Interim Core Map Documentation for Virginia Spiraea

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Draft Interim Core Map Developer: Compliance Services International (CSI) on behalf of Bayer CropScience

Species Summary

Virginia spiraea (*Spiraea virginiana*; Entity ID 1039) is a dicotyledonous threatened plant found in Georgia, Kentucky, North Carolina, Ohio, Tennessee, Virginia, and West Virginia. The U.S. Fish and Wildlife Service (FWS) has not assigned designated critical habitat for Virginia spiraea. FWS has not assigned designated critical habitat for Virginia spiraea. This species inhabits scoured banks of high gradient streams and braided features in lower stream reaches. Additional habitat information is provided in **Appendix 1**.

EPA Review Notes

The developers created this core map using EPA's process available at: https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas. EPA reviewed the draft interim map and documentation and evaluated if: (1) the map and documentation are consistent with EPA's process; (2) areas included or excluded from the interim core map are consistent with the biology, habitat, and/or recovery needs of the species; (3) data sources are documented and appropriate; and (4) the GIS data and mapping process are consistent with the stated intention of the developer. EPA agrees that this map is a reasonable depiction of core areas for this species and was consistent with the agency's mapping process. This documentation was not prepared by EPA, and EPA may have edited this documentation for clarity or other purposes. Some views expressed in this documentation may not necessarily be the views of EPA or its staff.

The core map developed for this species is considered interim and can be used to develop pesticide use limitation areas (PULAs). This core map incorporates information developed by FWS and made available to the public; however, the core map has not been formally reviewed by FWS. This interim core map may be revised in the future to incorporate expert feedback from FWS.

This core map does not replace or revise any range or designated critical habitat developed by FWS.

Description of Core Map

The core map for the Virginia spiraea is biological information type based on a combination of species range and watersheds known to contain extant populations. The species' 5-Year Review (FWS 2021) includes a map of Hydrologic Unit Code (HUC)-10 watersheds where the species is known to occur. Known location information from the iNaturalist and Global Biodiversity Information Facility (GBIF) databases, and NatureServe, provided validation of the use of range as the outer boundary of core map extent, but were not otherwise used in core map development.

In North Carolina, habitat was represented using a species-specific model developed by the North

Carolina Department of Transportation (NCDOT) in 2020. Because this model was species-specific and based on a thorough analysis of underlying variables, this dataset was the best available for the habitat of the Virginia spiraea; its main disadvantage is its extent, as the model does not extend to areas outside of North Carolina. In other states, habitat areas were represented using the National Wetlands Inventory (NWI) water bodies with attributes matching descriptions of species habitat. These selections of NWI water bodies were partially informed by information provided in documentation for the species-specific model used in North Carolina.

The core map developed in this document for the Virginia spiraea spans 27,639 acres (Figure 1). A summary of acreage by National Landcover Database (NLCD 2021) land use type is provided in

Table 1.

Based on the U.S. Environmental Protection Agency's (EPA) "best professional judgment classification" system, CSI has graded this core map as "moderate" (4) because assumptions were made when connecting species life history and/or biological needs (*i.e.* habitat preferences) to a Geographical Information System (GIS) dataset, in this case the NWI dataset (FWS 2023). These assumptions involved associating the species' primary habitat—high gradient streams and braided features in lower stream reaches—with corresponding NWI classifications, in this case, select riverine wetlands listed in **Appendix 2** Section 2.4. More information about the best professional judgment classification system and its definitions can be found in the core map process document (EPA 2024).

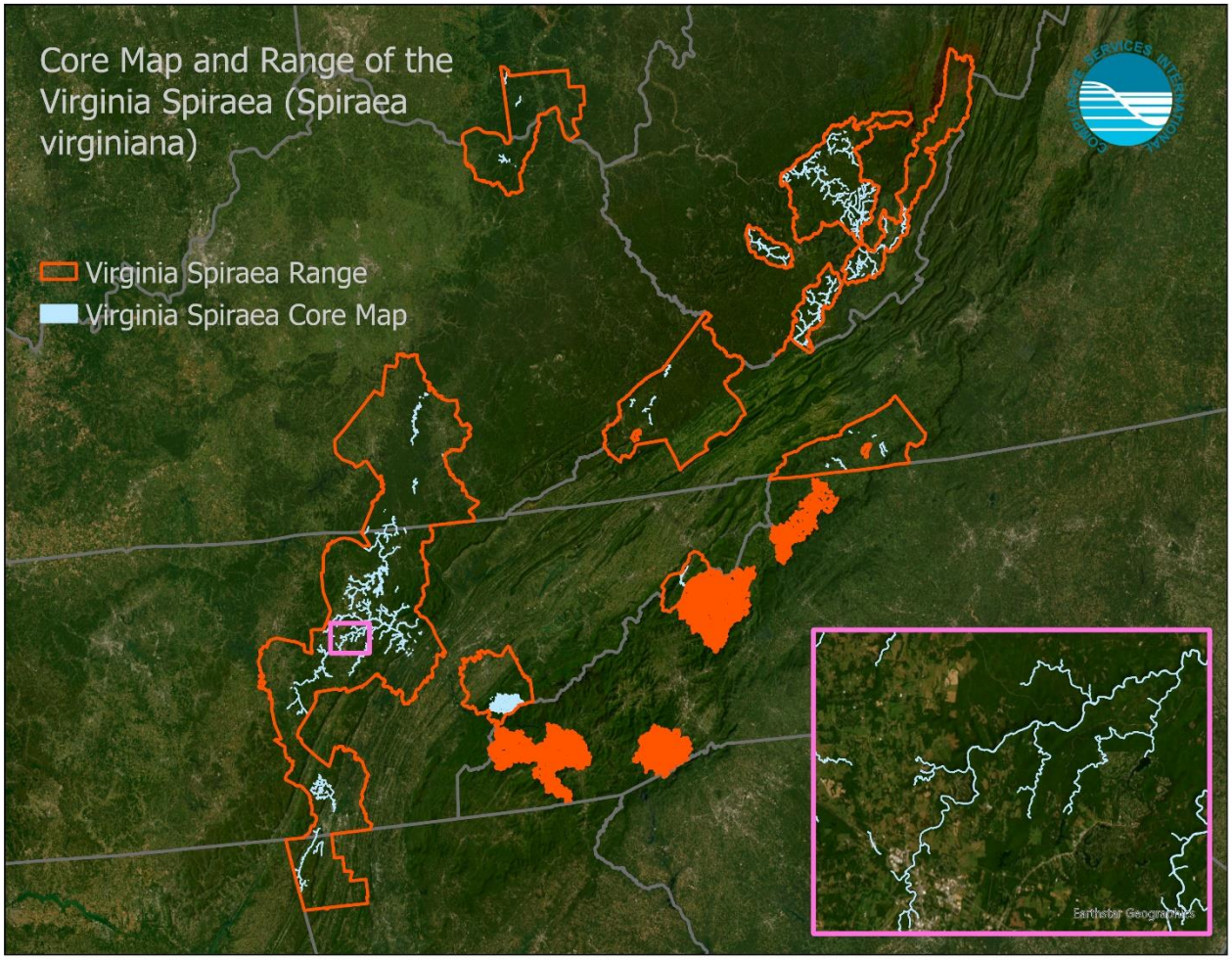


*Figure 1. Interim core map for the Virginia Spiraea (*Spiraea virginiana*; Entity ID 1039). The core map spans 27,639 acres, while the range is 9,339,355 acres.*

Table 1. Acres by National Land cover Database (NLCD 2021) class within the core map of the Virginia spiraea. Total core map area (based on NLCD pixel count): 27,617 acres[1].

NLCD Land Cover Class	Acres
Deciduous Forest	9,090
Open Water	5,760
Mixed Forest	4,852
Developed, Open Space	3,075
Hay/Pasture	1,749
Evergreen Forest	919
Developed, Low Intensity	646
Woody Wetlands	418
Emergent Herbaceous Wetlands	339
Developed, Medium Intensity	336
Herbaceous	200
Shrub/Scrub	108
Barren Land	54
Developed, High Intensity	36
Cultivated Crops	35

Evaluation of Known Location Information

There were four evaluated datasets with known location information:

- Descriptions of locations provided by FWS;
- Occurrence locations in iNaturalist;
- Occurrence locations in GBIF; and
- Occurrence locations in NatureServe

Compliance Services International evaluated these four datasets before developing the core map. Overall, there were 26 usable research-grade observations found in iNaturalist.[2] The GBIF dataset comprised 36 georeferenced observations, 23 of which were considered usable based on the criteria described below. Both datasets were useful to identify extant population sites for the Virginia spiraea, but not comprehensive enough to be used in core map development. These datasets were largely redundant because the iNaturalist observations comprised all the GBIF observations.

The FWS location information included a map of HUC-10 watersheds where the species is known to occur; this provided a refinement of species range. Additionally, species elevation requirements were

[1] This acreage is slightly different from the core map acreage (27,639) due to the pixelation of NLCD land cover. The core map is not developed from raster data.

[2] According to iNaturalist, an observation is designated as "research grade" if it 1) is verifiable with date, coordinates, photos/sounds, and not captive; 2) achieves community agreement defined as "more than 2/3 of identifiers needs to agree on the species level ID or lower;" and 3) "must pass a data quality assessment, which includes checks for accurate date and location, evidence of a wild organism, and clear evidence of the organism itself" (https://help.inaturalist.org/en/support/solutions/articles/151000169936-what-is-the-data-quality-assessment-and-how-do-observations-qualify-to-become-research-grade-).

used to further refine the core map extent, using even more refined (HUC-12) watershed boundaries.

Public occurrence data were used for comparison purposes, did not contribute to the development of the core map.

Approach Used to Create Core Map

The core map was developed using EPA's process for developing core maps for species listed by the FWS and their designated critical habitat (referred to as "the process"). This core map was developed by CSI using the four steps described in the process document:

1. Compile available information for a species;
2. Identify core map type from among the following defined types: critical habitat, range, and biological information. From EPA, summaries of each core map type are provided below (EPA 2024).
3. Develop the core map for the species; and
4. Document the core map.

For step 1, CSI compiled available information for Virginia spiraea (*Spiraea virginiana*) from FWS, as well as observation information available from various publicly available sources including iNaturalist, GBIF, and NatureServe. The information compiled for Virginia spiraea (*Spiraea virginiana)* is included in **Appendix 1**. Influential information that impacted the development of the core map includes a description of the species habitat from its ECOS webpage and the Recovery Plan:

- Virginia spiraea is found along scoured banks of high gradient streams or on [meandering] scrolls, point bars, natural levees, and braided features of lower stream reaches. In Virginia, soils are sandy, silty, or clay and elevation range is 1000-2400 feet. If the roots are exposed, they will give rise to upright stems (FWS 2025).
- *S. virginiana* typically is found in disturbed sites along rivers and streams. The species requires disturbance sufficient to inhibit arboreal competition, yet without scour that will remove most organic material or clones. (FWS 1992).

