as the percentage canopy cover of woodlots is maintained at 65% or more, and that best forest management practices are implemented. The complete removal of trees for the purposes of development or agriculture can be avoided or mitigated through the use of provincial and municipal planning policy and legislative tools, land stewardship activities, and land acquisition/ conservation agreements. Harvesting of wild Goldenseal can be mitigated through enforcement of the legislated prohibitions on this activity afforded under SARA and the ESA. Trampling can be mitigated through general public awareness initiatives to inform hikers and ATV users of the importance of remaining on trails to preserve natural habitat. Threats to recently surveyed populations were reported as potentially very minor (presence of a small number of individuals of introduced plant species, some light trampling in some areas) to non-existent (Bickerton and Sinclair 2016; Jolly 2016b).

⁴ Definitions of Subnational (S) ranks are provided in Appendix A.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Yes. Based on the best available information, the development of new recovery techniques is not needed to achieve the population and distribution objectives. The approaches to recovery consist of continued surveying and monitoring of populations, threat mitigation including habitat protection and management, and further research on the biology of the species, particularly the identification of its pollinating and dispersal agents (see Part 1, section 6 and Part 2, section 2). If, at a future date, increases in the number of populations, species distribution, and/or the size of one or more populations through active human intervention are identified as necessary in order to meet the objectives, information on propagation techniques and cultivation practices for Goldenseal exists (Davis and McCoy 2000; Sinclair and Catling 2001; Bedir et al. 2003; Van der Voort et al. 2003; Sanders and McGraw 2005).

2. COSEWIC* Species Assessment Information**

Date of Assessment: May 2000

Common Name (population): Goldenseal

Scientific Name: *Hydrastis canadensis*

COSEWIC Status: Threatened

Reason for Designation: A highly prized medicinal plant with a very few small populations remaining.

Canadian Occurrence: Ontario

COSEWIC Status History: Designated Threatened in April 1991. Status re-examined and confirmed Threatened in May 2000.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

** In May 2000, COSEWIC re-examined and confirmed the species' status as "Threatened". The proposed recovery strategy was posted in 2018. Prior to finalization of the recovery strategy, the species status was re-examined by COSEWIC in May 2019 and designated "Special Concern". However, it is important to note that the legal status of the species under SARA remains "Threatened" until a decision is taken by the Governor in Council to change the legal status of the species.

3. Species Status Information

Goldenseal is a perennial woodland herb that occurs in the eastern United States and in southwestern Ontario, Canada. The global conservation status rank for the Goldenseal, last reviewed on November 30, 2012, is Vulnerable-Apparently Secure (G3G4)

(NatureServe 2015). A numeric range rank is used to indicate uncertainty about the exact status of the taxon (Master et al. 2012), in this case, whether Goldenseal is, on a global scale, Vulnerable (G3) or Apparently Secure (G4). In Canada, the species is ranked Imperiled at both the national and subnational levels (N2 in Canada, S2 in Ontario) (NatureServe 2015). Definitions of National (N) and Subnational (S) ranks, as well as the national and subnational ranks of Goldenseal in the United States, are provided in Appendix A.

Goldenseal is listed as Threatened⁵ on Schedule 1 of the federal *Species at Risk Act, 2002* (SARA). In May 2019, COSEWIC designated the Goldenseal as Special Concern. As a result of this reassessment and change in risk category, the species will be eligible for an amendment of its status under Schedule 1 of SARA. In Ontario, the species is also listed as Threatened⁶ under the provincial *Endangered Species Act, 2007* (ESA) which protects both the plant and its habitat.

4. Threats

This section provides updated information on the threats to Goldenseal identified in section 1.5 of the *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario* (Part 2).

The provincial recovery strategy identifies the following processes as threats to Goldenseal: alteration to natural disturbance regime, deforestation, habitat destruction or fragmentation, changes in hydrology and drainage, harvesting, colonization by invasive species, and trampling of plants. A review of the published scientific literature in addition to field observations reported since the publication of the provincial recovery strategy (Bickerton and Sinclair 2016; Jolly 2016b) suggest that alteration to natural disturbance regime, changes in hydrology and drainage, as well as invasive species may not be threats to the species, or at least not to the extent that it has been previously suggested.

The suggestion that a decrease in the frequency of fire and flooding following European settlement may be a threat to Goldenseal is primarily based on an experimental simulation of disturbance (Sinclair and Catling 2004), and on the observation that plants were more frequently found near paths and woodlot edges (Sinclair and Catling 2000b). However, these studies do not directly address the types of disturbance hypothesized to impact Goldenseal, or other potential factors, such as reduced competition from other plants and an increase in light availability. Goldenseal occurs in hardwood woodlands and forests of southern Ontario which are considered to be relatively stable habitat, rather than disturbance-dependent habitats (such as fire-dependent prairie, for example), even though they are subject to seasonal changes and regular small-scale

⁵ Under SARA, a threatened species means a wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.

⁶ Under the ESA, a species shall be classified as a threatened species if it lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening to lead to its extinction or extirpation.

disturbance events in the form of tree-fall openings. Similarly, Bickerton and Sinclair (2016) report that changes in hydrology and drainage do not appear to be significantly impacting the surveyed populations. Both Bickerton and Sinclair (2016) and Jolly (2016b) report that although non-native plant species are present at several sites, there is no evidence that these species are impacting the surveyed Goldenseal populations. However, the impact on Goldenseal of several drainage ditches recently dug in the vicinity of two other populations has not been investigated, and invasive *Phragmites* (European Common Reed) is spreading in the sloughs and swales surrounding the woodlots where these two populations occur. In addition, the impact of a more open canopy as a result of ash trees dying from Emerald Ash Borer damage at these locations (and potentially others, including pre-emptive removal) is unknown at this time.

In light of the above, studies are needed to determine the relative importance of these potential threats to the recovery of Goldenseal. Such research is included as an approach to recovery under section 2.3 of the provincial recovery strategy. In the meantime, threat management approaches should prioritize the mitigation of impacts from deforestation, habitat destruction and fragmentation, harvesting, and trampling of plants.

5. Species Population and Distribution

A list of the populations occurring in Canada is shown in Table 1. This table replaces the information presented in Table 1 of the provincial recovery strategy. The updated information on the number of populations and the distribution of Goldenseal in Canada since the publication of the provincial recovery strategy is based on the occurrence records of the species in Ontario provided to ECCC in April 2016 by the Ontario Natural Heritage Information Centre (NHIC). As the centralized repository of data on species of conservation concern in Ontario, the NHIC holds the most comprehensive set of records for Goldenseal in the province. These records include some data that were not available at the time of publication of the provincial recovery strategy.

Thirty-one populations of Goldenseal have been recorded in Canada, all located within the province of Ontario: 24 extant, six historical and one extirpated. Because harvesting of wild Goldenseal is a threat to the species, the locations of the populations are not provided beyond the county name in Table 1. The number of Goldenseal populations was revised according to NatureServe's habitat-based strategy for delimiting plant element occurrences (NatureServe 2004), and the population ranks were revised according to NatureServe guidelines (Tomaino et al. 2008). Details of this review and resulting changes are provided in Appendix B.

Table 1. Populations of Goldenseal in Canada based on data from the Ontario Natural Heritage Information Centre (NHIC 2016)

Population location (County/Region, Province of Ontario)	Population identifier (Element Occurrence ^a number)	Population name in the provincial recovery strategy	Last observed/ Last searched (if more recent)	Status (Extant, Historical ^b , or Extirpated)
Brant	EO94889	Site A	2014	Extant
Chatham-Kent	EO11336	Site B	1986	Extant
Chatham-Kent	EO2520	Site C	2015	Extant
Chatham-Kent	EO67097	Site D	2010	Extant
Essex	EO11337	Not included	1948	Historical
Essex	EO11338	Site E	2015	Extant
Essex	EO2519	Site F	2015	Extant
Grey	Not tracked ^c	Site Q	1976	Historical
Halton	EO115688	Not included	1996	Extant
Halton	EO115689	Not included	2003	Extant
Halton	EO115690	Not included	1996	Extant
Halton	EO115691	Not included	1996	Extant
Halton	EO115693	Not included	1996	Extant
Huron	EO23277	Not included	1975/1998	Historical
Huron	EO11344	Not included	1889	Historical
Huron	EO11345	Not included	1942/1998	Historical
Huron	EO11346	Site H	2015	Extant
Lambton	EO11339	Site J	1958	Historical
Lambton	EO11340	Site K	2015	Extant
Lambton	EO11341	Sites M & O	2015	Extant
Lambton	EO11342	Site I	2008	Extant
Lambton	EO11343	Site L	2015	Extant
Lambton	EO11334	Not included	1989	Extant
Lambton	EO5514	Site G ^d	1998	Extant
Lambton	EO5516	Site G	1998	Extant
Lambton	Not tracked ^e	Site T	1994	Extant
Middlesex	EO115695	Not included	2010	Extant
Middlesex	EO94890	Site N	2007	Extant
Niagara	EO115697	Not included	2004	Extant

Population location (County/Region, Province of Ontario)	Population identifier (Element Occurrence ^a number)	Population name in the provincial recovery strategy	Last observed/ Last searched (if more recent)	Status (Extant, Historical ^b , or Extirpated ^f)
Niagara	EO92213	Site S	Pre-1943/ 2007	Extirpated ^f
Wellington	EO115696	Site P	2015	Extant

^a An Element Occurrence (EO) is “an area of land and/or water in which a species or natural community is, or was, present.” When the Element is a species, an EO generally corresponds to a population or metapopulation (NatureServe 2002). In this document, a Goldenseal EO corresponds to a population.

^b Historical: Recent field information verifying the continued existence of the occurrence is lacking (Hammerson et al. 2008). See Appendix B for details on the ranking of Goldenseal populations as Historical.

^c This is a naturalized population originating from planted individuals taken from a location in southern Ontario (Owen Sound Field Naturalists 2001).

^d The provincial recovery strategy indicates that Site G comprises seven populations, however upon re-examination the number of populations occurring in Site G has been revised to two (EO5514 and EO5516). See Appendix B for details on separation distances between populations.

^e This population is not part of the provincial record. It is documented in Thompson 1994, an unpublished report to government.

^f Extirpated: Adequate surveys by one or more experienced observers at times and under conditions appropriate for the species at the occurrence location, or other persuasive evidence, indicate that the species no longer exists there or that the habitat or environment of the occurrence has been destroyed to such an extent that it can no longer support the species (Hammerson et al. 2008). In this case, suitable habitat appears to remain however surveys conducted in 1980, 1993, 1995, 2004, and 2007 yielded negative search results.

6. Population and Distribution Objectives

Under subsection 41 (1) of SARA, a recovery strategy must include a statement of the population and distribution objectives that will assist the recovery and survival of the species.

ECCC’s population and distribution objectives for Goldenseal in Canada are to:

- Maintain the current distribution of Goldenseal in Canada by maintaining the 24 extant populations and any other extant population found in the future;
- Maintain, and if biologically and technically feasible, support a natural increase in abundance of Goldenseal within extant populations.

Based on the provincial record only one population has been confirmed extirpated in recent times, and that loss has not resulted in a substantial reduction in the distribution of Goldenseal in Canada. Furthermore, the description of encounters of the species in the location of the extirpated population as “... very rare, only infrequently being found” (Hamilton 1943) suggests that the extirpated population’s contribution to the species

abundance in Canada was likely relatively small. Therefore the first objective will act to, at a minimum, maintain the current Canadian distribution.

The Grey County population is a result of the naturalization of planted individuals originating from a location in southern Ontario (Owen Sound Field Naturalists 2001). Although the population occurs well north of its historical distribution, it naturally spread into the surrounding woodland (Sinclair and Catling 2000a). In the context of climate change, this peripheral population of Goldenseal, on the poleward edge of the species' range, may be of high conservation importance in future due to its adaptive and dispersal potential if it is confirmed extant (Gibson et al. 2009).

The second objective aims to maintain, and where possible support a natural increase in, the total abundance of Goldenseal in Canada. While recent field work provides an abundance estimate for nine Goldenseal populations (Bickerton and Sinclair 2016, Jolly 2016b), a current estimate of total abundance in Canada is not available. Estimating Goldenseal abundance is not straightforward because Goldenseal is a clonal species (Sanders 2004), meaning that an underground stem (called a rhizome) can produce from one to eight stems (called ramets) (Jolly 2016a). Therefore, the total number of ramets in a population does not represent the total number of individuals in that population. Since Goldenseal "patches" can include over 1000 ramets (Sanders 2004), counting them in order to determine the number of individuals in a population is labour intensive and prone to error. Furthermore, because survey methodologies have varied across studies (e.g. counting the total number of stems, counting only the tallest ramets as a surrogate for counting individuals, or counting individuals based on professional judgement), a reliable measure of abundance of the species in Canada is difficult to estimate at this time. However, the species' formation of dense, continuous patches lends well to estimating the area of occupancy⁷ (AO) of populations, and this method of measuring abundance should be considered when developing a standardized survey methodology (see Part 2, Table 3, Approach 1.1).

This federal population and distribution objective is consistent with the province of Ontario's Government Response Statement developed under the provincial *Endangered Species Act*, which outlines the provincial government's goal for the recovery of the species and summarizes the prioritized actions the government intends to take and support (see Part 3 for more information). The government of Ontario's goal for the recovery of Goldenseal is to maintain self-sustaining populations of Goldenseal throughout its current distribution in Ontario, and to support natural increases in its abundance through effective threat mitigation.

⁷ Area of occupancy (AO) is the area within 'extent of occurrence' that is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that the extent of occurrence may contain unsuitable or unoccupied habitats (COSEWIC 2015). For the purposes of this recovery strategy, the AO is a surrogate measure for species abundance, given that counting the number of Goldenseal stems does not provide a count of the number of individuals of the species

7. Broad Strategies and General Approaches to Meet Objectives

The government-led and government-supported actions tables from *Goldenseal – Ontario Government Response Statement* (Part 3) are adopted as the broad strategies and general approaches to meet the population and distribution objective. ECCC is not adopting the approaches identified in section 2 of the *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario* (Part 2).

