

Interim Core Map Documentation for the Harperella

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

Species Summary

The harperella (*Ptilimnium nodosum*; Entity ID 991) is a dicotyledonous endangered plant. The U.S. Fish & Wildlife Service (FWS) has not established designated critical habitat for the harperella. This species is typically found in seasonally flooded rocky streams and coastal plain ponds. Additional 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 the agency'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. This documentation may include views not necessarily held by 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 documentation may include views that are not necessarily the view of EPA or its staff.

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 harperella is based on biological information, which was used to refine an extent determined by known location information for the species (**Figure 1**). The extent of the core map is represented by a combination of occurrence data from the Georgia Department of Natural Resources (GDNR) in Georgia and occurrence data from NatureServe in other states (Alabama, Arkansas, Maryland, Oklahoma, North Carolina, South Carolina, Virginia and West Virginia) (NatureServe, 2025b). In North Carolina, this extent is refined to include only species habitat based on species-specific modeling. In other states, landcover information from LANDFIRE is used for refinement. The extent was also limited using range and counties known to include extant locations. Other available known location information from iNaturalist and the Global Biodiversity Information Facility (GBIF) were consistent with the core map.

In North Carolina, a state-level program from the North Carolina Department of Transportation (NCDOT) named ATLAS was found to have developed a high-quality habitat suitability model for the harperella. This dataset identifies areas—in this case stream areas—with habitat suitable for the harperella. This linear dataset was buffered by 22.5 m to account for bankfull width and additional width of streambank areas on which the plant may be observed.

In the remaining states containing the harperella, habitat was established by querying the LANDFIRE Existing Vegetation Type (EVT) for classes matching habitat description. Land cover categories within the core map extent were identified based on matches of key words¹ from a subset of LANDFIRE classes occurring within the range of the species. The relevant habitat description classes are shown in Table 1.

EVT_NAME	
Atlantic Coastal Plain Blackwater Stream Floodplain Forest	Ozark-Ouachita Riparian Forest
Atlantic Coastal Plain Blackwater Stream Floodplain Herbaceous	Ozark-Ouachita Riparian Herbaceous
Atlantic Coastal Plain Blackwater Stream Floodplain Shrubland	Ozark-Ouachita Riparian Shrubland
Atlantic Coastal Plain Brownwater Stream Floodplain Forest	Piedmont Seepage Wetland
Atlantic Coastal Plain Clay-Based Carolina Bay Wetland	Piedmont Upland Depression Swamp
Atlantic Coastal Plain Peatland Pocosin and Canebrake Shrubland	South-Central Interior Large Floodplain Forest
Atlantic Coastal Plain Peatland Pocosin and Canebrake Woodland	South-Central Interior Large Floodplain Herbaceous
Atlantic Coastal Plain Small Blackwater River Floodplain Forest	South-Central Interior Large Floodplain Shrubland
Atlantic Coastal Plain Small Brownwater River Floodplain Forest	South-Central Interior Small Stream and Riparian Forest
Atlantic Coastal Plain Streamhead Seepage Swamp-Pocosin-Baygall Shrubland	South-Central Interior Small Stream and Riparian Herbaceous
Atlantic Coastal Plain Streamhead Seepage Swamp-Pocosin-Baygall Woodland	South-Central Interior Small Stream and Riparian Shrubland
Central Appalachian River Floodplain Forest	Southeastern Exotic Ruderal Flooded & Swamp Forest
Central Appalachian River Floodplain Herbaceous	Southeastern Native Ruderal Flooded & Swamp Forest
Central Appalachian River Floodplain Shrubland	Southeastern Ruderal Wet Meadow & Marsh
Central Appalachian Stream and Riparian Herbaceous	Southern Atlantic Coastal Plain Depression Pondshore
Central Appalachian Stream and Riparian Shrubland	Southern Atlantic Coastal Plain Large River Floodplain Forest
Central Appalachian Stream and Riparian Woodland	Southern Atlantic Coastal Plain Large River Floodplain Herbaceous
Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods	Southern Atlantic Coastal Plain Large River Floodplain Shrubland
Central Interior Highlands and Appalachian Sinkhole and Depression Pond	Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest
Cumberland Seepage Forest	Southern Atlantic Coastal Plain Wet Pine Savanna and Flatwoods
East Gulf Coastal Plain Depression Pondshore	Southern Coastal Plain Blackwater River Floodplain Forest
East Gulf Coastal Plain Large River Floodplain Forest	Southern Coastal Plain Nonriverine Basin Swamp
East Gulf Coastal Plain Large River Floodplain Herbaceous	Southern Coastal Plain Seepage Swamp and Baygall Shrubland
East Gulf Coastal Plain Large River Floodplain Shrubland	Southern Coastal Plain Seepage Swamp and Baygall Woodland
East Gulf Coastal Plain Small Stream and River Floodplain Forest	Southern Piedmont Large Floodplain Forest
East Gulf Coastal Plain Small Stream and River Floodplain Herbaceous	Southern Piedmont Large Floodplain Herbaceous
East Gulf Coastal Plain Small Stream and River Floodplain Shrubland	Southern Piedmont Large Floodplain Shrubland
North-Central Appalachian Acidic Swamp	Southern Piedmont Small Floodplain and Riparian Forest
North-Central Appalachian Seepage Fen	Southern Piedmont Small Floodplain and Riparian Herbaceous
North-Central Interior and Appalachian Rich Swamp	Southern Piedmont Small Floodplain and Riparian Shrubland
Northern & Central Native Ruderal Flooded & Swamp Forest	Southern Ridge and Valley Seepage Fen
Northern & Central Ruderal Wet Meadow & Marsh	West Gulf Coastal Plain Herbaceous Seep and Bog
Northern Atlantic Coastal Plain Basin Peat Swamp	West Gulf Coastal Plain Large River Floodplain Forest
Northern Atlantic Coastal Plain Basin Swamp and Wet Hardwood Forest	West Gulf Coastal Plain Large River Floodplain Herbaceous
Northern Atlantic Coastal Plain Brackish Tidal Marsh	West Gulf Coastal Plain Large River Floodplain Shrubland
Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	West Gulf Coastal Plain Seepage Swamp and Baygall
Northern Atlantic Coastal Plain Riparian and Floodplain Forest	West Gulf Coastal Plain Small Stream and River Forest
Northern Atlantic Coastal Plain Riparian and Floodplain Herbaceous	West Gulf Coastal Plain Small Stream and River Herbaceous
Northern Atlantic Coastal Plain Riparian and Floodplain Shrubland	West Gulf Coastal Plain Small Stream and River Shrubland
Northern Atlantic Coastal Plain Tidal Swamp	

Table 1. LANDFIRE EVT classes comprising the core map of the harperella for range in AL, AR, GA, MD, OK, SC, VA, and WV.

The core map developed in this document for the harperella incorporates information developed by FWS, NatureServe, LANDFIRE, GDNr and NCDOT. The core map spans 127,633 acres. A summary of acreage by National Landcover Database (NLCD) land use type is provided in **Table 2**.

¹ Searched for Wetland, Pond, Pool, and Riparian. Also included 'Floodplain', 'Stream', 'River', 'Seep', 'Bog', 'Stream', 'Marsh', 'Fen', 'Peatland', 'Wet', 'Seepage' as synonyms

Based on EPA’s “best professional judgment classification” system, Compliance Services International (CSI) has graded this core map as “average” because it comprises land cover areas from geospatial datasets matched to habitat descriptions of the species, within an extent based on known locations with some degree of uncertainty. More information about this classification system and its definitions can be found in the core map process document (EPA 2024).

When FWS reviews this interim core map, it may be possible to improve confidence in this core map if FWS species experts have updated population location information. An additional consideration for refinement may include application of different land cover filters to remove areas and habitats that are inconsistent with the FWS habitat descriptions for this species.

