

Interim Core Map Documentation for Small-Anthered Bittercress

Date Posted to EPA's GeoPlatform: July 2025

Draft Interim Core Map Developer: Compliance Services International (CSI)

Species Summary

The small-anthered bittercress (*Cardamine micranthera*; Entity ID 655) is a dicotyledonous endangered plant found in the Mid-Atlantic United States. The U.S. Fish and Wildlife Service (FWS) has not assigned designated critical habitat for the small-anthered bittercress. This species inhabits seepages, wet rock crevices, streambanks, sandbars, and wet woods along small streams. Additional habitat information is provided in **Appendix 1**.

EPA Review Notes

The developers created this core map using the U.S Environmental Protection Agency's (EPA) 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, but EPA may have edited this documentation for clarity or other purposes. Some views expressed in this documentation may not necessarily reflect the viewpoints 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 small-anthered bittercress is biological information type, based on a combination of refined/endemic range and habitat preferences, the latter of which was used to refine the core map in North Carolina. The most recent 5-Year review includes a textual description of habitats (See **Appendix 1** for more information). Other available known location information from the Global Biodiversity Information Facility (GBIF), iNaturalist, and NatureServe databases were not used for core map development, as they did not improve on the datasets used for core map development.

In North Carolina, the species habitat is represented using a habitat model developed for the small-anthered bittercress by the North Carolina Department of Transportation (NCDOT), specifically areas considered "high"

potential habitat. High potential habitat areas were included because they displayed >65% similarity with the species' preferred habitat. Low and moderate potential habitat areas were excluded since a less than 38% similarity with the habitat of the small-anthered bittercress, as well as a lack of clarity on the definition of moderate potential habitat. Areas of high potential habitat were clipped to the species range, and then contiguous cultivated areas > 25 acres (EPA 2025) were removed, using a spatial data layer developed by EPA to develop the core map. The core map spans 162,324 acres (Figure 1). A summary of acreage by National Landcover Database (NLCD) land use type is provided in Table 1.

Based on EPA's "best professional judgment classification" system, CSI has graded this core map as "average" (3) because of uncertainties and documentation of habitat modeling. More information about this classification system and its definitions can be found in the core map process document (EPA 2024).

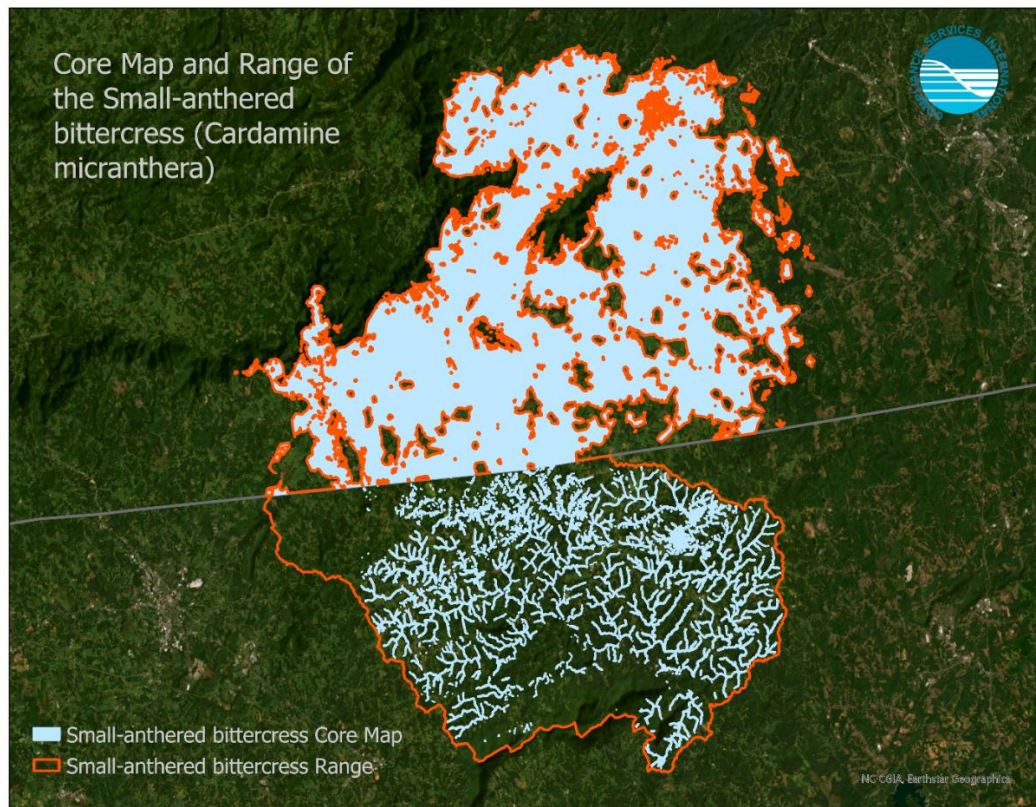


Figure 1. Interim core map for the small-anthered bittercress (162,324 acres).

