

Management Plan for the Houghton's Goldenrod (*Solidago houghtonii*) in Canada

Houghton's Goldenrod



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¹ <http://www.registrelep-sararegistry.gc.ca>

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 management plans for listed species of special concern and are required to report on progress five years after the publication of the final document on the SAR Public Registry.

The Minister of the Environment is the competent minister under SARA for the Houghton's Goldenrod and has prepared this management plan as per section 65 of SARA. To the extent possible it has been prepared in cooperation with the Government of Ontario.

Success in the conservation 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 plan and will not be achieved by Environment Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Houghton's Goldenrod and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

² <http://registrelap-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2>

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³ Ministry of Natural Resources and Forestry, previously called Ontario Ministry of Natural Resources (OMNR).

Executive Summary

Houghton's Goldenrod (*Solidago houghtonii*) is listed as special concern on Schedule 1 of the *Species at Risk Act* and as threatened under the Ontario *Endangered Species Act, 2007*.

Houghton's Goldenrod is a perennial plant in the Aster family (Asteraceae⁴). Young plants grow as rosettes of slender, untoothed leaves. In later years the plants produce upright flowering stalks about 30-60 cm tall with 5-50 flower heads in a flat-topped cluster. Houghton's Goldenrod can only be conclusively identified when the plants are fertile from late August through September. The species is easily confused with the Ohio Goldenrod which sometimes grows in the same habitat. Low germinability⁵ of seeds, low pollen transfer, low fruit set, and a very late bloom period may be natural limitations for this species.

Houghton's Goldenrod is found only on or near the northern shores of Lake Michigan, Lake Huron, and Georgian Bay. There are 33 occurrences in Canada, all in Ontario. There is currently no information on trends in population size. Many populations are on lands belonging to Wikwemikong Unceded Indian Reserve and Whitefish River First Nation. Roughly one third of the populations are on corporately-owned lands.

Houghton's Goldenrod is primarily found in alvar⁶ and bedrock shoreline habitats. The population on Cockburn Island is an exception and occurs on low sand dunes. Houghton's Goldenrod also persists in some degraded, weedy former alvar habitats. A moist microhabitat is required within all vegetation types.

Threats to Houghton's Goldenrod include heavy recreational use of alvars, off-road vehicle use, development and construction, logging and industrial activities, quarrying and aggregate extraction, invasion by exotic species, and grazing and browsing. The use of herbicides may also be a potential threat. A lack of public awareness underpins the threats stated above.

The management objectives for Houghton's Goldenrod are to maintain the distribution and abundance of all populations at current levels through maintenance of habitat and reduction of threats. Broad strategies to achieve the management objectives include: assessment of threats and work on threat mitigation and reduction; use of policy to protect Houghton's Goldenrod; outreach and education to promote awareness of Houghton's Goldenrod and its habitats; and research to inform monitoring and management approaches to promote the protection of Houghton's Goldenrod and its habitats. A number of conservation measures are suggested in Section 6.3. A recovery strategy is being prepared for Houghton's Goldenrod by the Province of Ontario and provincial general habitat provisions are in effect for the species in Ontario.

⁴ Includes asters, daisies, goldenrods, sunflowers and many others.

⁵ The degree of ability of a seed to germinate or sprout.

⁶ Alvars are open, sparsely treed or treeless ecosystems with very shallow soils on level limestone or dolostone bedrock. Alvar vegetation may be dominated by grasses and sedges or low, creeping shrubs. There are different types of alvars just as there are different types of forests (Jones and Jalava, 2006).

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1. COSEWIC* Species Assessment Information

Date of Assessment: May 2005

Common Name: Houghton's Goldenrod

Scientific Name: *Solidago houghtonii*

COSEWIC Status: Special Concern

Reason for Designation: A Great Lakes endemic present in Ontario at the tip of Bruce Peninsula and on Manitoulin Island. The few populations occupy very small areas of provincially rare alvar habitat that are at potential risk from aggregate extraction, use of recreational vehicles and expansion of invasive weeds.

Canadian Occurrence: Ontario

COSEWIC Status History: Designated Special Concern in May 2005.

* COSEWIC – Committee on the Status of Endangered Wildlife in Canada

2. Species Status Information

Houghton's Goldenrod (*Solidago houghtonii*) has a global conservation status rank of G3 (Vulnerable⁷) and is listed as Special Concern⁸ on Schedule 1 of the *Species at Risk Act* and as Threatened⁹ in Ontario on Schedule 3 of the Ontario *Endangered Species Act, 2007*. It has national conservation ranks of N2 (Imperiled¹⁰) in Canada and N3 (Vulnerable) in the United States. In Ontario, the species has a conservation status rank of S2 (Imperiled). In Michigan it is ranked S3 (Vulnerable) and in New York S1¹¹ (Critically Imperiled) (NatureServe 2013a).

3. Species Information

3.1. Species Description

Houghton's Goldenrod is a perennial plant in the Aster Family. In the first few years of growth it produces a rosette of slender (1-2 cm wide), untoothed leaves. In subsequent years, it produces an upright flowering stalk about 30-60 cm tall with narrow leaves, which become smaller going up the stem. One flower head is made up of many tiny

⁷ G3/N3/S3 - Vulnerable - At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

⁸ "Species of Special Concern" means a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

⁹ "Threatened" means the species 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.

¹⁰ 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.

¹¹ 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.

flowers. This is a trait shared by all flowers in the Aster family. In Houghton's Goldenrod, the heads are arranged in a flat-topped cluster and the stalks below the heads are rough. Plants typically have 5 to 50 heads, and each head has 6-12 ray florets and 8-15 disc florets. Both the ray flowers at the outside and the disc flowers in the centre of each head are bright yellow (Semple and Cook 2006; Reznicek et al. 2011).