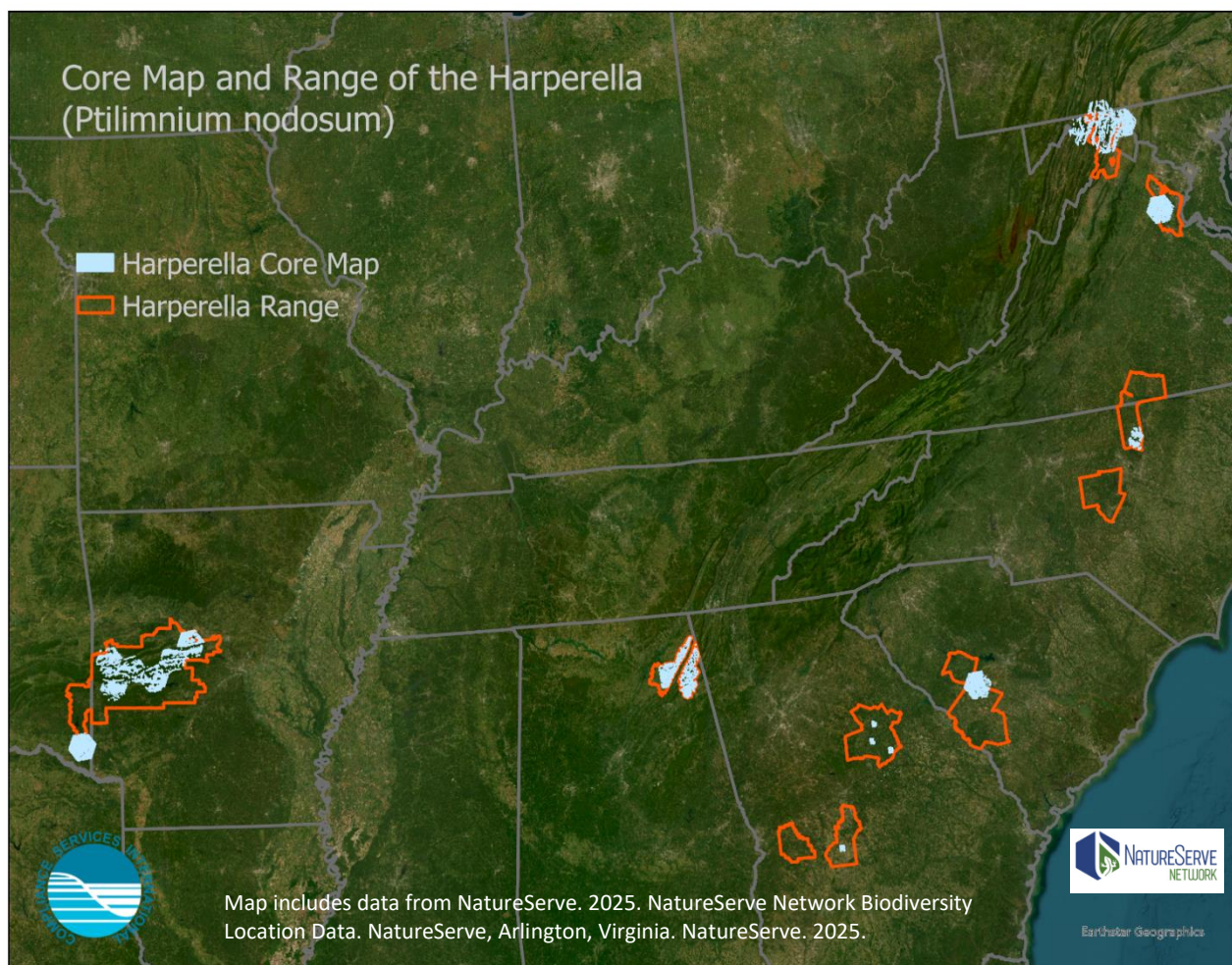


Figure 1. Interim core map for the harperella.

NLCD_Land_Cover_Class	Acres
Woody Wetlands	62,224
Deciduous Forest	34,435
Mixed Forest	15,162
Evergreen Forest	4,011
Open Water	3,582
Emergent Herbaceous Wetlands	2,868
Hay/Pasture	1,902
Herbaceous	1,222
Shrub/Scrub	1,150
Cultivated Crops	493
Developed, Open Space	420
Developed, Low Intensity	130
Barren Land	92
Developed, Medium Intensity	26
Developed, High Intensity	3

Table 2. Acres by National Land cover Database (NLCD) class within the core map of the harperella. Total core map area (based on NLCD pixel count): 127,720 acres².

Evaluation of Known Location Information

There were five evaluated datasets with known location information:

- Descriptions of locations provided by FWS;
- Occurrence locations in iNaturalist;
- Occurrence locations in Global Biodiversity Information Facility (GBIF); and
- Occurrence locations in NatureServe.
- Occurrence locations in the Georgia Department of Natural Resources (GDNR) database

Compliance Services International evaluated these five datasets before developing the core map. Overall, there were 74 research-grade observations found in iNaturalist³. These locations were generally consistent with the locations available through the GBIF, NatureServe, and the FWS datasets.

² This acreage is slightly different from the core map acreage (127,633) due to the pixelation of NLCD land cover. The core map is not developed exclusively from raster data.

³ 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->).

Approach Used to Create Core Map

The core map was developed using the process EPA uses to develop core maps for draft PULAs for species listed by FWS and their designated critical habitats (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 harperella from FWS, as well as observation information available from various publicly available sources including iNaturalist, GBIF, NatureServe, and GDNr. The information compiled for the harperella is included in **Appendix 1**. Influential information that impacted the development of the core map includes a description of the species locations as well as habitat from the FWS Recovery Plan (FWS 1991):

- “*P. nodosum* is a rare plant native to seasonally flooded rocky streams and coastal plain ponds. One site occurs on a granite outcrop. In both its riverine and pond environments (and its outcrop occurrence), the plant occurs only in a narrow range of water depths; it is intolerant of deep water or conditions that are too dry. The riverine form is found in microsites that are sheltered from rapidly moving water.”

For step 2, CSI used the compiled information including the species range, known locations, and habitat location information to determine the core map type. CSI compared the known location data to the range and found that known locations were generally contained within the range. The most recent 5-Year Review from FWS (2024) indicates that extant populations occur in certain counties, all of which intersect the range; however, some excluded counties also fall within the range, and these were, therefore, excluded from the core map extent. Review of the available data also suggested that the species is likely located in smaller areas within the extent (based on known observations). Finally, the species has specific habitat requirements that are not located everywhere within this extent. When weighing that information together for the harperella, CSI selected the biological information core map type. CSI used a combination of range, known observation/occurrence location data, and habitat information 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 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. Designated critical habitat was quickly eliminated as a core map type because the harperella does not have critical habitat. The range core map type was not selected because the species range is neither refined nor endemic. However, CSI judged that outside of Alabama there was known occurrence/location data that would better represent the current distribution of extant populations of the species and used these data to refine the extent of the core map to an area smaller than the species range. That extent was established using data from the FWS, NatureServe, and GDNr. The LANDFIRE Existing Vegetation Type layer (EVT) was queried for classes relevant to the harperella in all species-relevant states besides North Carolina, while a species/state-specific layer for habitat was developed by NCDOT and used for core map development for North Carolina. **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

Soil Survey Geographic Database (SSURGO)

The U.S. Geological Survey (USGS) SSURGO database could have been used to find areas with soils conducive to harperella habitat, but the species habitat was better-defined by land cover descriptions that could be matched to habitat type. Specifically, the SSURGO database could be used as a further refinement of the core map layer. The NCDOT layer references “Geology and Soils” as a thematic group contributing to its list of considered environmental data layers; it was assumed that the species-specific model included soil type in the development of the model underlying potential habitat for the harperella.

SSURGO indirectly contributes to LANDFIRE's Existing Vegetation Type (EVT) classifications. It provides detailed soil characteristics, which influence vegetation patterns and ecosystem dynamics. While LANDFIRE EVT is primarily derived from remote sensing, field plot data, and ecological models, SSURGO data can be incorporated into predictive models to refine vegetation mapping, especially in areas where soil properties strongly determine vegetation types (*e.g.*, wetlands, grasslands, and forested ecosystems). Additionally, SSURGO-derived variables like soil texture, drainage, and organic matter can support LANDFIRE's Biophysical Settings (BpS) and Environmental Site Potential (ESP) layers, which, in turn, inform EVT classifications. However, SSURGO is not a direct input to EVT mapping in LANDFIRE's core methodology.

Appendix 1. Information compiled for the Harperella

1. Recent U.S. Fish and Wildlife Service (FWS) documents

- 5 Year Review (2024) https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/15720.pdf
- Recovery Plan (1991) https://ecos.fws.gov/docs/recovery_plan/910305b.pdf

2. Background information

- Status: Federally listed as threatened in 1988.
- 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 and there is no species status assessment.
- Habitat, Life History, and Ecology
 - Habitat: “*P. nodosum* is a rare plant native to seasonally flooded rocky streams and coastal plain ponds. One site occurs on a granite outcrop. In both its riverine and pond environments (and its outcrop occurrence), the plant occurs only in a narrow range of water depths; it is intolerant of deep water or conditions that are too dry. The riverine form is found in microsites that are sheltered from rapidly moving water” (FWS 1991).
 - “Fluviatile is restricted to a very narrow range of mean water depths. For instance, the presence of Fluviatile in Maryland was strongly associated with certain intermediate water depths (Maddox and Bartgis 1990a). The plant was entirely absent from the shallowest or driest areas and deep waters, even though such areas could include *J. americana*” (FWS 1991).
 - Pollinators: Pollinators are not specified.
- Taxonomy
 - Wetland Species: “*Ptilimnium nodosum* (Harperella) is a small member of the carrot family (Apiaceae) that was originally described by Rose (1905) and taxonomically revised by Kral (1981) to include *P. fluviatile* Rose. It is a rare plant native to (1) seasonally flooded rocky streams in Maryland, West Virginia, North Carolina, Alabama, and Arkansas, and (2) coastal plain ponds in South Carolina. The sole Georgia site occurs on a granite outcrop” (FWS 1991).
- Relevant Potential Pesticide Use Sites
 - “The Arkansas Natural Heritage Commission has specified improper herbicide usage as a threat in Arkansas watersheds that contain the species” (5 Year Review, 2024).
 - Herbicide and pesticide runoff is listed as a possible threat to *P. nodosum* in West Virginia (FWS 1991).
- Relevant Recovery Criteria and Actions
 - 5-Year Review (2024) – Delisting Criteria (in italics) and the current status:
 1. There are at least 26 self-sustaining populations in existence. To reach this level, at least 13 new populations will have to be discovered or established. This is the total number of current and historically known populations. Self-sustaining populations are defined as being large enough to have a high probability of (1) surviving normal population cycles, (2) persisting through natural extremes in weather, and (3) containing sufficient genetic variation to adapt to natural habitat changes.
 - There are 28 populations of harperella across its range, indicating 15 new populations since the time of listing. It is difficult to assess

and quantify population trends because the numbers of plants fluctuate dramatically year to year in response to the hydrologic conditions of the streams in which they occur, populations are not visited on the same schedule across the species' range, not all sites are able to be visited regularly, and not all states quantify the plants or their populations the same. Of the 28 populations across the species' range, only 15 have been visited since 2021. The remaining 13 have not been visited in a decade or more. In addition, most of the sites do not have enough detailed long-term monitoring data available to draw meaningful conclusions about population size stability. Populations in West Virginia, historically the largest populations in the species' range, have been monitored annually since the time of listing; these monitoring data demonstrate that the populations have declined approximately 92 percent. Several other states' populations have declined or disappeared entirely. Most of the extant populations are small. Only 5 of the populations are estimated to support more than 10,000 individual plants (2 in Arkansas, 1 each in Maryland, West Virginia, and an introduced population in Georgia), 8 populations contain between 1,000 and 3,500 plants, and 13 populations contain fewer than 1,000 plants. Further, the only genetics research on the species across its range showed that while the species ecotypes are genetically distinct from one another, there is low allelic diversity across the species as a whole, indicating low representation and reduced opportunity for the species to adapt to environmental changes. Considering this information, coupled with knowledge of only nine potentially stable populations, as noted above, it is unlikely that many of these populations could be considered self-sustaining, thus, this criterion has not been met.