Example pesticide use sites/types	NLCD Class/Value	% Area	Total area for landcover type
Forestry	Deciduous Forest (41)	56%	84%
Forestry	Evergreen Forest (42)	4%	84%
Forestry	Mixed Forest (43)	23%	84%
Agriculture	Pasture/Hay (81)	9%	9%
Agriculture	Cultivated Crops (82)	0%	9%
Mosquito adulticide, residential	Open space, developed (21)	5%	6%
Mosquito adulticide,	Developed, Low intensity (22)	0%	6%

Example pesticide use sites/types	NLCD Class/Value	% Area	Total area for landcover type
residential			
Mosquito adulticide, residential	Developed, Medium intensity (23)	0%	6%
Mosquito adulticide, residential	Developed, High intensity (24)	0%	6%
Invasive species control	Woody Wetlands (90)	0%	2%
Invasive species control	Emergent Herbaceous Wetlands (95)	0%	2%
Invasive species control	Open water (11)	0%	2%
Invasive species control	Grassland/herbaceous (71)	1%	2%
Invasive species control	Scrub/shrub (52)	1%	2%
Invasive species control	Barren land (rock/sand/clay; 31)	0%	2%
Total Acres	Interim Core Map Acres	~ 162,324	

Table 1. Acres by National Land Cover Database (NLCD) class within the core map of the small-anthered bittercress. Total core map area (based on NLCD pixel count): 162,324 acres¹.

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 four research-grade observations found in iNaturalist². The GBIF dataset included one observation. Neither dataset was used for either core map development or validation of other datasets used.

FWS location information includes extant population information that identifies some areas of relevant occupancy; however, these descriptions could not be easily identified or otherwise converted to geospatial information.

NatureServe public element occurrence (EO) data were also evaluated. These data were considered for

¹ This acreage is slightly different from the core map acreage (162,324) 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->).

refinement but ultimately were only used for comparison with the other datasets: range in North Carolina and Virginia, and habitat suitability in North Carolina.

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 habitat² (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: designated 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 the small-anthered bittercress from FWS, as well as observation information available from various publicly available sources including iNaturalist, GBIF, and NatureServe. The information compiled for the small-anthered bittercress is included in **Appendix 1**. Influential information that impacted the development of the core map includes a description of the species habitat from the FWS Recovery Plan:

- “The habitat *Cardamine micranthera* consists of seepages, wet rock crevices, streambanks, sandbars, and wet woods along small streams. Although soil mapping is incomplete, preliminary indications are that *Cardamne micranthera* occurs on soils of the Rion, Pacolet, and Wateree series, where slopes are 25 to 60 percent” (FWS 1991).

For step 2, CSI used the compiled information including the species range, known locations, and habitat location information to determine the core map type. The known location data were compared to the range and found that known locations from larger databases (iNaturalist and GBIF) were too limited in extent (area) compared to the range to be used for core map development. Known location information from FWS was not detailed or specific enough to be used as a refinement of core map extent from species range.

A species-specific model was used to represent reasonable potential habitat for this species in North Carolina. Additionally, the small-anthered bittercress would not be expected to be found on agricultural land (*i.e.*, it is an “off-field” species). When weighing this information together, CSI selected a combination of refined/endemic range and biological information core map type. A combination of range, habitat information, and EPA’s cultivated areas > 25 acres layer were used to derive this core map.

For step 3, CSI used the best-available data sources to generate the core map. Data sources are discussed in the 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 combined refined/endemic range and biological information. Designated critical habitat was quickly eliminated as a core map type because the small-anthered bittercress does not have one. The range core map type was used to represent the core map in Virginia, but was not used in North Carolina because that portion is an unrefined range that appears not to have been developed with species habitat in mind.

In North Carolina, a species-specific model of low- and high-potential habitat for the small-anthered bittercress was developed by the NCDOT. Areas of “high” potential habitat (14,763 acres) were selected to represent the core map for this state.

Finally, cultivated lands were removed from this area; this removed 0.03% of area. **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

Known Observation Datasets

Datasets such as iNaturalist, GBIF, and NatureServe were considered but not used. The current range of the species encompasses all the occurrences based on visual inspection. Range was selected as the outer extent and further refined with biological data in North Carolina.

