Small Whorled Pogonia
(Isotria medeoloides)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
New England Field Office
Concord, New Hampshire

Fall 2008

5-YEAR REVIEW

Species reviewed: Small whorled Pogonia (*Isotria medeoloides*)

1.0 GENERAL INFORMATION

1.1 Reviewers 2
1.2 Methodology 2
1.3 Background 3

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment policy 4
2.2 Recovery Criteria 4
2.3 Updated Information and Current Species Status
2.3.1 Biology and habitat 7
2.3.2 Five-Factor Analysis 11
2.4 Synthesis 12

3.0 RESULTS

3.1 Recommended Classification 13
3.2 New Recovery Priority Number 13
3.3 Listing and Reclassification Priority Number 14

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS 14

5.0 REFERENCES 15

Signature Page 18

Appendix 1 19

Appendix 2 22

Table 1. Small whorled pogonia populations by State 9

Figure 1. Small Whorled Pogonia Occurrences 10

5-YEAR REVIEW
Small Whorled Pogonia/*Isotria medeoloides*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Field Office:

New England Field Office, Susanna von Oettingen, 603-223-2541, Susi_vonOettingen@fws.gov

Lead Regional Office:

Region 5 Regional Office, Mary Parkin, 413-253-8617, Mary_Parkin@fws.gov

Cooperating Field Offices:

Region5

Chesapeake Bay Field Office, Andy Moser, 410-573-4537, Andy_Moser@fws.gov
Maine Field Office, Mark McCollough, 207-827-5938, Mark_McCollough@fws.gov
New Jersey Field Office, Wendy Walsh, 609-646-9310, Wendy_Walsh@fws.gov
Pennsylvania Field Office, Robert Anderson, 814-234-4090, Robert_M_Anderson@fws.gov
Virginia Field Office, Kimberly Smith, 804-693-6694, Kimberly_Smith@fws.gov;
West Virginia Field Office, Barbara Douglas, 304-636-6586, Barbara_Douglas@fws.gov

Region 3

Reynoldsburg Field Office, Sarena Selbo, 614-469-6923, Sarena_Selbo@fws.gov

Region 4

Asheville Field Office, Carolyn Wells, 828-258-3939, Carolyn_Wells@fws.gov

Cooperating Regional Offices:

Region 3 Regional Office, Carlita Payne, 612-713-5339, Carlita_Payne@fws.gov
Region 4 Regional Office, Kelly Bibb, 404-679-7132, Kelly_Bibb@fws.gov

1.2 Methods Used to Complete the Review

The Small Whorled Pogonia 5-Year Review was conducted as an individual effort by Susi von Oettingen, the recovery lead biologist for the small whorled pogonia (SWP). U.S. Fish and Wildlife Service (Service) field offices and Federal and State natural resource agency

personnel responsible for the recovery of this species were contacted for the most current information on occurrences, threats, and recovery activities. Academics, non-governmental organizations, and other biologists conducting research on the SWP were also contacted. In addition to relevant information from the 1992 recovery plan, information provided by State and Service biologists is the principal basis for this review.

1.3 Background

1.3.1 Federal Register Notice (FR) announcing initiation of this review: 72 FR 4018 (January 29, 2007) Notice of Endangered and Threatened Wildlife and Plants; Initiation of a 5-Year Review of 10 Listed Northeastern Species

1.3.2 Listing history:

Original Listing

FR notice: Determination of *Isotria medeoloides* (small whorled pogonia) to be an Endangered Species. 47 FR 39827 39831
Date listed: September 9, 1982
Entity: Species
Classification: Endangered

Revised Listing

FR notice: Final Rule to Reclassify the Plant *Isotria medeoloides* (Small Whorled Pogonia) from Endangered to Threatened. 59 FR 50852 50857
Date listed: October 6, 1994
Entity listed: Species
Classification: Threatened

1.3.3 Associated rulemakings: None

1.3.4 Review history:

The SWP was included in cursory 5-year reviews conducted for all species listed in 1976, 1977, 1981, and 1982 (52 FR 25523), and for all species listed before 1991 (56 FR 56882). Although no other 5-year reviews have been completed for this species, an extensive status and literature review was conducted prior to the reclassification of the SWP from endangered to threatened in 1994.

1.3.5 Species' Recovery Priority Number at start of 5-year review:

The recovery priority number for the small whorled pogonia is 14, indicative of a species with a low degree of threat and high recovery potential.

1.3.6 Recovery plan:

Name of plan or outline: Small Whorled Pogonia (*Isotria medeoloides*) Recovery Plan, First Revision
Date issued: November 11, 1992
Dates of previous revisions: Small Whorled Pogonia Recovery Plan, 1985.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

No, the species is a plant; therefore the DPS policy is not applicable.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes; however, see below.

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

The recovery criteria are not current. It has been 13 years since the last comprehensive review of this species was completed and 15 years since the recovery criteria were developed. Additional life history information and potential management strategies have been identified that should be reflected in Criterion 2, focusing on protecting 75 percent of the viable (self-sustaining) populations and Criterion 3, describing management to maintain populations (see 2.2.3 below for discussion of these discussion).

2.2.2.2 Are all of the five listing factors relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

Yes, the five listing factors are addressed in the recovery criteria, although the delisting standards for one or more criteria may need revision.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

1992 Recovery Plan Criteria

In order to reclassify the SWP as threatened from endangered, the following criteria must be met:

1) At least 25 percent of the known viable sites are permanently protected and distributed proportionately throughout the species' range,
2) Sites or colonies are shown to be viable using a geometric mean of 20 emergent stems over a 3-year period, and

3) Sites are protected with a sufficient buffer zone around the population.

These criteria were met and as a result, the SWP was downlisted to threatened in 1994.

In order to delist the SWP, the following criteria must be met:

1) At least 61 sites distributed proportionately throughout the species' current range are permanently protected.