2. The populations are distributed throughout the historical range from Arkansas to Maryland. Specifics such as the exact location of populations, the number of individuals required in each population, and their potential response to environmental variation will be studied among the recovery tasks.
 - The populations are distributed from Arkansas to Maryland and new populations have been discovered in Oklahoma and Virginia. This criterion has been met.
3. All populations are permanently protected.
 - Sixteen of the extant populations are protected to some degree by being at least partially on either federal or state lands, under a conservation easement, or actively managed by a private conservation entity. Of these, 10 are in Arkansas (riverine), and one is in each state of Alabama (riverine), Georgia (pond), North Carolina (riverine), Oklahoma (riverine), South Carolina (pond), and Virginia (riverine). However, the recovery plan notes that localized habitat protection may not be sufficient to secure long-term protection for the species, and that for riverine populations in particular, watershed-level management is required. While the

riverine populations are in large part located on federally owned lands, few, if any, of these have comprehensive watershed level management in place throughout most of the watershed. Therefore, this criterion has not been met.

3. Range

The range of the harperella is illustrated in the figure below. “Harperella was known from 13 populations at the time of listing. Since the listing, an additional 15 populations have been observed and the species has been observed in two additional states, Oklahoma and Virginia. These new data bring the total number of populations to 28 occurring in nine states” (FWS 2024).

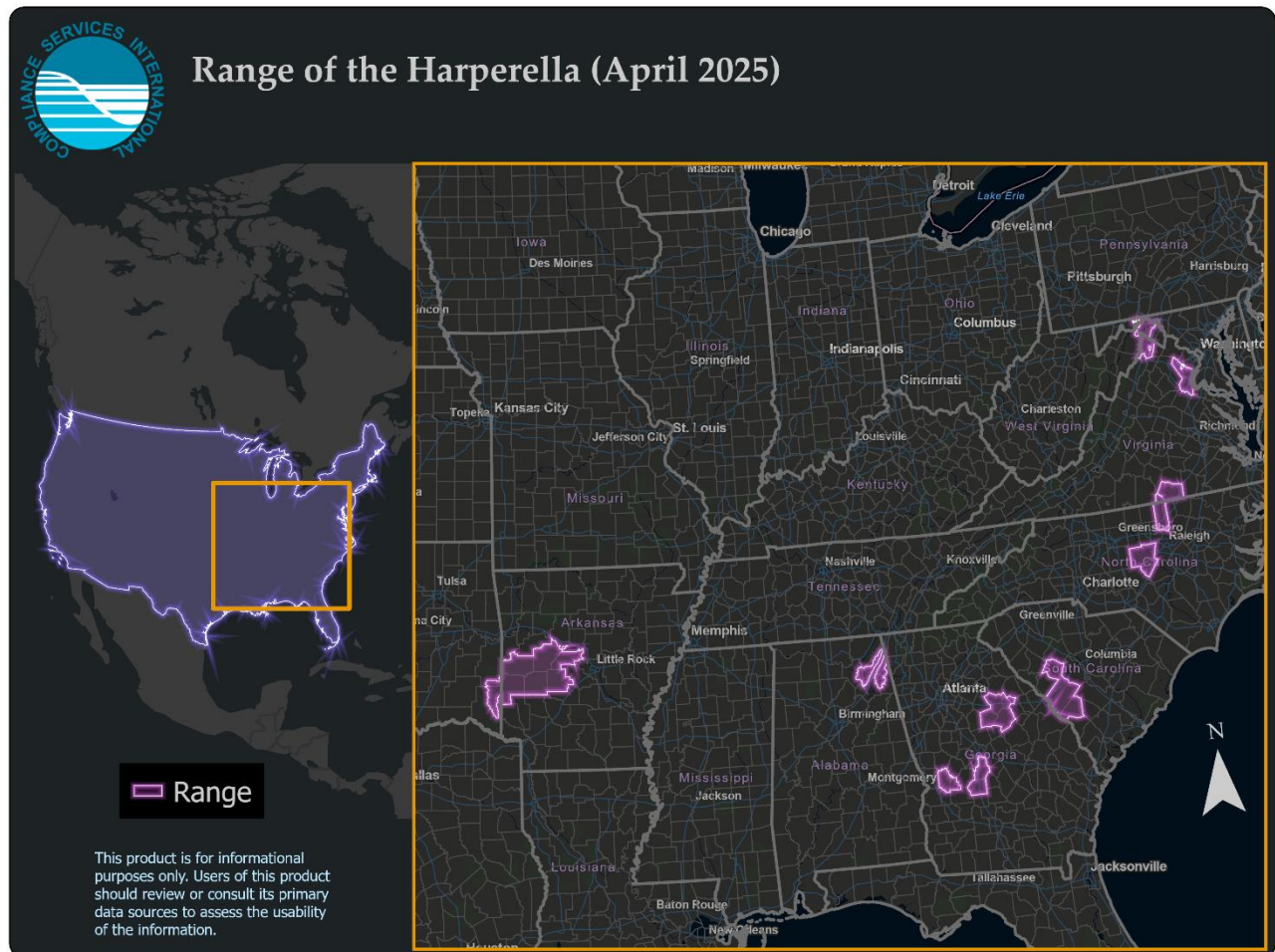


Figure 2. Current range of the harperella (FWS 2025).

4. Description of Critical Habitat

This species does not have designated critical habitat.

5. Known Locations

“As of 2023, there are a total of 28 extant populations. Since the time of listing, two populations have been lost (one in North Carolina and one in South Carolina) and 16 have been gained (one each in Virginia and Oklahoma, two in Georgia, and 12 in Arkansas)” (FWS 2024).

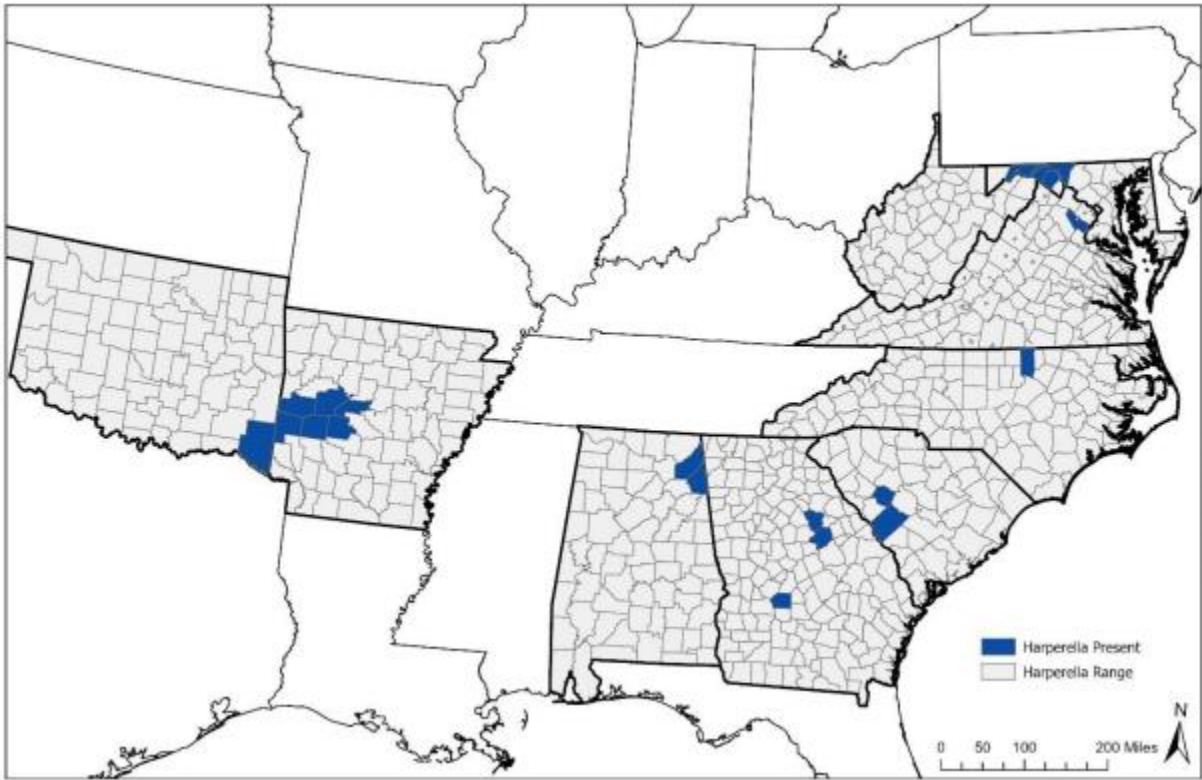


Figure 3. Distribution of extant harperella populations based on best information available in 2024. Copied from FWS 2024.

- iNaturalist: https://www.inaturalist.org/observations?taxon_id=1534982
 - 74 research-grade observations with coordinates, all dated since June 2016 (**Figure 4**. iNaturalist occurrences for the harperella (iNaturalist 2025)).
 - These locations align reasonably well with most regions of known extant populations (**Figure 3**). Consideration was given to refining the core map extent based on iNaturalist observations buffered by their corresponding “public positional accuracy” field⁴. Ultimately, spatial data received from NatureServe was used instead, for reasons discussed below.