NLCD, LANDFIRE, and other land cover datasets

Typically, it would be reasonable to refine a core map for a species with a large and/or unrefined range based on descriptions of its habitat, which can be mapped to land cover datasets such as NLCD, LANDFIRE, and others. For the small-anthered bittercress in Virginia, the core map was based on its range that could have been additionally refined using preferred habitat information.

Appendix 1. Information compiled for the small-anthered bittercress

1. Recent FWS documents

- 5-Year Review (2023): https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/5688.pdf
- Recovery Plan (1991): [https://ecos.fws.gov/docs/recovery_plan/Recovery plan for small-anthered bittercress.pdf](https://ecos.fws.gov/docs/recovery_plan/Recovery_plan_for_small-anthered_bittercress.pdf)

2. Background information

- Status: Federally listed as endangered in 1989.
- Resiliency, redundancy, and representation (the 3Rs)
 - The 3 Rs were not specifically described in the species Recovery Plan or most recent 5-Year Review for this species. There is no Species Status Assessment.
- Habitat, Life History, and Ecology
 - Habitat: “The habitat *Cardamine micranthera* consists of seepages, wet rock crevices, streambanks, sandbars, and wet woods along small streams. Although soil mapping is incomplete, preliminary indications are that *Cardamine micranthera* occurs on soils of the Rion, Pacolet, and Wateree series, where slopes are 25 to 60 percent” (FWS 1991).
 - Flowering and fruiting occurs in April and May (FWS 1991).
 - Pollinators: “Pollinators are unknown. However, ants have been observed visiting the flowers” (FWS 1991).
- Taxonomy
 - *Cardamine micranthera* is a member of the mustard family (*Brassicaceae*), and one of 13 species in the genus *Cardamine* native to the Carolinas (FWS 1991)
- Relevant Potential Pesticide Use Sites
 - “Many are in close proximity to fields and pastures, where they are vulnerable to herbicides, erosion, and siltation” (FWS 1991).
- Relevant Recovery Criteria and Actions
 - Downlisting Criteria (downlisting will be considered when the following have been met) (FWS 2023)
 - Management plans have been prepared and are being implemented for all publicly owned population centers and those owned by The Nature Conservancy, and [Status: partially complete].
 - Populations at these centers have been monitored for at least five years and are determined to be stable. [Status: partially complete].
 - Recovery Criteria (FWS 2023)
 - *It has been documented that at least six populations are self-sustaining and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival.*
 - Of the 29 extant populations, seven have a rank of A (excellent viability) and four have at least one EO with a rank of AB (excellent-good viability) (NCNHP 2021; Virginia Natural Heritage Program, 2014). Of the seven populations with excellent viability (rank of A), two are in North Carolina and five are in Virginia. Of these seven populations three were surveyed in 2014, two surveyed in

2013, and two surveyed in 2004. Each of the seven excellent viability sites lacks a management plan and does not have a survey which postdates the 2016 5-year review. Due to the outdated information, these populations cannot be assumed to meet this recovery criteria until re-evaluated. All 29 extant populations of *C. micranthera* are located on private property making private landowner permission a requirement for further evaluation of habitat protection priorities.

We currently lack information specific to the species and are still investigating aspects of this plant's biology. Without this life history information, we are unable to develop appropriate habitat management guidelines for existing populations. Therefore, this criterion has not been met.

- *All the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.*
 - Currently, there are only two populations afforded some protection, one (NCNHP EO 24.002; part of Service population 16 in Appendix A) is protected by a voluntary registry with the NCNHP, the second (NCNHP EO 23.019; part of Service population 23 in Appendix A) is subject to a conservation easement with the North Carolina Division of Mitigation Services. Neither site, (NCNHP EO 24.002 and NCNHP EO 23.019) has received an update to the status of its population or protection since the 2016 5-year review. Therefore, the criterion of at least six adequately protected populations has not been met.

3. Description of Species Range

- Spatial Distribution: "When *C. micranthera* was listed in 1989, the current and historical range was described as confined to the Dan River basin in Stokes and Forsyth counties, NC. In the 1989 listing rule, the Forsyth County occurrence was described as extirpated, and the current range was described as consisting of four populations in Stokes County, NC. The 1989 listing rule did not provide additional information on the location of these four populations; however, information on file with the Asheville Field Office suggests that they correspond to four tributaries of the Dan River (Peter's Creek, Little Peter's Creek, Elk Creek, and a fourth unnamed tributary to the Dan River)" (FWS 2023).

