



Houghton's Goldenrod

*Solidago
houghtonii*

Recovery Plan



U.S. Department of the Interior
Fish and Wildlife Service



**RECOVERY PLAN FOR HOUGHTON'S GOLDENROD
(*SOLIDAGO HOUGHTONII* A. GRAY)**

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Date: 9/17/97

EXECUTIVE SUMMARY

Current Status: *Solidago houghtonii* (Houghton's goldenrod), classified as threatened, is endemic primarily to the northernmost regions of Lakes Huron and Michigan in Michigan and Ontario. Of 58 known occurrences in the United States, at least portions of 32 are on public land and four are within private nature preserves. At least 33 of the U.S. occurrences are considered to be of good quality and highly viable. Several historic sites need to be surveyed to determine if populations there are still extant and intact.

Habitat Requirements and Limiting Factors: This species is generally restricted to narrow bands of open, calcareous, lakeshore habitat. The species' primary limiting factor is its restricted habitat, which requires the natural dynamics of the Great Lakes system to maintain a suitable environment. Preliminary findings from breeding system studies indicate that this species is self-incompatible, and requires outcrossing and insect pollen vectors to successfully set seed. The conservation of this species requires the maintenance of mature adult plants and their habitat, as well as the critical processes that maintain habitat. The current major threats to *Solidago houghtonii* are development and its ancillary activities, and the overuse of shoreline areas for recreational activities, particularly off-road-vehicles.

Recovery Objective: Delisting.

Recovery Criteria: Protect a minimum of 30 of the most viable occurrences of Houghton's goldenrod and preserve the species' essential habitat and the natural environmental processes that maintain it.

Tasks Needed:

1. Protect all known occurrences, with priority given to the most viable occurrences and the species' essential habitat.
2. Survey suitable habitat for additional occurrences and verify the status of historic occurrences.
3. Educate and notify land managers and the public.
4. Monitor occurrences for population demographics, viability, and threats.
5. Conduct biosystematic research throughout the species' range.

Estimated cost of Recovery for FY 1998-2008 (in \$1000's):

<u>Year</u>	<u>Task 1</u>	<u>Task 2</u>	<u>Task 3</u>	<u>Task 4</u>	<u>Task 5</u>	<u>Total</u>
1998	35.50	4.00	5.00	0.00	0.00	44.50
1999	56.50	8.00	15.00	10.00	30.00	119.50
2000	56.50	14.00	15.00	10.00	55.00	150.50
2001	23.75	7.00	6.00	5.00	6.00	47.75
2002	21.75	5.00	6.00	5.00	6.00	43.75
2003	12.25	1.00	4.00	5.00	0.00	22.25
2004	13.00	1.00	0.00	5.00	0.00	19.00
2005	9.75	1.00	0.00	5.00	0.00	15.75
2006	9.75	1.00	0.00	5.00	0.00	15.75
2007	9.75	0.00	0.00	2.50	0.00	12.25
2008	13.00	0.00	0.00	2.50	0.00	15.50
Total	261.50	42.00	51.00	55.00	97.00	506.50

Date of Recovery: Delisting should occur in 2004, if recovery criteria have been met.

DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director or Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

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I. INTRODUCTION

A. Background and Description

Houghton's goldenrod, *Solidago houghtonii* A. Gray, a member of the Asteraceae (aster family), was discovered on the north shore of Lake Michigan by a team of the Michigan Geological Survey on August 15, 1839 (McVaugh 1970).¹ This survey team was headed by Douglass Houghton, Michigan's first appointed State geologist and the person in whose honor the species was named by Asa Gray in the first edition of Gray's Manual (Gray 1848). The type locality is between approximately 10.4 km (6.5 mi) southeast of Naubinway and 10.4 km (6.5 mi) west of Epoufette in western Mackinac County (Voss 1956, Guire and Voss 1963). Although Houghton was an experienced botanical surveyor and collector (Rittenhouse and Voss 1962, Voss 1978), the type specimens of *S. houghtonii* were most likely gathered by George Bull, who probably collected the majority of the plant specimens obtained in the 1839 expedition (Voss 1956, McVaugh 1970).

As a species of very restricted range and uncertain origin, *S. houghtonii* is a taxon of considerable interest to floristic specialists, plant systematists, and ecologists. Proposed as a Federal threatened species in 1987 and listed as such in 1988 (U.S. Dept. of Interior 1987, 1988), *S. houghtonii* is classified as threatened in Michigan (MDNR, Michigan Special Plants List 1991), endangered in New York (Young 1996), and considered rare in Canada (Argus and Pryer 1990). The scientific attributes of this species, in addition to its contribution to the biological diversity of Michigan, Ontario, and New York, provide strong reasons for initiating and supporting its conservation. The need to conserve *S. houghtonii* gives further reason for protecting the unique and fragile shoreline ecosystem of the Great Lakes, which also provides essential habitat for many other rare plants and animals, including such species as *Cirsium pitcheri* (Torr.) T. & G. (Pitcher's thistle), *Iris lacustris* Nutt. (dwarf lake iris), *Mimulus glabratus* var. *michiganensis* (Pennell) Fassett (Michigan monkey-flower), *Charadrius melodus* Ord (piping plover), and *Trimerotropis huroniana* Walker (Lake Huron locust). As a species with a moderate threat and a high recovery potential, *S. houghtonii* is considered to have a Recovery Priority of 8 (U.S. Dept. of Interior 1990).

Solidago houghtonii is a distinctive species of the Upper Great Lakes region, characterized by its flat-topped inflorescence comprised of relatively few, large flower heads (capitula) borne on finely hairy stalks (Figure 1). This persistent perennial herb has stems that are frequently tufted or clumped and can reach a height of 75 cm (29 in), arising from a thickened, branching, fibrous-rooted base (caudex). Rhizomes are commonly produced from the caudex, resulting in the production of additional clumps of stems (ramets). The smooth, slender, sometimes reddish stems have rosettes of elongated, acute, linear-oblong basal leaves that are about 20 cm (7.8 in) long and 20 mm (0.8 in) wide. The weakly triple-nerved basal leaves are hairless, entire, and sometimes rough-margined, tapering to a narrow, slightly clasping base.

¹The undated type specimen is located in the Gray Herbarium (GH); an isotype on which a collection date of August 15, 1839, is indicated, is located in the University of Michigan Herbarium (MICH) (Voss 1956).

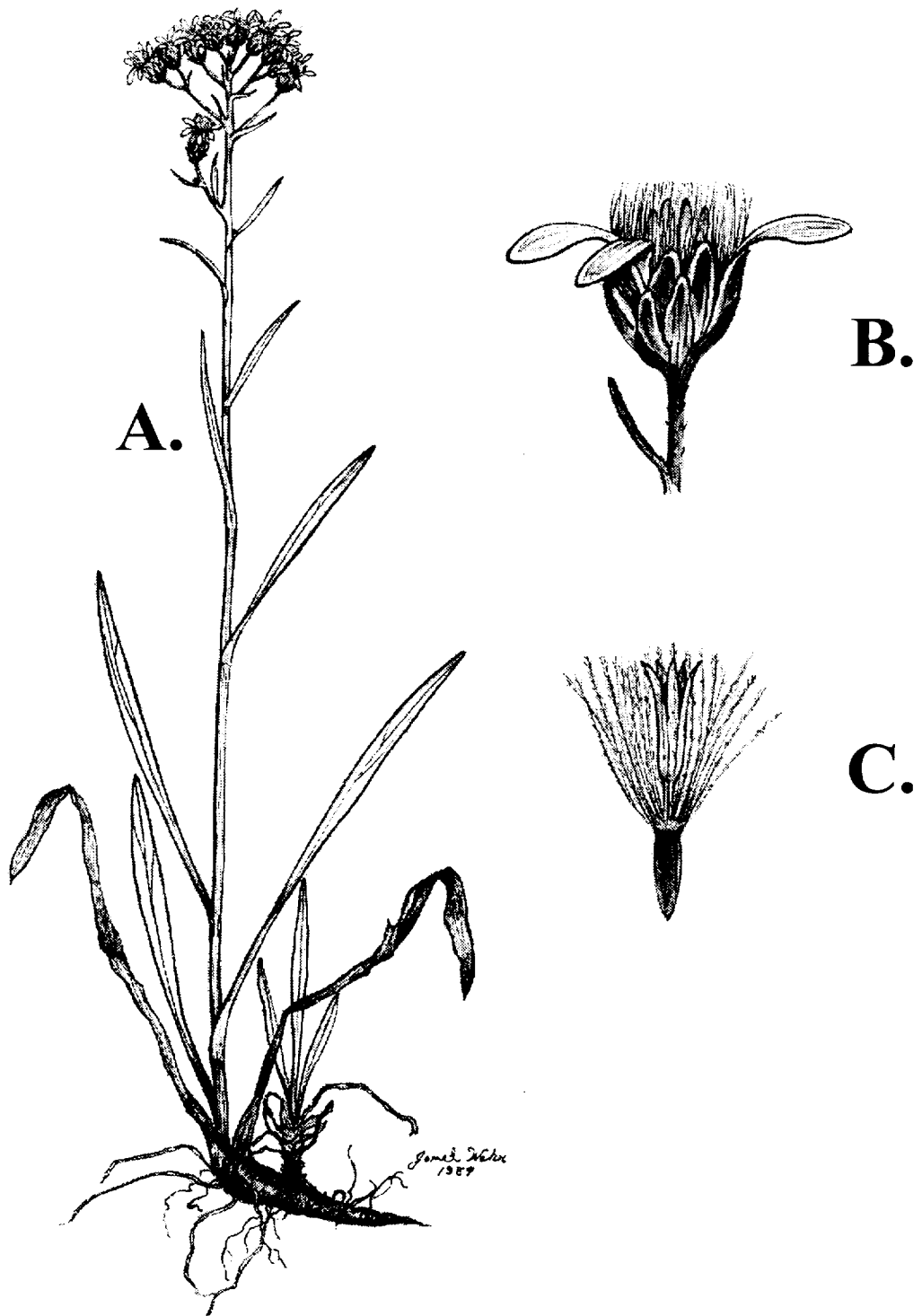


Figure 1. Illustration of *Solidago houghtonii* (Houghton's goldenrod). A. Habit B. Capitulum
C. Tubular disc floret and achene

Upward the leaves are similar but well scattered and reduced, becoming linear, sessile, and somewhat v-shaped or infolded in cross-section (conduplicate). Terminating the stem is a more or less flat-topped, (corymbiform) inflorescence consisting of relatively few, showy, large flower heads that number from five or more.

Although some manuals describe the number of flower heads as 2-18 (Semple and Ringius 1992) or 5-15 (Gleason and Cronquist 1991), plants with about 20-30 heads or more are common. Occasionally, individuals with more than 200 heads have been documented (*E. G. Voss 14965, 15909*, MICH; *M. R. Penskar & W. W. Brodowicz 1067*, MICH). The branches of the inflorescence are smooth, but the stalks (pedicels) of the flower heads are finely but distinctly hairy. Individual flower heads have an involucre about 5-8 mm (0.2-0.3 in) high, composed of an unequal series of bracts (phyllaries) that are blunt, rough-margined, and weakly lined (striated). The flower heads are 20-30 flowered, each consisting of about six to nine large, pale to bright yellow ray florets and several yellow disc florets. The achenes are glabrous and ribbed, bearing at their apex a hairy pappus composed of numerous bristles that are slightly expanded (clavate) at their tips.

Solidago graminifolia (L.) Salisb. (grass-leaved goldenrod) and *S. ohioensis* Riddell (Ohio goldenrod) are superficially similar species that commonly occur with *S. houghtonii* and are sometimes confused with it. *Solidago graminifolia*, (also known as *Euthamia graminifolia* (L.) Nutt.) can be distinguished by its more leafy stem with withering (or absent) basal leaves, narrower 3-5 nerved leaves, and an inflorescence composed of distinctly smaller flower heads with short ray florets and with the heads borne in tight clusters (glomerules) on leafy, smooth branches. The hairy achenes of *S. graminifolia* also enable it to be readily distinguished from *S. houghtonii*. *Solidago ohioensis* is a more robust species, which can be distinguished from *S. houghtonii* by its relatively broad, flat, ovate-lanceolate leaves, a dense, many-headed inflorescence with smooth, non-hairy branches, flower heads with distinctly smaller ray flowers, and smooth but unribbed achenes. Additional characters that distinguish *S. graminifolia* and *S. ohioensis* from *S. houghtonii* are provided in Appendices A and B.

B. Taxonomy and Origin

Solidago houghtonii is widely accepted as a distinctive species (Morton 1979), but there is apparently little agreement among botanists on the details of its origin. Its present distribution (primarily the northern shores of Lakes Michigan and Huron) and endemism to areas that were covered by the waters of Glacial Lake Nipissing until approximately 5,000 years ago suggest to some researchers that the species may be of relatively recent origin. According to J. K. Morton (1979), it has likely evolved over the past 3,000 years, during which time its coastal dune and shoreline habitat developed and became available for colonization. Alternatively, this species may have evolved long before Lake Nipissing was formed (Voss 1989). As earlier lakes began taking on their modern configurations, the *S. houghtonii* distribution followed the moving band of suitable habitat to its present location.

There is little published biosystematic research concerning taxonomic relationships of *S. houghtonii*, but knowledge of a well-known hybrid has been used to construct one possible scenario for its origin. *Aster ptarmicoides* (Nees) T. & G. (upland white goldenrod) and *Solidago ohioensis* (Ohio goldenrod) are two species of calcareous habitats that occasionally hybridize, producing offspring which are morphologically similar to *S. houghtonii*. *Aster*

ptarmicoides, long known as an aster, is considered to be a white-rayed goldenrod, *S. ptarmicoides* (Nees) Boivin, by Brouillet and Semple (1981) on the basis of morphological, cytological, chemical, and hybridization data. This species, which is vegetatively similar to *S. houghtonii*, is characterized by a flat-topped, corymbiform inflorescence comprising large, white-rayed flower heads borne on densely scabrid-pubescent peduncles. The flower heads have acute to obtuse phyllaries, glabrous ribbed achenes, and pappus bristles that are strongly clavate. *Solidago ohioensis* is a robust goldenrod with ovate to narrowly lanceolate or elliptic leaves and dense, many headed inflorescences. Its inflorescence branches are completely smooth, and the achenes are glabrous and unribbed, bearing awl-tipped bristles that are not expanded toward their apex (Semple and Ringius 1992).

Both *S. ohioensis* and *S. ptarmicoides* are diploid ($2x = 18$). At several locations where these two species occur together, hybrids ($2x = 18$) have been observed and collected. The hybrid usually can be distinguished from *S. houghtonii* in the field by its paler flowers, a characteristic not evident in herbarium specimens which lose flower color. Several names are attributed to the hybrid, including *Diplopappus lutescens* Lindley ex DC and *Solidago X krotkovii* Boivin, among others. According to Morton (1979), the production of diploid or unreduced gametes ($n = 18$) by the F_1 hybrid and a subsequent backcrossing with *S. ohioensis* (Figure 2) may have then produced a triploid hybrid ($3x = 27$). Ultimately, through chromosome doubling (amphidiploidy), this sterile backcross may have then produced a fertile hexaploid species ($6x = 54$), resulting in the taxon known as *S. houghtonii*. Morphological characteristics of *S. houghtonii* that display a possible intermediacy between *S. ohioensis* and *S. ptarmicoides* include the relatively flat-topped inflorescence with sparsely hairy branches, relatively few flower heads with large ray flowers, and the slightly clavate pappus bristles (Morton 1979).