⁴ For “obscured” observations—which most observations are for the harperella are—public positional accuracy represents the diagonal of a 0.2 x 0.2 arc cell. See the iNaturalist geoprivacy page for more details on this and related terms [What is geoprivacy? What does it mean for an observation to be obscured? : iNaturalist Help](#).

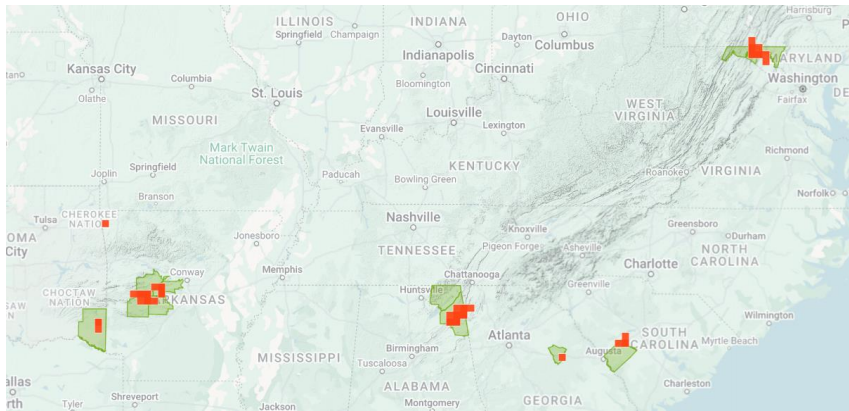


Figure 4. iNaturalist occurrences for the harperella (iNaturalist 2025).

- GBIF: <https://www.gbif.org/species/3034204>
 - GBIF includes 84 georeferenced records, 59 of which had usable coordinate data based on latitude/longitude precision (3+ decimal places) and relative recency (2010-present).

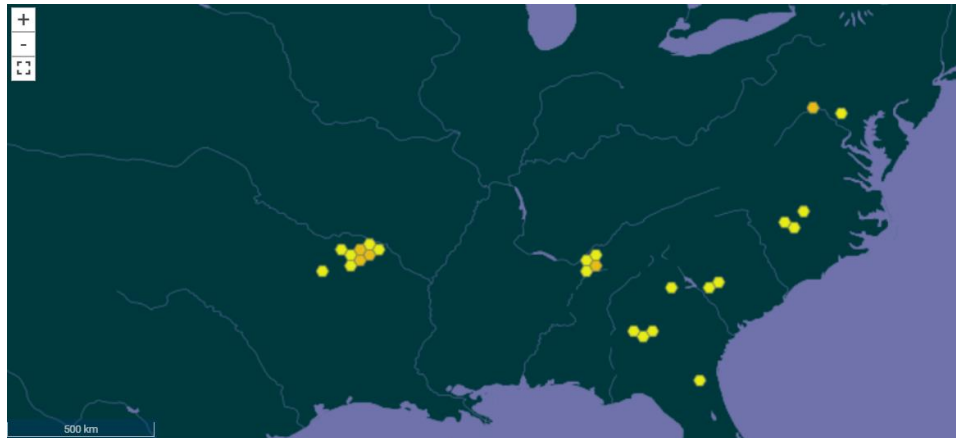


Figure 5. GBIF occurrences for the harperella (GBIF 2025).

- NatureServe
 - Available public occurrence information from NatureServe Explorer (NatureServe, 2025a) generally aligns well with the observation data from iNaturalist and GBIF, and the counties with known extant observations (**Figure 6**).

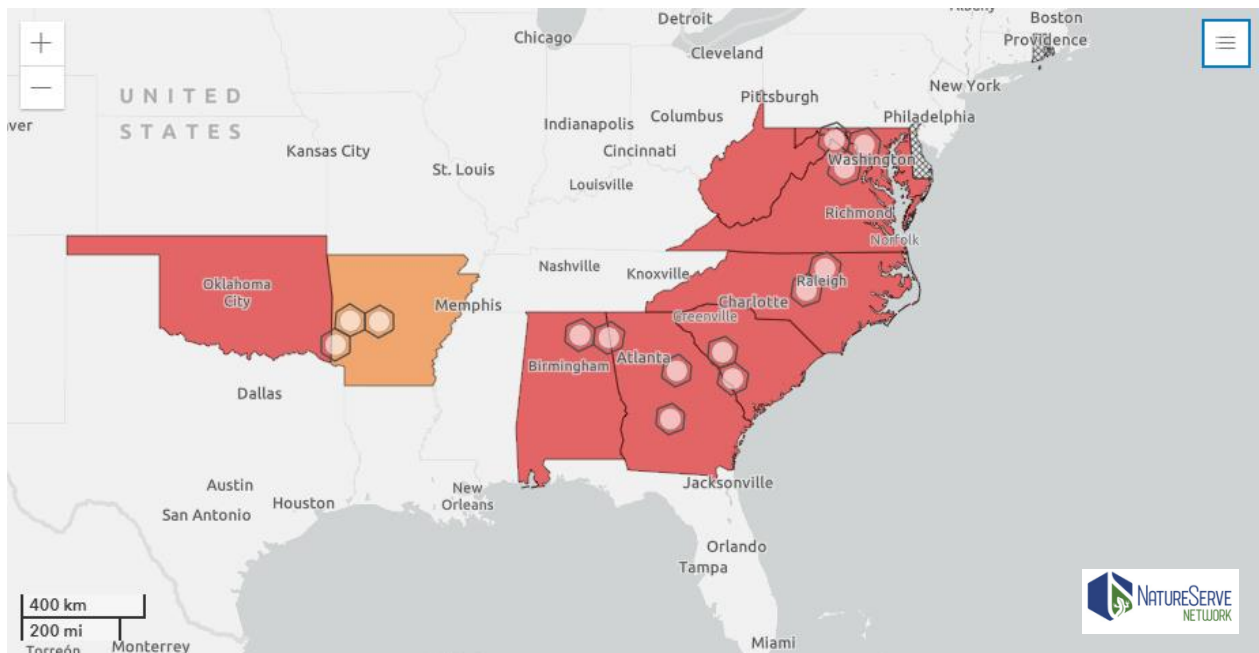


Figure 6. NatureServe Explorer occurrences for the *harperella* (NatureServe, 2025a).

- CSI requested and received from NatureServe a feature layer that included 343 mi² hexagons viewable in the public version of the Explorer mapper (NatureServe, 2025b). These were examined relative to range and known occurrences from the Georgia Department of Natural Resources (which is a NatureServe heritage member program) and iNaturalist. The NatureServe dataset was more consistent with GDNR data (which were used in Georgia), as two “quarter quad” shapes (discussed below) were not captured by the iNaturalist points buffered by public positional accuracy. Therefore, NatureServe public hexagons were used as a modest refinement of species extent. NatureServe notes that “If ground-disturbing activities are proposed on a site, the appropriate NatureServe Network Program should be contacted for a site-specific review of the project area. For contact information, go to the NatureServe Network Directory at: <https://www.natureserve.org/ns-network-directory>.”
- Georgia Department of Natural Resources:
https://georgiabiodiversity.org/portal/rangemaps?es_id=21710

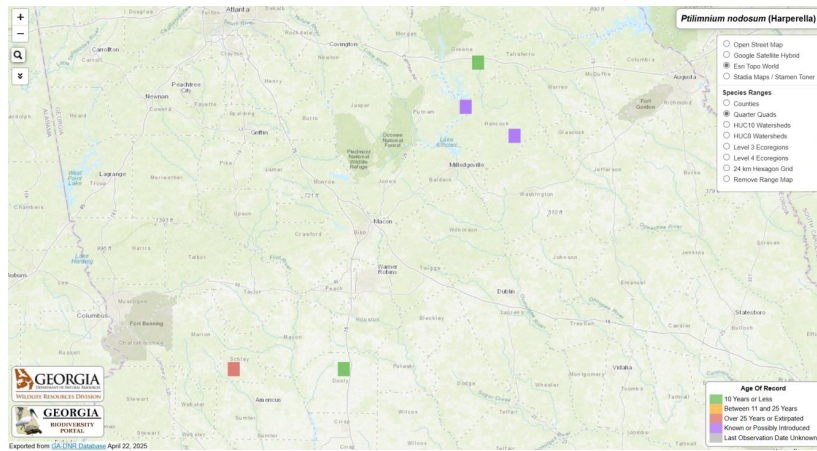


Figure 7. Quarter quads (known observations) of the harperella (GDNR 2025).

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 an extent based on known observations. The core map identifies all areas within the extent (described below) matching its habitat description in its most recent 5-Year Review using professional judgment to match classes in the LANDFIRE EVT dataset (FWS 2024, LANDFIRE 2022). The LANDFIRE dataset is regarded as a high quality national-level dataset that is appropriate to identify habitat for plant species (LANDFIRE 2022). In North Carolina, habitat was identified using a species-specific model developed by NCDOT (NCDOT 2022).

1. References and Software

- Georgia Department of Natural Resources. 2025. "Range Maps: Harperella." *Georgia Biodiversity Portal*. Accessed April 22, 2025. https://georgiabiodiversity.org/portal/profile?group=all&es_id=21710.
- 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>.
- National Hydrography Dataset (NHD Plus v. 2): <https://www.usgs.gov/national-hydrography/access-national-hydrography-products>.
- NatureServe. 2025a. NatureServe Network Biodiversity Location Data accessed through NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. (Accessed: April 22, 2025).
- NatureServe. 2025b. NatureServe Network Biodiversity Location Data. NatureServe, Arlington, Virginia. NatureServe. 2025.
- North Carolina Department of Transportation. 2022. "Harperella - Potential Habitat." ATLAS Project. Accessed April 22, 2025. <https://xfer.services.ncdot.gov/gisdot/AtlasData/AtlasSpeciesModels/ATLASPlantMachineLearningModels/>.
- Software used: ArcGIS Pro version 3.2.
- U.S. Fish and Wildlife Service. 2024. "Harperella (*Ptilimnium nodosum*)." Environmental Conservation Online System (ECOS). Accessed April 22, 2025: <https://ecos.fws.gov/ecp/species/3739>.

