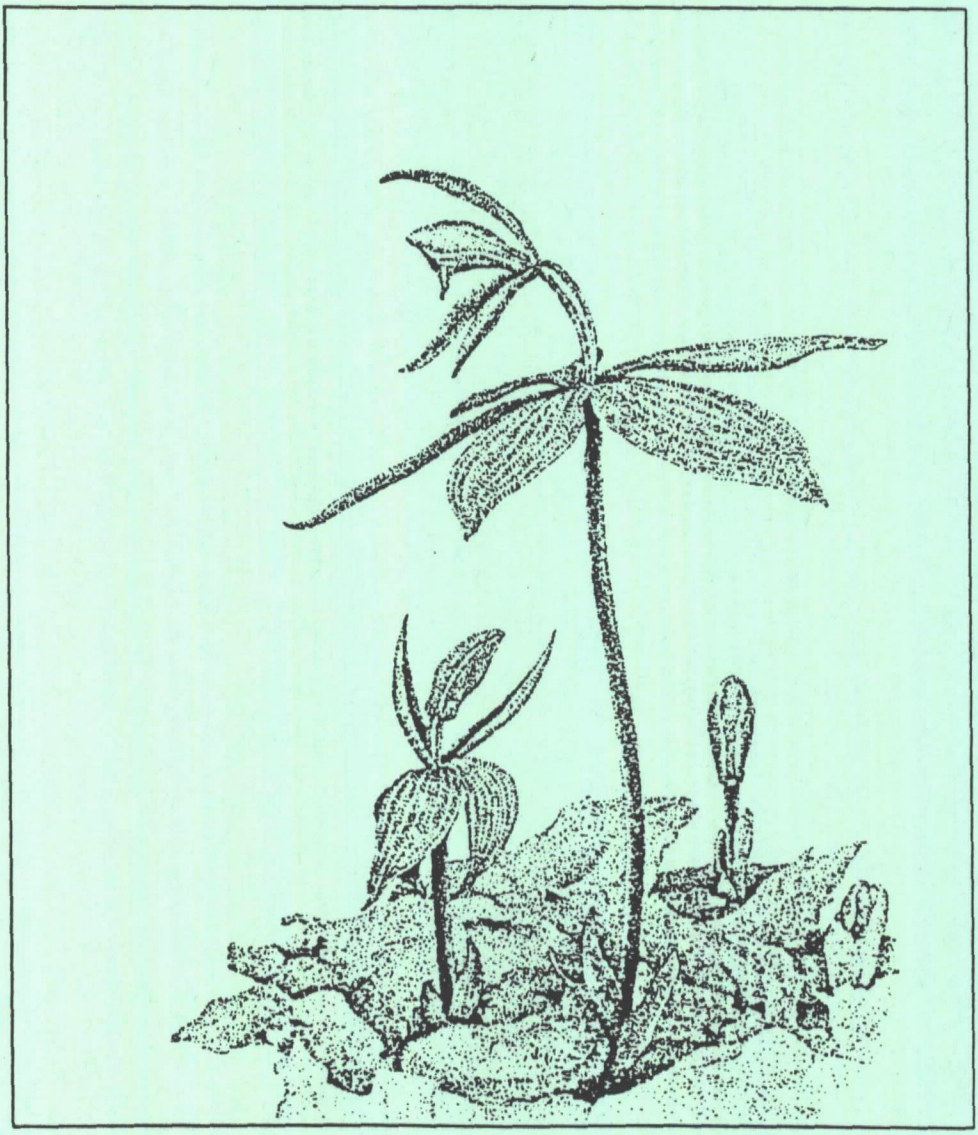
Small Whorled Pogonia
(*Isotria medeoloides*)
Recovery Plan

FIRST REVISION



U.S. Fish and Wildlife Service

Region Five, Newton Corner, Massachusetts

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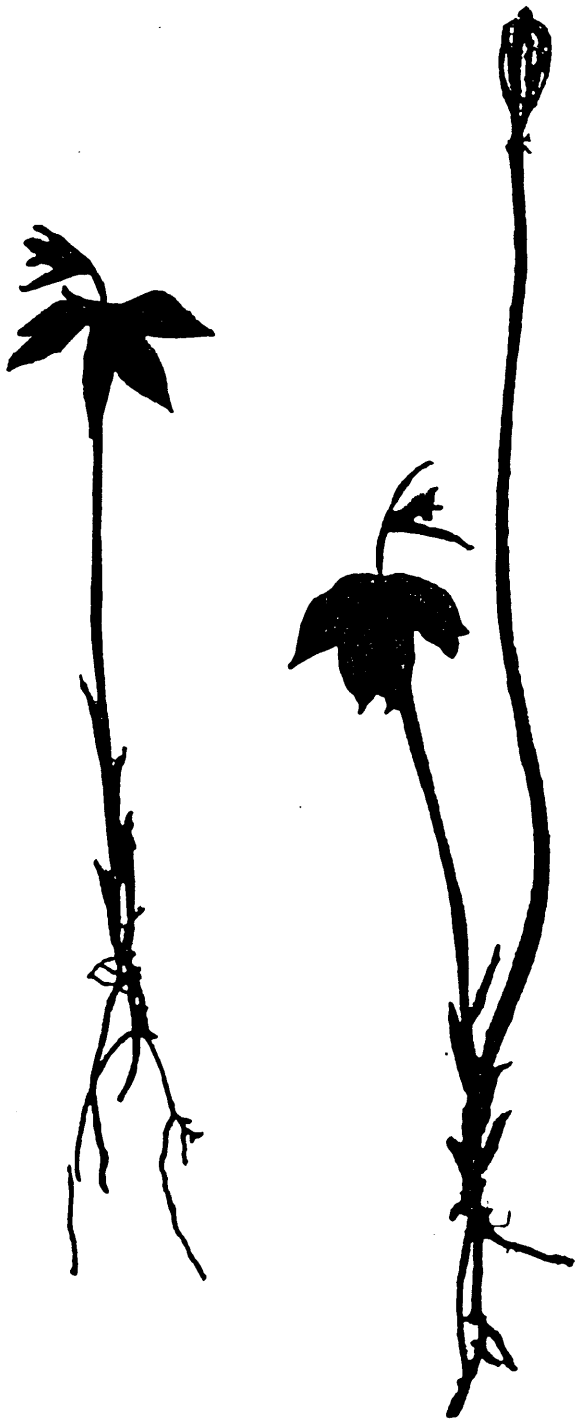

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Newton Corner, Massachusetts

Approved: _____
ACTING
Regional Director, Region Five
U.S. Fish and Wildlife Service

Date: 11/13/92

The title page illustration is a xerox of a National Arboretum herbarium specimen collected by O.M. Freeman in May of 1941. The specimen is an historical record for James City County, Virginia, and is currently housed at the herbarium of the College of William and Mary, Williamsburg, Virginia.

EXECUTIVE SUMMARY

Small Whorled Pogonia Revised Recovery Plan

Current Status: This rare but widely distributed species is currently known from 86 sites in 15 states and Canada, with a total of approximately 2,600 stems (1991 data). This population level exceeds the number of occurrences known at the time of listing (17 extant sites); however, 13 to 15 sites are known to be extirpated, while as many as 41 sites are considered to be historical. Populations continue to be lost as habitat is degraded, developed, and otherwise threatened. *Isotria medeoloides* was listed as endangered on October 12, 1982, and the initial recovery plan was completed in 1985. Recovery activity to date has generated new site, life history, and population information. In addition, some level of habitat protection has been achieved for 47 percent of the known sites.

Habitat Requirements: The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed-deciduous/coniferous forests that are generally in second- or third-growth successional stages. Characteristics common to most *I. medeoloides* sites include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long-persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil moisture values. Light availability could be a limiting factor for this species.

Recovery Objectives: The immediate objective of the recovery program is to reclassify the small whorled pogonia from endangered to threatened status. The ultimate objective of the program is to delist the small whorled pogonia by ensuring long-term viability of the species.

Recovery Criteria: *Isotria medeoloides* will be considered for reclassification when: (1) at least 25% of the known viable sites, distributed proportionately throughout the species' range, are permanently protected, (2) sites or colonies are shown to be viable using a geometric mean of 20 emergent stems over a 3-year period, and (3) site protection includes a sufficient buffer zone around the population. Delisting will be considered when: (1) at least 61 sites distributed proportionately throughout the species' current range are permanently protected; (2) these sites represent at least 75% of the known self-sustaining populations, using an average of 20 emergent stems, with 25% flowering stems, over a 10-year period; and (3) appropriate management programs are established, or sufficient habitat adjacent to existing colonies is protected, to allow for natural colonization.

Actions Needed:

1. Protect known *Isotria medeoloides* populations and essential habitat.
2. Manage protected habitats for *I. medeoloides*.
3. Monitor existing populations.
4. Survey for new populations.
5. Investigate population dynamics.
6. Investigate species biology.
7. Provide public information and education.

Estimated Costs ($000):

	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Total
FY1	22.5		5	22.5	7.5	5		62.5
FY2	20	5	7	25	7.5	10	10	84.5
FY3	20	25	5	20	20.5	10	13	113.5
FY4	9.5	17	5	22	5	10		68.5
FY5	9.5	12	5	22	5	5		58.5
FY6	9.5	10	5	15				39.5
FY7-10	9.5		20	15				44.5
Total	100.5	69	52	141.5	45.5	40	23	471.5

Estimated Time Frame: Reclassification should be initiated in 1993. Delisting may be initiated by the year 2003, if recovery actions are implemented on schedule.

* * *

Based on additional information generated by past recovery activities, this revised recovery plan updates the recovery objectives and tasks of the initial Small Whorled Pogonia Recovery Plan (U.S. Fish and Wildlife Service 1985), carrying forward a course of action for protecting and recovering this endangered species.

The plan does not necessarily represent the views of any individuals or agencies other than the U.S. Fish and Wildlife Service. It is subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks. Recovery objectives will be attained and funds expended contingent on budgetary constraints affecting the parties involved, as well as the need to address other priorities.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1992. Small Whorled Pogonia (Isotria medeoloides) Recovery Plan, First Revision. Newton Corner, Massachusetts. 75 pp.

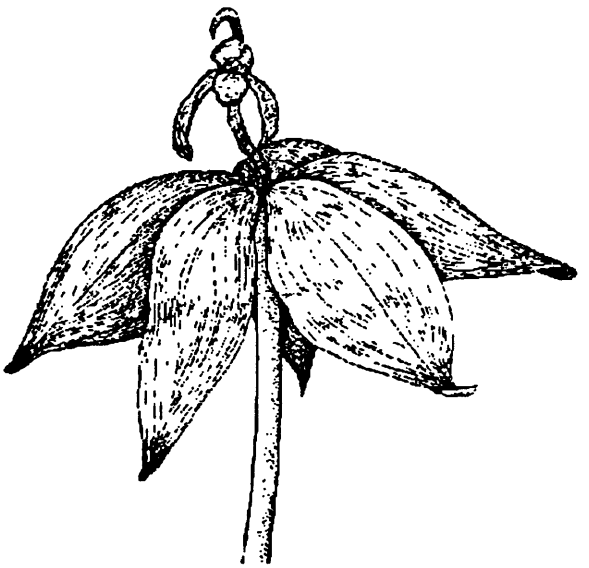
Additional copies of this plan can be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
301-492-6403
or
1-800-582-3421

Fees vary according to number of pages.

ACKNOWLEDGMENTS

Portions of this revised recovery plan were written under contract by Dr. Donna M.E. Ware, College of William and Mary. Her hard work and astute insights into the biology and status of Isotria medeoloides are much appreciated. Recognition is also extended to the cadre of State botanists and others who provided population and site-specific information to help further our understanding of this species.



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PART I: INTRODUCTION

Isotria medeoloides (Pursh) Raf., a member of the orchid family (Orchidaceae) (Figure 1), has long been considered a rare and intriguing species (Ames 1922). This perception was epitomized by one small whorled pogonia colony near Williamsburg, Virginia (Grimes 1921, Baldwin 1967), which inspired botanists to travel hundreds of miles to observe and photograph it (Morris and Eames 1929, Luer 1975, Ware 1988a). Although sparse, the species is widely distributed, with a primary range extending from southern Maine and New Hampshire through the Atlantic Seaboard states to northern Georgia and southeastern Tennessee. Outlying colonies have been found in the western half of Pennsylvania, Ohio, Michigan, Illinois, and Ontario, Canada.

Isotria medeoloides was listed as endangered on October 12, 1982 (U.S. Fish and Wildlife Service 1982). At the time of listing, records for the species were known from 48 counties in 16 states and Canada. However, only 17 sites (in ten states and Ontario, Canada) were known to be extant, and these sites contained a total of fewer than 500 plants. Subsequent searches have resulted in the discovery of several new sites: the 1991 census totaled approximately 2,600 stems at 86 sites in 15 states and Canada.