8. Critical Habitat

8.1 Identification of the Species' Critical Habitat

Section 41(1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. Under section 2(1) of SARA, critical habitat is "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

Identification of critical habitat is not a component of provincial recovery strategies under the Province of Ontario's ESA. Under the ESA, when a species becomes listed as endangered or threatened on the Species at Risk in Ontario List, it automatically receives general habitat protection. Goldenseal currently receives general habitat protection under the ESA. In some cases, a habitat regulation may be developed that replaces the general habitat protection. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species by the Province of Ontario. A habitat regulation has not been developed for Goldenseal under the ESA; however, the provincial recovery strategy (Part 2) contains a recommendation on the area for consideration in developing a habitat regulation.

Critical habitat for Goldenseal in Canada is identified in this federal recovery strategy for 14 of 24 known extant populations (Figure 1, Table 2). Critical habitat is not identified for the remaining extant populations as either information (species and/or habitat) are known to exist but not currently available to ECCC or available information is insufficient to identify the occupied habitat areas. For these reasons, the critical habitat identified is considered insufficient to achieve the population and distribution objectives. A Schedule of Studies (section 8.2, Table 3) outlines the activities required for identification of additional critical habitat. Additional critical habitat may be added in the future, if new information supports the inclusion of areas beyond those currently identified (e.g., new or re-discovered populations). For more information on critical habitat identification, contact ECCC – Canadian Wildlife Service at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

In Canada, the presence and persistence of Goldenseal in a given location depends on an area greater than that occupied by individual plants. It requires the ecological or landscape features that promote and maintain suitable habitat⁸ for the plants and allow for natural processes related to population dynamics and reproduction (e.g., pollination and dispersal) to occur. The geographic locations of areas containing critical habitat for Goldenseal are identified to the extent possible⁹ and critical habitat exists within these areas where the necessary biophysical attributes (defined below) are found. Additionally, a critical function zone distance¹⁰ of 50 m is identified as critical habitat when the biophysical attributes around an individual plant or patch of plants extend for less than 50 m. Maintained roadways or built-up features such as buildings do not possess the biophysical attributes of suitable habitat or assist in the maintenance of natural processes and are therefore not considered critical habitat.

Biophysical attributes of critical habitat

In Canada, Goldenseal occurs in southern Ontario's deciduous woodlands and forests located in upland, lowland, and areas associated with stream and river banks and floodplains (Sinclair and Catling 2000b). Suitable habitat is typically characterized by the biophysical attributes described below (Sinclair and Catling 2000b; Sinclair and Catling 2001; Bickerton and Sinclair 2016):

In woodland habitats:

- Tree canopy cover ranging from 30% to 60%, of which 75% or more consists of deciduous tree species;
- The dominant tree species are usually Bitternut Hickory (*Carya cordiformis*), Black Walnut (*Juglans nigra*), Hackberry (*Celtis occidentalis*) or White Elm (*Ulmus americana*);
- Other overstory species include White Oak (*Quercus alba*), Red Oak (*Quercus rubra*) and Sugar Maple (*Acer saccharum*);
- Topography is often floodplain;
- Moisture regime is usually moist or very moist.

In forest habitats:

- Tree canopy cover is 65% or greater, of which 75% or more consists of

⁸ Suitable habitat is composed of the biophysical attributes of an ecosystem (e.g. soil and moisture conditions, light penetration, species composition and species interactions) that provide Goldenseal individuals with the necessary conditions to carry out essential life processes.

⁹ Goldenseal occurrences known to Environment and Climate Change Canada as of September 2016.

¹⁰ Critical function zone distance is the radial length surrounding an occurrence that is required to maintain constituent microhabitat properties (e.g. light, moisture, and humidity levels) critical to the survival of an individual of the species. Although it is not clear at what exact distances physical and/or biological processes begin to negatively affect Goldenseal in Ontario, existing research provides a logical basis for suggesting a minimum critical function zone distance of 50 m for rare plant species occurrences (see: http://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6A845288-1%20-%20Toc285808423#_Toc285808423; Appendix 1). The area within the critical function zone distance may include habitat that does not contain the biophysical attributes described for the species and is not currently mapped as part of the geographic location of areas containing critical habitat.

deciduous tree species;

- The dominant tree species is most often Sugar Maple, but may also be Red Maple (*Acer rubrum*), Red Oak, Bitternut Hickory, Shagbark Hickory (*Carya ovata*), or Black Maple (*Acer nigrum*);
- Other overstory species present include Black Walnut, White Oak, White Ash (*Fraxinus americana*), Sassafras (*Sassafras albidum*), White Elm, American Beech (*Fagus grandifolia*), Basswood (*Tilia americana*) and Bur Oak (*Quercus macrocarpa*);
- Ironwood (*Ostrya virginiana*) is a common mid-story tree species;
- Topography can be upland, lowland or floodplains;
- Moisture regime is often mesic in upland habitat and dry mesic to mesic near rivers;
- Soils are usually slightly acidic sandy loam or loam in uplands, and slightly acidic to slightly basic clay or sandy loam in lowlands.

Suitable habitat can be described using the Ecological Land Classification (ELC) framework for Southern Ontario (Lee et al. 1998, Lee 2008)¹¹ and based on best available information they are described by the following ELC Ecosites (ABCA 2010; Bickerton and Sinclair 2016; Jolly 2016b; NHIC 2016):

- Dry-Fresh Upland Deciduous Forest Ecosite (FODM4)
- Dry-Fresh Sugar Maple Deciduous Forest Ecosite (FODM5)
- Fresh-Moist Sugar Maple Deciduous Forest Ecosite (FODM6)
- Fresh-Moist Lowland Deciduous Forest Ecosite (FODM7)
- Fresh-Moist Oak-Maple-Hickory Deciduous Ecosite (FODM9)
- Fresh-Moist Carolinian Deciduous Forest Ecosite (FODM10)
- Fresh-Moist Deciduous Woodland Ecosite (WODM5)

Geographic location of areas containing critical habitat

The geographic location of an area containing critical habitat for Goldenseal is the entire portion of the continuous ecological or landscape feature with relatively distinct

¹¹ The ELC framework provides a standardized approach to the interpretation and delineation of dynamic ecosystem boundaries in Ontario. The ELC approach classifies habitats not only by vegetation community but also considers soil moisture conditions and topography, and as such provides a basis for describing suitable habitats that encompass the biophysical attributes for Goldenseal. In addition, ELC terminology and methods are familiar to many land managers and conservation practitioners who have adopted this tool as the standard approach for Ontario.

boundaries (i.e., ELC Community Series¹² polygon(s)) where Goldenseal individual plants or patches of plants are known to occur¹³.

Given the vulnerability of the species to illegal harvesting, the geographic locations of areas containing critical habitat are not mapped in this federal recovery strategy. They are, however, presented at a broader scale, using a 100 km x 100 km UTM grid (Figure 1). This is a standardized national grid system that highlights the general geographic area containing critical habitat, for land use planning and/or environmental assessment purposes, without disclosing sensitive location information.

¹² The ELC Community Series identifies ecological or landscape features at a scale that is normally visible and consistently recognizable on air photos (>2.5- 5 ha minimum mapping unit) and will provide the most detailed geographic locations of areas containing critical habitat without a site visit. For clarity, the ELC Community Series is a broader classification than ELC Ecosite used to describe the suitable habitats for Goldenseal thus portions of this geographic location may include areas that are not critical habitat (i.e., where the biophysical attributes are absent).

¹³ Where available occurrence records are < 25 years old for extant populations and where suitable habitat still exists and/or could be restored at the location to support the species. An occurrence record represents an occupied area at the finest-scale of data available (e.g., point data representing individual plants, polygons representing discrete patches of plants, or coordinate of survey location) and includes occurrence records with a potential location error up to 100 m uncertainty distance.

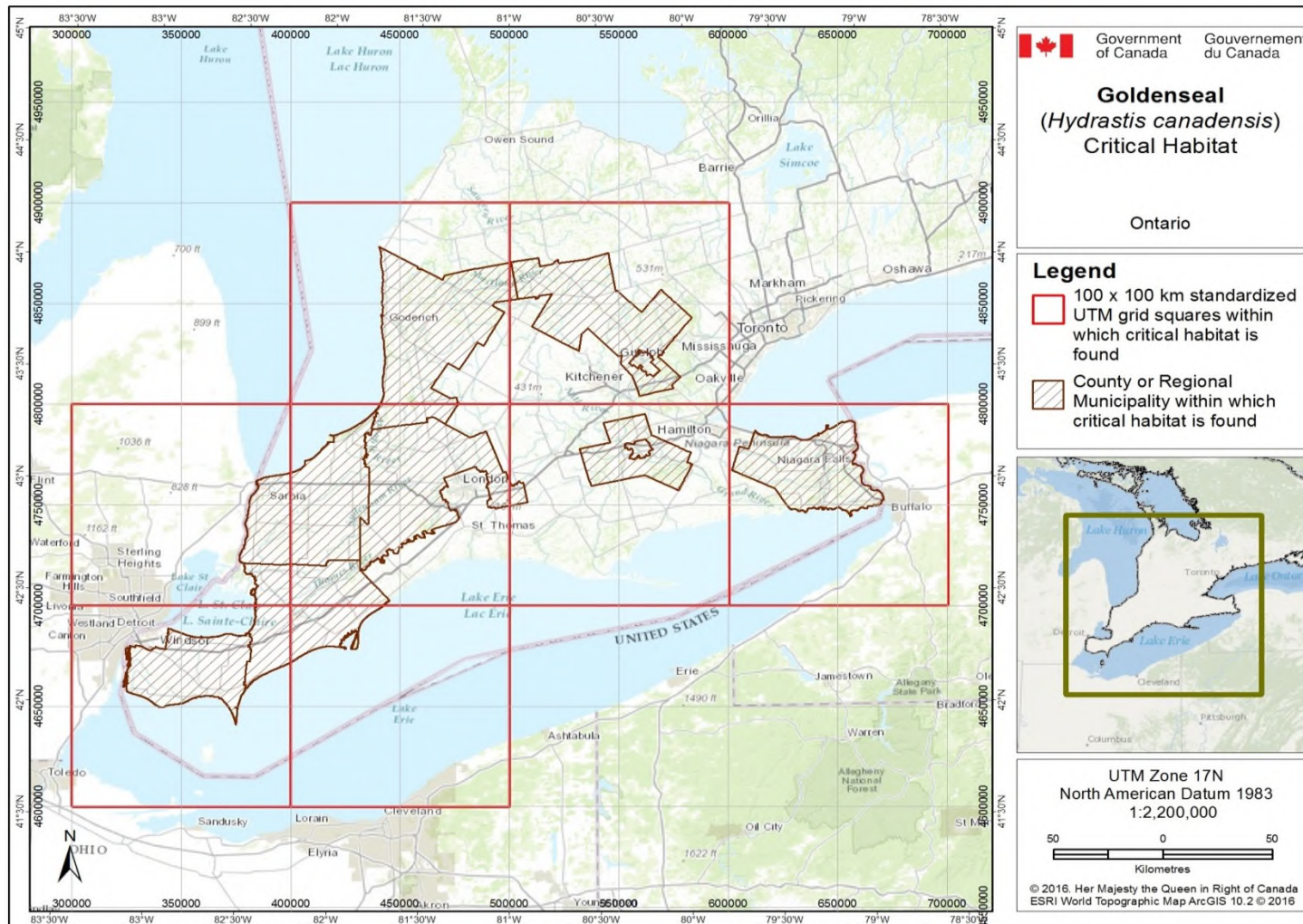


Figure 1. Grid squares that contain critical habitat for Goldenseal in Canada. Critical habitat for Goldenseal occurs within these 100 x 100 km UTM grid squares (red outlined squares), where the description of critical habitat is met. Detailed areas containing critical habitat have been removed due to the vulnerability of the species to illegal harvesting.

Table 2. Grid squares that contain critical habitat for Goldenseal in Canada.
Critical habitat for Goldenseal occurs within these 100 x 100 km UTM grid squares where the description of critical habitat is met.

Population identifier (EO number)	100 x 100 km Standardized UTM grid square ID ¹	Province/Territory	UTM Grid Coordinates ²		Land Tenure ³
			Easting	Northing	
EO2519	17TLG	Ontario	300000	4600000	Non-federal Land
EO11338					
EO11342					
EO67097	17TLH		300000	4700000	Non-federal Land
EO2520	17TMH		400000	4600000	Non-federal Land
EO11340			400000	4700000	Non-federal Land
EO11343					
EO115695					
EO11341					
EO94890					
EO11346					
EO94889	17TMJ				
EO115696	17TNH	500000	4700000	Non-federal Land	
EO115697	17TNJ	500000	4800000	Non-federal Land	
	17TPH	600000	4700000	Non-federal Land	

¹ Based on the standard UTM Military Grid Reference System (see <http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789>), where the first 2 digits and letter represent the UTM Zone, the following 2 letters indicate the 100 x 100 km standardized UTM grid containing all or a portion of the critical habitat unit. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See <http://www.bsc-eoc.org/> for more information on breeding bird atlases).

² The listed coordinates are a cartographic representation of where critical habitat can be found, presented as the southwest corner of the 100 x 100 km standardized UTM grid square containing all or a portion of the critical habitat unit. The coordinates may not fall within critical habitat and are provided as a general location only.

³ Land tenure is provided as an approximation of the types of land ownership that exist at the critical habitat units and should be used for guidance purposes only. Accurate land tenure will require cross referencing critical habitat boundaries with surveyed land parcel information.

8.2 Schedule of Studies to Identify Critical Habitat

Table 3. Schedule of Studies to Identify Critical Habitat.