2. Datasets Used in Core Map Development

2.1. Range

The range for this species was last updated by FWS on September 13, 2023. 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 991 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 (5YR), and the available occurrence information from the GBIF database. The current range and NatureServe public Element Occurrences (EOs) capture the locations identified in the 5-year review and include the occurrence information from iNaturalist to within the published uncertainty of each observation.

In Alabama, known occurrence information received from NatureServe, filtered to exclude historical or extirpated data, did not include 2 counties known to contain extant populations of harperella. For this state, species range was used to clip the known extant counties. Further details on the development of the core map extent and the core map itself are provided in Section 3.

2.2. GDNR Biodiversity Portal

The GDNR Biodiversity Portal includes a mapping tool that was used to query and download known location information for the harperella (**Figure 8**Figure 8). A shapefile of the most detailed dataset available, “Quarter Quads,” was exported to a file geodatabase and queried for recent observations according to the procedure detailed in Section 3. The resulting shape was later merged with others to form the extent of the core map.

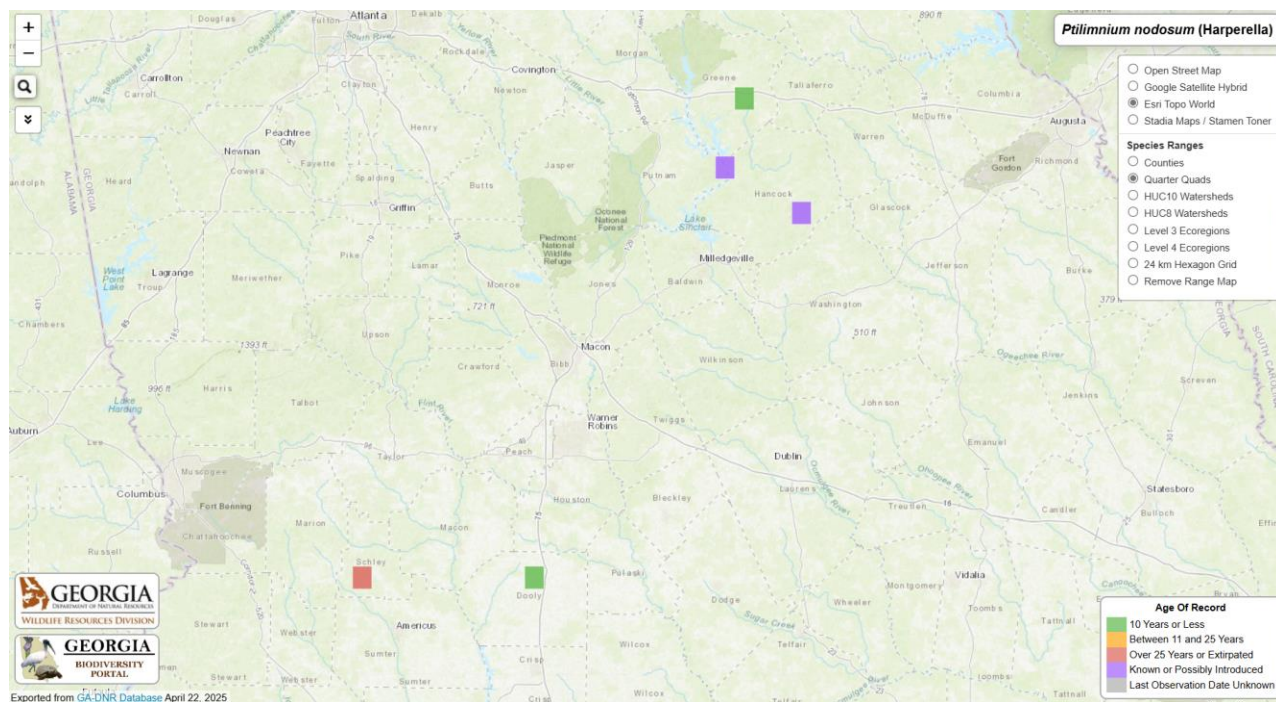


Figure 8. Quarter Quads of harperella. Reproduced from Figure 7 above. Coral-colored quads represent areas where the observation is over 25 years old or extirpated (GDNR 2025).

2.3. NatureServe

NatureServe Explorer was used to identify public EOs for the harperella and spatial data were obtained from NatureServe representing these public EOs (NatureServe 2025a, 2025b). These were compared with other known occurrence data from GBIF and iNaturalist, and the known counties with extant populations across the species range identified by the FWS in the 5YR document (**Figure 3**). Global Biodiversity Information Facility coordinates were buffered to their largest uncertainty distance of 28,874 m for this species (all coordinates had uncertainties greater than 28 km). It was observed that EO data were more precise (smaller

area) and still captured all known populations published by the FWS, so EOs were adopted as the extent in North Carolina. FWS did not provide maps or spatial data for populations in other states, so only the North Carolina portion of species range was analyzed this way. The public NatureServe EOs (NatureServe, 2025b, **Figure 9**) were used to determine the core map extent according to the procedure detailed in Section 3 and are being provided to EPA as part of this core map documentation. *Disclaimer: CSI hereby informs EPA of their obligation to adhere to the NatureServe data use terms* (<https://explorer.natureserve.org/AboutTheData/UseGuidelinesCitations>). Per those terms, EPA may not redistribute the data unless written permission is requested and provided by NatureServe.

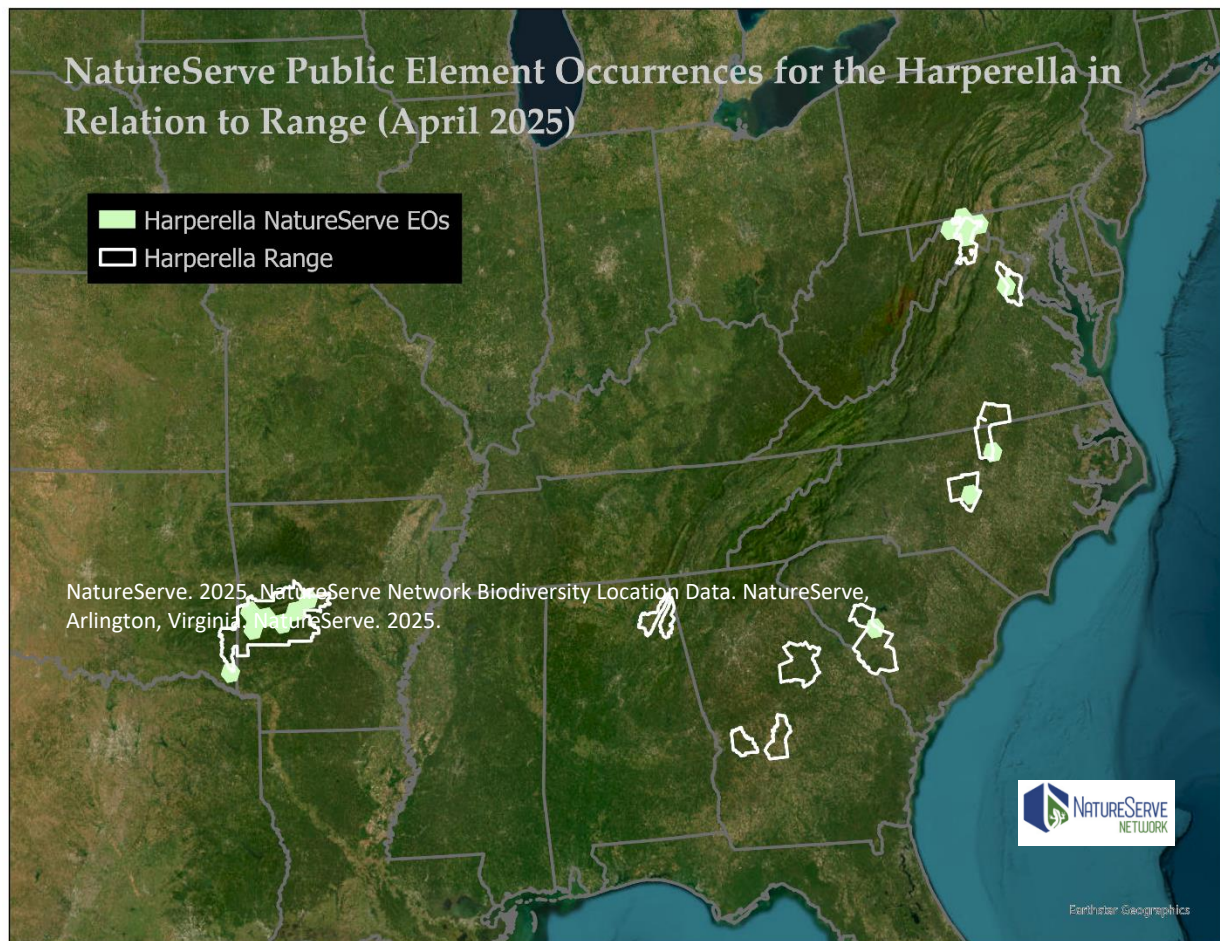


Figure 9. Harperella range and NatureServe public element occurrences (FWS 2025; NatureServe 2025b).

In Georgia, there are 5 EOs representing the harperella. They lie in proximity to the five “quarter quads” from the GDNR. These EOs were not incorporated into the final development of the harperella’s core map.