For step 2, CSI used the compiled information including the species range, known locations, and habitat location information to determine the core map type. Compliance Services International compared the known location data to the range and found that known locations from FWS (HUC-10 watersheds with extant populations) were usable as a refinement of range in determining the core map extent. Other known location data from GBIF, iNaturalist, and NatureServe were not used to develop the core map.

Review of the available data also suggested that the core map could be refined based on habitat requirements. To represent the species' habitat outside of North Carolina, the NWI dataset was used to identify habitat classes associated with the species habitat description above; using the "ATTRIBUTE" field. The resulting shapes were dissolved together and clipped to the core map extent. In North Carolina, habitat was represented using a state-wide species-specific model developed by the NCDOT, by extracting areas of high probability of habitat suitability according to its categorical model. Finally, these two datasets (NWI and NCDOT) were merged and had contiguous cultivated areas > 25 acres (EPA 2024) removed to develop the core map.

For step 3, CSI used the best-available data sources to generate the core map. Data sources are discussed in EPA's core map process document. For this interim core map, CSI followed EPA's decision framework to arrive at a core map type of biological information within an extent refined from species range. Designated critical habitat was eliminated as a core map type because the Virginia spiraea does not have critical habitat. The range core map type was not selected because the species range is not particularly refined. **Appendix 2** provides more details on the GIS analysis and data used to generate the core map.

Discussion of Approaches and Data that were Considered but not Included in Core Map

Alternative approaches not already described in this documentation were not explored.

Appendix 1. Information compiled for Virginia spiraea

1. **Recent FWS documents**
   - 5-Year Review (2021): https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3626.pdf
   - ECOS Species Profile Page (2025): https://ecos.fws.gov/ecp/species/1728
   - Recovery Plan (1992): https://ecos.fws.gov/docs/recovery_plan/921113a.pdf

2. **Background information**
   - Status: Federally listed as threatened in 1990.
   - Resiliency, redundancy, and representation (the 3Rs) (Table 2, FWS 2021)
     - When assessing the 3 Rs, 36.0% of historically known EOs are considered healthy (e.g., moderately to highly resilient) and 22.5% of historically known EOs are both considered healthy and located on public or permanently managed/protected lands. However, 25.8% of historically known EOs have an uncertain probability of persisting (fairly resilient) and 16.9% of historically known EOs have a high risk of extirpation (poorly resilient), if current conditions prevail. If we predict that approximately half of the EOs with an uncertain probability and all the EOs with a high risk of extirpation will not persist in the future, there is a potential for 48.3% of historically known EOs to become extirpated in the future when including EOs that are currently presumed extirpated or historical.
     - Overall, Virginia spiraea lost redundancy in the northern and southern portions of the historical range prior to 1992, but since then the species has increased redundancy in the middle part of the range with 11 new HUC-10s due to increased searches for the species; however, the species has become presumed extirpated in 1 HUC-10 in this area since 1992.
     - Collections of living Virginia spiraea plants from 26 of 72 extant EOs (36.1%) and 2 of 7 historical/extirpated EOs (28.6%) across the range are maintained at multiple gardens. Efforts to conduct genetic analyses to determine genotypes across the range and within the collections are needed to determine which localities should be added to cultivated collections to provide genetic representation. Genetic analyses are ongoing.

- Table 2 summarizes current conditions.

Table 2. Resiliency, redundancy, and representation (3Rs) for Virginia spiraea and its currents condition. Copied from Table 7 of the 5-Year Review (FWS 2021).

3Rs	Requisites	Description	Current Condition
Resiliency (ability to withstand stochastic events)	Healthy populations and habitat	Populations with: * High gradient streams/rivers with scoured banks, meander scrolls, point bars, natural levees, or other braided features; * Normal hydrologic flows to maintain habitat integrity and reduce competing arboreal and invasive vegetation; * Connectivity—waterways without impoundments and significant barriers to allow dispersal.	Each population or EO with excellent or good (A or B rank) current condition is thought to be healthy and have adequate habitat, thus has high or moderate resiliency, respectively. * 72 of 89 EOs (80.9%) are known to be extant. * EO status: - 32 EOs (36%) excellent/good condition - 23 EOs (25.8%) fair condition (C rank) - 15 EOs (16.9%) poor condition (D rank) - 2 EOs (2.2%) unknown condition (E rank) - 17 EOs (19.1% presumed extirpated (F or X rank) or historical
Redundancy (ability to withstand catastrophic events)	Sufficient distribution of healthy populations	Sufficient distribution of healthy populations to prevent catastrophic losses of species' adaptive capacity due to severe flood events. Multiple healthy populations and occupied HUC10s (watersheds) distributed within the species range are important for the species' redundancy.	* Healthy EOs (good to excellent condition) throughout range, but not evenly distributed in some areas: fewer healthy EOs in specific areas of middle portion of range and northern and southern extents of the range. * Loss of occupied HUC10s in the northern and southern extents of the range (historically; priori to 1992) * Increase in occupied HUC10s in the middle portion of the range due to increased searches for the species.
Redundancy (ability to withstand catastrophic events)	Sufficient number of healthy populations	Sufficient number of healthy populations and occupied HUC10s to prevent catastrophic losses of adaptive capacity.	* 32 of 89 EOs (36.0%) are good to excellent condition across the range. - Ohio basin: 14 of 52 (26.9%) are good to excellent condition. 16 of 52 (30.8%) are fair condition. - Tennessee basin: 18 of 37 (48.6%) are good to excellent condition. 7 of 29 (24.1%) are fair condition. * 40 of 47 HUC10 watersheds (85%) currently occupied.
Representation (ability to adapt)	Sufficient capacity to adapt to new, continually changing environments	Genetic diversity within and among populations contribute to and maintain adaptive capacity. Occupied HUC10s distributed across the range, including the ecological diversity of river basins and physiographic provinces that contribute and maintain adaptive capacity. Adequate dispersal ability for the species to migrate to suitable habitat and climate over time.	Low genetic diversity documented among populations analyzed thus far, but able to reproduce asexually. Connected, occupied HUC10s found in both river basins and physiographic provinces. **River basin:** * Ohio- 22 of 26 HUC10s (84.6%) occupied. * Tennessee- 18 of 21 HUC10s (85.7%) occupied. **Physiographic province:** * Appalachian Plateau- 28 of 32 HUC10s (87.5%) occupied. * Blue Ridge- 12 of 14 HUC10s (85.7%) occupied. * Interior Low Plateau- 0 of 1 HUC10s (0%) occupied.

- Habitat, Life History, and Ecology
    1. Virginia spiraea is found along scoured banks of high gradient streams or on meander scrolls, point bars, natural levees, and braided features of lower stream reaches. In Virginia, soils are sandy, silty, or clay and elevation range is 1000- 2400 feet. If the roots are exposed, they will give rise to upright stems (FWS 2025).

2. *S. virginiana* typically is found in disturbed sites along rivers and streams. The species requires disturbance sufficient to inhibit arboreal competition, yet without scour that will remove most organic material or clones (FWS 1992).
3. Rhode Ward and Estep (2019) conducted studies to survey floral insect visitors of Virginia spiraea corymbs and assessed pollen on the insects to determine which of the insects could be effective pollinators; preliminary data analyses suggest that bee species carried higher percentages of Virginia spiraea pollen (FWS 2021).
4. The 1992 Recovery Plan notes that lowering occurs Late May-late July. However, the FWS 2021 indicates that peak flowering in West Virginia occurs from June 1 to September 30.

- Taxonomy

1. 'Clarkson (1959) reviewed the taxonomic and distributional history of *S. virginiana* and restated the narrow delineation of Britton (1890) and Rehder (1920, 1949). He stated that the species has "quite constant characters," referred two collections (Morgan County, Tennessee, and Walker County, Georgia) to *S. corymbosa* Raf., and highlighted a Dade County, Georgia collection that did not resemble the type of description' (FWS 1992).

- Relevant Potential Pesticide Use Sites
    1. 'Herbicide (triclopyr) applied to manage invasive Japanese knotweed has been observed to spread and impact a few adjacent Virginia spiraea stems across 3 populations in the Little Tennessee River, White Oak Creek, and Nolichucky River' (G. Kauffman, USFS, email to J. Stanhope, Service, July 30, 2021).

- Relevant Recovery Criteria and Actions
    1. Criteria for Delisting (FWS 2021)
        1. <u>Any existing or, if possible, a minimum of three stable populations are permanently protected in each drainage system where populations are currently known.</u> It is difficult to determine abundance and population trends for Virginia spiraea due to different monitoring approaches for abundance (e.g., stem counts, areal coverage, clumps) and definitions for populations (clones, population, element occurrence [EO], and sub-EOs) over time and among the states in Virginia spiraea's current range… In addition, drainage system was not sufficiently defined in this criterion. Recognizing the ambiguity in this criterion, we made an assessment based on assumptions that an EO is a population, stable populations are those with an A or B rank, and drainage system is a minor drainage basin based on hydrologic unit code (HUC) 4 basins. Based on these assumptions, the criterion has not been met because only 4 of the 9 minor drainage basins with known populations (i.e., based on 1992 recovery plan) have 3 or more A- or B-ranked EOs on public or permanently managed/protected lands. For the 5 minor drainage basins that do not meet the criterion, 4 have no A- or B-ranked EOs on public or permanently managed/protected lands and 1 has 1 A- or B-ranked EO on public or permanently managed/protected lands.
        2. <u>A minimum of three stable populations are established or found in drainages where documented vouchers have been collected, and that the species is not currently known. These populations must also be permanently protected.</u> This criterion is ambiguous for the same reasons discussed above for the first criterion. If we make

the same assumptions as for criterion 1, there is only 1 minor drainage basin where documented vouchers have been collected and the species was not known at the time of the 1992 recovery plan, which is the Middle-Tennessee-Elk. This basin contained a historical occurrence in Cypress Creek, AL. This criterion has not been met because no Virginia spiraea occurrences have been documented in this basin since the 1890s.

