Small Whorled Pogonia
(Isotria medeoloides)

5-Year Review:
Summary and Evaluation

Photo Credit: Aat Barendregt

U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
Annapolis, Maryland

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5-YEAR REVIEW

Small Whorled Pogonia (*Isotria medeoloides*)

TABLE OF CONTENTS

1.0 GENERAL INFORMATION 1
1.1 Reviewers 1
1.2 Methodology Used to Complete the Review 2
1.3 Background 2
2.0 REVIEW ANALYSIS 3
2.1 Application of the 1996 Distinct Population Segment (DPS) policy 3
2.2 Recovery Criteria 3
2.3 Updated Information and Current Species Status 5
2.3.1 Biology and Habitat 5
2.3.2 Biology and Life History 6
2.3.3 Abundance, Distribution, and Current Status of the Populations 11
2.3.4 Genetics 20
2.3.5 Taxonomic Classification or Changes in Nomenclature 20
2.3.6 Trends in Spatial Distribution or Historical Range 20
2.3.7 Habitat or Ecosystem Conditions 21
2.4 Five-Factor Analysis 22
2.4.1 Destruction, Modification or Curtailment of Habitat or Range 22
2.4.2 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes . 23
2.4.3 Disease or Predation 24
2.4.4 Inadequacy of Existing Regulatory Mechanisms 24
2.4.5 Other Natural or Manmade Factors Affecting its Continued Existence 25
2.5 Synthesis 25
3.0 RESULTS 26
3.1 Recommended Classification 26
3.2 New Recovery Priority Number 26
3.3 Listing and Reclassification Priority Number 26
4.0 RECOMMENDATIONS FOR FUTURE ACTIONS 26
5.0 REFERENCES 29
APPENDIX A: Search Image for Forest Sites Occupied by Small Whorled Pogonia 34

TABLES

Table 1. Number of occupied sites by State in past years (as summarized in the 2008 5-year review, USFWS 2008, p.9) and the number of occupied sites in 2021. Summaries by geographic region are also provided. 13

Table 2. Number of EOs in each of the North American Level 3 ecoregions (EPA 2021) in the Northeast, Central, and Southern geographic regions for small whorled pogonia 14

Table 3. EO ranks of small whorled pogonia sites provided by states and grouped for this review into size categories of large, medium, and small populations. 18

Table 4. Number of sites by size and region for 179 sites where small whorled pogonia was present in the last 20 years. 19

Table 5. Protected sites of small whorled pogonia (109 total) by region and size. 19

FIGURES

Figure 1. Green plant on the right with two buds about to flower and the previous year's plant with seed capsule on the left. (Photo credit Melissa McCormick). 6

Figure 2. Flowering plant above ground and the green bud for the next year's growth, roots shown with double arrow (Figure 1 in Rock-Blake et al. 2017). 6

Figure 3. Life cycle of small whorled pogonia. Stages in brown boxes occur underground; stages in green boxes are above ground. All stages require mycorrhizal fungi. 7

Figure 4. Left: Seed packets collected after 13 years in New Hampshire. Right: embryos from one of the seed packets that stained positively using a standard Tetrazolium staining technique.. 8

Figure 5. Left: Isotria medeoloides protocorms from seed packets collected from a West Virginia site. Right: One of the protocorms isolated from the seed packet (note: fungal network on outside of the protocorm). (Photo credit Dennis Whigham). 8

Figure 6. Counties where small whorled pogonia is currently considered extant, counties historically occupied, and those where plants have not been seen in more than 20 years. The three regions are also delineated. 12

Figure 7. Distribution of counties occupied by small whorled pogonia across North American Level 3 ecoregions (EPA 2021). 15

5-YEAR REVIEW

Small Whorled Pogonia (*Isotria medeoloides*)

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology Used to Complete the Review

This 5-year review was prepared by Cherry Keller, recovery lead for this species, with assistance from Kathleen Cullen, Chesapeake Bay Field Office (CBFO), and input from cooperating U.S. Fish and Wildlife Service (Service) Field Offices, state and Federal agencies, and other species experts. Distribution data and information regarding the species' life history and population status were based on data requested from state natural resource agencies, Federal agencies (National Park Service [NPS], U.S. Forest Service [USFS]), and researchers. New information obtained was combined with published literature and internal files. A draft of Section 2 was provided for technical review to all Service Field Offices, state contributors, and expert contributors within the species' range.

Note that data received by December 2021 are included, though a new population was discovered in Vermont in May of 2022 in Chittenden County and was then added to the draft.

1.3 Background

FR Notice citation announcing initiation of this review: November 6, 2021 (86 FR 61778-61780).

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

Associated rulemakings: None.

Review History:

Previous 5-Year Reviews

- The small whorled pogonia was included in a cursory 5-year review conducted for all species listed before 1991 (Initiated: 56 FR 56882).

- In 2008, the first formal 5-year status review was initiated January 29, 2007 (72 FR 4018-4019) and no change in status was recommended (USFWS 2008, Finalized September 30, 2008).
- In 2013, a status review was initiated March 6, 2012 (77 FR 13251- 13253) and a review was drafted, but not finalized and signed.

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.

Recovery Plan or Outline:

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

2.0 REVIEW ANALYSIS

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

Is the species under review a vertebrate?
No, the species is a plant and therefore the DPS policy is not applicable.

2.2 Recovery Criteria

Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes.

Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? Yes. While our understanding of a self-sustaining population is likely better defined as a large protected area with multiple populations that likely exceed the 80 stems described in Criterion 2, this is generally covered in Criterion 2 and 3. We are learning more about what constitutes appropriate management, but management generally is covered in Criterion 3.

Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?
Yes.

1992 Recovery Plan Criteria

In order to reclassify the small whorled pogonia 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 small whorled pogonia (SWP) was downlisted to threatened in 1994.

In order to remove the SWP from the Federal list of threatened and endangered species, according to the Recovery Plan (USFWS 1992, p. 43) the following criteria must be met:

Criterion 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,"

> ***Criterion 1 is met***. There are 109 sites on lands protected from development and this includes 41 in the Northeast, 41 in the Central Region and 27 in the Southern Region (Table 5 below).

Criterion 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."

> ***Criterion 2 has been partly met.*** There are 46 protected sites (less than 61) that have 20 or more stems (large and medium sites total in Table 5 below) and this is our best equivalent for the Recovery Plan description of self-sustaining population. There are 24 sites (more than 20) that are large (though this NatureServe category has greater than 50 stems). As described in the 2008 5-year review (USFWS 2008), the definition of self-sustaining may not be right for this species as populations may require some management to stay large and sustainable over time. Large populations may decline as forest succession continues and canopies close and small populations can persist for long periods of time and then increase dramatically in size with management or tree falls that open the canopy and provides light to the plants (Whigham et al. 2021, entire).

Criterion 3: "Appropriate habitat management programs must be established for occupied *Isotria 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."

Criterion 3 has been partly met. Habitat management for light includes cutting or girdling canopy trees or control of understory vegetation to enable some light to reach plants. How we manage to also increase soil fungi needs to be further understood. We now know that a canopy tree that falls and leaves its root system in place provided additional light and decaying roots and this was associated with a large increase in soil fungi as well as a large increase in the number of plants (Whigham et al. (2021). Understanding how long these effects continue, or other management techniques to increase soil fungi are needed. Additional management techniques (including understory burning) are being explored but we have not yet described a management technique that would create habitat in adjacent areas.

This species is a mid-successional forest species that requires some disturbance or management to prevent forest succession from closing the canopy, over-shading these plants, and diminishing numbers and viability (percent flowering, fruiting etc.). Protection of larger landscapes where the suitability of different areas is allowed to change over time is necessary. Site conditions can change with time and/or management as trees fall or forest succession continues. Protection of larger areas that have multiple occupied sites and allow for changing conditions are likely to sustain populations more successfully.

We already have many large, protected landholdings that currently host multiple sites of small whorled pogonia, and where some management for this plant does, or could, occur. These "conservation areas" are generally on lands owned by the Department of Defense, National Park Service, and U.S. Forest Service. These areas can meet the goal of this Criterion for protected lands where multiple sites can be sustained and potentially managed. And while the size and location of populations may change over time, the overall viability of the species remains stable or positive in each conservation area. Identifying these areas, ensuring that any needed management for this plant will continue after delisting and that we have a good distribution of conservation areas across the range will be important next steps in recovery. These steps will be described in a Recovery Implementation Strategy.

In summary, the major goal of these three criteria for delisting is protection of sufficient number of sites where management can occur and populations can be sustained. As suggested in Criterion 3, if we focus on larger areas than just the individual sites, where new habitat might be created or discovered, we will have better assurances for the long-term survival of this species. A more complete discussion of the environmental conditions needed for this plant and descriptions of viability of populations are provided below.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

The small whorled pogonia is a perennial orchid about 5 to 25 centimeters (cm) (2 to 10 inches) tall that occurs in 16 states from Maine to Georgia. Plants typically have one stem but occasionally two, each stem has a single whorl of three to five leaves (Figure 1).