Criterion 1 has not been met.
Permanent protection of small whorled pogonia populations through land acquisition and conservation easements has primarily been undertaken in the northeastern portion of the SWP species' range (New Hampshire, Connecticut, Maine, and Ohio). Protection of SWP sites elsewhere in its range is primarily as a result of surveys documenting populations on State and Federal lands. Mechanisms should be developed to ensure long-term protection and management of populations on State and Federal lands.

2) Permanently protected sites represent at least 75 percent of the known viable (self-sustaining) populations, using an average of 20 emergent stems, with 25 percent flowering stems, over a 10-year period.

Criterion 2 has not been met.
There is some debate regarding the viability of a population as defined in the 1992 recovery plan (a geometric mean of 20 emergent stems over a 3-year period, as outlined above), and whether the definition accurately reflects a population's self sustainability. SWP plants may lie dormant for up to 4 years; it is therefore difficult to determine how many plants are actually present and contributing to the local population at a given time. Some populations documented as having 20 or fewer stems appear to persist indefinitely, producing flowers and capsules over a long period of time (Cairns 2005). These populations might not be considered viable under the current definition. A number of small populations are permanently protected; however, some of these may not be

considered viable under the current definition even though they have persisted for many years. These populations are not counted under Criterion 2.

3) Appropriate management programs are established, or sufficient habitat adjacent to existing colonies is protected, to allow for natural colonization.

Criterion 3 has not been met.
Research on appropriate habitat management strategies to maintain SWP population has recently been initiated, chiefly in the northern portion of the range. However, canopy management designed for northern-tier SWP populations may not be applicable to populations located in the warmer, southern portion of the plant's range. The development of effective habitat management strategies for the southern populations must be completed in order to meet this criterion.

This is a wide-ranging species on the brink of recovery that ineffectively competes for limited management resources with other federally-listed plant and animal species, many of which are narrow-ranging endemics or on the brink of extinction. Many recovery efforts in the southern portion of the SWP's range are limited or are conducted by Federal landowners, including the Department of Defense, the U.S. Forest Service and the National Park Service in cooperation with State agencies or the Service.

To date, natural colonization by SWP into habitat adjacent to existing populations has not been documented. Canopy manipulation experiments that resulted in an increased number of stems within a population have not documented population expansion into adjacent habitat. Since the microhabitat characteristics are unknown (e.g., potential dependence upon or associated with ectomicorrhyzal fungi), it is unknown whether protecting adjacent habitat will actually provide habitat for SWP colonization. This criterion should be reviewed.

Recent recovery activities include the development and implementation of a standardized small whorled pogonia monitoring program by the North Carolina Plant Conservation Program (C. Wells, USFWS, pers. comm. 2007) and the discovery of new populations in North Carolina, Virginia, South Carolina, and Georgia through periodic plant surveys (see section 2.3.1.2 for further detail on new pops). Population monitoring and habitat management investigations are ongoing in New Hampshire, Maine, Connecticut, and Massachusetts, where the bulk of the large populations are known to occur. Small, outlying populations in Ohio (S. Selbo, USFWS, pers. comm. 2007), West Virginia (P.J. Harmon, WVDNR, pers. comm. 2007), and Ontario, Canada (McConnell 2006) have also been the focus of monitoring and conservation efforts. Habitat management work, including light manipulation to increase viability in Ohio, was conducted in the winters of 2006 and 2007; effects of this management, however, are inconclusive at this time (C. Payne, in litt. 2008).

2.3 Updated Information and Current Species Status

2.3.1 Biology and habitat:

2.3.1.1 New information on the species' biology and life history:

Since the species was downlisted in 1994, there has been limited research on the reproductive biology and habitat of the species. Vitt and Campbell (1997) determined that SWP was primarily self-compatible and self-pollinating and concluded that reproduction may be limited by resources rather than pollen availability. Reproductive output appears to be closely correlated to plant size.

Sperduto and Congalton (1996) developed a predictive SWP habitat model for New Hampshire and Maine using a geographic information system (GIS). General habitat characteristics positively associated with small whorled pogonia sites included: Soils with a pan layer, slopes between 11 and 17 percent gradient, and forest reflectance greater than 68 for the NIR band (Band 4) of Landsat TM data (Sperduto and Congalton 1996). Nine new sites in New Hampshire and Maine were discovered as a result of field testing the model.

Dibble et al. (in preparation) found evidence of a decline in four populations in Maine but did not identify any clear correlations with respect to weather or changes in the habitat. Based on the high variability of annual population counts, the authors proposed that the 1994 recovery plan's definition of a viable population might not be accurate. The authors suggest that a better parameter for viability would be the number of capsules produced, rather than the number of flowering stems.

Ongoing research
A long-term demographic study of a large population of SWP in New Hampshire is ongoing (Brumback 2004, Brumback 2007). Preliminary analyses of the demographic data are expected this year.

Currently, the National Park Service is funding the Smithsonian Environmental Research Center to identify the ectomicorrhyzal fungi needed for successful SWP germination. Previous research was unable to isolate and identify the host fungus from in situ plants.

Recent research has focused on the effects of habitat manipulation, in particular increasing light levels, to enhance SWP populations (Brumback 2005, Cairns 2006). Anecdotal evidence as well as experimental manipulations within populations (Brumback 2007, Cairns and Herrmann 2005, Cairns 2006) in New Hampshire indicates that increasing the level of light reaching the forest floor through understory and overstory canopy removal *may* increase the number of plant stems, flowers and capsules and may affect plant vigor. However, these

data are preliminary and are based on observations over a limited time period. Cairns (2006) states that natural variation found in SWP populations, the effects of weather, seed banking, and age structure of the experimental population are unknown and may have a greater effect on the number of stems emerging annually than habitat management. Cairns (2006) developed recommendations for data collection methodology for research on SWP habitat management (see Appendix 1). This methodology is being implemented at some sites in New Hampshire.

2.3.1.2 Abundance, population trends, demographic features, and/or demographic trends:

A number of additional populations of the SWP have been found in New Hampshire, Virginia, West Virginia, North Carolina, and Georgia within the three geographic units identified in the 1992 recovery plan (see page 8 of the plan). The majority of the populations in North Carolina, South Carolina, West Virginia, Tennessee, and Georgia generally have less than 20 stems. The largest populations (> 100 stems) are found in New Hampshire. Overall, most SWP populations are small, ranging from 1 to 20 stems, and are not considered viable (see discussion under section 2.2.3).