The initial Small Whorled Pogonia Recovery Plan was completed in 1985 (U.S. Fish and Wildlife Service 1985). Implementation of recovery activities specified in that plan generated additional site, life history, and population information. In addition, habitat protection efforts successfully resulted in some level of protection for approximately 50 percent of the known sites. This revision reflects these accomplishments and incorporates the latest information in updating recovery objectives and activities.

Figure 1. *Isotria medeoloides*

DESCRIPTION AND TAXONOMY

The small whorled pogonia was first described by Frederick Pursh in 1814 under the name Arethusa medeoloides. Pursh based this new species on a specimen from the Kittatinny Mountains, a mountainous region along the border of New York, New Jersey, and Pennsylvania (Fernald 1947). By 1838, the plant was recognized to be in a separate genus and was named Isotria medeoloides, although it later became known as Pogonia affinis and Isotria affinis. M.L. Fernald finally clarified the nomenclature in 1947, making the latter names synonyms of I. medeoloides.

Isotria is a genus with only two species: I. medeoloides and I. verticillata, the large whorled pogonia. Both species are herbaceous perennials with slender, hairy, fibrous roots that radiate from a crown or rootstock. In the genus Isotria, overwintering buds for the next year's shoot form on the rootstock at ground level in robust plants and beneath the soil surface on most smaller plants. The five or six leaves of Isotria plants (or four leaves in some vegetative plants) display themselves in a circular arrangement (false whorl) at the apex of a robust, smooth, hollow stem. A single flower, or flower pair, stands in the center of the whorl of leaves. The sepals are outwardly spreading, and the overall shape of the Isotria flower superficially resembles a typical Easter corsage orchid; however, in the Isotria species two lateral petals point forward above the lip, and the petals and sepals are narrower than the typical orchid. The three sepals of the flower are more or less equal in length, the attribute for which the genus received its name (isos, equal; treis, three) (Fernald 1950).

Isotria medeoloides has a number of key characteristics that differentiate it from I. verticillata. Particularly important are the color of the stem and flower, the relative lengths of the sepals and petals, and the length of the stem (peduncle) of the fruit capsule in relation to the length of the capsule itself. An

individual small whorled pogonia is usually single-stemmed, although occasionally a plant produces two or more stems in a cluster. The stem ranges from 6 to 35 centimeters tall in a flowering plant and is similar in color, with the same degree of glaucousness, as white seedless grapes; the elliptic to elliptic-obovate leaves are also a pale milky-green or grayish-green. The flower is yellowish-green with a greenish-white lip. The sepals vary from linear-oblanceolate to narrowly spatula-like in shape, and spread outward when in full flower (Figure 2). The lateral petals are oblanceolate to oblong-elliptic and point forward above the lip. The sepals are approximately 1.5-2.5 cm long and either equal in length to the lateral petals or up to 1.5 times as long.

Figure 2. *I. medeoloides* flower

During the flowering stage, the ovary appears to be attached directly to the center of the whorl or on a very short stalk. As the erect fruit capsule develops, this stalk elongates, but it does not exceed the length of the body of the capsule (Figure 3). When the capsule dries, it splits and releases thousands of minute seeds (Figure 4).

Figure 3. *I. medeoloides* maturing capsule

Figure 4. *I. medeoloides* dehiscent capsule

Colonies of the large whorled pogonia often occur near colonies of the small whorled pogonia in the extensive region in which they occur together (Morris and Eames 1929; Ware 1988a; A. Belden, Virginia Division of Natural Heritage, in litt. 1991; N. Murdock, USFWS, pers. comm. 1991; E. Johnson, New Jersey Natural Heritage, pers. comm. 1991; K. Clancy, Delaware Natural Heritage, pers. comm. 1991; J. Cavanaugh, pers. comm. 1991). The

two species have also been reported to grow mixed together (Dixon and Cook 1988).

The combination of the overlap in ranges and the eye-catching generic characteristics that the two species share results in frequent misidentifications of Isotria verticillata as Isotria medeoloides. Similarities aside, there are striking differences between the two in both vegetative and reproductive parts that can be used in the field to tell them apart (Table 1).

Table 1. Contrasting characteristics of *Isotria medeoloides* and *Isotria verticillata*.

Morphological Characteristic	*Isotria medeoloides*	*Isotria verticillata*
Stem	stem greenish-white	stem reddish-purple (at least in lower portion)
Sepal length	sepals equal to or up to 1.5 times as long as petals	sepals 2 to 3 times as long as petals
Flower	flower is yellow-green with a greenish-white lip	sepals grade form greenish-white at the base to reddish-purple toward tip
Leaves	leaves are glaucous	leaves are not glaucous
Leaf development	leaves are well developed when flowering begins	leaves are very small when flowering begins
Leaf whorl development	leaf whorl of flowering plants reflexes	leaf whorl does not reflex
Peduncle length	length of peduncle does not exceed length of capsule	length of peduncle is longer than length of capsule

Indian cucumberoot, Medeola virginiana (lily family), often grows with Isotria, and when in its vegetative stage is frequently confused with it. This confusion is reflected in the specific name of the small whorled pogonia, medeoloides (like "Medeola"). Medeola can be distinguished from Isotria by its wiry, solid stem clothed with cobwebby hair near the base.

POPULATION STATUS AND DYNAMICS

The distribution and dynamics of small whorled pogonia populations are discussed here in terms of sites and colonies. For the purposes of this document, the following definitions are applied to these two terms: A **site** is considered to be the proximal area where one isolated small whorled pogonia colony or a cluster of colonies occurs. All the colonies comprising a site are usually within the same watershed and are usually separated from one another by no more than a quarter of a mile to one half of a mile. A **colony** is a single natural grouping of plants in a particular locality. There may be gaps between clusters of stems within the colony, but there should be no large disjunctions and no major habitat discontinuities. The terms group, subgroup, population, and subpopulation are frequently found in the literature and are approximate synonyms for colony.

The small whorled pogonia has a broad but sparse primary distribution in the Atlantic seaboard states from Maine to Georgia with outlying occurrences in the midwest United States and Canada. The States of Delaware, Tennessee, and Ohio have been added to the species' range in recent years, each on the basis of the discovery of a single colony.

Historical records exist for localities within Vermont, Maryland, Missouri, Ohio, eastern Pennsylvania, and the District of Columbia. The habitat of many of these known historical sites has been destroyed; for example, sites in Maryland, the District of

Columbia, and New Jersey have been lost to habitat destruction, primarily from development. Recent efforts to relocate historical sites in New York, Vermont, and Missouri have been unsuccessful (Dixon and Cook 1988; T. Smith, Missouri Natural Heritage Program, pers. comm. 1992).

There are three main population centers of the small whorled pogonia today (Figure 5). The northernmost is centered in the Appalachian Mountains foothills in New England and northern coastal Massachusetts, with one outlying site in Rhode Island. A second grouping is located at the southern extreme of the Appalachian chain in the Blue Ridge Mountains where North Carolina, South Carolina, Georgia, and Tennessee join. The third center is concentrated in the coastal plain and piedmont provinces of Virginia, with outliers in Delaware and New Jersey. Six sites scattered in four outlying states (west-central Pennsylvania, Ohio, Michigan, and Illinois), and one in Ontario, are considered disjunct populations.

The largest by far of the population centers in terms of sites, colonies, and stems is the New England concentration. In 1991, this center comprised 53 sites (with 92 colonies) that produced a total of approximately 2,200 stems. The southern Blue Ridge concentration consisted of 15 sites (23 colonies) that produced 172 stems in 1991. The Virginia center had 12 sites (21 colonies) and produced over 250 stems, while the midwestern outliers produced a total of nine stems in 1991. Because colony sizes and stem counts fluctuate widely on an annual basis, population dynamics must be factored into both the decline and the recovery of the species. This consideration is discussed below.

Population dynamics

Individual colonies of small whorled pogonia have wide population fluctuations from year to year, making assessment of their presence and viability difficult at best. Monitoring is

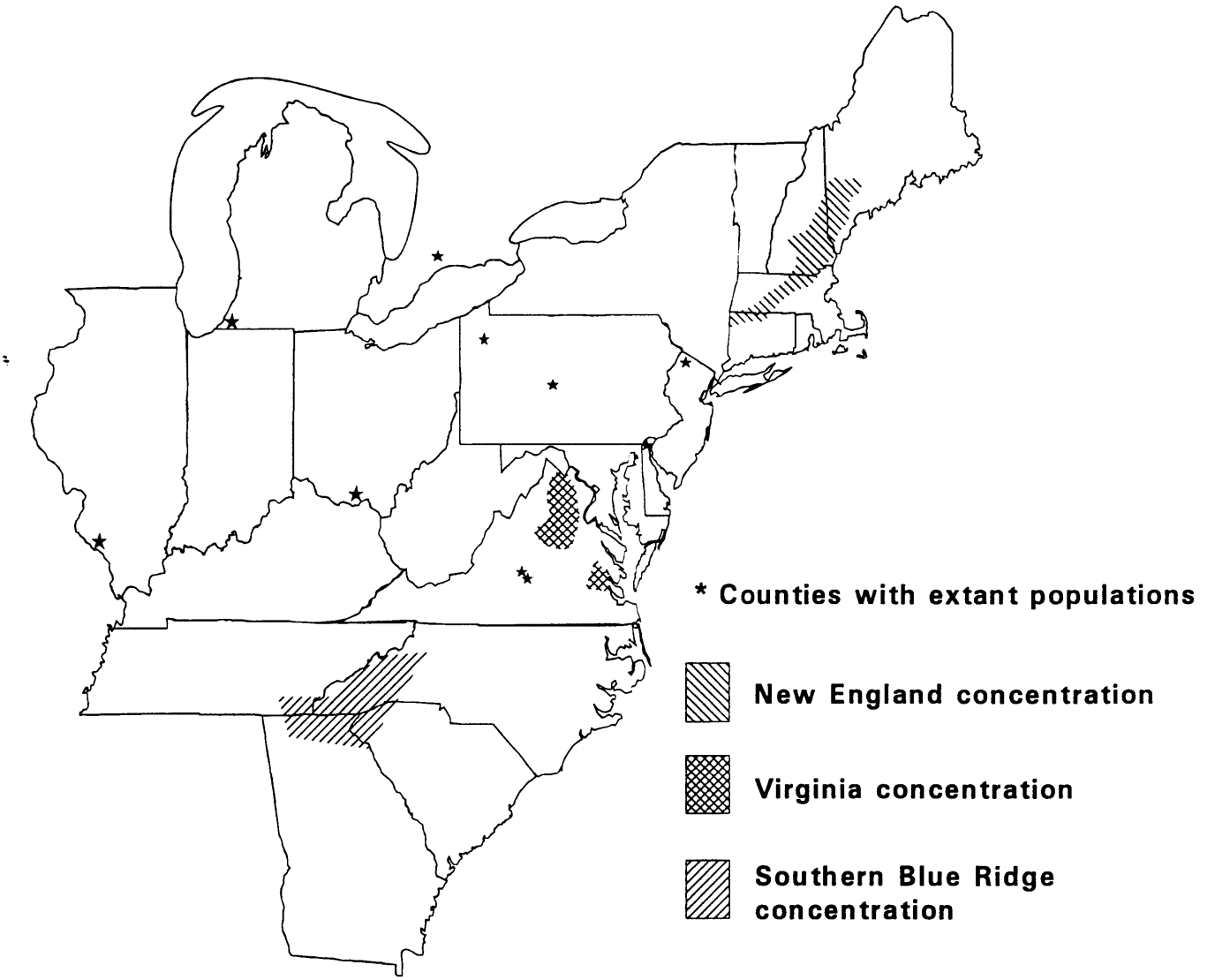


Figure 5. Population concentrations of *Isotria medeoloides*

being conducted throughout the range of this species in an effort to interpret the age and stage of colonies being studied and their fate through time. The percent of stems emerging has declined in many of the colonies being monitored, sometimes in the absence of any obvious cause (Brumback and Fyler 1988, Vitt 1991a, Ware 1991).

Possible causes for the decline of a population include one or a combination of the following: changes in habitat that lead to the death of adult plants, changes that prevent seed germination, or changes that prevent seedling establishment (Mehrhoff 1989b). Thus, a colony with an extremely high percentage of vegetative plants may be an established colony that has been repressed (Brackley 1985). On the other hand, such a colony may be one that is young and just getting established. At this time, it is virtually impossible to determine whether such a colony is young or in decline.

A different scenario for a non-viable colony would be of a colony that consisted mostly or solely of flowering plants. This type of population structure may indicate a temporary lapse in reproduction, or that it is a "dead end" colony. The latter would be a situation in which the habitat is still amenable to mature plants, but is no longer amenable to the germination and/or establishment of seedlings. Some of the smaller colonies (10 stems or less) are made up solely of plants known to have flowered, often with successful fruiting (D. Ware, College of William and Mary, pers. comm. 1992). Further investigation into the population structure and reproductivity is needed to determine the viability of such skewed colonies.