Flowers are yellowish green, 1 to 2.5 cm long, and born on top of the leaf whorl. Flowers appear soon after plants emerge in May or June. This species is non-clonal, and plants may emerge each spring or they may remain vegetatively dormant and below the ground for one to several years. Each plant produces only one, rarely more than one, overwintering bud per year (Figure 2).

Figure 1. Green plant on the right with two buds about to flower and the previous year's plant with seed capsule on the left. (Photo credit Melissa McCormick).

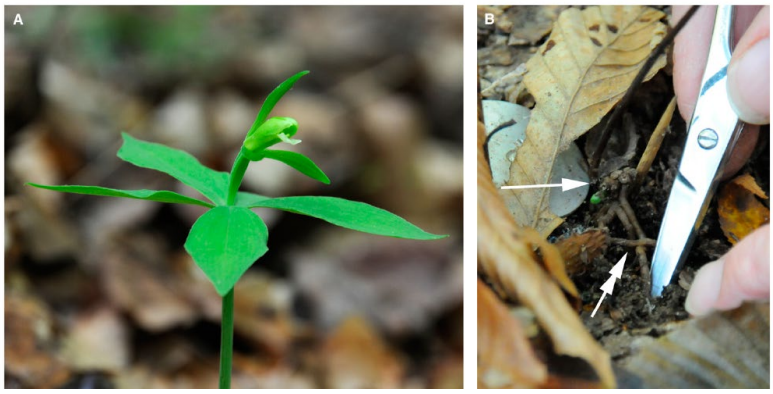

Figure 2. Flowering plant above ground and the green bud for the next year's growth, roots shown with double arrow (Figure 1 in Rock-Blake et al. 2017).

2.3.2 Biology and Life History

There is considerable new information on the life history of this species and the importance of light in promoting emergence and flowering since the last 5-year review (USFWS 2008). The small whorled pogonia, like many orchids, has a complicated life history and all stages are dependent on a mycorrhizal fungus (Figure 3). Plants may appear aboveground each year, but

individual plants can also enter a period of vegetative dormancy when they do not produce aboveground shoots for an entire growing season or more than a decade (Rock-Blake et al. 2017). Plants that produce aboveground shoots are either vegetative or reproductive (produce flowers). Flowering plants may or may not produce fruits.

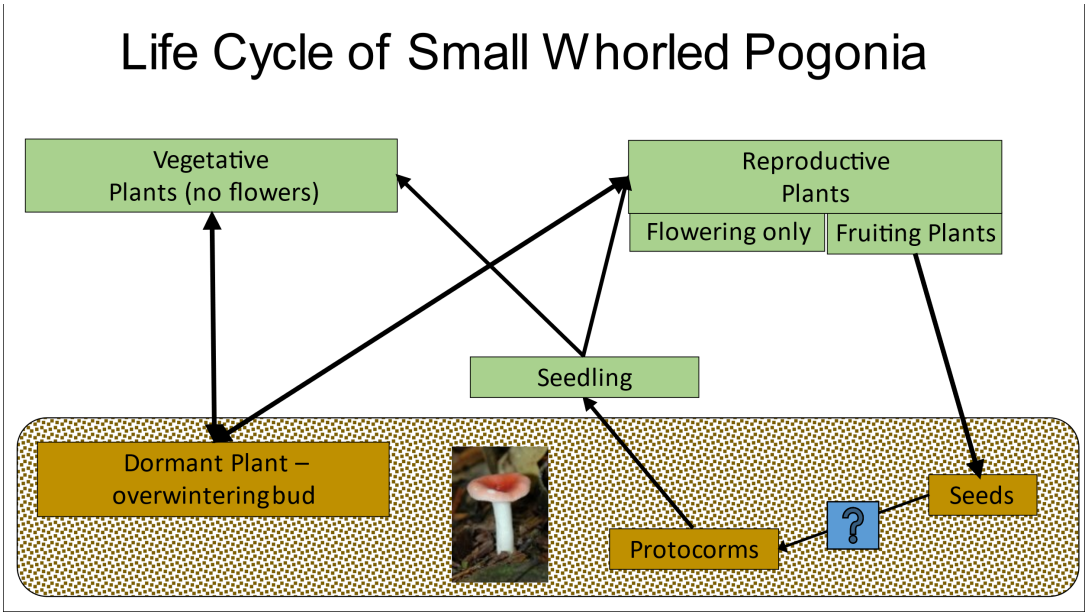

Figure 3. Life cycle of small whorled pogonia. Stages in brown boxes occur underground; stages in green boxes are above ground. All stages require mycorrhizal fungi.

New information on the seed to protocorm stage of the life history: Details of this phase of the life cycle have been unclear and there has been recent work trying to better understand it. Details of this work are provided below (Whigham 2021 pers. com) and are also described in a newsletter of the North American Orchid Conservation Center (NAOCC 2019).

Each seed contains an embryo. When the seed germinates, the embryo grows if it associates with an appropriate mycorrhizal fungus, and then will develop into a protocorm. Embryos of all orchids transition through the protocorm stage to the seedling stage and it is noteworthy that the protocorms of all terrestrial orchids do not contain chlorophyll and are not able to support growth from the embryo to protocorm stage though photosynthesis. Thus, if the appropriate mycorrhizal fungus is not present in the area where the seed germinates, the embryo will not survive.

Researchers at the Smithsonian Environmental Research Center (SERC) have buried packets of seeds in the ground (as described in Rasmussen and Whigham 1993) to determine when small whorled pogonia seeds germinate and whether any protocorms develop. The seed packets are constructed of netting within a slide frame and enable retrieval of the seeds to quantify germination. SERC collaborated with the New England Wildflower Society (now called the Native Plant Trust) on a seed packet study and seed packets were collected at different times over several years and sent to SERC for analysis. In all but one instance (described below), SERC researchers found that every seed packet examined contained seeds with embryos that were still alive. Figure 4 shows two seed packets that were retrieved and sent to SERC by Bill

Brumback of the Native Plant Trust after they had been in the soil for 13 years in New Hampshire. The image on the right shows embryos that stained with Tetrazolium (Porter et al. 1947, Verma and Majee 2013), indicating they remained viable after 13 years in the soil.

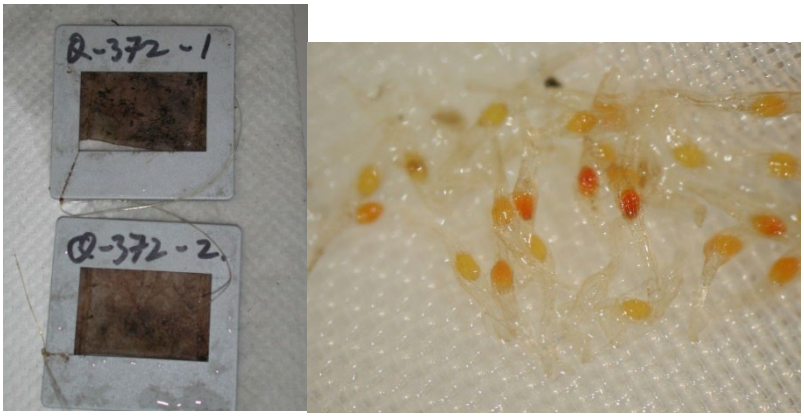

Figure 4. Left: Seed packets collected after 13 years in New Hampshire. Right: embryos from one of the seed packets that stained positively using a standard Tetrazolium staining technique.

In 2019, SERC researchers also collected seed packets from a study site in West Virginia. All but one of the seed packets had viable embryos and one (Figure 5) had protocorms. This was the first time anyone had ever seen a protocorm of small whorled pogonia. What triggers germination in nature remains unknown.

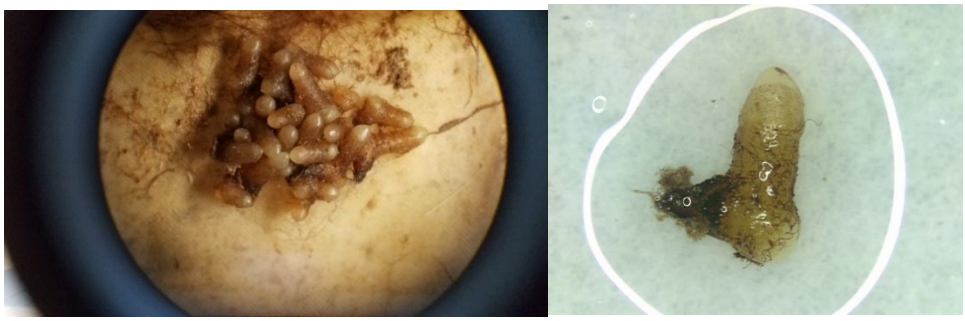

Figure 5. Left: Isotria medeoloides protocorms from seed packets collected from a West Virginia site. Right: One of the protocorms isolated from the seed packet (note: fungal network on outside of the protocorm). (Photo credit Dennis Whigham).