3. Potential habitat in all states with present or past collections has been searched for other populations. This criterion has not been met as stated. Ogle (2008) estimated that approximately 60% of potential habitat in states with present or past collections, specifically in the Blue Ridge and Appalachian Plateau physiographic provinces, had been surveyed for additional populations by 2007. Since then, additional surveys in known drainages (as defined by state natural resource agencies) have found 12 new EOs across the range in North Carolina, Ohio, Tennessee, and West Virginia, as well as rediscovered an EO in the Buckhannon River, WV, in 2019, which was thought to be extirpated in 2007. It would be difficult to provide an updated percent of potential habitat surveyed in states with any collections, but it is expected to be more than 60% but less than 100%. State natural resource agencies expect to find new EOs/sub-EOs with additional comprehensive surveys of potential habitat in known drainages. Also, there is the possibility of additional areas of suitable habitat based on a species distribution model.
4. Representative genotypes are cultivated in permanent collections with adequate locality information. This criterion has not been met. Collections of living Virginia spiraea plants from 26 of 72 extant EOs (36.1%) and 2 of 7 historical/extirpated EOs (28.6%) across the range are maintained at multiple gardens. Efforts to conduct genetic analyses to determine genotypes across the range and within the collections are needed to determine which localities should be added to cultivated collections to provide genetic representation. Genetic analyses are ongoing.

- Recovery Actions (FWS 2021)
    1. Clarify recovery criteria 1 and 2 to support consistent evaluation and to reflect current information. Specifically, both recovery criteria should be clarified in terms of population assessment measures (e.g., what factors determine a “stable” population) and definition of “population.” In addition, the definition of “drainage system” should be clarified as it relates to this species’ recovery and definition of a population.
- Recommendations for Future Actions (FWS 2021)
    1. Continue genetic analysis of Virginia spiraea across its range and within collections to determine genotypes and ploidy numbers, which will help guide potential propagation efforts and determine which localities/genotypes should be added to cultivated collections to provide genetic representation [Priority 1].
    2. Develop specific guidance on the treatment of invasive species that threaten this species and recommendations for habitat management to increase viability of the populations, in particular EOs with C or D ranks. Include invasive species specialists and encourage practical application of invasive species and habitat management in populations across the range [Priority 1].
    3. If deemed necessary based on the genetic analysis, develop a range-wide propagation and reintroduction plan [Priority 2].
    4. Coordinate with natural resource agencies to complete range-wide review and revision, if needed, of the Virginia spiraea species distribution model to help identify potential suitable

habitat [Priority 2].

5. Conduct comprehensive surveys of potential habitat in streams/rivers with known occurrences and no known occurrences, but identified in a species distribution model, to find new populations. Efforts should focus within the Blue Ridge and Appalachian Plateau physiographic provinces, where almost all EOs occur [Priority 2].
6. Conduct surveys of extant EOs that have not been surveyed for more than 10 years to verify presence and update their EO ranks [Priority 2].
7. Determine if there is suitable habitat in areas where the species has been historically documented or extirpated and search these areas. Some areas that should receive priority ranking for survey work include, but are not limited to: Cypress Creek, AL; Youghiogheny River, MD and PA; Little River, TN; Hominy Creek, NC; Monongahela River, WV; and New River, WV [Priority 3].
8. Coordinate with natural resources agencies and Service Field Offices to develop methods and resolve nomenclature for accurately counting/measuring individual plants, population size, and populations to provide consistency and allow objective assessment of populations. Also coordinate to define appropriate ecological units (e.g., HUC units) to assist with organizing populations as it relates to species' recovery [Priority 3].
9. Coordinate with natural resource agencies and NatureServe to utilize consistent definitions of EO and EO rank for Virginia spiraea across the range to allow analysis of population trends and consistent assessment of status [Priority 3].
10. Develop educational materials for local government and public use aimed at increasing public awareness of the species, particularly in areas where development and recreational activities may impact Virginia spiraea [Priority 3].

3. Range

'Specimens have been deposited in herbaria collections and the species occurrence has been vouchered since the initial description in 1890. Virginia spiraea is widely scattered within 7 states (Georgia, Kentucky, North Carolina, Ohio, Tennessee, Virginia, West Virginia) and recorded from historical locations in Pennsylvania and Alabama (Youghiogheny River and Cypress Creek, respectively). Historical records from both states have been examined and verified and periodic searches have occurred in both locations, but the species is not currently known from either state (Ogle 1991; Ogle 2008; R. Anderson, Service, email to J. Stanhope, Service, December 17, 2019; A. Schotz, Auburn University, email to J. Stanhope, Service, January 17, 2021). There is currently a question to the validity of the location of the historical Alabama collection in Cypress Creek (last verified observation in 1890s [Service 1992, p. 9]), because the stream is "fairly pristine" and may not have "conditions favorable to the species," based on observations of the species at other sites and its habitat in Georgia, West Virginia, and Virginia (A. Schotz, Auburn University, email to J. Stanhope, Service, January 17, 2021). However, Ogle visited that the historical site and believes that it was likely flooded by backwaters of the Tennessee River/Wilson Lake and there continues to be suitable habitat for the species nearby and in adjacent drainages (D. Ogle, formerly VHCC, email to J. Stanhope, Service, July 15, 2021). A specimen reported from Louisiana (Thomas and Allen 1998 in Ogle 2008) was determined to be a misidentified specimen of a cultivated spiraea.'

See Figure 2 and Figure 3 for current range information for the Virginia spiraea.

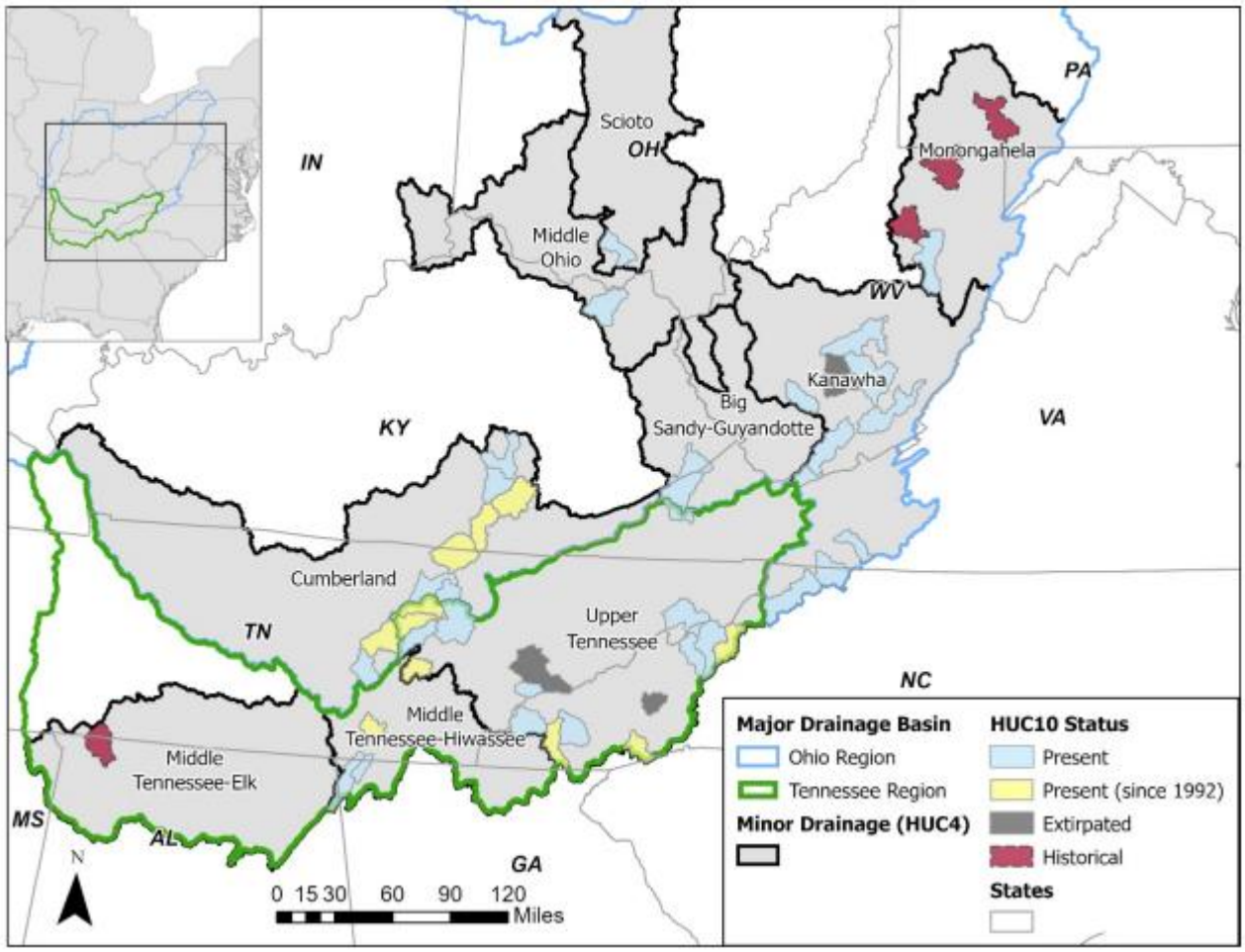


Figure 2. Historical and current range of Virginia spiraea as shown by HUC-10 watersheds in major and minor drainage basins. Minor drainage basins are labeled. HUC-10s with extant element occurrences (EOs) as of 2019 have "Present" status (e.g., discovered 1992 and earlier). HUC-10s with EOs discovered since 1992 and still extant in 2019 are labeled as "Present (since 1992)." HUC-10s with "Extirpated" or "Historical" status are based on the EO ranks assigned by the state natural resource agencies. Note: All EOs with F rank ("failed to find") occurred in HUC-10s that also had EOs that are present (e.g. A, B, C, D, or E ranks). Copied from Figure 1 of the 5-Year Review (FWS 2021).