Identification of Houghton's Goldenrod requires expertise, and even then this species can only be conclusively identified when the plants are fertile. Thus, presence of Houghton's Goldenrod can only be determined from late August through September when the plants are in flower or fruit. Determining absence of Houghton's Goldenrod may require a few years of monitoring, because individual plants normally do not flower in consecutive years (Jolls and Tolley in prep.). Houghton's Goldenrod is easily confused with Ohio Goldenrod (*Solidago ohioensis*), especially as the two sometimes grow in the same habitat and both species have flat-topped capitulescences¹². Some morphological characteristics help to distinguish between the two species (see Table 1).

Table 1. Morphological differences between Houghton's Goldenrod and Ohio Goldenrod (Semple and Cook 2006; Voss and Reznicek 2012).

	Houghton's Goldenrod	Ohio Goldenrod
Basal Leaves	Narrow	Ovate
Rays	3 to 4.5 mm, max.7 mm long	1.5 to 3 mm long
Involucres	5 to 7mm, max.8 mm long	3.5 to 5.5 mm, max.6.5 mm
Stalks under the flower heads	Rough	Smooth
Flower Heads	Large and few	Small and numerous
Flowering	Bloom late August – end of September	Blooms August – early September

It is important to note that Houghton's Goldenrod cannot always be identified using standard field botanical survey methods only. Genetic analysis may be required to confirm identification, as explained below.

Genetics

Over the global range of Houghton's Goldenrod, the species exhibits some variation in habitat preferences and morphological traits. Based on these variations, Pringle (USFWS 1997) outlined four different entities within *S. houghtonii*: #1 in Michigan on both sides of the straits of Mackinac and in Ontario on Cockburn Island; #2 in Ontario on limestone or dolostone; #3 a single disjunct population in central Michigan; #4 a single occurrence in New York. This has resulted in discussions on what traits belong within the species called *S. houghtonii*, and has led many researchers to speculate on the hybrid origins of the species from a range of potential progenitors¹³ (Morton 1979; Edwards-Wilson 1999; Pringle in USFWS 1997; Semple et al. 1999).

A recent genetic study (Laureto and Barkman 2011) suggested a hybrid origin for *S. houghtonii*, with several progenitors contributing to the genome¹⁴. Nuclear DNA sequence data show that *S. riddellii* (Riddell's Goldenrod), *S. ptarmicoides* (Upland White Aster), and *S. ohioensis* (Ohio Goldenrod) likely have contributed to the nuclear

¹² An aggregate inflorescence made of capitula (tiny flowers arranged in a platform-like base) instead of individual flowers.

¹³ Progenitor: A biologically related ancestor.

¹⁴ Genome: The full complement of genetic material within an organism.

genome¹⁵ of *S. houghtonii*. Analysis of chloroplast¹⁶ DNA data suggests *S. gigantea* (Tall Goldenrod) was the maternal genome donor. The data suggest a single origin for *S. houghtonii* with a complex, reticulate evolution¹⁷ from different types of genetic events. Unlike entities #1, 3, and 4, the Ontario alvar entity #2 did not contain sequences from *S. ptarmicoides*.

Laureto and Barkman (2011) offer a few explanations for the lack of *S. ptarmicoides* sequence in the Ontario alvar entity #2, such as PCR¹⁸ associated problems (Rauscher et al. 2002), incomplete sampling of clones, or evolutionary processes such as concerted evolution¹⁹. They explain that even though they screened 22 clones, a larger number (Small et al, 2004) may be required to explain the difference. The authors also consider that evolution may have eliminated or silenced *S. ptarmicoides* in individuals from this geographic region. Alternatively, *S. ptarmicoides* may not have been involved in the parentage of individuals from this geographic region although morphology suggests otherwise.

In addition, Laureto (2010) states that since *S. houghtonii* is a sexually reproducing hexaploid²⁰ species, the existence of three genomes is expected. Essentially two genomes, *S. ohioensis* and *S. riddellii*, were recovered from this individual; the third parental genome remains unclear. Cloning additional individuals from this geographic region may reveal the presence of the *S. ptarmicoides* genome as it is believed to be the most likely contributor of the large ray flowers of *S. houghtonii*.

True *S. houghtonii* is hexaploid (Semple et al. 1981, 1984) (entity #1 - populations of Michigan on the straits of Mackinac and of Ontario on Cockburn Island). As a result, entity #3 from central Michigan has been described as a new species, *S. vossii* (Laureto and Pringle 2010), because it is octoploid²¹ and has genetic evidence of separate evolutionary events.

3.2. Populations and Distribution

Houghton's Goldenrod is endemic to the Great Lakes; it is found only on or near the northern shores of Lake Michigan, Lake Huron, and Georgian Bay (Guire and Voss 1963; Morton 1979; USFWS 1997; Semple et al. 1999; COSEWIC 2005; Jones 2007, 2010, and unpubl. data; NatureServe 2013a). In the North American range (see COSEWIC 2005 for a figure of the global (North American) distribution of the species), a large group of populations occurs in the Straits of Mackinac, Michigan and on Beaver and Drummond Islands, Michigan. The population on Cockburn Island, Ontario is likely

¹⁵ Nuclear genome: Genetic material stored in the nucleus of the cell.

¹⁶ Chloroplast: A specialized part of a cell (organelle) that contains chlorophyll (green pigment of plants, essential for its survival).

¹⁷ Reticulate evolution is characterized by occasional hybridization and combination of two species.

¹⁸ PCR (Polymerase Chain Reaction) is a biochemical technique that focus on a specific piece of the DNA and copy it billions of times over. It is used for many purposes, including DNA-based phylogeny (study of evolutionary relationships among groups of organisms) (Metzker et al., 2009).