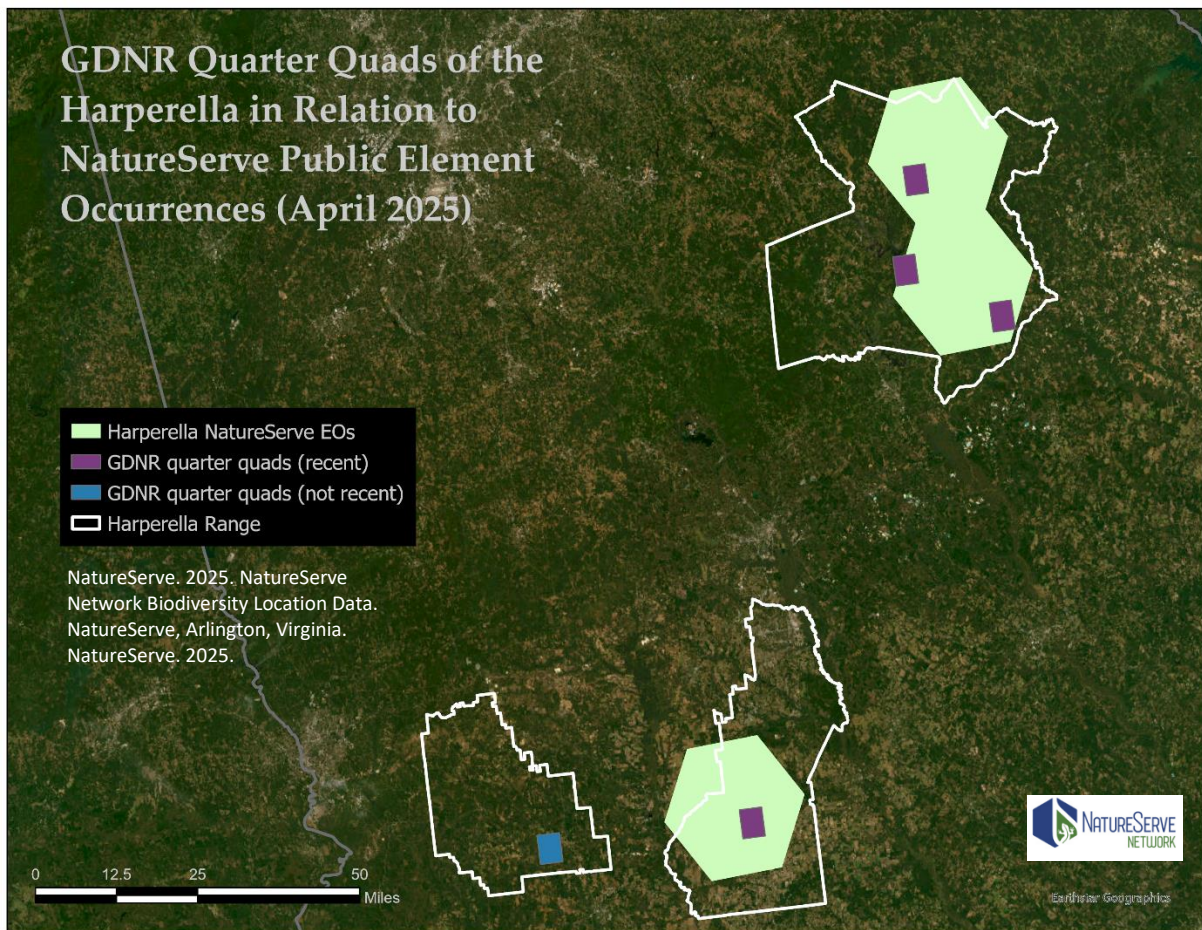


Figure 10. Harperella GDNR quarter quads (blue and purple) and NatureServe public EOs (green) in GA. GDNR data were filtered to exclude out of scope data (>25 years old), which removed the blue quarter quad (NatureServe 2025b; GDNR 2025).

In the process of developing the core map extent, described in Section 3, it was observed that the process of including only current (i.e. not historical) EOs eliminated all EOs from Alabama, despite there being counties with known extant populations. As a result, the use of NatureServe EOs was limited to states outside of Alabama and Georgia, the latter of which relied on more precise (GDNR) location information.

2.4. NCDOT ATLAS and National Hydrography Dataset (NHD)

Regions of suitable habitat were used to refine the core map based on biological information. NCDOT completed a project named “ATLAS” in 2022 that identified regions of potential habitat for the harperella. These comprised a network of streams. **Figure 11** below shows what this streams network looks like in the extent of the harperella in North Carolina (a single hexagon).

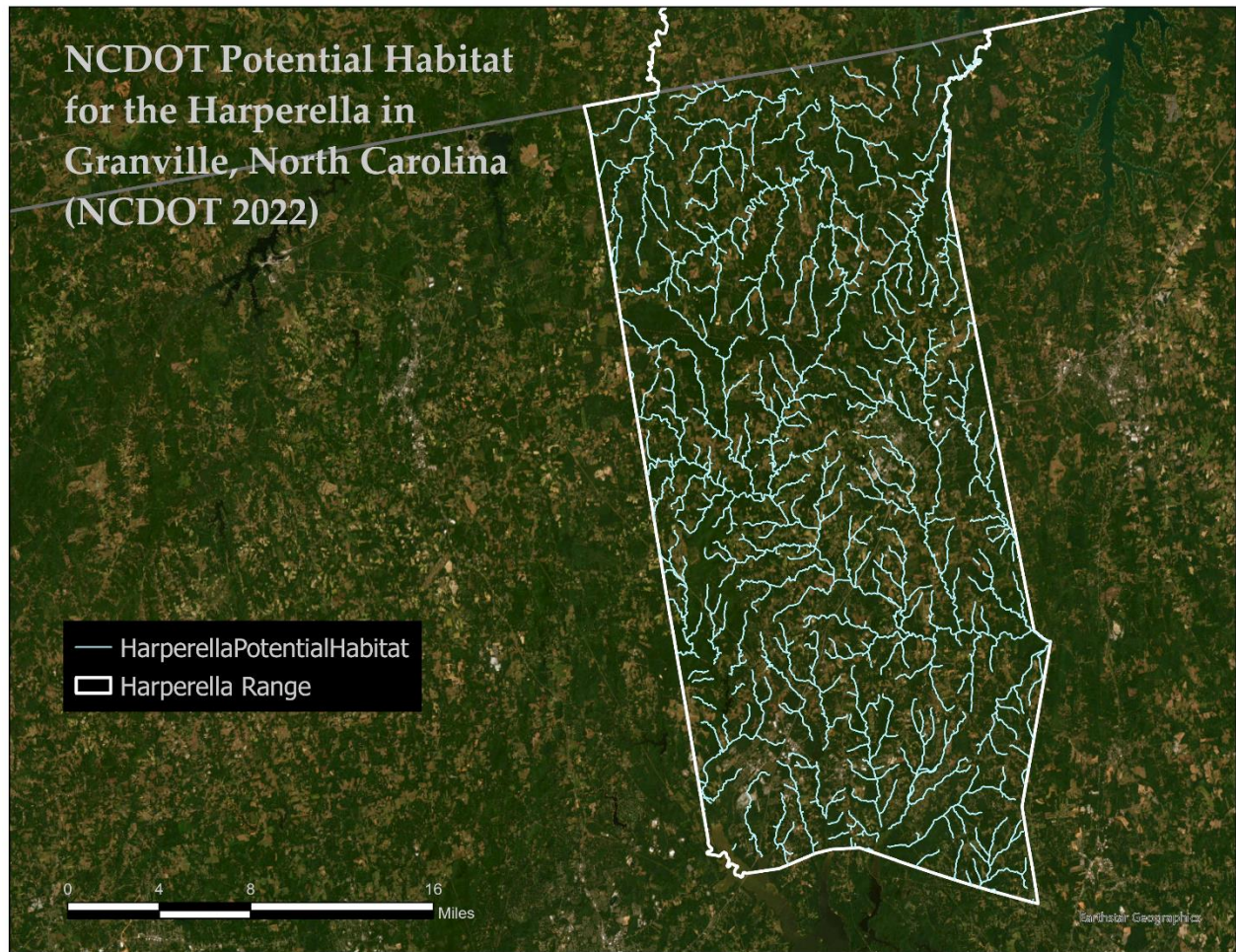


Figure 11. NCDOT ATLAS potential habitat for the harperella in Granville, NC (NCDOT 2022).

These linear features were converted into a polygonal area by applying a buffer developed from two underlying variables as described below. Stream features from NCDOT appear to be developed from the National Hydrography Dataset (NHD; USGS 2023). To facilitate core map development, NHD streams corresponding to the NCDOT data were used in data processing.

1. 12.5 m buffer to account for bankfull width of the streams network
 - The linear features of NCDOT do not capture the width of the streams. To account for this, streams width (“bankfull width”) data from NHD were used by joining the “BANKFULL_CONUS” table to flowlines from NHD Region 3N, clipped to the harperella extent.
 - The 95th percentile value, 25 m, was chosen to represent stream width across all streams from NCDOT within the extent of the harperella. A 25 m width is obtained by applying a buffer of half that distance, or 12.5 m.
2. 10 m buffer to account for the harperella distance from edge of stream
 - Professional judgment was used to apply an additional 10 m buffer to account for the species’ distance from water. The harperella inhabits seasonally flooded areas and coastal plain ponds and may be found in proximity to water.

In total, a 22.5 m buffer (12.5 + 10 m) was used to buffer streams from NCDOT.