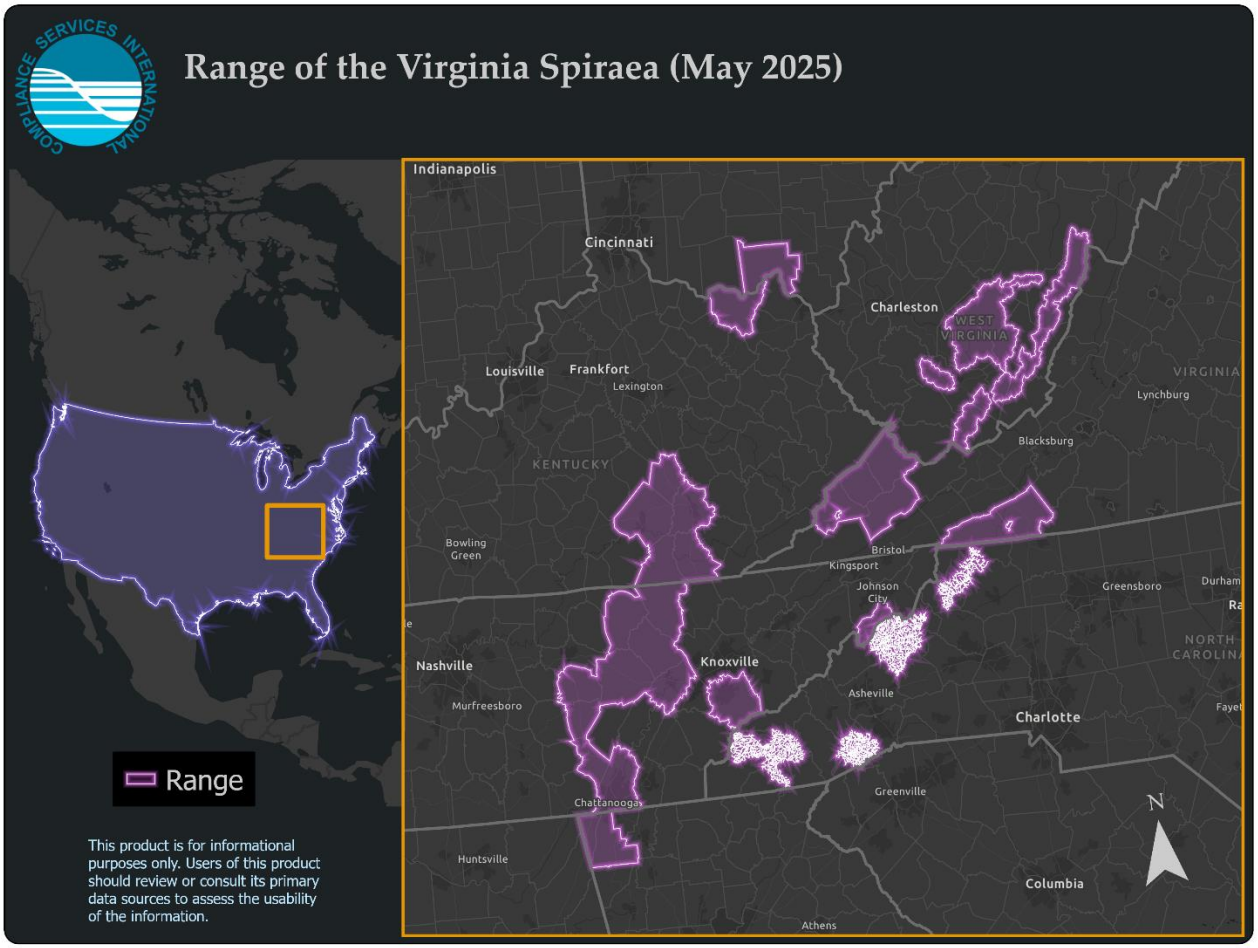


Figure 3. Range of the Virginia spiraea (FWS 2025).

4. Description of Critical Habitat

- Critical habitat has not been designated for this species.

5. Known Locations

- 'As of 2019, of 89 total EOs across the range, 72 are extant (80.9%), 32 have an A or B rank (36.0% of historically known EOs) and 23 have a C rank (25.8% of historically known EOs) (Tables 2 and 3). Fifteen EOs (16.9% of historically known EOs) have a D rank (poor condition) and NatureServe (2020b) indicates that "if current conditions prevail, occurrence has a high risk of extirpation." For the 17 EOs that are not extant, 11 EOs became presumed extirpated (F or X rank) since 1992, when the species' recovery plan was completed. Of the extant EOs, 36 (40.4% of historically known EOs) are located on public or permanently managed/protected property, and of those, 20 have an A or B rank (22.5% of historically known EOs). A greater proportion of the A or B ranked EOs are located on public or permanently managed/protected property (20 EOs) versus not (12 EOs) (62.5% vs. 37.5%), suggesting a potential conservation benefit from being located on such lands. When considering C ranked EOs, a lower proportion are located on public or permanently managed/protected property (9 EOs) vs. not (14 EOs) (39.1% vs. 60.9%). However, it should be noted that 6 of the 11 EOs that became presumed extirpated since 1992 were located on public or permanently managed/protected property.

To further help evaluate the status of the EOs, state natural resource agencies were asked for their assessment of population stability in their state in 2007 (Ogle 2008) and 2019. In 2007, populations were assessed as: stable in Georgia, North Carolina, West Virginia, and Ohio; increasing in Tennessee; decreasing to stable in Virginia; and decreasing in Kentucky (Ogle 2008) (*Table 3*). At that time, most experts cautioned that assessments were based on anecdotal or casual observation and little, if any quantitative data were available for those determinations. Kentucky State Nature Preserves Commission (now OKNP) was considering raising their state listing status from threatened to endangered and Tennessee officials were considering lowering their state status from endangered to threatened (Ogle 2008). In 2019, some state natural resource agencies and federal agencies indicated that they conduct periodic monitoring of their EOs (Ohio Department of Natural Resources, Division of Natural Areas and Preserves [ODNR-DNAP]; TDEC-DNA; WVDNR; National Park Service [NPS] at Big South Fork National River and Recreation Area/Obed Wild and Scenic River [BSFNRRA/OWSR]) or have conducted status surveys of their EOs recently (e.g., OKNP in 2018, NPS at Great Smoky Mountains National Park [GSMNP] in 2020). Populations are currently assessed as stable in Georgia, Kentucky, North Carolina, Ohio, Tennessee, and Virginia and stable to decreasing in West Virginia (Table 2). State listing status has not changed (see Section 2.3.2.4) (Table 3,

Table 4 and Table 5, FWS 2021).

Table 3. Number of extant clones reported in 1992 (Service 1992). Number of element occurrences (EOs) and sub-EOs reported in 2007 and related information (Ogle 2008). N/A = not applicable. Copied from the 5-Year Review (FWS 2021).

State	Number if extant clones in 1992	Number of extant EOs in 2007	Number of extant sub-EOs in 2007	Were EOs located on public property as of 2007?	Population stability as assessed by survey respondents in 2007
Alabama	0 (historical record prior to 1992)	0	N/A	N/A	N/A
Georgia	7	3	8	Partial	Stable
Kentucky	20	17	Not reported	Yes (7), No (10)	Decreasing
Louisiana	Misidentification	N/A	N/A	N/A	N/A
North Carolina	12	Not reported	36	Partial	Stable
Ohio	3	Not reported	5	Partial	Stable
Pennsylvania	0 (historical record prior to 1992)	0	N/A	N/A	N/A
Tennessee	20	31+	Not reported	Partial	Increasing
Virginia	18	Not reported	24[1]	Partial (at least 3 clones)	Decreasing to Stable
West Virginia	27	Not reported	109[2]	Partial but primarily on private lands	Stable
All States	107	52+	182	Partial	

[1]Four sub-EOs with propagated/outplanted stems not included because these sites are not tracked in VDCR-DNH database.
[2]Reported as 109 EOs and sub-EOs in Ogle (2008). Placed on sub-EO column due to unknown number of EOs vs. sub-EOs.

Table 4. Number of element occurrences (EOs) and sub-EOs in 2019, and number of extant EOs located in managed/protected land and their EO rank (i.e., estimated viability by state natural resource agency). Extant EOs are those with A, B, C, D, or E rank. N/A = not applicable. Copied from the 5-Year Review (FWS 2021).

State	Number of extant EOs in 2019	Number of extant sub-EOs in 2019 (of total sub-EOs)	Total Number of EOs (all ranks)	Number of extant EOs located on public or permanently managed/ protected land – A or B rank[1]	Number of extant EOs located on public or permanently managed/ protected land – C rank[1]	Number of extant EOs located on public or permanently managed/protected land – Total extant (all ranks)	Range of years for when extant EOs last observed	Population stability as assessed by survey respondent in 2019/2020
Alabama	0	N/A	1	N/A	N/A	N/A	N/A	N/A
Georgia	3	6+ (of 8+)[2]	3	3	0	3	2010-2015	Stable
Kentucky	13	15_ (of 37)[3]	16	1	3	7	2018, except 1 in 1996 and 1 in 2013	Stable
North Carolina	14[4]	46 (of 55)[5]	16	2	0	3	2011-2019	Stable
Ohio	6	9 (of 9)[2,6,7]	6	0	1	1	2015-2018	Stable
Pennsylvania	0	N/A	1	N/A	N/A	N/A	N/A	N/A
Tennessee	22[8]	57 (of 67)[3,6]	28	9	5	16 (3 partial)	2007-2019, except 2 in 1995	Stable
Virginia	4[9]	24 (of 25)[3,10]	5	2	0	3	2017[11]	Stable
West Virginia	10[12]	126 (of 136)[6]	13	3	0	3	2015-2020[12], except 1 in 2002	Stable to Decreasing
All States	**72**	**283+ (of 337+)**	**89**	**20**	**9**	**36**		

[1]A or B rank (excellent or good viability) includes B, BC-ranked occurrences, though there is uncertainty regarding the rank. C rank (fair viability) includes BCD and CD-ranked occurrences (D indicates poor viability). See the NatureServe Element Occurrence Data Standard (2002) for more details on ranking methodology and Appendix B for ranking definitions.
[2]Number of sub-EOs based on EO description.
[3]Number of sub-EOs based on number of source features.
[4]Number of EOs based on number of parent EOs and standalone EOs (e.g., EOs that are not nested within a parent EO).
[5]Number of sub-EOs based on number of EOs nested within a parent EO (i.e., each sub-EO had a separate record) and standalone EOs.
[6]Number of sub-EOs based on state agency expert opinion or provided in occurrence table.
[7]Historical number of sub-EOs not provided and assumed to be the same as current.
[8]Two EO rankings updated to failed to find based on EO descriptions of not finding plants when last surveyed (C. Elam, TDEC, email to J. Stanhope, Service, March 11, 2021).
[9]One EO on the North Fork Pound River is assumed to be failed to find because it was last observed in 2002 and not found during 3 searches in recent years (J. Rhode Ward, University of North Carolina at Asheville [UNCA], email to J. Stanhope, Service, January 24, 2020). Ogle (2008) also suggested that an EO on the North Fork Pound River was based on a misidentified specimen and should be deleted from the database. It is not clear if this is the same EO.
[10]Three sub-EOs with propagated/outplanted stems not included because they are not tracked in VDCR-DNH database and status is unknown. They were last observed to be extant 10 years ago (D. Ogle, formerly Virginia Highlands Community College, email to J. Stanhope, Service, March 4, 2021).
[11]Although the 4 extant EOs were last observed by Appalachian State University researchers in 2017, they were last surveyed in 1992, 1993, 2007, and 2014 and their EO ranks may not be current.
[12]Includes new EO found in 2020.

Table 5. Number of element occurrences (EOs) by rank (i.e., estimated viability by state natural resource agency) in 2019. N/A = not applicable. Copied from the 5-Year review (FWS 2021).