Researchers from the Smithsonian and Longwood Gardens have attempted to germinate small whorled pogonia in the laboratory using a variety of substrates, treating the seeds in a variety of ways, and conducting the experiments using mature seeds and green-pod seeds (i.e., a seed coat has not yet grown around the embryo). Until recently, all attempts had been unsuccessful but recently, Peter Zale reported successful germination of mature seeds at Longwood Gardens (Dennis Whigham 2021 pers. comm.). The Longwood Gardens technique will be used again to confirm that seeds can be germinated in the laboratory. If these efforts are successful, the next research objective will be to determine if protocorms can be grown to the seedling stage on aseptic substrates or if methods can be developed to grow small whorled pogonia orchid

mycorrhiza and conduct growth experiments symbiotically. While ultimately, we would like to grow seedlings in the lab and be able to transplant them to the wild, that may or may not be possible and is not necessary for recovery for this species.

New information on rates of emergence, growth, flowering and fruit available from long-term study: A 15-year study in Maine by Dibble et al. (2019, p.96) confirmed earlier findings of Mehrhoff (1983, p. 1452) that pollination and seed development were not likely to be limiting factors for this species. Dibble et al. (2019, p.84-85) followed approximately 360 plants at 4 sites through all stages of the life history noting the proportion of plants that made it to each stage. On average, 45 percent of the plants emerged each year. Most plants (86.3 percent) were only vegetative and did not flower their first year. The percent of all plants that flowered ranged from 16 to 42 percent and larger plants, defined by leaf whorl diameter, tended to be those that flowered (Dibble et al. 2019, p.95 and p.86). Of the total number of plants that flowered across all sites and years, 55 percent produced fruit (fruit set) (Dibble et.al 2019 p.75 and p.96). This value is similar to the 57 percent found by Mehrhoff (1983, p.1451) for plants in the southern portion of the range, but lower than the rate of 83 percent for control plants in a different study in Maine (Vitt and Campbell 1997, p.60). The rate of fruit set found is high compared to the 19.5 percent average of 11 other orchid species (Dibble et al. 2019, p.96).

Long-term monitoring data from two Virginia sites had lower estimates of these population parameters as the percent of emergent plants producing flowers ranged from 10 to 37 percent and the percent of flowering plants producing seeds ranged from 20 to 29 percent (McCormick et al. 2015, p. 6). Emergence was generally low and highly variable as most plants (70 of 117 at one site and 61 of 90 at a second site) only emerged in 1or 2 years of the 7-year study and only two plants emerged in all 7 years of the study (McCormick et al. 2015, p.5). The percent of the underground population that emerges each year is a difficult parameter to measure and not always defined the same way.

Light is an important environmental factor that can improve all aspects of the life history and may be an important management technique as well: The importance of light was suggested initially because many populations have been found near semi-permanent canopy gaps caused by old logging roads, blowdowns, or streams (Mehrhoff 1989a; p.288). At one site in New Hampshire, an increase in population size was observed after gypsy moth defoliation (Brackley 1985, p.79). More recently, management efforts to increase light support the importance of this environmental requirement.

- **New Hampshire (Brumback et al. 2011, entire).** In East Alton, NH, a population of SWP was partitioned into two groups, with one left as a control and the other subjected to canopy-reduction management. The removal of all shrubs and 25 percent of the tree basal area approximately doubled light transmission to the managed group. The number of stems and seed capsules dramatically increased in this group relative to the control group.
- **New Hampshire (Young 2016).** Investigators have been monitoring one of the largest SWP populations in NH and helped design a timber harvest of the site to avoid impacts to the current populations while also increasing light. The site is a hemlock (*Tsuga sp.*), beech (*Fagus sp.*), oak (*Quercus sp.*), and pine (*Pinus sp.*) forest and logging occurred

prior to the 2014 growing season. The increased light has had beneficial effects on emergence and flowering.

- **Maine (Dibble et al. 2019, p.92).** Canopy thinning that increased light to the forest floor maintained the number of emerging plants in treated areas as well as improved flowering while the number of plants in control plots declined without treatment.

- **Virginia (Whigham et al. 2021, entire).** From 2008 to 2020, investigators followed colonies at Fort A.P. Hill (APH) and Prince William Forest Park (PRWI). Populations were generally in decline at both sites but an understory canopy thinning study at APH resulted in an increase in the number of plants. At PRWI, a large tree died slowly at the edge of a population that had declined to two plants. Following death of the tree, light increased, fungal abundance increased, and the number of plants increased to 80 (McCormick et al. 2015, entire). In 2022, SERC will collaborate with staff at APH and PRWI to conduct additional experiments that will involve canopy thinning and the addition of wood chips as a soil amendment to increase the abundance of the orchid mycorrhizal fungi that the species requires. See below for additional discussion of the soil fungi aspects of this study.

These studies illustrate that a very closed canopy can over-shade these plants and that increasing the light reaching the forest floor can be beneficial; however, these increases are still in primarily shaded forests, not open areas where excessive sun could dry out the site. The range of percent canopy closure that is suitable for small whorled pogonia is not fully understood and not simple to measure. Brumback et al. (2011) used the Gap Light Index using a camera pointed at the sky from the plant locations. Other techniques used by foresters need to be connected to this type of data (Blizzard et al. 2013). There are many ways to measure canopy closure depending on the size of the area that is the focus (micro-site or 100-acre forest stand). How to manage a forest stand to create the appropriate light for small whorled pogonia micro-sites within that forest may be helpful.

The abundance of Russulaceae fungi in the soils is positively related to small whorled pogonia plant emergence and flowering and may be as important as light: Soil fungi are understood to be critical to orchid species and while they generally are not considered to affect the overall distribution of the species at large scales, they do affect the local presence and abundance and contribute to the patchy distributions of orchids (McCormick et al. 2018, p.1211; McCormick and Jacquemyn 2014, entire). Recent work has underscored the importance of the soil fungi for small whorled pogonia.

Rock-Blake et al. (2017) found that the abundance of soil fungi (Russulaceae) on tree root tips and in the adjacent soil significantly increased the likelihood of small whorled pogonia plant emergence from dormancy. Additional research at PRWI, described above, also demonstrated the importance of fungal abundance as an important factor in sustaining populations (Whigham et al. 2021, entire). The response of small whorled pogonia to the natural tree fall at PRWI was especially dramatic, increasing emergence from 2 to 80 plants (Whigham et al. 2021, p.8; McCormick pers. comm. 2022). In addition, DNA from Russulaceae fungi in the soil was four orders of magnitude more abundant than that measured before the tree fell. This natural tree fall

increased light but also provided decaying roots and other woody debris to feed soil fungi. These observations led the authors to propose the *Fungal Abundance Hypothesis* stating that the abundance of the fungi may be as important as the increased light in management of this species. The hypothesis will be tested in an experiment at APH starting in 2022.

2.3.3 Abundance, Distribution, and Current Status of the Populations

To assess the distribution, abundance, and current condition of small whorled pogonia across its range, data were requested from State Heritage Programs. States provided data on 207 populations (Element Occurrences) where small whorled pogonia is considered present (extant). In this document, we consider the terms Element Occurrence (EO), population, and site to all refer to a group of plants that are within 1 kilometer (km) of each other and separated by more than 1 km from other such plants. This was the case for all State Heritage Programs except in Virginia, where a few EOs were defined using a habitat approach (NatureServe 2020a) that resulted in some Virginia EOs being all plants within 2 km of each other. Smaller groups of plants within an EO are described as a colony or sub-EO. In our assessment of the data, to be conservative, we only considered EOs that had been observed within the last 20 years, using data received by 2021. This resulted in 178 EOs in 15 states and 64 counties. A new discovery in Vermont was confirmed in May of 2022 and added to the data set for a total of 179 EO's.

The small whorled pogonia is distributed from Maine to Georgia in three general regions: the Northeast, Central, and Southern regions (Figure 6). These regions were also noted in the Recovery Plan (USFWS 1992, p.7-8).