Five colonies have been closely monitored for seven to nine years in Virginia. Of these, one is stable, three are showing gradual decline in numbers, and one declined radically in 1989 (Ware 1990). As an example, one colony had 143 stems in 1986, the highest number known for a single colony south of New England (Ware 1987a); however, its size had gradually declined to 62 stems by 1991, apparently as a result of increased grazing by deer. At

another Virginia site, the population in each of four colonies plummeted in one year from 34, 25, 14 and 8 stems to six, seven, six, and 0 stems (Ware 1991).

In North Carolina, one site (two colonies) located in the Nantahala National Forest (Macon County) has steadily declined over a 15-year period. Only one plant was present in 1991 at what had been the larger of the two colonies. There has been no apparent change in the habitat except for some reduction in shading due to oak wilt.

In some cases, populations that had shown a decline in numbers have since demonstrated a reversal. In Maine, subsets of monitored plants in each of four of the five large colonies declined in 1989 and 1990 (Vitt 1991b), but three of them increased in numbers the following year (Vitt in litt. 1991). A colony in Massachusetts that had diminished from 130 to 62 stems over an eight-year period rebounded to 100 stems in one year (P. Dunwiddie, Massachusetts Audubon Society, pers. comm. 1991). No obvious environmental changes were observed. Further monitoring data are needed to determine whether certain colonies are in a true decline or whether natural cycles, perhaps related to weather patterns, are taking place.

Throughout this plan, numbers designating colony size (stem counts) refer to the total number of stems emerged in a given year, not to the total number of different plants that have been known to emerge in that colony over a period of years. For instance, in the large colony in Virginia, the greatest number of stems known to have emerged in a given year is 144; however, over nine years of monitoring, stems have emerged at 261 different loci in that colony. Those not emerging in a given year are considered to be either dead or dormant (D. Ware pers. comm. 1992). Dormant plants usually return as vegetative plants, but may return in the flowering state (Brumback and Fyler 1988). Vitt (1991a) observed a 40-45 percent likelihood that a re-emergent individual would be vegetative.

State-by-state distribution and status

On a per state basis, the largest number of colonies are in New Hampshire (65), Maine (17), and Virginia (17). In addition, these three states, and Massachusetts, are the only states where large colonies (100 or more stems) have been documented. Historical and current distribution and the current level of protection of extant sites are described below for each state.

Maine

There are 16 extant sites (17 colonies) and three historical sites in Maine. Of Maine's five largest colonies (on five sites), three have some form of protection. One site occurs on property owned by The Nature Conservancy; TNC holds a conservation easement on another site. The Maine Department of Inland Fisheries and Wildlife owns most of a third site. The remaining two large colonies, and all the smaller colonies, are on private land.

New Hampshire

New Hampshire appears to be the major "hot spot" for this species. Thirteen extant sites were known at the time of the original recovery plan (USFWS 1985); as of 1991 there were 30 sites (65 colonies). Two sites accounted for approximately 60 percent of the total stem count in 1991. One Belknap County "megasite" is composed of 23 colonies in which a total of over 800 stems emerged in 1991. One of these colonies alone produced 326 stems in 1985 (W. Brumback, New England Wild Flower Society, in litt. 1992), the record for the species throughout its range. The second largest site, on municipal and private property in Strafford County, had five colonies (285 stems) in 1991. Only two sites are found west of the Merrimack River, the second of which was recently discovered (S. von Oettingen, USFWS, pers. obs. 1991). In 1991 approximately 100 stems were counted at this location.

Nine New Hampshire sites are under some form of protection: the majority of populations of the Belknap County megasite are now

on town conservation land and/or have conservation easements, two populations are on property owned by The Nature Conservancy, two others are registered by TNC (voluntary protection only), one population is on property owned by a watershed association with a conservation easement held by TNC, one population is owned by a land trust organization, one population is partially municipally owned, and one has voluntary landowner protection.

Vermont

Vermont has one historical site and no known extant sites. Searches undertaken in 1989 at the historical site and other potential habitat in Chittenden County were not successful (B. Popp, Vermont Natural Heritage Program, pers. comm. 1991).

Massachusetts

There are three sites with extant colonies in northeastern Massachusetts, and two sites in the central portion of the state. The largest site, in Essex County, supported one large and four small colonies in 1991 (P. Swain, Massachusetts Natural Heritage Program, pers. comm. 1991). A colony discovered in Hampden County in 1986 (with 30 stems) had only three stems in 1991 (J. Cavanaugh pers. comm. 1991).

Two of the Massachusetts sites have some degree of protection. One site is on municipal land, while the other site is owned by a conservation land trust (T. Simmons, TNC, pers. comm. 1992).

Rhode Island

The species has been reported from two sites in Rhode Island (R. Enser, Rhode Island Natural Heritage Program, pers. comm. 1991). One colony in Providence County was discovered in the 1930s, relocated in 1979, and last monitored in 1990, when only a few stems were present. A 1957 report recorded 23 stems from the second Rhode Island site; however, no stems have been reported since the early 1970s (Church and Champlin 1978). This site is on privately owned land with no habitat protection.

Connecticut

The one extant site (one colony) in Connecticut is on state forest land. Four stems were present when it was first recorded in 1983 (USFWS 1985); the same number was reported in 1991. In the intervening years the count fluctuated from one to eight stems (N. Murray, Connecticut Natural Diversity Data Base, in litt. 1991). There are eight historical sites in the state.

New York

All six historical sites in New York have been extirpated (S. Clemants, Brooklyn Botanic Garden, in litt. 1989). The most recent report for the state was of a single plant seen in Onondaga County in 1980 (USFWS 1985). Four of the six historical sites fell victim either to reservoir construction or housing development.

Pennsylvania

There are three extant sites (four colonies) in Pennsylvania. The largest colony is in Centre County where 14 stems were discovered in 1987, although only five emerged in 1991. This site is in a special management area owned by Pennsylvania Department of Fish and Game (P. Wiegman, TNC, pers. comm. 1991). The second Centre County site, on privately owned land, was discovered in 1979 and has two very small colonies (E. Dix, Bureau of Forestry, pers. comm. 1992). The third site, also privately owned, had only one plant in 1991. Five of the historical sites in eastern Pennsylvania have been intensively searched at least twice, with no success (J.Kunsman, Eastern Pennsylvania Natural Heritage Program, in litt. 1991). A sixth historical site is based on one herbarium specimen dating from the 1920s.

New Jersey

There are two and possibly three extant sites in New Jersey. The Nature Conservancy has a cooperative agreement with the private landowner for one site in Sussex County, where the number of plants has fluctuated from 21 stems in 1981 to six in 1987. A second site in the county has two small colonies and is located on a preserve

owned by TNC. Three small whorled pogonias were found on a previously unconfirmed historical site in May of 1991, but had been grazed early in the season, presumably by deer (R. Radis pers. comm. 1992). There are eight historical sites in the state.

Delaware

The small whorled pogonia was reported from Delaware (New Castle County) for the first time in 1985 (eleven stems in the one colony). In 1991 five stems were reported. The private landowner has shown interest in protecting the site (K. Clancy, Delaware Natural Heritage Program, pers. comm. 1991).

Maryland

There have been no sightings of the species in Maryland since 1928-1930 when it was found at three, and perhaps as many as five, sites in Montgomery County. All these sites were located within an area of less than two square miles that has since been developed (G. Cooley, Maryland Natural Heritage Program, pers. comm. 1992).

Washington, D.C.

Recent checks have verified that two historical sites in the District of Columbia have been destroyed by land development, one as recently as 1991 (K. Minnichello pers. comm. 1992).

Virginia

The small whorled pogonia is known from nine sites in Virginia (18 colonies), a number of which are protected or semi-protected. Sites located on military reservations are afforded some level of protection; at the military reservation in Caroline County, no disturbance to Isotria medeoloides has been observed over the past ten years, although training occurs nearby. In 1991, searches on another military base yielded three new sites. One site (four colonies) is located on National Park Service property (D. Ware pers. comm. 1992). Despite being on Federal property, these colonies are susceptible to disturbance from adjacent housing developments.

Records based on the sighting of a single stem are known from Buckingham County (Harvill 1969) and Appomattox County (C. Stevens pers. comm. 1988). Recent attempts to relocate the species in these central piedmont counties and in New Kent County (last seen in 1929) have not been successful (Ware 1988b).

North Carolina

There are five extant sites (seven colonies) in North Carolina (N. Murdock pers. comm. 1991). Most are located on Federal or municipal land and are afforded some protection. The Haywood County site (one colony) -- found at 3600 feet, the highest known elevation of any of the small whorled pogonia occurrences -- is located on National Park Service land. It produced only one stem in 1991 (D. Pittillo, West Carolina University, pers. comm. 1992). Another site (one colony), located in Nantahala National Forest, has steadily declined over a 15-year period. A third site (two colonies), located on municipal land, is semi-protected. The two remaining sites (one colony each) are on privately owned land; one of these had 25 stems when last recorded in 1986.

South Carolina

Three extant sites (seven colonies) of small whorled pogonia are found in South Carolina, located within a five-mile radius of one another in the Sumter National Forest (Gaddy 1985). Three of these colonies were known in 1980, three more were found in 1985, and one in 1991. Six of the colonies produced an average of six or fewer stems per year. One has had no plants since 1982; another has had none since 1987. In a seventh colony, 12 to 14 stems emerged over each of the last six years.

Georgia

As of 1985, Georgia had no confirmed occurrences of Isotria medeoloides. By 1991, six different sites with seven colonies had been found on the Chattahoochee National Forest (T. Patrick, Georgia Natural Heritage Program, pers. comm. 1991). A seventh site (one colony) was found on private land adjacent to the

National Forest. The colony on private land has not been checked since 1987, when it had eight stems (T. Patrick pers. comm. 1991). Two other sites in Georgia are now considered extirpated (T. Patrick pers. comm. 1991).

Tennessee

Isotria medeoloides is known from one site (one colony) in Tennessee on privately-owned farmland (B. Wilkey, Tennessee Department of Conservation, pers. comm. 1991). When the site was discovered in 1986, there were 19 stems, but the number of emerging stems had dwindled to seven in 1991 (P. Somers, Tennessee Department of Conservation, pers. comm. 1992).

Ohio

The only report of small whorled pogonia from Ohio was a single plant found in 1985 on state forest land. None were found on two later visits to the site (F. Case pers. comm. 1992).

Michigan

The single known site in Michigan was discovered in 1968 (Case and Schwab 1971). Two plants were last seen at this location in 1984, although there had been as many as 20 stems counted previously (W. Schwaub pers. comm. 1992). This site was made a preserve expressly for the protection of this species.

Illinois

The single Illinois site (one colony) was discovered in 1973. In 1991, only one plant was observed. This site is located on land owned by The Nature Conservancy and is protected.

Missouri

Despite repeated searches, no small whorled pogonias have been located in the vicinity of the "limestone hill" in Bollinger County where the species was first collected in 1897 (T. Smith, Missouri Natural Heritage Program, pers. comm. 1991).

Canada

The only records for small whorled pogonia in Canada are from an Elgin County, Ontario site discovered in 1977 (Stewart 1977). Only one plant emerged in 1989, 1990, and 1991. The site is on a preserve purchased by The Conservation Authority specifically to protect this species (W. Stewart pers. comm. 1992). Table 2 summarizes the 1985 and 1991 distribution and status of Isotria medeoloides throughout its range.

Table 2. Distribution and status of *Isotria medeoloides*.

STATE	COUNTY	No. SITES 1985	No. SITES 1991
Maine	Cumberland	1(E) 1(H)	3(E) 1(H)
	Kennebec	1(E)	1(E)
	Oxford	1(H)	3(E)
	York		2(H) 9(E)
Total Extant		**2**	**16**
New Hampshire	Belknap	2(E) 2(H)	6(E) 2(H)
	Carroll	3(E) 2(H)	7(E) 2(H)
	Grafton	1(H)	1(H)
	Hillsborough		1(E)
	Merrimack	2(E)	3(E)
	Rockingham	1(E)	1(E)
	Strafford	8(E) 2(H)	12(E) 2(H)
Total Extant		**16**	**30**
Vermont	Chittenden	1(H)	1(H)
Total Extant		**0**	**0**
Massachusetts	Essex	1(E)	2(E)
	Hampden		1(E)
	Hampshire	1(H)	1(H)
	Middlesex		1(E) 1(H)
	Worcester		1(E)
Total Extant		**1**	**5**

Table 2. Continued.

