Interim Core Map Documentation for the Cumberland Rosemary

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Draft Interim Core Map Developer: U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs

Species Summary

The Cumberland rosemary (*Conradina verticillata*, Entity ID 677) is a threatened terrestrial plant (dicot). The U.S. Fish and Wildlife Service (FWS) has not designated a critical habitat for the Cumberland rosemary. The species is a low-growing, perennial, scrub mint restricted to river scour prairie and cobble bar habitats in the Cumberland Plateau in Tennessee and Kentucky. The Cumberland rosemary appears to need seasonal flooding to help limit competition and enhance seed deposition, openness, and germination. Currently there are three known population in the Big South Fork, Emory, and Caney Fork watersheds. Additional information on the species is provided in **Appendix 1**.

Description of Core Map

The core map for the Cumberland rosemary is biological information type, based on habitat and known locations. The outer extent of this core map is the borders of the HUC 12 watersheds that have known locations present. HUC 12 watersheds were initially selected based on overlap with the current ECOS species range for the Cumberland rosemary. These regions were further refined based on known locations present as well as areas containing full to moderate sunlight and sandy soils.

Figure 1 depicts the resulting interim core map for the Cumberland rosemary. The size of this core map is approximately 2,573 acres. Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly deciduous forest, mixed forest, evergreen forest, and pasture/hay land.

The core map developed for the Cumberland rosemary is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the Cumberland rosemary. 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 species expert feedback from FWS. This interim core map has a "moderate" (4) best professional judgment classification to describe major uncertainties/limitations. The map is based on known locations described by FWS and their surrounding watersheds, which represent the biological needs of the species. This core map does not replace or revise any range developed by FWS for this species.

Figure 1. Interim core map for Cumberland rosemary.

Table 1. Percentage of Interim Core Map Represented by the National Land Cover Dataset (NLCD)[1] Land Covers and Associated Example Pesticide Use Sites/Types.

Example pesticide use sites/types	NLCD Class/Value	% Area	Total area for landcover type
Forestry	Deciduous Forest (41)	37%	56%
Forestry	Evergreen Forest (42)	6%	56%
Forestry	Mixed Forest (43)	14%	56%
Agriculture	Pasture/Hay (81)	19%	19%
Agriculture	Cultivated Crops (82)	0%	19%
Mosquito adulticide, residential	Developed Open Space (21)	7%	11%
Mosquito adulticide, residential	Developed Low Intensity (22)	3%	11%
Mosquito adulticide, residential	Developed Medium Intensity (23)	1%	11%
Mosquito adulticide, residential	Developed High Intensity (24)	0%	11%
Invasive species control	Woody Wetlands (90)	0%	14%
Invasive species control	Emergent Herbaceous Wetlands (95)	0%	14%
Invasive species control	Open Water (11)	2%	14%
Invasive species control	Grassland/Herbaceous (71)	9%	14%

[1] Dewitz, J., 2023, National Land Cover Database (NLCD) 2021 Products: U.S. Geological Survey data release, https://www.usgs.gov/data/national-land-cover-database-nlcd-2021-products

Example pesticide use sites/types	NLCD Class/Value	% Area	Total area for landcover type
Invasive species control	Shrub/Scrub (52)	1%	14%
Invasive species control	Barren Land (31)	2%	14%
Total Acres	Interim Core Map Acres	~ 2573	

Evaluation of Known Location Information

EPA evaluated known location data (Appendix 1) before selecting the type of and developing the core map. FWS data identified the general population range and counties where the species was discovered, including the Cumberland River's Clear Fork, White Oak Creek, Big South Fork, Caney Fork and Tennessee River's Clear Creek, Daddy's Creek, Obed River, and Emory River (**Figure A1-2 in Appendix 1**). HUC12[2] watersheds that encompassed these rivers were used to refine species habitat. Occurrences in other public databases did not support expanding the core map outside of these three watersheds. **Appendix 1** includes more information on the available known location information.

Approach Used to Create Core Map

The core map was developed using the "Process EPA Uses to Develop Core Maps for Draft Pesticide Use Limitation Areas for Species Listed by the U.S. Fish & Wildlife Service (FWS) and their Designated Critical Habitats"[3] (referred to as "the process"). EPA developed the core map using the 4 steps described in the process document:

1. Compile available information for a species;
2. Identify core map type;
3. Develop the core map for the species; and
4. Document the core map.