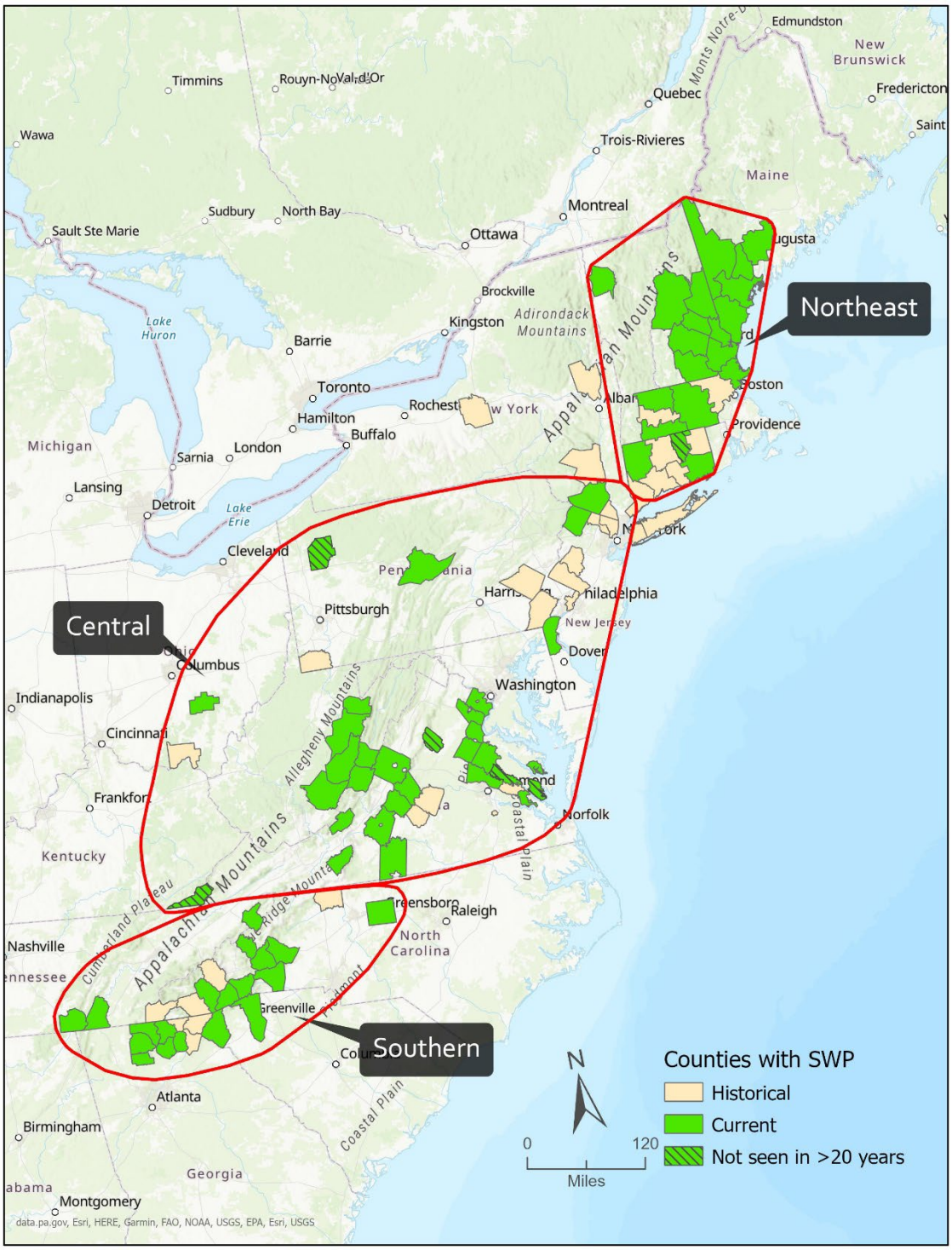

Figure 6. Counties where small whorled pogonia is currently considered extant, counties historically occupied, and those where plants have not been seen in more than 20 years. The three regions are also delineated.

Redundancy - Changes in the Number of Sites by State

We have compared the current number of extant sites in each State to past estimates summarized in the 2008 5-year review (USFWS 2008, p. 9) (Table 1). Most states have stable or increasing numbers of sites with the highest numbers still occurring in New Hampshire, Maine, and Virginia. States in the southern portion of the range have lower, but stable numbers. Overall, there are now 179 locations where States reported extant populations of small whorled pogonia and where these sites have been visited within the last 20 years.

Table 1. Number of occupied sites by State in past years (as summarized in the 2008 5-year review, USFWS 2008, p.9) and the number of occupied sites in 2021. Summaries by geographic region are also provided.

State	1985	1991	1996	2007	2021
Maine	2	16	21	18	27
New Hampshire	16	30	40	49	47
Vermont	--	--	--	--	1
Massachusetts	1	5	5	5	8
Rhode Island	1	1	2	2	--
Connecticut	1	1	1	2	2
Northeast Total	**21**	**53**	**69**	**76**	**84**
New York	--	--	--		1
Pennsylvania	1	3	3	3	1
New Jersey	2	3	3	3	4
Delaware	--	1	1	1	1
Maryland	--	--	--	--	--
Washington, DC.	--	--	--	--	--
Virginia	2	9	24	33	46
West Virginia	--	--	2	2	8
Ohio	--	--	--	1	1
Central Total	**5**	**16**	**33**	**43**	**62**
North Carolina	3	5	8	7	11
South Carolina	1	5	5	3	5
Georgia	1	7	17	19	13
Tennessee	--	1	2	2	3
Southern Total	**5**	**18**	**32**	**31**	**32**
Michigan	1	1	1	--	--
Illinois	1	1	1	--	--
Missouri	--	--	--	--	--
Canada (Ontario)	1	1	1	--	--
Total	34	90	137	150	179

*Virginia EO's were delineated using the NatureServe habitat-based protocol thus a few sites include all plants within 2 km.

There have been some State extirpations in the periphery of the range (e.g., Michigan and Illinois, where single populations were known to occur) but these extirpations were already noted in the 2008 5-year review (USFWS 2008, p.9). Small whorled pogonia has not been found in Missouri, Maryland or the District of Columbia since listing (USFWS 1992, p.11-17). There are also extirpations within the range as small sites disappear and may result in no extant sites in counties adjacent to occupied counties (Figure 6). But overall, the number of new sites discovered is greater than the number of extirpations resulting in a higher number of occupied sites.

The numbers in Table 1 are likely approximate as the exact distances used to delineate sites in the previous assessments may be slightly different (the 1992 Recovery Plan defines a site as all plants within .25 to .5 miles (0.4 to 0.8 km) (USFWS 1992, p.6)), and we have been conservative in our 2021 estimate as some sites not visited in 20 years may still be present. Despite possible differences in delineation distances and approximate numbers of sites, we consider it reasonable to conclude that there are more occupied sites currently than in the past. While we can never know how much of this increase is a result of increased searching for this plant, the larger number of sites identified indicates improved status and lower vulnerability of this species to threats. Simply put, the greater redundancy across the range reduces the extinction risk for this species.

Representation - Ecoregions and habitats where small whorled pogonia occurs

Across the range, small whorled pogonia is found in 11 ecoregions (North American Level 3) (EPA 2021) primarily surrounding the Appalachian Mountains (Table 2, Figure 7). These areas tend to have some slope and provide the needed micro-sites with cool, moist soils. The large geographic area of the Central region includes a larger variety of ecoregions than the Northeast or Southern regions. The current range occupies a similar set of ecoregions as the historical range (Figure 7) except for the isolated occurrences in Illinois, Missouri, and Ontario that were extirpated by 2007 (Table 1).

Table 2. Number of EOs in each of the North American Level 3 ecoregions (EPA 2021) in the Northeast, Central, and Southern geographic regions for small whorled pogonia

Ecoregion Name	Northeast	Central	Southern	Total
Northeastern Highlands	58	1		59
Northeastern Coastal Zone	24			24
Acadian Plains and Hills	3			3
Piedmont		19	1	20
Southeastern Plains		18		18
Ridge and Valley		15		15
Central Appalachians		2		2
Western Allegheny Plateau		1		1
Blue Ridge		5	29	34
Southwestern Appalachians			2	2
Middle Atlantic Coastal Plain		1		1
Total	**85**	**62**	**32**	**179**