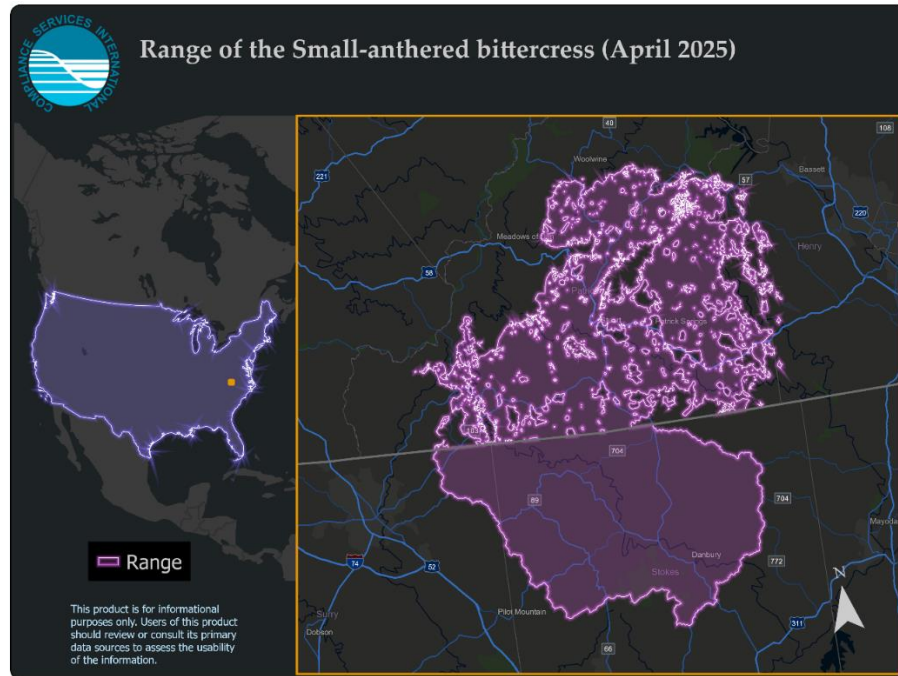


Figure 2. Range of the small-anthered bittercress (FWS 2025).

4. Critical Habitat

The small-anthered bittercress does not have DCH.

5. Known Locations

- FWS 5-Year Review (2023)
 - “Of the 37 known populations (Appendix A), 29 known populations are still extant, 12 populations within North Carolina and 17 populations within Virginia, all on privately owned lands (Van Alstine 2016; Van Alstine 2018; Stanley 2021; NCNHP 2021). The remaining eight populations are likely extirpated with no plants found in the 2020 surveys (i.e., recorded as extirpated or failed to find by the state natural resource agencies).”

“Since the 2016 5-year review, three populations (Service populations 1, 25, and 32, Appendix A) have been moved from a D-ranking (poor viability) to F (failed to find). Therefore, the current species remains confined to 29 populations in the Dan River system in Stokes County, NC and Patrick County, VA. The 29 extant populations (13 in NC and 16 in VA) represented by current (within the last 5 years) population surveys ranged from 10 to 3,000 plants. New occurrences were identified in Patrick County, VA (Van Alstine 2018). One hundred and fifty-two new plants were found within Peters Creek and Little Peters Creek and one new plant in Russell Creek (Van Alstine, N.E. 2018). One new discrete site has been added to the Dan River, NC (NCNHP 2021). The EOs have been expanded to represent these increases. These 29 populations represent some 124 sites (28 in NC and 96 in VA). A historical review of extant populations and more current information is provided below (Tables 1 and 2).”

“The number of populations in North Carolina has remained stable at 13 since 2016. Of these 13 populations, five were surveyed in 2013 and eight were surveyed in 2018 (NCNHP 2021). The number of extant populations in Virginia has declined from 20 to 16 (Van Alstine 2016,

2018). Of these 16 populations, 2 were surveyed in 2004, 6 in 2014, 4 in 2015, 2 in 2017 and 2 in 2020. Current estimates of abundance for the 29 populations range from ten plants (Dan River, NC) to 3,000 – 5,000 plants (Peters Creek, VA) (Appendix A). Nine of the 29 populations are in a decline, 4 are stable, 8 are increasing, and 8 are unknown” (FWS 2023).

Year	Number of Populations in North Carolina	Number of Populations in Virginia	Total Number
1991	4	5	9
2016	13	20	32
2021	13	16	29

Table 2. Number of small-anthered bittercress extant populations. Copied from Table 1 of the 5-Year Review (FWS 2023).