For step 1, EPA compiled available information for the Cumberland rosemary from FWS, as well as observation information available from various publicly available sources (including iNaturalist and the Global Biodiversity Information Fcaility ((GBIF)). The information compiled for the Cumberland rosemary is included in **Appendix 1**. Influential information that impacted the development of the core map included:

- Occurrences and known locations of the Cumberland rosemary are in nine major streams in Tennessee and Kentucky (Big South Fork River, New River, Clear Fork River, White Oak Creek, Caney Fork River, Obed River, Daddy's Creek, Clear Creek, and the Emory River);
- The FWS range includes a lot of empty space so would be too expansive; and
- The species has a widespread distribution so known location alone would be too narrow.
- The species prefers sandy soils and areas with moderate to full sun exposure.

[2] The HUC 12 GIS data were obtained from the National Hydrography Dataset (NHD) Plus Version 2: https://www.epa.gov/waterdata/nhdplus-national-data, using the specific layer NHDPlusV21_NationalData_Seamless_Geodatabase_Lower48_07.

[3] Dated 2024, available online at: https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas

For step 2, EPA used the compiled information to identify the core map type including species range and known location information. The extant populations are located in stream drainages identified by FWS (Cumberland River's Clear Fork, White Oak Creek, Big South Fork, Caney Fork and Tennessee River's Clear Creek, Daddy's Creek, Obed River, and Emory River) within the species' range. Therefore, EPA based the core map on the HUC12 watersheds associated with the streams identified by FWS, as well as the sandy and moderate to full sun habitats within those areas. The Soil Survey Geographic Database (SSURGO) and NLCD tree canopy national datasets were used to identify these habitats). The entire range of the species was not used as the core map because the range contains areas where the species does not occur.

For step 3, EPA used the best available data sources to generate the core map. Data sources are discussed in the process document. For this core map, EPA used the HUC12 watersheds for the Cumberland rosemary's known occupied stream drainages identified by FWS. **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

EPA explored using the FWS range as the core map but ultimately known locations was chosen as the range is not refined and known location information is robust. The species ecology suggests the species sightings are widespread, yet this characteristic was not enough to select this option due to the lack of refinement in the range.

Critical habitat was not considered because there is no critical habitat listed for this species on the FWS website.

Cultivated lands were considered for removal using EPA's modified cultivated GIS layer, but this was not done because the known location and habitat refinements filtered out cultivated lands.

Appendix 1. Information Compiled for the Cumberland Rosemary During Step 1

1. **Recent FWS documents/links and other data sources**
   - Five Year Review (2023) (https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/5259.pdf)
   - Five Year Review (2018) (https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2578.pdfhttps://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/1839.pdf)
   - Five Year Review (2011) (https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/1714.pdf)
   - Recovery Plan (1996) (https://ecos.fws.gov/docs/recovery_plan/960712.pdf)

2. **Background information**
   - **Status**: Federally listed as threatened in 1991.
   - **Resiliency, redundancy, and representation** (the 3Rs) (Five Year Review, 2023):
     - No 3R report found, synthesis of 2023 5-year review plan below:
       - "Cumberland rosemary is a low-growing, perennial, scrub mint restricted to river scour prairie and cobble bar habitats in the Big South Fork, Obed, and Caney Fork river systems in Tennessee and Kentucky. While NPS monitoring data shows some decline over the last five years, most sites appear stable with the declines concentrated at specific sites. Further data is needed to understand what is contributing to these trends. The species has a limited ability to recruit new seedlings due to low seed viability and small population size. Sites near popular recreation areas are still threatened by trampling, and encroachment by invasive plant species still threatens sites on and off NPS lands. There is concern that increased flooding and inundation is contributing to species declines at sites in the Big South Fork watershed. This flooding and increased woody vegetation growth may be exacerbated by climate change and result in declines in suitable habitat for Cumberland rosemary. Because of ongoing threats and the current condition of the species, Cumberland rosemary continues to meet the definition of a threatened species." (Cumberland Rosemary (Conradina verticillata) 5-Year Status Review: Summary and Evaluation (ecosphere-documents-production-public.s3.amazonaws.com))