Few SWP populations are monitored annually, and some populations may only be visited once every 5 to 10 years. Thus, it is difficult to assess population viability or whether a small population is extant, since plants lie dormant for up to 4 years. Populations that are regularly monitored appear to be stable, although the number of plants may vary widely depending upon habitat conditions. Cairns (2007) developed recommendations for consistently monitoring SWP populations based on 10 years of monitoring SWP in New Hampshire (Appendix 2). These recommendations are being implemented in New Hampshire and are attached as Appendix 2.

There is little information documenting populations that were extirpated due to habitat destruction. For example, of the 59 sites in New Hampshire, only one is known to have been extirpated by a residential development since the species was listed, although others are known or suspected of being at risk (S. Cairns, New Hampshire Natural Heritage Bureau, pers. comm. 2007). One site in Pennsylvania may have been lost during construction of a garage (on private property); however, the population's status is unknown because the landowner has restricted access to the site.

Table 1 provides a rough indication of the number of populations and their status by State since 1985 (E = Extant; X = Historic, Extirpated, or Unknown). Extant sites are those where plants have been observed within the past 10 years. It should be noted that many of these observations may be based on only one or two visits within this time frame, and the viability of the site may be uncertain.

Additionally, States often use different criteria for determining whether a SWP population is extirpated, historic, or of unknown status.

Table 1. Small whorled pogonia populations by State.

State	No. Sites 1985		No. Sites 1991		No. Sites 1996		No. Sites 2007	
	E	X	E	X	E	X	E	X
Maine	2	2	16	3	21	1	18	10
New Hampshire	16	7	30	7	40	9	49	10
Vermont		1		1		1		1
Massachusetts	1	1	5	2	5	2	5	2
Rhode Island	1	1	1	1	2	1	2	1
Connecticut	1	8	1	7	1	7	2	7
New York		6		6		6		6
Pennsylvania	1	7	3	6	3	6	3	6
New Jersey	2	8	3	8	3	8	3	8
Delaware			1		1		1	
Maryland		2		3-5		3-5		3-5
Washington D.C.		2		2		2		2
Virginia	2	4	9	3	24	5	33	19
West Virginia					2		2	
North Carolina	3	1	5	2	8	2	7	8
South Carolina	1		5	1	5	1	3	3
Georgia	1	1	7	2	17	2	19	2
Tennessee			1		2		2	
Ohio				1		1	1	
Michigan	1		1		1			1
Illinois	1		1		1			1
Missouri		1		1		1		1
Canada	1		1		1			1
Range Total	**33**	**53**	**90**	**57+/-**	**136**	**56+/-**	**150**	**90+/-**

2.3.1.3 Genetics, genetic variation, or trends in genetic variation:

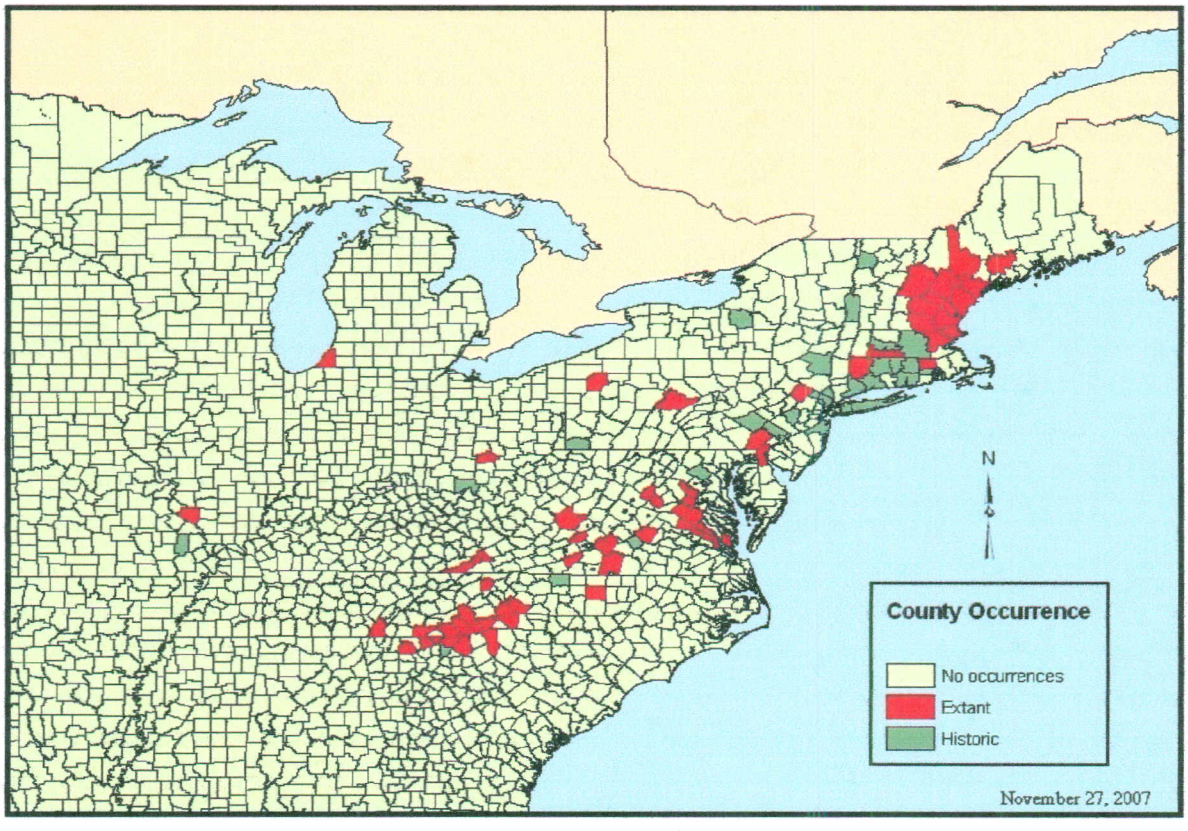
Preliminary genetic analyses of SWP microsatellite markers (Stone 2006, Devlin 2007) indicate that the species is primarily self-pollinating (supporting Vitt and Campbell 1997 and Mehrhof 1983) with a high rate of self-fertilization. New England populations (New Hampshire and Maine) appear to have the most genetic diversity, while southern populations (Virginia and Georgia) appear to be primarily monomorphic (Stone 2006, Devlin 2007). Additional genetic analyses are proposed for future research.