Description of Activity	Rationale	Timeline
Work with applicable organizations to secure the necessary information to identify critical habitat.	Further work is required to complete the identification of critical habitat to meet the population and distribution objectives.	2020-2025
In co-operation with landowners, collect more precise/recent information on the location and habitat of extant populations where critical habitat is not currently identified.	Location and habitat information obtained so that sufficient critical habitat is identified to meet the population and distribution objective.	2020-2025
In co-operation with landowners, conduct surveys in areas where historical populations have been documented (including the Grey County population, for the reasons explained in Part 1, section 6).	Best available information indicates that forested habitat remains in the vicinity of all historical populations. The activity will verify whether historical populations persist, and if so, evaluate additional areas that may contain critical habitat.	2020-2025

8.3 Activities Likely to Result in Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if all or part of the critical habitat was degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single activity or multiple activities at one point in time or from the cumulative effects of one or more activities over time. It should be noted that not all activities that occur in or near critical habitat are likely to cause its destruction. Activities described in Table 4 are examples of those likely to cause destruction of critical habitat for the species; however, destructive activities are not necessarily limited to those listed.

Table 4. Activities Likely to Result in the Destruction of Critical Habitat

Description of Activity	Description of effect in relation to function loss	Details of effect
Construction of built structures (including houses and buildings), infrastructure (including roads, utility lines, and energy installations); establishment of aggregate pits, quarries, agricultural fields and gardens; associated removal of soils and/or vegetation cover)	Construction within critical habitat results in the direct loss of critical habitat upon which the species relies for survival, successful seed germination and seedling establishment. Construction within and adjacent to critical habitat may also affect the moisture regime of critical habitat. Direct removal of soil/substrate would render the habitat unsuitable for Goldenseal by removing the biophysical attributes required for survival of the species.	When this activity occurs within and adjacent to critical habitat, at any time of year, the effects will be direct, and is certain to result in the permanent destruction of critical habitat. There are no possible thresholds for this activity.
Logging conducted under certain tree harvesting systems such as clear-cut, diameter-limit cutting, and high-grading	Shade loss due to tree removal results in a reduction in soil moisture such that the habitat is no longer able to support Goldenseal.	When this activity occurs within critical habitat, at any time of year, the effects will be direct, and in most instances result in the long-term destruction of critical habitat. In forest habitats where current canopy cover is more than 65%, single-tree selection logging that does not result in critical habitat with less than 65% canopy cover both at the scale of the areas occupied by individuals plants and at the Ecosite scale, and that are undertaken according to best forest management practices (including appropriate time of year and vehicle/machinery use) is not likely to result in the destruction of critical habitat. Logging in woodland habitats (where current

		canopy cover is less than 65%) would likely result in destruction of critical habitat.
Off-trail motorized vehicle use (e.g. ATVs, trucks), heavy equipment use and heavy repeated foot traffic	Trampling from these activities can result in soil compaction such that germination of seeds and root growth is reduced or eliminated.	When this activity occurs within critical habitat, the effects would be direct (soil compaction) and cumulative. This activity is very likely to result in destruction of critical habitat because the species is dependent upon uncompacted forest soils for germination. The information available at this time is insufficient to develop a threshold for this activity. Activities restricted to the surface of authorized roadways/access roads and recreational trails would not result in the destruction of critical habitat.

The logging threshold is based on a survey of 21 locations that found that the canopy cover of habitats where Goldenseal occurred was 65% on average (Sinclair and Catling 2001). Consistent with this finding, surveys of nine Goldenseal populations by Bickerton and Sinclair (2016) and Jolly (2016b) found that the majority of the habitats where the species occurred were forests as defined in Lee et al. (1998) as having greater than 60% canopy cover. These findings suggest that the average Goldenseal population can persist in habitats with at least 65% canopy cover.

9. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

Every five years, success of recovery strategy implementation will be measured against the following performance indicators:

- Persistence of all extant populations, currently determined to be 24 at a minimum.
- The abundance of each extant population is maintained or increased.

10. Statement on Action Plans

One or more action plans will be completed for Goldenseal and posted on the Species at Risk Public Registry by 2025.

11. Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the [Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals](#)¹⁴. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the [Federal Sustainable Development Strategy](#)'s¹⁵ (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Protecting the woodland habitat of Goldenseal in Canada will benefit many other species and ecosystem functions of the heavily impacted Carolinian life zone. At some sites, Goldenseal grows in very close proximity to rare and at-risk species including Butternut (*Juglans cinerea*, Endangered), Eastern Flowering Dogwood (*Cornus florida*, Endangered), American Chestnut (*Castanea dentata*, Endangered), False Rue-anemone (*Enemion biternatum*, Threatened) and Green Dragon (*Arisaema dracontium*, Special Concern) (ABCA 2010; Bickerton and Sinclair 2016). Goldenseal also occurs within Conservation Areas that include species such as Big Shellbark Hickory (*Carya laciniosa*, S3), Black Cohosh (*Cimicifuga racemosa*, S2), Burning Bush (*Euonymus atropurpureus* var. *atropurpureus*, S3), Perfoliate Horse-gentian (*Triosteum perfoliatum*, S1), Common Hoptree (*Ptelea trifoliata*, S3) and Shumard Oak (*Quercus shumardii*, S3) (Lebedyk pers. comm. 2015), the latter two being listed under both SARA and the ESA as Threatened and Special Concern, respectively (see Appendix A for S rank definitions).

The creation and enhancement of open canopy conditions may not be beneficial to shade-tolerant and forest-interior species. Caution will need to be taken to reduce any impacts on the woodland community during monitoring and restoration activities, and to avoid stimulation of growth of any invasive species.

The potential for this recovery strategy to inadvertently lead to adverse effects on other species was considered. Currently, recovery actions for Goldenseal focus on identifying, protecting and monitoring populations and habitat, conducting research to better understand the species and its habitat, and managing threats. In general, these

¹⁴ www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html

¹⁵ www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1

activities have little potential to lead to adverse effects on other species that may share the habitat or range of the Goldenseal. Only habitat management activities (e.g. invasive species control, opening of the canopy) have the potential to directly affect other native species, and their potential to inadvertently lead to adverse effects on other species will be considered during action plan development.

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Appendix A: National and Subnational Conservation Status Ranks of Goldenseal (*Hydrastis canadensis*) in Canada and the United States

Country (N Rank)	State or Province (S Rank)
Canada (N2)	Ontario (S2)
United States (N3N4)	Alabama (S2), Arkansas (S4S5), Connecticut (S1), Delaware (S3), Georgia (S2), Illinois (S4), Indiana (S3), Iowa (S3), Kansas (S1), Kentucky (S4), Maryland (S2), Massachusetts (S1), Michigan (S2), Minnesota (S1), Mississippi (S1), Missouri (S5), New Jersey (S1), New York (S2), North Carolina (S3), Ohio (S4S5), Pennsylvania (S4), Tennessee (S4), Vermont (S1), Virginia (S3), West Virginia (S3S4), Wisconsin (S3S4)

Source: NatureServe 2015

Definitions of National (N) and Subnational (S) Conservation Status Ranks (Master et al. 2012)

Rank	Definition
N1 S1	Critically Imperiled— At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
N2 S2	Imperiled— At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3 N3 S3	Vulnerable— At moderate risk of extinction or elimination (G3), or extirpation in the jurisdiction (N3, S3), due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4 N4 S4	Apparently Secure— At a fairly low risk of extinction or elimination (G4), or extirpation in the jurisdiction (N4, S4), due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
N5 S5	Secure— At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.
N#N# S#S#	Range Rank— A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).

Appendix B: Explanation of the differences in the Goldenseal population count between the federal addition and the provincial recovery strategy

a) The planted population identified as “Site R” (Stormont County) in the provincial recovery strategy is not included in Table 1. Although Sinclair and Catling (2000a) make reference to cultivation of the species in Cornwall, Stormont County, there is no indication that the species occurred there as a naturalized population.

b) The “last observed” date for the population identified as Site T in the provincial recovery strategy has been changed to 1994, and its status changed to Extant accordingly. See c) below for details on status ranking.

c) During the preparation of the federal addition, ECCC and the NHIC jointly reviewed the status (Extant/ Historical/ Extirpated) of the populations listed in Table 1 against NatureServe’s Key for Ranking Species Element Occurrences (Tomaino et al. 2008). After applying the key, the status of one population in Chatham-Kent (EO11336) was changed from Historical to Extant because the population’s existence has been verified within the last 40 years (in 1986), but no persuasive information exists to indicate that the population is extirpated. Because Goldenseal is a perennial understory plant found in stable habitats (i.e. mature hardwood forests), it is appropriate for this taxon to rank populations as Extant even though they have not been verified in more than 20 years (but verified within the last 40 years) if no surveys have been recently conducted and there is no indication of a known major disturbance or general habitat loss/degradation in the area (Hammerson et al. 2008; Tomaino et al. 2008). All six populations ranked as Historical in Table 1 meet these criteria (NHIC 2016).

The status of the population in Grey County was changed from Extant to Historical because it was last verified 40 years ago (in 1976), and according to NatureServe guidelines, “With very few exceptions, occurrences are to be regarded as H after 40 years without confirmation, even with no effort to locate the species” (Hammerson et al. 2008).

d) The number of populations of a species in Canada is an important metric in assessing its conservation status (see criteria B and C in COSEWIC 2015). For this reason, ECCC and the NHIC jointly reviewed how the provincial record spatially grouped species observations into populations. This review was also needed in order to reconcile differences between the number of Goldenseal populations previously reported in various other documents. The authors of the first and second COSEWIC status reports for Goldenseal (White 1991 and Sinclair and Catling 2000a, respectively) separated groups of plants into populations if they were more than 500 m apart, whereas the author of the provincial recovery strategy used a distance of 1km (Jolly 2016a). Meanwhile, NatureServe’s recommendation for Goldenseal specifically is to use a separation distance of 1.5 km when the habitat between two occurrences is suitable (Weldy and Young 2000). An inappropriately small separation distance will lead

to an overestimate of the number of populations which will in turn distort the conservation status of the species in Canada.

Populations are the result of two factors in a species' biology: reproduction and dispersal. Based on general plant dispersal biology, NatureServe recognizes that the default 1km minimum used to separate one Element Occurrence (EO) from another is inappropriately small (NatureServe 2004). To address this shortcoming, a habitat-based plant element occurrence delimitation guidance was developed whereby, depending on the habitat where a species occurs, groups of plants located within 2km, 3km or in some instances 10km of each other are considered as belonging to the same population (NatureServe 2004).

When applying this guidance to element occurrence data for Goldenseal, the resulting populations are at least 1600 m apart (NHIC 2016). This distance is consistent with that which is arrived at based on the distance within which sexual reproduction (pollen transfer) can occur between Goldenseal individuals. Since pollinating insects' foraging distance generally increases with body size (Gathmann and Tscharrtk 2002; Greenleaf et al. 2007) individual Goldenseal plants located within the maximum foraging distance of the species' largest known pollinators, bumble bees (Sinclair et al. 2000), have the potential to interbreed. In their compilation of literature data on maximum foraging distances in bees, Zurbuchen et al. (2010) reported various findings on the foraging distance of a bumble bee species overlapping in size with those that occur within the Ontario range of Goldenseal. The maximum foraging distance measured specifically through mark-recapture studies was 1750 m (Walther-Hellwig and Frankl 2000).

In conclusion, the above review accounts for the following differences in the number of populations in Table 1 compared to that reported in the provincial recovery strategy:

- i) The population identified as EO2519 in Essex County comprises the four groups of plants listed as distinct populations under Site F in the provincial recovery strategy;
- ii) The two populations identified as EO5514 and EO5516 in Lambton County comprise the seven groups of plants identified as distinct populations under Site G in the provincial recovery strategy (Site G is located within the geographic region of Lambton County, not Essex County as reported in the provincial recovery strategy);
- iii) The population identified as EO11341 in Lambton County comprises the two groups of plants identified as distinct populations under Site M and the one group of plants identified as a population under Site O in the provincial recovery strategy.

Part 2 – *Recovery Strategy for the Goldenseal (Hydrastis canadensis) in Ontario*, prepared for the Ontario Ministry of Natural Resources and Forestry



Goldenseal

(*Hydrastis canadensis*) in Ontario

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This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the *Endangered Species Act, 2007* (ESA) and the *Accord for the Protection of Species at Risk in Canada*.

What is recovery?

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

What is a recovery strategy?

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

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

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

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources and Forestry Species at Risk webpage at:

www.ontario.ca/speciesatrisk

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DECLARATION

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

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

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

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

RESPONSIBLE JURISDICTIONS

Ontario Ministry of Natural Resources and Forestry
Environment and Climate Change Canada – Canadian Wildlife Service, Ontario
Parks Canada Agency

EXECUTIVE SUMMARY

Goldenseal (*Hydrastis canadensis*) is a long-lived perennial herb that grows in moist deciduous woodlands in Ontario. It is currently listed as threatened in Ontario under the provincial *Endangered Species Act, 2007* (ESA). The Natural Heritage Information Centre (NHIC) has designated the plant with a conservation status rank of S2, indicating that it is imperiled in Ontario.

In Ontario, Goldenseal has remained relatively stable over the past four decades with approximately 24 distinct extant natural populations (defined as at least one km apart) scattered among seven counties and regional municipalities. Historically it had a wider distribution, possibly reaching as far as eastern Ontario. Current Ontario populations are primarily restricted to the deciduous forest region (ecoregion 7E) of southwestern Ontario, with the majority of populations confined to the western half of the region around Lake Huron. One non-native population exists within the Great Lakes-St. Lawrence forest region (ecoregion 6E).

The main threats to Ontario's populations are alteration of the natural disturbance regime, deforestation, habitat destruction or fragmentation, changes in hydrology and drainage, harvesting, invasive species and trampling of plants. The recovery goal for Goldenseal in Ontario is to maintain the existing populations at sustainable levels. Research on the natural disturbance regime favoured by Goldenseal should inform conservation management approaches. The following protection and recovery objectives are recommended to accomplish the recovery goal.

1. Survey and monitor all extant populations of Goldenseal and its habitat across its native range in southern Ontario.
2. Address knowledge gaps relating to the species' habitat needs.
3. Manage and protect habitat at all extant sites in Ontario.
4. Develop and deliver education and stewardship programs for private landowners.
5. Address knowledge gaps relating to the species' biology and conservation, including potential propagation and reintroduction.