Semple and Ringius (1992) do not agree that *S. houghtonii* is necessarily the result of hybridization between *S. ohioensis* and *S. ptarmicoides*. They concluded that *S. riddellii* Frank (Riddell goldenrod) ($x = 18$), another member of *Solidago* sect *Oligoneuron* might be involved rather than *S. ohioensis*. *Solidago* sect *Oligoneuron* is known to hybridize with *S. ptarmicoides* (Pringle 1968) and produce a specimen bearing similar conduplicate leaves and a hairy inflorescence.

The unpublished data and research of James S. Pringle (1987), who has studied *S. houghtonii* extensively, provide a markedly different set of conclusions concerning the origin and affinities of this species and a different concept of the identities of certain populations within the currently known range. According to Pringle (1987), four taxonomic entities that have been referred to as *S. houghtonii* were likely derived from past hybridization. The entities are now fertile, freely interbreed within their own groups, and produce fertile, relatively uniform progeny. The four taxonomic groups have been identified as follows:

- 1) True *S. houghtonii*, the group represented by the nomenclatural type, that occurs primarily in Michigan within the Straits of Mackinac region and possibly in Ontario on Cockburn Island. This species' origin is probably the result of hybridization between *S. ptarmicoides* and *S. riddellii*.

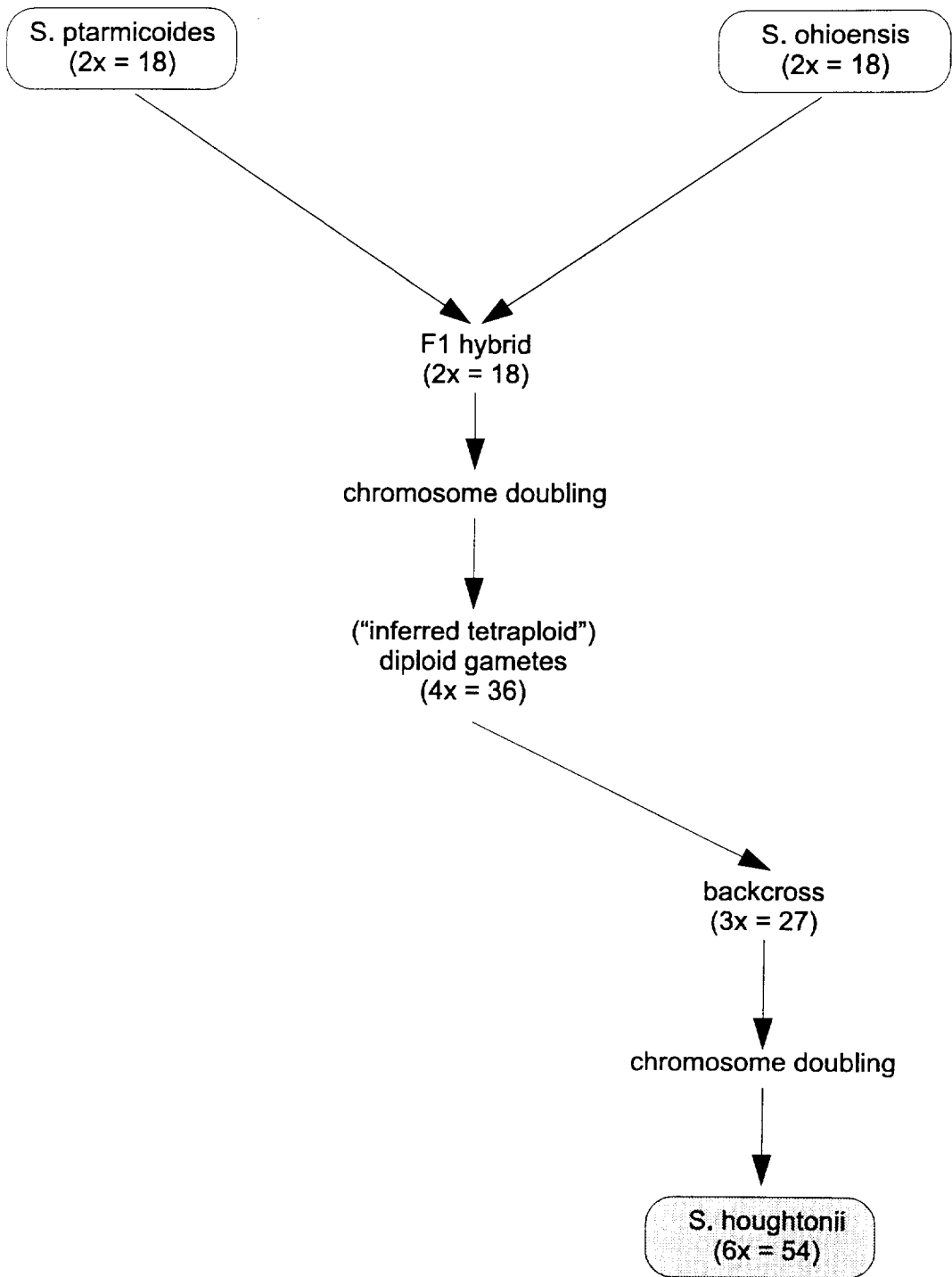


Figure 2. Putative origin of *Solidago houghtonii* from *S. ptarmicoides* and *S. ohioensis*, based on the hypothesis of Morton (1979).

2) Michigan plants located within Camp Grayling in southern Crawford County. These represent the only known octoploids of *Solidago* and apparently resulted from the hybridization of *S. ptarmicoides* and a diploid race of *S. uliginosa* Nutt. (swamp goldenrod).

3) Ontario plants that occur from the Manitoulin Island region to the east side of the Bruce Peninsula. This hexaploid taxon appears to have resulted from hybridization between *S. ohioensis* and *S. ptarmicoides*, likely through a far less complex series of events than those proposed by Morton (1979).

4) Plants that occur in Bergen Swamp in Genesee County, New York. This hexaploid population appears to have been derived from hybridization between *S. ptarmicoides* and *S. uliginosa* (the latter species referred to in the broad sense). Pringle notes that, because collections of this population are better represented in New England and New York herbaria than Michigan populations, descriptions of *S. houghtonii* in standard botanical manuals (Gleason 1952, Gleason and Cronquist 1991) are incorrect, since they are not based on the correct taxon. Bergen Swamp plants are reported to be much smaller than those of true *S. houghtonii* and have fewer flower heads, the latter characteristic giving rise to the prominently misdirected key characteristic of 2 to 15 flower heads for *S. houghtonii*.

The eventual publication and acceptance of Pringle's research would affect the consideration of *S. houghtonii* in two substantive ways. First, the range of *S. houghtonii* would be considered much more restricted, and thus considerably greater emphasis would be placed on the protection and conservation of all occurrences. Criteria for delisting should subsequently be reconsidered and modified as necessary. Second, occurrences in Crawford County, Michigan, and Genesee County, New York, would not be federally protected and recognized in the recovery plan. The latter populations perhaps represent much rarer but different taxonomic entities and possibly warrant specific or other recognition. Specific recognition would maintain the potential for eventual federal listing and merit high priority for research and immediate state protection.

The disagreements concerning the origin of *S. houghtonii* and, more importantly, the true identities of populations within the currently circumscribed range, argue strongly for considering the species in the broad sense now. This is especially true for the present purpose of recovery, and the current approach. Additional biosystematic research, such as chloroplast DNA, flavonoid, and isozyme analyses, in conjunction with field investigations and standard morphological studies, are the type of investigations that should be conducted to determine the identities and origins of *S. houghtonii* populations.

C. Distribution

Solidago houghtonii is primarily an endemic of the Upper Great Lakes region, occurring principally on the northern shores of Lakes Michigan and Huron in Michigan and Ontario (Figure 3). From the Straits of Mackinac in Michigan, the approximate center of its main distribution, it ranges west about 160 km (99 mi) to Schoolcraft County (Voss 1996). To the east and southeast, it ranges about 280 km (174 mi) to Ontario, where it occurs on the Bruce Peninsula near Cabot Head and on Cockburn and Manitoulin Islands (Figure 4), with wide gaps between the latter two occurrences (Morton 1979). *Solidago houghtonii* was not known to occur in Canada until 1932, when it was discovered on Cockburn Island (C.O. Grassl 2362, MICH).

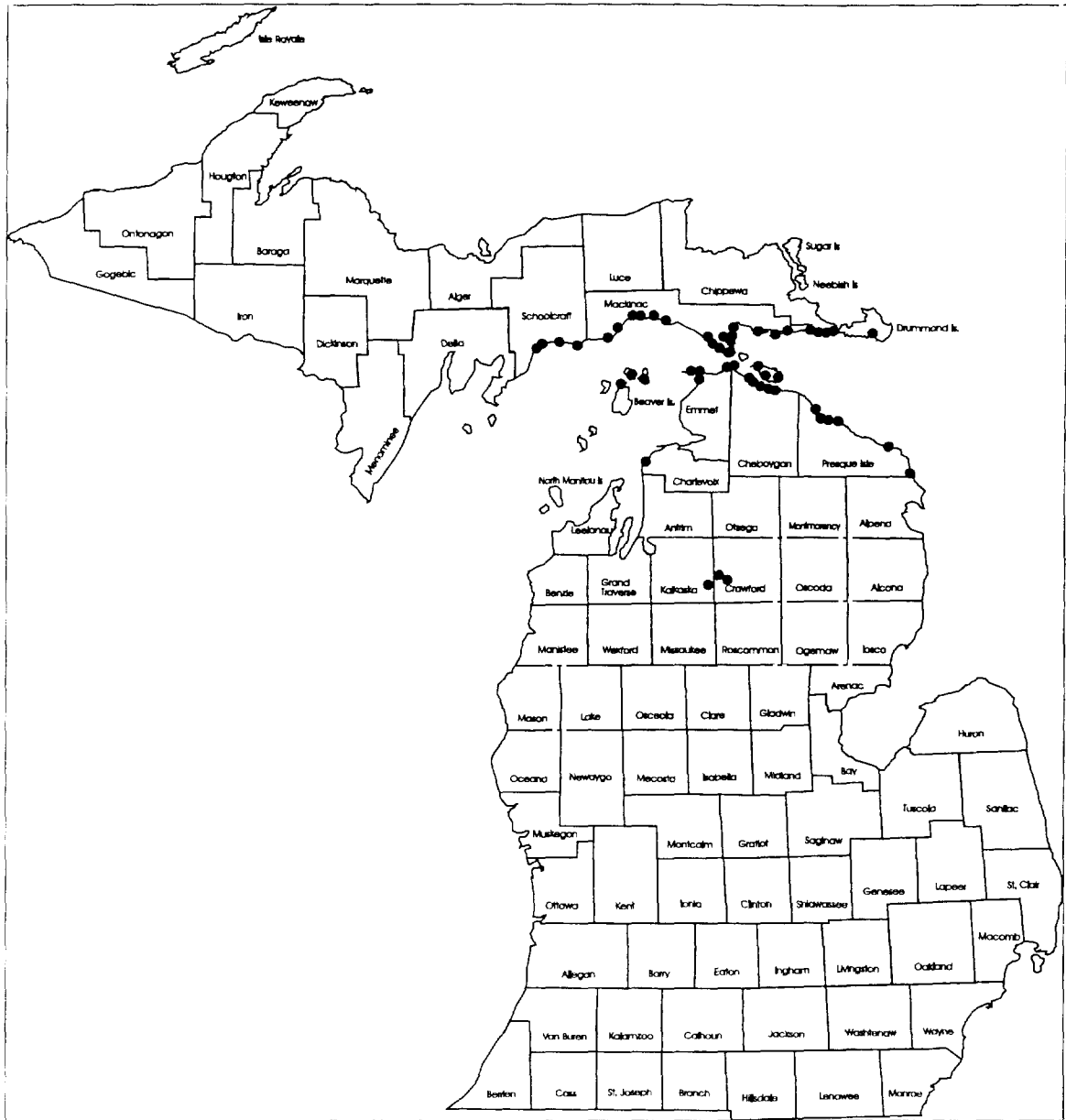


Figure 3. The distribution of *Solidago houghtonii* in Michigan, based on element occurrence records of the Michigan Natural Features Inventory (MNFI).

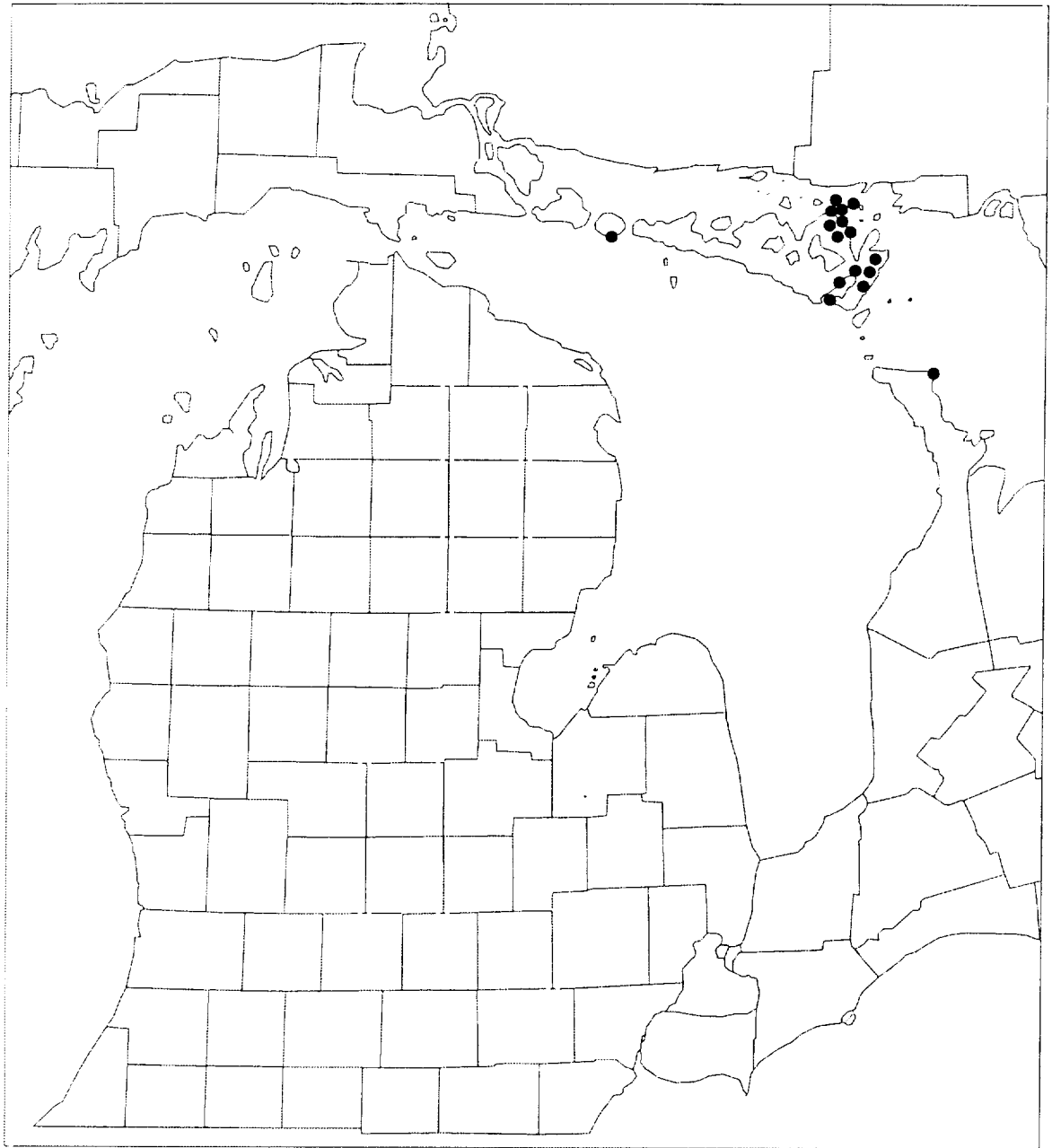


Figure 4. The distribution of *Solidago houghtonii* in Ontario, Canada, based on Morton (1979) and Morton and Venn (1984).