2.3.1.4 Taxonomic classification or changes in nomenclature: Not applicable.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:

There has been no major change in the distribution or range for this species, although new populations found in Virginia and North Carolina may possibly bridge the coastal plain populations to the mountainous region (Figure 1). Additional searches need to be undertaken to verify this connection. The outlying population found in Michigan has not been documented to have emergent stems for over 10 years and the population is considered to be historic (habitat is present but plants have not been located). Missouri's single population is believed to be extirpated.

Figure 1. Small Whorled Pogonia Occurrences



2.3.1.6 Habitat or ecosystem conditions:

No significant change has been documented in the habitat requirements or conditions for this species; however, it is unknown how global warming may affect SWP populations, particularly in the southern portion of the range.

2.3.1.7 Other: None

2.3.2 Five-factor analysis:

2.3.2.1 Factor A. Present or threatened destruction, modification or curtailment of its habitat or range:

Conversion of forested SWP habitat into roads and/or residential development continues to be the primary threat to this species, as described in the 1992 recovery plan (USFWS 1992), the 1994 reclassification rule (59 FR 50852), and a 2007 biological opinion (USFWS 2007). Individual sites may be degraded or eliminated as a result of development within or adjacent to its habitat. Recently, most sites known to have been directly affected by development have occurred in Virginia (USFWS 2007). For further detail, refer to the discussion on delisting criteria in section 2.2.3 of this review.

2.3.2.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes: Not applicable.

2.3.2.3 Factor C. Disease or predation:

Ware (1999) identified a disease presumed to be of fungal origin in a population in Virginia in 1985 and 1986. No other diseases have been documented at SWP populations. Herbivory continues to be documented for numerous populations throughout this species' range, in particular by deer and rabbits. As the rural, forested SWP habitats are converted into developments and deer and rabbit populations increase due to hunting restrictions, increased herbivory on SWP may be anticipated. Smaller SWP populations may be particularly vulnerable to herbivory. A few populations in Virginia and North Carolina are protected by wire fencing around clustered SWPs to prevent deer browse (C. Ulrey, National Park Service, pers. comm. 2007). Ohio's population is fenced for herbivore protection (deer) as well (C. Payne, in litt. 2008). Other herbivores include non-native slugs, camel crickets, leaf rollers (Ware 1999), and possibly feral hogs in the mountains of North Carolina.

2.3.2.4 Factor D. Inadequacy of existing regulatory mechanisms:

Populations found primarily on private lands occur in North Carolina, Virginia, New Jersey, Connecticut, New Hampshire, and Maine, as well as the outlying States. Residential or commercial development of these populations often does not require Federal permits or consultation under section 7 of the Endangered Species Act (ESA). Although the SWP is State-listed as endangered in every State within its range, State listing rarely if ever provides regulatory protection, albeit project review for State-listed species may be required. Recommendations provided by State agencies to avoid or minimize adverse effects are generally not mandatory. The SWP is listed as endangered under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Species at Risk Act

(SARA, Section 37); however, this designation does not afford regulatory protection. The SARA only requires the preparation of recovery strategies for listed species (McConnell 2006).

Populations occurring on Federal lands (the majority of which occur in North Carolina, South Carolina, Georgia, and Tennessee) may benefit from section 7(a)(1) of the ESA and may require consultation under section 7(a)(2) if the federal agency proposes an action that may affect the species.

2.3.2.5 Factor E. Other factors affecting its continued existence:

Historically, poaching SWP plants was documented as a threat to the species (USFWS 1992). Limited illegal plant collecting on Federal lands continues to be documented (C. Ulrey, pers. comm. 2007). No other observations of illicit collecting have been reported recently.

2.4 Synthesis

The number of known, extant populations of SWP has increased five-fold since the species was listed. Most of the new sites documented within the last 10 years have been found in the southern tier of the species' range. Many of these new sites are small, having fewer than 20 stems. The majority of newly known southern sites are on Federal land, a result of increased survey efforts by the National Park Service and the National Forest Service.

Populations in the Northeast are monitored on an annual, systematic basis; however, populations in Connecticut, New Jersey, South Carolina, and Georgia (where the bulk of the southern populations occur) are monitored less frequently. Recent life history studies confirmed that an individual plant may remain dormant for at least 4 years. Plant dormancy confounds a determination of population viability when monitoring does not occur on a regular basis. The viability of small populations is particularly difficult to ascertain when individual stems are not marked and monitored annually to determine whether plants are dormant or dead.

Since listing, several small whorled pogonia populations in New Hampshire, Connecticut, Maine, and Ohio have been permanently protected through land acquisition and conservation easements; however, few populations on private land have been permanently protected since the species was downlisted to threatened in 1994. Populations in Tennessee and Georgia may be considered to be protected from development since they occur on Federal lands. It has not been verified that merely providing buffer habitat for populations to colonize as existing habitat changes through succession is adequate to maintain viable populations. Habitat management experiments in the northeast portion of the SWP range may maintain population viability, but the long-term beneficial effects have not been confirmed. Similar habitat management experiments have not been implemented in the southern portion of the species' range (Virginia, West Virginia, North Carolina, South Carolina, Tennessee, and Georgia), and it is unknown if habitat management in these States will benefit and help maintain smaller, more vulnerable populations. The George Washington Jefferson National Forest and Pisgah National Forests, as well as the Blue Ridge Parkway, have each implemented habitat manipulations for this species. The results

of these manipulations are inconclusive at this time, with some of these efforts (on the Pisgah National Forest) having only been initiated in spring of 2007 (C. Wells, pers. comm. 2007).