¹⁹ Concerted evolution is a genetic process by which repetitive deoxyribonucleic acid (DNA) sequences are homogenized so that the sequence of a given multigene family within a species shares much higher sequence identity than that of the homologous gene family between two different species (Liao, 2008).

²⁰ Hexaploid: Having six copies of each chromosome in the nucleus.

²¹ Octoploid: Having eight copies of each chromosome in the nucleus.

part of the Michigan group. Another group of populations occurs at the eastern end of the Manitoulin Island region. Single populations are known to be present on the Bruce Peninsula and in western New York.

There are 33 occurrences²² of Houghton's Goldenrod in Canada (Morton and Venn 2000; Brownell and Riley 2000; Jalava 2008; Jones 2004, 2005, 2007, 2010, and unpubl. data; W. D. Bakowsky, pers. comm. 2014). All are in Ontario (Figure 1). Information on trends in population size is lacking because most sites have had only one observation or lack abundance data. Studies on population trends and dynamics, and surveys to map all existing populations are recommended in Section 6.3. Many populations and thousands of individuals are found on lands belonging to two First Nations communities in the Manitoulin Region, Wikwemikong Unceded Indian Reserve (WUIR) and Whitefish River First Nation. Approximately one third of populations are on land in corporate ownership.

²² An occurrence consists of all populations, subpopulations, or patches that are within 1 km of each other (NatureServe 2013b).

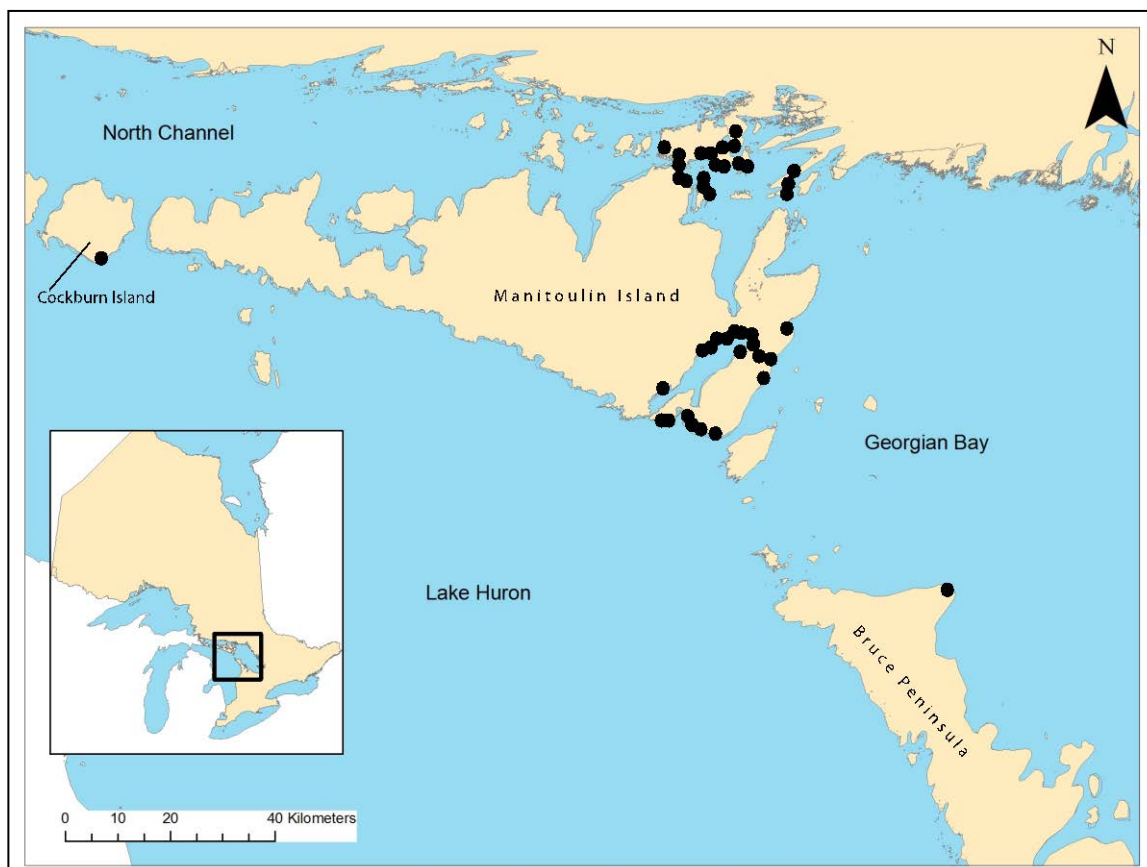


Figure 1. The range of Houghton's Goldenrod in Canada. Black dots represent Houghton's Goldenrod's occurrences. (Reproduced from the unpublished draft Recovery Strategy for Houghton's Goldenrod in Ontario. Used with permission from the Ontario Ministry of Natural Resources and Forestry).

3.3. Needs of the Houghton's Goldenrod

Biology

Houghton's Goldenrod is a rhizomatous²³ perennial²⁴ herb. Plants may produce 2-12 ramets²⁵ which may break off and become established as separate plants. Young individuals may live for 1-6 years as basal rosettes of leaves before flowering, and flowering plants may live for many years following a successful fruit set (Semple and Ringius, 1992; USFWS 1997). The maximum age of individuals of Houghton's Goldenrod is unknown, but may possibly be a decade or more (J. Jones, pers. comm. 2014.). Individual plants normally do not flower in consecutive years (Jolls and Tolley in prep.). Plants flower late in the season, sometimes as late as the end of September (J. Jones, pers. comm. 2014). If successfully pollinated, each central disc flower produces a single seed-like fruit, with an attached ring of bristles (pappus) at the top which catches air movements and allows dispersal of the fruit by wind (Semple et al. 1999).