- iNaturalist: https://www.inaturalist.org/observations?subview=map&taxon_id=159840
 - Seven verifiable observations, 4 of which are research-grade with public coordinate data (Figure 3).
 - These locations align with species range, but there are not enough observations to meaningfully contribute to core map development. This is especially true in Virginia, where there is a single observation despite there being 16 extant populations known to occur (Table 2, FWS 2023).

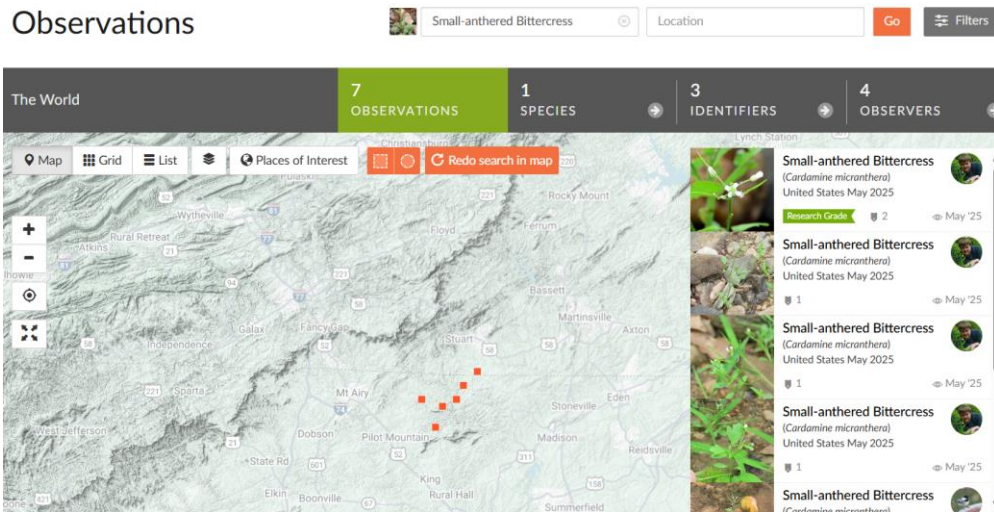


Figure 3. iNaturalist occurrences for the small-anthered bittercress.

- GBIF: <https://www.gbif.org/species/3045962>
 - GBIF includes 96 occurrence records; only one of which is georeferenced and is in North Carolina. Given the lone observation, this dataset was not used for core map development or validation of other datasets.

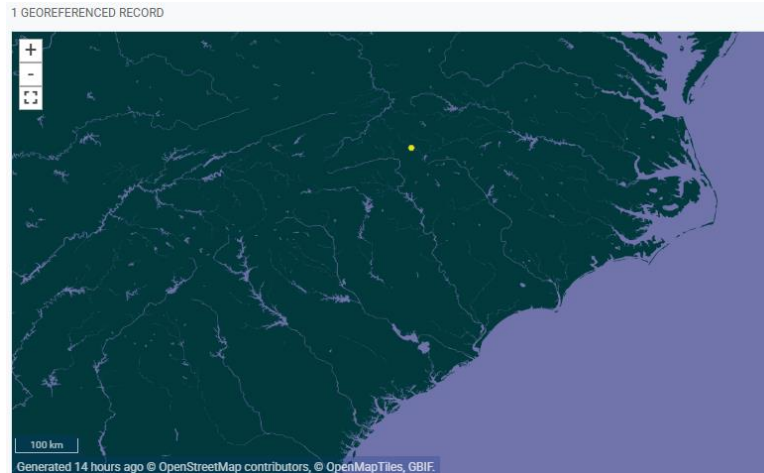


Figure 4. GBIF occurrence of the small-anthered bittercress.

- NatureServe Explorer: <https://explorer.natureserve.org/>
 - Available public EO information from NatureServe Explorer is generally consistent with the other data sources and the FWS range.

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

The core map for this species is based on a combination of species range and biological information, which includes the habitat used by this species found within a spatial extent of range in North Carolina. In Virginia, the core map is represented by its range. In North Carolina, the core map identifies areas within the range with a “high” potential habitat for the species, according to a species-specific model developed by the North Carolina Department of Transportation (NCDOT). These state-specific layers were merged and had contiguous cultivated areas > 25 acres removed to create the final core map shape.

1. References and Software

- LANDFIRE. 2022. "Existing Vegetation Type (EVT)." U.S. Department of Agriculture and U.S. Department of the Interior. Accessed April 22, 2025. <https://landfire.gov/data/FullExtentDownloads>.
- North Carolina Department of Transportation: "Small Anthered Bittercress - Potential Habitat, December 2021" <https://xfer.services.ncdot.gov/gisdot/AtlasData/AtlasSpeciesModels/ATLASPlantMachineLearningModels/>.
- Software used: ArcGIS Pro version 3.2.
- EPA Modified Cultivated Layer: <https://cdn.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668>.
- FWS Species Range: <https://ecos.fws.gov/ecp/species/3462>.