The SWP should remain listed as threatened across its entire range. The criteria for delisting have not been met, and threats to the species have not been abated to an extent that eliminates the likelihood that the species could again become endangered across all or a significant portion of its range in the foreseeable future. With regard to the delisting criteria, most of the known sites currently fail to meet the minimum measure of viability (a geometric mean of 20 or more stems over 3 or more years), the goal of permanent protection of 75 percent of the viable populations has not been met, and habitat management strategies to maintain viable populations have neither been confirmed for northern populations nor developed for southern populations. Without significant recovery activities targeted at southern populations, it is unlikely the species can be delisted in the near future, especially considering the uncertainty about the long-term viability of many of these populations.

3.0 RESULTS

3.1 Recommended Classification

Retain as Threatened. No change is needed.

Rationale: Although numerous additional populations of SWP have been found since the time of listing, particularly in the southern portion of the range, many of the known populations cannot be considered viable according to current criteria. Further, threats to the species, in particular habitat loss and degradation, have not been sufficiently abated to warrant delisting. Finally, uncertainties about the demographic status of most SWP populations and about the potential effects of habitat management should be resolved prior to delisting. Because the demographic status of and the threats to the SWP are generally consistent through the species' range, there is no significant portion of the range that warrants either listing as endangered or delisting.

3.2 New Recovery Priority Number

Retain as 14. No change is needed.

Rationale: Due to the number of extant populations and the fact that many of these populations occur on Federal lands, extinction risks are considered to be low. The potential for recovery is presumed to be high, although more resources need to be dedicated to resolving data gaps and assessing the conservation potential for populations on private lands. Although risks posed by land development are recognized as the primary threat to the species, these activities are diffuse across the species' range and do not, therefore, constitute an acute threat to SWP survival and recovery.

3.3 Listing and Reclassification Priority Number: not applicable

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Future actions required to proceed with the recovery of this species center on assessing the true population trend and determining management strategies that can be implemented rangewide.

- In order to assess the rangewide population trend of this species, a significant portion of the populations should be surveyed within the same time frame. This could be accomplished over a 2 to 3-year period. Climatological data, stem counts, habitat condition, and ownership data should be collected.

- Geographically appropriate habitat models similar to the New England models (Sperduto and Congalton 1996) should be developed and applied to targeted surveys to search for new populations.

- The proposed monitoring protocol developed by Cairns (Appendix 2) should be reviewed and refined as necessary in order to implement a consistent methodology throughout the SWP range.

- The definition of population viability should be re-assessed in order to determine whether the recovery criterion 3 is still valid.

- The recovery plan should be revised.

- Standard means of describing existing and desired canopy conditions should be devised and distributed to those working with the species, so that results can be compared across sites throughout the range.

- Standard canopy management methodology should be determined and implemented at a select number of locations throughout the species' range in order to determine population response in relation to geographic location.

- Periodic rangewide recovery conference calls and/or meetings should be conducted to ensure dissemination of information.

- Genetics investigation between and among populations should be continued in order to determine the relatedness of the Coastal Plain and Blue Ridge Mountain populations of Virginia, North Carolina, South Carolina, Tennessee, and Georgia.

- The ectomiccorhyzal fungus associated with SWP should be determined in order to conduct captive propagation experiments.

- Seed banking should be investigated.

REFERENCES

Brumback, W. and Fyler, C. 2004. Monitoring and habitat management of *Isotria medeoloides* at E. Alton, New Hampshire: 2003. Report in completion of Agreement No. 50181-0-J054 for the U.S. Fish and Wildlife Service, New England Field Office, Concord, New Hampshire. 8 pp. and tables.

Brumback, W. and Fyler, C. 2005. Response of *I. medeoloides* to experimental canopy management (1997-2004). Report in completion of Agreement No. 50181-0-J054 Modification No. 04 for the U.S. Fish and Wildlife Service, New England Field Office, Concord, New Hampshire. 5 pp.

Brumback, W., Fyler, C., and Korecki, J. 2007. Monitoring and habitat management of *Isotria medeoloides* at E. Alton, New Hampshire: 2006. Report in completion of Agreement No. 53410-5-0621 for the U.S. Fish and Wildlife Service, New England Field Office, Concord, New Hampshire. 5 pp. and tables.

Cairns, S. 2006. 2006 *Isotria medeoloides* recovery activities in New Hampshire. Report submitted to the U.S. Fish and Wildlife Service, Hadley, Massachusetts, by the New Hampshire Natural Heritage Bureau. 14 pp. and appendices.

Cairns, S. and Herrmann, H. 2005. 2005 *Isotria medeoloides* recovery activities in New Hampshire. Report submitted to the U.S. Fish and Wildlife Service, Hadley, Massachusetts, by the New Hampshire Natural Heritage Bureau. 9 pp. and appendices.

COSEWIC. 2000. Update COSEWIC status report on the Small Whorled Pogonia (*Isotria medeoloides* in Canada, 1998 by David J. White *in* COSEWIC assessment and update status report on the Small Whorled Pogonia *Isotria medeoloides* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, Canada. vi + 6pp.

Devlin, E. 2007. Geographic distribution of genetic variation in the rare orchid *Isotria medeoloides*. Student thesis. Colby College, Waterville, Maine. 35 pp.

Dibble, A.C., Wright, W.A., Gawler, S.C., Vitt, P., and Campbell, C.S. *In preparation.* Decline of a woodland orchid: Demography of Isotria medeoloides over fifteen years in Maine, USA. 28 pp.

McConnell, A. 2006. Recovery Strategy for the Small Whorled Pogonia (*Isotria medeoloides*) in Canada [Proposed]. www.sararegistry.gc.ca. 13 pp.

Mehrhoff, L.A. 1983. Pollination in the genus Isotria (Orchidaceae). Amer. J. Bot. 70: 1444-1453.

Michigan Natural Features Inventory. 2007. Rare Species Explorer (Web Application). Available online at http://web4.msue.msu.edu/mnfi/explorer [Accessed Sep 7, 2007].