STATE	COUNTY	No. SITES 1985	No. SITES 1991
Rhode Island	Kent	1(H)	1(H)
	Providence	1(E)	1(E)
Total	**Extant**	**1**	**1**
Connecticut	Fairfield	2(H)	1(H)
	Hartford	1(H)	1(H)
	Litchfield	1(E)	1(E)
	New Haven	1(H)	1(H)
	New London	2(H)	2(H)
	Tolland	1(H)	1(H)
	Windham	1(H)	1(H)
Total	**Extant**	**1**	**1**
New York	Nassau	1(H)	1(H)
	Onondaga	1(H)	1(H)
	Rockland	1(H)	1(H)
	Suffolk	1(H)	1(H)
	Ulster	1(H)	1(H)
	Washington	1(H)	1(H)
Total	**Extant**	**0**	**0**
Pennsylvania	Berks	1(H)	1(H)
	Centre	1(E)	2(E)
	Chester	1(H)	1(H)
	Greene	1(H)	1(H)
	Monroe	1(H)	1(H)
	Montgomery	1(H)	1(H)
	Philadelphia	1(H)	1(H)
	Venango	1(H)	1(E)
Total	**Extant**	**1**	**3**
New Jersey	Bergen	3(H)	3(H)
	Hunterdon	1(H)	1(H)
	Monmouth	1(H)	1(H)
	Passaic	2(H)	1(U)
			1(H)
	Sussex	2(E)	2(E)
		1(H)	2(H)
Total	**Extant**	**2**	**2 to 3**
Delaware	New Castle		1(E)
Total	**Extant**	**0**	**1**
Maryland	Montgomery	2(H)	3 to 5(H)
Total	**Extant**	**0**	**0**

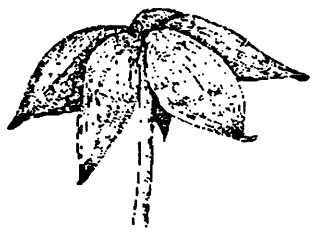
Table 2. Continued.

STATE	COUNTY	No. SITES 1985	No. SITES 1991
Washington D.C.		2(H)	2(H)
Total	**Extant**	**0**	**0**
Virginia	Appomattox	1(U)	
	Buckingham	1(H)	1(H)
	Caroline	1(E)	2(E)
	Gloucester	1(H)	1(E)
	James City	1(E)	2(E)
		1(H)	1(H)
	New Kent		1(H)
	Prince William		3(E)
	Stafford		1(E)
Total	**Extant**	**2 to 3**	**9**
Georgia	Habersham	1(H)	1(H)
	Gilmer		2(E)
	Rabun	1(E)	2(E)
			1(H)
	Towns		1(E)
	Union		1(E)
Total Extant		**1**	**6**
Tennessee	Hamilton		1(E)
Total Extant		**0**	**1**
Ohio	Scioto		1(U)
Total Extant		**0**	**0 or 1**
Michigan	Berrien	1(E)	1(E)
Total Extant		**1**	**1**
Illinois	Randolph	1(E)	1(E)
Total Extant		**1**	**1**
Missouri	Bollinger	1(H)	1(H)
Total Extant		**0**	**0**
Canada	Elgin	1(E)	1(E)
Total Extant		**1**	**1**
Range Total		30(E) 50(H)	86(E) 53(H)

E = Extant H = Historical U = Status Unknown

LIFE HISTORY

Populations of Isotria medeoloides consist of plants that may be in any of four different states: vegetative, with an abortive flower bud, flowering, or dormant (Mehrhoff 1989a). On the average, a flowering plant is taller and has a wider whorl diameter than one with an abortive bud; likewise, the latter is bigger than a vegetative plant (Mehrhoff 1980, 1989a).



Reproduction

Mehrhoff (1989a) determined that the leaf whorl diameter in a given year is a good predictor of the reproductive state of that plant for the following year. Plants that are large one year are more likely to bloom the next year, while plants that are small are more likely to be vegetative, go dormant, or die (Mehrhoff 1989a, Vitt 1991a). However, an event that prevents a large plant from storing adequate energy (the loss of the whorl early in the season, for instance) may interrupt this sequence. A previously large plant may then reappear the next year as a small vegetative plant or may fail altogether to emerge (Mehrhoff 1989a). At present, short of examining the rootstock or doing annual monitoring, one cannot tell whether a small vegetative plant is a seedling, a young plant, or an older plant that may have flowered in the past.

The small whorled pogonia appears to have a staggered system of emergence, depending upon the reproductive status of the individual plant. On the average, those stems that form an abortive flower bud emerge later than flowering plants, while vegetative plants emerge latest of all (Brumback and Fyler 1988). In the northern part of its range, plants with flowering buds emerge from the leaf litter in May and flower in June (Brumback and Fyler 1988). Farther south (e.g., in Virginia), such plants

typically emerge in April, with flowering beginning in very late April to mid-May (Ware 1987a). An individual plant may stay in flower from four days to nearly two weeks (Mehrhoff 1983).

Isotria medeoloides is scentless, apparently lacks nectar, and is primarily self-pollinating (Mehrhoff 1983, 1989a; Vitt 1991a). The effects of inbreeding, if any, on the long-term viability of this species are not known (L. Mehrhoff in litt. 1992). Insect pollination may take place on occasion; however, this has not been documented. The small whorled pogonia only occasionally reproduces vegetatively, as indicated by rare occurrences of two or more stems originating from a single root stock (Ames 1922, Brumback and Fyler 1983, D. Ware pers. comm. 1992).

As soon as pollination occurs, the ovary begins to plumpen. The fruit capsule does not fully ripen until fall, and may not dehisce until late fall. Many plants form a visible over-wintering vegetative bud at the base of the stem in August or September (Mehrhoff 1983).

Dormancy

Dormancy for I. medeoloides continues to be a matter of speculation and debate. Early comments suggested that dormancy for this species could extend from 10 to 20 years (Correll 1950, USFWS 1985). To date, this length of dormancy has not been substantiated. However, shorter periods of dormancy are being documented. Mehrhoff (1989b) conducted a six-year study and observed that no plants emerged after three or more consecutive years of dormancy. Brumback and Fyler (1988) also followed a number of colonies through time. Their data show periods of dormancy for up to four years. During a study of four sites in Maine, Vitt (1991a) determined that dormancy varied by year and site. The majority of plants in this study experienced dormancy for only a single year before re-emerging, while a very small

percent were dormant for three consecutive years, re-emerging in the fourth. In Virginia, among five colonies monitored from four to seven years, 14 stems reappeared after one year of dormancy and two stems after two years (Ware 1990). Continued annual tracking of dormant plants will be necessary to determine the maximum length of dormancy.

Mycorrhizal relationships

Orchid seeds, unlike seeds of other angiosperms, contain either very small quantities of food reserves or none at all. They will not germinate and/or establish seedlings unless they fall on a substrate containing a suitable mycorrhizal fungus (Jackson and Mason 1984). These fungi are often ones that can use cellulose as an energy source (Mallock et al. 1980). The strands of the fungus penetrate the cells of the orchid and form a symbiotic root/fungus association known as a mycorrhiza.

Mycorrhizae serve as conduits through which the young, non-photosynthetic orchid seedling receives water and nutrients (Mallock et al. 1980). In return, the orchid provides the fungus with carbohydrates at a later stage of its life cycle (Sanders et al. 1975).

Mycorrhizal fungi have been seen in the tissues of mature Isotria medeoloides (Ames 1922), although, to date, no specific mycorrhizal fungus has been identified. However, a member of the genus Rhizoctonia, a commonly encountered mycorrhizal fungus, was isolated from Isotria verticillata (L. Mehrhoff, Connecticut Natural Diversity Data Base, in litt. 1983). In addition, a species known to be a fungal symbiont of other orchids, Armillariella mellea, the honey mushroom (C. Ovrebo, Central State University at Edmond, Oklahoma, pers. comm. 1985), was identified from decaying wood in a large Virginia colony (Ware 1987b).

HABITAT REQUIREMENTS

Vegetation characteristics

Although varying in composition, the mixed-deciduous or mixed-deciduous/coniferous forests in which the small whorled pogonia grows are generally in second- or third-growth successional stages. The small whorled pogonia occurs both in fairly young forests and in maturing stands. The ages of the older trees forming the canopy at some of the sites have been estimated at 45-50 and 60-80 years old in Virginia (Ware 1987b), at least 75 years old in New Hampshire (Brumback and Fyler 1983), and as little as 30 years old in white pine stands in South Carolina (Gaddy 1985).

Historical agricultural use of small whorled pogonia habitat may not be uncommon. At some sites, vestiges of rows and furrows from past cultivation are still visible (F. Brackley pers. comm. 1991, D. Ware pers. comm. 1992). For example, some of the habitat at the megasite in Belknap County, New Hampshire was known to be open pasture 80 years ago (Brumback and Fyler 1983), and a site in Union County, Georgia was stony old pasture about 50 years ago (B. Sanders, U.S. Forest Service, pers. comm. 1992). There is also circumstantial evidence that the site of the large colony in James City County, Virginia, was once a hog lot (B. Apperson, Virginia Division of Forestry, pers. comm. 1986).

The majority of Isotria medeoloides sites share several common characteristics. These include: sparse to moderate ground cover in the microhabitat of the orchids (except when among ferns); a relatively open understory canopy; and proximity to logging roads, streams, or other features that create long persisting breaks in the forest canopy (Mehrhoff 1989a). Beyond this "common ground" of habitat characteristics, there are myriad exceptions and variations that may occur regionally and/or locally. As one example, the

single Illinois site is on a steep, thinly forested slope atop a vertical sandstone bluff. Wilted and withered plants have been observed there (Homoya 1977), and it has been described as perhaps the driest of all known sites (USFWS 1985).

Various second-growth forest types in which Isotria medeoloides occurs in its primary range include: mixed deciduous/white pine or hemlock forests in New England, mixed deciduous forests in Virginia, and white pine/mixed deciduous or white pine/oak/hickory forests in Georgia. In Michigan, the habitat of the single known extant colony is dominated by red maples (Case and Schwab 1971). The Illinois plants inhabit an oak/hickory forest (Homoya 1977). The Ohio site is in the region along the Ohio River that supports an Appalachian-type forest association and several species of Appalachian affinities (A. Cusick, Ohio Department of Natural Resources, pers. comm. 1992). Species associated with each forest type are identified by range section in Table 3.

Understory trees and shrubs in the northern part of the range include witch-hazel (Hamamelis virginiana), striped maple (Acer pensylvanica), American hazelnut (Corylus americana), and serviceberry (Amelanchier arborea) (Mehrhoff 1980). In the southern part of the range flowering dogwood (Cornus florida), sourwood (oxydendron arboreum), mountain laurel (Kalmia latifolia), American chestnut (Castanea dentata), witch-hazel, and, in the mountains, flame azalea (Rhododendron calendulaceum) are the more common understory tree and shrub associates (Mehrhoff 1980).

A few ground-layer taxa that are associated with the small whorled pogonia in the northeastern part of its range also occur with it in at least a portion of its southern range. This is particularly true for partridge berry, Indian cucumber root, New York fern, and sweet lowbush blueberry. In general, however, herbaceous associates vary greatly from region to region, and none can be considered true indicator species because of their

Table 3. Typical canopy species associated with *Isotria medeoloides*.

RANGE SECTION	SCIENTIFIC NAME	COMMON NAME
New England	*Acer rubrum*	Red maple
	Tsuga canadensis	Eastern hemlock (Canada hemlock)
	Betula papyrifera	Paper birch
	Quercus rubra	Northern red oak
	Pinus strobus	White pine
	Fagus grandifolia	American beech
Virginia	*Quercus alba*	White oak
	Q. velutina	Black oak
	Q. coccinea	Scarlet oak
	Liquidambar styraciflua	Sweet-gum
	Liriodendron tulipifera	Tulip poplar
	F. grandifolia	American beech
South Carolina and Georgia	*P. strobus*	White pine
	A. rubrum	Red maple
	L. tulipifera	Tulip poplar
	Quercus prinus	Chestnut oak
	Q. alba	White oak
Michigan	*A. rubrum*	Red maple
Illinois	*Q. alba*	White oak
	Q. rubrum	Red oak
	Carya ovata	Shagbark hickory

widespread distribution in sites where I. medeoloides does not occur. Rawinski (1986a) pointed out that a site where several of these species occur in eye-catching abundance is worth perusing for the small whorled pogonia. Table 4 lists those ground layer species most often found in association with the small whorled pogonia.

Decaying vegetable material may be important to the small whorled pogonia; Grimes (1921) found several plants rooted in decaying wood litter. Various types of decaying vegetation are almost always found in small whorled pogonia habitat, including fallen trunks and limbs (Brumback and Fyler 1983), leaf and frond litter, bark, stumps, and roots of dead trees (Ware 1987b).

Table 4. Typical ground layer species associated with *Isotria medeoloides*.

RANGE SECTION	SCIENTIFIC NAME	COMMON NAME
Throughout Range	*Mitchella repens*	Partridge berry
	Medeola virginiana	Indian cucumber root
	Thelypteris noveboracensis	New York fern
	Vaccinium pallidum (vacillans)	Sweet lowbush blueberry
	Goodyera pubescens	Rattlesnake plantain
	Acer rubrum (seedlings)	Red maple
	Quercus spp. (seedlings)	Oak species
Northern Part of Range	*Maianthemum canadense*	Canada mayflower
	Gaultheria procumbens	Wintergreen
	Trientalis borealis	Star-flower
	Lycopodium digitatum	Running cedar
Southern Part of Range	*Parthenocissus quinquefolia*	Virginia creeper
	Desmodium nudiflorum	
	Smilax glauca	Cat-brier
	Polystichum acrostichoides	Christmas fern

Shade/light factors

It appears that too much shading could be a limiting factor for this species. Sites where colonies of small whorled pogonia had once occurred but no longer could be found were more shaded by vegetation than were the extant sites (Mehrhoff 1989a). There is anecdotal evidence of burgeoning numbers and vigor in Isotria following major events that caused an increase in the amount of light reaching the forest floor. In New Hampshire, gypsy moth outbreaks preceded the discovery of the orchid at several sites in the 1980s (Brackley 1991). In North Carolina, it was newly discovered at the annual camp site of a wildflower photographer the year after a major ice storm created canopy gaps (N. Murdock pers. comm. 1991).