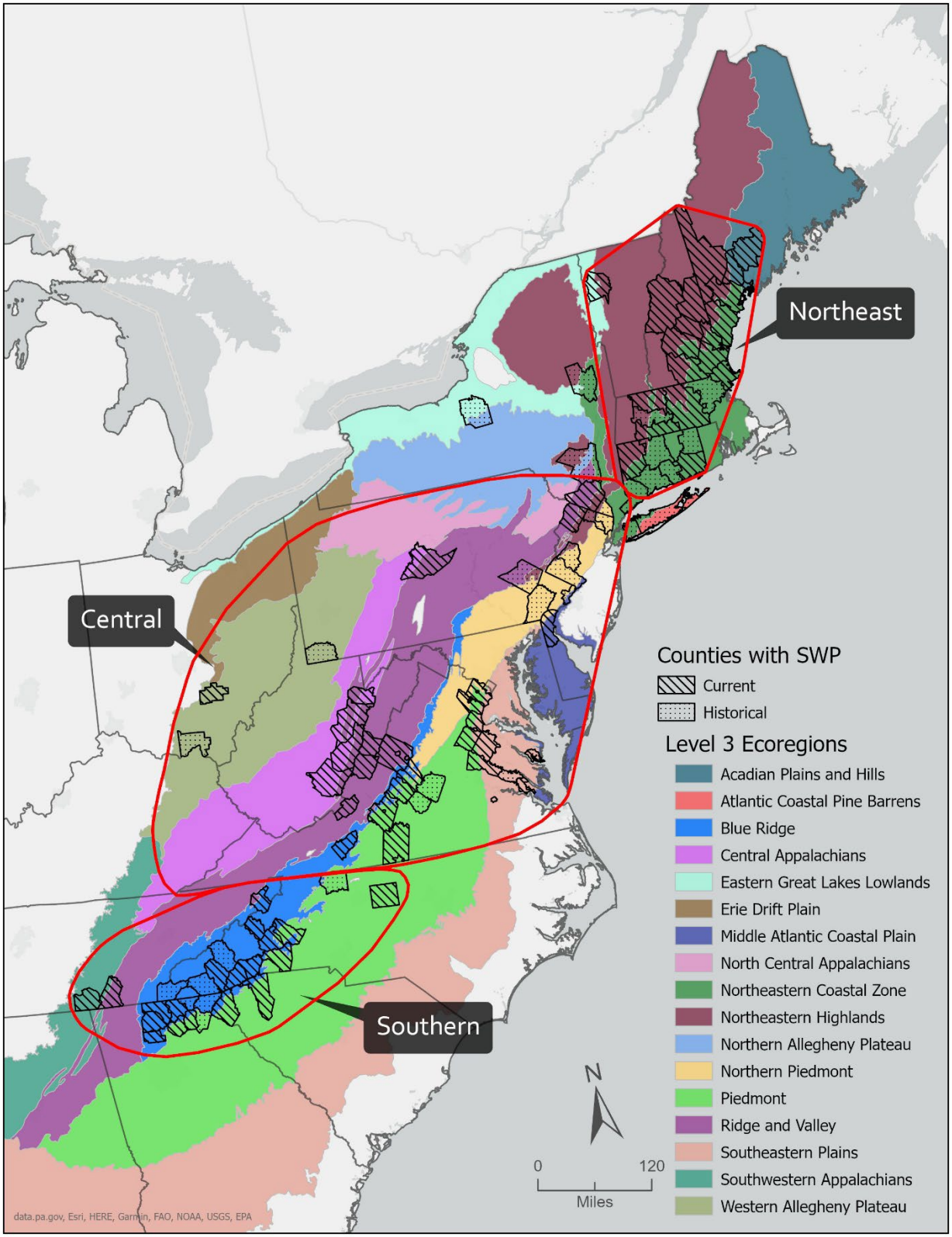

Figure 7. Distribution of counties occupied by small whorled pogonia across North American Level 3 ecoregions (EPA 2021).

Habitat and micro-sites: Within these larger geographic regions, the plant occurs in micro-sites where sufficient light, moisture, and soil fungi are present. Available descriptions of the forested habitats and micro-sites from the literature or habitat models are provided below. However, the range of habitats and micro-sites is large and it is not easy to generalize.

> **Northeast Region** (ME, NH, CT, MA): In the Northeast, small whorled pogonia occurs in the Northeastern Highlands and Northeastern Coastal ecoregions (Figure 7) and is often found in suitable microsites within hemlock - pine - hardwood forests. A 1996 habitat model for the Northeast found this orchid associated with soils that had a pan layer (and thus higher moisture) and percent slopes between 11 and 27 percent (Sperduto and Congalton 1996, entire). It has been found associated with logging roads, trails, or other openings in the forest where light is more available, and perhaps where water may accumulate if a road crosses any downslope flow of water (USFWS 1992, p.2.). The species may also be associated with forests that have grown up on previous pastureland, perhaps because the forest has attained an age and structure suitable for small whorled pogonia.
>
> **Central Region** (NY, NJ, PA, DE, WV, OH, VA): In the Central Region, it occurs in a broad range of ecoregions including both the Piedmont and Ridge and Valley areas surrounding the Appalachian Mountains, but also in the Coastal Plain and into the Western Allegheny Plateau (Figure 7). It can be found in a wide range of habitats from hardwood and mixed forests on steep slopes to areas along or near small streams. In the Coastal Plain and Piedmont ecoregions, it may be found on nearly flat to moderate slopes in hardwood dominated forests.
>
> **Southern Region** (NC, SC, TN, GA): In the southern portions of the range, this plant is primarily associated with the Blue Ridge and Southwestern Appalachian ecoregions (also called the Cumberland Plateau Physiographic area (USGS 2000, entire)). A habitat model created for this area found the plant in mixed acidic cove forests, with high canopy cover (81 to 98 percent), moderately sloped terrain (5 to 40 percent), low soil pH (4.0 to 4.9), and soils with a hardpan layer that retains moisture at the surface (Montgomery 2014; p.7). This study also found a positive association with overstory snag density and large populations of small whorled pogonia. This is likely a result of the higher light penetration and potentially higher soil moisture and fungi abundance associated with dead and dying trees.

The current range of ecoregions and forest habitats occupied by this species' is generally representative of the ecoregions of its historic range. We have lost three sites from more western areas (Illinois, Michigan, and Ontario), but the majority of the current populations and historic populations are distributed in the general areas surrounding the Appalachians (Table 2,Figure 7). When a species occurs in a variety of ecological conditions, it generally indicates tolerance to a wide range of habitat conditions and some ability to respond to future changes in environmental conditions (its adaptive capacity). However, this plant is still rare within this large distribution because it needs very specific micro-sites that supply the moist soil, appropriate light, and soil fungi that are essential to its growth. We are not yet able to clearly identify suitable micro-sites,

describe these and understand their frequency, or how they may change over time. Because this is a mid-successional forest species, the locations where these suitable sites occur may change with succession and closure of the canopy cover. Better understanding of these micro-sites would enable us to find and search additional suitable habitat.

Resiliency - Viability of Occupied Sites

We have used the Element Occurrence rank provided by the states, to describe viability of the site. The element occurrence (EO) rank is a system developed by NatureServe to describe the viability of a species occurrence (NatureServe 2020a; NatureServe 2020b). EO ranks are intended to document the status and quality of plant population occurrences and assess the probability of an occurrence persisting based on the surrounding area. NatureServe (2021) provides species-specific ranks for small whorled pogonia, largely based on the size of the population (number of stems) and status of surrounding habitat. These are provided verbatim below:

> **Excellent Viability:** A-ranked occurrence of small whorled pogonia contains more than 100 emergent stems (annual average, greater than 5 years of data), with at least 25 percent of the plants flowering and with habitat and upslope hydrologic integrity protectable.
> **Good Viability:** B-ranked occurrence of small whorled pogonia should have between 50 and 99 emergent stems (annual average, from over 5 years of data), with at least 25 percent of the plants flowering, and with habitat and upslope hydrologic integrity protectable.
> **Fair Viability:** C-ranked occurrence of small whorled pogonia should have between 20 and 49 stems in protectable habitat (annual average, from over 5 years of data); or larger population with less than 25 percent reproduction in protectable habitat.
> **Poor Viability:** D-ranked occurrence of small whorled pogonia should have fewer than 20 stems (annual average, from over 5 years of data); or habitat seriously degraded or unprotectable.

Populations with EO ranks of A, AB, or AC, B, BC, or BD are grouped together as large; populations with EO ranks of C or CD as medium; and populations with an EO rank of D or E (extant) as small (Table 3). Combined or range ranks are used to indicate uncertainty when assigning the EO rank or when further information is needed to determine the degree of viability. For example, BC-ranked populations are deemed to have a good to fair probability of persisting, if current conditions prevail (NatureServe2020b p.5). Note that NatureServe 2021 states that ranks should be assigned based on 5 years of data, thus recently discovered sites that have less than 5 years of data are sometimes described as E (extant). We described sites with an E or extant score as small to be conservative. We considered populations with EO ranks of F (Failed to Find), H (Historical Occurrence), or X (Extirpated Occurrence) as simply Absent.

Table 3. EO ranks of small whorled pogonia sites provided by states and grouped for this review into size categories of large, medium, and small populations.

EO Rank Rating Provided by States	Size	# of Stems	EO Rank Name
A, AB, B, B/C, B? BC	**Large**	>50 stems	Good
C, C-, C/D, C?, CD	**Medium**	20 to 49 stems	Fair
D, D?, E or E*	**Small**	< 20 plants	Poor
F, H, or X	**Absent**		Absent

While larger populations are understandably considered higher in viability, it is possible that the frequent case of small populations (less than 20 stems) is not necessarily poor but rather plants that are in a holding pattern in mature forest until tree falls produce breaks in the canopy and the necessary light and soil fungi for resurgence of a larger population. How long that resurgence lasts is not fully understood and may be related to the extent and type of canopy opening provided. Small sites also maintain a potential seed source across a larger area and may be important in maintaining the overall size of the range. Support for the importance of small sites include long-term studies described below:

- A small population in NH remained small for 14 years and after management to increase light, it increased from 5 plants to 45 plants in 6 years (Brumback et al. 2011, entire). These increases were still apparent after 11 years (Brumback et. al 2016).
- A small population in VA increased from 2 plants to nearly 80 plants after a large tree fell and increased light to the plants (Whigham et al. 2021, p.6 Fig 3).
- A small population in VA persisted for at least 29 years (McCormick et al 2015, p.38).
- A small population in ME persisted at least 13 years (Dibble et al. 2019, site 4, p.77).
- A small population in CT persisted for at least 38 years with less than 10 plants but increased to 31 plants 3 years after cutting to increase light. It returned to a population of generally less than 10 plants within 1 year after the peak (Connecticut Natural Diversity Data Base, 2022).

We are thus summarizing large, medium, and small sites because we consider all to be important to the survival of the species.

Of the 179 sites where plants were observed in the last 20 years, we examined their distribution by region (Table 4). The Northeast and Central regions have 85 and 62 sites respectively and the Southern region has 32. If we only considered the large and medium sites, there is a total of 73 sites across the range with 45, 21, and 7 sites in the Northeast, Central and Southern regions respectively. But as we have seen (Whigham et al. 2021, p.6), small sites can become medium in size in a very short time with a single tree fall. Thus, small sites also contribute to this species' viability.

Table 4. Number of sites by size and region for 179 sites where small whorled pogonia was present in the last 20 years.