Sperduto, M. B. and Congalton, R. G. 1996. Predicting rare orchid (Small Whorled Pogonia) habitat using GIS. Photogrammetric Engineering & Remote Sensing. Vol. 62, No. 11, November 1996, 1269-1279.

Stone, J.L. 2006. AFLP fingerprints of the rare orchid *Isotria medeoloides* suggest little genetic variation within or among populations. *in* Section 2: Summary Small Whorled Pogonia Work (E – 2 – 19), Maine Natural Areas Program report to the U.S. Fish and Wildlife Service, Hadley, Massachusetts. 5 pp.

USFWS. 1992. Small whorled pogonia (*Isotria medeoloides*) recovery plan, first revision. Newton Corner, Massachusetts. 75 pp.

USFWS. 2007. Biological Opinion for New Town Development, Sections 7, 8, and 9, Project Number 05-V2948, James City County. Ecological Services' Virginia Field Office, Gloucester, Virginia. 17 pp.

Vitt P. and Campbell, C.S. 1997. Reproductive biology of *Isotria medeoloides* (Orchidaceae). Rhodora. Vol. 99, No. 897. 56-63.

Ware, D.M.E. 1999. A recovery plan for the small whorled pogonia at Fort A.P. Hill. Unpublished report. 105 pp.

Principal Non-FWS Contacts – Provided Information

David Boyd
Conservation Lands GIS Planner
VA-DCR, Division of Natural Heritage
217 Governor Street
Richmond, Virginia 23219
david.boyd@dcr.virginia.gov

William Brumback
New England Wild Flower Society
Garden in the Woods
Hemenway Road
Framingham, Massachusetts 01701
BBrumback@newfs.org

Sara Cairns
New Hampshire Natural Heritage Bureau
DRED Division of Forest and Lands
P.O. Box 1856
172 Pembroke Road
Concord, New Hampshire 03302
S_Cairns@dred.state.nh.us

Paul. J. Harmon
WV Division of Natural Resources
Wildlife Resources
P.O. Box 67, Ward Road.
Elkins, West Virginia 26241
pjharmon@wvdnr.gov

Suzanne Mason
Environmental Biologist
North Carolina Natural Heritage Program
1601 Mail Service Center
Raleigh, New Hampshire 27699
Suzanne.mason@ncmail.net

Judy L. Stone
Department of Biology
Colby College
5720 Mayflower Hill Drive
Waterville, Maine 04901
jstone@colby.edu

Chris Ulrey, Ph.D.

Plant Ecologist
National Park Service Blue Ridge Parkway
Branch of Resource Management
199 Hemphill Knob Rd.
Asheville, North Carolina 28803
Chris_Ulrey@nps.gov

Cindy Wentworth
Forest Ecologist/Botanist
Chattahoochee-Oconee National Forest
P.O. Box 9
Blairsville, Georgia 30514
cwentworth@fs.fed.us

U.S. FISH AND WILDLIFE SERVICE FIVE-YEAR REVIEW
Species: Small Whorled Pogonia *(Isotria medeoloides)*

Current Classification: Threatened

Recommendation Resulting from the Five-Year Review: No change

Review Conducted by: Susi von Oettingen, New England Field Office

FIELD OFFICE APPROVAL:

New England Field Office Supervisor, U.S. Fish and Wildlife Service (Actng)

Approve _____ Date 5/23/08

REGIONAL OFFICE APPROVAL:

Regional Director, U.S. Fish and Wildlife Service Region 5

Approve Sherry R. Morgan Date 10/16/08

Acting

REGIONAL CONCURRENCE:

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service Region 3

Signature Lynn M Lewis Date 6/17/08

Regional Director, U.S. Fish and Wildlife Service Region 4

Signature _____ Date 7/23/08

ACTING Assistant Regional Director
Ecological Services

Appendix 1.

Cairns, S. 2006. Data Collection at *Isotria medeoloides* sites, 2005 and 2006 for future canopy management *Isotria* censuses and quantitative characterization of the natural community. New Hampshire Natural Heritage Bureau, Concord, NH.

Our goals were to collect data that will be used to:

1) Plan thinning activities and
2) Perform 'Before vs. After' analyses of the effect of canopy thinning on the *Isotria*.

10 x 10 m cells (*Isotria* counts)

- At each site we laid out a grid of 10 x 10 m cells in areas where *Isotria* were growing. Cell sides were oriented to true north.
- We selected 1-3 "target" cells based on their having a relatively high concentration of *Isotria*.
- When only one cell was set up at a site, its location was selected to center the cell on a cluster of *Isotria* plants.
- 2005 and 2006: Within each 10 x 10 m cell, all *Isotria* stems were located and their reproductive status noted (V = vegetative, C = one seed capsule, C2 = two capsules).
- 2005: each *Isotria* plant was measured for height and leaf whorl diameter.

1 x 1 m plots (herbaceous and low shrub vegetation)

- Within each target 10 x 10 m cell, five 1 x 1 m plots were established: One on the inside of each corner, and one in the center. For the center plot, one corner was at the center of the cell, and it was then randomly assigned to either the NW, NE, SW, or SE quadrant.
- 2005 and 2006: Within each 1 x 1 m plot, all herbaceous and low shrub plants were censused (see appendix for details).

20 x 40 m plots (tree dbh)

- For 1-2 of the 10 x 10 m target cells at each site, a 20 x 40 m plot was set up around it as follows: Extend 10 m north of and 20 m south of the cell (40 m total on the north-south axis). Extend 5 m on either side of the cell (20 m east-west).
- This plot was flagged at 5-m intervals (sides and inside), creating eight 10 x 10 sub-plots: 2 north of the target cell, 2 that each cover half of the target cell, and 4 south of the target cell.
- 2006: Censused and flagged all *Isotria* plants within the 20 x 40 m plots, even if outside the 10 x 10 m cell grid: avoid trampling, and relate *Isotria* abundance to tree composition.
- 2006: Recorded sub-plot, species, and dbh for all woody plants 6 feet or higher within each 20 x 40 m plot, including snags. Used a Biltmore stick (dbh tape for largest trees) and rounded to the nearest inch, but including a "< 1 inch" category.