Existing colonies are generally near some habitat feature that effects a semi-permanent break in the canopy, such as a stream bed or a logging road (Mehrhoff 1989a). Colonies may form in more ephemeral types of canopy breaks, such as those caused by wind-throws and dead standing trees, but may go dormant or die out much more quickly than colonies in more stable habitats. In his study of seven North Carolina sites, Gaddy (1985) noted that circumstantial evidence indicated that the plant germinates on bare soil or disturbed leaf litter (old logging roads) at sites where light intensities are greater than under normal canopy cover.

Topography

Slope exposure and degree, and the position of the plants on the slope vary throughout the range of I. medeoloides. Mehrhoff (1989a) found that most of his study sites were on level terrain or at the base of slopes facing south or southeasterly. In New England, easterly slopes are the most frequently identified exposures (Rawinski 1986a), yet the highly prolific site in East Alton, New Hampshire faces northwest (Brumback and Fyler 1983). In Virginia, most colonies are on north- or northeast-facing slopes, but some have southerly exposure (Ware 1991). Six sites checked in South Carolina faced south, west, or southwest (Gaddy 1985).

Slopes varied from 0 to 30 percent among the sites studied by Mehrhoff (1989a). He also observed that colonies, although found at a variety of slope positions, are most often found at the base of a slopes or at mid-slope positions.

In Maine and New Hampshire, botanists have had great success locating colonies by searching along the braided channels of vernal streams and in gullies up slope from where the streams arise (Rawinski 1986a). The plants tend to occur in the water-sorted leaf litter along these streams. Small whorled pogonia has also been found in this type of habitat in Massachusetts (P. Dunwiddie

pers. comm. 1991), although this is not the case outside of New England (Homoya 1977, Gaddy 1985, Ware 1987b, Dixon and Cook 1988). Most of the historical sites in New York were not in vernal streambeds (Dixon and Cook 1988), and in Virginia, I. medeoloides has been found on the floor of ravines that have no stream channel (Ware 1987b; Crouch 1990).

Soils

The soil in which the shallowly-rooted small whorled pogonia grows is usually covered with leaf litter (Homoya 1977). The substrate in which it is rooted may be a variety of different textures, from extremely stony glacial till (Brumback and Fyler 1983), to stone-free sandy loams (Ware 1987b), to sterile duff (Rawinski 1986a). At one site in Massachusetts, the plants are rooted in a thin, easily punctured layer of humus that overlies boulders (T. Smith pers. comm. 1991). One site west of the Merrimack River in New Hampshire is on rockier terrain than typical and appears to be on a different soil type than that of those New Hampshire east of the river (S. von Oettingen pers. comm.).

The common soil factor at most sites is the highly-acidic, nutrient-poor quality of the soil in which this orchid grows (Mehrhoff 1989a, Rawinski 1986a). Soil analyses in New Hampshire, Rhode Island, and Virginia showed a combined overall range in pH values from 4.0 to 5.0, and low to extremely low nutrient values (Brumback and Fyler 1983, Stuckey 1967, and Ware 1987b). There are, however, several reports of the small whorled pogonia from calcareous soils (Correll 1950, Steyermark 1963, Dixon and Cook 1988) or from sites at which the presence of certain associated species indicate that the soil is very likely nutrient-rich (N. Murdock pers. comm. 1991). Historical sites in New York were found on acidic soil types (Dixon and Cook 1988), and the Haywood County site in North Carolina occurs in habitat with associated species indicative of a basic soil type (N. Murdock pers. comm. 1991).

At sites in New England, there is an impermeable soil layer (fragipan) beneath the highly acidic soils supporting Isotria medeoloides (Rawinski 1986a). Downward percolation of water is blocked by this layer; therefore, on sloping terrain there is a significant increase in the lateral flow of water. Botanists searching for new small whorled pogonia sites in Maine and New Hampshire were successful in locating additional populations by concentrating their searches on fragipan soils identified in county soil surveys. At the Tennessee site, an impervious sandstone lies beneath the topsoil, and cracks in the soil allow rapid drainage and leaching (B. Wilkey pers. comm. 1991). Fragipans may also account for the low nutrient soils in other parts of the species' range; however, this has not yet been substantiated.

In the past, the habitat of the small whorled pogonia was described as "dry woodland" (Fernald 1950) and "moist to dry leaf mold in rather dry . . . woods" (Correll 1950). The plant is now known to occur on much moister sites than indicated by these descriptions. Soil moisture measurements carried out in a colony in the coastal plain of Virginia showed more or less consistently high soil moisture values, even through a summer drought (Ware 1989a). However, when under sufficient and sustained drought stress, the plant will be affected as the whorl droops, wilts and withers (Homoya 1977, Ware 1989a).

THREATS

The 1985 Small Whorled Pogonia Recovery Plan identified habitat destruction and collection as the two main threats to the continued existence of this species. Although collecting can still be regarded as a factor in the partial or complete destruction of individual small whorled pogonia colonies, actual and potential habitat destruction is now considered to be the primary threat to the species. Other threats such as recreational use of the

habitat, herbivory, and inadvertent damage from research activities have also been identified as harming small whorled pogonia populations, albeit to a lesser extent.

Residential or commercial development, both directly and indirectly, is a primary factor in the destruction of small whorled pogonia habitat. In several cases, house lots are adjacent to or very near colonies of the orchid. At one site in Virginia, two colonies are on house lots in a rapidly developing subdivision, one colony is on land slated for development, and a fourth colony is in a highway corridor. In 1986 in New Hampshire, the habitat of a large colony of plants was destroyed during the construction of summer housing (Brumback pers. comm. 1992). In an attempt to mitigate this loss, the developer financed the transplanting of small whorled pogonias to a protected site where the species already occurred. However, the transplanted population has since undergone a steep decline; only one-third of those plants emerged five years later (W. Brumback pers. comm. 1992). In addition to the loss of plants, what had been productive habitat is now a residential area.

Development in areas surrounding Isotria medeoloides habitat could indirectly be responsible for habitat destruction as roads, power lines and sewer mains are designed to connect settled areas. Because I. medeoloides occurs in uplands, there are few state or Federal regulatory means of protecting this species on private lands. For example, the second largest site for the species, located in New Hampshire on municipal and private property, is in a precarious situation. Publicity surrounding its discovery could potentially prompt collecting, vandalism, or cause inadvertent disturbance by visitors; further, there is recreational use of the property with no consideration taken to managing for the population at this time. This site is also in a potential new highway corridor (Brackley 1991).

The concentration of white-tail deer onto smaller and smaller parcels of woodland is an indirect effect of development pressure that may pose an increasing threat to the small whorled pogonia. The decline of a large Virginia colony appears to be primarily due to grazing of whorls early in the season (Ware 1991), and circumstantial evidence indicates that the grazers are deer.

Another indirect effect of development is the formation of barriers to seed dispersal, in that it is vital that populations have adequate space in which to "move around" (Brackley 1991). Further, depending upon the methods used, selective timbering may not necessarily be harmful to a population, but heavy timbering and clear-cutting are real threats. Potential habitat and colonies not yet known could be destroyed before being discovered. In New Hampshire, except for sites located within state forests, most of the sites chosen for de novo searches were found to have been logged (Brackley 1991). One privately owned site (one colony) of Isotria medeoloides in Tennessee has been logged, burned, and otherwise disturbed for the last 150 years (B. Wilkey pers. comm. 1991). There were 19 stems on the site when it was discovered in 1986, but the number of emergent stems decreased to seven in 1991.

One site (four colonies) on National Park Service property in Virginia is threatened by "people pressure" from adjacent housing developments (D. Ware pers. comm. 1992). In Georgia one site on National Forest lands is considered historical since it was unwittingly destroyed when a culvert was installed for a Forest Service road (B. Sanders pers. comm. 1992).

Events causing drastic changes in the amount of light reaching the forest floor, such as severe and repeated defoliation of the canopy by gypsy moths, might cause the herbaceous layer to flourish. This would result in more interspecific competition and increased shading (Brackley 1991), thus reducing the functional suitability of the habitat.

Additional threats cited by those involved in small whorled pogonia monitoring include trampling or uprooting by wild pigs, and crushing by off-road vehicles, and, to a lesser extent, by researchers and recreational users of the sites which support the small whorled pogonia. Although disturbance to the plants by researchers is inadvertent, techniques must be developed that will minimize such impacts on frequently visited sites. Encroachment of certain ground-covering plant species such as hog-peanut, running cedar, and blueberry may also adversely affect this species. The possibility of fire caused by military training is another concern (A. Belden in litt. 1991).

Herbivory by deer is a known threat; however, other types of herbivory have recently come to light. In New England, slugs are considered by some to be a serious pest to the orchid (Brumback and Fyler 1988). It has been suggested that touching the plants may leave salts on the leaves that are, in turn, attractive to slugs (Brackley 1991). In Virginia, camel crickets were identified (by night-time surveillance) as at least one of the agents causing progressive herbivory of the whorls throughout the season (Ware 1989b).

Although few cases of vandalism or collections have been reported, such activities do still occur. The release of specific locational information on small whorled pogonia sites increases the potential for the plant's removal. All eight stems comprising a colony in Strafford County, New Hampshire, were dug up in 1986 (Rawinski 1986b). Within days after a newspaper article was published revealing the location of one site in Connecticut, the plants had been dug up and removed (L. Mehrhoff pers. comm. 1991).

A few states have no laws preventing the destruction or removal of Isotria medeoloides plants. Federally endangered plant species are protected from "taking" if they occur on Federal land or if the destruction and/or removal is in knowing violation of a state endangered species law. None of the populations in Maine or

Rhode Island occurs on Federal land. Rhode Island law does not provide any protection beyond that provided by the Federal Endangered Species Act; state law only prohibits collection of the state listed species for sale. There is also no Maine State law protecting endangered plant species. In lieu of state legal protection of the plants, botanical collecting and/or vandalism could constitute threats to the species.

CONSERVATION MEASURES

The data referred to in Table 2 show a substantial increase in the number of known sites of small whorled pogonia in all three of the species' centers of distribution since the species was listed in 1982. This increase is due to intensive field work throughout the species' range as a result of listing as well as the implementation of the 1985 Recovery Plan. These search efforts in turn have played a vital role in pinpointing sites where conservation efforts are needed. Indeed, in many instances conservation of the small whorled pogonia through habitat protection has been initiated; Table 5 identifies the number of protected sites to date. In this case, protection is defined as habitat protection afforded at a level that prevents immediate development such as that which could occur on privately owned land. This definition does not distinguish habitats that are protected only from those that are both protected and managed.

Botanists in the New England states have actively, and successfully, searched both historical and de novo locations for the small whorled pogonia. In some cases, botanists have used soil maps to identify new, potential sites; additional populations have been found by greatly expanding the search radius of known populations, while still others have been discovered by pure chance. Since 1985, 14 additional extant sites in Maine have been

located, along with 14 sites in New Hampshire and four in Massachusetts.

A number of small whorled pogonia sites have been discovered on lands under state and Federal jurisdiction, and are thus afforded at least some protection (primarily from development). Sixteen sites are located on property under the jurisdiction of Federal agencies including the U.S. Forest Service, the National Park Service, and the Department of Defense. Approximately six sites are located on state-owned lands (Table 5).

Federal agencies have intensified their protection efforts on behalf of the small whorled pogonia. In Virginia, the National Park Service has provided funding for monitoring and is seeking ways to prevent disturbance to sites under their jurisdiction. Six colonies (five populations) on two different military installations in Virginia are protected; personnel at both bases have facilitated searches and monitoring, and have limited the activities that can occur in the vicinity of the colonies. At one base, the tract of land on which a colony was located was withdrawn from sale. At another military base, consultations were held to determine adequate buffer zones between small whorled pogonia colonies and land to be timber harvested (J. Wolflin, USFWS, in litt. 1991).

Many states are actively pursuing conservation easements or agreements with private landowners. Since the species was listed in 1982, a number of sites have been protected through conservation easements, deed restrictions, acquisition, or voluntary, non-binding agreements with private landowners. Seven sites are on lands owned by various private conservation agencies (refer to Table 5). Some state agencies pursue voluntary registration of small whorled pogonia sites. While such registration does not guarantee habitat protection, it does seek to recognize the importance of the site in the hopes of voluntary protection on the part of the landowners.