Documentation of new and significant populations east of Cockburn Island has occurred since 1970 and represents a major extension of the range of *S. houghtonii*, in the broad sense of its genetic derivations (Morton 1979).

Disjunct occurrences of *S. houghtonii* occur about 130 km (81 mi) south of the Straits region in Crawford County, Michigan (Figure 3). A second, more markedly disjunct population, tentatively referred to *S. houghtonii*, occurs in Genesee County, New York, approximately 500 km (300 mi) southeast of the Ontario populations (Guire and Voss 1963).

Solidago houghtonii occurrences on the shores of the Great Lakes are strongly correlated with a geological feature known as the Niagaran Escarpment, a dolomitic limestone formation extending through the Bruce Peninsula and Manitoulin District in Canada, the southern shoreline of the Michigan's Upper Peninsula, and the Door Peninsula of Wisconsin (Dorr and Eschman 1970). All but the occurrences in Crawford and Genesee Counties are associated with this geological feature.

1. Canadian Distribution

In Ontario, *S. houghtonii* is classified as rare (Semple and Ringius 1983). It is also reported as rare in Canada (Argus and Pryer 1990) where, according to Nature Conservancy of Canada ranking criteria, it is equivalent to the status of threatened in the United States.² Occurrences in Ontario, however, often consist of large colonies. In the eastern region of Manitoulin Island, on Great Cloche Island, and on other nearby islands, *S. houghtonii* has been described as abundant (Morton 1979). On Great Cloche Island, it was found to be abundant over an area in excess of 51 km² (20 mi²) (Morton and Venn 1984). The Cabot Head population on the Bruce Peninsula consists of hundreds of individuals over several acres of suitable limestone pavement habitat (Morton 1989).

2. Michigan Distribution

Michigan localities of *S. houghtonii* appear to comprise the majority of known occurrences for this species. The term *occurrence* is applied here and throughout this plan rather than *population*, owing to the difficulty of defining what actually constitutes a population in a biologically meaningful way. Site occurrences for *S. houghtonii* have been delineated and tracked as more or less contiguous colonies or *patches* of plants delimited by marked, substantial gaps from other such clusters. Occurrences may thus be thought of as *metapopulations*, defined as a patchwork of interacting populations over a wide and sometimes heterogeneous area of landscape, or a network of populations in various stages of colonization and succession (Primack 1996, Sundland et al. 1992). Generally, a gap of approximately 1.6 km (1 mi) or more has been considered the minimum distance to delimit occurrences in this arbitrary but practical fashion.

Following this approach, the Michigan Natural Features Inventory Program (MNFI) has identified a total of 58 occurrences in nine counties, with the majority of sites (51) located in

²Canada and the Province of Ontario have ranked this species as "N2" and "S2," respectively.

Cheboygan, Chippewa, Emmet, Mackinac, Presque Isle, and Schoolcraft Counties (Table 1). Twenty-three occurrences have been identified in Mackinac County, where at least 15 sites supporting *S. houghtonii* occur wholly or partially on Federal, State, or local government land. One of the largest occurrences is found mostly on state land east and west of the mouth of the Crow River near Big Knob Campground, where large numbers of plants are distributed for several miles along the Lake Michigan shoreline in narrow but extensive, well developed interdunal wetlands. Another densely populated occurrence is found on Point La Barbe, where a high concentration of plants occurs throughout a wide band of cobbly shoreline flats, persisting in high numbers even adjacent to the shore road where it has been disturbed. Horseshoe Bay North and especially Summerby Fen represent unusual inland localities. These occurrences are mostly small colonies in openings around marl pools within northern fen communities (MNFI 1993).

Other exemplary occurrences include Cheboygan Point and Grass Bay in Cheboygan County and Sturgeon Bay and Sturgeon Bay Point in Emmet County, where *S. houghtonii* is common to at least locally abundant. Of these occurrences, Grass Bay colonies are largely contained and protected within the Michigan Nature Conservancy's Grass Bay Preserve, whereas localities in Cheboygan Point and Sturgeon Bay Point are within State Parks and therefore, receive at least informal protection.³ Plants on Sturgeon Bay Point occur primarily in interdunal wetlands contained within a rapidly developing residential shoreline area (MNFI 1993). *Solidago houghtonii* is reported to lie within four preserves of the Michigan Nature Association (MNA), the most exemplary being the Lake Huron Sand Dunes Preserve (Daubendiek 1993), although verification will be needed to document these likely localities.

Plants from the six occurrences of *S. houghtonii* in Cheboygan County and seven occurrences in Chippewa County are occasional to locally common or abundant. A few clumps of plants on the east shore of Douglas Lake, at Pine Point, Cheboygan County, were determined to be transplanted individuals "planted as seedlings from Bot. Garden" (Ehlers 7130, MICH). Five of the six known occurrences in Presque Isle County support populations described as at least locally abundant. In Schoolcraft County, *S. houghtonii* has been recorded by collectors as being very local to "plentiful." A field survey in 1985 by a Michigan Department of Transportation (MDOT) botanist indicated that plants remained locally frequent on private land at Manistique Shore East in Schoolcraft County. Three of four sites known in Charlevoix and Schoolcraft Counties are island localities on Garden, Hog, and Summer Islands. A recently discovered large occurrence in Fisherman's Island State Park in Charlevoix County is the southernmost known occurrence in the Lake Michigan basin (Penskar 1993).

Disjunct localities of *S. houghtonii* (*sensu lato*) include two occurrences in Crawford County, all on State land within Camp Grayling Military Reservation, a National Guard training

³Informal protection is used here in the sense that both Federal and State land management agencies have received notification of the presence of *Solidago houghtonii* and other listed plant and animal species within their boundaries. Federal and State land managers are thus aware of the legal obligation to protect these species pursuant to the appropriate provisions of federal and state endangered species acts. The actual degree of required consultations and local enforcement, however, is known to vary.

Table 1. *Solidago houghtonii* occurrences in Michigan, arranged by county and hierarchically ordered by Element Occurrence rank.

OCCURRENCE NUMBER	COUNTY	SITE NAME	OWNERSHIP	EO RANK	LAST OBSERVED	ABUNDANCE
062 ¹	Charlevoix	Fishermans Island State Park	State	AB ²	1992 ³	locally abundant
045	Charlevoix	Garden Island	State	BC	1981	locally abundant on South shore
063	Charlevoix	Donegal Bay	multiple private	C	1993	ca. 100 flowering stems
051	Charlevoix	Baltimore Bay	State	CD	1986	uncommon
003	Cheboygan	Grass Bay	The Nature Conservancy	A	1990	common to abundant
022	Cheboygan	Cheboygan Point	State	B	1990	locally abundant
050	Cheboygan	Point Nipigon	Glen Chamberlain	C	1985	"small amount"
024	Cheboygan	Pries Landing	Penn Central Railroad	C	1980	about 100 plants
036	Cheboygan	Stoney Point Road	City of Cheboygan and/or multiple private	C	1981	infrequent
057 ⁴	Cheboygan	Mackinaw City	Detroit and Mackinac Railroad	D	1989	one plant in right-of-way (ROW)

¹ Occurrence numbers are sequential within the statewide data base, but due to skipped numbers from subsequently merged or deleted records will number higher than the total of 58 occurrences

² Element occurrence ranking assigned by Michigan Natural Features Program; for explanation of ranking criteria, see Appendix C.

³ Last observation date according to formal survey or endangered species reports received by MNFI; this does not necessarily mean that the species has not been observed at this site subsequent to the year noted here.

⁴ MNFI 1996 surveys indicate this site has been extirpated due to loss of habitat.

Table 1 (cont.). *Solidago houghtonii* occurrences in Michigan, arranged by county and hierarchically ordered by Element Occurrence rank.

OCCURRENCE NUMBER	COUNTY	SITE NAME	OWNERSHIP	EO RANK	LAST OBSERVED	ABUNDANCE
032	Chippewa	Albany Creek Mouth	Omar Anderson et al.; Michigan Department of Transportation (MDOT) ROW	AB	1981	abundant
015	Chippewa	St. Vital Bay	MDOT ROW; State	B	1981	common to abundant
016	Chippewa	Albany Island Drive	Walt Carey	B?	1993	locally common
008	Chippewa	Seaman's Point	State/private	C	1994	local, ca. 100 plants
035	Chippewa	Rice Point	MDOT; State	B?	1981	common
034	Chippewa	Seymour Bay	Robert La Pointe; MDOT ROW	B?	1981	common
033	Chippewa	Strawberry Island	State	CD	1981	2 clumps
026	Crawford	Howes Lake/Portage Creek	State	A	1995	locally abundant + patches
065	Crawford	Cantonement Rd - Camp Grayling	State	C	1995	localized, small patch
021	Emmet	Sturgeon Bay	State	A	1990	locally abundant
046	Emmet	Sturgeon Bay Point	multiple private	AB	1990	locally abundant
002	Emmet	Waugoshance Point	State	B	1973	infrequent to common
001	Emmet	Trail's End Bay	County ROW (in charge of mowing); multiple private; State	BC	1987	scattered throughout
020	Emmet	Big Stone Bay	State	C?	1960	not found 1981
064	Kalkaska	Bluestem prairie	State	D	1993	very local on dirt bank
042	Mackinac	Crow River Mouth	State	A	1988	common to abundant
030	Mackinac	Point La Barbe	City of St. Ignace; City or County ROW; gas company ROW	A	1990	common to abundant

Table 1 (cont.). *Solidago houghtonii* occurrences in Michigan, arranged by county and hierarchically ordered by Element Occurrence rank.

OCCURRENCE NUMBER	COUNTY	SITE NAME	OWNERSHIP	EO RANK	LAST OBSERVED	ABUNDANCE
017	Mackinac	Pointe Aux Chenes	MDOT ROW; U.S. Forest Service (USFS)	AB	1986	abundant
049	Mackinac	Horseshoe Bay	USFS	B	1984	frequent along shore
041	Mackinac	Lower Millecoquins Creek Mouth	Hiawatha Sportsmen's Club; MDOT ROW	B	1982	locally common
039	Mackinac	Snake Island	The Nature Conservancy	B	1981	no date
031	Mackinac	Stevenson Bay	MDOT ROW; The Nature Conservancy	B	1981	locally abundant
061	Mackinac	West Moran Bay	Multiple private	BC	1993	locally common
040	Mackinac	Beach Road	John Dix et al.	BC	1982	frequent
053	Mackinac	Epoufette	State	BC	1991	locally common in swale
007	Mackinac	Lime Kiln Point	Brightwaters Products Group	BC?	1973	common
047	Mackinac	St. Martin Point	private; USFS	BC?	1988	local
010	Mackinac	Black River Road	MDOT ROW; multiple private; Dewey Snyder; State	C	1991	local
059	Mackinac	Horseshoe Bay North	U.S. Steel Corporation	C	1992	ca. 30+ shoots
048	Mackinac	Gros Cap	E. Laroue; multiple private; USFS	C	1984	locally common
054	Mackinac	Horseshoe Bay North	USFS	C	1987	local
052	Mackinac	Summerby Fen	MDOT ROW; USFS	C	1987	small, local colonies
058	Mackinac	Voight Bay	The Nature Conservancy	C?	1992	"only a couple of plants observed, but likely more abundant"

Table 1 (cont.). *Solidago houghtonii* occurrences in Michigan, arranged by county and hierarchically ordered by Element Occurrence rank.

OCCURRENCE NUMBER	COUNTY	SITE NAME	OWNERSHIP	EO RANK	LAST OBSERVED	ABUNDANCE
056	Mackinac	Charles Road	USFS	CD	1987	uncommon, local
012	Mackinac	Rabbit Back Peak	multiple private; USFS	CD	1981	locally common
009	Mackinac	West Mile Creek	Hiawatha Sportsmen's Club	CD	1969	ca. 12 plants
019	Mackinac	Sand Bay	Leona H. Case; H.L. Caukins	U ⁵	1938	no data
027	Mackinac	Point Patterson	State	U	1979	no data
006	Presque Isle	Huron Beach	Abitibi Corporation; MDOT ROW	A	1986	locally abundant
055	Presque Isle	Thompson's Harbor	State	AB	1989	locally abundant
005	Presque Isle	Hammond Bay	State	B	1981	locally abundant
025	Presque Isle	Black Mallard Creek Mouth	Abitibi Corporation	BC?	1981	locally abundant
029	Presque Isle	Evergreen Beach	local ROW; multiple private	BC?	1981	locally abundant
043	Presque Isle	Ferron Point	Consumers Power Corporation	U	1982	needs confirmation
028	Schoolcraft	Manistique Shore East	multiple private	BC?	1990	locally frequent
044	Schoolcraft	Rocky Point	multiple private	BC?	1982	locally frequent
038	Schoolcraft	Goudreau's Harbor	multiple private	C	1981	rare, local
023	Schoolcraft	Manistique Shore West	unknown (general record)	U	1915	"plentiful"

⁵ U = Undetermined rank due to lack of field data on occurrence.

facility managed by the Michigan Department of Military Affairs. A colony of approximately several hundred stems occurs along a short stretch of sandy roadside of Highway M-72 in MDOT right-of-way, within a protected area. This colony was subsequently found to be contiguous with a large occurrence ranging from Howe's Lake to Portage Creek. The occurrence remains vulnerable to the potential installation of a proposed pipeline through the site and continuing disturbance from persistent illegal off-road-vehicle (ORV) use. Plants within the immediate vicinities of Howe's Lake and Portage Creek are numerous and occur in fen to wet prairie-like habitat within a jack pine barrens/wet prairie complex (Higman et al. 1994). The second delineated occurrence within Camp Grayling consists of a relatively small colony of plants discovered along the camp's entry or cantonment road. These and all other identified areas within Camp Grayling supporting Federal and State listed species are being protected and managed by the Department of Military Affairs' environmental staff (Larry Jacobs, Michigan Department of Military Affairs, pers. comm. 1993).