Region	Large	Medium	Small	Total
Northeast	24	21	40	85
Central	7	14	41	62
Southern	2	5	25	32
Total	33	40	105	179

Likelihood of Persisting – Occurrence on Protected Land

A major threat identified in the Recovery Plan is residential or commercial development of sites (USFWS 1992, p.30). We considered the number of sites that are protected from development because they are on Federal, state, or city property or owned by a conservation organization such as The Nature Conservancy. The U.S. Geological Survey GIS data on land protection (USGS 2021) was used to determine if the land was protected unless the protection status was clear from the existing EO data.

There are 109 of 179 total sites (61 percent) protected from development. They are distributed among Northeast, Central, and Southern regions and 46 of these are medium or large populations. The Southern region has the fewest sites but has the highest proportion of populations on protected lands (27 of 32 sites are protected) (Table 4 and Table 5).

Table 5. Protected sites of small whorled pogonia (109 total) by region and size.

Region	Large	Medium	Small	Total
Northeast	16	9	16	41
Central	6	8	27	41
Southern	2	5	20	27
Total	**24**	**22**	**62**	**109**

Most of the protected sites (78 percent) are on Federal or state land. These Federal and state properties may still have some small amounts of habitat loss, but they generally enable access for monitoring and management of these populations. Past management to increase light to populations has primarily occurred on protected lands and this is likely to continue in the future. Sites on private lands can still thrive and may be accessible for monitoring and management depending on landowner interest. However, monitoring and management supporting long-term persistence is more likely to occur on protected lands.

Overall, the number of protected sites does not yet meet the Criterion in the Recovery Plan (only 46 sites are medium or large on protected lands, not 61). However, protection from development is only one aspect of future viability of these sites; management for light and fungi abundance may be needed as forest succession continues. Whether management for the appropriate light regime may be needed for long-term survival of the species is still to be understood. There is a

need to experimentally determine what frequency of management is beneficial and whether increasing light is sufficient. In most instances, increased light has resulted from the removal of understory trees and shrubs, but Whigham et al. (2021, entire) suggests that periodic management of large trees in or near a population may provide benefits by increasing light and increasing the abundance of the orchid mycorrhizal fungus required by the species.

2.3.4 Genetics

Genetic diversity is limited in the small whorled pogonia because this species is primarily self-pollinating. Experiments with insect exclosures (Vitt and Campbell 1997) and cameras focused to detect insects on flowers (Horth 2019) found no insect pollination. However, the larger populations that are found in the northern portions of the range had higher genetic diversity than the smaller populations in more southern areas (Stone et al. 2012, entire). This is likely due to the size of the populations rather than latitude. There is ongoing research into the genetic diversity of the southern populations (Coffey 2021, pers. comm.) and study of populations in Virginia have found they are genetically diverse (McCormick et al. 2015; p.20-21). While understanding genetic diversity is important, there is currently, no suggestion that a lack of genetic diversity is limiting the distribution and abundance of this species.

2.3.5 Taxonomic Classification or Changes in Nomenclature

There have been no changes in the taxonomy of this species, and it is considered a valid taxonomic entity. The genus *Isotria* contains only two species globally: small whorled pogonia (*Isotria medeoloides*) and large whorled pogonia (*Isotria verticillata*) (Mehrhoff 1989a; Tamm 1972). The large whorled pogonia is larger and has three sepals that are long and tinged with purple and brown.

2.3.6 Trends in Spatial Distribution or Historical Range

Extirpations: Three states had only a single known site for the species and those populations have been extirpated over the years (e.g., Michigan, Illinois, Ontario) as described in the last 5-year review (USFWS 2008, p. 9). While these extirpations reduce the overall range, they were all single sites that probably did not add much to the overall viability of the species based on their disjunct distribution. However, they demonstrate that suitable habitat has been available in other areas of the Midwest and may still be present. It would be worthwhile to examine similar locations to those previously occupied to see if any other populations could be discovered in midwestern states.

Discoveries: There have been discoveries across the range but a new population discovered in Vermont in 2022 is the first population found in that state since 1902 (https://www.upi.com/Science_News/2022/06/09/Vermont-orchid-found/8441654764281). Discoveries are often made by interested citizens or knowledgeable people who are simply hiking, or by botanists discovering additional sites near currently occupied areas. It is difficult to find this small plant on the forest floor and to clearly identify the micro-sites it inhabits. It seems likely that there are additional sites where small whorled pogonia occurs that have not been discovered.

The potential for using scent detection dogs to find this plant was explored in summer of 2022 in both Virginia and New Jersey. Training on known sites in the field was successful (Chesapeake Bay Detector Dog Program 2022; K. Walz, NJDNR 2022 pers. com) and further work may result in a protocol for dog assisted surveys. Improved understanding and models of the micro-sites within a forest where this plant occurs may also be beneficial in finding more sites. Despite these challenges, there have been 54 new sites discovered in the last 10 years across its range and this is somewhat higher than the previous 10 years (42 sites discovered). Thus, while they are hard to find, discoveries are still occurring. Overall, the spatial distribution for this species is broad (Maine to Georgia), it occurs across a variety of ecoregions, and there have not been current concerns raised regarding colonization or connectivity. Appendix A provides descriptions of the micro-sites where this species occurs from individuals experienced with finding this plant to assist in the discovery of new sites.

2.3.7 Habitat or Ecosystem Conditions

Our ability to identify potential habitat for this species is limited. We know there are important features for soil moisture, soil fungi and light, but landscape features that we can use to find such habitat is still not clearly identified. There have been several habitat models created that attempt to identify potential suitable habitat for this species, including the Northeast region (Sperduto and Congalton 1996), Northeast and Central region (Virginia Natural Heritage Program 2018, entire), West Virginia (Krause 2021, entire), and Southern region (Montgomery 2014, entire). They all identify potential suitable habitat, and there have been subsequent discoveries in some of these areas, however, it is still challenging to pinpoint appropriate micro-sites and potential habitat for this species. This also limits our ability to find new occupied sites.

Preliminary results from habitat studies in the Southern region found larger populations of small whorled pogonia were associated with forests that had more conifers, and in this region those forests are typically younger (Xingwen et al. 2021, entire). Species composition was more important than the structural cover in the different forest layers which may also suggest fungal abundance associated with particular tree species had a relationship as well. This study also mentioned frequently finding small whorled pogonia associated with dead hemlocks (*Tsuga sp*.) (Xingwen et al. 2021, p. 12) and this has also been mentioned anecdotally in descriptions of sites in the Northeast as well. It is possible that the death of hemlocks in some areas is enabling more light to the forest floor and improving conditions for small whorled pogonia. The distribution of hemlocks and the recent invasion by hemlock woolly adelgid (*Adelges tsugae*) is very similar to the distribution of small whorled pogonia (Hessl and Pederson 2013, p.2). It would be interesting to understand how soil fungi is affected by the invasion of this hemlock pest, but it is especially important to improve our ability to find suitable habitat.

The association with mid-successional forests also creates some challenges in our assessment of this species' habitat. Plants may be most vigorous when forests are middle-aged, and then decline and perhaps hang on in small numbers in more mature forest until light gaps from falling trees are created and emergence improves (Whigham et al. 2021, entire). Thus, potential habitat can change over time and landscapes with different aged forests may be important to long-term survival.

Overall, there is a need to better understand the forest age and composition associated with larger populations of small whorled pogonia and this may be different in the Northern, Central, and Southern regions. Standardized habitat data to describe the surrounding forest age and composition would also be beneficial in determining these relationships and providing a better idea of suitable habitat and habitat quality. In addition, a better understanding of how fire and timber management practices affect this species would be useful for long-term survival of this species across larger areas (Fryer 2019, entire).

2.4 Five-Factor Analysis

The purpose of a 5-year review is to recommend whether a listed taxon continues to warrant protection under the Endangered Species Act (ESA) and, if so, whether it should be reclassified (from threatened to endangered or from endangered to threatened). This task requires that the analysis of the threats to the species be performed while assuming that the species is not receiving the regulatory protections, funding, recognition, and other benefits of ESA listing. Summaries of ongoing applications of ESA protections may shed light on some future activities that constitute threats to the species. However, the analysis under Factor D (Inadequacy of Existing Regulatory Mechanisms) focuses on the adequacy of existing alternative (i.e., non-ESA) mechanisms to address the continuing and foreseeable threats.

2.4.1 Destruction, Modification or Curtailment of Habitat or Range

While it is difficult to quantify suitable habitat available for this plant and any changes that may have occurred, there are certain threats that can destroy or modify its habitat as follows:

Development: The Recovery Plan describes the primary threat to this species' habitat as residential development (USFWS 1992, pp.29-32; USFWS 2008, p.11). This includes loss of forest for homes, roads, infrastructure, and energy. While this continues to be a major threat in some areas (e.g., Virginia), Table 5 above identified 109 sites that are generally protected from development because they occur on land owned by Federal, state, or city governments or conservation organizations; 46 of these sites were medium to large in size. Of course, other threats are possible on these lands such as timber harvest on U.S. Forest Service land and military maneuvers on Department of Defense land which could be detrimental. However, if not listed, these Federal agencies have regulations that may continue to protect this plant (see section 2.4.4). And while there are also sites on private lands that are well managed and maintained with low likelihood of development, the protected sites in Table 5 are an identifiable group of 109 sites where at least residential development will not become a threat, even in the absence of ESA protections.