Table 5. Protection status of extant sites

STATE	# Sites 1991	OWNERSHIP/ PROTECTION [1]	% PROTECTED
Maine	16	1 - State, partial site 1 - TNC 1 - TNC easement	New England Center 28%
New Hampshire	30	2 - TNC 2 - TNC registered (voluntary protection) 1 - Conservation easement in progress with TNC 1 - Voluntary landowner protection 1 - Municipal, partial site 1 - Conservation trust 1 - Municipal, w/ easement	
Massachusetts	5	1 - Municipal 1 - Conservation land trust	
Rhode Island	1		
Connecticut	1	1 - State	
New Jersey	2	1 - TNC 1 - Landowner agreement	Coastal Mid-Atlantic Center 83%
Delaware	1	1 - Conservation easement in progress	
Virginia	9	5 - Department of Defense 1 - National Park Service 1 - State	
North Carolina	5	1 - U.S. Forest Service 2 - Municipal 1 - National Park Service	Southern Blue Ridge Center 80%
South Carolina	3	3 - U.S. Forest Service	
Georgia	6	5 - U.S. Forest Service	
Tennessee	1		
Pennsylvania	3	1 - State	Outliers 66 %
Ohio	1	1 - State	
Michigan	1	1 - Private conservation organization	
Illinois	1	1 - TNC	

[1] All other sites not counted are owned by private individuals, no protection.

In some instances, protective efforts have involved habitat manipulation or physical protection of I. medeoloides plants. U.S. Fish and Wildlife Service personnel have successfully used tomato cages to protect some of the larger plants from grazing by deer and/or rabbits at one of the sites in North Carolina. Several trees were also girdled in 1988 to open the canopy; however, no response has yet been seen in that colony. In New England, biologists from the University of Maine are currently investigating the potential use of habitat manipulation as a tool for enhancing population viability.

Some protection through Federal and State legislation is provided to the species. All states with current and historical populations have cooperative plant agreements with the Fish and Wildlife Service as specified under Section 6(c)(2) of the Endangered Species Act. The 1988 amendments to the Act increased protection to plant species not on Federal land by making it illegal to destroy or remove an endangered plant if it is in knowing violation of a state endangered species law. A number of states have enacted such laws, providing various levels of additional protection to the small whorled pogonia (Appendix 1).

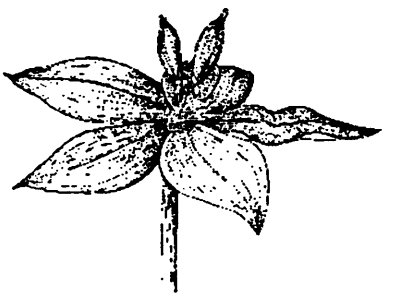
Consultations with Federal, state, and local agencies, as well as private developers have resulted in the avoidance of adverse impacts to the small whorled pogonia. For example, a road and a sewer main in a private subdivision near Williamsburg, Virginia, were re-routed to avoid direct destruction of small whorled pogonia colonies. In Connecticut, a trail was re-routed to avoid a colony in a state forest. Consultations required under Section 7 of the Endangered Species Act resulted in the re-routing of a highway in Virginia and the avoidance of adverse impacts to a colony.

Recent intensive search efforts by Federal and state agencies and other conservation organizations have been particularly fruitful. The U.S. Forest Service in Georgia hired eight botanists to spend the summer of 1991 searching more than 10,000 acres of

Forest Service land for 100 rare plant species. As a result, four colonies of small whorled pogonia (B. Sanders pers. comm. 1992) were discovered. In Virginia, Heritage Program surveys in 1991 at a Marine Corps base added three new colonies to the growing list for that state (N. van Alstine, Virginia Division of Natural Heritage, pers. comm. 1991). Also in 1991, one new site was discovered in New Hampshire and one in Massachusetts.

Recovery efforts have also been directed toward research and environmental education relating to the small whorled pogonia. Educational materials in the form of posters (The Maine Critical Areas Program, in conjunction with voluntary contributions from four industries, produced a poster of rare Maine plants, centered on the small whorled pogonia), U.S. Fish and Wildlife brochures, and fact sheets (Massachusetts Natural Heritage Program) have been made available to the general public. Other educational efforts have been, and continue to be, directed towards information dissemination to the general public through the publication of articles in newspapers and other periodicals.

RECOVERY STRATEGY



Recovery of Isotria medeoloides is based on a multi-faceted strategy of habitat protection and management (on a case-by-case basis), threat reduction, and environmental education to ensure the continued existence of this species. Although many more sites are now known for this species than were known when it was first listed, the habitat continues to face unrelenting pressure from development, logging, and recreational activities.

Of utmost importance is the conservation of both occupied and potential small whorled pogonia habitat. In this respect, potential habitat is considered to be habitat adjacent to extant colonies, or historical sites that appear to be good habitat. Habitat conservation will require significant time and funding to prevent loss or alteration caused by development or disturbance. Because this is an upland species -- often located on prime, developable land -- there may be few regulatory opportunities for protection. Direct acquisition of habitat or conservation easements and deed restrictions will be considered the primary methods of protecting viable populations of the species. Although New England has the greatest concentration of populations, the region has the lowest percentage of protected populations. A significant conservation effort will thus be needed in New England to achieve the recovery objectives.

In considering priorities for habitat conservation, the maintenance of the population distribution of the three geographic centers, as well as the outlying sites, will be emphasized. Widespread distribution of the species is a vital component for the preservation of the genetic diversity of this species and ultimately its recovery. The genetic make-up of the outlying populations may differ greatly from the more centrally located, eastern populations, or the coastal sites may differ from the populations in more mountainous regions. Research will be necessary to determine if genetic variability influences population viability.

Recent monitoring results indicate a decline in viability of many of the populations that have been followed over a number of years; indeed, many extant colonies may not be viable. This in turn may impede recovery in significant portions of the species' range. In those areas, a second priority is not only to protect the habitat of known sites, but to develop management plans that will augment the colonies with the goal of bringing them at least

to minimum viability. This will be done to a level that will meet the recovery objectives.

To date, no causes for the decline of many of the monitored colonies have been determined; however, the loss of functionally suitable habitat may be a factor. Research on manipulation of the habitat, particularly with regard to light intensity, will need to be performed to determine whether habitat management will promote small whorled pogonia growth. Other research needs include the impacts of deer management (or lack thereof) on small whorled pogonia habitat, and investigations into techniques to alleviate impacts by researchers and other visitors on the species' habitat.

During the recovery period, all Isotria medeoloides sites will be protected through enforcement of the Endangered Species Act. In order to ensure long-term protection for all viable populations of the species and enable its eventual delisting, efforts will be made to strengthen regulations protecting endangered plants at the state and local levels.

Public awareness of the species and its recovery needs has been a major factor in the protection and recovery efforts. Educational efforts will continue to promote the conservation this species and its habitat. Information will be distributed to the general public and to schools. The addition to school curricula of endangered species activities and information, including the small whorled pogonia, will be supported.

PART II: RECOVERY

The original objective outlined in the 1985 Small Whorled Pogonia Recovery Plan, based on the best available information at that time, was to locate and protect 30 populations (sites) of at least 20 individuals each, with at least 15 of the sites to be located in New England. This recovery objective is no longer considered appropriate, due to new information regarding the small whorled pogonia's life history and site viability, as well as the dramatic increase in known sites. Consequently, the objective has been revised. Its two components, reclassification and delisting, emphasize site viability and levels of protection.

RECOVERY OBJECTIVES

The immediate objective of the recovery program is to **reclassify** the small whorled pogonia from endangered to threatened by meeting the following conditions:

1. A minimum of 25 percent of the known viable sites as of 1992 must be permanently protected. These sites should be distributed proportionately throughout the species' current range, and a given site should include the majority of the colonies.

2. Sites or colonies must be shown to be viable as indicated by a geometric mean of 20 emergent stems, of which at least 25 percent are flowering stems, over a three-year period. The geometric mean is considered a better indicator of the stability of a population that exhibits wide year-to-year

fluctuations than is the arithmetic average (Sokal and Rohlf 1969).

Data used to determine site viability over time will be retroactive for those sites where the information is available. For sites lacking complete quantitative flowering data but showing persistence of the population with no significant change in habitat conditions, evidence of successful reproduction will be extrapolated from records showing stable or increasing stem counts; this will apply only as a reclassification criterion.

3. Site protection must include a buffer zone around the colony or colonies (if there is more than one colony at a site) sufficient to allow some natural colonization of habitat that becomes functionally suitable over time, and to provide protection from outside disturbance, including human-generated disturbance. The buffer will be determined on a site-by-site basis, as sites differ in number of colonies, topography, number of landowners, and abutting land uses.

   Protection will be accomplished through: (1) ownership by government agency or a private organization that considers maintenance of the I. medeoloides population to be the predominant management objective for the site, or (2) a deeded easement or covenant that effectively commits present and future landowners to protecting the population and allowing the implementation of management activities when appropriate. This high level of landowner commitment to site protection will be even more critical if it is determined that the species requires habitat management to offset countervailing decreases in the amount of unoccupied, suitable habitat.

The ultimate objective of the recovery program is to **delist** the small whorled pogonia by ensuring its long-term viability. This will be accomplished by meeting the following conditions:

1. A minimum of 61 sites (75 percent of the number of sites known in 1992) must be permanently protected. These sites should be distributed proportionately among the three geographic centers and the outliers. The level of protection considered to be sufficient for the purpose of reaching this objective is defined in condition 3 for reclassification.

2. These sites must represent at least 75 percent of the known viable (self-sustaining) populations as determined at the time of reclassification, including a total of 20 sites having 80 stems or more. Self-sustaining populations are indicated as those sites showing a geometric mean of 20 emergent stems, of which at least 25 percent are flowering stems, over a 10-year period. This length of time should account for naturally induced dormancy of individual plants and their potential re-emergence. Quantitative data regarding reproductive success will be required to meet this condition.

3. Appropriate habitat management programs must be established for occupied I. medeoloides habitat as necessary to ensure the continuation of certain self-sustaining populations. Historically, there was additional habitat adjacent to I. medeoloides colonies that naturally became available for recolonization. This habitat allowed for the replacement of those colonies that either died out or went into extended dormancy as a result of changing habitat parameters, particularly light conditions. In certain colonies, management strategies will need to replace the historical availability of this additional habitat.

- OR -

A sufficient amount of unoccupied habitat adjacent to existing colonies must be protected to allow for natural colonization and maintenance of a self-sustaining population. This will be determined on a site-by-site basis.

RECOVERY TASKS

1. Protect known Isotria medeoloides populations and essential habitat.

The overriding recovery necessity for I. medeoloides is habitat protection, particularly for those sites with viable populations. I. medeoloides habitat and populations are threatened directly and indirectly by development and recreational activities. Many sites have already been provided some level of protection, although in several cases it is insufficient to guarantee the long-term conservation of the species. Measures such as land acquisition, conservation easements, or landowner agreements will be pursued as a means of habitat protection.

1.1 Identify ownership of all known populations. Ownership information for many of the small whorled pogonia sites is still incomplete. Such information is often scattered among different agencies, not yet collected, or difficult to ascertain (the latter can be particularly problematic for those sites with more than one landowner).

1.2 Determine those areas in need of protection. When land ownership has been determined (Task 1.1), those sites most in need of protection will be identified. Priorities for pursuing habitat protection should be based on criteria such as: (1) significance of the site with respect to population viability (e.g., those sites having greater than minimally viable populations should be given higher priority), (2) potential for recoverability (for those sites not currently viable), and (3) distribution. Along with these criteria, the opportunity for protection, e.g., willingness of sellers, needs to be considered.

1.21 Identify gaps in protected habitat throughout the range of the species. Many states are beginning to develop GAP analyses for wildlife habitat and other parameters. This type of analysis will be used to identify unprotected small whorled pogonia sites.

1.22 Determine overall priorities for land protection. On a state-by-state and site-by-site basis, priorities for protection will be determined according to the significance of the population (e.g., size and distribution among geographical centers of concentration), potential for recoverability, and magnitude/immediacy of threats.

1.3 Develop and implement habitat protection strategies. As sites in need of protection are identified and prioritized (Tasks 1.1 and 1.2), appropriate habitat protection strategies will be determined and implemented on a site-by-site basis.

1.31 Coordinate among Federal and state agencies and conservation organizations in providing permanent protection. Permanent protection may be provided for sites either through land acquisition or conservation easements. Maintenance of I. medeoloides populations should be the predominant management objective for these sites.

1.32 Seek cooperation and active support of private landowners in protecting known sites through the development of voluntary agreements. Cooperation from landowners is an extremely important facet of protection for sites located on private lands, especially since the laws of most states within its range do not prohibit taking of Isotria medeoloides from private property with the landowner's

permission. A deeded easement or covenant that effectively commits present and future landowners to protecting the population and allowing the implementation of management activities (as needed) is vital for those areas where conservation easements or land acquisition are not applicable.

1.4 Use existing regulatory mechanisms to protect I. medeoloides habitat. Section 7 Endangered Species Act responsibilities will continue to be carried out to avoid direct and secondary impacts to populations or their habitat. Section 7(a)(1) of the Act, which directs Federal agencies to use their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation and recovery of listed species, will be emphasized. In addition, active consultation with state agencies needs to be pursued for those states with endangered species laws regulating state funded, authorized, or carried out activities that might threaten the continued existence of the species.