²³ Rhizome: is a rootlike subterranean stem, commonly horizontal in position, that usually produces roots below and sends up shoots progressively from the upper surface.

²⁴ Plants that have a life cycle of more than 2 years.

²⁵ Ramets: an individual of a clone.

According to Penskar (1997), specific insect pollinators of *S. houghtonii* have not been identified. Arthropod associates were identified by Jolls (1994), and include several families from the orders Coleoptera (Phalacridae), Diptera (Bombyliidae, Syrphidae), Hemiptera (Nabidae), Hymenoptera (Formicadae, Halictidae), Lepidoptera (Coliophoridae), and Orthoptera (Cercophidae).

Successful sexual reproduction, however, is infrequent and is likely limited by pollen transfer. The authors observed that self-pollination is largely unsuccessful and fruit set for open pollination²⁶ is low (17%). Growth chamber experiments showed Houghton's Goldenrod has low germinability (56%) which does not appear to be affected by substrate type or moisture level (Jolls and Tolley in prep.). Seeds require light and chilling for germination, and germinability declines significantly after a period of months.

The flowers of Houghton's Goldenrod are showy and very late blooming, so the species may play some ecological role for insect populations at the end of growing season, but it is possible there may be some years when early frost prevents successful pollination (J. Jones, pers. comm. 2014).

Houghton's Goldenrod can also reproduce vegetatively by means of underground rhizomes. The species can apparently survive transplantation, with disarticulated ramets establishing as independent plants, as exhibited by an inland population established by transplantation in Michigan (Penskar, 1997; USFWS 1997).

Some of the reproductive characteristics described above, such as low germinability of seeds, low pollen transfer, and low fruit set, may also be natural limitations for Houghton's Goldenrod. There are several unknowns about the species' reproductive biology, such as pollination and dispersion, viability, and conditions for the germination of seeds. Studies to address these knowledge gaps are recommended in Section 6.3.

Habitat

In Canada, except on Cockburn Island (discussed below), the habitat of Houghton's Goldenrod is found in open, nearly treeless areas on Ordovician²⁷ limestone or Silurian²⁸ dolostone, in alvars or on bedrock shorelines along Lake Huron or Georgian Bay (Reschke et al. 1999; Brownell and Riley 2000; Jones 2004, 2005, 2007, 2010; and unpubl. data on file with the Natural Heritage Information Centre (NHIC); Jalava 2008; Reznicek et al. 2011). The vegetation communities in the Ecological Land Classification (Lee et al. 1998) that support habitat for Houghton's Goldenrod in these situations include: Shrubby Cinquefoil Carbonate Open Bedrock Beach (BBO2-1); Dry-Fresh Little Bluestem Open Alvar Meadow (ALO1-3); Fresh-Moist Tufted Hairgrass Open Alvar Meadow (ALO1-5); Creeping Juniper-Shrubby Cinquefoil Dwarf Shrub Alvar (ALS1-2); and more open (low tree cover) examples of Jack Pine – White Cedar – White Spruce Treed Alvar (ALT1-4) (Bakowsky 1996; Reschke et al 1999; Brownell and Riley 2000; Jones unpubl. data).

²⁶ Open pollination: pollination by insects, birds or wind or other natural mechanisms.

²⁷ The Ordovician is a geologic period and covers the time between 485 ± 1.9 to 443 ± 1.5 million years ago.

²⁸ The Silurian is a geologic period that extends from the end of the Ordovician Period, about 443 ± 1.5 million years ago (mya), to the beginning of the Devonian Period, about 419 ± 3 mya.

These communities may be dominated by Shrubby Cinquefoil (*Dasiphora fruticosa*), Northern Dropseed (*Sporobolus heterolepis*), Little Bluestem (*Schizachyrium scoparium*), Tufted Hairgrass (*Deschampsia cespitosa*), or Creeping Juniper (*Juniperus horizontalis*) (Reschke et al. 1999; Brownell and Riley 2000; Jones 2004, 2005, 2010, and unpubl. data). In ALT1-4, the ground flora may be dominated by any of the five above-mentioned species.

On Cockburn Island, Houghton's Goldenrod occurs on low sand dunes dominated by Little Bluestem and Long-leaved Reed Grass (*Calamovilfa longifolia* var. *magna*). The vegetation community may be classified as Little Bluestem – Long-leaved Reed Grass – Great Lakes Wheatgrass Open Dune (SDO1-2). Frequent associates of Houghton's Goldenrod in both alvar and dune vegetation include Ohio Goldenrod, Upland White Goldenrod (*Solidago ptarmicoides*), Kalm's Lobelia (*Lobelia kalmii*), Twig Rush (*Cladium mariscoides*), and Sticky False Asphodel (*Triantha glutinosa*), in addition to the dominants already listed (Penskar et al. 2000; J. Jones, unpubl. data).

Houghton's Goldenrod is also able to persist after a moderate level of disturbance, and the species is abundant in some degraded, weedy former alvar habitats, such as alvars that were used as livestock pasture or alvars that extend into roadside ditches or utility corridors (J. Jones, pers. comm. 2014 and unpubl. data). The vegetation community in these areas may be classified as either Bedrock Cultural Meadow (CUM2) or Common Juniper Cultural Alvar Thicket (CUT2-1).

Houghton's Goldenrod requires a moist microhabitat within these vegetation types. The species tends to grow in the moist parts of alvars and bedrock shores, at the edge of low, marshy spots and where water pools for a while before evaporating. Often, these wet areas are the result of shallow depressions in the underlying bedrock or spots where the rock has no fissures or fractures that allow drainage. On sand, Houghton's Goldenrod is most common in the moist flat sand between low dune ridges and at the edges of marshy areas (Jones 2004, 2005, 2007, 2010 and unpubl. data).