It is recommended that the area to be prescribed as habitat in a regulation for Goldenseal includes the extent of the area of occupancy within which the species is found, the Ecological Land Classification (ELC) ecosite polygon plus an additional 50 metres of natural vegetation. For plants which are within 50 m of the edge of their polygon, a minimum distance of 50 m from the outer limit of the population and around each plant is recommended for regulation. It is recommended that cultivated (i.e., plants grown commercially for the purpose of propagation or medicinal uses) Goldenseal should be excluded from a habitat regulation.

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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME: Goldenseal

SCIENTIFIC NAME: *Hydrastis canadensis*

SARO List Classification: Threatened

SARO List History: Threatened (2008), Threatened – Not Regulated (2004)

COSEWIC Assessment History: Threatened (2000, 1991)

SARA Schedule 1: Threatened (2003)

CONSERVATION STATUS RANKINGS:

GRANK: G3G4

NRANK: N2

SRANK: S2

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

1.2 Species Description and Biology

Species Description

Goldenseal (*Hydrastis canadensis*), also known by the local vernacular names of Orangeroot and Yellow-puccoon, is a perennial long-lived herb measuring 20 to 50 cm in height. The bottom, middle and upper leaves of the Goldenseal plant are palmately¹ shaped with one to nine lobes radiating from the central part of the leaf (NatureServe 2014). Superficially, these leaves resemble maple (*Acer* spp.) leaves. Leaves are generally doubly toothed, or coarsely serrated around the edges and are usually attached to the main plant stem in sub-opposite or alternate leaf arrangement (Jolly 2015). The number of leaves present is a function of age, with younger plants possessing one leaf and older, more reproductively mature plants having two to three leaves. Plants producing a flower are one-leaved plants at least two or three years old. Two-leaved plants are four to six years old, and three-leaved plants are greater than six years old (Jolly 2015).

The leaves of Goldenseal plants may be mistaken for other Ontario plants, particularly during early growth stages. The first or second year Goldenseal seedling is identified by a stem, which may be hairy, approximately five cm tall, reddish towards the base and attached to a bright yellow root (Riley 2009). The first pair of leaves from older plants that emerge from the ground in the early spring are called cotyledon leaves

¹ Palmate means radiating from a common point, as in leaflets or veins in a leaf (Voss 1985).

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(NatureServe 2014). The general structure of a Goldenseal plant emerging with cotyledon leaves may be visually mistaken in the field with palmately-shaped leaves from other plants emerging in the early spring. Some of these other plants include Wild Geranium (*Geranium maculatum*) and Maryland Black-snakeroot (*Sanicula marilandica*). Later in the season, after leaves are completely unfolded and expanded, Goldenseal leaves may resemble the maple leaf shape of other plants, such as Mayapple (*Podophyllum peltatum*) and Sweet Coltsfoot (*Petasites frigidus* var. *palmatus*) (Cherniawsky and Bayer 1998).

The root is a bright yellow or orange rhizome measuring 4 to 7 cm long by 0.5 to 2 cm wide when fresh (Sinclair and Catling 2000b) and covered with fine yellow rootlets. Annual growth rings on the rhizome have been observed (Jolly 2016) and may be used to measure age.

The solitary flower (Figure 1), located at the base of the uppermost leaf is distinctive in that it lacks showy petals or sepals (Gleason and Cronquist 1991, Jolly 2015). The flower has multiple conspicuous, showy white stamens (i.e., the male part of the flower), which may number as many as 50. The flower diameter averages 1.4 cm (EARTHQUEST 2014). Fertilized flowers develop into fruit, maturing in June or July, with 10 to 30 dark shiny seeds (Sinclair 2002, USDA Forest Service 2003, NatureServe 2014, Jolly 2015). The fruit somewhat resembles raspberries, with each “berry” the product of a collection of fertilized pistils or carpels (i.e., the female part of the flower) (Sinclair and Catling 2000b). This collection of fertilized pistils or carpels (i.e., by insect pollinators), may contain 1 or 2 achenes for each pistil or carpel.

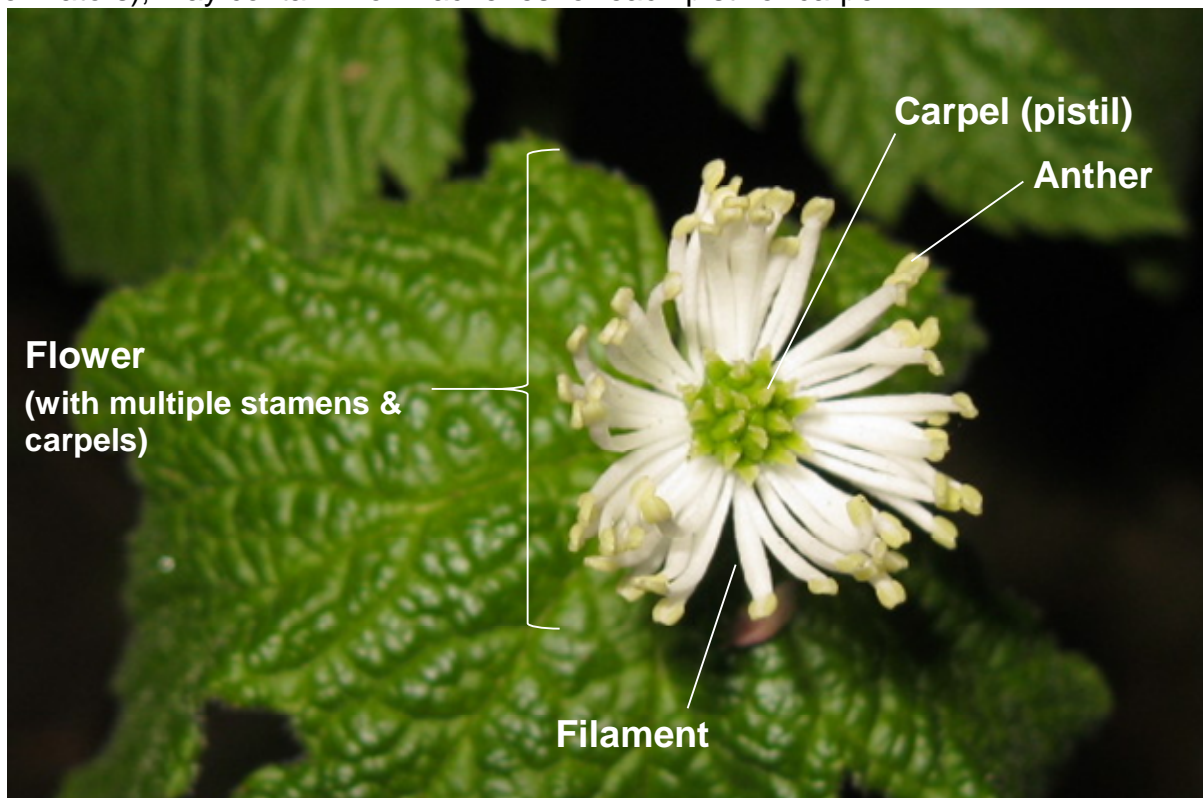


Figure 1. Structure of Goldenseal flower. Photo by Dave Jolly.

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Species Biology

Goldenseal plants in Ontario have been observed to emerge as seedlings or cotyledon leaves between April 28 and May 10 before the overhead canopy has fully closed (EARTHQUEST 2014). Flowering may occur within several days of emergence. They have been observed to flower until May 30 in Ontario (EARTHQUEST 2014). At the first frost (mid to late October), most plants die (Sinclair and Catling, in press), although some plants may persist until December (D. Jolly, pers. obs. 2014). Goldenseal overwinters as either seeds or rhizomes. Little published information is available on what length of time is required for wild plants to grow from seed to sexually maturity with viable fruits.

Goldenseal can reproduce both asexually (new shoots from rhizomes) and sexually (seeds produced from self-fertilization or cross-fertilization). Self-fertilization is common in most flowering plants with both male and female reproductive organs and has been documented for Goldenseal by some researchers (Sanders 2004). Asexual reproduction is accomplished through the production of vegetative ramets from rhizomes between October 27 and November 8 (Jolly 2015, Jolly 2016, Sinclair and Catling in press). Each rhizome may have a single, or as many as eight stems arising from it, which complicates estimations of how many individuals live in a population. Sexual reproduction through cross-fertilization is likely accomplished through the action of pollinating insects. Plants do not flower until they are two to three years old with at least one leaf. The oldest age noted for first flowering is five years old (NatureServe 2014). The few insects documented as visiting Goldenseal flowers in Ontario include sweat bees (*Lasioglossum* spp.), bumble bees (*Bombus* spp.) (Sinclair et al. 2000, Sinclair 2002), and flies in the family Syrphidae (Environment Canada 2011). Pollination does not appear to limit population growth and spread of Goldenseal in Ontario (Environment Canada 2011).

Seed dispersal is believed to be facilitated by animals eating ripe fruits (Tait 2006, Lonner 2007, D. Jolly, pers. obs. 2014). Sinclair et al. (2000) found that Red-winged Blackbirds (*Agelaius phoeniceus*) may serve as effective dispersal organisms, but may not disperse seeds to appropriate germination sites (Environment Canada 2011). It has been inferred by Tait (2006) that birds may be carrying the bright red fruits containing seeds larger distances than other dispersers. Some researchers suggest that these other dispersers may be ants, but do not specify which species of ants (Albrecht and McCarthy 2011).

Goldenseal tends to occur in clumps as a result of their vegetative growth and presumed limited seed dispersal (Eichenberger and Parker 1976, Sinclair and Catling 2000a). In a study of Goldenseal in Ohio, Eichenberger and Parker (1976) found that clumps in interior forests had more individuals than clumps at forest edges. Plants that originate from asexual reproduction (shoots from rhizomes) exhibit slower growth rates than plants grown from seeds (Lonner 2007). Sanders (2004) found that how Goldenseal reproduces (vegetatively versus sexually) appears unlikely to be a major factor limiting the distribution or abundance of Goldenseal. A study of three Ohio populations of Goldenseal suggested 87.5 percent of new seedlings originated from

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asexual and 12.5 percent from sexual reproduction (Christensen and Gorchoff 2010). Sinclair and Catling (in press) noted that on average 24 percent of Ontario's populations produce healthy, viable flowers during a given year. In their 2015 field surveys, however, Sinclair and Bickerton found that 31 percent of 14 populations were in bloom (COSEWIC 2016). Flowering plants usually produce fruit in Ontario (Sinclair et al. 2005).

Since Goldenseal rhizomes are sometimes harvested illegally (see Threats section), responses to rhizome cutting is a key aspect of this species' biology for conservation management. It is not known what rate of recovery can be expected under various levels of harvest, given natural levels of mortality. Limited laboratory and field-based results suggest Goldenseal can grow new stems from the root fragments remaining after harvest, but these stems are generally shorter, fewer in number, and less frequently have flowers than stems from intact roots (Van der voort et al. 2003). This is supported by observations of Tait (2006) for Ohio populations of Goldenseal.

1.3 Distribution, Abundance and Population Trends

The global distribution of Goldenseal is restricted to eastern North America, with most of its range occurring in the United States. In the United States, Goldenseal occurs on rich and moist soils of deciduous forests. The distribution extends from New England in the east, to southern Minnesota and northeastern Kansas in the west, and from Mississippi, Alabama and Georgia in the south, to Wisconsin in the north. Goldenseal is currently ranked rare (S3) in Indiana and most of the other states of the USA except Illinois, Kentucky, Ohio, Pennsylvania, West Virginia and Wisconsin (BONAP 2013, NatureServe 2014).

In Canada, Goldenseal is largely confined to the deciduous forest region (ecoregion 7E) of southwestern Ontario between the north shore of Lake Erie and the southern ends of Lake Huron from Windsor to Goderich (COSEWIC 2000). The most northern occurrence of the species in Ontario is in Grey County, but this population was planted and spread into the surrounding woodland (White 1990, J. Penner, pers. comm. 2014).

Overall, the abundance of Goldenseal in Ontario appears to be increasing, with some colonies declining in abundance (Sites C, E, L, and O, Table 1) and others increasing (Sinclair and Catling in press). It is not known how many Goldenseal colonies (i.e., groups of Goldenseal separated by a distance of 500 m) existed in Ontario prior to 1957, but they were likely more extensive than they are today. Most studies of Ontario colonies occurred between 1989 and 2001 (A. Sinclair, pers. comm. 2014), with approximately 14,500 stems being surveyed in 1998 (Sinclair and Catling 2002). Although considered native, the origin of the newly-discovered population in Wellington County (Site P, Table 1) is uncertain (COSEWIC 2016). Nevertheless, added with 13 known populations resurveyed (COSEWIC 2016) in 2015 the total number of native, wild extant Goldenseal in Ontario is estimated to be approximately 76,053 stems from 24 populations (Figure 2; Table 1). The increase in some populations between 1998 and 2015 may be attributable to disturbances in the forest canopy such as from

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Emerald Ash Borer (*Agrilus planipennis*) (Site M, Table 1) and Hickory die-off (Site H, Table 1) (COSEWIC 2016). Past survey results have been complicated by inconsistent application of survey protocols, such as some surveys assuming that each stem represents a distinct plant when, in fact, several stems may share the same root. Sites are defined as a group of Goldenseal within 1.5 km of each other. Populations are considered by the author to be distinct if they are separated by at least one km, consistent with the approach employed by COSEWIC, NatureServe, and Ontario's Natural Heritage Information Centre (NHIC). Groups of plants within 500 m of each other are considered sub-populations of a single population, and are referred to in this report as colonies. There is often more than one colony in a population of Goldenseal. Subsequently, there are approximately 79 distinct colonies ranging from several individuals to several hundred ramets (i.e., vegetative stems emerging from one parental plant) currently occurring in Goldenseal populations in the province of Ontario (Sinclair and Catling 2000b, Mulligan and Gorchov 2004, Sanders and McGraw 2005). Projection matrix models suggest that flowering stems is the most important factor that contributes to Goldenseal population growth in Ontario (Sinclair et al. 2005).