1.5 Encourage the development of comprehensive State plant protection legislation. A number of state acts could provide better protection of I. medeoloides habitat if stronger amendments were added. In addition, a few states do not have comprehensive plant protection laws. A coordinated effort among public agencies and private conservation groups should be undertaken to develop and pass legislation that will provide legal State protection and enhanced Federal protection for threatened and endangered plants, including the small whorled pogonia.

2. Manage protected habitats for Isotria medeoloides. Site-specific conservation plans or management strategies will be developed for protected sites, when necessary. Plans for

sites on Federal and other public lands will be developed in cooperation with the administering agency, on an as needed basis. Plan products will be brief and will include statements regarding protection agreements, management activities as defined in Task 2.1, and/or actions for long-term preservation.

2.1 Determine appropriate habitat management strategies. Currently, there is a lack of information regarding specific habitat requirements of the small whorled pogonias. Anecdotal evidence indicates that I. medeoloides may require certain levels of disturbance in its habitat, allowing openings in the forest canopy. Evidence also indicates that herbivory, incidental trampling from visitors, and other forms of physical disturbance may adversely affect the orchids. Habitat manipulation and protection from physical disturbance must be investigated, with results being incorporated into management plans. Management strategies will be applied on a site-specific basis -- not all sites will need active management.

2.11 Investigate effects of manipulation of light levels on I. medeoloides. There has been increased interest in determining how light levels affect the growth, and possibly the dormancy, of Isotria medeoloides. It appears that I. medeoloides populations are often found near some habitat feature that causes a semi-permanent break in the canopy, such as a stream bed or a logging road (Mehrhoff 1989a), and that light levels are an important component in small whorled pogonia habitat. Further research is needed to determine whether the opening of understory and/or overstory canopies will positively affect I. medeoloides growth by altering light levels. These

quantitative studies should determine what level of light is necessary to maintain viable populations or enhance marginally viable colonies.

2.12 Determine researcher/visitor impacts on populations. I. medeoloides does not appear to be tolerant of physical disturbance, such as trampling. In addition, it is speculated that handling of plants might attract herbivores such as slugs. To prevent the decline of easily accessible, often visited populations, impacts from researchers or visitors, and concomitant management recommendations, must be determined.

2.13 Identify herbivore impacts. In areas of large deer concentrations, the effects of herbivory on the populations will be determined. In addition, other animals are known to feed on the small whorled pogonia. As part of a management strategy, it may be necessary to identify and alleviate these impacts.

2.2 Develop and maintain conservation plans for each site protected under Task 1. Mehrhoff (1989a) stated that conservation programs for the small whorled pogonia cannot consist exclusively of habitat acquisition and preservation; some type of management will be necessary to maintain mid-successional conditions. However, not all sites are in mid-successional forests, since some of the largest sites (in New England) are found in stable forests and would not need active management if the populations are viable. Conservation plans will be developed on a site-by-site basis and should incorporate management strategies, when necessary, and monitoring programs to ensure the long-term viability of the

populations. Research results from Tasks 5 and 6 will be incorporated into these plans as appropriate.

3. Monitor existing populations.
All known sites will continue to be monitored. Meeting the recovery objectives is contingent upon the stabilization of viable populations over time. Consistent monitoring will provide population data necessary to reach the objectives.

3.1 Develop rangewide consistency in monitoring strategies.
A uniform method of estimating colony or population extent and viability should be incorporated throughout the species' range. The definitions for colony and site stated on page 6 of this plan should either be used in all monitoring efforts or refined. Observations regarding the reproductive status of the plants, such as the number of flowering versus non-flowering stems, must be incorporated into monitoring parameters.

3.2 Monitor known sites and new sites as they are found.
All sites will continue to be monitored using a consistent scheme (Task 3.1) throughout the range of the species. Monitoring will be conducted, at a minimum, on a biennial basis.

3.3 Determine when a population is to be considered historical. Because I. medeoloides may go dormant, it is difficult to determine whether or not a site, particularly one with very few stems, is extant. For those sites not physically destroyed (i.e., habitat no longer exists), a standard formula will be used to determine whether a site is historical.

4. Survey for new populations.
Past survey efforts undertaken by state agencies and other conservation organizations resulted in a dramatic increase in

known populations. It is imperative that this effort continue, especially in those portions of the range where most of the sites are considered to be historical.

4.1 Continue statewide surveys. Searches of suitable habitat will be continued until a comprehensive database of occupied sites is completed.

4.2 Develop a predictive model based on Geographical Information System (GIS) methods to identify new search areas for I. medeoloides. I. medeoloides habitat does not appear to have unique characteristics that make it easily identifiable. Predictive models will be developed to enable the identification of potential habitat and facilitate survey efforts of de novo sites. The use of a GIS will be emphasized since much of the information on these habitat parameters is available in digitized format.

4.21 Assess known habitat characteristics. In order to develop a predictive model, small whorled pogonia habitat characteristics need to be identified.

4.22 Determine those parameters most representative of preferred habitat. Once Task 4.21 is completed, those environmental factors that are most critical to small whorled pogonia populations need to be quantified.

4.23 Develop predictive models for all three centers of geographical distribution. Because there appear to be three distinct geographical concentrations of I. medeoloides, it is possible there may be different regional habitat parameters. The development of more than one predictive model may be necessary, dependent upon the results of Tasks 4.21 and 4.22.

4.3 Survey areas identified by predictive models for I. medeoloides. When Task 4.2 has been completed, the predictive model will be tested. Areas identified as potential small whorled pogonia habitat by the predictive model will need to be ground-truthed.

5. Investigate population dynamics.

5.1 Conduct detailed, demographic studies of selected sites. Populations of I. medeoloides are composed of four stages of plants: dormant, vegetative, with an abortive bud, and flowering (Mehrhoff 1989a). It appears that the distribution of plants in these stages may determine whether a colony is increasing, decreasing, or stable. Mortality, dormancy, recruitment, and sequence in appearance in vegetative, flowering, and arrested plants will be followed throughout a number of populations. Previously initiated studies of this type (for which data is already available for a series of years) will be continued and the data analyzed.

5.2 Determine population colonization of unoccupied habitat in order to identify appropriate buffers. The upland habitat of the small whorled pogonia often appears to be uniform; however, the orchid generally is found in clusters. Appropriate buffers to allow dispersal and colonization need to be determined and incorporated into habitat protection strategies.

5.3 Determine minimum viability of a colony. Incorporating data on the reproductive status of the small whorled pogonia plants, i.e., percent flowering versus non-reproductive, minimum viability of a population will be determined. When this figure has been established, those colonies below minimum viability may need special

management considerations (Task 2.1) to bring them up to minimum viability or higher.

6. Investigate species biology.

The 1985 Recovery Plan for the small whorled pogonia identified the investigation of species biology as a recovery task. To date, some new life history information has been discovered as a result of research. However, much is still unknown about the mechanisms that control growth and reproduction of this species. Limiting factors, management needs, and recovery efforts cannot be addressed without data on species biology.

6.1 Investigate dormancy. A clear understanding of dormancy and how to differentiate it from the death of the plant needs to be in place to determine the health of colonies. Basic questions such as the maximum and minimum lengths of dormancy and potential causes will be investigated. A long-term effort to precisely monitor marked plants will assist in assessing the species' dormancy in different parts of its range. The possibility of an extended subterranean juvenile stage before seedlings become photosynthetic should also be examined (USFWS 1985).

6.2 Investigate reproductive strategies. Reproductive strategies of I. medeoloides are still relatively unknown. Seed banking, flower and seed development, pollination, seed production, seed germination strategies, and vegetative reproduction are all components of the small whorled pogonia's reproduction that should be studied in order to develop the most suitable habitat management plans for individual sites.

6.3 Determine mycorrhizal interaction and function. It is not known whether this could be a limiting factor in the

small whorled pogonia's habitat. Studies are needed to determine the association of mycorrhizal fungi with I. medeoloides, its degree of specificity, and role in the species life cycle.

6.4 Investigate genetic variability of populations within the three geographic centers and the outlying sites. Historically, the distribution of I. medeoloides may have been more uniform, with the exception of the western outliers. Electrophoretic analyses to determine whether there are genetic distinctions between the three geographic centers of concentration and the outliers may be warranted. Differences in the genetic composition of populations may influence site protection priorities (Task 1.22).

7. Provide public information and education.
Public support of recovery efforts for I. medeoloides plays a significant role in encouraging landowner assistance and raising awareness of activities on behalf of the species. Outreach opportunities for educating the general public about the species will be identified, and appropriate informational materials will be developed. Outreach and education efforts will take care to avoid identifying specific locations of populations in order to protect sites from vandalism.

7.1 Update and reprint brochure on I. medeoloides. The current small whorled pogonia brochure will be updated to include new life history and distribution information. Many schools, conservation organizations, and private individuals request general information on this orchid; to date, there are no more available brochures or fact sheets.

7.2 Develop educational materials for distribution in schools. Increasingly, school curricula include

sections on endangered species. Information and activities focusing on rare plants, including the small whorled pogonia, should be developed and distributed to accompany these curricula.

7.3 Contact and provide information to conservation commissions or other pertinent municipal agencies in areas of known I. medeoloides populations. The general caution in publicizing I. medeoloides sites often means that municipal agencies are unaware of the presence of the orchid in their towns. It is important that appropriate municipal agencies are informed about the small whorled pogonia so that they (1) take the small whorled pogonia and its habitat into consideration in town management or zoning plans, and (2) become interested and supportive in protecting occupied habitat.

7.4 Create displays for use at information centers of National Parks, National Forests, and military bases in those areas with I. medeoloides populations. Many of the populations are on Federal lands, providing an ideal opportunity for exposing the general public to the species and its history (i.e., decline, management, and recovery efforts). The purpose for this aspect of outreach is to inform the public about the rarity of this plant and its needs, not necessarily to encourage seeking it out. Furthermore, through efforts to inform the public about this one species, the importance of the need to protect endangered species, in particular, plants, may be more braodly emphasized.

8. Review recovery progress and update or revise plan as necessary.

Progress towards recovery will be reviewed on an annual basis, and this plan will be updated and revised as needed.

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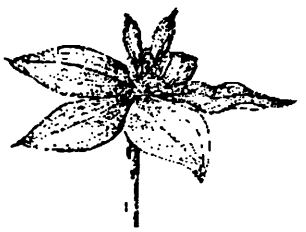
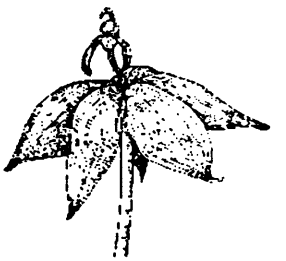


PART III: IMPLEMENTATION



The Implementation Schedule lists and ranks tasks that should be undertaken within the next three years in order to implement recovery of the small whorled pogonia. This schedule will be reviewed annually until the recovery objective is met, and priorities and tasks will be subject to revision. Tasks are presented in order of priority.

Key to Implementation Schedule Column 1

Task priorities are set according to the following standards:

Priority 1: Those actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: Those actions that must be taken to prevent a significant decline in species population, or some other significant impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

Key to Agency Designations in Column 5

USFWS = U.S. Fish and Wildlife Service
R5 FWE = Region 5, Division of Fish and Wildlife Enhancement, U.S. Fish and Wildlife Service
R4, R3 = Regions 4 and 3, U.S. Fish and Wildlife Service
FA = Other Federal agencies
SA = State agencies
CO = Conservation organizations
PI = Private research or academic institutions

IMPLEMENTATION SCHEDULE
Small Whorled Pogonia

Revised Plan, October 1992

Priority	Task Description	Task Number	Duration	Responsible Agency		Cost Estimates, $000			Comments
				USFWS	Other	FY1	FY2	FY3	
1	Identify ownership of all known populations.	1.1	3 years	R5 FWE R4	SA, CO	10	5	5	R3 landowner information known.
1	Identify gaps of protected habitat throughout the species' range.	1.21	3 years	R5 FWE	SA, CO	3	3	3	
1	Determine overall priorities for land protection.	1.22	2 years	R5 FWE	SA, CO		2.5	2.5	
1	Coordinate among governmental agencies and conservation organizations in providing permanent protection.	1.31	7 years	R5 FWE R4 FWE	FA, SA, CO, PI	7	7	7	+ 7,000/yr for at least 4 more years = $49,000 total
1	Develop and maintain conservation plans for each protected site.	2.2	4 years	R5, R4, R3	SA, CO			20	+ FY 4-6 at 10,000/yr = $30,000 total
1	Continue statewide surveys.	4.1	7 years		SA, CO	15	15	15	+ 15,000/yr for at least 4 more years = $95,000 total
1	Determine minimum viability of a colony.	5.3	1 year		SA, CO			3	
2	Seek support of private landowners in protecting habitat through voluntary agreements.	1.32	7 years		SA, CO, PI	2.5	2.5	2.5	+ 2,500/yr for at least 4 more years = $17,500 total
2	Use existing regulatory mechanisms to protect *I. medeoloides* habitat.	1.4	Ongoing	R5 FWE, R4 FWE, R3 FWE	FA, SA				No funding
2	Investigate effects of manipulation of light levels on *I. medeoloides*.	2.11	3 years		SA, PI		5	5	+5,000 for FY 4 = $15,000 total
2	Develop rangewide consistency in monitoring strategies.	3.1	1 year	R5	SA, CO		2		