State	Number of EOs in Excellent or Good Rank (A or B)	Number of EOs in Fair Rank (C)	Number of EOs in Poor Rank (D)	Number of EOs in Verified Extant Rank (E)	Number of EOs in Failed to Find Rank (F)	Number of EOs in Historical/ Extirpated Rank (H or X)	[1]Total (all ranks)
Alabama	0	0	0	0	0	1	1
Georgia	3	0	0	0	0	0	3
Kentucky	3	4	6	0	3	0	16
North Carolina	8	3	3	0	1	1	16
Ohio	0	5	0	1	0	0	6
Pennsylvania	0	0	0	0	0	1	1
Tennessee	10	9	3	0	5[2]	1	28
Virginia	2	0	2	0	1[3]	0	5
West Virginia	6	2	1	1	0	3	13
All States	**32**	**23**	**15**	**2**	**10**	**7**	**89**

[1]A or B rank includes B and BC-ranked occurrences, though there is uncertainty regarding the rank. C rank includes CD and BCD-ranked occurrences. E rank are EOs that have been recently verified as extant, but insufficient information to estimate viability. See the NatureServe Element Occurrence Data Standard (2002) for more details on ranking methodology and Appendix B for ranking definitions.

[2]Two EO rankings updated to failed to find based on EO descriptions of not finding plants when last surveyed (C. Elam, TN Department of Environment and Conservation, email to J. Stanhope, Service, March 11, 2021).

[3]One EO on the North Fork Pound River (VA EO#7) is assumed to be failed to find because it was last observed in 2002 and not found during three searches in recent years (J. Rhode Ward, University of North Carolina at Asheville [UNCA], email to J. Stanhope, Service, January 24, 2020). Ogle (2008) also suggested that an EO on the North Fork Pound River was based on a misidentified specimen and should be deleted from the database. It is not clear if this is the same EO.

- GBIF: https://www.gbif.org/species/3027290
  - GBIF includes five-hundred fifty occurrence records; thirty-six of which are georeferenced (Figure 4). Twenty-three of these had usable coordinate data based on these criteria:
    - U.S. only (excludes Canada)
    - Latitude and longitude precision were both 3+ decimal places.
    - Coordinate uncertainty values no greater than 30 km.
    - Relative recency (2010-present)
    - Must include date information.
    - No “preserved specimen” observations; only “human observation.”
  - The 23 usable coordinates were mapped against the species range to evaluate their utility in representing species extent (Figure 5). It was observed that all the usable GBIF coordinates are originally sourced from iNaturalist, which also had more records. Therefore, the GBIF dataset was not used for core map development.

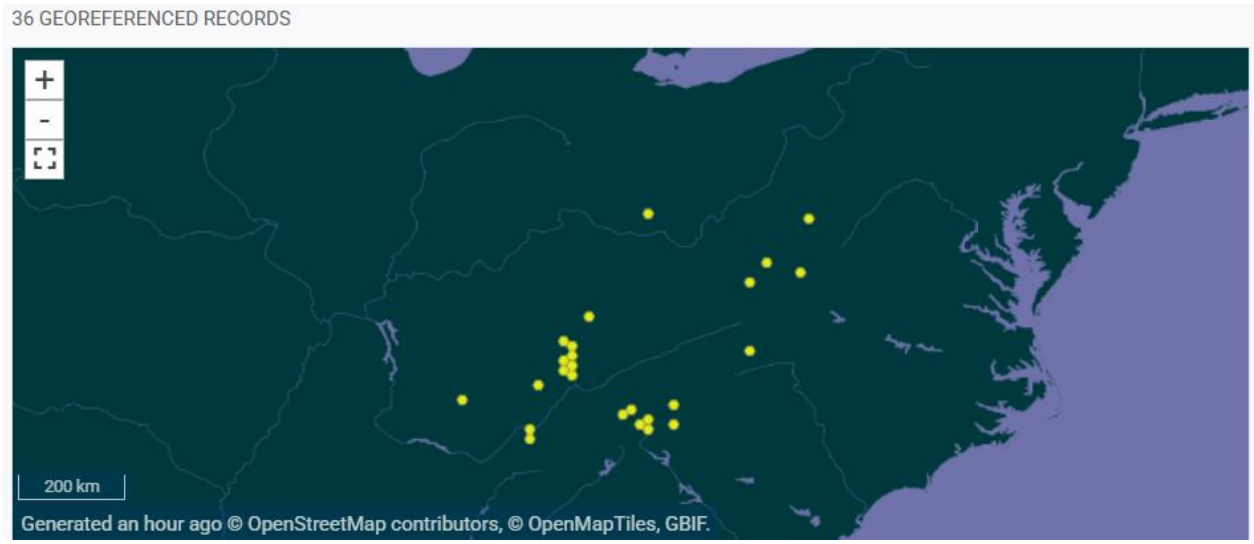
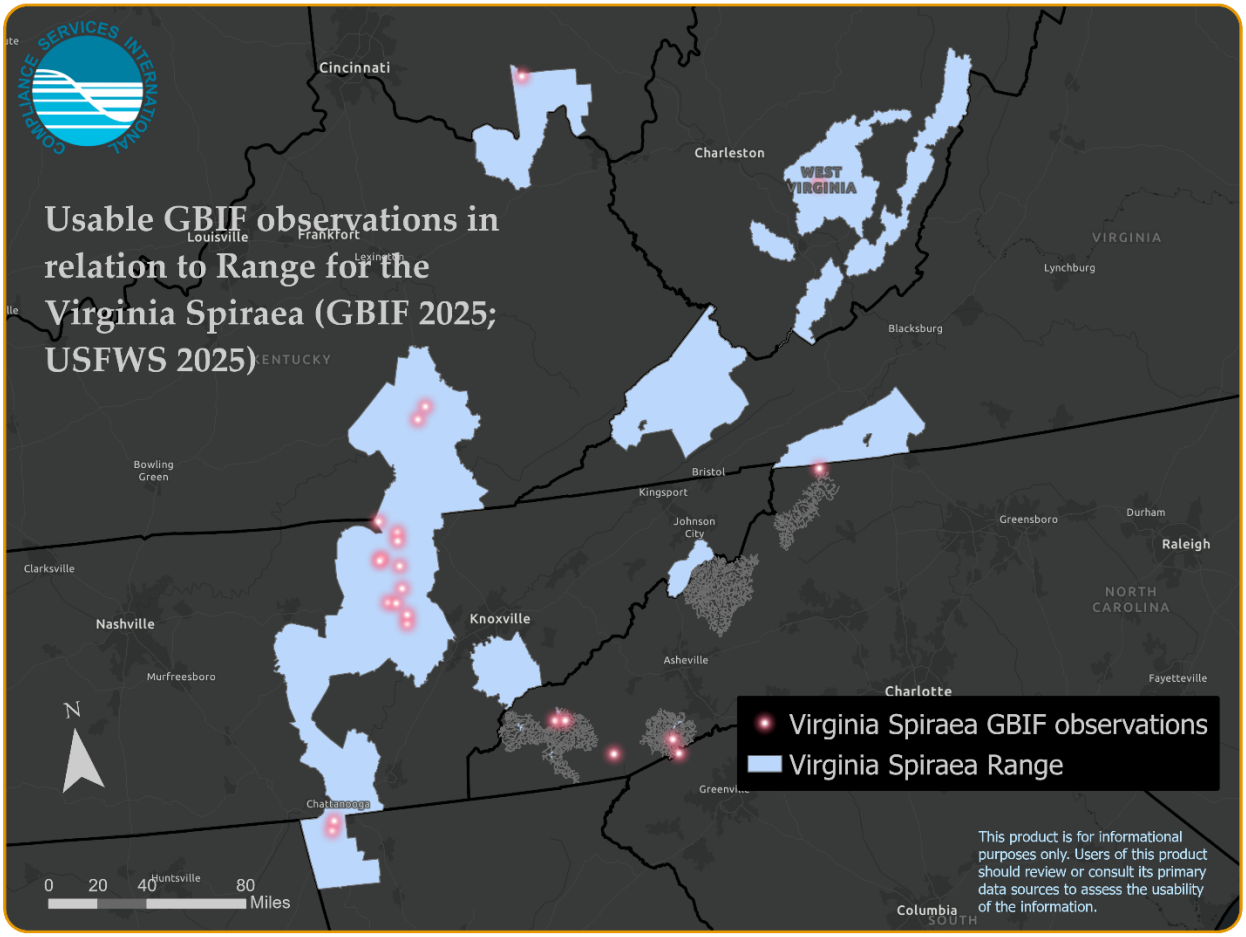


Figure 4. GBIF occurrences for the Virginia spiraea (GBIF 2025).



- *Figure 5. Usable GBIF occurrences (pink) in relation to the Range of the Virginia spiraea (GBIF 2025; FWS 2025).iNaturalist: https://www.inaturalist.org/observations?taxon_id=169257*

- iNaturalist: https://www.inaturalist.org/observations?taxon_id=169257\
    - iNaturalist includes sixty-two total observations (Figure 6), twenty-six of which are research-grade with usable coordinate data based on these criteria:
    - U.S. only (excludes Canada)
    - Latitude and longitude precision were both 3+ decimal places.
    - Relative recency (2010-present)
    - Observation description did not include the text “intentionally incorrect.”
    - Public positional accuracy (PPA) value no greater than 30 km 3’
        - This did not result in the exclusion of any records.
    - Locations are consistent with GBIF, which is expected because all of the GBIF observations are imported from iNaturalist.
    - All of the observations intersect the range when accounting for the PPA uncertainty value (Figure 7).
    - While most distinct (contiguous) pieces of the range are represented by one or more points, their general shape is not well represented by the iNauralist distribution.