Forest Succession and Shading: Forest succession was not described as a specific threat in the Recovery Plan or last 5-year review though too much shade was briefly discussed in both documents (USFWS 1992, p.26) (USFWS 2008, p.7). As described above, there have been recent studies indicating that management to open the canopy and increase the amount of light and soil fungi can be important (Brumback et al. 2011, entire; Dibble et al. 2019, entire; Whigham et al. 2021, entire). Many populations could be threatened with forest succession that closes the canopy and reduces the light to the plants making the habitat unsuitable. As described

earlier, this is a mid-successional forest species and as we follow populations through time, we would logically be watching the population decline as the surrounding forest becomes more shaded and less favorable for the species. Once a tree falls or a storm creates a canopy gap, there may be sufficient light and fungus for the plants at that site to flourish once again (Whigham et al. 2021, entire). It is possible that management is needed at many sites, or that timber harvests, perhaps selective harvests, is needed to create new suitable habitat across larger areas. Certainly, there is clear evidence that light and soil fungi can be limiting plant abundance and flowering (Brumback et al. 2011, entire; Dibble et al. 2019, entire; Whigham et al. 2021, entire). Many of the Federal lands that protect this species from development also have legislation that require that they maintain rare plants, regardless of their ESA status (see section 2.3.2.4 below). This legislation can prompt these organizations to manage for this species in order to maintain the populations.

Timber harvest: As described in the Recovery Plan (USFWS 1992, p.31), **s**ome timber harvests, such as clear-cutting of an existing small whorled pogonia site, would be completely detrimental to an occupied site, however, other types of harvest (like selection harvest) may be beneficial. And 30 percent of the protected sites of small whorled pogonia are on U.S. Forest Service property where timber management is an additional goal. We have examples of individual timber harvests that have avoided destruction of small whorled pogonia sites with careful planning and this has significantly enhanced the populations by providing more light to the site (Scott Young 2018, pers. comm.). But we do not have a forest management plan for larger areas that can insure protection of colonies, and potential creation of additional habitat. How we might create new habitat through appropriate forest management over a large area would be helpful research as Federal and State Forests could provide this even after the protections of ESA are not present.

2.4.2 Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Collection of this plant (digging it up and removing it from the site) has occurred and this is illegal on Federal lands. This is likely conducted for the purposes of sale or possession because rare orchids are prized by collectors. Collection risk is described as a threat in the current Recovery Plan and a 1986 and 1991 example of this problem are cited (USFWS 1992, p.32). In addition, in 2017 plants were dug up and removed from the Monongahela National Forest and U.S. Fish and Wildlife Service law enforcement offered a reward for information (The State Journal 2017). These activities destroy sites and continue to be a threat, but importantly, these plants will not survive if dug up because they rely on soil fungi that is connected to a living tree. Thus, attempts to develop a long-term illegal market is limited because plants cannot currently survive in a greenhouse or laboratory setting, but collectors may not realize this when they are digging up a site. The threat of collection may occur with or without the ESA protections, though the perception may be that it is less risky to collect the plant after delisting. Education and outreach that informs the public that this plant "must stay wild" and cannot be grown in a greenhouse or maintained alive after collection may be helpful in diminishing the interest in collection.

2.4.3 Disease or Predation

An unidentified mold or pathogen has been observed on small whorled pogonia in Virginia (McCormick et al. 2015, p.7), and an increase in its presence has been noted at one location (Jason Applegate 2021, pers. comm.). Herbivory by deer can be a problem and is described as a threat in the Recovery Plan (USFWS 1992, p.32). Populations that are being studied or managed are often caged to prevent this threat. While herbivory can be a local problem, this does not pose a rangewide threat and this would not change in the absence of ESA protections.

2.4.4 Inadequacy of Existing Regulatory Mechanisms

In this status review, we must evaluate what protections would occur if this species were not on the Federal endangered species list. Continued protections and management for this species would occur even without the ESA designation through the following mechanisms:

U.S. Forest Service Protections: Plants on U.S. Forest Service (USFS) lands are subject to USFS regulation 36 CFR 261.9 that prohibits removing or damaging any plant that is classified as a threatened, endangered, sensitive, rare, or unique species (https://www.ecfr.gov/current/title-36/chapter-II/part-261/subpart-A/section-261.9). It is likely that small whorled pogonia would continue to be classified as rare or unique even if not on the Federal endangered species list. Protection of rare plants is consistent with the USFS general mission as well.

National Park Service Protections: The mission of the National Park System (NPS) is to preserve, unimpaired, the natural and cultural resources and values of the NPS for the enjoyment, education, and inspiration of this and future generations. Protection and management of rare plants is part of this mission but depends on staff and funding.

Military Land Protections: Plants on Department of Defense (DoD) lands are subject to the Sikes Act Improvement Act of 1997, that requires DoD and its military services (i.e., Army, Air Force, Navy, and Marine Corps) to prepare and implement Integrated Natural Resources Management Plans (INRMPs) for each military installation with significant natural resources. INRMPs aim for sustainable natural resources management while ensuring no net loss in the capability of installation lands to support the military mission.

In addition, DoD Directive 4715.03 establishes goals for the conservation of biological diversity on military lands. This includes the goal to maintain or reestablish viable populations of all native species in an installation's areas of natural habitat, when practical.

State Protections: Federally listed species, such as small whorled pogonia, currently occur on state lists of threatened and endangered species as well, and if delisted, this plant is likely to remain on state lists under some designation. However, state endangered species protections vary and are generally limited to restrictions on prohibition of direct harm or take.

2.4.5 Other Natural or Manmade Factors Affecting its Continued Existence

Climate change has the potential to affect the suitability of current sites. Over the whole range, increases in temperature and total precipitation would be expected along with more frequent, severe weather events; droughts are also possible at times. But predicted changes also differ across this large range, and the actual response of the plants is uncertain. For example, in areas of the Northeast, increases in temperature and precipitation are expected but these changes are smaller in the Southeast (USGCRP 2017) and how these changes would affect the plant is not clear. Dibble et al. (2019, p. 90) attempted to examine weather variables such as precipitation and capsule production at four sites in Maine, but clear relationships were not apparent. Severe storms may bring trees down and improve conditions for the plant, but in other areas some sites may become too warm or dry or have too much sunlight. Given that this species occurs in a wide range of latitudes and elevations, it may have the adaptive capacity to adjust to some changes in climate; thus, we do not consider it to be especially sensitive to the negative effects of climate change. Furthermore, we do not envision that removal of ESA protections would create or exacerbate threats to small whorled pogonia due to climate change.

No other factors are considered to affect this species range wide. There is always the risk of plants being trampled inadvertently by researchers or recreational hikers, but this is not considered a factor effecting the populations range wide.

2.5 Synthesis

The status of the small whorled pogonia has improved since its last 5-year Review (USFWS 2008). We now have more sites (179) where plants are extant (Table 1) providing greater redundancy across the large range. The increases have primarily occurred in the Northeast and Central regions of the range, as the Southern portions of the range have remained about the same. Most management experiments have occurred in the Northeast and Central regions and additional studies of management in the Southern region would be helpful. There are a few large and medium sites in the south, but these may not be sufficiently abundant to secure the populations. There are more sites (109) on protected lands that will have higher resiliency from the threat of development (Table 5). However, the threat of forest succession and increased shading remains a threat for all sites regardless of protected status.

We are getting a better understanding of the environmental requirements for this species, especially the need for abundant soil fungi and light (see section 2.3.1). Based on the current information, it appears that some disturbance or management may be needed for this species to persist over time. We need to identify larger protected landscapes that contain multiple small whorled pogonia sites where management can occur to enhance persistence of existing sites and potentially create or find new areas of suitable habitat. These should be distributed across the range and provide a description of the specific management needs for this species in order to avoid the threat of continued forest succession over-shading these populations.

Without this list of secure sites with recommended management plans, this species is still considered at risk of extinction in the foreseeable future from continued succession and lack of management. After evaluating the status of the species and current and future threats, we

conclude that the small whorled pogonia continues to meet the definition of a threatened species under the ESA.

3.0 RESULTS

3.1 Recommended Classification

____ Downlist to Threatened
____ Uplist to Endangered
____ **Delist** (Indicate reasons for delisting per 50 CFR 424.11):
____ *Extinction*
____ *No longer meets the definition of threatened or endangered*
____ *No longer meets the definition of a species*
_X___ No change is needed

3.2 New Recovery Priority Number

Retain as 14. No change is needed.

Brief Rationale: This species has a large range with a large number of sites where the species occurs which makes the recovery potential relatively high, but the threat of forest succession diminishing habitat quality is likely to occur across the range. This species is likely to need some management to persist over long periods of time and this threat still needs to be addressed.