Photographs

Percent cover by the canopy

- Fisheye photographs were taken at the center and each corner of 10 x 10 m target cells in 2005, and the center photographs were re-taken in 2006. Orientation was to magnetic north, height ca. 1 m (same camera, lens, and monopod used both years). Whenever possible, photographs were taken during overcast conditions.

Context photos (methods not standard enough to be easily replicated from year to year)

- Ground cover at each fisheye photo site was recorded by taking a photograph while holding a digital camera directly over the point where the fisheye photo was taken, at eye level, facing directly down (more or less oriented toward the north).
- 2006: A panorama was taken of each target cell within a 20 x 40 m plot, by setting a camera on a monopod at the mid-point of the southern side of the cell and taking a series of photos from due west of that point to due east.
- 2006: A single photograph was taken of each sub-plot within the 20 x 40 m plots from an internal corner, facing toward the diagonal opposite corner.

Vegetation sampling methods for 1 x 1 meter plots

- Flags marking the four corners and center of the 10 x 10 m plot are used to initially orientate the 1 x 1 m plot. The 1 x 1 m plot is then eyeballed to line up with another flag marking the 10 x 10 m plot. Once the 1 x 1 m plot is lined up where you want it, 3" long white toothpick-ish plastic drink stirrers used to mark the final orientation of the 1 x 1 m plot.
    - Alton Bay site: white drink stirrers placed on OUTSIDE corners of frame (except the corner marked by a flag).
    - All other locations: white drink stirrers placed on INSIDE corners of frame (except the corner marked by a flag).
    - Note:
        - No white drink stirrer used when rock, log, tree, etc in the way.
        - On 9/12/05, (second visit to Merrymeeting Lake and only visit to Alton Group Y) other stirrers ran out so black, straw like drink stirrers used (cut in half so about 2" long).

- No walking within the 1 x 1 m plot so stirrers are not broken and plant growth adversely effected.
- Shrub width: maximum horizontal width of shrub.
- Fern counts: by frond (1 frond equals 1 count); if a fern frond is half in or half out then 0.5 count (estimate percentatge of frond in plot).
- T2 and T3 not noted unless the trunk originates in the plot and then just dbh.
- *Diphasiastrum digitatum* (southern ground-cedar): count by branch whorls (2+ whorls above one another count as 1 plant)
- Mosses: estimate cover (inch squared)
- *Maianthemum canadense* (Canada mayflower): 1 leaf equals 1 count.
- For S1-sizedtree species with branches overhanging plot – do not count in anyway.

- *Gaultheria procumbens* (wintergreen): 1 upright stem with 1 to many leaves equals 1 count.
- *Mitchella repens* (partridgeberry): similar to *Gaultheria* (1 upright stem with 1 to many leaves equals 1 count) except if stem clearly running across surface, then 1 horizontal stem with 0-1+ upright stems equals 1 count.
- Shrubs/trees designated seedling equals less than or equal to 2" tall.
- *Clintonia borealis* (blue-bead lily): 1 plant (1 count) can equal 1 to many leaves (all leaves more or less originating from same location).
- Mushrooms: count number in plot per species and give average head diameter.
- Shrubs: estimate height and maximum horizontal width.
- Bryophytes: estimate square inches (for example, a patch 4 x 5" would be 20 square inches).
- *Monotropa uniflora* (Indian pipes): for each plant, count how many above ground stems (1 plant-4 stems; 1 plant-1 stem; 1 plant-5 stems, etc.).

Appendix 2

Isotria inventory methods

Recommendations based on ca. 10 years documenting *Isotria medeoloides* (small whorled pogonia) populations by the NH Natural Heritage Bureau, primarily monitoring known populations.

Goals

Consider in advance what types of data are needed:

1) Distribution in space
2) Population size
3) Population condition (seed capsule production, plant size...)
4) Habitat condition

In general, information must be collected consistently (by different observers, at different locations and densities of plants, at the beginning vs. the end of the day, etc.) to be useful. *Ad hoc* notes (e.g., heavy herbivory on one plant) may help suggest what data should be collected in the future, but won't allow comparisons between locations or different time periods. Think ahead to the time investment needed to record, digitize, and analyze the data.

Finding plants (*de novo* searches).

Suggestions for microhabitat types to focus on:

- Terraces and base-of-slope locations.
- Small openings, fern patches (but be aware that some *Isotria* plants are known to occur under thick conifers and on almost-bare ground under dense canopy).
- Vernal runoff locations (leaf piles).
- Areas with rattlesnake plantain (*Goodyera* sp.).

Be prepared to record (a) what area was searched and (b) where plants are found. GPS tracks & points are best, but what if satellite reception is poor under the canopy? Have a printed topographic map, and make notes on it. Hang a strip of flagging from a tree branch near located plants, and especially if GPS is not working, write down a detailed description of how to relocate the site (compass bearing and distance based on paces to a recognizable landmark, e.g. "From gap in stone wall walk 22 paces (110 ft.) at a 50-degree bearing (magnetic north)).

Two approaches to searching a small to moderately large area *thoroughly* for *Isotria*:

1. Decide on the area to be searched, based on flagging or natural landmarks. Line up two or more people almost close enough to touch fingertips. Walk back & forth through the area from edge to edge. To mark the outer edge of the searched area, on each pass the person next to the not-yet-searched area either puts in wire/PCV flags periodically (different color from those used to mark plants) or drapes a piece of flagging over tree/shrub branches. Meanwhile, the person next to the already-searched area picks up the markers left on the previous pass, and by staying close to the edge keeps the line of searchers in the right location. All plants found are flagged (flags can be picked up after the census if they cannot be permanent).

2. Single searchers: Pick out landmarks (fallen trees, distinctive rocks or trees) that define a fairly small area (e.g., 2x2 – 4x4 m). Search within that area, then pick out an adjacent area. This approach works best when searching inside a larger area with marked edges.