Comprehensive data on the status and extent of many Michigan occurrences are lacking, despite wide-ranging *S. houghtonii* field surveys performed in 1981 by MNFI staff (Nepstad 1981) and subsequently by others. Much of the field data compiled during the 1981 shoreline survey consisted primarily of occurrence boundaries and provided only very cursory estimates, if any, of population sizes. Additional fieldwork will be required to ascertain if *S. houghtonii* remains extant at several sites and to determine the specific extent and status of occurrences. For example, in Big Stone Bay in Wilderness State Park, *S. houghtonii* was not found during the 1981 survey, although the habitat appeared to be intact. Plants observed on Consumers Power land in Presque Isle County at Ferron Point need to be verified, preferably by obtaining a voucher specimen. The species was recorded as "plentiful" in 1915 at Manistique Shore East and Manistique Beach West (*C.K. Dodge s.n., Sept. 17, 1915, BLH*)⁴, and these vague localities need to be pinpointed, field checked, and accurately mapped. These and several other sites, particularly those that were inundated by the high lake levels of the past few years, will require field surveys to determine the status of *S. houghtonii*.

Of Michigan's 58 occurrences of *S. houghtonii*, 32 are at least partially contained within Federal, State, township, or city lands or a nature preserve. For nature preserves alone, four occurrences are known and four additional but unconfirmed sites are reported. At least six occurrences lie within the boundaries of State-designated Critical Dune Areas, and one occurrence (Snake Island) lies within a formally dedicated State Natural Area. Portions of several occurrences lie within MDOT rights-of-way in designated protected areas (MDOT undated). A summary of Michigan's *S. houghtonii* occurrences by element occurrence rank and major ownership category are provided in Table 2.

3. New York Distribution

A disjunct occurrence of what can be considered to be *S. houghtonii* exists in Genesee County in the Bergen Swamp Nature Preserve, a site protected through the cooperative efforts of the Bergen Swamp Preservation Society and the Western Office of the New York Nature Conservancy. The occurrence, which is protected under the ownership of the Society, consists of

⁴BLH - herbarium collection, Cranbrook Institute of Science, Bloomfield Hills, Michigan.

Table 2. Summary of *Solidago houghtonii* occurrences in Michigan, listed by Element Occurrence rank and ownership category.

Occurrence Rank	A	AB	B	BC	C	CD	D	U	Total
Ownership category: ¹									
Federal land ²	0	1	1	1	2	2	0	0	7
State land ³	3	2	5	2	3	2	1	1	19
City land	1 ⁶	0	0	0	1	0	0	0	2
Private	1	2	2	8	8	1	1	2	25
Private nature preserve ⁴	1	0	2	0	1	0	0	0	4
Unknown ownership	0	0	0	0	0	0	0	1	1
Occurrences summarized by rank	6	5	10	11	15	5	2	4	58

¹ Ownership is listed by what is believed to be the major or principal landholder. Because of the linear shoreline distribution of *Solidago houghtonii*, many occurrences likely occur on land owned by multiple and numerous owners.

² Federal holdings include two Environmental Areas and one Wilderness Area.

³ State holdings include four Environmental Areas, one Natural Area, one Nature Study Area, and one Wilderness Research Area.

⁴ As noted in the text, four additional localities have been reported as occurring within nature preserves of the Michigan Nature Association, for which verification and specific status data are lacking.

hundreds of plants within a marl fen, according to staff of the New York Natural Heritage Program (Stephen Young, New York Natural Heritage Program, pers. comm. 1992).

D. Habitat

Solidago houghtonii occurs primarily along the northern shores of Lakes Huron and Michigan and is restricted to calcareous beach sands, rocky and cobbly shores, beach flats, edges of marl ponds, and especially the shallow, trough-like interdunal wetlands that parallel shoreline areas (MNFI 1993). It also occurs on seasonally wet limestone pavement, which is the species' more typical habitat in the eastern portion of its range, particularly in Ontario (Morton 1979, Semple and Ringius 1992), as well as in a marl fen in the single New York locality (MNFI 1992). In sand dune areas, it tends to occur on the lee side of low foredunes and on low stabilized dunes adjacent to interdunal wetlands, especially in moist to saturated sands within and around interdunal depressions. The sands in which it grows are circumneutral (pH 7.0) to alkaline (pH 8.0) and may occasionally have a thin covering of organic material (Collins 1989).

Solidago houghtonii usually occurs where there is a relatively low density of competing vegetation. However, in its calcareous, fen-like shoreline habitats, the associates are often quite diverse. A list of vascular plants commonly associated with *S. houghtonii* in Michigan, many of which are excellent indicator species, is provided in Table 3.

There are few available data concerning the specific microhabitat of *S. houghtonii* in the eastern portion of its range, where it commonly occurs on seasonally wet to marshy limestone pavement, as well as in sand dune habitats (Semple and Ringius 1992). On Great Cloche Island, *S. houghtonii* was collected from open limestone pavements in moist rock crevices (*D.F. Brunton* 3352, CAN)⁵, where it was considered uncommon, and occurred with *Andropogon scoparius* (little bluestem), *Coreopsis lanceolata* (lance-leaved tickseed), and *Potentilla fruticosa* (shrubby cinquefoil). In what appear to be similar limestone habitats in Michigan, MNFI staff have observed *S. houghtonii* growing in open, dry to moist sandy loam soil in limestone crevices with such associates as *Iris lacustris*, *Andropogon scoparius*, *Carex eburnea* (sedge), *Hypericum kalmianum* (Kalm's St. John's-wort), *Physocarpus opulifolius* (ninebark), *Satureja arkansana* (savory), *Senecio pauperculus* (northern ragwort), and *Zigadenus elegans* (white camass) (MNFI 1993).

The beach flats, dunes, and interdunal wetlands in which *S. houghtonii* occurs are active, dynamic habitats. These sites are characterized by their constant exposure to wave and wind action, with the continual movement of sand leading to cycles of destabilization, plant colonization, and subsequent dune restabilization. Beach flats and frontal dunes are also strongly affected by Great Lakes water level fluctuations, as are interdunal wetlands, whose water tables fluctuate in relation to the cyclical Great Lakes regime. *Solidago houghtonii* sometimes occurs along cobble shorelines, sandy beaches, and on wide beach flats, but in Michigan it is most commonly found in or near interdunal wetlands, especially in moist sand along the margins. The species' apparent establishment in the better drained portions of dunes, such as along the backside of foredunes, may indicate it has some resistance to desiccation. However, its growth

⁵CAN - herbarium collection, National Museum of Canada, Ottawa

Table 3. Common vascular plant associates of *Solidago houghtonii* in Michigan.

SPECIES	COMMON NAME
<i>Agalinis purpurea</i>	false foxglove
<i>Ammophila breviligulata</i>	beach grass
<i>Andropogon scoparius</i>	little bluestem
<i>Artemisia campestris</i>	beach wormwood
<i>Calamagrostis canadensis</i>	blue-joint grass
<i>Calamovilfa longifolia</i>	sand reed grass
<i>Carex crawei</i>	sedge
<i>Carex garberi</i>	sedge
<i>Carex viridula</i>	sedge
<i>Cirsium pitcheri</i>	Pitcher's thistle
<i>Cladium mariscoides</i>	twig-rush
<i>Eleocharis pauciflora</i>	spikerush
<i>Elymus canadensis</i>	nodding wild-rye
<i>Equisetum laevigatum</i>	smooth scouring rush
<i>Gentiana procera</i>	fringed gentian
<i>Geocaulon lividum</i>	geocaulon
<i>Hypericum kalmianum</i>	Kalm's St. John's wort
<i>Juncus balticus</i>	rush
<i>Juncus canadensis</i>	rush
<i>Juniperus horizontalis</i>	creeping juniper
<i>Larix laricina</i>	American larch or tamarack
<i>Lathyrus japonicus</i>	beach pea
<i>Lobelia kalmii</i>	Kalm's lobelia
<i>Muhlenbergia glomerata</i>	muhly grass
<i>Myrica gale</i>	sweet gale

Table 3 (cont.). Common vascular plant associates of *Solidago houghtonii* in Michigan.

SPECIES	COMMON NAME
<i>Parnassia glauca</i>	grass-of-Parnassus
<i>Physocarpus opulifolius</i>	ninebark
<i>Pinus strobus</i>	white pine
<i>Potentilla anserina</i>	silverweed
<i>Potentilla fruticosa</i>	shrubby cinquefoil
<i>Salix cordata</i>	sand-dune willow
<i>Salix exigua</i>	sandbar willow
<i>Salix myricoides</i>	blueleaf willow
<i>Satureja arkansana</i>	savory
<i>Senecio pauperculus</i>	northern ragwort
<i>Shepherdia canadensis</i>	Canadian buffalo-berry
<i>Smilacina stellata</i>	small false Solomon's-seal
<i>Solidago graminifolia</i>	grass-leaved goldenrod
<i>Solidago ohioensis</i>	Ohio goldenrod
<i>Solidago spathulata</i>	goldenrod
<i>Spiranthes cernua</i>	nodding ladies'-tresses
<i>Spiranthes romanzoffiana</i>	hooded ladies'-tresses
<i>Thuja occidentalis</i>	arbor vitae or white-cedar
<i>Tofieldia glutinosa</i>	false asphodel
<i>Triglochin maritima</i>	arrow-grass
<i>Triglochin palustris</i>	arrow-grass
<i>Zigadenus elegans</i>	white camass

in these areas may also merely mean that plants became established in wetter ground and later became partially buried by blowing, drifting sand, a common event in sand dune communities (Voss 1989). Plants established in this fashion are able to root deeply enough with extensive, fibrous root systems to obtain sufficient water to persist. The growth of *S. houghtonii* in seasonally wet, limestone pavement habitats (alvar) is another possible indicator of desiccation resistance, since these bedrock community sites are quite xeric environments for long periods during the growing season (Stephenson and Herendeen 1986). D.E. Buchel  et al. (1989) determined that *S. shortii* (Short's goldenrod), a federally endangered goldenrod endemic to Kentucky, is able to persist in xeric sites due to an ability to extend its roots 50 cm (20 in) or more through cracks in rocky soil. *Solidago houghtonii* may possibly adapt in a similar manner.

Much less commonly, *S. houghtonii* occurs in wet prairie-like habitats in Lower Michigan and locally in a New York marl fen. In the disjunct Crawford County sites, it occurs in abundance in intermittent wetlands that can be characterized as northern wet prairie, a natural community type with a strong affinity to both northern and southern fens. The soils are comprised, in part, of a Kinross-Au Gres soil series complex (Werlein and Kroell 1991) where the surface organics have a pH of 7.5 and the subsoil has a pH of 8.0 (P. Comer, MNFI, pers.comm. 1992). Associates include such species as *Hypericum kalmianum*, *Potentilla fruticosa*, *Carex conoidea* (sedge), *Castilleja coccinea* (Indian paintbrush), *Houstonia longifolia* (long-leaved bluets), *Lobelia spicata* (spiked lobelia), *Andropogon gerardii* (big bluestem), *Pinus banksiana* (Jack pine), *Prunus pumila* (sand cherry), the state threatened *Scirpus clintonii* (Clinton's bulrush), and *Spiranthes caseii* (Case's ladies'-tresses orchid) (MNFI 1993).

At the New York site, *S. houghtonii* occurs in a marl fen with such species as *Cypripedium calceolus* (yellow lady's-slipper orchid), *C. candidum* (small white lady's-slipper orchid), *Eleocharis rostellata* (spike-rush), *Juniperus horizontalis* (creeping juniper), *Kalmia* sp. (laurel), *Ledum groenlandicum* (Labrador-tea), *Parnassia glauca* (grass-of-Parnassus), *Scirpus caespitosus* (bulrush), *Scleria verticillata* (nut-rush), *Solidago ohioensis* (Ohio goldenrod), *S. purshii* (Pursh's goldenrod), *S. uliginosa* (swamp goldenrod), *Tofieldia glutinosa* (false asphodel), *Valeriana sitchensis* ssp. *uliginosa* (valerian), and many other typical fen and bog species (S. Young, New York Natural Heritage Program, pers. comm. 1992). Several of these species are typically associated with *Solidago houghtonii* in the main portion of its range in Michigan and Ontario.

E. Biology

Solidago houghtonii is an herbaceous perennial which arises from a branching, thickened base with a strongly fibrous root system. Stems are frequently clumped, arising from a caudex, and also occur as vegetative shoots or ramets produced from branching rhizomes. Numerous ramets are commonly produced and indicate that vegetative propagation is an important form of reproduction for this species, as it is for several other species of goldenrod. *Solidago houghtonii* is insect-pollinated, bearing flower heads composed of six to nine large, bright yellow ray florets, which are pistillate, and numerous bisexual disc florets (Gleason and Cronquist 1991). Flowering occurs primarily in August and early September but may occur as early as late July and not uncommonly well into October. Fruiting and seed dispersal appears to occur mostly from August through November and undoubtedly later (MNFI 1993). In researching the ecology of *S. shortii*, Buchel  et al. (1991) found their data suggested no persistent seed bank for the species. In examining numerous other studies concerning the phenology of *Solidago* seed

dispersal and germination, they concluded there is a good possibility that members of this genus produce seeds that remain viable for no more than one year, resulting in transient seed banks.

Little is known of the breeding system of *S. houghtonii* nor the particular conditions required for seedling germination and establishment. An important study, however, has been initiated by C.L. Jolls (East Carolina University and University of Michigan Biological Station) to answer specific questions concerning these critical life history components. Although no publications are currently available, this research has been directed at determining the phenology and abundance of seedlings, the specifics of the breeding system, and an evaluation of seed set and seedling germination ecology. In addition to these investigations, the relationship between substrate type, burial depth, seed mass, and seedling success was evaluated experimentally in a controlled growth facility (Jolls 1994). With regard to the breeding system, Jolls' preliminary findings from the 1993 research indicate that *S. houghtonii* is self-incompatible and thus dependent on insect vectors for successful pollination. Demographic monitoring in 1993 found that leaf characters (e.g. length, number) were not significant predictors of flowering. However, rhizome size was a significant predictor of flowering. Achene (seed) studies indicated that no emergence from depth was observed (the species requires light for germination), and achenes did not respond to differences in substrate types between the two study sites (Sturgeon Bay and Point La Barbe). Successful germination was found to require an obligate overwintering (chilling) period.

Jolls (1994) autecological research resulted in several important preliminary findings. It was noted that because flowering is size-related and inversely correlated between years, maintaining large, mature individuals is critical to conservation efforts for this species. Jolls (1994) further noted that "given that seed set and seedling success may be limited by pollinator activity, genetics, and microsite availability, sexual reproduction may be a relatively infrequent event related to pollinator activity, climate, and disturbance, such as water level fluctuations. For a relatively long-lived taxon with limited successful sexual reproduction such as *S. houghtonii*, maintenance of adults and their habitats becomes critical."

A wide variety of insect pollen vectors are attracted to *Solidago* flowers, which provide both pollen and nectar. Potential pollen vectors include bees (Hymenoptera), butterflies (Lepidoptera), flies (Diptera), moths (Lepidoptera), and wasps (Hymenoptera). Goldenrod pollen is well adapted to these invertebrate pollen vectors, since it is relatively heavy and minutely spiny (echinate) and can readily attach to the hairs and bristles of insects in several groups (Semple and Ringius 1992). Specific insect pollinators of *S. houghtonii* have not been identified, but arthropod associates were further detailed by Jolls (1994), including several families from the orders Coleoptera (Phalacridae), Diptera (Bombyliidae, Syrphidae), Hemiptera (Nabidae), Hymenoptera (Formicidae, Halictidae), Lepidoptera (Coliophoridae), and Orthoptera (Cercophidae).