Small Whorled Pogonia Implementation Schedule, continued, October 1992

Priority	Task Description	Task Number	Duration	Responsible Agency		Cost Estimates, $000			Comments
				USFWS	Other	FY1	FY2	FY3	
2	Create displays for use at visitor information centers.	7.4	2 years	R5, R4	FA, SA		3	3	
3	Encourage the development of comprehensive State plant protection legislation.	1.5	Ongoing		SA, PI				No funding
3	Determine researcher/visitor impacts on populations.	2.12	2 years		SA, CO				FY 4-5 at 2,000/yr = $4,000 total
3	Identify herbivore impacts.	2.13	2 years		SA, CO				
3	Investigate reproductive strategies.	6.2	3 years		SA, PI		5	5	+ 5,000 in FY 4 = $15,000 total
3	Determine mycorrhizal interaction and function.	6.3	2 years		PI				
3	Investigate genetic variability of populations within the three geographic centers and the outlying sites.	6.4	2 years		PI				
3	Develop educational materials for distribution in schools.	7.2	1 year	R5, R4	SA, CO			10	
3	Review recovery progress and update plan as necessary.	8	Ongoing	R5					

Samll Whorled Pogonia Implementation, continued, October 1992

Priority	Task Description	Task Number	Duration	Responsible Agency		Cost Estimates, $000			Comments
				USFWS	Other	FY1	FY2	FY3	
2	Monitor known sites and new sites as they are found.	3.2	10 years	R5, R4, R3	SA, CO	5	5	5	+ 5,000 for FY 4-10 = $50,000 total
2	Determine when a population is to be considered historical.	3.3	1 year		SA, CO				
2	Assess known habitat characteristics.	4.21	2 years	R5	SA, PI	5	5		
2	Determine those parameters most representative of preferred habitat.	4.22	2 years	R5	SA, PI	2.5	2.5		
2	Develop predictive models for all three centers of geographical distribution.	4.23	2 years	R5, R4	SA, PI		2.5	5	
2	Survey areas identified by predictive models.	4.3	2 years	R5, R4	SA, CO, PI				FY 4-5 at 7,000/yr = $14,000 total
2	Continue detailed demographic studies of selected sites.	5.1	3 years	R5, R4	SA, CO, PI	7.5	7.5	7.5	
2	Determine colonization of unoccupied habitat in order to identify appropriate buffers.	5.2	3 years	R5, R4	SA, CO, PI			10	+ FY 4-5 at 5,000/yr = $20,000 total
2	Investigate dormancy.	6.1	5 years		SA, CO, PI	5	5	5	Continuation of ongoing studies. $25,000 total
2	Update brochure on *I. medeoloides*.	7.1	1 year	R5, R4			7		
2	Provide information to pertinent municipal agencies in areas of *I. medeoloides* populations.	7.3	Ongoing	R5, R4, R3	SA, CO				

APPENDIX 1.

AVAILABLE REGULATORY AUTHORITIES

FEDERAL AUTHORITIES

Endangered Species Act of 1973
(87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.)

Prohibits import and export; removal, damage and possession of listed species from lands under Federal jurisdiction; removal, damage, etc. in violation of any state law or regulation; transport in course of commercial activity; or sale of the species. Requires Federal agencies to ensure that their actions do not jeopardize the continued existence of listed species or result in adverse modification of critical habitat. Requires consultation with the U.S. Fish and Wildlife Service when an activity may affect listed species or critical habitat. Directs Federal agencies to utilize their authorities in furtherance of the purposes of the Act by carrying out conservation and recovery activities for listed species.

Regulations Protecting Proposed, Listed Endangered or Threatened Species on National Forests

Isotria medeoloides is protected under FSM 2670.44 R-8 supp 37. Since this species is Federally listed endangered, it qualifies as a Forest Service PET species, and as such should receive a level of protection that will lead to identification of possible recovery opportunities and ensure that no adverse effects occur.

STATE AUTHORITIES

Connecticut
(Chapter 495 Sec. 26-303 through 26-314)

Protects State listed species from take on state-owned land. In addition, activities that are state funded, authorized, or performed may not threaten the continued existence of State or Federally listed plants. Allows for acquisition of essential habitat.

Georgia Wildflower Preservation Act of 1973
(43:43-1801 to 43-1806)

Prohibits taking of State listed plants from public lands without permit from the Georgia Department of Natural Resources. Prohibits sale and transport of listed species without landowner's written permission.

Illinois Endangered Species Protection Act
(Section 331-341 of Illinois Revised Statutes)

Protects State listed species from take on private lands without landowner permission.

Maryland Nongame and Endangered Species Conservation Act
(Natural Resources Article §10-2A-01 through 10-2A-09)

Prohibits taking from private land without written landowner permission, taking without a permit from State land, and prohibits trade and possession of listed species. Provides for development of programs for the conservation of listed species.

Massachusetts Endangered Species Act
(Chapter 131A)

Although regulations have not been promulgated at this time, this Act protects listed species from take, unless a permit has been issued by the Director of the Division of Fisheries and Wildlife. Additional protection may be afforded if significant habitat is designated. Under State law, there may be no alteration of significant habitat.

Michigan Endangered Species Act of 1974
(Public Act 203 as amended, Section 6)

This act protects State endangered and threatened taxa on both private and public lands. In addition, other State laws indirectly protect State listed species. For example, species within or near wetlands are indirectly regulated through the wetland permitting process, and in fact the permitting process for wetlands does consider the proximity of natural features and potential detriment. Thus, if Isotria medeoloides occurs within or near a State-regulated wetland, it may receive protection through other than the State endangered species act.

New Hampshire Plant Protection Act
(SB 152-FN, Chapter 217-A)

Prohibits the taking of listed species from private and State property without permission of the landowner.

New Jersey Endangered Plant Species List Act
(N.J.S.A. 13:1B-15.151 to 13:1B-15.158)

Establishes a list of endangered plant species to be utilized by the State's regulatory agencies.

New York State Environmental Conservation Law
(Section 9-1503, Reg 6NY CRR Part 193.3)

New York State law protects State and Federally listed plants. Listed plant species are protected from take or destruction without the permission of the landowner.

North Carolina Plant Protection and Conservation Act
(General Statute 19B (202.12-202.19)

Protects listed species by prohibiting taking without written landowner permission, intrastate trade (without a permit), and provides management and monitoring activities.

Ohio Endangered Plant Law
(Ohio Revised Code Chapter 1518:18)

Take of Ohio State listed plants for commercial purposes is prohibited. Take, possession, or transport for botanical, educational, or scientific purposes, or for propagation in captivity to preserve the species is prohibited without first obtaining a State permit, unless a Federal permit has already been issued for Federally listed species. Nothing prohibits take on private lands by the landowner or with landowner permission.

Pennsylvania Wild Resources Conservation Act
(25 Pa. Code, Chapter 82).

Permits are required to collect, remove, or transplant wild plants classified as threatened or endangered, though landowners are exempt from these requirements. Also provides for the establishment of native wild plant sanctuaries on private lands where there is a management agreement between the landowner and the State Department of Environmental Resources.

Rhode Island General Laws, 1956 for the Preservation and Conservation of Wild Plants
(Title 20 -37-3)

Prohibits commercial traffic in State or Federally listed plants.

South Carolina legal protection

All plants on South Carolina heritage preserves have legal protection.

Tennessee Rare Plant Protection and Conservation Act of 1985
(Chapter 242, Section 1)

Prohibits sale and taking (include destruction and removal) of State listed plants. Take on private lands with landowner permission is allowed. Nurserymen can purchase up to ten plants for commercial propagation purposes from landowners.

Vermont Endangered Species Law
(10 V.S.A. Chapter 123)

Affords protection to listed species from taking, possession or transport by any person, unless exempted, or authorized by certificate or permit. Permits could be granted for scientific purposes, enhancement of survival of the species, economic hardship, educational purposes or special purposes consistent with the purposes of the Federal Endangered Species Act. However, take is allowed for agricultural or silvicultural activities since no permit is required.

Endangered Plant And Insect Species Act of Virginia
(1979, c. 372).

Prohibits taking without permits, except by private landowners. Also gives the Department of Agriculture and Consumer Services the authority to regulate the sale and movement of listed plants and to establish programs for the management of listed plants.

APPENDIX 2.

LIST OF REVIEWERS AND SUMMARY OF COMMENTS

Comments and suggestions received during the recovery planning process were reviewed and incorporated to the extent appropriate into this document. Agencies, organizations, and individuals who participated in the review of the draft revised recovery plan are listed below.

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SUMMARY OF COMMENTS

Most of the comments received were specific corrections that were incorporated into the document. In addition, three substantial comments were made during review of the draft recovery plan. Following are summaries of these comments with the Service's responses.

COMMENT 1. Two reviewers questioned the number of stems that define the minimum viable population of small whorled pogonia (page , Part II). Both reviewers felt that in New England, the minimum viable population should be greater than an average of 20 stems.

RESPONSE The Service chooses to retain the geometric mean over three years of 20 stems, with an average 25 percent flowering as the definition of a minimum viable population for **reclassification to threatened** for the small whorled pogonia. Currently, there are no available data indicating that minimum viability will change throughout the range of the small whorled pogonia. That is to say, that populations of an average of 20 stems with 25 percent flowering in Virginia are viable, while populations of the same size and reproductive status would not be considered viable in New Hampshire.

One reviewer provided data for a single New Hampshire population that fluctuated in stem counts from one to 34 over a 27 year period; however, the reproductive status of this population was not documented. A population with a three-year geometric mean of 20 stems that did not have a minimum average of 25 percent flowering stems over that same time period would not be considered viable. Since the data provided was from only one of thirty populations in New Hampshire, more populations counts indicating severe fluctuations **with** the accompanying reproductive status of these populations will be necessary before the Service can reconsider the definition of minimum viability. The Service believes that the two-pronged definition of average stems and reproductive status (or persistence) should sufficiently identify those populations considered to be minimally viable for purposes of reclassification.

The recovery objectives are subject to modification based on information gathered during the completion of the recovery tasks. As more populations are followed through time, and the reproductive status is documented, the minimum viable population may be reconsidered if information indicates that it is necessary to do so.

In addition, one reviewer felt that habitat protection of those populations with greater than an average of 20 stems should be emphasized, and that efforts to protect populations barely meeting the current definition might be misguided. The condition for habitat protection of 25 percent of known viable sites is further clarified under Task 1.2. Those areas in need of protection will be identified and prioritized if possible. Priority will be determined based on the significance of the site with respect to its population size (with a higher priority given to those populations of greater viability), the potential for recoverability, and its distribution.

COMMENT 2. One reviewer disagreed with the recovery objective of a minimum of 25 percent of known viable sites (based on 1992 population counts) needing protection to satisfy this goal. The reviewer felt that the 25 percent should refer to a total number of known populations at any given time to account for new populations as they are discovered.

RESPONSE The Service believes that the recovery objective stated for reclassification will be sufficient to protect the species from imminent extinction. A finite point (1992 data) was purposely chosen for this species because of the five-fold increase of known populations since listing; 17 extant sites in 1985, 86 extant sites in 1991. The additional population information that has been acquired since 1985 includes historical site verification and the discovery of many new sites.

Without a finite overall population figure, the reclassification recovery objective of 25 percent (a minimum of 22 sites distributed proportionately throughout the range) and the delisting recovery objective of 75 percent (a minimum of 61 sites), could become impossible to attain. As more populations are found, the number of protected sites needed to meet the criteria for recovery would increase, potentially to the point where recovery could not realistically be met. Indeed, as additional populations are discovered, a time lag will occur due to the need to determine minimum viability of these populations.

Furthermore, since the criteria states that protection of sites must occur proportionally throughout the range of the species, discoveries of additional populations that are skewed to one center of concentration might decrease the feasibility of reaching the recovery goal. For example, New England has the majority of populations to date. Should many more populations be discovered only in this region, the potential of reaching the goal of the protection of 25 percent of known viable

populations will either decrease, or be delayed as studies are undertaken to determine the viability of the populations.

COMMENT 3. A number of reviewers corrected the approximate stem count given in the draft recovery plan (duly corrected). In fact, one reviewer felt that more quantitative information about the sizes of the population was necessary, perhaps presented in a graphic format.

RESPONSE A quantitative count of **all** of the known populations has not been possible to date. The approximate stem count given in the recovery plan is based on the best available information submitted by State resource agencies in 1991. A number of populations were not visited, and therefore, the 1991 total stem count may be incomplete. Colony sizes and stem counts fluctuate widely (and wildly) from year to year. To make a quantitative graphic of stem counts for one given year might give an incorrect impression of the status of the species.

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