3.3 Listing and Reclassification Priority Number

Not applicable**.**

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

This species is a mid-successional forest species that requires some disturbance or management to prevent forest succession from closing the canopy, over-shading these plants and diminishing numbers and viability (percent flowering, fruiting etc.). Taken together, the remaining three Recovery Criteria focus on having large, protected landscapes where small whorled pogonia can be managed and there is sufficient area to create new areas of suitable habitat. These larger landholdings or landscapes are important strongholds for this species that can ensure future survival.

There are National Forests, Department of Defense properties, National Parks, and state lands that contain multiple small whorled pogonia sites where monitoring and management is occurring or could occur. We need to identify these as part of a Recovery Implementation Strategy, and better define appropriate management for these sites. The many small whorled pogonia sites that are more isolated and scattered across the range remain important to recovery as they provide a source of seeds across the range and the potential to increase populations to larger numbers. But having known strongholds of multiple sites, in protected landscapes where

management can occur (if needed) will be important for long-term conservation. We need to pay special attention to the needs of the populations in the Southern region because there are fewer sites and we are not clear if they are more susceptible to climate change.

The needed future recovery actions for this plant focus on three areas and these should be addressed in a Recovery Implementation Strategy:

1) **Identify protected Conservation Areas** that host multiple small whorled pogonia sites that could provide monitoring and management for this species after delisting. This is essentially Recovery Criterion 3 where protected lands included sufficient space for habitat change to occur and occupied sites might change locations. Examples of Conservation Areas include Fort A.P. Hill (Department of Defense) and Prince William Forest Park (National Park Service) where we have multiple sites, extensive monitoring, and potential management for small whorled pogonia. A Recovery Implementation Strategy will develop this list.

2) **Provide a description of the needed management for each area**. This might be a general description presently, but we anticipate management occurring with monitoring and adaptive management to improve our understanding of management techniques that are best for each site in the future. Initial work should summarize current and new research on increasing light to populations to understand: how much, and what type of timber is removed; what is the suitable range of canopy closure or light transmittance; how long does the management effect last and; how do we best describe this management actions and measurements to monitor in terms that foresters might use. Current research describes changes at a particular micro-site, can we translate that to management of forest stands?

3) **Improve our ability to survey for this species** and find it in new locations, both within and outside the Conservation Areas because as habitat matures, sites we currently know about are likely to decline over time and new sites are likely to be developing. We will need to be able to find this plant in newly created habitat.
    a. Explore the use of scent dogs to detect small whorled pogonia (summer of 2022 this work began).
    b. Explore better modeling of micro-sites where this species occurs to improve searches.
        i. Potentially the HUC 12s could be analyzed using topography, canopy closure (using LiDAR?), and soil maps to improve our ability to find suitable micro-sites.
        ii. Compare the micro-sites supporting large vs small populations. Are there key features that consistently occur with large sites? Consider forest stand age and past history as well as past disturbance that has occurred, etc.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of SMALL WHORLED POGONIA

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_x___ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Cherry Keller, Chesapeake Bay Field Office

LEAD REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Fish and Wildlife Service

Approve SHARON MARINO Digitally signed by SHARON MARINO Date: 2022.08.26 13:50:10 -04'00' Date _____

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APPENDIX A: Search Image for Forest Sites Occupied by Small Whorled Pogonia

The small whorled pogonia is found in appropriate micro-sites (here defined as sites of about 1 acre (0.4 ha) in size) within mid-successional to mature mixed hardwood and hardwood-coniferous forests from Maine to Georgia. The requirements for particular microsites creates a patchy distribution for this species within forested areas. The common features of the appropriate micro-sites are cool temperatures, moist and acidic soils often with heavy leaf litter, the presence of some dead or decaying wood (snags or stumps) and sufficient light. We believe these are the important environmental needs for both the mycorrhizal fungi and the plant as the plant cannot occur without the fungi. A few descriptions of these micro-sites and cues that investigators can look for when searching for this plant are described below.

New Hampshire (S. A. Young, 2022, personal communication):
This search profile should be an aid while exploring new areas or monitoring existing EOs for new sub populations. This is not for recently logged situations as many of these features will be obscured.

Elevation: Range 250-1100 ft, large EOs are most common between 600-900 ft, sub populations below 500 ft tend to have a maximum sub population size of < 30 stems per season.
Acid soils on supporting bedrock.
Generally, south facing slopes- this can be ENE to NNW, with the more southerly exposure being ideal.

Forest Composition: hemlock-beech-oak-pine forest where there are abundant dead or dying fast decaying trees in the following order of importance/abundance: Red maple, Birches, Poplar, White Pine, Hemlock, and White Ash. Preferably the canopy should be variable with alternating patches of conifers and deciduous. Gaps in mature forests or late early successional. Anywhere the trees are weak and the witchhazel is strong.
These are not wetland plants so avoid long term saturated soils, indicated by alder or where sphagnum is common. *Botrychium oneidense* is often near SWP subpopulations but is restricted to the more saturated wetland transition zone. *Corallorhiza odontorhiza* has been found multiple times just uphill. All other forest floor plants tend to be typical, sparse and lack vigor.
When Mt. Laurel has colonized the hill tops, slopes and wetland margins then the chances of SWP are minimized.

Drainage/Soil Moisture/Fungal Activity: Look for evidence of high moisture content in soils within this forested system. Deep permeable soils are not ideal.
Look for small rock outcrops immediately above drainage corridors or terraces or abundant surface rock and stone within a low to moderately sloped terraced terrain. This tends to increase surface soil moisture for the available soil.
Look for groups of dead or dying trees in these moister areas, either large lone specimens (particularly of maple), groups of canopy or sub canopy trees (including hemlock), or stands of sapling to pole sized trees where the competition is sorting them out (young white pine stands).

If the following conditions occur frequently across a broad area, then the chances of SWP also increase:

1. Lightly Scoured Ephemeral Stream Corridor- most often interrupted, benches adjacent to intermittent soft streams alternating with outwash terraces/soft basins are a common theme. The base of the stream has exposed mineral soil, not rock.

2. Outwash Plains- result of larger ephemeral stream activity when it encounters a terrace.

3. Pit Mound Basins- Frequently well populated with large *Hammamelis virginiana*, sphagnum rarely present.

4. Low Slope (cobbled) Terrace-SWP more often associated with the lower elevations.

5. Pit Mound Medium Slope

6. Terrace Dropoff- this often is associated with a poorly defined basin immediately above.

7. Human alterations- Cow paths, skidder ruts that cut across a slope can dam percolation and increase near surface moisture content. Log landings can shed water like rock outcrops, improving soil moisture on the downside. Stone walls cutting across the slope can store runoff waters and collect organic debris that improves chances of SWP below the feature.

8. Dead Trees- Remember to always check standing dead trees! A rotting root system is a sponge. Large downed woody matter is most important in the last stages of decomposition when it is nearly incorporated into the soil. Generally, this contribution is minimal in our modern forests. These don't have to be directly or obviously in a drainage. Trees best suited to the development of SWP rings (these are higher concentrations of SWP surrounding stressed or standing dead /decaying tree) in order of highest to lowest occurrence: Red/Sugar maple, Birch sp. (White in particular) ,Poplar sp., White Pine, Hemlock. I have not identified this pattern around beech or oak. Usually the trees have a 8" or greater diameter.

9. Transition areas leading into swamps or beaver ponds- Red maple, Atlantic white Cedar, areas above the shrubby transition area leading into a beaver ponds where the water table is high

10. Isolated Large White Pine- In the duff of the root flare of larger diameter white pine that have been overlooked during previous logging cycles. So far, always on the south facing side. Within the HBOP topography the SWP are mostly located in higher mesic conditions. In a basin situation they can be in pits where the mounds stay too dry or they are on the mound slopes when the soil stays overly moist too long. The plants can handle short term inundations but not long term. I believe their position also demonstrates that the appropriate fungi are feeding near the surface of the organic horizon. Hypothesis: early contact between seed and highly active fungi is required for establishment. This is most likely to occur in moist areas with abundant deteriorating organic debris. The most obvious example that reinforces the notion of this requirement would be the SWP-ring phenomenon. In these situations, the plants are both more robust and dense in stem numbers-light isn't the major factor dictating establishment. Higher

light levels on the forest floor would increase soil temperature increasing fungal activity. The catch is that the light would also tend to increase evaporation, decreasing fungal activity. When looking at topo maps to select search areas remember that the lines are averages of the actual terrain topography. In fact when you arrive at your search area and discover that the topography is extremely pit/mound or highly undulated with deep drainages, its best to employ a nearby back up search area.

Central Region, West Virginia (Short et al. 2021):
Elevation: Range 2080-2850 feet
Soils: Acidic Soils with deep litter/duff layer
Slopes: Typically located on south facing slopes – S, SW, SE. Occasionally located on east facing slopes.
Typical forest associations: Primarily associated with mid-late successional oak dominated forest communities – Mixed-oak, Oak-pine, Oak-ericad, Oak-hickory, but occasionally found in mid-late successional mixed northern hardwoods forest communities.

Areas deemed more suitable to the species include intact/mature forest, areas with a thick duff layer, transition zones between mesic and xeric forest types, riparian corridors, hillside drains, and locations where large whorled pogonia (*Isotria verticillata*) are present. Thus, sites might include a mesic bottomland adjacent to a perennial stream, or a more xeric oak-pine forest with a mesic understory.