In Michigan, *S. houghtonii* is a hexaploid species ($6x = 54$) except Crawford County occurrences, which are the only known *Solidago* octoploids and may represent a different taxon. Canadian plants are all hexaploid but have different origins and may represent two distinct taxonomic entities. New York plants in Bergen Swamp are hexaploid (Pringle 1987). Although taxonomic botanists do not agree on the details of this goldenrod's origin and no biosystematic studies have been published, they believe that all populations currently referable to *S. houghtonii* probably arose after hybridization and perhaps backcrossing.

The restriction of *S. houghtonii* to calcareous sands and dolomitic limestone areas of the Niagaran Escarpment suggests that the species requires a relatively high amount of calcium and magnesium (and possibly sodium and potassium) in its substrate. Dune sands in the region of the Niagaran Escarpment generally have a calcareous component of about 1 to 5 percent that is composed primarily of ground mollusk shells (Collins 1989). The pH range of this substrate is generally circumneutral to about 8.0 (Collins 1989).

To date, no demographic, pollination biology, or seed establishment studies of *S. houghtonii* have been published. In 1983, MNFI staff initiated monitoring studies within two large populations of *S. houghtonii* located in Cheboygan County in the Grass Bay Preserve of The Nature Conservancy (Grass Bay) and in Emmet County along Sturgeon Bay in Wilderness State Park (Sturgeon Bay). Data from this 10-year monitoring study have not been fully analyzed, but preliminary results and observations are presented below (MNFI 1997).

Within the monitoring sites, permanent plots with an area of approximately 3 m² (32 ft²) were established in areas of high *S. houghtonii* concentrations. In Grass Bay, the plot was established along the margin of an interdunal wetland. In Sturgeon Bay, the plot was placed adjacent to a large interdunal area in a low, seasonally moist flat behind a foredune; this site was noted as being very damp during high water years for Lake Michigan. In both plots, a total of 100 plants were initially identified, mapped, and tagged (Soulé 1984). In the first year of monitoring, plants in the Sturgeon Bay plot were less dense (23 plants per m² (2.1 plants per ft²)) and had a higher proportion of flowering stems (31 percent) in comparison to the Grass Bay plot (30 plants per m² (2.8 plants per ft²) and 23 percent flowering stems). Of about 98 plants censused at Sturgeon Bay in 1988, approximately 90 percent consisted of non-flowering shoots and 10 percent of flowering shoots. Many of the non-flowering shoots appeared to be seedlings or young offshoots (MNFI 1997). Similar data for Grass Bay have not been summarized.

Over the course of the last several years of monitoring, individual plants were found to have from 2 to 12 ramets. It is likely that more ramets per plant were produced in several individuals but not identified, since ramets were found to disarticulate and become established as independent plants. One of the primary impediments in monitoring *S. houghtonii* and obtaining meaningful demographic data has been the difficulty in ascertaining exactly what constitutes an individual plant. The fragmentation of ramets has made it difficult to distinguish whether different genetic individuals exist among closely clumped stems and basal rosettes.

Despite the inherent problems of identifying genetic individuals with certainty, all tagged stems and rosettes within monitoring plots as well as seedlings identified as colonizers have been tracked. Basal rosettes of seedlings or ramets were found to persist for one to six years without flowering and often persisted following successful flowering and fruiting. Submergence during years of high lake levels, such as that observed in the Grass Bay interdunal wetland plot, resulted in high mortality and recolonization occurring during low water years. Damage to plants by animals does not seem to be severe. In both monitoring sites, herbivore damage has been noted as occasional to frequent, and aphid and other insect infestations were occasionally observed but did not seem to produce significant effects.

The dynamics of the dune environment were especially evident in the Sturgeon Bay plot. The continual movement of sand occasionally caused partial and sometimes nearly entire rootstocks exposure. Large, vigorous plants growing up the lee side of foredunes had rhizomes

which elongated through several centimeters (inches) of accumulated, wind-deposited sand. Plants at Sturgeon Bay and elsewhere appear to respond to burial by developing numerous additional inflorescence shoots from upper leaf axils, which results in many-headed plants. Two collections (*E.G. Voss 14965* and *15909*, MICH) of individuals with 225 and more than 125 flower heads, respectively, indicate this to be the case.⁶

The preceding demographic study, although relatively simple in design, indicates several problems that may be encountered in studying the life history of a clonal, perennial plant species and demonstrates some of the sampling and monitoring difficulties that can be expected in future life history and population biology studies of *S. houghtonii*. Despite the inherent difficulties, this 10-year study of two *S. houghtonii* occurrences has provided useful data, which, when fully analyzed, should give a preliminary assessment of colonization rate, growth, population trends, and reproduction. These factors can then be correlated with habitat conditions and cyclical fluctuations in Great Lakes water levels.

Since the aforementioned monitoring efforts, a more rigorous and extensive study of the Grass Bay population has been implemented by J.W. White (Michigan State University). A long-term monitoring study to determine the abundance and flowering dynamics of *S. houghtonii* was initiated in 1994 to elucidate the demographics and fecundity of this species and its relationship to shoreline microhabitats.

F. Threats and Limiting Factors

Solidago houghtonii, like several of its associated endemics, is particularly vulnerable to extirpation because of its restriction to narrow shoreline habitats of the Great Lakes. In a 1981 status survey, D.C. Nepstad considered habitat destruction to be the greatest threat to populations of *S. houghtonii* and cited the desirability of shoreline areas for residential housing and the escalating pressure for this type of development as a principal cause of this habitat destruction. The rate of residential development continues to accelerate, and it is highly unlikely that there will be any abatement of this trend in the near future. Nepstad (1981) also noted that some major occurrences of *S. houghtonii* have been considerably altered and fragmented by private development such that their long-term viability has been severely diminished. This has been a view supported by subsequent field surveys (MNFI 1993).

There are many causes of habitat alterations that have adversely affected *S. houghtonii* populations. Construction of beach retaining walls and other emergency erosion control measures (e.g. rip-rap and bulkhead installation) prevents or inhibits dune formation. Excessive foot and off-road vehicle (ORV) traffic destabilizes dune and beach flats. Marina construction, road construction, sand mining, and home and cottage construction where improved lake views are desired, have resulted in leveling of dune ridges (Collins 1989). Driveway installation or permitted work performed by utilities and railroads near interdunal wetlands have fragmented colonies and altered the hydrology. Residential development further potentially threatens habitat by altering hydrology with the placement and construction of septic systems whose nutrient

⁶ A similar situation was documented in Cheboygan State Park along the southern portion of Duncan Bay, where a plant with an inflorescence of more than 200 flower heads was collected from the backside of a foredune (*M.R. Penskar and W.W. Brodowicz 1067*, MICH).

loading degrade adjacent interdunal wetlands. Finally, both foot and ORV traffic have caused the direct destruction of plants.

Several *S. houghtonii* occurrences in Michigan are within or along rights-of-way administered by MDOT. Records in the MNFI show that there are at least 11 occurrences partially within or along MDOT rights-of-way, representing nearly 20 percent of the known occurrences in Michigan. Kim D. Herman (1988) notes that *S. houghtonii* is more vulnerable to disturbance than two other endemics of Great Lakes shorelines, dwarf lake iris and Pitcher's thistle, because of its restriction to narrow bands of interdunal wetland habitats, many of which occur between coastal roads and lakeshores. In some of these sites, highways may be severely fragmenting *S. houghtonii* populations or preventing them from expanding and colonizing suitable habitat available further inland.

Herman (1988) further states that the MDOT activities which resulted in the most adverse effects to this species and other Great Lakes endemics are projects along two major State roadways, US-2 and US-23, located in the Upper Peninsula and Lower Peninsula, respectively. These activities included culvert extensions, pavement recycling, shoulder widening, and other types of safety work. In the Pointe Aux Chenes area, several hundred *S. houghtonii* plants were collected under the authority of a State threatened species permit granted to MDOT. Prior to their listing as federally threatened species, a large number of individuals of *Cirsium pitcheri* and *S. houghtonii* were collected in anticipation of the proposed development of a US-2 boulevard in Mackinac County. All the plants collected before these two projects began were prepared as dried specimens, but it is thought they were not retained within any herbaria (Michael Penskar, MNFI, pers. comm. 1993). The boulevard project, initiated under the provisions of a State Environmental Impact Statement (EIS), has been halted indefinitely and the habitat currently remains intact. A Federal EIS may be required if the project is resumed with Federal funding (Herman 1988).

A number of common road maintenance activities, including emergency repairs on eroding shoreline areas, herbicide application, mowing, road salting, shoulder grading, snow removal, and tree removal, have affected populations of *S. houghtonii* (Herman 1988). A number of illegal activities which have occurred on or near MDOT rights-of-way have also affected this species and its habitat. Illegal use of sites by commercial fishermen and encroachments by ORV operators and other recreationists have had adverse effects (MNFI 1993).

Habitat damage resulting from ORV traffic is one of the major threats to *S. houghtonii*. The restriction of this species to a very limited, narrow expanse of shoreline habitat renders it particularly vulnerable to destruction and habitat fragmentation. Off-road-vehicles are in widespread use and are very difficult to exclude from most kinds of natural areas, particularly beaches and coastal dunes. Their use and resulting effects on these sites are well documented throughout Michigan (MNFI 1993). Off-road-vehicle traffic or evidence of it has been observed in areas of exemplary *S. houghtonii* occurrences, such as Crow River Mouth (Mackinac County), Grass Bay (Cheboygan County), and Wilderness State Park (Emmet County) (MNFI 1993), and probably occurs in many and perhaps most other sites throughout the range of the species.

Artificial disturbance may not always represent a threat to *S. houghtonii* populations. According to Morton (1989), road construction and maintenance on Great Cloche Island in Ontario seems to have benefited the species. The densest and most vigorous colonies there occur

on the marshy edges of the main road across the island. Construction of the road produced ecotonal habitat suitable for colonization, and plants there are reported to remain vigorous despite current road maintenance practices. William J. Mahalak (1989) similarly observed *S. houghtonii* colonizing artificially disturbed sites in Michigan. However, despite the apparent benefits of some forms of artificial disturbance, colonies that become established in such situations remain particularly vulnerable to continued human activities. The colonization of artificially disturbed sites is therefore likely to be of temporary advantage as local refugia.

The restriction of *S. houghtonii* to low-lying, linear coastal zone habitats also causes it to be highly susceptible to natural disturbance. Rises in lake levels, such as the record highs attained in 1986, may severely reduce population numbers throughout the entire range of the species (Voss 1987). It is thus very important that destructive human activities are minimized or eliminated so as not to exacerbate the effects of natural disturbance (Voss 1987).

It is unlikely that the range of *S. houghtonii* will expand because of the accelerating habitat loss and fragmentation due to development, increasing human-caused habitat disturbance, and the restriction of nearly all individuals of the species to shores of the Great Lakes. Therefore, essential habitat must be protected. Any artificial stabilization of Great Lakes levels could markedly change the natural dynamics of shoreline habitats and be highly detrimental to *S. houghtonii*, as well as to many other sensitive species and significant natural communities. Stabilization of the Great Lakes at low water levels might initially benefit *S. houghtonii* by temporarily exposing maximum suitable habitat. However, unless lake levels are continually lowered, stabilized *S. houghtonii* habitat is likely to be altered and will become unsuitable through plant succession. As a relatively poor competitor restricted to dynamic shoreline areas, this species depends on the cyclical fluctuations of the Great Lakes. It suffers local extirpations during high water years, but later exploits and colonizes newly exposed habitat as it becomes available again.

Some *Solidago* species are available from seed companies for propagation as ornamentals (Anthony A. Reznicek, Michigan State Technical Committee, pers. comm. 1993) and others, such as *S. graminifolia* (grassleaf goldenrod), *S. riddellii* (riddell goldenrod), and *S. rigida* (rigid goldenrod), may be included in prairie mixtures (Iowa Prairie Seed Company 1989, Prairie Moon Nursery 1993). The common misconception that goldenrods cause fall hay fever probably reduces interest in propagating members of this genus as ornamentals. *Solidago houghtonii* is not currently known to be utilized commercially. A discussion of horticultural, medicinal, and other cultural uses of goldenrods is provided in a magazine article by Jepson (1993).

Like many rare species, *S. houghtonii* can potentially be over-collected by individuals with legal collecting permits, such as those who desire specimens for herbaria in which this taxon is poorly represented. Despite the good intentions of removing live plants for propagation and exhibition in rare plant collections, such activities, if done excessively or without proper permits, also represent a threat to populations. Permits granted for the taking of this species should be issued only after careful consideration and consultation with appropriate, knowledgeable individuals. Permits should stipulate that collections may be made only when an occurrence (i.e., a "population") would not be significantly diminished or adversely affected by removal of individuals. Simple collecting criteria should be established to define more precisely what constitutes population degradation or over-collection. These criteria may consist of

establishing a minimum population size that can sustain collecting; prohibiting collecting in specific sites, especially areas which are already well documented in public herbaria or living collections; and regulating the number of plants that can be taken.

G. Conservation Measures

Conservation measures provided to *S. houghtonii* as a listed threatened species under the Federal Endangered Species Act of 1973, as amended (Act), include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private agencies, groups, and individuals. The Act provides for possible voluntary land acquisition and cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required of Federal agencies and the prohibition against certain activities involving listed plants are discussed, in part, below.

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any has been designated. *Solidago houghtonii* was listed as a threatened species without critical habitat designation. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(2) requires Federal agencies to insure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its critical habitat. If a Federal action is likely to adversely affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the U.S. Fish and Wildlife Service. Thus, if any occurrence is on land that is administered by a Federal agency or for which a Federal permit or funding is used, procedures in Section 7(a) must be followed.

Sections 9 and 10 of the Act and its implementing regulations found at 50 CFR 17.71 and 17.72 set forth a series of prohibitions and exceptions that apply to all threatened plant species not covered by a special rule. No special rule has been published for *S. houghtonii*. These prohibitions, in part, make it illegal, with respect to any endangered or threatened plant subject thereto, for any person subject to the jurisdiction of the United States to import or export; transport in interstate or foreign commerce in the course of a commercial activity; sell or offer for sale this species in interstate or foreign commerce; or to remove and reduce to possession this species from areas under Federal jurisdiction; maliciously damage or destroy this species on any area under Federal jurisdiction; or remove, cut, dig up, damage, or destroy this species on any other area in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law. "Plant" means any member of the plant kingdom, including seeds, roots, and other parts. Because *S. houghtonii* is a threatened plant species, seeds from cultivated specimens are exempt from these prohibitions provided that a statement of "cultivated origin" appears on their containers. Certain exceptions apply to agents of the U.S. Fish and Wildlife Service and State conservation agencies.

The Act and 50 CFR 17.72 also provide for the issuance of permits to carry out otherwise prohibited activities involving threatened species under certain circumstances. Such permits are available for scientific purposes or to enhance the propagation or survival of the species. In some instances, permits may be issued for a specified time to relieve undue economic hardship that would be suffered if such relief were not available. It is anticipated that few trade

permits would ever be sought or issued, because this species is not common in cultivation or in the wild. Requests for copies of the regulations on plants and inquiries regarding them may be addressed to Permits Coordinator, Division of Endangered Species, U.S. Fish and Wildlife Service, 1 Federal Drive, Fort Snelling, MN 55111-4056 (phone 612-725-3536, fax 612-725-3526).