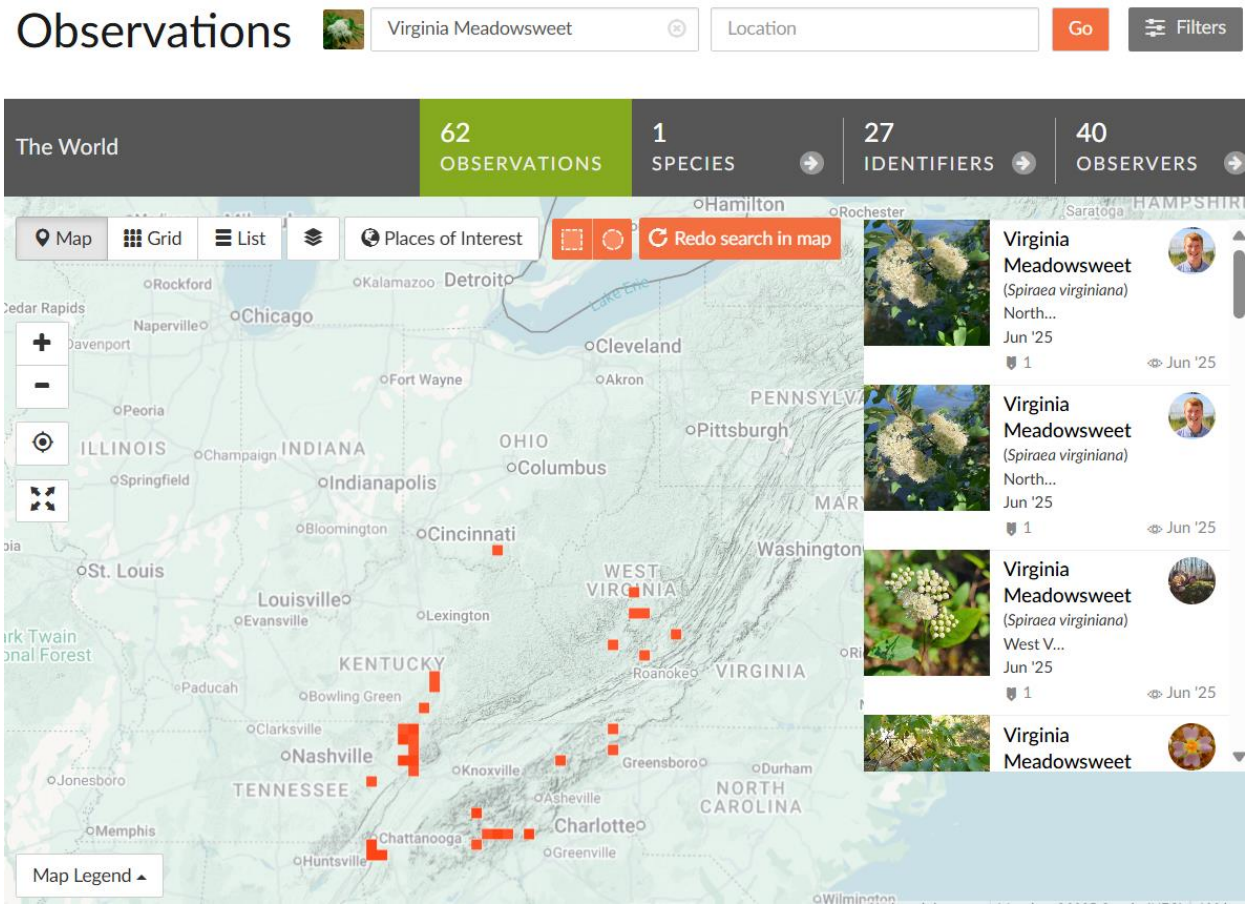


Figure 6. iNaturalist occurrences for the Virginia spiraea (also known as Virginia Meadowsweet) (iNaturalist 2025).

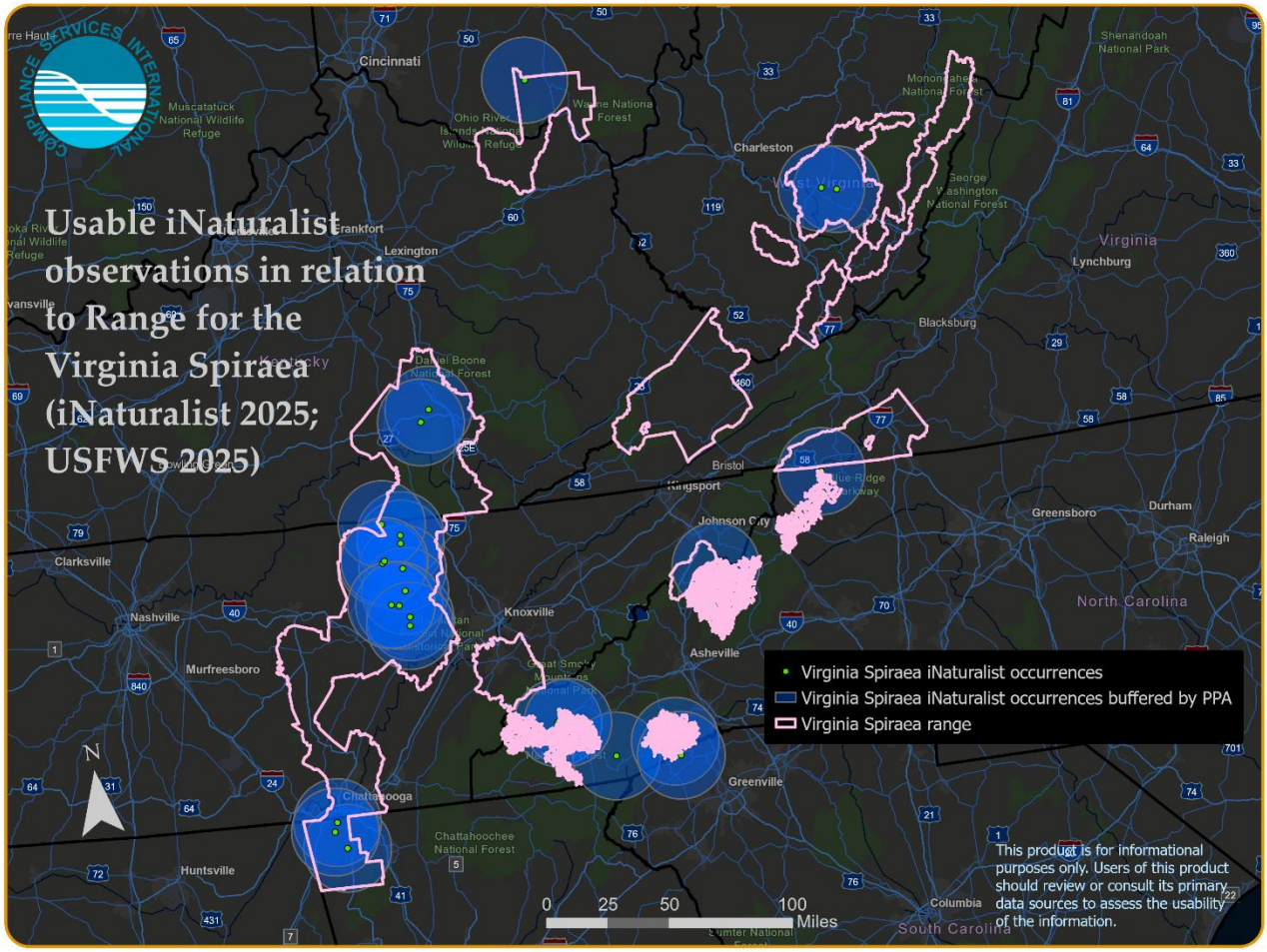


Figure 7. Usable iNaturalist observations, buffered by public positional accuracy (PPA), for the Virginia spiraea (iNaturalist 2025; FWS 2025).

- NatureServe Explorer: https://explorer.natureserve.org/
    - Available public occurrence information from NatureServe Explorer aligns with the information from iNaturalist and GBIF and additionally includes more area in the western portion of the range.
    - EOs were used to support the decision to use a combination of range, ecoregion, and counties with extant populations to develop the core map.

Appendix 2. GIS Data Review and Method to Develop Core Map

The core map for this species is based on biological information, which includes the habitat used by this species found within a spatial extent of species range. The core map identifies all areas within the extent matching the species' habitat description from **Appendix 1**. In North Carolina, potential habitat areas were primarily represented using a species-specific model developed by the NCDOT. In other states, professional judgment was used to match "ATTRIBUTE" classes in the National Wetland Inventory (NWI) dataset as described below (FWS 2023). NWI is regarded as a high quality national-level dataset that is appropriate to identify habitat for aquatic species such as the Virginia spiraea.

1. References and Software

- National Wetlands Inventory (FWS 2023): https://www.fws.gov/program/national-wetlands-inventory.
- North Carolina Department of Transportation: "Virginia Spiraea - Potential Habitat, March 2020." https://xfer.services.ncdot.gov/gisdot/AtlasData/AtlasSpeciesModels/ATLASPlantMachineLearningModels/.
- Software used: ArcGIS Pro version 3.5.2.
- U.S. Geological Survey (USGS) National Hydrography Dataset (NHD version. 2.1): https://www.usgs.gov/national-hydrography/access-national-hydrography-products.
- EPA Modified Cultivated Layer: https://cdn.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668.
- FWS Species Range (FWS 2025): https://ecos.fws.gov/ecp/species/1720.

2. Datasets Used in Core Map Development

2.1. Range

The range for this species was last updated by FWS on June 14, 2022. A shapefile including species range for all listed species was downloaded from the FWS ECOS website on May 5, 2025. The shapefile was converted to a feature class stored in a file geodatabase and reprojected to WKID #102008 ("North America Albers Equal Area Conic").

1. Using an ArcGIS Web Map the species was queried based on the ECOS listed "Entity ID" of 1039 and exported as a feature class to a temporary file geodatabase as a standalone Entity ID-specific layer.
2. The area of the range was calculated automatically by loading it into the software (ArcGIS Pro version 3.2) and reading its area from the attribute table ("Shape_Area"), then converting its units (square meters) into acres with a conversion factor of 0.000247105.

This shapefile was added to an ArcGIS Pro map and compared against the known observation datasets and state-level habitat information (described below). The range was used to establish the outer boundary of the core map.

2.2. USGS National Hydrography Dataset (version 2.1)

The National Hydrography Dataset (NHD) version 2.1 is a comprehensive and detailed dataset that provides extensive information about the surface water features across the United States. This dataset includes both landscape-type data, such as watershed boundaries, and water bodies like rivers, lakes, and streams.

The NHD HUC-12 layer was used to develop a layer of HUC-10 boundaries. HUC-10 watersheds were selected for just those containing extant populations of Virginia spiraea, according to the most recent 5-Year Review (Figure 2). Only watersheds labeled as "Present" or "Present (since 1992)" were selected; "Extirpated" and "Historical" HUC-10s were excluded. Figure 2 was georeferenced in ArcGIS Pro version 3.2 and juxtaposed against the NHD watershed boundaries; the latter (vector) data were used in subsequent geoprocessing steps. The following 38 HUC-10 watersheds were considered extant and thus included:

- 505000102, 505000104, 505000107, 505000209, 505000309, 505000506, 505000508, 505000902, 506000215, 507020205, 507020207, 509020101, 513010108, 513010109, 513010204, 513010205, 513010401, 513010402, 513010405, 513010802, 513010803, 601010501, 601010801, 601010802, 601010803, 601010806, 601020105, 601020203, 601020204, 601020401, 601020402, 601020801, 601020802, 601020803, 601020804, 602000105, 602000110, 602000111

The NHD dataset was additionally used to identify HUC-12 areas within HUC-10s with extant populations that do not meet the elevation requirements of the species. The best available information about the elevation requirements for the Virginia spiraea is catalogued in NatureServe Explorer, which identifies these state-specific range requirements for the species (NatureServe 2025):

- Tennessee: 850-1,400 ft
- Virginia: 1,000-2,400 ft
- West Virginia: 1,000-1,800 ft

These elevation ranges were used as lower and upper bounds in the development of the core map for these states. For other states intersecting the species range where this information was not specified (Georgia, Kentucky, North Carolina, Ohio), the lower and upper bounds were adopted from the extrema of these states; thus, the elevation requirements in these states were inferred to be 850 – 2,400 ft. This wider range of elevations is the same as EPA's most current species-wide elevation restriction information for the species, which is 259-732 meters (850-2,400 ft; EPA 2025).