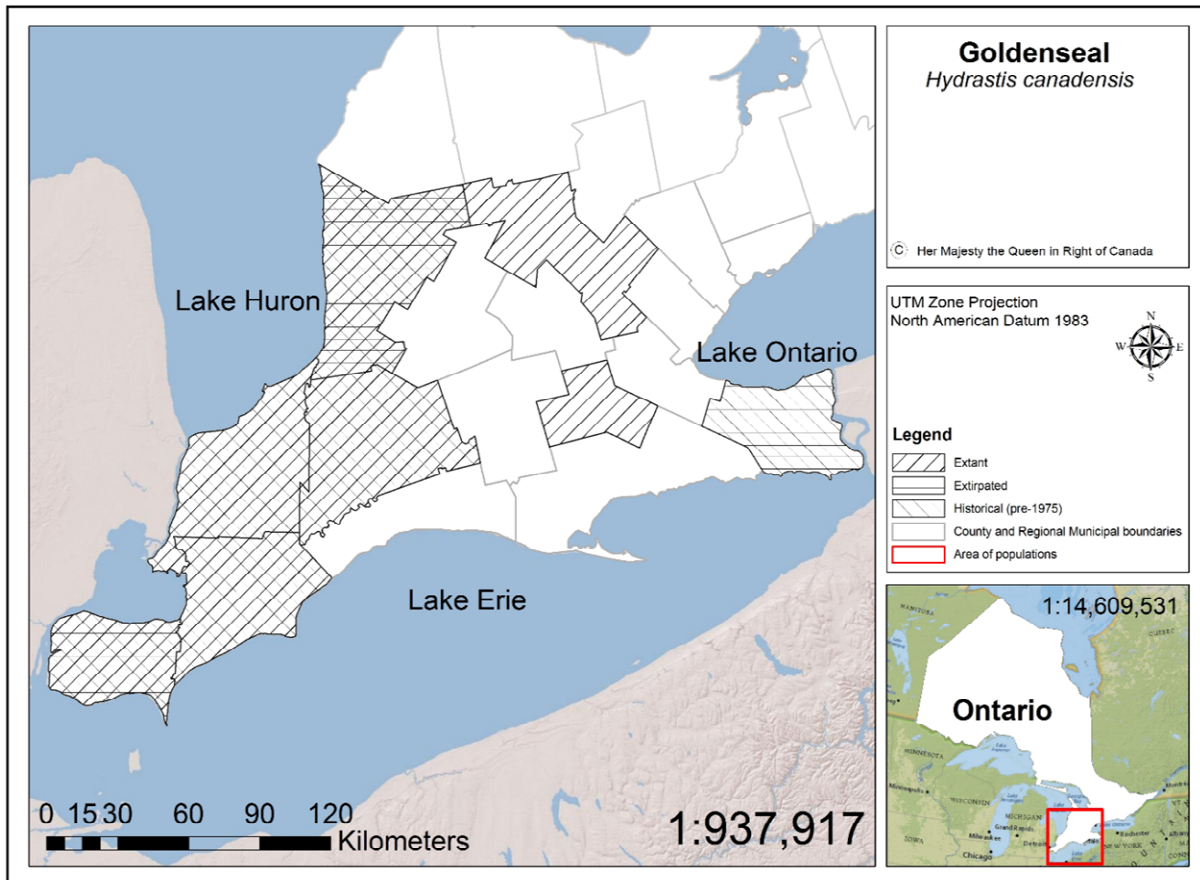


Figure 2. Population distribution by county of extant, extirpated and historical range of Goldenseal in Ontario (NHIC 2014b). Excludes populations considered to be planted.

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Table 1. Summary of known extant populations of Goldenseal in Ontario documented between 1957 and 2015 (Botham 1981, White 1990, Morningstar 2005, Environment Canada 2011, NHIC 2014b, Sinclair and Catling in press, EARTHQUEST 2014, C. Cecile, pers. comm. 2014).

County/ Region	Site Name	Status	Number of Known Colonies/ Populations	Year of Last Survey/ Observation	Approximate Number of Stems	Surveyor(s)
Brant County	A	Extant	1 colony; 1 population	2014	26,122	Dave Jolly, Nata Mateev, Kathryn Markham, Lindsay Campbell (2014), Derek Morningstar (2005)
Chatham- Kent	B	Historical	1 colony; 1 population	1986	70	Ian Macdonald
	C	Extant	4 colonies; 1 population	2015	397	Adrienne Sinclair & Holly Bickerton (2015), Adrienne Sinclair & Paul Catling (1998), David White (1989), Mike Oldham & Gary Allen (1986), R. Zavitz (1964), James Soper & M. Landon (1957)
	D	Extant	2 colonies; 1 population	2014	100*	Melody Cairns (2014), Dave Jolly (2009), Allen Woodliffe (2006), Ramsay Hart et al. (2002)
Essex County	E	Extant	6 colonies; 1 population	2015	2,179	Adrienne Sinclair & Holly Bickerton (2015), Adrienne Sinclair & Paul Catling (1998)
	F	Extant	27 colonies; 4 populations	2015	21,384	Adrienne Sinclair & Holly Bickerton (2015), Adrienne Sinclair & Paul Catling (1998), David White (1989), Mike Oldham & Gary Allen (1986), William Botham (1973)
	G	Extant	22 colonies; 7 populations	1998	1,607	Adrienne Sinclair & Paul Catling (1998), Gary Allen & Allen Woodliffe (1985 - 1989)

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Huron County	H	Extant	5 colonies; 1 population	2015	8,308	Adrienne Sinclair & Holly Bickerton (2015), Dave Jolly (2014; 1 colony), Julia Riley (2009), K. Vlasman (2005), Adrienne Sinclair (1998), Mike Oldham (1995)
Lambton County	I	Extant	1 colony; 1 population	2008	6 (106 in 1998)	Tim Payne (St. Clair Region Conservation Authority, 2008), Adrienne Sinclair & Paul Catling (1998, 2000, 2001)
	J	Historical	1 colony; 1 population	1958	Unknown	H. Lawrence
	K	Extant	2 colonies; 1 population	2015	6,832	Adrienne Sinclair & Holly Bickerton (2015), Adrienne Sinclair & Paul Catling (1998), David White (1991)
	L	Extant	2 colonies; 1 population	2015	149	Adrienne Sinclair & Holly Bickerton (2015), Adrienne Sinclair & Paul Catling, Larry Lamb (1980)
	M	Extant	4 colonies; 2 populations	2015	3,116	Confidential (2015, 2008)
Middlesex County	N	Extant	1 colony; 1 population	2010	430* +	Melody Cairns (2014), Sandy Dobbyn (2007)
	O	Extant	1 colonies; 1 population	2015	335	Adrienne Sinclair & Holly Bickerton (2015), Ausable River Conservation Authority (2008) Adrienne Sinclair & Paul Catling (1998)
Wellington County	P	Extant	1 colony; 1 population	2015	5,088	Adrienne Sinclair, Holly Bickerton, Charles Cecile (2015)
Populations considered to be non-native in origin						
Grey County	Q	Extant	1 colony; 1 population	1998	50,544	Adrienne Sinclair (1998)
Stormont County	R	Extirpated	1 colony; 1 population	1998	Unknown	Cited in Sinclair and Catling (in press)
Populations not assigned an Element Occurrence (EO) by the NHIC						
Niagara Region	S	Extirpated	1 colony; 1 population	1894	Unknown	R. Cameron cited in Plants of the Niagara Parks System of Ontario (1943)

Recovery Strategy for the Goldenseal in Ontario

Lambton County	T	Extirpated	1 colony; 1 population	Late 1970s	30 - 40	Environment Canada (2011)
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* Exact number of Goldenseal not provided by surveyor(s)

1.4 Habitat Needs

Goldenseal tends to live in, or at the edge of, nutrient-rich, deciduous forests with fairly neutral soils (Sinclair and Catling 2000a). The amount of overhead forest canopy cover can vary from semi-open to closed, with 47 to 80 percent shade being considered optimal for Ontario populations (Sinclair and Catling 2001). Goldenseal is often associated with disturbed forest areas and edges of forests, suggesting they may benefit from some disturbance (Sinclair and Catling 2000b). Soil pH of Ontario populations can range from slightly acidic (5.4) to slightly basic (7.8) (Sinclair and Catling in press), with the type of soil including clay, sandy loam, or loam (Riley 2009). Moisture levels can range from dry mesic to mesic (Sinclair and Catling in press).

Transplantation experiments have been successful in Ontario. Germination rates were low (9%) in growth chamber experiments using wild Goldenseal seeds, with shaded conditions only benefiting germination under dry conditions (Environment Canada 2011). Ontario field transplantation experiments revealed that Goldenseal plants produced more flowers, fruits and seeds when their soil was disturbed than when it was not (Sinclair and Catling 2004). It was successfully demonstrated that transplanting should be considered an effective tool for restoration efforts of Goldenseal and transplant success can be increased with soil turnover (Sinclair and Catling 2004).

Many plants can co-exist with Goldenseal in Ontario because Goldenseal can occur in lush, diverse groundcover communities in several habitats (Sinclair and Catling 2000b). The sparse shrub understory can consist of Red Maple (*Acer rubrum*) and Swamp White Oak (*Quercus bicolor*), among other species (Sinclair and Catling in press). Lists of plants associated with Ontario populations of Goldenseal have been summarized in White (1990), Sinclair and Catling (2000b, 2001), and NHIC (2014b). Some of the plant associates noted in the Wellington County population discovered in 2013 are new and include Zigzag Goldenrod (*Solidago flexicaulis*), Smooth Goldenrod (*Solidago gigantea*), Early Meadow-rue (*Thalictrum dioicum*), Yellow Trout-lily (*Erythronium americanum*), several sedge species (*Carex* spp.), Red Baneberry (*Actaea rubra*), White Trillium (*Trillium grandiflorum*), False Solomon's-seal (*Maianthemum racemosum*) and Large-flowered Bellwort (*Uvularia grandiflora*) (Cecile 2014).

Ecological Land Classification (ELC) data for Goldenseal has been updated by COSEWIC (2016) and Jolly (2016). To date, the author and other surveyors have classified 12 communities from 11 Goldenseal sites:

- Dry-Fresh Basswood Deciduous Forest Type (FODM4-9);
- Fresh-Moist Sugar Maple Deciduous Forest Ecosite (FODM5);
- Dry-Fresh Sugar Maple Deciduous Forest Type (FODM5-1);

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- Fresh-Moist Sugar Maple-Beech Deciduous Forest Type (FODM5-2);
- Fresh-Moist Oak-Sugar Maple Deciduous Forest Type (FODM7-5);
- Fresh-Moist Poplar Deciduous Forest Type (FODM8-1);
- Fresh-Moist Oak-Sugar Maple Deciduous Forest Type (FODM9-1);
- Fresh-Moist Shagbark Hickory Deciduous Forest Type (FODM9-4);
- Fresh-Moist Bitternut Hickory Forest Type (FODM9-5);
- on a drier micro-habitat within Fresh-Moist Sugar Maple/Beech-Spicebush Carolinian Deciduous Forest Type (FODM10-1a);
- Fresh-Moist Deciduous Woodland Ecosite (dominated by Black Walnut) (WODM5); and
- Fresh-Moist Elm Deciduous Woodland Type (WODM5-2).

1.5 Threats to Survival and Recovery

Five out of 24 populations (21%) of Goldenseal are found on public lands within conservation areas, provincial parks, and provincial nature reserves, which are relatively secure. Two populations (8%) are on First Nations land, while the remaining 17 populations (71%) are located on private property. A few populations may be under environmental pressure from human-induced influences due to trampling of plants found along trails, removal of forest canopy, non-selective cutting, changes in hydrology including drainage, and harvesting. However, Sinclair and Catling (2000a, 2003, 2004) suggest that trampling of plants, removal of forest canopy and non-selective cutting may be beneficial since they simulate natural disturbance processes that have been lost through the settlement of southern Ontario landscapes. The main threats facing populations of Goldenseal in Ontario include alteration to natural disturbance regime, logging, changes in hydrology and drainage, harvesting, flooding and invasive species.

Alteration to Natural Disturbance Regime

Goldenseal may benefit from woodland disturbances, such as floods and fires, which were more common prior to European settlement (COSEWIC 2000). Perhaps these disturbances facilitated Goldenseal dispersal or colonization (Sinclair and Catling 2004), and the recent rarity of these disturbances may be a reason why many Ontario populations are ageing without spreading (Sinclair and Catling 2002, Sinclair et al. 2005). A reduction in these forest disturbances may affect soil moisture, nutrient levels, and result in over-shading of undergrowth, all of which may hinder Goldenseal colonization. Ontario populations of Goldenseal are often associated with disturbed forest areas, such as forest paths and forest edges, suggesting a benefit of disturbance (Sinclair and Catling 2000a). Furthermore, Goldenseal tends to have relatively larger populations in smaller habitat patches in Ontario, suggesting a benefit of habitat fragmentation for this species (Sinclair and Catling 2000a). This was verified with field surveys of one of the largest native stands in Ontario in Brant County (Site A) (Jolly 2016) and Site H in Huron County (COSEWIC 2016). Goldenseal may have also benefited from now-extinct animals, such as massive flocks of Passenger Pigeon (*Ectopistes migratorius*) or large pleistocene mammals, which may have not only

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contributed to disturbance but also facilitated seed dispersal (Sinclair and Catling 2000b).

Deforestation

Selective cutting has occurred at nine populations, mostly on private properties or adjacent to an Area of Natural and Scientific Interest (ANSI), and is contributing to Goldenseal disappearance or decline at three locations (Environment Canada 2011). If standard forestry Best Management Practices (BMPs) are not implemented during selective cutting activities, the changed micro-habitat may not be suitable to support healthy Goldenseal populations. Mulligan's (2003) observations from her study on the impact of logging practices on Goldenseal also apply here, whereby too much selective cutting would allow excess sunlight to penetrate the forest floor. Logging and commercial deforestation practices have been implicated in the decline of Goldenseal populations in the United States, particularly in Ohio. At one site in Ohio, which had been logged a few weeks prior to a site visit, Mulligan (2003) observed plants aging prematurely as a result of full exposure to direct sunlight since the canopy had been almost entirely removed. The disturbance caused by not clearing woody debris away from Goldenseal colonies, or the increased soil compaction caused by commercial machinery, may also restrict soil drainage. However, there is considerable evidence that Goldenseal plants in Ontario and their immediate habitat are frequently damaged by logging (Environment Canada 2011).