2. Datasets Used in Core Map Development

2.1. Range

The range for this species was last updated on September 27, 2022. A shapefile including species range for all listed species was downloaded from the FWS ECOS website on January 24, 2025. The shapefile was converted to a feature class stored in a file geodatabase and reprojected to WKID #4269 (“North America Albers Equal Area Conic”).

1. Using an ArcGIS Web Map the species was queried based on the ECOS listed “Entity ID” of 655 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 rate of 0.000247105.
3. This shapefile was added to an ArcGIS Pro map and compared against the available known locations described in the FWS 5-Year Review, and the available occurrence information from the GBIF, iNaturalist, and NatureServe databases.

Compliance Services International has determined that the portion of the species range occurring in Virginia is somewhat refined, and, therefore, suitable for use in core map development without a need for further modification (Figure 5). The species range was clipped to the state of Virginia and incorporated into the core map. Further details related to data processing are provided in Section 3.1.

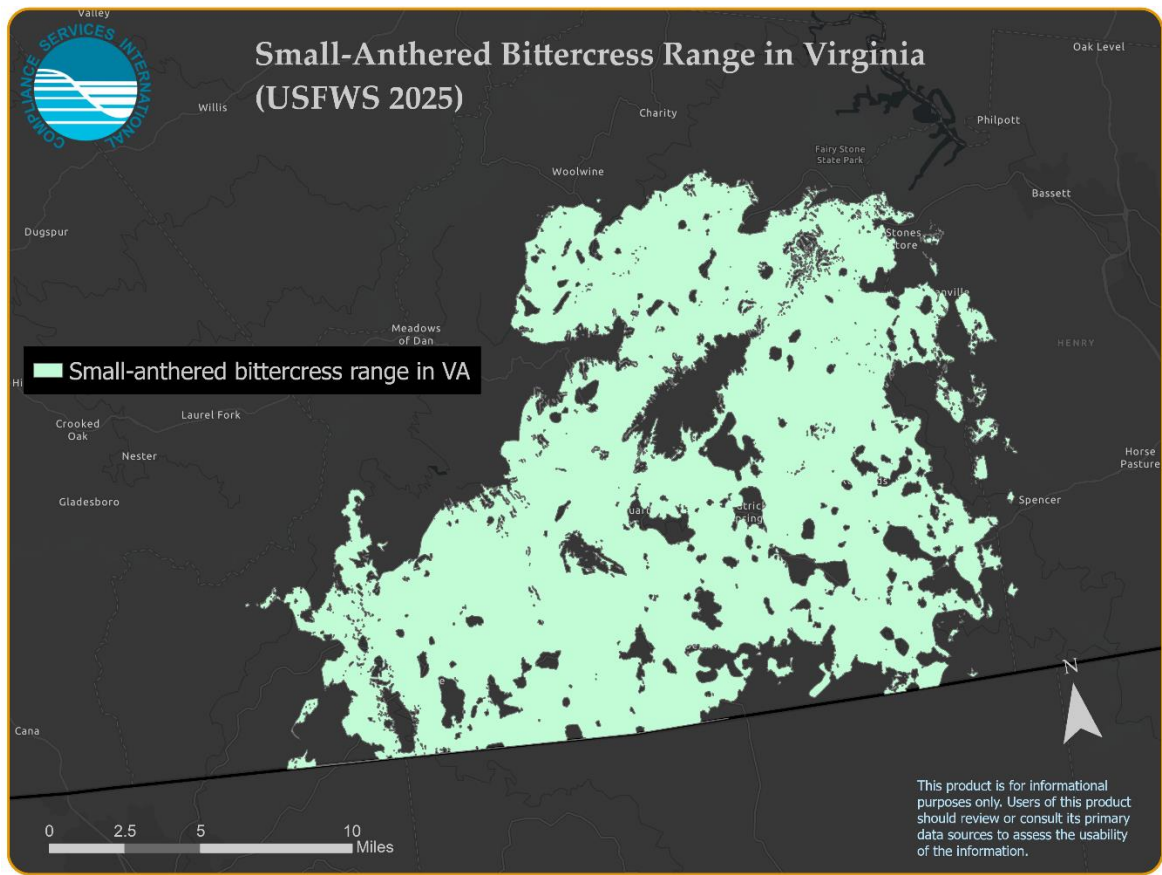


Figure 5. Range of the small-anthered bittercress in Virginia (FWS 2025).