Network flowlines within selected HUC-10 watersheds were queried for those meeting the species' elevation restriction requirements, which are state-specific. To conduct the state-level analysis, HUC-12 watersheds were matched to a single state (one-to-one); when HUC-12s overlapped multiple states, the state with greatest overlap ("Lead_state") was assigned. For HUC-12s overlapping out-of-range states (Alabama and South Carolina) the state with the next-largest area was chosen.

NHD flowlines in HUC-10s representing areas currently occupied by the species were joined to "Lead_state" using joins to HUC-12 and then to the HUC-12 layer with Lead_state information. Flowlines were then split into four separate layers by Lead_state, one each for Tennessee, Virginia, West Virginia, and other states ("Other"). Each of these layers was queried for records corresponding to elevations consistent with the habitat of the Virginia spiraea and exported as standalone layers. HUC-12 boundaries intersecting these streams were selected and exported to form the elevation restriction layer used to refine the core map shape.

2.3. NCDOT Dataset

Regions of suitable habitat were used to refine the core map based on biological information. NCDOT completed a project named "ATLAS" in 2021 that categorized land within the range as low, moderate, or high suitability for species habitat for the Virginia spiraea. Ultimately, regions of Low and Moderate suitability were excluded from the core map, while High suitability were included. Categories of "low" and "high" for this species are defined as follows:

- Low: Regions and sites where biologists would be very surprised to find this species and its habitat (occurrence here should be extremely rare). =
- High: Biologists expect to frequently encounter areas that look like potential habitat based on visible environmental and vegetation community characteristics (Figure 8, NCDOT 2020).

NCDOT does not provide a definition for moderate habitat suitability. In the absence of clear guidance, best professional judgment was applied based on the descriptions of low and high habitat suitability provided above. Areas classified as moderate suitability were interpreted as locations where biologists would not frequently encounter potential habitat and were therefore excluded from core map. Moderate suitability areas account for 5.1% of the extent examined by NCDOT. These areas can, however, be incorporated in the future if expert judgment specific to this species determines that they are relevant to areas for pesticide mitigation.

The spatial extent of this data source is limited to North Carolina. Regions of high suitability are associated with water bodies consistent with the species' habitat requirements described in **Appendix 1**. Additionally, the comprehensive metadata for this species model was used to inform the selections of water body types from the National Wetlands Inventory dataset that was used to represent species habitat in other states. Specifically, riverine waters associated with lower perennial and upper perennial subsystems were considered appropriate, based on review of the NCDOT metadata.

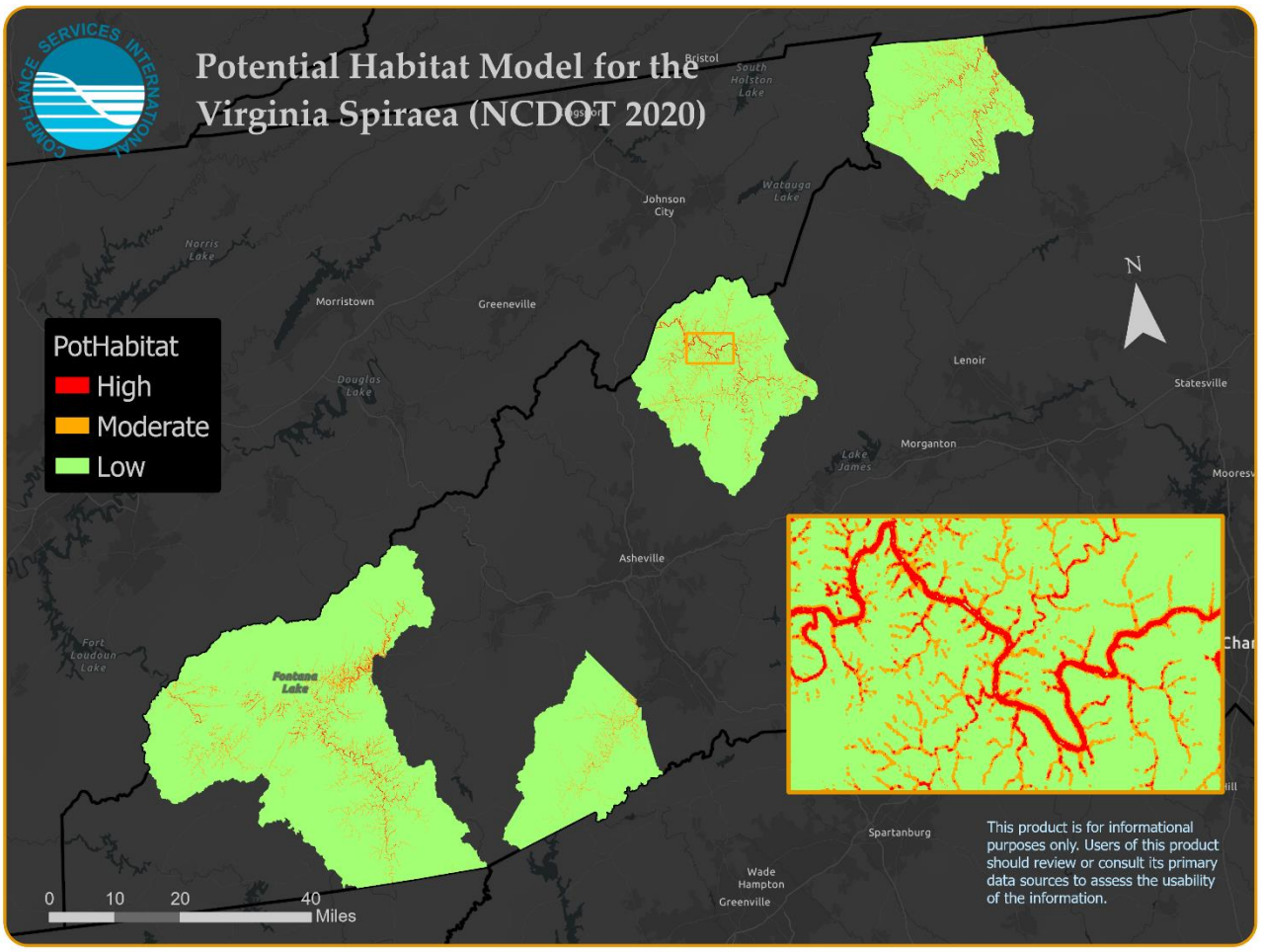


Figure 8. Areas of low, moderate, and high habitat suitability for the Virginia spiraea in North Carolina (NCDOT 2020).

2.4. National Wetlands Inventory (NWI) dataset

The NWI dataset was preliminarily vetted to determine its appropriateness in representing aquatic areas matching descriptions of the Virginia spiraea habitat, for areas not already represented by the species-specific model developed by the NCDOT. As indicated previously, the species inhabits scoured banks of high gradient streams and on meandering scrolls, point bars, natural levees, and braided features of lower stream reaches (FWS 2025). CSI reviewed NWI attribute classes in relation to this description and determined that the species' potential habitat is best represented by a selection of riverine subsystems:

- Riverine (NWI code = R)
  - Subsystems: Lower Perennial (2), Upper Perennial (3)
  - Classes: Rock Bottom (RB), Unconsolidated Bottom (UB), Aquatic Bed (AB), Rocky Shore (RS), and Unconsolidated Shore (US)

These possible site location types were selected in the merged NWI wetlands dataset using the following SQL query:

- ATTRIBUTE LIKE '%R2RB%' OR ATTRIBUTE LIKE '%R2UB%' OR ATTRIBUTE LIKE '%R2AB%' OR ATTRIBUTE LIKE '%R2RS%' OR ATTRIBUTE LIKE '%R2US%' OR ATTRIBUTE LIKE '%R3RB%' OR

ATTRIBUTE LIKE '%R3UB%' OR ATTRIBUTE LIKE '%R3AB%' OR ATTRIBUTE LIKE '%R3RS%' OR ATTRIBUTE LIKE '%R3US%'

The selected water body features were clipped to the core map extent (based on a combination of range and watersheds listed in **Appendix 2** Section 2.2 with extant populations and state-specific elevation criteria, and excluding North Carolina) dissolved into a single shape to represent potential habitat of the Virginia spiraea outside of North Carolina, then merged with the separately developed dataset for North Carolina developed by the NCDOT.

2.5. EPA Cultivated Lands > 25 acres

SEPA has developed and published its own cultivated layer for use in core map development as a potential refinement of habitat and/or extent (EPA 2025). For the Virginia spiraea, habitat was refined by this layer using the Pairwise Erase tool to remove significant areas of agriculture because the species habitat is not consistent with cultivated land and is therefore considered by CSI to be an "off-field" species. This removed only 9 acres (0.03% of area) and is considered a reasonable refinement for core map development for off-field species.

3. Creating the Core Map

3.1. Defining core map extent

The core map extent for the Virginia spiraea was developed using a combination of range and watershed boundaries (both HUC-10 and HUC-12). HUC-12 boundaries meeting habitat requirements (elevation restrictions in this case) from within HUC-10s known to contain extant populations of the species were dissolved into a single shape and clipped to the species range to form the extent; the layer was created as follows:

1. Save an image with extant populations information (Figure 2) to a directory. Use the Raster to Geodatabase tool to import the image into a geodatabase, saved as a new layer ("Fig1_png")[3]. Choose to export this layer—and all subsequent layers—into the preferred projection (WKID #102008). Render it partially transparent (70% transparent was chosen).
2. Initiate a georeferencing session and georeference the previous layer ("Fig1_png") using control points and an underlying layer of state boundaries. This is to facilitate the selection of HUC-10 boundaries that are developed in Step 4.
3. Use the Select by Location tool to select records of HUC-12 boundaries from the NHD version 2.1 dataset that intersect the species range ("VS_range") and save as a new layer, "VS_HUC12".
4. Add a new text field ("HUC10"; character length = 10) to the previous layer ("VS_HUC12") to be populated with HUC-10 boundaries. Use the Calculate Field tool to populate the new HUC-10 field with the first 10 characters of the HUC12 field, using the following query:
    - HUC10 = !huc12![:10]
5. Use the Pairwise Dissolve tool to dissolve the previous layer ("VS_HUC12") by the "HUC10" field, and save as a new layer, "VS_HUC10".
6. Use the Select tool to select HUC-10 polygons associated with "Present" or "Present (since 1992)" from the previous layer ("VS_HUC10"), using the underlying georeferenced "Fig1_png" image for guidance. Export selected features to a new feature class, "VS_HUC10_extant".
7. Use the Pairwise Clip tool to clip the NHD Network streams layer by the HUC-10s with extant

[3] Figure 2 of this document is Figure 1 in the source document, the 5-Year Review (FWS 2021).