Habitat destruction or fragmentation

Development, such as the construction of housing, can cause habitat destruction or fragmentation. This threat has been documented and is believed to have caused local extirpation in one population located primarily on First Nations land (A. Sinclair, pers. comm. 2014). With the clearing of woodlands some of the prime Goldenseal habitat may have been converted to residential housing for development. Two additional populations on private property have had the forest canopy altered or removed through clearing of lots for constructing houses. This activity may detrimentally affect the survival and growth rate of Goldenseal by increasing exposure to direct sunlight.

Changes in hydrology and drainage

Plants are negatively affected by prolonged dry conditions; seeds are susceptible to drying out, and fruit and seed production are reduced (Sinclair and Catling 2001). Alteration of the water regime (e.g., dams), agricultural drainage and changes in local climate may restrict the growth and spread of Goldenseal (Sinclair and Catling 2001). The rivers along which Goldenseal occurs do not appear to flood to the extent that they did in the past (Environment Canada 2011). One population occurs in close proximity to a major highway corridor (Site L, Table 1) which may have affected the soil hydrology and drainage patterns (Environment Canada 2011, NHIC 2014b). Since Goldenseal is associated with riparian forests adjacent to water courses in Ontario, changes to soil hydrology and drainage resulting from land uses adjacent to riparian areas (such as from agriculture, grading, ditching, sand pits or quarries) may also be a significant threat affecting habitat quality and suitability.

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Harvesting

The root of wild Goldenseal is valuable to harvesters for medicinal purposes in Ontario (NHIC 2014a) and in the United States (Gagnon 1999, Mulligan 2003, Lonner 2007, NatureServe 2014, Sinclair and Catling in press). It is known as a popular herb that soothes and heals the mucous membranes of the respiratory, digestive and genitourinary tracts when affected by allergy or infection (Lenarduzzi 2000). Tinctures of the root are believed to provide some relief for stomach pains (Sinclair 2002) and serve as an agent that helps to constrict blood vessels, relieving inflammation (Lenarduzzi 2000, Plants for a Future 2009).

An observed 10 percent rate of decline of the North American Goldenseal population as a result of harvesting wild populations may contribute to extinction over time (Mulligan and Gorchoy 2004). The threat posed by harvest and international trade prompted listing of the plant in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) on June 8, 1998 (Sinclair and Catling in press). The threat of harvest is considered medium in Ontario (Sinclair and Catling in press). Although this threat is not as clearly evident in Ontario, it may be a greater threat for some of the smaller populations located close to trails. These populations are primarily on land under public ownership and, to a lesser extent, on private property. Sinclair and Catling (in press) noted that since public access to private lands is more restricted, plants on private lands may be more protected from wild harvest. One population could be in danger of harvest if the location becomes public knowledge (C. Cecile, pers. comm. 2014). Over a period of four years (1998 – 2001) Sinclair and Catling (2000b) found that only two of 20 populations showed signs of harvesting, where holes in the ground were discovered with the vegetative portions of approximately 90 plants left and rhizomes missing. However, evidence of harvest was not observed during field visits to 11 sites in 2003, 10 sites in 2004 (Environment Canada 2011) and 13 sites in 2015 (COSEWIC 2016). Three populations in Ontario that are in danger of potential harvesting due to their close proximity to recreational trails are located on public lands owned and managed by conservation authorities or provincial parks (NHIC 2014b). People harvesting Wild Leek (*Allium tricoccum*) were observed on public land within close proximity to the Brant County site (Site A in Table 1) in 2010 (Jolly 2016).

Invasive species

Disturbances to Goldenseal habitat from natural or human-induced factors promote the expansion of invasive alien species, such as Garlic Mustard (*Alliaria petiolata*). Three populations have substantial amounts of Garlic Mustard that may be out-competing native Goldenseal. While the effects of Garlic Mustard and the severity of this threat on Goldenseal are not known, Garlic Mustard is known to inhibit germination and growth of several other native plants by interfering with their root growth (Roberts and Anderson 2001) and is recognized as a threat to native biodiversity in Canada (Catling et al. 2015). Additionally, three Goldenseal sites, Site F in Essex region, Site H in Huron County and Site M in Lambton County, have invasive woody shrub species such as Poison Ivy (*Toxicodendron radicans*) and numerous non-native woody plants including Tatarian Honeysuckle (*Lonicera tatarica*), Common Barberry (*Berberis vulgaris*),

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Japanese Barberry (*Berberis thunbergii*), Japanese Honeysuckle (*Lonicera japonica*), European Privet (*Ligustrum vulgare*), Multiflora Rose (*Rosa multiflora*) and Raspberries (*Rubus* spp.). Another invasive species observed at the Brant and Wellington County populations was European Buckthorn (*Rhamnus cathartica*) (D. Jolly, pers. obs. 2014, C. Cecile, pers. comm. 2014).

Trampling of plants

Thirteen Ontario populations are located within close proximity or adjacent to well used hiking or recreational trails. Proximity to trails may lead to trampling of Goldenseal plants. At least three sites, Site A in Brant County, Site F in Essex region and Site H in Huron County (Table 1), exhibit impacts from trampling (Riley 2009, D. Jolly, pers. obs. 2014, COSEWC 2016) and are located on public land or within a conservation area. Indeed, Riley (2009) stated that the most noticeable threats to Goldenseal in her survey were proximity to a hiking trail and die-off of Bitternut Hickory (*Carya cordiformis*) causing large openings in the canopy. Catling and Kostuik (2011) noted that hiking trails are beneficial, rather than a hindrance, to populations of wild orchids found in close proximity. This supports the contention by Sinclair (Environment Canada 2011) that hiking trails may also be beneficial to Goldenseal. Site C in Chatham-Kent, Sites E and F in Essex region, Site L in Lambton County and Site O in Middlesex County (Table 1) may be in jeopardy of damage from the unauthorized or authorized use of all-terrain vehicles (ATVs) which wander off trails, inadvertently crushing vegetation. However, this may be a short term threat that may be remedied in the long term by soil disturbance and crushing of competing plants.

1.6 Knowledge Gaps

A number of knowledge gaps exist that may hinder Goldenseal recovery efforts in Ontario. These include our understanding of Goldenseal habitat quality, the species' pollinators and animal dispersers, pathogens and diseases, as well as the factors influencing growth and reproduction. Specific knowledge gaps and research questions are listed below.

- What is the size and extent of potential suitable habitat such as mesic, deciduous woods and wooded floodplains with closed or semi-closed canopies occupied by Goldenseal?
- How much, and what type of, forest disturbance benefits Goldenseal? The precise extent of habitat at extant sites is needed to determine the species-specific boundaries for potential habitat protection (e.g., habitat quality and condition at disturbed forested riparian areas that are prone to periodic flooding versus less disturbed mature forest sites with closed canopies).
- What influences rates of seed germination and seedling establishment? Are populations with young one-leaved and two-leaved plants less successful than those with older three-leaved plants?

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- What factors lead to Goldenseal reproducing sexually or asexually? Is there a mechanism which turns plants reproducing asexually into sexual reproducers?
- What soil pathogens and diseases may affect Goldenseal survival rates? Some information is available for cultivated Goldenseal in the U.S.A., but we know little about the pathogens and diseases of wild populations in Ontario.
- What species are pollinators of Goldenseal in Ontario?
- What animals disperse Goldenseal seeds in Ontario and how far are they dispersed?

1.7 Recovery Actions Completed or Underway

To date, recovery actions for Goldenseal that are completed or currently underway are limited to population surveys, landowner engagement, monitoring, mapping and educational initiatives. There is no official survey protocol methodology available for Goldenseal. Such a protocol would aid in undertaking standardized survey, mapping, inventory and monitoring initiatives. EARTHQUEST is currently writing a best management practices survey methodology for Ontario species at risk plants which may be available to professionals and practitioners by late 2016. When released this may provide a good foundation for establishing monitoring programs. Current recovery actions include the following.

- **Management via *in situ*² augmentation and *ex situ*³ conservation:** Field trials of Goldenseal transplantation in Ontario have been successful, with high rates of survival, flowering, fruiting, and seed production (Sinclair 2002, Sinclair and Catling 2003, 2004). The influence of soil disturbance and fertilization on transplantation success has been evaluated (Sinclair and Catling 2004), which may inform any future transplantation projects.

The Canadian Clonal Gene Bank is maintaining Goldenseal plants and seeds from sites across Ontario. These plants and seeds may facilitate research (e.g., studies of genetic variation) and stewardship (e.g., population augmentation).

- **Population surveys:** Surveys and monitoring of Ontario's Goldenseal colonies have occurred, with survey effort peaking in the late 1990s and early 2000s with Adrienne Sinclair's Ph.D. research on Goldenseal in Ontario. The most recent survey provided new information on nine sites in Ontario (COSEWIC 2016).
- **Walpole Island First Nation:** Goldenseal populations occurring at Walpole Island First Nation (WIFN) have been surveyed and mapped as part of the draft Walpole Island Ecosystem Recovery Strategy (Bowles 2005). The WIFN

² A Latin term meaning on site.

³ A Latin term meaning off site.

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conducts various conservation activities, including education about Goldenseal and other species at risk at the Walpole Island Heritage Centre.

- **Public education:** EARTHQUEST (Canada) for the Environment received funding from TD/Canada Trust's Friends of the Environment Foundation in 2010 to produce a book on species at risk trees, shrubs and wildflowers of Ontario. A revised copy that includes Goldenseal has been prepared for distribution to conservation authorities, habitat stewardship councils, naturalist clubs, provincial and national parks. A webpage has also been constructed featuring Goldenseal, with conformity to NHIC data sensitivity policies, available on the EARTHQUEST website⁴.

The Huron Habitat Stewardship Council has conducted some education and stewardship programs for Goldenseal.

Adrienne Sinclair produced a pamphlet "Woodlot Management Recommendations" and a document "Suggestions for Various Ways of Monitoring Populations" with guidance on habitat management and monitoring protocols for Goldenseal in Ontario (A. Sinclair, pers. comm. 2014).

⁴ Supplemental information on Goldenseal can be found at the following link:
<http://www.earthquestcanada.ca/Goldenseal.htm>

2.0 RECOVERY

2.1 Recovery Goal

The recovery goal for Goldenseal in Ontario is to maintain the existing populations at sustainable levels.

2.2 Protection and Recovery Objectives

Table 2. Protection and recovery objectives.

No.	Protection or Recovery Objective
1	Survey and monitor all populations of Goldenseal and its habitat across its native range in southern Ontario.
2	Address knowledge gaps relating to the species' habitat needs.
3	Manage and protect habitat at all extant sites in Ontario.
4	Develop and deliver education and stewardship programs for private landowners.
5	Address knowledge gaps relating to the species' biology and conservation, including potential propagation and reintroduction.

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2.3 Approaches to Recovery

Table 3. Approaches to recovery of the Goldenseal in Ontario.

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
1. Survey and monitor all populations of Goldenseal and its habitat across its native range in southern Ontario.				
Critical	Ongoing	Inventory, Monitoring and Assessment	1.1 Establish and regulate monitoring programs for all populations. <ul style="list-style-type: none"> - Ensure that data are collected in a systematic and consistent manner implementing standardized survey methodology and a protocol developed specifically for Goldenseal in consultation with Dr. Adrienne Sinclair's survey techniques (Sinclair 2002). 	Knowledge gaps: <ul style="list-style-type: none"> • habitat suitability
Critical	Ongoing	Inventory, Monitoring and Assessment	1.2 Inventory all occupied and historical areas of known sites. <ul style="list-style-type: none"> - Monitor Goldenseal populations at occupied sites. - Monitor habitat at currently and historically occupied sites, including habitats exhibiting disturbance regime. - Conduct demographic studies to further quantify demographic parameters (e.g., growth, seed production, mortality) to estimate population growth rates. 	Knowledge gaps: <ul style="list-style-type: none"> • habitat suitability • seed germination and establishment • mode of reproduction
Necessary	Short term	Research	1.3 Identify and survey additional sites with suitable habitat that may be downstream from Site H in Huron County, the Ausable River population in Middlesex County and the surrounding woodland for Site P in Wellington County. <ul style="list-style-type: none"> - Ensure that habitat regulation includes any newly-discovered populations 	Knowledge gaps: <ul style="list-style-type: none"> • habitat suitability

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Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
2. Address knowledge gaps relating to the species' habitat needs.				
Critical	Long term	Research	<p>2.1 Encourage research on topics related to Goldenseal biology and habitat.</p> <ul style="list-style-type: none"> - Research potential negative impacts of Garlic Mustard and other non-native plants. - Research natural disturbance regime favoured by Goldenseal. - Determine the precise extent of habitat at extant sites in order to inform habitat protection decisions. - Investigate seed productivity, dispersal, fertility and vitality. - Conduct forest interior habitat studies and compare with edge habitat studies. - Conduct field and demographic studies at the largest native Ontario populations to understand growth success compared to other populations. - Investigate habitat suitability modeling for optimal Goldenseal seed germination sites. - Determine which pollinators are visiting Goldenseal flowers, which animals are dispersing seeds, how far seeds are dispersed. - Examine which soil pathogens and what diseases affect Goldenseal populations. 	<p>Threats:</p> <ul style="list-style-type: none"> • alteration to natural disturbance regime • invasive species <p>Knowledge gaps:</p> <ul style="list-style-type: none"> • habitat suitability • size and type of forest that benefits Goldenseal • seed germination and establishment • mode of reproduction • seed dispersal • pollinators • pathogens and diseases
Beneficial	Short term	Research	<p>2.2 Research health, vitality and age-structure.</p> <ul style="list-style-type: none"> - Collect data on health and vitality of populations found at all sites. - Determine if seedlings require different habitats from already established plants. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • habitat suitability • seed germination and establishment • mode of reproduction
3. Manage and protect habitat at all extant sites in Ontario.				
Critical	Short term	Management	<p>3.1 Establish formal management agreements between private landowners to develop Best Management Practices (BMPs) for property management plans.</p>	<p>Threats:</p> <ul style="list-style-type: none"> • all