   - **Habitat**
     - Clumps occur on sandy and gravelly stream banks, sandbars, gravel and boulder bars, as well as on terraces of sand, sloped on riverbanks and islands, and within sandy pockets between boulders.
     - Full to moderate sunlight required for growth and reproduction, encroachment from plants that create shade hinder this growth (1996 Recovery Plan).
     - Substrate:
       - Varies from deep, pure sand to densely rocky areas, well drained and devoid of organic matter

- Flooding, seasonal, that lasts at least two weeks, is vital for success of growth of plants due to:
    - Aids in limiting resource competition for sunlight against other plants.
    - Flooding helps initiate seed germination.
    - Enhances seed deposition and openness, leads to bigger clump sizes.
    - Flooding is most common during the winter, happening in some populations "three to seven times a year for up to 3 days at a time" (1996 Recovery Plan).
- Threats of habitat:
    - Dams and other commercial and man-made bodies of water that impact flooding rates, and their respective activities (boating, jet ski, recreational fishing, etc.)
    - Encroachment of other plants either above, creating shade that hinders growth and flowering, or adjacent, taking up space on substrate.
    - Some idea that people may pick the flowers and impact habitat but there is not enough data to support this theory (1996 Recovery Plan).
- Specific locations:
    - Three populations of 91 extant colonies, 79 in TN and 12 found in KY.
    - "At the time of the listing (1991) there were three populations and 44 known colonies of the species" (1996 Recovery Plan).

- **Pollinator/reproduction (1996 recovery plan)**
    - Flowers in May and early June
    - Functionally male when they first open for several hours or up to a day; then female parts come
    - Produce small quantities of nectar that attracts a range of insects but are mainly pollinated by honeybees and bumblebees
    - Flowers fall off within two days of pollination and one week if not pollinated
    - NEEDS insect visits for seed production
    - Lots of seeds are produced and mature in the middle of June but less than 10% of seeds are actually developed and fertile (viable, post-zygotic breakdown of offspring)
    - No dormancy mechs recorded and germination normally takes two weeks but can be sped up to 2-3 via scarification
    - Idea that they can self-pollinate but since they are highly clonal one flower pollinated could be on the same genetic individual that is not visited by pollinators
        - Maintains itself via clonal spread and stem longevity
    - Fungal infection can cause poor seed development.

- **Taxonomy**
    - Semi-aquatic plant. Grows in major floodplain of major streams with sandstone bedrock substrate (1996 Recovery Plan).

- **Relevant Pesticide Use Sites**
    - No data found

- **Recovery Criteria/Objectives (1996 recovery plan)**
    - "Cumberland rosemary will be considered for delisting when there are five protected and managed colonies with 50 genetically distinct individuals per colony in each of the five main rivers (Big South Fork, Emory, Clear Fork, Caney, and Obed) where it occurs (25 colonies total). Introduced colonies will not be considered successfully established until after a 5-year period" (1996 Recovery Plan).
    - Proposed date of Recovery was 2005, given funds are available to accomplish goals and recovery tasks. Total financial amount needed from 1996-2005 was 325 dollars (1996 Recovery Plan).

- **Recovery Actions (1996 recovery plan)**

1. Protect existing colonies and habitat.
    a. Determine protection priorities
    b. Develop management plans
    c. Obtain baseline population data
    d. Monitor colonies that have been determined to be essential for the survival of the species
    e. Contact private landowners
2. Develop management plans.
3. Study the biology of the species.
    a. "Because seed production is known to be low for Conradina verticillata, seed dispersal and germination requirements need to be studied in depth. Genetic studies are extremely important for determining the extent of individual populations and identifying the populations that should be protected and managed" (1996 Recovery Plan).
    b. Proposed actions include "studying seed biology and germination" and "conducting further genetic research".
4. Conduct genetic studies; maintain seeds in storage and plants in cultivation.
    a. "Genetic studies for the genus Conradina, using DNA as well as electrophoresis, are currently being conducted at the University of Georgia, Athens. The results of this analysis will be important for the management of Cumberland rosemary, identifying genetically distinct populations (or colonies) for protection."
    b. "Numerous plant nurseries located in the following States propagate Cumberland rosemary: Tennessee, Georgia, Louisiana, North Carolina, South Carolina, Mississippi, and Maryland. Plants from these sources could be used to establish new populations."
    c. Proposed actions include maintaining seeds and plants ex situ.
5. Search for new populations" (1996 Recovery Plan).
    a. "Searches for new populations of Conradina verticillata were conducted in Kentucky primarily during May and June of 1994 (White 1994). The survey was designed to investigate other river systems in Kentucky and other sections of the Big South Fork River. After a thorough search, no new populations were discovered in apparently suitable habitat."