2.2. NCDOT ATLAS

Regions of suitable habitat were used to refine the core map based on biological information in North Carolina. The NCDOT completed a project named “ATLAS” in 2021 that categorized land within the range as low, moderate, or high potential habitat ability for species habitat for the small-anthered bittercress based on the similarity of that area to the species’ preferred habitat. Professional judgment was used to exclude areas of Low (38% or less similarity to species’ habitat) and Moderate (no clear definition provided) potential habitat, while High (65% or greater similarity to species’ habitat) 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 6, NCDOT 2021).

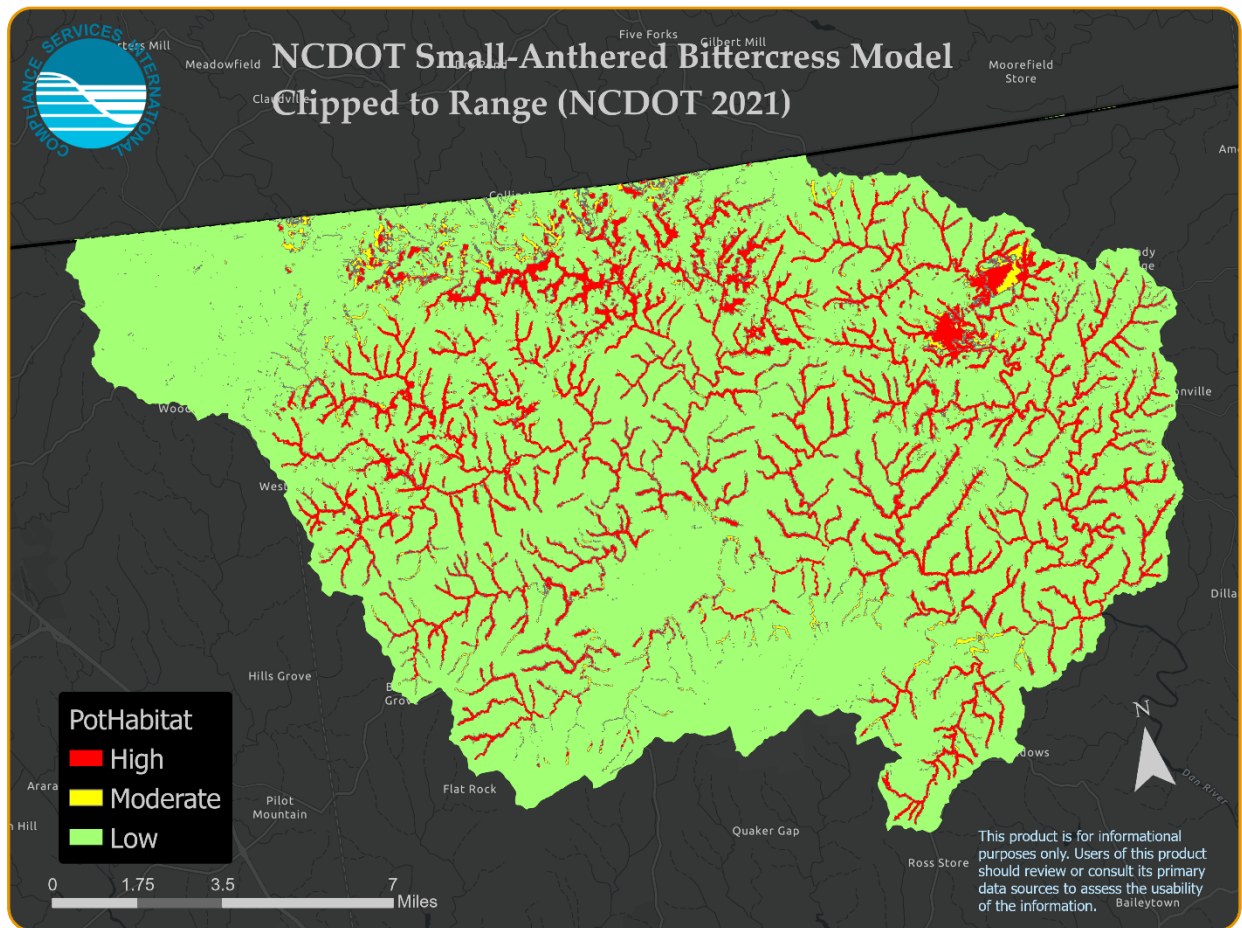


Figure 6. Areas of low, moderate, and high habitat suitability for the small-anthered bittercress range in North Carolina (NCDOT 2021).