Alvars are open habitats, and as with other open habitats, such as prairies and oak savannas, have traditionally been maintained by periodic fire (Tester 1989; Riley 2013). As a result, there has been much discussion on the role of fire in maintaining alvars (Catling and Brownell 1998; Reschke et al. 1999; Brownell and Riley 2000; Catling et al. 2001; Catling 2009). Some researchers maintain that fire is harmful to alvars (Gilman 1995, 1997), while others maintain it is beneficial or required (Catling and Brownell 1998; Catling et al. 2001; Catling 2009). Some types of alvars show evidence of burning, while other types do not, so it is possible that fire may play a role in some types, but not in others (Jones and Reschke 2005).

Most alvars where Houghton's Goldenrod is found do not show evidence of past burning (Jones unpubl. data on file at NHIC). It is possible these open alvars were not created by burns, but instead by the extremely slow and sparse vegetative growth since post-glacial times (Jones and Reschke 2005). It is also possible that in these alvars other ecological processes, such as the drought-flood cycle and the creation of shallow soils, may inhibit growth of woody vegetation, keeping the habitat in a sparse, open state without fire (Rosén 1995; Reschke et al. 1999).

Conversely, a few alvars where Houghton's Goldenrod occurs do have evidence of historical burning (Jones unpubl. data on file at NHIC). However, most have no evidence that they have been burned in the last 130 years (Jones unpubl. data), so it is possible they may have been created in a single fire or may burn only on very long repeat cycles. Jones (2000) found that oak savannas in one township on Manitoulin Island were created in a single, catastrophic fire, had not burned again in any repeat fire, and eventually grew into woodland habitats. Overall, the Manitoulin Island oak savanna vegetation has been maintained within the landscape (by being periodically created), but individual patches and their locations may have changed over time. Alvars may have a similar history to oak savannas, but their growth is much slower. Currently, it remains unknown whether controlled burning on alvars would be beneficial or harmful to Houghton's Goldenrod.

Houghton's Goldenrod occasionally occurs in the same alvars as Gattinger's Agalinis (*Agalinis gattingeri*, endangered in Canada) and Hill's Thistle (*Cirsium hillii*, threatened in Canada) and at the same dune sites as Pitcher's Thistle (*Cirsium pitcheri*, special concern in Canada). However, none of these species occur together in the same microhabitats (Jones unpubl. data on file at NHIC). Catling (1995) found Houghton's Goldenrod to be highly (85-100%) confined to alvars, but the study only included Canadian populations. In the North American range of what is currently considered *S. houghtonii* (see in Genetics, Section 3.1), many populations of this species occur on sand (Penskar et al. 2000; Reznicek et al. 2011; NatureServe 2013a).

4. Threats

There are some potential threats to Houghton's Goldenrod, and these include heavy recreational use of habitat and a lack of public awareness, off-road vehicle use, use of herbicide, development and construction, logging and industrial activities, quarrying and aggregate extraction, grazing and browsing, and invasion by exotic species. Severe climatic/weather events, such as droughts, can potentially wipe out a vulnerable species or habitat. Many of these threats are to the alvars, for which the species is dependent upon and according to Catling (2013) there is little hope of artificially creating or restoring alvars once they have been destroyed. Therefore, it is important that the alvars are not destroyed or degraded. Table 2 assesses the threats to Houghton's Goldenrod.

4.1. Threat Assessment

Table 2. Threat Assessment Table

Threat	Level of Concern ^a	Extent	Occurrence	Frequency	Severity ^b	Causal Certainty ^c
Disturbance or Harm						
Heavy Recreational Use	High	Localized	Current	On-going	Medium	High
Off-road Vehicle Use	High	Widespread	Current	On-going	Medium	High
Habitat Loss or Degradation						
Development and Construction	High	Widespread	Current	On-going	High	High
Logging and Industrial Activities	High	Several Locations	Current	On-going	High	High
Quarrying and Aggregate Extraction	Medium	Localized	Current	On-going	Medium	High
Grazing and Browsing	Medium	Localized	Current	Seasonal	Medium	High
Pollution						
Use of Herbicide	Unknown	Localized	Potential	Periodic	Unknown	Unknown
Exotic, Invasive, or Introduced Species/Genome						
Invasion by Exotic Species	Medium	Widespread	Current	On-going	High	High
Climate and Natural Disasters						
Changes in Climate	Low	Widespread	Current	Unknown	Unknown	Unknown

^a *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the conservation of the species, consistent with the management objectives. This criterion considers the assessment of all the information in the table.*

^b *Severity: reflects the population-level effect (High: very large population-level effect, Medium, Low, Unknown).*

^c *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g. expert opinion; Low: the threat is assumed or plausible; Unknown).*

4.2. Description of Threats

Disturbance or Harm

Heavy Recreational Use

Houghton's Goldenrod is found in alvar and interdunal wetlands. These habitats are frequently used for activities such as unmonitored camping (allowing for the placement of tents, fire pits and latrines on alvars) and heavy pedestrian traffic (associated with vegetation trampling and possible littering) (COSEWIC 2005). Lack of public awareness about the importance of alvar habitats underpins other threats, and may expedite habitat degradation. Perhaps due to the sparse vegetation and lack of trees, alvars are frequently perceived as waste land where indiscriminate usage does not matter because "there is nothing there". In addition, because they are thought of as "waste land", alvars are often chosen as the locations for many of the activities that result in the threats listed below (Jones and Jalava, 2006).