- Should do an updated one since last one was 30 years ago.
- Proposed actions in Recovery Plan (1996) include "preparing and distributing new releases and informational brochures", as well as "preparing articles and scientific populations."

- Best to use a boat and look for sandy stream banks and gravel and boulder bars during May as there will be other co-flowering species (1996 Recovery Plan).

3. **Description of Species Range**
   - **Figures A1-1, A1-2** depict the FWS range
   - "Cumberland rosemary is represented by three populations in Tennessee and Kentucky in the Big South Fork, Emory, and Caney Fork watersheds. The species is monitored at 25 sites at varying frequency by the National Park Service's Appalachian Highlands Inventory and Monitoring Network (NPS-APHIN), Tennessee Department of Environment and Conservation (TDEC), and the Office of Kentucky Nature Preserves (OKNP)" [Cumberland Rosemary (Conradina verticillata) 5-Year Status Review: Summary and Evaluation (ecosphere-documents-production-public.s3.amazonaws.com)](ecosphere-documents-production-public.s3.amazonaws.com) (5 Year Review, 2023)

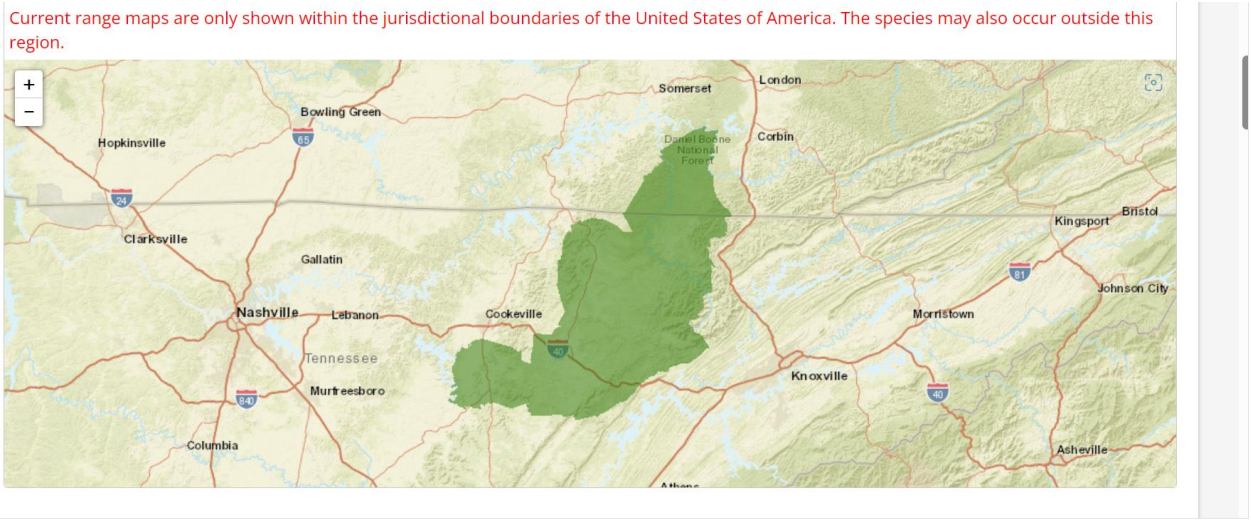

Figure A1-1. FWS range for the Cumberland rosemary. The total acreage is around 1,952,278 acres.