Rules for protection of listed plants in the National Forests are in the U.S. Forest Service Manual Title 2600--Wildlife, Fish, and Sensitive Plant Habitat Management, Chapter 2670--Threatened, Endangered and Sensitive Plants and Animals. The U.S. Forest Service must abide by the Endangered Species Act and the National Environmental Protection Act in managing their forests. Horseshoe Bay Wilderness Area within the Hiawatha National Forest was established by the Wilderness Act and yields an untouched, protected area. The National Forest Management Act of 1976 mandates that a Management Plan be written for each National Forest. The Hiawatha National Forest Land and Resources Management Plan (U.S. Department of Agriculture, Forest Service 1986) includes management actions to be performed for endangered, threatened, and special concern plants, including *S. houghtonii* (Larry Stritch, Eastern Region, U.S. Forest Service, and Lynden Gerdes, Hiawatha National Forest, pers. comm. 1993).

In Michigan, according to Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act (NREPA)(Act 451 of the Public Acts of 1994, sections 324.6501 - 324.6507 of Michigan Compiled Laws) it is illegal to take (collect, pick, cut, dig up, or destroy in any manner), possess, transport, import, export, process, sell or offer for sale, or buy or offer to buy any plant occurring on the State or Federal lists of endangered and threatened species, except as otherwise provided for in the Act. "Plant" means any member of the plant kingdom, including seeds, roots, or other parts. Listed species are protected on both private and public land, and may not be taken without a permit (Thomas Weise, Michigan Department of Natural Resources, pers. comm. 1996). On state lands, including state parks and state forests, as well as specially designated sites such as Critical Dune Areas, Natural Areas, Environmental Areas, Wildlife Study Areas, and Management Areas, special use permits are usually required in addition the appropriate State and Federal permits for the taking of listed species. The MDOT Special Plant Manual reiterates the Federal and State protection afforded listed species. MDOT has also agreed with the Michigan Department of Natural Resources to place "PROTECTED AREA" signs at each listed species site in their ROW areas..

In accordance with New York State Environmental Conservation Law, " it is a violation for any person, anywhere in the state to pick, pluck, sever, remove, damage by the application of herbicides or defoliants, or carry away, without the consent of the owner, any protected plant. Each protected plant so picked, plucked, severed, removed, damaged or carried away shall constitute a separate violation." Violators of the regulation are subject to fines of \$25 per plant illegally taken.

H. Strategy of Recovery

The goal of Priority 1 tasks is to protect at least 30 occurrences of *S. houghtonii*, with emphasis placed on the most viable occurrences and the species' essential habitat. An important aspect of managing these populations is the ability and willingness of responsible individuals to use the most current information available about their sites to make decisions. To this end, the MNFI must distribute current information and the responsible agencies must update and consult

their records. Other protective strategies include development and implementation of methods to prevent ORV damage, effective monitoring and law enforcement, private landowner contact, education, and registry (see Narrative Outline 143), protection of sites through local zoning ordinances, Natural Areas designation, land acquisition, and written agreements and management plans for occurrences on public land. The bulk of these tasks would be completed in the first three years of the recovery process, with less time necessary for updating in following years.

Goals of Priority 2 tasks include educating land managers and the public, monitoring occurrences, searching for additional sites, and verifying historical occurrences. Most of this work would be done in the second and third years followed by updating in later years.

II. RECOVERY

A. Recovery Plan Objective

Solidago houghtonii is virtually endemic to the northern shores of Lakes Huron and Michigan. A significant expansion in range is very unlikely, and the shoreline areas supporting this species are being developed and used for recreation at an ever increasing pace. These activities render *S. houghtonii* extremely vulnerable to extirpation, particularly within the context of the cyclical, natural habitat reduction which results from periodic rises in lake levels and plant succession. Because the species is restricted primarily to narrow interdunal wetlands along upper Great Lakes shores, *S. houghtonii* will almost certainly never become as abundant and widespread as many of its shoreline associates, including two other Great Lakes endemics, *Iris lacustris* and *Cirsium pitcheri*.

The **primary recovery objective for *S. houghtonii* is the effective protection of all known occurrences of the species in the United States** (Michigan and New York). As used here, *protection* consists of all actions necessary to conserve known occurrences, maintain ecosystem processes for the perpetuation of essential habitat, and enable each occurrence to be naturally self-sustaining. ***Solidago houghtonii* will be considered for delisting when 30 distinct, self-sustaining occurrences are protected.** Delisting criteria are preliminary and may be revised on the basis of new information. Although population viability has not been strictly determined for this species (*i.e.*, the number of individuals and area of essential habitat necessary for a self-sustaining population), emphasis should be placed on protecting occurrences (or the largest populations occurring in the highest quality habitat globally ranked A or B, see Appendix C for Global Ranking Criteria), thus conserving colonies most likely to be self-perpetuating.

The goals of the recovery plan can be accomplished by: 1) protecting all known occurrences of *S. houghtonii*, with priority on achieving effective protection for the highest ranking occurrences and essential habitat; 2) conducting field surveys to determine possible new occurrences and to verify the status and extent of known occurrences; 3) educating and notifying land managers and the public; 4) monitoring occurrences to determine population demographics, threats, and viability; and 5) conducting biosystematic research on the species throughout its global range.

B. Step-down Outline

1. Protect all known occurrences, placing priority on achieving effective protection for the highest ranking occurrences and essential habitat.
 11. Provide and update current site occurrence information at least yearly.
 111. Provide current site occurrence information at least yearly to all appropriate departments and divisions of pertinent Federal, State, and local public agencies.
 112. Update U.S. Fish and Wildlife Service records.
 113. Update U.S. Forest Service records.
 114. Update Michigan Forest Management Division records.
 115. Update Michigan Land and Water Management Division records.
 116. Update Michigan Department of Transportation right-of-way records and ensure transfer of data to District Offices.
 117. Update Michigan State Park master plans.
 12. Develop written agreements and management plans for protection on public lands.
 13. Develop and implement strategies to protect occurrences and sites from off-road-vehicle (ORV) damage.
 131. Develop strategies.
 132. Restrict access routes with new or improved barriers.
 133. Post signs.
 134. Work with law enforcement and other agencies to monitor sites and coordinate effective enforcement.
 14. Promote protection of occurrences on privately owned land.
 141. Initiate private landowner contact.
 142. Provide education for private landowners.
 143. Promote private landowner involvement in a registry program.
 15. Promote development of local zoning ordinances favorable to the protection of *S. houghtonii* and its habitat if existing laws are inadequate.
 16. Recommend and support sites for potential Natural Area designation.
 17. Encourage land acquisition.
2. Conduct field surveys to determine possible new occurrences and verify the status and extent of known occurrences.
 21. Systematically assess potential habitat from aerial photographs; map known occurrences and delineate potential habitat.

22. Conduct systematic field surveys.
 23. Prepare maps of *S. houghtonii* occurrences.
 24. Reassess ranks of known occurrences; determine ranks of newly identified occurrences; and revise protection priorities, if necessary.
3. Educate land managers and the public.
 31. Distribute relevant biological and management information about *S. houghtonii* to public land managers, enforcement officials, and the general public.
 32. Conduct management workshops for public agencies.
 33. Post signs indicating the presence of sensitive habitat and rare species.
 4. Monitor occurrences to determine population trends, viability, and threats.
 5. Conduct biosystematic research on the species throughout its global range.
 51. Determine the taxonomic relationships of *S. houghtonii* populations in Michigan, New York, and Canada, with emphasis on outlier populations.
 52. Determine the genetic variability within and between occurrences throughout the global range.
 53. Conduct research on autecology.

C. Narrative Outline

1. Protect all known occurrences, placing priority on achieving effective protection for the highest ranking occurrences and essential habitat.

The few occurrences of *S. houghtonii* are primarily within a restricted, vulnerable zone of habitat along shorelines of the Great Lakes. To ensure the perpetuation of this species, which is likely to become more imperiled in the future, **protect a minimum of 30 occurrences believed to be the most viable.** Estimate viability and establish priorities for protection and recovery efforts by using global ranking criteria (Appendix C). Ranks of A, B, and C represent excellent, good, and fair occurrences, respectively. Focus protection activities primarily on occurrences classified in these three categories, because they are the most viable and self-sustaining. D-ranked occurrences often persist but occur in the most degraded, least defensible sites and have the poorest prospect of self-sustainability. Regard these sites as representing small but important seed sources and significant reservoirs of genetic diversity. These lower ranked sites may also offer educational opportunities and resulting enhancement to the protection of higher ranked occurrences, if such activities would not further degrade the sites.

Focus strategies for the conservation of *S. houghtonii* occurrences on the protection of essential shoreline habitat and the natural environmental processes that maintain it. These strategies involve a number of approaches, often in combination, to achieve as much protection as possible for the relatively few occurrences that exist. Protect key buffer areas that enhance the integrity of occurrences as well as the immediate habitat of the species. Avoid fragmentation of occurrences. The protection of *S. houghtonii* and its habitat helps to ensure the protection of its shoreline ecosystem which also supports several other rare animals and plants.

Table 4 summarizes, by site, the recommended protection strategies identified under Task 1.

11. Provide and update current site occurrence information at least yearly.

Land protection, the foundation of recovery efforts, is based on communication of occurrence and management information to Federal, State, and local government agencies and significant private landowners. Principal cooperators include: The U.S. Fish and Wildlife Service; the U.S. Forest Service (USFS); the Michigan Department of Natural Resources (MDNR); the Michigan Department of Transportation (MDOT); township and city governments; The Nature Conservancy (TNC), via the Michigan and New York Heritage Programs and Field Offices; and private landowners.

111. Provide current site occurrence information at least yearly to all appropriate departments and divisions of pertinent Federal, State, and local public agencies.

Distribute MNFT's database of *S. houghtonii* occurrences to all appropriate offices at least yearly so that land managers may use current information to make management decisions and anticipate and avoid actions that may adversely affect colonies or essential habitat.

112. Update U.S. Fish and Wildlife Service records.

Update files of appropriate regional offices yearly or more often if possible and distribute information to the field offices responsible for the occurrences. Consult these files when reviewing permit applications and during consultations with other Federal agencies.

113. Update U.S. Forest Service records.

Update USFS files of significant natural features locations yearly or more often if possible. Consult this database on a regular basis to help avoid management activities detrimental to *S. houghtonii* occurrences.

Table 4. Recommended protection strategies for all known U.S. occurrences of *Solidago houghtonii*, arranged by Element Occurrence Record (EOR) number.

OCCURRENCE NUMBER	SITE NAME	RECOMMENDED PROTECTION STRATEGIES						
		Updated Occurrence Information	Written Agreements and Management Plans	Restriction of Off-road Vehicles	Private Landowner Contact / Registry Program	Local Ordinance	Potential Natural Area Designation	Encouragement of Land Acquisition
001 (NY)	Bergen Swamp (New York)		X	X	X?		X?	X?
001	Trail's End Bay	X	X	X	X	X		
002	Waugoshance Point	X	X	X			X	
003	Grass Bay			X			X	X
005	Hammond Bay	X	X	X				
006	Huron Beach			X	X			
007	Lime Kiln Point	X	X	X	X	X?		X?
008	Seaman's Point	X	X	X	X			X
009	West Mile Creek			X	X			
010	Black River Road	X	X	X	X			
012	Rabbit Back Peak	X	X	X		X?		
015	St. Vital Bay	X	X	X				
016	Albany Island Drive			X	X			
017	Pointe Aux Chenes	X	X	X	X		X ¹	
019	Sand Bay			X	X			
020	Big Stone Bay	X	X	X				
021	Sturgeon Bay	X	X	X			X	X?

Table 4 (cont.). Recommended protection strategies for all known U.S. occurrences of *Solidago houghtonii*, arranged by EOR number.

OCCURRENCE NUMBER	SITE NAME	RECOMMENDED PROTECTION STRATEGIES						
		Updated Occurrence Information	Written Agreements and Management Plans	Restriction of Off-road Vehicles	Private Landowner Contact / Registry Program	Local Ordinance	Potential Natural Area Designation	Encouragement of Land Acquisition
022	Cheboygan Point	X	X	X				
023	Manistique Beach West ²							
024	Pries Landing			X	X			
025	Black Mallard Creek Mouth			X	X			X?
026	Howes Lake - Portage Creek	X	X	X				
027	Point Patterson	X	X	X				
028	Manistique Shore East			X	X			X?
029	Evergreen Beach			X	X	X?		X?
030	Point La Barbe	X	X	X		X		X?
031	Stevenson Bay			X	X	X?		X
032	Albany Creek Mouth			X	X			
033	Strawberry Island	X	X	X				
034	Seymour Bay			X	X			
035	Rice Point	X	X	X				
036	Stoney Point Road	X	X	X		X?		
038	Goudreau's Harbor			X	X			
039	Snake Island	X	X	X	X			

Table 4 (cont.). Recommended protection strategies for all known U.S. occurrences of *Solidago houghtonii*, arranged by EOR number.

OCCURRENCE NUMBER	SITE NAME	RECOMMENDED PROTECTION STRATEGIES						
		Updated Occurrence Information	Written Agreements and Management Plans	Restriction of Off-road Vehicles	Private Landowner Contact / Registry Program	Local Ordinance	Potential Natural Area Designation	Encouragement of Land Acquisition
040	Beach Road			X	X			
041	Lower Millecoquins Creek Mouth			X	X			
042	Crow River Mouth	X	X	X	X		X ³	
043	Ferron Point			X	X			
044	Rocky Point			X	X	X?		
045	Garden Island	X	X	X			X	
046	Sturgeon Bay Point			X	X	X		X?
047	St. Martin Point	X	X	X	X			X?
048	Gros Cap	X	X	X	X			
049	Horseshoe Bay	X	X	X				
050	Point Nipigon			X	X			
051	Baltimore Bay	X	X	X				
052	Summerby Fen	X	X	X			X ¹	
053	Epoufette	X	X	X				
054	Horseshoe Bay North	X	X	X				
055	Thompson's Harbor	X	X	X			X	

Table 4 (cont.). Recommended protection strategies for all known U.S. occurrences of *Solidago houghtonii*, arranged by EOR number.

OCCURRENCE NUMBER	SITE NAME	RECOMMENDED PROTECTION STRATEGIES						
		Updated Occurrence Information	Written Agreements and Management Plans	Restriction of Off-road Vehicles	Private Landowner Contact / Registry Program	Local Ordinance	Potential Natural Area Designation	Encouragement of Land Acquisition
056	Charles Road	X	X	X				
057	Mackinaw City			X	X			
058	Voight Bay	X		X				
059	Bush Bay	X	X	X	X			
061	West Moran Bay			X	X			
062	Fisherman's Island State Park	X	X	X				
063	Donegal Bay			X	X			
064	Bluestem Prairie	X	X	X				
065	Cantonment Road - Camp Grayling	X	X	X				

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¹ This site is a proposed U.S. Forest Service Research Natural Area.

² This occurrence was derived from a general record; a field survey to verify status is required.

³ This site could be designated as a Nature Study Preserve.

114. Update Michigan Forest Management Division records.

Update occurrence and management information yearly or more often if possible and review prior to anticipated management activities.

115. Update Michigan Land and Water Management Division records.

Update occurrence and management information yearly or more often if possible and consult during permit reviews.