Off-road Vehicle use

Off-road use of all-terrain vehicles (ATVs) and other vehicles is a threat to both Houghton's Goldenrod individuals and their habitats. Off-road vehicle use may disturb or destroy vegetation, displace shallow layers of soil, and bring in weedy/invasive species. Ruts made by vehicles in wet soil or sand tend to channel water and can change moisture and drainage regimes (Reschke et al. 1999).

Habitat Loss or Degradation

Development and Construction

Most sites where Houghton's Goldenrod occurs are in close proximity to the Lake Huron or Georgian Bay shorelines, which are in demand for residential or cottage development. Industrial and commercial development are also current threats to habitat in one area of Manitoulin Island (COSEWIC, 2005). The construction of buildings, yards, driveways, and roads on alvars and/or dunes may completely eliminate suitable habitat. Development may have negative effects as a result of clearing vegetation, blasting bedrock to level foundations or anchor other structures, trucking in fill which introduces invasive plants and covers suitable ground, displacing shallow soil, and trampling vegetation with heavy machinery (COSEWIC, 2005; Jones and Jalava, 2006).

Kraus et al. (2009) studied the biodiversity and conservation of Lake Huron's Islands (including Manitoulin and Cockburn Islands) and identified incompatible development as one of the most dominant threats: it results in habitat loss, including fragmentation; and degradation of natural processes in and nearshore waters. The authors stated that habitats in the Les Cheneaux Islands (USA), southeastern Georgian Bay region and along the Bruce Peninsula and Manitoulin Island, are particularly vulnerable to this threat.

Logging and Industrial Activities

Alvar habitats are frequently used as staging areas for logging operations in adjacent forests and for storage of materials and machinery for industrial uses. Moving logs, materials, and heavy machinery across alvars tramples plants, dislodges shallow soils, and brings in exotic

species that degrade habitat. These activities impact the alvar habitats as well as the plants themselves (Jones and Jalava, 2006).

Quarrying and Aggregates Extraction

Alvars are often in demand for quarry development because the limestone bedrock is close to the surface, and little clearing of forest and soil is necessary (Reschke et al. 1999). Quarrying usually destroys alvar habitat. In the Manitoulin Island region, several populations of Houghton's Goldenrod are within an area that is licenced for aggregate extraction. However, licence holders have an agreement under the Ontario *Endangered Species Act, 2007 (ESA)* that requires surveys be conducted and appropriate mitigation measures be implemented should the species be found before any new expansion (Steedman, R. pers. comm. 2014). A large amount of habitat in the area was seriously degraded by extraction activities between 1996 and 2007, and it is not known if, or how much of, these populations may still remain.

Grazing and Browsing

Livestock grazing degrades habitat, reduces populations of plants, and spreads non-native weeds (Reschke et al. 1999). Historically, several alvars where Houghton's Goldenrod occurs had livestock on them, and the presence of weeds (such as Common Timothy and White Sweet-Clover) and tall Eurasian grass species (i.e. European Common Reed - *Phragmites australis* ssp. *australis*) are indicative of habitat degradation. In 2013, only one of the Houghton's Goldenrod surveyed sites was being grazed (J. Jones, pers. obs.), but grazing remains a potential threat in a few places. In addition, there are exceptionally large populations of White-tailed Deer (*Odocoileus virginianus*) in some areas where Houghton's Goldenrod occurs. White-tailed Deer browsing has been shown to affect the composition of several plant communities in the north-central and northeastern United States (Russel et al., 2001). Research on the effects of deer browsing on alvars (Reschke et al. 1999, Jones unpubl. data) has shown that deer frequently eat the flower stalks of other species of goldenrods. Intentional reduction of natural predators and a lack of appropriate management of deer populations results in an ongoing browsing threat to Houghton's Goldenrod.

Pollution

Use of Herbicides

The use of herbicides is a potential threat where alvars and Houghton's Goldenrod occur along roads, roadside, ditches or under power lines and utility corridors. These areas are sometimes sprayed with herbicides to reduce unwanted vegetation, and this could be a threat to Houghton's Goldenrod if the municipality or utility company is not aware of the species' presence in these areas (J. Jones pers. Comm. 2014).

Exotic, Invasive, or Introduced Species/Genome

Invasion by Exotic Species

The presence of non-native species in alvars or on dunes is usually the result of past disturbance which has brought in seeds or other propagules²⁹. Exotic species, especially non-native grasses, degrade habitat for Houghton's Goldenrod by their rapid growth and expansion into spaces required for the goldenrod. Fourteen of the most common exotic

²⁹ Propagules: a structure capable of being propagated or acting as an agent of reproduction.

species occurring on alvar habitats (Reschke et al., 1999) are listed in decreasing order of frequency in Table 3.

Table 3. Exotic species of greater frequency on alvar habitats (Reschke et al., 1999)

Common Name	Scientific Name
Canada bluegrass	<i>Poa compressa</i>
St. John's-wort	<i>Hypericum perforatum</i>
Rough-fruited cinquefoil	<i>Potentilla recta</i>
Common mullein	<i>Verbascum thapsus</i>
Common timothy	<i>Phleum pratense</i>
Ox-eye daisy	<i>Chrysanthemum leucanthemum</i>
Glaucous king devil	<i>Hieracium piloselloides</i>
Curly-leaf dock	<i>Rumex crispus</i>
Hawkweed	<i>Hieracium</i> sp.
Wild carrot	<i>Daucus carota</i>
Blueweed	<i>Echium vulgare</i>
White sweet-clover	<i>Melilotus albus</i>
Kentucky bluegrass	<i>Poa pratensis</i>
Buckthorn	<i>Rhamnus cathartica</i>

Table 3 presents the exotic species that were found frequently on alvar habitats in 1995/1996. If the study was repeated today, the species and their relative frequencies might be different. European Common Reed (*Phragmites australis* spp. *australis*), Mossy Stonecrop (*Sedum acre*) and White Sweet Clover (*Melilotus alba*), for example, are now also known to be found in alvar habitats supporting Houghton's Goldenrod (Jones and Jalava, 2006; Kraus et al., 2009).