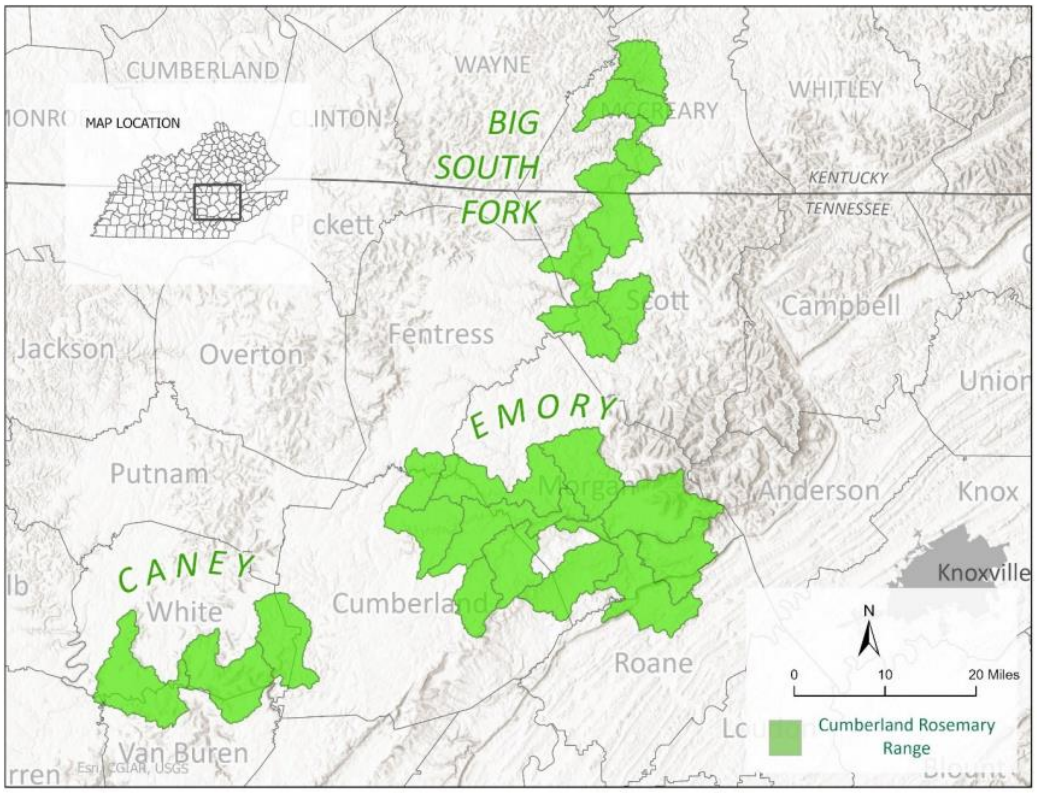

Figure A1-2. Range of the Cumberland rosemary, distributed among its three main river drainages, Big South Fork, Obed-Emory, and Caney Fork rivers [(5 Year Review, 2023)](#).

4. **Critical Habitat**
   - FWS has not designated a critical habitat for this species (https://ecos.fws.gov/ecp/species/3677).

5. **Known Locations**
   - **Source 1: iNaturalist https://www.inaturalist.org/observations**
   - **Source 2: GBIF https://www.gbif.org/**
   - **Source 3: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.148865/Conradina_verticillata**
   - Endemic to the Cumberland Plateau of North central Tennessee and Southeastern Kentucky, with 91 extant colonies as of 1991. Colonies exist along nine major streams (across three watersheds) of the plateau: Big South Fork River, New River, Clear Fork River, White Oak Creek, Caney Fork River, Obed River, Daddy's Creek, Clear Creek, and the Emory River (1996 Recovery Plan). These colonies stretch across the Tennessee counties of Scott, Morgan, Cumberland, White, and Fentress, and the Kentuckian county of McCreary (1996 Recovery Plan).
   - Important to note that despite this widespread distribution, the colonies are "disjunct and seldom abundant", often featuring a single plant. The Recovery Plan notes that "fewer than ten locations …are known to have more than 100 clumps". The plan suspects there are most likely less than 4,000 total clumps across all locations. (1996 Recovery Plan)

- The Cumberland's River New River did not have any observed populations. Given the age of the historic river reports and the lack of any current operations, the New River subwatersheds were omitted from the final core map
- See also **Table A1-1** for exact dates of discovery along major streams.