116. Update Michigan Department of Transportation rights-of-way records and ensure transfer of data to District Offices.

Portions of a significant number of the known occurrences of *S. houghtonii* occur partially within or along MDOT rights-of-way. Update occurrence and management information yearly or more often if possible and provide it to District Offices for appropriate modifications of management practices in protected areas of rights-of-way and for installation of protected area signs.

117. Update Michigan Park master plans.

Incorporate updated site location data in the State Parks master plans to avoid conflict with *S. houghtonii* protection during facility planning.

12. Develop written agreements and management plans for protection on public lands.

Because *S. houghtonii* is a listed species, public agencies have a legal obligation to protect the plant. To ensure a high level of protection now, as well as when and if the species is delisted, obtain written commitments to protect the species and its habitat in perpetuity. This is especially important when public lands are managed for multiple purposes. Guide the protection of occurrences on public lands by the preparation of specific management plans that will enable occurrences to be self-perpetuating. Prepare concise and understandable management plans for public agencies and government units, which experience frequent personnel changes and need a familiar and consistent management policy. Many of the materials developed for private landowner contact (elaborated in 14, below) can also be used to educate public land managers.

13. Develop and implement strategies to protect occurrences and sites from ORV damage.

One of the most pernicious threats to the sustainability of *S. houghtonii* occurrences and habitat is the ever increasing use of shoreline areas by operators of ORVs. Develop and implement strategies to eliminate ORV encroachment on *S. houghtonii* occurrences.

131. Develop strategies.

Develop strategies to minimize adverse effects by convening one or more meetings of agencies responsible for areas where ORVs affect occurrences.

132. Restrict access routes with new or improved barriers.

Off-road-vehicle traffic is difficult to exclude from natural areas, particularly from shorelines where access is easily gained from adjacent private land. Construct new or improved barriers and obstructions to inhibit or limit illegal encroachments.

133. Post signs.

Post signs indicating the presence of sensitive species and communities and Federal and State penalties for illegal damage or destruction of *S. houghtonii* to help limit ORV incursions. Accompanying literature including an illustration of the plant but not conveying specific locations may also be useful.

134. Work with law enforcement and other agencies to monitor sites and coordinate effective enforcement.

Make directed efforts to achieve compliance with Federal and State laws in high priority areas.

14. Promote protection of occurrences on privately owned land.

Notify private landowners and provide them with educational materials. This is essential to both the short and long-term conservation of *S. houghtonii* and potentially can result in voluntary agreements to protect occurrences through a registry program.

141. Initiate private landowner contact.

Communicate to all private landowners on whose property *S. houghtonii* occurs that a Federal and State threatened species occurs on their land. Landowner notification or contact is an immediate, short-term recovery action fundamental, and precursory to, long-term recovery efforts. Prepared educational materials should include: information on the rarity of the species, an understandable and nontechnical description and illustration of the plant, the species requirements to be self-sustaining, why the species is rare, and the value of protecting the species. Apprise landowners of the legal protection afforded by the Federal and State Endangered Species Acts. Notify adjacent landowners whose property provides contiguous and potential habitat so they will know not to engage in activities indirectly detrimental to the species.

Transmit new information as it becomes available so that notification is a continuing process.

142. Provide education for private landowners.

Provide landowners with specific instructions and guidelines for site management. Such guidelines are best prepared by a natural resource agency, such as the Michigan Natural Heritage Program, and can be distributed with other prepared educational materials.

143. Promote private landowner involvement in a registry program.

Encourage landowners to sign private registry agreements, which are non-legally binding contracts that are proactive alternatives and can provide significant protection for many occurrences. Registry can provide short-term protection and may ultimately lead to long-term protection through donation, legally binding conservation easements (Part 21, Conservation and Historic Preservation Easement, NREPA) Natural Area designation, or purchase by a public agency.

15. Promote development of local zoning ordinances favorable to the protection of *S. houghtonii* and its habitat if existing laws are inadequate.

If protection is inadequate within local governmental units, local zoning ordinances, such as those that protect natural features, may provide an additional measure of protection for several *S. houghtonii* occurrences.

16. Recommend and support sites for potential Natural Area designation.

Work towards designation of areas as State Natural Areas as provided for by Part 351, Wilderness and Natural Areas, NREPA. This provides a large measure of protection for appropriate public lands. Achieve long-term protection by eliminating or controlling activities (*e.g.*, logging, certain types of recreation, and development of facilities such as marinas) that would reduce the quality of the Natural Area and adversely affect rare animal and plant species.

17. Encourage land acquisition.

Pursue land acquisition from willing sellers through Federal and State agencies and private conservation organizations such as The Nature Conservancy. The Natural Resources Land Trust Fund is a potential source of funding for the acquisition of public lands. Land acquisition can protect significant *S. houghtonii* occurrences and their habitats as well as preserve adjacent habitats that can buffer occurrences, may eventually be colonized, and may provide refugia during periods of high lake levels.

2. Conduct field surveys to determine possible new occurrences and verify the status and extent of known occurrences.

Determine the status and precise extent of colonies for known occurrences by conducting detailed field surveys, as described below. Delineate possible new occurrences through systematic surveys of potential habitat.

21. Systematically assess potential habitat from aerial photographs; map known occurrences and delineate potential habitat.

Interpret the most current aerial photographic imagery available before field surveys are initiated, reassess known sites, and delineate potential new sites for field checking. Map known occurrences and potential habitat on topographic maps.

22. Conduct systematic field surveys.

Conduct surveys of known occurrences and potential habitat using standard field inventory methodology during peak flowering, usually from mid-August through September. Estimate population condition, size, and extent; determine precise location. Record significant natural and human-caused disturbances that appear to affect *S. houghtonii* colonies. Such effects may include ORV and other human-caused damage, evidence of water table fluctuations, and disturbance to adjacent upland dune areas or other nearby land. Observe and record surrounding land use patterns that may affect the sustainability of occurrences.

23. Prepare maps of *S. houghtonii* occurrences.

Prepare base maps which indicate the following: All currently known occurrences, the extent of essential habitat, natural communities, and surrounding lands that may serve as buffer areas, future colonization sites, or refugia during high lake level periods.

24. Reassess ranks of known occurrences; determine ranks of newly identified occurrences; and revise protection priorities, if necessary.

Following field surveys, reassess known occurrences that were surveyed; rank new occurrences; and revise protection priorities, if needed.

3. Educate land managers and the public.

Inform local land managers of the significance and rarity of *S. houghtonii* and teach them to identify the species in the field through literature and workshops. Educate the public about the species through nontechnical literature, informative signage, and public outreach.

31. Distribute relevant biological and management information about *S. houghtonii* to public land managers, enforcement officials, and the general public.

Provide basic information concerning identification and management to land managers and the public. They are often willing to assist in the protection and stewardship of rare species if they have such knowledge. Materials prepared for private landowner contact will also be useful for public land managers.

32. Conduct management workshops for public agencies.

Hold workshops to provide more specialized instruction on management and to encourage the exchange of ideas and techniques among managers.

33. Post signs indicating the presence of sensitive habitat and rare species.

Post signs indicating the presence of rare or sensitive species and their habitats and possibly illustrating *S. houghtonii* and other protected plants and animals. This may be effective in reducing disturbances to sites from recreationists and others. Place interpretive displays and disseminate relevant literature in selected sites, such as MDOT campgrounds, roadside parks, State Parks, and other public areas.

4. Monitor occurrences to determine population trends, viability, and threats.

Monitor selected occurrences to determine population trends, including response to periods of high lake levels and the degree of human-caused disturbance (e.g., ORV encroachments) that may affect reproduction and survival. Before monitoring is begun, clearly define simple monitoring methods to assess effects of natural and human-caused disturbance, natural history, population trends, and species biology. This will allow useful data to be collected and will encourage monitoring to be performed consistently over time and personnel changes. Detailed monitoring of even a few occurrences is an intensive and logistically difficult endeavor; therefore, implement a simple censusing technique, such as measuring the aerial extent of colonies and counting flowering stems and rosettes. Install permanent plots of a few square meters each to sample occurrences and assess trends. Determining exactly what constitutes a population of this species at a site is probably not particularly important. Establish trends through plot sampling and assume they are applicable to at least the local occurrence. During the course of population monitoring, determine the effects of disturbance on *S. houghtonii* occurrences by measuring parameters such as sand accumulation and water levels in interdunal wetlands. Record human-caused disturbance, such as evidence of foot and ORV traffic during population monitoring. Analyze habitat and population monitoring data yearly to provide relevant information to guide management plans and revise strategies, if necessary.

5. Conduct biosystematic research on the species throughout its global range.

Although no research has been published on the breeding system, establishment, floral biology, genetic variability, population biology, or seed germination of *S.*

houghtonii, such studies merit a low priority for the immediate short-term protection of the species. Conduct such research, however, to improve management plans for the conservation and perpetuation of *S. houghtonii* over the long-term.

51. Determine the taxonomic relationships of *S. houghtonii* populations in Michigan, New York, and Canada, with emphasis on outlier populations.

Ascertain the taxonomic relationships of *S. houghtonii* occurrences in all geographic areas to resolve how populations in Lower Michigan and New York should be considered.

52. Determine the genetic variability within and among occurrences throughout the global range.

Elucidate the amount of genetic variability within and between *S. houghtonii* occurrences to help determine the long-term viability of each occurrence and of the species throughout its range. Preliminary work may be required to determine the most informative type of genetic analysis (*e.g.*, chloroplast DNA analysis, isozyme analysis, or other techniques). Such studies will result in a better understanding of the systematics of this species and will provide information to develop better protection and management strategies.

53. Conduct research on autecology including population viability analyses.

Little study has been conducted on the biology of *S. houghtonii*. Conduct the following types of research: Basic ecology of the species, floral biology and breeding system studies, population demography, and seed germination ecology. The information generated from this research would also contribute to population viability analyses.

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows (Table 5) outlines actions and estimated costs for the recovery program. It is a guide for meeting the objective discussed in Part II of this Plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, responsible agencies, and estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its essential habitat. The estimated funding needs for all parties anticipated to be involved in recovery are identified and, therefore, Part III reflects the total estimated costs for the recovery of this species. The estimated recovery cost for the 11-year program is \$506,500; approximately \$30,000 of this estimated cost is allocated to a minimum of 5 years of monitoring following a potential delisting date of 2004, to assess the adequacy of recovery actions and determine if there will be cause to consider relisting.

The costs presented are the estimates of the author and the Service, based on experience with costs of similar work. They are not based on budgets prepared for individual sub-tasks. Actual costs may be higher or lower than costs indicated in the Implementation Schedule.

Priorities in the first column of the following implementation schedule are assigned as follows:

1. **Priority 1** - An action that *must* be taken to prevent extinction or to prevent the species from declining irreversibly in the *foreseeable* future.
2. **Priority 2** - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
3. **Priority 3** - All other actions necessary to meet the recovery objectives.

Key to Acronyms Used in the Implementation Schedule

FA	= Division of Federal Aid
FY	= fiscal year
LE	= Division of Law Enforcement
MDNR	= Michigan Division of Natural Resources
MDOT	= Michigan Department of Transportation
MFMD	= Michigan Forest Management Division
MI	= Michigan
MLWMD	= Michigan Land and Water Management Division
MNFI	= Michigan Natural Features Inventory
MSP	= Michigan State Parks
NY	= New York
NYNHP	= New York Natural Heritage Program
ORV	= off-road-vehicle
RE	= Division of Realty
TE	= Division of Endangered Species
TNC	= The Nature Conservancy
Univ.	= university researchers
USFS	= U.S. Forest Service
USFWS	= U.S. Fish and Wildlife Service

Table 5. Implementation table for Houghton's Goldenrod (*Solidago houghtonii*) Recovery Plan.

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YEARS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)				COMMENTS
				USFWS		Other	FY98	FY99	FY00	FY01 -08	
				Region	Program						
1	111	Provide current site occurrence information at least yearly to agencies.	ongoing			MNFI NYNHP	2.0	2.0	2.0	10.0	
1	112	Update USFWS records.	ongoing	3	TE		1.0	1.0	1.0	5.0	
1	113	Update USFS records	ongoing			USFS	0.5	0.5	0.5	2.5	
1	114	Update MFMD records.	ongoing			MFMD	1.0	1.0	1.0	5.0	
1	115	Update MLWMD records.	ongoing			MLWMD	0.5	0.5	0.5	2.5	
1	116	Update MDOT records and transfer to District Offices.	ongoing			MDOT	0.5	0.5	0.5	2.5	
1	117	Update MSP master plans.	ongoing			MSP	1.0	1.0	1.0	5.0	
1	12	Develop written agreements and management plans for protection on public lands.	4 to 5	3	TE	MNFI USFS	2.0	4.0	4.0	2.0	
1	131	Develop strategies to protect occurrences and sites from ORV damage.	ongoing	3	TE	MNFI TNC USFS	1.0	0.5	0.5	2.0	
1	132	Restrict access routes with barriers.	ongoing			MDNR TNC USFS	0	1.0	1.0	2.0	
1	133	Post signs.	ongoing			MDNR TNC USFS	0	1.0	1.0	2.0	

Table 5 (cont.). Implementation table for Houghton's Goldenrod (*Solidago houghtonii*) Recovery Plan.

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YEARS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)				COMMENTS
				USFWS		Other	FY98	FY99	FY00	FY01 -08	
				Region	Program						
1	134	Work with law enforcement and other agencies to monitor sites and coordinate effective enforcement.	ongoing	3	TE LE	MDNR TNC USFS	1.0	1.0	1.0	8.0	
1	141	Initiate private landowner contact.	ongoing	3,5	FA TE	MDNR	10.0	10.0	10.0	40.0	Pilot program has been initiated with USFWS funding.
1	142	Provide education for private landowners.	ongoing	3,5	TE	MDNR	2.0	1.0	1.0	4.0	
1	143	Promote private landowner involvement in a registry program.	ongoing	3,5	TE	MDNR	2.0	1.0	1.0	1.5	
1	15	Promote development of local zoning ordinances favorable to protection of species and its habitat.	ongoing	3	TE	MDNR	1.0	0.5	0.5	1.0	
1	16	Recommend and support sites for potential Natural Area designation.	ongoing			MDNR MNFI	5.0	20.0	20.0	10.0	Funding assumes resumption of State Natural Areas Program.
1	17	Encourage land acquisition.	ongoing	3,5	TE RE	MDNR MNFI TNC USFS	5.0	10.0	10.0	8.0	

Table 5 (cont.). Implementation table for Houghton's Goldenrod (*Solidago houghtonii*) Recovery Plan.

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YEARS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)				COMMENTS
				USFWS		Other	FY98	FY99	FY00	FY01 -08	
				Region	Program						
2	21	Systematically assess potential habitat from aerial photographs; map known occurrences and delineate potential habitat.	2 to 3	3.5	TE FA	MNFI	2.0	2.0	0	0	Some survey work has been completed during 1992 Coastal Zone Management shoreline survey.
2	22	Conduct systematic field surveys.	6	3.5	TE FA	MNFI	2.0	4.0	8.0	8.0	
2	23	Prepare maps of <i>S. houghtonii</i> occurrences.	6	3.5	TE FA	MNFI	0	2.0	6.0	6.0	
2	24	Reassess ranks of known occurrence; determine ranks of newly identified occurrences; revise protection priorities.	2	3.5	TE FA	MNFI	0	0	0	2.0	
2	31	Distribute relevant biological and management information to public land managers, enforcement officials, and the general public.	ongoing	3	TE	MNFI	5.0	5.0	5.0	6.0	Can be coordinated with private landowner contact project.
2	32	Conduct management workshops for public agencies.	ongoing	3	TE	MNFI	0	5.0	5.0	6.0	
2	33	Post signs indicating the presence of sensitive habitat and rare species.	ongoing			MDNR TNC USFS	0	5.0	5.0	4.0	

Table 5 (cont.). Implementation table for Houghton's Goldenrod (*Solidago houghtonii*) Recovery Plan.