Minimizing impacts

- Plan activities so as to minimize foot traffic through areas known to have plants.
- When workers need to pass from one end to another of an area known to have plants, they should detour around the edges of the area.
- Do not touch the plants with your fingers. To check stems, move the plant gently with a small stick, not your hand (which can leave salt behind, attracting herbivores).

Counting plants

- Conduct censuses in mid-August to mid- to late-September. Plants are larger and easier to see than in the spring, and late-season counts provide a better measure of actual reproductive success than when flowering (since some flowers abort). But do the census before plants begin to turn yellow (which occurs earlier in dry years).
- In any given year, start by looking at a known population to develop a search image.
- In general, conduct a census (count all stems) rather than sample (e.g. on transects). Collecting representative samples of scattered, clumped plants is difficult, and most *Isotria* populations are small enough to census without much more effort than would be required to lay out a sampling pattern.
- If plant counts are to be compared between years, mark the outer bounds of a census area that will be searched each year. (Note: at one of the larger sites we monitor, a 4,300-square-meter area, a census has taken us about 6-7 person-hours.)
- Count stems, not plants. Make separate notes about close-together stems that may be a single plant. This avoids problems with differences between workers and between years in how 'one plant' is defined.

Recording reproduction (seed capsules)

Record V = 1 vegetative stem, V2 = 2 vegetative stems arising from one point, C = one stem with a single seed capsule, C2 = one stem with a double capsule.

Marking plant locations

In any given search, this helps avoid double counting; increases accuracy by allowing a second search through areas with plants; and provides a visual overview of distribution at the end of the count. Markers that are left in place from year to year improve count accuracy by focusing searches near known locations, and allow for tracking individual IDs.

- Place a flag (wire or, preferably, PVC stem) or a small plastic stake 4-6" from the stem.
- If markers are temporary (will be pulled after the census), count the number each worker starts with, then count again after they have been pulled up (any left behind?).
- If a site will be visited repeatedly, and is not in an area frequently visited by the general public, leave the markers next to the plants. Make sure all field workers use a standard location relative to the plant stem (e.g., 4" north or 4" uphill of the stem).

To search an area where plant locations are already marked

- First search carefully in the immediate vicinity of marked plant locations. Then, as time allows, check the edges & more distant locations.
- Ensure that you can distinguish between a newly found plant and one found earlier, or by a different worker. Options include different flag colors, re-tracing numbers on flagging with a permanent marker (faded vs. new marks are easy to distinguish) or having a checklist of known plant IDs & noting those found.

Marking individual plant IDs

Advantages: Allows life history information to be gathered, e.g. life span, dormancy periods, lifetime reproductive success.
Disadvantages: Time required, threat to plants from leaving visible markers. (Somewhat surprisingly, we have not had a problem with plants or markers being vandalized in the last 10 years.)

Assign a unique ID to the plant. Attach a metal, numbered tag to the flag and/or write the ID on the actual flag (or plastic stake) with a thick permanent marker.

- Metal tag: we've started to use rectangular aluminum tags where writing on them leaves a deep imprint in aluminum-covered soft (cardboard?) interior. They worked well for one year; we haven't yet used them for longer. If just slipped through the flag stem & left on the ground they have to be extracted from over-lying leaf litter the next year. Alternative: tie a bit of flagging below the tags to hold them on the stem of the flag above the ground.
- Permanent marker: Mark both sides of the flag, with the marks offset from each other. Underline the bottom of "6" and "9". Offsetting makes it easer to read. Marking both sides helps when a cocoon has been built on one side, or the sun has faded the upper side. Note that these marks need to be renewed – a time-intensive process as markers accumulate over the years - or they will fade to illegibility in about 2 to 3 years.

Unique ID options:

- Sequential numbers for each site (either just the number or year and then number, e.g. 06-15). Disadvantage: if > 1 person working, someone has to be in charge of numbers, telling anyone who finds a new plant what the next number is.
- Alternative (recommended): each worker gets a letter of the alphabet, and assigns their own sequence of unique IDs, e.g. A-1, A-2, etc. Next year, whoever does the survey is assigned one of the letters used previously and starts with the last number assigned to that letter (e.g., A-27 in 2006, so start with A-28 in 2007).

Lost/illegible IDs: Flags will get pulled up (bears...) or knocked down, and ID values will become illegible (e.g., flag with ID chewed off by wildlife, bare flag stem left).

- Record plants with an existing but illegible marker as "X-n", where n is a sequential number. The X indicates that the plant is not new that year, but the ID is unknown.
- If individual IDs really important, in addition to the flags, push a knobbed toothpick/cocktail stirrer right up to the knob very close to (about 1" from) each stem. This helps in determining which plant goes with which marker: if only marked by putting a flag 4 to 6" from a stem, it's not always clear next year whether a nearby plant is

the same as was seen earlier. Also, if a plant is found without a flag next to it, feeling around for the toothpick will help determine whether it's really a never-before-found plant, or a case of a pulled/lost flag.

Other data collected

- Plant size: height and maximum width of the leaf whorl.
- Evidence of herbivory.
- Natural community information
    - Habitat photographs. (See the Forest Service's Photo Point Monitoring Handbook: http://www.fs.fed.us/pnw/pubs/gtr526/).
    - Releve: list of all plant species, with strata and % cover (20x20-ft. plots)
    - DBH measurements for all woody stems > 6' high, classed by species and live/dead (20x40 m plots)
    - Stem counts and/or area estimates for herbaceous and low shrub vegetation (1x1 m plots)
    - Fisheye photographs of the canopy, which can be analyzed (warning: time intensive) to produce estimates of percentage cover and direct, indirect light reaching the plants.

Equipment Checklist (with costs from the 2007 Forestry Suppliers catalog)

Item	**Approximate Cost**
Compass	
Flagging rolls	$2 / 12
Vinyl flags with 24" PCV stakes Vinyl flags with 30" wire stakes Plastic pot labels (stakes)	$10 / 100 $8 / 100 $22 / 500
Permanent markers	
Double-faced aluminum tags	$74 / 1,000 ($8-30/100)
30-m tape	$25
Sonin electronic (infrared) distance measurer	$90
GPS unit	$100-400