Table A1-1. Discovery year of species at various major streams along the Cumberland and TN River

Drainage	Major Stream	Year of Discovery	Collectors/Observers
Cumberland River	Clear Fork	1894	Ruth, Percival
Cumberland River	White Oak Creek	1930	Cain
Cumberland River	Big South Fork, KY	1935	Braun
Cumberland River	Big South Fork, TN	1947	Clebsch, Shanks, Sharp
Cumberland River	Caney Fork	1961	Channell
Cumberland River	New River	1975	Leonard
Tennessee River	Clear Creek	1965	Sharp, Taylor
Tennessee River	Daddys Creek	1969	Clebsch, Bowers, Evans
Tennessee River	Obed River	1979	Schmalzer
Tennessee River	Emory River	1979	Schmalzer

- **Occurrences Included in Public Databases**
    - EPA queried iNaturalist, GBIF, and NatureServe. Collectively, the occurrence data did not support expanding the core map further and were consistent with the core map.

Appendix 2. GIS Data Review and Method to Develop Core Map (Step 3)

This core map was created based on biological information, including habitat and known locations. EPA used the FWS species range as the starting point (outer extent) for developing this core map. The core map was refined to the HUC12 watersheds present in the current ECOS species range. Next, those watersheds were overlaid with the observed locations from iNaturalist research grade observations to confirm they overlapped. Finally, soil and tree canopy cover datasets were overlaid on top of this and filtered to remove areas with greater than 50% cover (since the species prefers sun) as well as areas that are not sandy.

1. **Dataset References and Software**
   - Software used: ArcGIS Pro 3.4
   - FWS Species Range – last updated on January 26, 2018.

2. **Datasets Used in Core Map Development**
   - Watershed Boundary Dataset HUC 12s: https://epa.maps.arcgis.com/home/item.html?id=b60aa1d756b245cf9db03a92254af878 alternatively https://www.usgs.gov/national-hydrography/watershed-boundary-dataset
   - USA NLCD Tree Canopy Cover: https://epa.maps.arcgis.com/home/item.html?id=f2d114f071904e1fa11b4bb215dc08f3
   - USA SSURGO – Soil Hydrologic Group: https://www.arcgis.com/home/item.html?id=be2124509b064754875b8f0d6176cc4c
   - FWS Species Range: https://ecos.fws.gov/ecp/species/3677
   - USA NLCD Land Cover: https://www.arcgis.com/home/item.html?id=3ccf118ed80748909eb85c6d262b426f
   - EPA Modified Cultivated Layer: https://cdn.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668.

3. **Core Map Development**

   - Started with importing the watersheds that historically had observed populations of the Cumberland rosemary (**Table A1-1, Figures A2-1, A2-2**) onto the map.
   - The watersheds were selected using the HUC 12's present in the current ECOS species range for the Cumberland rosemary.
   - Next, those watersheds were overlaid with the observed locations (**1996 Recovery Plan**) from research grade observations to confirm they overlapped (**see "Known Locations" section**)).