The spread of invasive species was identified by Kraus et al. (2009) as one of the most dominant threats to Lake Huron's Islands, particularly in Saginaw Bay (USA) where islands under public ownership are being invaded by non-native plant and animal species such as European Common Reed (*Phragmites australis* spp. *australis*), Zebra Mussel (*Dreissena polymorpha*) and Common Carp (*Cyprinus carpio*).

Climate and Natural Disasters

Changes in Climate

Changes in temperature and rainfall patterns may affect alvars and alvar species. Alvar species are subjected to flood seasonally, when the snow melts; and to drought and extreme heats during the summer (COSEWIC, 2005; Jones and Jalava, 2006). Climate change may cause modifications in the frequency and/or intensity of those events, and the effects on Houghton's Goldenrod or other alvar species are unknown.

5. Management Objectives

The management objective for Houghton's Goldenrod is to maintain the distribution and abundance of all Canadian populations at current levels through the maintenance of habitat and reduction of threats.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

As part of The International Alvar Conservation Initiative (IACI) surveys and research on alvars were conducted from 1995 to 1999 throughout the Great Lakes basin (Reschke et al. 1999). Data on alvar sites and characteristics, vegetation community types within alvars, and information on the ecological dynamics of alvars were collected as part of this initiative. Surveys of Houghton's Goldenrod at several sites were part of the IACI. As well, public outreach activities were undertaken to inform landowners, the aggregate industry, and the general public of the significance of alvars through magazine articles and other media sources.

During the Ontario Alvar Theme Study (Brownell and Riley 2000) information was compiled on all Ontario alvars; alvars were ranked according to their relative significance (presence of at-risk species, for example); and recommendations were made for some alvar sites to become Areas of Natural and Scientific Interest (ANSI). Several significant alvars support Houghton's Goldenrod.

Field work on Houghton's Goldenrod and its habitat was done at several locations as part of different projects (Jones 2004, 2005; Jalava 2008).

Since 2007, both Wikwemikong Unceded Indian Reserve (WUIR) and United Chiefs and Councils of M'Nidoo M'nising (UCCMM³⁰) have conducted field work on Houghton's Goldenrod and have survey data on where it occurs. These First Nations communities are working on protection and management of habitat for Houghton's Goldenrod (T. Flamand, pers. comm. 2014; G. Migwans, pers. comm. 2014). WUIR and UCCMM continue to conduct outreach about species at risk including Houghton's Goldenrod. WUIR has prepared educational booklets about species at risk including Houghton's Goldenrod (Wikwemikong Department of Lands and Natural Resources 2012). Both WUIR and UCCMM have conducted presentations on species at risk to various audiences including elders groups, school classes, community college programs, Anishnaabe language conferences, and local naturalist clubs (T. Flamand, pers. comm. 2014; Madahbee et al. 2010).

Strawberry Island, which has three populations of Houghton's Goldenrod, was protected as a provincial nature reserve park in Ontario in 2014.

Wikwemikong Unceded Indian Reserve (WUIR) is preparing a land use plan to guide future development of its lands. Alvars, along with habitats supporting species at risk, including Houghton's Goldenrod, have been designated areas of concern and will have some protection during planning (J. Maniwabi, pers. comm. 2014a,b). In addition, the community has been mapping Houghton's Goldenrod occurrences' locations as well as evaluating possible suitable habitat for this species for the last five years. They also have an internal protocol to ensure potential and confirmed species at risk habitat will

³⁰ United Chiefs and Councils of M'Nidoo M'nising (UCCMM) is an umbrella agency that handles most land management issues. Whitefish River First Nation (WRFN), mentioned earlier, is a member of this council.

be considered in reviews of new development projects prior to project approvals (J. Manitowabi, pers. comm. 2014a).

In the Manitoulin Region, a new official plan to guide land use and development is in the process of being approved as of 2014/2015. The new official plan restricts site alteration in alvar habitats unless an environmental study shows there will be no impacts from the proposed project (Manitoulin Planning Board 2013). Local municipalities still have to develop by-laws to implement the new plan, but this is expected in the following two years.

6.2. Broad Strategies

Broad strategies to achieve the management objective include:

- Monitoring of the species and assessment of threats and work on mitigation and reduction.
- Use of policy to protect Houghton's Goldenrod.
- Outreach, stewardship promotion and education to raise awareness of Houghton's Goldenrod and its habitats.
- Research to inform monitoring and management approaches to promote the protection of Houghton's Goldenrod and its habitats.

6.3. Conservation Measures

Table 4. Conservation Measures and Implementation Schedule

Conservation Measure	Priority ³¹	Threats or Concerns Addressed	Timeline
1. Monitoring of the species and assessment of threats and work on mitigation and reduction.			
1.1 Conduct monitoring to assess population levels and to monitor threats; conduct a survey to map all existing populations.	High	Identification of populations; current status of the populations and active threats; status of conditions of habitats; response of plants/populations to management actions.	2015 - 2020
1.2 Encourage necessary liaisons to support UCCMM and WUIR in management actions developed by the communities.	High	Development/Construction Logging and Industrial Activities Off-road Vehicle Use Invasion by Exotic Species Lack of Public Awareness	2015 - 2025
1.3 Encourage the development of a range-wide survey protocol, to ensure compatibility of data across collections.	High	Any or all threats	2015 - 2017

³¹ "Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of the population. Low priority conservation measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.