2.3. EPA Cultivated Lands Layer

EPA has developed and published its own cultivated layer for use in core map development as a potential

refinement of extent. For the small-anthered bittercress, extent 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 0.03% of area but is considered a reasonable refinement for core map development for an off-field species.

3. Creating the Core Map

3.1. Range-Based Core Map Development

In Virginia, the small-anthered bittercress core map is developed from range data. The range layer for the species was downloaded and processed as follows:

1. Import the species range as a feature class named “SAB_range.”
2. Add a layer of state boundaries into a new map.
3. Use the Select tool to select only the state of Virginia from the state boundaries layer.
4. Use the Pairwise Clip tool to clip the species range (“SAB_range”) by the state layer selection and save as a new feature class (“SAB_range_pcVA”).

3.2. Habitat-Based Core Map Development

In North Carolina, the core map was developed from biological/habitat information produced by the NCDOT, a species-specific model for the small-anthered bittercress. Generally, NCDOT models are produced with an extent of species range; in the case of this species, the NCDOT model covered a larger area. This is likely due to the species range last changing in September 2022; the NCDOT model was developed in 2021. The habitat-based core map in North Carolina was developed according to this procedure:

1. Import the species model (“SmallAntheredBittercressThreeLevelPotentialHabitat.shp”) and save as a new layer with a projection of WKID #4269 (“NCDOT”).
2. Use the Pairwise Clip tool to clip the species model (“NCDOT”) by the range (“SAB_range”) and save as a new feature class, “NCDOT_pcRange”.
3. Use the Select by Attributes tool to select features from the previous layer (“NCDOT_pcRange”) with high potential habitat using this SQL query: PotHabitat = 'High'. Export selected features as a new layer, “NCDOT_pcRange_sel”.
Use the Pairwise Dissolve tool to dissolve the previous layer (“NCDOT_pcRange_sel”) into a single feature; save as a new layer, “NCDOT_pcRange_sel_pd”.

3.3. Merging Core Map Layers

The layers developed in the previous section for both states intersecting the species range were merged according to this procedure:

1. Use the Merge tool to merge the core map datasets (listed below) into a single layer, named “SAB_extent.”
 - a. SAB_range_pVA
 - b. NCDOT_pcRange_sel_pd
2. Use the Pairwise Dissolve tool to dissolve the previous layer (“SAB_extent”) into a single feature, named “SAB_extent_pd.”

3.4. Cultivated Lands-based Refinement

The small-anthered bittercress 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 according to a layer developed by EPA ("CultivatedAreas_Over25acres"). Save as a new layer ("SAB_extent_pd_peCultivated25ac").
2. (Optional) Export previous layer as a new layer identifiable as the species core map ("SAB_CoreMap").

References

Documents

- U.S. Environmental Protection Agency. 2024. Process EPA Uses to Develop Core Maps for Pesticide Use Limitation Areas. Accessed May 7, 2025. <https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas>.
- U.S. Fish and Wildlife Service. 1991. *Recovery Plan: Small-anthered bittercress*. Accessed May 7, 2025. https://ecos.fws.gov/docs/recovery_plan/Recovery%20plan%20for%20small-anthered%20bittercress.pdf.
- U.S. Fish and Wildlife Service. 2023. *Small-anthered bittercress (Cardamine micranthera) 5-Year Review*. Accessed May 7, 2025. https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/5688.pdf.
- U.S. Fish and Wildlife Service. 2025. *Small-anthered bittercress (Cardamine micranthera)*. Accessed May 7, 2025. <https://ecos.fws.gov/ecp/species/3462>.

Spatial Data & Software

- GBIF Secretariat. "*Cardamine micranthera* (Small-anther bittercress)." *GBIF Backbone Taxonomy*. Accessed May 7, 2025. <https://www.gbif.org/species/3045962>.
- iNaturalist. "Small-anthered bittercress (*Cardamine micranthera*)." Accessed May 7, 2025. https://www.inaturalist.org/observations?subview=map&taxon_id=159840.
- NatureServe. 2025. NatureServe Network Biodiversity Location Data accessed through NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. Accessed May 7, 2025.
- North Carolina Department of Transportation. 2021. "Small Anthered Bittercress - Potential Habitat, December 2021." ATLAS Project. Accessed March 1, 2025. <https://xfer.services.ncdot.gov/gisdot/AtlasData/AtlasSpeciesModels/ATLASPlantMachineLearningModels/>.
- Software used: ArcGIS Pro version 3.2.
- U.S. Environmental Protection Agency. 2025. Modified Cultivated Layer. Accessed April 1, 2025. <https://cdn.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668>.