2.5. LANDFIRE

In all states with harperella except North Carolina, biological information was spatially informed using the LANDFIRE EVT dataset. LANDFIRE provides datasets that cover the entire United States, including vegetation types, disturbance events, and fuel distributions. These datasets are mapped at a 30-m pixel resolution, which allows for refinement of the harperella core map. As described below, the core map extent relies on spatial data that are more generalized than local sites where the species has been observed; therefore, CSI determined it is appropriate to use select LANDFIRE classes matching habitat descriptions to identify areas within the extent that are suitable to represent the species' core map. Details on the key words used for class identification are provided in the "Description of Core Map" section above.

3. Creating the Core Map

3.1. Defining Extent

The extent for the harperella was created in two distinct processes, one for Georgia and another for other states. In Georgia, the extent was defined by the four GDNr quarter quads with a harperella observation dated within the past 25 years (or with information that could not exclude them). In all other states, NatureServe EOs were the basis of the extent. Once the polygons were established, these two datasets were merged and dissolved into a single shape, then clipped to both species range and counties with extant populations as described below.

1. Alabama

- 1.1. Use the Select tool to select counties from a national counties layer that contain extant populations of the Harperella, according to FWS 2024 and **Figure 3**. Export selection as a standalone layer, "Harperella_counties".
- 1.2. Use the Select tool to select counties from the previous layer ("Harperella_counties") occurring in Alabama, and save as a new layer, "Harperella_countiesAL".
- 1.3. Use the Pairwise Clip tool to clip the previous layer ("Harperella_countiesAL") by the species range ("Harperella_range") and save as a new layer, "Harperella_countiesAL_pcRange".

2. Georgia (**Figure 12**)

- 2.1. Download the quarter quads as a shapefile and export as a feature class in a file geodatabase ("GDNr_quarter_quads").
- 2.2. Use a SQL query to select only recent quads: age_text2 IN ('10 Years or Less', 'Between 11 and 25 Years'). Export selected quads as a new feature class ("GDNr_quarter_quads_recent").

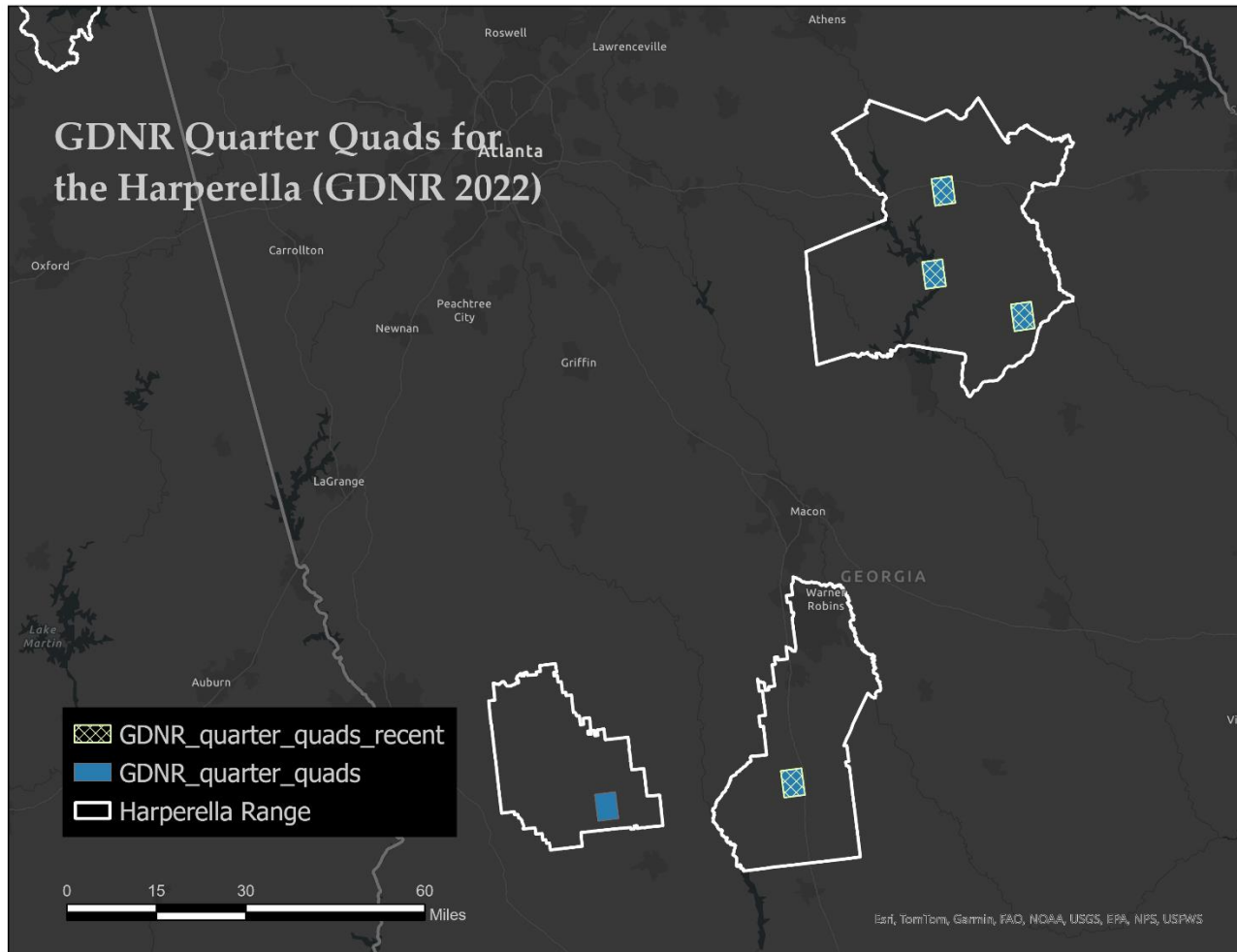


Figure 12. Core map extent of GDNR quarter quad (recent, green cross-hatching), in comparison to all quarter quads for the harperella (blue) (GDNR 2025).

3. All Other States Besides Alabama and Georgia

3.1.1. Query the NatureServe public EO hexagons file received for just this species:

BLD_EO_SPECIES_GCOMNAME = 'Harperella'. Export features as a new layer, "NS_hex".

3.2. Use the Select by Attributes tool to select EOs that are neither marked as historical or with a last observed date before January 1, 2000⁵. Export selected features as a standalone feature class saved as "NS_hex_sel". This step excluded 34 EOs.

3.2.1. Use the Select tool to select all states except Georgia from a layer of US state boundaries. This is to facilitate the next step.

3.2.2. Use the Select by Location tool to select from the previous dataset ("NS_hex_sel") only EOs that are not in Georgia. Export selected features as a new layer ("NS_hex_sel2"). This removed 3 EOs.

3.2.3. Use the Select by Location tool to select from the previous dataset ("NS_hex_sel2") only EOs

⁵ For convenience, the opposite query was used as follows, then the "Switch Selection" tool was applied:

- BLD_EO_SPECIES_EORANK_CD IN ('H', 'X') Or BLD_EO_SPECIES_LASTOBS_D IN ('1885-04-25', '1887-08', '1902-07-10', '1905-11-25', '1914-10-02', '1933-08-28', '1936-06-30', '1945-08-15', '1953-08-14', '1956-08-28', '1969-08-30', '1971-08', '1979-06-01', '1981-08-15', '1985-06-28', '1987-09-22', '1990-08-20', '1990-08-21', '1990-08-22', '1992-06-04', '1991-08-08', '1993-08-03', '1994-07-14', '1994-07-15', '1994-SU', '2000')

that are intersecting the species range. Export selected features as a new layer ("NS_hex_sel3"). This removed 1 EO.

3.2.4. Use the Select by Location tool to select from the previous dataset ("NS_hex_sel3") only EOs that are intersecting the counties with known extant populations ("Harperella_counties"). Export selected features as a new layer representing extent ("NS_hex_sel4"). This removed 3 EOs.

3.2.5. (Optional) Export the previous layer with an easily identifiable name representing relevant EOs that are not in Georgia ("NS_noGA").

4. Combining the Extent

4.1. Use the Merge tool to combine the 3 "final" layers of Steps 1 and 2 above:

"Harperella_countiesAL_pcRange", "GDNR_quarter_quads_recent" and "NS_noGA," respectively. Save as a new layer ("AL_GA_Other_merge").

4.2. Use the Pairwise Dissolve tool to dissolve the previous layer ("AL_GA_Other_merge") into a single shape ("AL_GA_Other_merge_pd").