PRIORITY NUMBER	TASK NUMBER	TASK DESCRIPTION	TASK DURATION (YEARS)	RESPONSIBLE PARTY			COST ESTIMATES (\$000)				COMMENTS
				USFWS		Other	FY98	FY99	FY00	FY01 -08	
				Region	Program						
2	4	Monitor occurrences to determine population trends, viability, and threats.	ongoing	3,5	FA TE	MDNR MNFI TNC USFS Univ.	0	10.0	10.0	35.0	
3	51	Determine taxonomic relationship of populations in MI, NY, and Canada, with emphasis on outlier populations.	2 to 3	3	FA TE	MNFI Univ.	0	10.0	20.0	4.0	
3	52	Determine genetic variability within and between occurrences throughout global range.	2 to 3	3	FA TE	MNFI Univ.	0	10.0	15.0	4.0	
3	53	Conduct research on autecology.	ongoing	3	FA TE	MNFI Univ.	0	10.0	20.0	4.0	

IV. APPENDICES

APPENDIX A.

MNFI DRAFT ABSTRACT OF *SOLIDAGO HOUGHTONII*

Solidago houghtonii Gray
Asteraceae

Houghton's goldenrod
Composite Family

State Threatened
Federally Threatened

Taxonomy: Although *Solidago houghtonii* is widely accepted as a distinctive species, its origin and affinities are disputed. Morton (1979) theorizes that a hybrid of *S. ptarmicoides* (Nees) Boivin (*Aster ptarmicoides* (Nees) T. and G.) and *S. ohioensis* Riddell backcrossed with *S. ohioensis* to form a sterile triploid; a subsequent doubling of chromosomes resulted in the fertile hexaploid ($6x = 54$) known as *S. houghtonii*. Semple and Ringius (1992), among others, disagree, concluding that *S. riddellii* Frank, not *S. ptarmicoides*, is the second parent. Most anomalous among the *S. houghtonii* "complex" is a population identified in Crawford County within Camp Grayling. These plants are octoploids, the only such ploidy level known for *Solidago*, and thus possibly represent a different taxon. A reported disjunct station in Genesee County, New York, tentatively referred to *S. houghtonii*, is believed to be a taxon resulting from the hybridization of *S. ptarmicoides* and *S. uliginosa*.

Total range: *Solidago houghtonii* (in the broad sense) occurs primarily along the northernmost shores of Lakes Michigan and Huron, ranging to the Bruce Peninsula in Ontario. An isolated inland station of what some authors believe to be this species exists in Crawford County, Michigan, more than 100 km south of the Mackinac Straits region. It is considered rare in Ontario and rare in Canada.

State distribution: The greatest concentrations of *S. houghtonii* lie in Chippewa, western Mackinac, northern Emmet, Cheboygan, and northern Presque Isle Counties. Each of these areas has large populations extending over at least a mile of shoreline, as well as scattered smaller populations.

Recognition: This goldenrod has smooth, slender, often somewhat reddish stems that reach 30-60 cm in height. The well-scattered, pointed leaves are long (to 13 cm), narrow (less than 1 cm), and often folded along the midrib, tapering to a slightly clasping base. Terminating the stem is a more or less **flat-topped, branched inflorescence consisting of relatively few, showy, large flower-heads** that may number from 5-30 or more (standard manuals, basing their description on the wrong taxon, incorrectly state the number of flower-heads to be only 5-15). **The branches and pedicels of the inflorescence are finely hairy, at least sparsely so**, and the achenes are smooth and ribbed.

This species is most likely to be confused with the widespread *Solidago graminifolia* (grass-leaved goldenrod) and *S. ohioensis* (Ohio goldenrod). *Solidago graminifolia* can be distinguished by its more leafy stem that lacks basal leaves, narrower 3-5 nerved leaves, and an inflorescence composed of distinctly smaller flower heads with short ray florets and hairy achenes. *Solidago ohioensis* is a more robust species with relatively

broad, flat, ovate-lanceolate leaves and a dense, many-headed inflorescence that has glabrous branches, smaller ray flowers, and bears smooth, unribbed achenes.

Habitat: *Solidago houghtonii* occurs primarily along the northern shores of Lakes Huron and Michigan, restricted to calcareous beach sands, rocky and cobbly shores, beach flats, and shallow, trough-like interdunal wetlands that parallel shoreline areas. It also occurs on seasonally wet limestone pavement, its more typical habitat in the eastern portion of its range, particularly in Ontario (Morton 1979; Semple and Ringius 1992). Common associates include *Parnassia glauca* (grass-of-Parnassus), *Lobelia kalmii* (Kalm's lobelia), *Tofieldia glutinosa* (false asphodel), *Potentilla fruticosa* (shrubby cinquefoil), *Gentiana procera* (fringed gentian), *Carex crawei* (sedge), *C. garberi* (sedge), *Eleocharis pauciflora* (spikerush), and dune willows (*Salix cordata* and *S. myricoides*).

Biology: *Solidago houghtonii* is a perennial, frequently forming small clumps (clones) propagated by means of relatively short rhizomes. Flowering occurs primarily in August and early September, but some plants may flower as late as October.

Conservation/management: The shoreline habitat of *S. houghtonii* is strongly threatened by residential development and heavy recreational use. Off-road-vehicles pose an ever present and increasing threat, as do heavy foot traffic and wetland alterations during the course of shoreline development. Four populations thought to be the largest in existence are currently under protective ownership, one on a Nature Conservancy preserve and three on State land. About fifteen other substantial populations lie on State Forest, National Forest, and State Park lands, receiving at least informal protection. Several populations occur partly within Michigan Department of Transportation rights-of-way, most within protected areas.

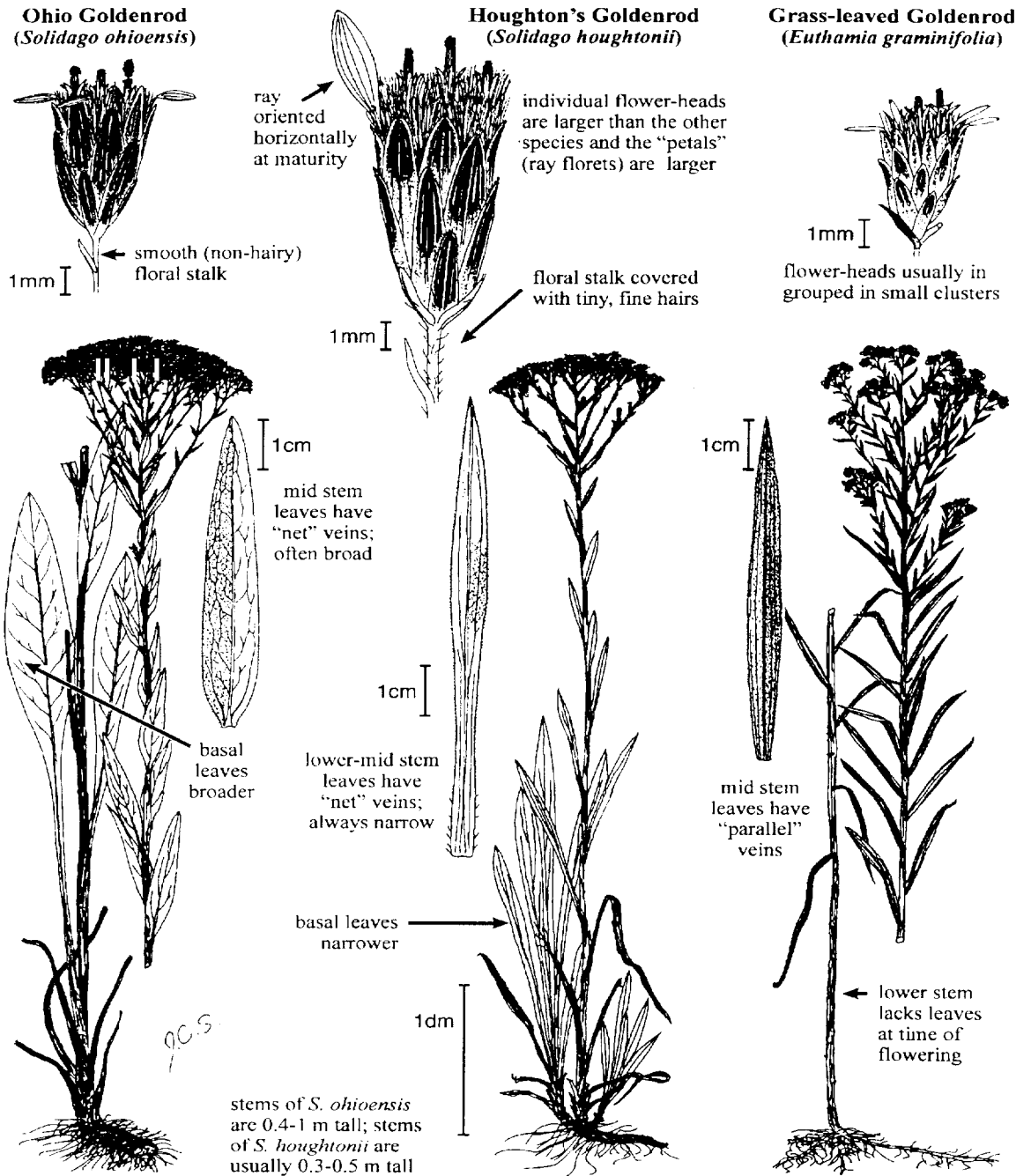
Comments: This species is named in honor of Douglass Houghton, Michigan's first State Geologist, whose survey team discovered this Great Lakes endemic on the north shore of Lake Michigan during an 1839 expedition.

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Appendix B

Comparison of Houghton's Goldenrod, Ohio Goldenrod and Grass-leaved Goldenrod



Illustrations by Dr. John C. Semple

APPENDIX C.

GLOBAL RANKING CRITERIA FOR *SOLIDAGO HOUGHTONII*

SPECIFICATIONS FOR A-RANK:

Habitat: Large, undisturbed habitats (beach flats, rocky and cobbly shores, dunes, interdunal wetlands or alvar) with sufficient buffer to protect the integrity of the habitat; OR, habitats of similar size that have recovered from past disturbance. Species composition shows little departure from original structure and composition (except in seral or disturbance-dependent communities).

Population Size and Vigor: A population consisting of 1000 or more individuals. Populations of this rank are stable or growing in size, large in number of individuals, show good reproduction, and exist in a natural, sustainable habitat.

SPECIFICATIONS FOR B-RANK:

Habitat: Moderate-sized habitats (beach flats, rocky and cobbly shores, dunes, interdunal wetlands or alvar) with sufficient buffer to protect the integrity of the habitat; OR, habitats of similar or larger sizes that are still recovering from early or recent light disturbance but eventually will reach an A-rank. Presence of exotic species (if only localized and/or a minor component of flora), recoverable departure from original structure and composition for the site (except in seral and disturbance-dependent communities) result in B-rank.

Population Size and Vigor: A population consisting of 100-999 individuals. Populations of this rank are stable and are of moderate size.

SPECIFICATIONS FOR C-RANK:

Habitat: Small-sized habitats (beach flats, rocky and cobbly shores, dunes, interdunal wetlands or alvar) with sufficient buffer to protect the integrity of the habitat; OR, larger habitat areas lacking sufficient buffer for habitat protection. Habitats of this rank are in the early stages of recovery from disturbance; OR, the structure and composition of the habitat has been altered such that the original vegetation of the site will never rejuvenate, yet with management and time, partial restoration of the habitat is possible.

Population Size and Vigor: A population consisting of 10-99 individuals. Populations of this rank are small. All populations larger than 99 individuals that continually decline in number over a period of several years are of this rank.

SPECIFICATIONS FOR D-RANK:

Habitat: Beach flats, rocky and cobbly shores, dunes, interdunal wetlands or alvar habitats that are severely disturbed, their structure and composition having been greatly altered. Recovery of habitats of this rank to original conditions, despite management and time, essentially will not take place. Small habitats that lack sufficient buffer to protect the existing quality of the site are of this rank, for long-term survival is not likely.

Population Size and Vigor: A population consisting of 1-9 individuals. Populations of this size are very small, with a high likelihood of dying out or being destroyed. Populations smaller than 100 individuals that continually decline in number over a period of several years are of this rank.

APPENDIX D.

PRINCIPAL FEDERAL AND STATE LAWS APPLICABLE TO THE PROTECTION OF *SOLIDAGO HOUGHTONII* AND ITS HABITAT

Clean Water Act (Section 404). Public Law 92-500, as amended. Regulations found at 33 CFR Parts 320-330.

Federal Endangered Species Act of 1973. Public Law 93-205, as amended. U.S.C. 1531-1544. Related regulations found at 50 CFR Part 17.

National Environmental Policy Act of 1969. Public Law 91-190, U.S.C. 4321-4347, January 1, 1970, as amended by Public Law 94-83, August 9, 1975.

Part 17, Michigan Environmental Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.1701 - 324.1706.

Part 19, Natural Resources Trust Fund, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, as amended. MCL Sections 324.1901 - 324.1910.

Part 21, Conservation and Historic Preservation Easement, of the Natural Resources and Environmental Protection act, 1994 PA 451, as amended. MCL Sections 324.2140 - 324.2144.

Part 301, Inland Lakes and Streams Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.30101 - 324.30113

Part 303, Wetland Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.30301 - 324.30323.

Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.32501 - 324.32515.

Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection act, 1994 PA 451, as amended. MCL Sections 324.35101 - 324.35111.

Part 353, Sand Dune Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.35301 - 324.35326.

Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. MCL Sections 324.36501 - 324.36507.

New York State Environmental Conservation Law, Section 9-1503, Reg 6NYCRR Part 193.3.

U.S. Forest Service Manual Title 2600 - Wildlife, Fish, and Sensitive Plant Habitat Management, Chapter 2670 - Threatened, Endangered, and Sensitive Plants and Animals.

APPENDIX E.

PEER REVIEW AND PUBLIC COMMENT

Development of this recovery plan began shortly after listing in July, 1988, long before the Service issued its July 1, 1994 policy on peer review. A Technical Review Draft was first circulated for review and comment by a Service March 13, 1989, cover letter. Several imminent botanists familiar with the species were included among those solicited for comment at that time. A Draft Recovery Plan for *Solidago houghtonii* (Houghton's goldenrod) was made available for public review and comment for 30 days on September 17, 1993 (58 FR 48670). On July 15, 1994, the public comment period for the Agency Draft Recovery Plan for *Solidago houghtonii* (Houghton's goldenrod) was reopened for 60 days.

Comments and opinions received are not summarized separately in this plan, but have been considered and incorporated when appropriate into the Final Recovery Plan. Some comments are referenced in the text, i.e., Daubendieck (1993), including those of noted species experts (Morton 1989, Voss 1989). The administrative record for public review and comment on this plan is maintained by the Service's Regional Office in Twin Cities, MN.