Virginia spiraea populations ("VS_HUC10_extant") and save as a new layer, "NHD_flow_pcHUC10".

8. Assign "Lead_state" designation to HUC-12 boundaries. Use the Pairwise Intersect tool to create a layer representing the intersection of the HUC-12 watersheds corresponding to Virginia spiraea range ("VS_HUC12") and state boundaries. Save as a new layer, "VS_HUC12_piState". In Excel, use pivot tables to determine which state contributes the most area to every HUC12 (excluding records from Alabama and South Carolina, states where the species is not known to occur). Export this Excel file to a .csv file and use a join to import this data into the "VS_HUC12" layer.
9. Join the "VS_HUC12" layer to the "NHD_flow_pcHUC10" layer to import lead state information ("Lead_state") into the streams layer.
10. For each of the 4 regions with unique elevation data (Tennessee, Virginia, West Virginia, and all other states), use a definition query on the previous layer ("NHD_flow_pcHUC10") to restrict records to that region, and then use the Select by Attributes tool to select NHD streams with elevation consistent with the Virginia spiraea for each respective state (NatureServe 2025). This step is further in explained in **Appendix 2** Section 2.4. The following SQL queries were used for each respective state/region:
    - "Other" (Georgia, Kentucky, North Carolina, Ohio): 850 - 2,400 ft (25,908 - 73,152 cm)
        - SQL query: (minelevraw > 25908 OR minelevsmo > 25908) AND (maxelevraw < 73152 OR maxelevsmo < 73152)
    - Tennessee: 850 - 1400 ft (25,908 - 43,210 cm)
        - SQL query: (minelevraw > 25908 OR minelevsmo > 25908) AND (maxelevraw < 43210 OR maxelevsmo < 43210)
    - Virginia: 1,000 - 2,400 ft (30,480 - 73,152 cm)
        - SQL query: (minelevraw > 30480 OR minelevsmo > 30480) AND (maxelevraw < 73152 OR maxelevsmo < 73152)
    - West Virginia: 1,000 - 1,800 ft (30,480 - 54,864 cm)
        - SQL query: (minelevraw > 30480 OR minelevsmo > 30480) AND (maxelevraw < 54864 OR maxelevsmo < 54864)
11. Use the Merge tool to merge the elevation-restricted streams from the previous step into a single layer of streams consistent with Virginia spiraea elevation data, "NHD_flow_pcHUC10_selElev".
12. Use the Select by Location tool to select HUC-12 watersheds within the species range ("VS_HUC12") that intersect the streams from the previous layer ("NHD_flow_pcHUC10_selElev"), and save selected features as a new layer, "VS_HUC12_sblElev".
13. Use the Pairwise Clip tool to clip the previous layer ("VS_HUC12_sblElev") by the HUC-10 layer of extant populations ("VS_HUC10_extant") and save as a new layer, "VS_HUC12_sblElev_pcHUC10extant".
14. Use the Pairwise Dissolve tool to dissolve features from the previous layer ("VS_HUC12_sblElev_pcHUC10extant") into a feature class with a single shape, saved as "VS_HUC12_sblElev_pcHUC10extant_pd".
15. Use the Pairwise Clip tool to clip the previous layer ("VS_HUC12_sblElev_pcHUC10extant_pd") by the species range ("VS_range") and save as a new layer, "VS_HUC12_sblElev_pcHUC10extant_pd_pcRange".
16. Export the previous layer ("VS_HUC12_sblElev_pcHUC10extant_pd_pcRange") to a new feature class with a name that is easily recognizable as the core map extent ("VS_extent").
17. Use the Select tool to select the state of North Carolina from a layer of state boundaries. Invert

the selection to select every other state and exclude North Carolina. This is to facilitate a clip in the next step.

18. Use the Pairwise Clip tool to clip the core map extent ("VS_extent") by the selected features from the previous layer (every state besides North Carolina) and save as a new layer, "VS_extent_noNC". This is to facilitate the biological information refinements described in the next section.

3.2. Refinement based on Biological Information

North Carolina

The core map for the Virginia spiraea in North Carolina was developed primarily using a specific-specific model produced by the NCDOT. The data downloaded contained areas of low, moderate, and high probability of potential species habitat (Figure 9). Finally, this portion of the core map was clipped to species range, which has decreased in North Carolina since the time the NCDOT data were developed (2020).

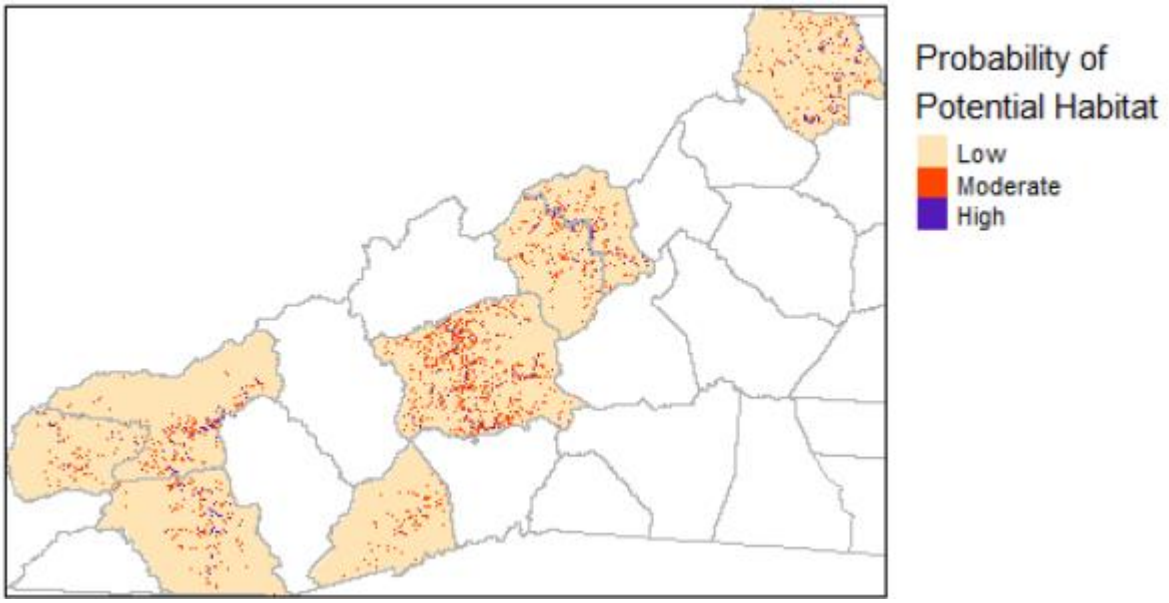


Figure 9. Final three-level map product approved based on all available observational data and discussions with field biologists. Copied from Figure 11 of the metadata document (NCDOT 2020).

1. Download the species habitat model shapefile for the Virginia spiraea. Import this layer into a geodatabase, saved as "NCDOT".
2. Use the Select by Attributes tool to select only areas of high potential habitat from the previous layer ("NCDOT") using the following SQL query. Save as a new layer, "NCDOT_high".
    - PotHabitat = 'High'
3. Use the Pairwise Dissolve tool to dissolve the previous layer "NCDOT_high" into a feature class with a single shape, saved as "NCDOT_high_pd".
4. Use the Pairwise Clip tool to clip the previous layer ("NCDOT_high_pd") by the species extent ("VS_extent"), and save as a new layer, "NCDOT_high_pd_pcExtent".

Outside of North Carolina

Outside of North Carolina, biological information was matched to wetland types from the National Wetlands Inventory according to the following procedure:

1. Download the state-level NWI datasets for all states intersecting the core map extent, except for North Carolina. This includes Georgia, Kentucky, Ohio, Tennessee, Virginia, West Virginia.
2. For each state listed in Step 1, use the Pairwise Clip tool to clip the state-level NWI layer by the core map extent excluding North Carolina ("VS_extent_noNC"). Save as new layers, "NWI_{state name}_pcExtentnoNC".
3. Use the Merge tool to merge the state-level clipped datasets from the previous step ("NWI_{state name}_pcExtentnoNC") into a single feature class, saved as "NWI_pcExtentnoNC".
4. (Optional) Delete the state-level clipped datasets from the geodatabase. This is to facilitate file transfer by reducing file size.
5. Use the Select by Attributes tool to query for water bodies from the previous layer ("NWI_pcExtentnoNC") matching the species habitat description as described in Appendix 2 Section 2.4, using the following query. Save output as a new layer, "NWI_pcExtentnoNC_sel".
    - ATTRIBUTE LIKE '%R2RB%' OR ATTRIBUTE LIKE '%R2UB%' OR ATTRIBUTE LIKE '%R2AB%' OR ATTRIBUTE LIKE '%R2RS%' OR ATTRIBUTE LIKE '%R2US%' OR ATTRIBUTE LIKE '%R3RB%' OR ATTRIBUTE LIKE '%R3UB%' OR ATTRIBUTE LIKE '%R3AB%' OR ATTRIBUTE LIKE '%R3RS%' OR ATTRIBUTE LIKE '%R3US%'
6. Use the Pairwise Dissolve tool to dissolve the features from the previous layer ("NWI_pcExtentnoNC_sel") into a feature class with a single shape, saved as "NWI_pcExtentnoNC_sel_pd".

3.3. Merging Core Map Elements

The habitat layer based on NCDOT data in North Carolina and NWI shapes outside of North Carolina are mutually exclusive datasets that were merged and dissolved to form the core map habitat as follows:

7. Use the Merge tool to merge the core map elements from North Carolina ("NCDOT_high_pd_pcExtent" and elsewhere ("NWI_pcExtentnoNC_sel_pd") into a single layer representing species habitat in all states. Save as a new layer, "VS_habitat".
8. Use the Pairwise Dissolve tool to dissolve the previous layer ("VS_habitat") into a feature class with a single shape, saved as "VS_habitat_pd".

3.4. Cultivated Lands-based Refinement

The Virginia spiraea is not expected to be found in agricultural areas, so a refinement to exclude areas of agriculture was applied. Here agricultural areas are represented by EPA's modified cultivated layer, which includes areas spanning at least 25 acres. This was done as follows:

1. Use the Pairwise Erase tool to exclude cultivated areas > 25 acres from the previous layer ("VS_habitat_pd") according to a layer developed by EPA ("CultivatedAreas_Over25acres"). Save as a new layer ("VS_habitat_pd_peCultivated25ac").
2. (Optional) Export features from the previous layer ("VS_habitat_pd_peCultivated25ac") into a new layer recognizable as the Virginia spiraea core map, "Virginia_Spiraea_CoreMap".

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