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Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Critical	Long term	Management	<p>3.2 Actively seek partnerships with landowners, municipalities, Conservation Authorities, MNRF and First Nations groups.</p> <ul style="list-style-type: none"> - Work with groups to remove invasive plants from Goldenseal sites to improve seed establishment areas. - Monitor and evaluate potential illegal harvesting. - Promote and encourage canopy thinning to promote the growth and enhancement of populations that are declining due to over-shading. 	<p>Threats:</p> <ul style="list-style-type: none"> • alteration to natural disturbance regime • invasive species • harvesting
Critical	Long term	Management	<p>3.3 Delineate suitable ecosite and vegetation types as prescribed habitat within a habitat regulation. Add other ecosite and vegetation types as more ELC is completed.</p>	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • habitat suitability
Critical	Short term	Stewardship	<p>3.4 Provide recommendations and BMPs to municipalities, Conservation Authorities, MNRF, Ontario Ministry of Agriculture, Food and Rural Affairs, adjacent landowners, private land owners and members of First Nations groups.</p> <ul style="list-style-type: none"> - Concentrate habitat stewardship agreement on the natural areas occupied by Goldenseal on privately owned land. 	<p>Threats:</p> <ul style="list-style-type: none"> • all
4. Develop and deliver education and stewardship programs for private landowners.				
Critical	Short term	Protection, Stewardship	<p>4.1 Implement and maintain a Goldenseal educated network of landowners.</p> <ul style="list-style-type: none"> - Protect habitat on public lands by updating Forest Management Plans. - Protect habitat on private lands through land acquisitions and landowner agreements. 	<p>Threats:</p> <ul style="list-style-type: none"> • all
Critical	Ongoing	Education and Outreach	<p>4.2 Develop outreach materials that highlight the significance, vulnerability and threats to Goldenseal, emphasizing the threat of illegal collecting and trampling.</p>	<p>Threats:</p> <ul style="list-style-type: none"> • all

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Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Short term	Stewardship	<p>4.3 Based on knowledge obtained from researchers and members of First Nations groups, provide resources and fact sheets on:</p> <ul style="list-style-type: none"> - species ecology; - mechanisms for seed dispersal; - how to manage plants to encourage seed establishment; - optimal habitat conditions; and - disturbance factors, etc. 	<p>Threats:</p> <ul style="list-style-type: none"> • all
Necessary	Short term	Education, Outreach, Communication	<p>4.4 Disseminate educational materials to target audiences (landowners and First Nations).</p> <ul style="list-style-type: none"> - Continue communication with Walpole Island First Nation to find ways to meet community needs while still protecting the species. 	<p>Threats:</p> <ul style="list-style-type: none"> • all
<p>5. Address knowledge gaps relating to the species' biology and conservation, including potential propagation and reintroduction.</p>				
Necessary	Long term	Research	<p>5.1 Evaluate feasibility of reintroduction and restoration efforts.</p> <ul style="list-style-type: none"> - Evaluate feasibility of restoring historical populations based on ELC data and results of research on population ecology. - If deemed necessary and feasible, establish additional populations in suitable habitat to enhance population expansion. - Employ population augmentation at locations where Goldenseal populations are stationary or declining. - Perform additional work on seed germination models and methodology. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • seed germination and establishment
Necessary	Short term	Research	<p>5.2 Management of habitat.</p> <ul style="list-style-type: none"> - Encourage studies that link habitat quality (i.e., amount of canopy closure, soil hydrology, etc.) with threats facing Goldenseal populations (e.g., alteration of disturbance regime) and knowledge gaps. 	<p>Threats:</p> <ul style="list-style-type: none"> • all <p>Knowledge gaps:</p> <ul style="list-style-type: none"> • habitat suitability

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Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Ongoing	Management, Research	5.3 Complete germination and vitality studies. <ul style="list-style-type: none"> - Investigate germination rates and identify optimal germination conditions. 	Knowledge gaps: <ul style="list-style-type: none"> • seed germination and establishment

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Narrative to Support Approaches to Recovery

Table 3 provides the recovery approaches needed to address knowledge gaps, reduce the threats to Goldenseal populations in Ontario and implement actions for the recovery of the species. Of these, some of the critical actions linking most recovery approaches emphasized are monitoring, surveying, protecting and reintroduction or restoration. An extension of reintroduction and restoration efforts would be to conduct germination studies to investigate germination rates, seed establishment and vitality and identify optimal germination conditions. It has been demonstrated that transplanting rhizomes is a successful way to reintroduce Goldenseal. Once germination rates are understood, transplant and reintroduction programs could be supplemented by seed germination programs. Such reintroduction and restoration efforts are needed to propagate Goldenseal at low quality habitat sites, altered disturbance regime areas, or areas where Goldenseal occurred historically. Concurrently, ongoing assessments and evaluations of habitat condition and quality are recommended coinciding with research efforts in order to prioritize recovery activities. Best Management Practices for the management of Goldenseal should be developed to facilitate forest management plans and watershed report cards for Conservation Authorities. Recovery actions should be coordinated with efforts being undertaken by the Carolinian Canada Coalition's Conservation Action Plans (CAPs) and the Carolinian Woodland Recovery Strategy. The purpose of the Carolinian Woodland Recovery Strategy is to improve the integrity of those portions of the Carolinian woodland landscape in which species at risk occur (Jalava and Ambrose 2012). Many of the recovery steps recommended in this strategy could be incorporated into planning, policy, habitat stewardship and restoration activities associated with these CAPs and likely benefit the species in the long term.

Regular surveying (i.e., once every three years) of extant colonies to develop a consistent population growth rate estimate, after Sinclair and Catling's (in press) benchmark comparison between historical and extant populations, is critical and would greatly aid in recovery, management and protection efforts. Regular sampling could also include searching for any new patches that may arise and monitoring for illegal harvest. Sampling should occur at various time periods, depending on project goals. For example, studies seeking demographic structural analysis should time sampling to occur in mid to late May, when Goldenseal are in full bloom and July when most plants have produced fruits. This time period would enable researchers to readily differentiate plants from confusing look-a-likes and ensure that plants may be separated by age. It is also suggested that invasive species, such as Garlic Mustard, should be removed from within and around Goldenseal colonies to prevent any adverse competition that may occur and encourage the spread of Goldenseal and their native plant associates. Thinning of the canopy may enhance the survival and expansion of populations that have declined due to extensive shading.

2.4 Performance Measures

Performance measures can best be addressed and gauged for implementation once more information is gathered on Goldenseal population ecology from monitoring efforts and research. Performance measures should be based on the extent to which goals and objectives can be met within measurable target ranges and dates. Measurements to gauge recovery should include long term trends and patterns in population size and ecology, habitat quality and success in mitigating threats. As with other species at risk in Ontario such as Drooping Trillium (*Trillium flexipes*), site quality could be measured through habitat suitability modelling, or an index constructed based on habitat need parameters. In the absence of standardized survey protocol methodology, habitat suitability modelling has been utilized by the Nature Conservancy of Canada (NCC) for identifying suitable high quality habitats for the threatened Massasauga (*Sistrurus catenatus*)⁵.

Once data from regular population counts and monitoring are collected, a scoring system should be developed to allow for quantitative comparisons between Goldenseal populations and factors affecting the quality and extent of its suitable habitat. For example, scoring the level and type of threat such as the distance to recreational trails and volume of trail usage. Specific recommended performance measures are outlined in Table 4 below.

Table 4. Performance measures for the recovery of Goldenseal.

Objective	Performance Measure
1. Survey and monitor all populations of Goldenseal and its habitat across its native range in southern Ontario.	<ul style="list-style-type: none"> • Monitoring protocol is established in a consistent and repeatable fashion. • Accessible database of habitat characteristics and plant survey results is established and maintained. • Several field seasons required to complete updated monitoring by 2025.
2. Address knowledge gaps relating to the species' habitat needs.	<ul style="list-style-type: none"> • Devise habitat suitability models. • Score habitat based on quality in order to derive an index. • Several field seasons required; all habitats scored by 2025. • Conduct seed germination, vitality and establishment experiments by 2020. • Allow research community to be aware of research needs. • Review information gathered to consider when developing a habitat regulation. • Research on population health, vitality and age-structure should be completed by 2020. • Other research (e.g., demographic studies to further quantify demographic parameters) to be completed by 2024. • Municipalities and affected landowners become aware of Goldenseal habitat.

⁵ Additional information on NCC habitat suitability modeling for Massasauga can be found at the following link: <http://massasauga.ca/html/stewardship/section5.pdf>

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<p>3. Manage and protect habitat at all extant sites in Ontario.</p>	<ul style="list-style-type: none"> • Develop habitat and stewardship Best Management Practices (BMPs) and tools for public and private landowners by 2018. • Coordinate Garlic Mustard invasive species management plan and implement by 2020. • Implement habitat stewardship agreements with landowners by 2020.
<p>4. Develop and deliver education and stewardship programs for private landowners.</p>	<ul style="list-style-type: none"> • Maintain a Goldenseal educated network of landowners and integrate with habitat stewardship agreement by 2020. • Develop outreach materials that highlight the significance, vulnerability and threats to Goldenseal by 2018. • Disseminate educational materials to target audiences (landowners and First Nations) by 2020. • Outreach material developed and delivered by 2020. • Ensure reconnection with or keep landowners, property managers, and stakeholders current with knowledge about Goldenseal.
<p>5. Address knowledge gaps relating to the species' biology and conservation, including potential propagation and reintroduction.</p>	<ul style="list-style-type: none"> • Nurseries and restoration ecologists provided with information on Goldenseal reintroduction and restoration efforts continue communication with clonal⁶ gene bank in Harrow, Ontario, that maintains Goldenseal <i>ex situ</i> from a sample plant taken from various sites in 1998. • Revisit reintroduction plots established in 1999 to measure plants and evaluate longer term success. • Develop seed germination and successful seedling establishment protocols.

⁶ Clonal plants are derived from genetically identical individuals by asexual reproduction, in this case by vegetative growth (modified from Allaby 1992)

2.5 Area for Consideration in Developing a Habitat Regulation

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

It is recommended that the area prescribed as habitat in a regulation for Goldenseal should include the following three area types:

1. The full extent of the ELC ecosite polygon within which a population occurs.
2. A 50 metre area around each Goldenseal plant when located within 50 metres of the outer edge of the ELC ecosite polygon to protect the microhabitat.
3. If naturally vegetated, a minimum distance of 50 metres from the outer limit of the ecosite occupied by the Goldenseal population to protect the terrestrial integrity and hydrological function of the population.

The ELC ecosite within which a population occurs is recommended for protection to provide suitable habitat conditions (e.g., mesic, deciduous woods and wooded floodplains with closed or semi-closed canopies) to carry out essential life processes for the species. This includes seed germination sites, the surface water features that influence disturbance regimes and thereby promote recruitment areas, and areas required for seed dispersal and pollination to encourage sexual reproduction.

Specific habitat information for some Ontario Goldenseal populations has been updated for consideration when developing a habitat regulation with the aid of ELC data. The 12 ELC vegetation communities within which Goldenseal has been observed may be regarded as a starting point to consider in developing a habitat regulation area. However, since not all ELC vegetation types are known for all populations, it is recommended that the full extent of the ELC ecosite polygon within which the population occurs be considered when developing a habitat regulation. This approach takes into account that Goldenseal is found in a variety of different deciduous forest ecosites. Moreover, it is not possible to delineate all the suitable habitat on a finer scale using remote survey techniques such as aerial photo interpretation.

A 50 m radius around native/wild Goldenseal plants is recommended for plants located within the ELC ecosite polygon but near its edge (i.e., within 50 m of its edge). A distance of 50 m is important to protect Goldenseal microhabitat.

The 50 m distance of natural vegetation from the outer limit of the ecosite is recommended as the distance to protect the habitat for Goldenseal. A buffer distance of 50 to 120 m is required to minimize the negative impacts of water draw down caused

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by human-induced activities such as changes in hydrology from elevating water levels (Brown et al. 1990). Moreover, it has been demonstrated that buffers at least 30 m wide are needed to protect the biological, chemical and physical integrity of small streams (Sweeney and Newbold 2014). A minimum buffer of an 80 m radius was recommended for wetlands smaller than 2 ha by Brown et al. (1990). In the case of Goldenseal, a forest understory species that depends on soil and canopy disturbances and primarily propagates vegetatively by rhizomes (Gagnon 1999, COSEWIC 2000, Environment Canada 2011), the suggested buffer of a 50 m radius may help maintain local drainage requirements needed for propagation. Prescribing 50 m of habitat beyond the ecosite boundary also allows expansion of Goldenseal colonies via vegetative or sexual mechanisms into areas influenced by the natural disturbance regime (e.g., floodplains). This includes potential seed germination sites, the surface water features that influence disturbance regimes and thereby promote recruitment areas, as well as the areas required for seed dispersal and pollination to encourage sexual reproduction. The 50 m of natural vegetation around Goldenseal-inhabited ecosites may also reduce the potential for incursion of invasive plants into the forest ecosite from its edge.

The Grey County population is thought to be of non-native stock and planted. Given the size of this population, it may be valuable for restoration purposes should the wild Ontario population experience notable declines. At this time, however, it is not recommended that a habitat regulation for Goldenseal include this population or other potential future planted populations.

GLOSSARY

Abiotic: A process that is not associated with living organisms.

Achene: The seed of flowering plants, which is usually encased by a hard outer capsule or coat.

Anther: The portion of the stamen that bears and produces pollen, usually found at the end of the filament.