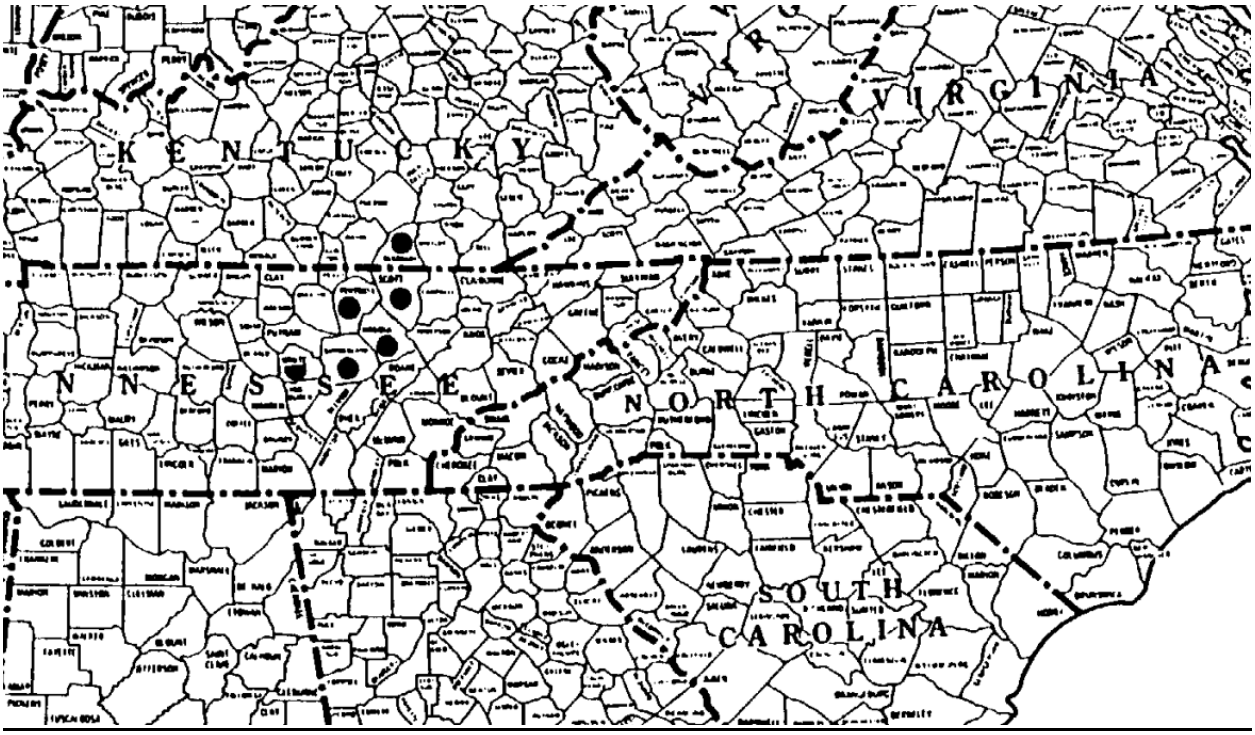

Figure A2-1. Species distribution of the Cumberland rosemary across its range.

Figure A2-2. Initial map showing the observed points and the HUC12 subwatersheds that intersected with them. Where the points are scaled based on their positional accuracy (m). The red boundary is the original ECOs range for the Cumberland rosemary.

- Once the refinement based on known location (watersheds) was completed, the core map was refined based on habitat. This started by removing areas of unsuitable soil types, which required adding the layer for the USA SSURGO – Soil Hydrologic Group to the map project.
- Next, limited the extent of the SSURGO raster to the extent of the selected HUC 12's present within the Cumberland rosemary's range by right clicking on the raster dataset in the Contents pane of ArcGIS Pro, indicating "Data" and "Export Raster," ensuring that the clip feature was the range area refined by HUC12s known locations.
- Once the extent of the raster dataset was limited, transformed it into vector format using the "Raster to Polygon" tool. Made sure to indicate the ClassName as the field of interest in the geoprocessing tool.
- Opened the attribute table and applied a "Select By Attributes" query with the expression: ClassName is equal to Group A. This is because according to the SSURGO data source, "Group A soils consist of deep, well drained sands or gravelly sands with high infiltration and low runoff rates." The species prefers sandy, gravelly soils.
- Exported the result of selecting by sandy soils to a new layer that contained only those sandy soil areas, named it "Coremap_sandy_sba," and applied the "Dissolve" tool to speed up the next geoprocessing step.

- Once sandy soil areas only were selected, the next step was to select only moderate to full sun areas using the NLCD tree canopy cover layer. So, that dataset was imported into the map project.
- The NLCD tree canopy cover was limited to the extent of the sandy refined area using "Export Raster," then the "Raster to polygon" tool was applied indicating "ClassName" as the field of interest.
- Once the canopy cover dataset was vectorized, a "Select by Attributes" query was run with the expression: ClassName is equal to 0-1% Or ClassName is equal to 1-25% Or ClassName is equal to 25-50%. This was done because the species prefers moderate to full sunlight.
- The output of the "Select by Attributes" query was exported as its own layer, then it was dissolved to make the area draw more efficiently on the map. This was saved as the interim core map for the Cumberland rosemary, which is shown in Figure 1 of the main document. Removing closed canopy areas and areas that were not sandy soil reduced the core map acreage considerably from the range (range totaled ~2 million acres while the core map totals ~2500 acres).

References

Documents

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Spatial Data & Software

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