1.4 Encourage necessary liaisons to support corporate and private owners in management actions.	High	Any or all threats	2015 - 2025
1.5 Encourage appropriate zoning and protection within parks and protected areas.	Medium	Invasion by Exotic Species Off-road Vehicle Use Lack of Public Awareness Grazing and Browsing	2015 - 2025
1.6 Encourage recovery actions that are appropriate for each site (e.g. population maintenance, population augmentation, appropriate habitat management) through the use of tools such as management plans.	Medium	Any or all threats	2015 - 2025
2. Use of policy to protect Houghton's Goldenrod.			
2.1 Encourage municipalities to consider alvars and species at risk in their official plans and by-laws.	High	Development/Construction Quarrying and Aggregates Extraction Logging and Industrial Activities Lack of Public Awareness	2015 - 2025
2.2 Encourage the recognition of Alvar ANSIs in the Manitoulin Official Plan.	High	Development/Construction Logging and Industrial Activities Quarrying and Aggregates Extraction Lack of Public Awareness	2019 - 2025
2.3 Encourage necessary liaisons to support First Nations in designing community-based policies to protect alvars and Houghton's Goldenrod.	Medium	Development/Construction Quarrying and Aggregates Extraction Logging and Industrial Activities Lack of Public Awareness	2015 - 2025
3. Outreach and education to promote awareness of Houghton's Goldenrod and its habitats.			
3.1 Conduct outreach (including user-friendly identification resources) on Houghton's Goldenrod and alvar habitats supporting the species with corporate landowners and aggregate operators.	High	Quarrying & Aggregates Extraction Logging and Industrial Activities Livestock Grazing Invasion by Exotic Species Development/Construction Lack of Public Awareness Use of Herbicide	2015 - 2025
3.2 Conduct outreach (including user-friendly identification resources) on Houghton's Goldenrod and alvar habitats supporting the species with private landowners, municipalities, and enforcement officials.	Medium	Any or all threats	2015 - 2025
3.3 Assist with updating/preparing outreach and educational materials for First Nations supporting the species, where feasible and if requested.	Low	Any or all threats	2015 - 2025

4. Research to ensure adequate protection of Houghton's Goldenrod and its habitats.			
4.1 Encourage research on Houghton's Goldenrod taxonomy; genetics; reproductive biology: pollination, dispersion, viability, and conditions for the germination of seeds; to ensure the management plan covers all biophysical needs of the species.	High	Habitat requirements and dynamics; improved success of management actions	2015 - 2025
4.2 Encourage studies on detectability of the species; population dynamics and viability; population trend in Ontario.	High	Any or all threats	2015 - 2025
4.3 Study potential habitat management tools such as controlled burning, fencing to exclude deer, and weed removal.	Medium	Habitat requirements and dynamics; improved success of management actions	2015 - 2025
4.4 Study moisture regime in Houghton's Goldenrod habitat for a better understanding of the key characteristics comprising suitable habitat.	Medium	Habitat requirements and dynamics; improved success of management actions; climate change.	2015 - 2025
4.5 Encourage studies on propagation and transplant techniques	Medium	Population viability may be restored	2015 - 2025

7. Measuring Progress

Every five years, success of the implementation of this management plan will be measured against the following performance indicators:

- Known populations of Houghton's Goldenrod and the habitat where it is currently known to occur have been conserved.

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Appendix A: 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*](#)³². 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 achievement of any of the [*Federal Sustainable Development Strategy*](#)'s³³ (FSDS) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may 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 management plan itself, but are also summarized below in this statement.

The primary management approach for Houghton's Goldenrod focuses on leaving habitat in its natural state and allowing ecological processes to function naturally. As such, this management plan should result in very few changes to the environment and no overall negative impacts. Secondary management approaches involve communications and policy tools which do not affect the environment.

A few potential activities to maintain habitat may result in small impacts to more common species. For example, if removal of invasive species is required, these non-native plants will be impacted, which may provide an overall benefit to the habitat and to native alvar and dune species. A small amount of soil may be displaced during hand-pulling actions but is not expected to have any negative impact. Allowing natural processes to function could result in closing in of vegetation through natural succession, which would be harmful for alvar species and for Houghton's Goldenrod. However, it is hoped that natural processes will continue to maintain suitable habitat for Houghton's Goldenrod in the overall landscape. As well, it is hoped that knowledge gaps regarding succession and the use of controlled burning on alvar habitats and impacts on Houghton's Goldenrod will be filled. It is assumed any study of controlled burning in alvar habitats would also include assessment of the overall impacts, both positive and negative, to these habitats and species found within them. Table 5 outlines some of the species at risk that may be found in habitats where Houghton's Goldenrod occurs in Ontario.

³² <http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1>

³³ www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

Table 5. Examples of Species At Risk expected to benefit from conservation measures directed at Houghton's Goldenrod.

Common Name	Scientific (Latin) Name	SARA Status	Province
Gattinger's Agalinis	<i>Agalinis gattingeri</i>	Endangered	ON
Lakeside Daisy	<i>Tetraneuris herbacea</i>	Threatened	ON
Dwarf Lake Iris	<i>Iris lacustris</i>	Threatened	ON
Hill's Thistle	<i>Cirsium hillii</i>	Threatened	ON
Tuberous Indian-plantain	<i>Arnoglossum plantagineum</i>	Special Concern	ON
Massasauga Rattlesnake (Great Lakes/St. Lawrence population)	<i>Sistrurus catenatus</i>	Threatened	ON
Eastern Milksnake	<i>Lampropeltis triangulum</i>	Special Concern	ON, QC
Eastern Ribbonsnake (Great Lakes population)	<i>Thamnophis sauritus</i>	Special Concern	ON, QC