Areas of Natural and Scientific Interest (ANSI): Areas of land and water that represent significant geological (earth science) and biological (life science) features.

Basal leaf: The lowest, or lower leaf on the main plant stem.

Colony: For the purposes of this recovery strategy, a group of Goldenseal plants within 500 m of each other. There may be several colonies within a population.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee established under section 14 of the Species at Risk Act that is responsible for assessing and classifying species at risk in Canada.

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

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

1 = critically imperilled

2 = imperilled

3 = vulnerable

4 = apparently secure

5 = secure

NR = not yet ranked

Cotyledon leaves: Flowering plants whose seed typically has two embryonic leaves or cotyledons that emerge after the seedling sprouts.

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

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Filament: The anther-bearing stalk of the stamen.

Pistil: The female organ of the flower usually made up of the ovary, style and stigma.

Mesic: A habitat that has a well-balanced supply of moisture, making it more moist than dry habitats.

Population: For the purposes of this recovery strategy, a group of Goldenseal plants within one km of each other. There may be several colonies within a population, and several populations within a site.

Ramets: New vegetative growth that occurs on the plant, generally on the rhizome or roots, that is formed asexually.

Rhizome: The portion of a plant stem that is below ground from which roots and shoots grow.

Site: For the purpose of this recovery strategy, a group of Goldenseal plants within 1.5 km of each other. There may be several colonies within a population, and several populations within a site.

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

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

Stamen: The pollen-producing male organ of the flower containing an anther and filament.

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**Part 3 – *Goldenseal* – Ontario Government Response
Statement, prepared by the Ontario Ministry of Natural
Resources and Forestry**

Goldenseal

Ontario Government Response Statement



Photo: Sam Brinker

Protecting and Recovering Species at Risk in Ontario

Species at risk recovery is a key part of protecting Ontario's biodiversity. The *Endangered Species Act, 2007* (ESA) is the Government of Ontario's legislative commitment to protecting and recovering species at risk and their habitats.

Under the ESA, the Ministry of Natural Resources and Forestry (the Ministry) must ensure that a recovery strategy is prepared for each species that is listed as endangered or threatened. A recovery strategy provides science-based advice to government on what is required to achieve recovery of a species.

Within nine months after a recovery strategy is prepared, the ESA requires the Ministry to publish a statement summarizing the government's intended actions and priorities in response to the recovery strategy. The response statement is the government's policy response to the scientific advice provided in the recovery strategy. In addition to the strategy, the government response statement considered (where available) input from stakeholders, other jurisdictions, Indigenous communities and organizations, and members of the public. It reflects the best available local and scientific knowledge, including Traditional Ecological Knowledge, at this time and may be adapted if new information becomes available. In implementing the actions in the response statement, the ESA allows the Ministry to determine what is feasible, taking into account social and economic factors.

The Recovery Strategy for the Goldenseal (*Hydrastis canadensis*) in Ontario was completed on June 2, 2016.

Goldenseal is a perennial herb that reaches 20 to 50 cm in height, with between one and three leaves and a bright yellow or orange underground stem (rhizome). It produces a solitary flower in the spring that lacks showy petals but has conspicuous white stamens, and develops a raspberry-like fruit in July and August.

Protecting and Recovering Goldenseal

Goldenseal is listed as a threatened species under the ESA, which protects both the plant and its habitat. The ESA prohibits harm or harassment of the species and damage or destruction of its habitat without authorization. Such authorization would require that conditions established by the Ministry be met.

Goldenseal is found in eastern North America, and grows in moist deciduous woodlands. Its range extends from southern Ontario and New England to Georgia and Arkansas in the south, and west to Kansas and Oklahoma. It is considered at risk in most of the U.S. states in which it is found. In Canada, it is found mostly in the Carolinian Zone of southwestern Ontario, between the north shore of Lake Erie and the southern end of Lake Huron from Windsor to Goderich. It also occurs farther north in Grey County, its most northern location, where it is reported to have naturalized from cultivated plants of unspecified origins.

Goldenseal populations have been reduced throughout the species' range with most remaining populations being small and restricted to woodland fragments. Within Ontario, there are estimated to be 24 extant populations. Although several known populations have been recently surveyed, about half of Goldenseal surveys in Ontario occurred at least 15 years ago, and location data for some of these populations is vague.

The overall Ontario population abundance appears to be stable, with variation in growth rates among populations. Increases observed in some populations may be linked to recent forest canopy disturbances. This includes those caused by Emerald Ash Borer (*Agilus planipennis*) and Hickory (*Carya cordiformis* and *Carya ovata*) die-off that have provided small canopy openings, resulting in reduced over-shading and enhanced light penetration.

Goldenseal reproduces both asexually (from rhizomes) and sexually (via seed production). Despite the fact that pollination does not seem to be limiting and seed production is successful, reproduction by seed is low. Because of its vegetative growth and presumed limited seed dispersal, Goldenseal tends to occur in clumps. It is typically found in or at the edge of deciduous forests in nutrient rich, moist soils with varying amounts of canopy cover.

The main threats to Goldenseal in Ontario include habitat loss resulting from woodland clearing associated with land development for residential, commercial, industrial and agricultural purposes, along with habitat

degradation. Historically, causes of habitat degradation are thought to have included alteration of natural disturbance regimes (e.g., fires, floods, and effects of colonial birds on canopy gaps, soil disturbance and seed dispersal) and of hydrologic regimes (e.g., changes to soil drainage patterns). Goldenseal is often associated with forest edges and paths, suggesting that it may benefit from localized disturbance such as tree-fall openings. The reduced levels of the natural woodland disturbances once typical of northeastern woodlands may limit seedling establishment and inhibit the spread of Goldenseal within its range. Forestry, land developments, road construction and agricultural activities can alter site drainage, which can change soil moisture and micro-habitat conditions from those which are required by the species.

Harvesting and trade of wild Goldenseal is also a significant threat to the species across its North American range, and these activities have resulted in the listing of the species under the Convention on International Trade in Endangered Species (CITES). The root of wild Goldenseal in Ontario and the United States is used in herbal medicines, and almost all of the Goldenseal sold in Canada comes from North American wild populations. In particular, populations on public land close to recreational trails may be at risk from illegal harvesting. Plants in such locations adjacent to well-used trails may also be at risk from trampling.

Competition with invasive woodland species poses a potential threat to Goldenseal. Garlic Mustard (*Alliaria petiolata*) may be out-competing Goldenseal at three population locations, and four other Goldenseal sites also have invasive woody shrub species and non-native woody plants.

Approaches to Goldenseal recovery will require collaboration with landowners, land managers and Indigenous communities and organizations to effectively protect and manage habitat and reduce threats. They will also include filling knowledge gaps through monitoring and research on Goldenseal habitat requirements, biology (e.g., seed dispersal and conditions for germination and establishment), and response to management techniques. Reducing threats to the species from illegal harvest and invasive species at the site-level will support persistence of the population in Ontario, while research to understand natural disturbance effects and requirements, and the application of this knowledge, will support natural increases within the Ontario population.

Government's Recovery Goal

The government's goal for the recovery of Goldenseal is to maintain self-sustaining populations of Goldenseal throughout its current distribution in Ontario, and to support natural increases in its abundance through effective threat mitigation.

Actions

Protecting and recovering species at risk is a shared responsibility. No single agency or organization has the knowledge, authority or financial resources to protect and recover all of Ontario's species at risk. Successful recovery requires inter-governmental co-operation and the involvement of many individuals, organizations and communities. In developing the government response statement, the Ministry considered what actions are feasible for the government to lead directly and what actions are feasible for the government to support its conservation partners to undertake.

Government-led Actions

To help protect and recover the Goldenseal, the government will directly undertake the following actions:

- Continue to implement the Ontario Invasive Species Strategic Plan to address the invasive species (e.g., Garlic Mustard) that threaten Goldenseal.
- Continue to monitor populations and manage Goldenseal habitat in provincially protected areas where the species occurs.
- Co-operate with federal partners, such as Environment and Climate Change Canada, to implement protection and recovery actions, where appropriate.
- Educate other agencies and authorities involved in planning and environmental assessment processes on the protection requirements under the ESA.
- Encourage the submission of Goldenseal data to the Ministry's central repository at the Natural Heritage Information Centre.
- Undertake communications and outreach to increase public awareness of species at risk in Ontario.
- Protect the Goldenseal and its habitat through the ESA.
- Develop direction to provide greater clarity to proponents and partners on the areas of general habitat protected under the ESA for species at risk plants.
- Support conservation, agency, municipal and industry partners, and Indigenous communities and organizations to undertake activities to

protect and recover the Goldenseal. Support will be provided where appropriate through funding, agreements, permits (including conditions) and/or advisory services.

- Encourage collaboration, and establish and communicate annual priority actions for government support in order to reduce duplication of efforts.

Government-supported Actions

The government endorses the following actions as being necessary for the protection and recovery of the Goldenseal. Actions identified as “high” will be given priority consideration for funding under the ESA. Where reasonable, the government will also consider the priority assigned to these actions when reviewing and issuing authorizations under the ESA. Other organizations are encouraged to consider these priorities when developing projects or mitigation plans related to species at risk. The government will focus its support on these high-priority actions over the next five years.

Focus Area: Threat and Habitat Management

Objective: Manage Goldenseal populations and their habitats to improve long-term viability and reduce threats to the species in collaboration with local landowners, land managers, municipalities and the community of Bkejwanong (Walpole Island First Nation) and other interested Indigenous communities and organizations.

Habitat degradation and loss, and associated population declines, are significant threats to Goldenseal. Because this plant is found on public land, including in protected areas, as well as on private land and in Bkejwanong (Walpole Island First Nation), a collaborative approach to developing, implementing and assessing effective management practices will ensure that the best available resources and information are shared and used to support Goldenseal recovery.

Actions:

1. **(High)** Collaboratively work with landowners, land managers, municipalities and the community of Bkejwanong (Walpole Island First Nation) and other interested Indigenous communities and organizations to minimize threats to the species and maintain or enhance habitat conditions for Goldenseal by:
 - developing, implementing, and evaluating the effectiveness of site management plans for Goldenseal, including for logged woodlots;

- removing invasive species (e.g., Garlic Mustard) in Goldenseal habitat, in locations where invasive species are degrading habitat or threatening the species;
- implementing best practices for woodlot management to support suitable habitat conditions for Goldenseal;
- minimizing site-level threats to the species by redirecting recreational activities through the use of signage and fencing, as appropriate; and,
- monitoring the species' and habitat responses to invasive species control, woodlot management and canopy thinning, and threat management to inform adaptive management of the habitat.

Focus Area: Research and Monitoring

Objective: Improve understanding of Goldenseal habitat requirements, effects of changes to disturbance regimes, reproductive biology, and population trends to inform approaches to habitat management and species conservation.

There are substantial knowledge gaps that exist for Goldenseal, including its ecology, habitat requirements, and approaches to address threats. Improving the availability of knowledge on how natural disturbance patterns and the hydrologic regime affect Goldenseal and its habitat will support woodlot management for the species. Filling knowledge gaps related to reproductive ecology and propagation such as pollination, seed dispersal, germination and establishment will inform the implementation of recovery actions related to reproductive success. In addition, continued population monitoring will track whether current Ontario population levels are being maintained, and how they are responding to management actions.

Actions:

2. **(High)** Conduct research on Goldenseal demographics, ecology and habitat requirements, including:
 - research into the effects of forest fragmentation and alterations to disturbance and hydrologic regimes (e.g., land drainage, flood mitigation) on Goldenseal; and,
 - research on Goldenseal seed pollination, dispersal and germination, and seedling ecology.
3. **(High)** Monitor Goldenseal populations and habitat conditions using standard survey techniques to track trends in population abundance, area occupied, demographics, and reproduction at existing locations.
4. Survey historical locations of Goldenseal to determine if populations are extant.

5. Investigate knowledge gaps related to the resilience of Goldenseal populations to harvest and the prevalence of this threat in Ontario.
6. Work with Indigenous communities and organizations to record, share and transfer Traditional Ecological Knowledge on Goldenseal as available, including information on the condition of the species and its habitat to inform habitat management actions.

Focus Area: Education and Awareness

Objective: Increase public awareness about Goldenseal, its potential threats, and approaches to address threats.

Indigenous communities and organizations, municipalities, landowners and land managers have an important role to play in reducing threats to Goldenseal, in particular those associated with illegal harvest, invasive species control, and woodlot management. By increasing the level of awareness of the public with regards to the species and its habitat, more effective protection can be provided.

Due to the popularity of Goldenseal for medicinal use, public awareness of the status of Goldenseal and the effects of illegal harvest on wild populations is also important for its protection and recovery. Because of the risk of illegal harvest, caution should be used about providing information that could result in identification of species' locations.

Actions:

7. Increase awareness among private landowners and the public about Goldenseal, its protections under the ESA, and its vulnerability to illegal harvest. Educate users of herbal medicines on the status of the species and legal sources of Goldenseal to support demand reduction for wild populations.

Implementing Actions

Financial support for the implementation of actions may be available through the Species at Risk Stewardship Program. Conservation partners are encouraged to discuss project proposals related to the actions in this response statement with the Ministry. The Ministry can also advise if any authorizations under the ESA or other legislation may be required to undertake the project.

Implementation of the actions may be subject to changing priorities across the multitude of species at risk, available resources and the capacity of partners to undertake recovery activities. Where appropriate, the implementation of actions for multiple species will be co-ordinated across government response statements.

Reviewing Progress

The ESA requires the Ministry to conduct a review of progress towards protecting and recovering a species not later than five years from the publication of this response statement. The review will help identify if adjustments are needed to achieve the protection and recovery of the Goldenseal.

Acknowledgement

We would like to thank all those who participated in the development of the Recovery Strategy for the Goldenseal (*Hydrastis canadensis*) for their dedication to protecting and recovering species at risk.

For additional information:

Visit the species at risk website at ontario.ca/speciesatrisk

Contact your MNRF district office

Contact the Natural Resources Information Centre

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TTY 1-866-686-6072

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