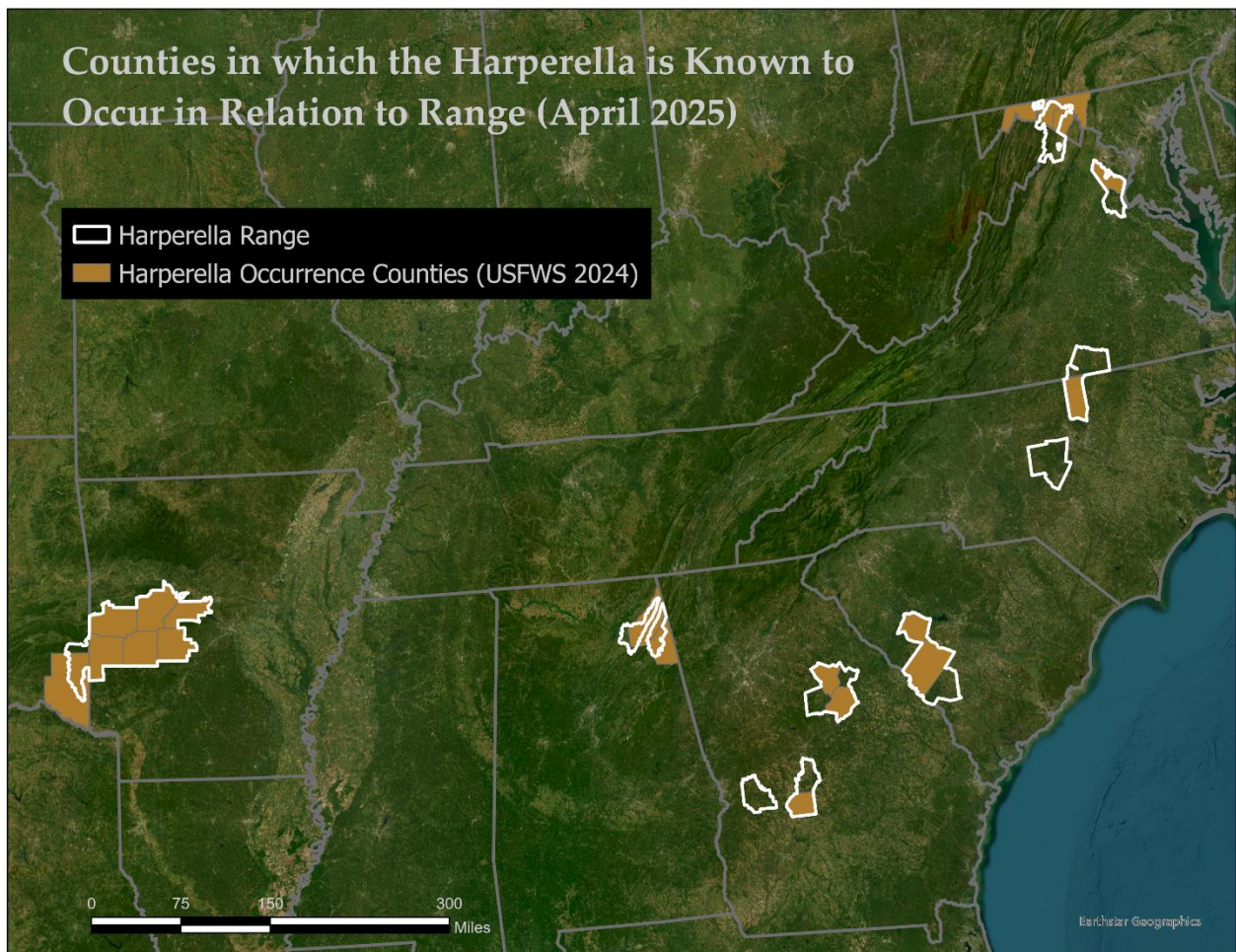


Figure 13. Counties containing extant populations of the harperella, as identified by FWS in its most recent 5-Year Review (FWS 2024), in relation to species range.

4.3. (Optional) Export previous layer ("AL_GA_Other_merge_pd") with a new name ("Harperella_extent").

3.2. Refinement based on Biological Information

The total extent of the harperella core map—which comprises quarter quads in Georgia and NatureServe EOs in all other states—includes a significant area and number of different land cover types that do not align with descriptions of harperella habitat. To improve confidence in the core map, a refinement based on biological information was applied to extent in each state.

The best-available dataset for suitable species habitat was found to be a model developed by NCDOT, which developed an artificial intelligence-based model with the explicit purpose of identifying habitat for the harperella. This dataset was used only for North Carolina core map extent, which additionally excluded one county within the range but outside the list of counties with known extant populations (FWS 2024). In all other states, the best-available dataset was determined to be the LANDFIRE EVT layer, which was used to refine the core map as described below.

All States Besides North Carolina

In the remaining states, the core map identifies areas within a core map extent created as part of this analysis with land cover classes from the LANDFIRE EVT that match habitat descriptions for the harperella. Land cover categories within the core map area were identified based on matches of the key words listed in Footnote 1.

1. The LANDFIRE dataset was clipped to the harperella extent of observations (“Harperella_extent”) and saved as a new layer (“LF_crExtent”).

The previous layer was reclassified using the Reclassify tool to include only class names matching those from

EVT_NAME	
Atlantic Coastal Plain Blackwater Stream Floodplain Forest	Ozark-Ouachita Riparian Forest
Atlantic Coastal Plain Blackwater Stream Floodplain Herbaceous	Ozark-Ouachita Riparian Herbaceous
Atlantic Coastal Plain Blackwater Stream Floodplain Shrubland	Ozark-Ouachita Riparian Shrubland
Atlantic Coastal Plain Brownwater Stream Floodplain Forest	Piedmont Seepage Wetland
Atlantic Coastal Plain Clay-Based Carolina Bay Wetland	Piedmont Upland Depression Swamp
Atlantic Coastal Plain Peatland Pocosin and Canebrake Shrubland	South-Central Interior Large Floodplain Forest
Atlantic Coastal Plain Peatland Pocosin and Canebrake Woodland	South-Central Interior Large Floodplain Herbaceous
Atlantic Coastal Plain Small Blackwater River Floodplain Forest	South-Central Interior Large Floodplain Shrubland
Atlantic Coastal Plain Small Brownwater River Floodplain Forest	South-Central Interior Small Stream and Riparian Forest
Atlantic Coastal Plain Streamhead Seepage Swamp-Pocosin-Baygall Shrubland	South-Central Interior Small Stream and Riparian Herbaceous
Atlantic Coastal Plain Streamhead Seepage Swamp-Pocosin-Baygall Woodland	South-Central Interior Small Stream and Riparian Shrubland
Central Appalachian River Floodplain Forest	Southeastern Exotic Ruderal Flooded & Swamp Forest
Central Appalachian River Floodplain Herbaceous	Southeastern Native Ruderal Flooded & Swamp Forest
Central Appalachian River Floodplain Shrubland	Southeastern Ruderal Wet Meadow & Marsh
Central Appalachian Stream and Riparian Herbaceous	Southern Atlantic Coastal Plain Depression Pondshore
Central Appalachian Stream and Riparian Shrubland	Southern Atlantic Coastal Plain Large River Floodplain Forest
Central Appalachian Stream and Riparian Woodland	Southern Atlantic Coastal Plain Large River Floodplain Herbaceous
Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods	Southern Atlantic Coastal Plain Large River Floodplain Shrubland
Central Interior Highlands and Appalachian Sinkhole and Depression Pond	Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest
Cumberland Seepage Forest	Southern Atlantic Coastal Plain Wet Pine Savanna and Flatwoods
East Gulf Coastal Plain Depression Pondshore	Southern Coastal Plain Blackwater River Floodplain Forest
East Gulf Coastal Plain Large River Floodplain Forest	Southern Coastal Plain Nonriverine Basin Swamp
East Gulf Coastal Plain Large River Floodplain Herbaceous	Southern Coastal Plain Seepage Swamp and Baygall Shrubland
East Gulf Coastal Plain Large River Floodplain Shrubland	Southern Coastal Plain Seepage Swamp and Baygall Woodland
East Gulf Coastal Plain Small Stream and River Floodplain Forest	Southern Piedmont Large Floodplain Forest
East Gulf Coastal Plain Small Stream and River Floodplain Herbaceous	Southern Piedmont Large Floodplain Herbaceous
East Gulf Coastal Plain Small Stream and River Floodplain Shrubland	Southern Piedmont Large Floodplain Shrubland
North-Central Appalachian Acidic Swamp	Southern Piedmont Small Floodplain and Riparian Forest
North-Central Appalachian Seepage Fen	Southern Piedmont Small Floodplain and Riparian Herbaceous
North-Central Interior and Appalachian Rich Swamp	Southern Piedmont Small Floodplain and Riparian Shrubland
Northern & Central Native Ruderal Flooded & Swamp Forest	Southern Ridge and Valley Seepage Fen
Northern & Central Ruderal Wet Meadow & Marsh	West Gulf Coastal Plain Herbaceous Seep and Bog
Northern Atlantic Coastal Plain Basin Peat Swamp	West Gulf Coastal Plain Large River Floodplain Forest
Northern Atlantic Coastal Plain Basin Swamp and Wet Hardwood Forest	West Gulf Coastal Plain Large River Floodplain Herbaceous
Northern Atlantic Coastal Plain Brackish Tidal Marsh	West Gulf Coastal Plain Large River Floodplain Shrubland
Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	West Gulf Coastal Plain Seepage Swamp and Baygall
Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	West Gulf Coastal Plain Small Stream and River Forest
Northern Atlantic Coastal Plain Riparian and Floodplain Herbaceous	West Gulf Coastal Plain Small Stream and River Herbaceous
Northern Atlantic Coastal Plain Riparian and Floodplain Shrubland	West Gulf Coastal Plain Small Stream and River Shrubland
Northern Atlantic Coastal Plain Tidal Swamp	

2. Table 1, saved as a new layer “LF_crExtent_rec.”
3. The clipped and reclassified LANDFIRE data (“LF_crExtent_rec”) were converted to polygon using the Raster to Polygon tool (“LF_crExtent_rec_r2p”).
4. The Select tool was used to select only features from the previous layer (“LF_crExtent_rec_r2p”) outside of North Carolina. Selected features were exported as a new layer “LF_crExtent_rec_r2p_noNC.”
5. The previous layer (“LF_crExtent_rec_r2p_noNC”) was dissolved using the Pairwise Dissolve tool (“LF_crExtent_rec_r2p_noNC_pd”).

North Carolina

Areas of potential habitat within the harperella extent are described in Section 2.4. These were identified as follows:

1. From the downloaded NCDOT habitat model for the harperella (“HarperellaPotentialHabitat”), use the Select by Attributes tool to select areas of high potential habitat using the following SQL query: PotHabitat = 1. Export the selected features as a new layer named “NCDOT_sel” and change the output projection to WKID #4269.

2. Use the Select tool to select features from the “NS_noGA” layer that are in North Carolina.
3. Use the Pairwise Clip tool to clip NHD streams from Region 3N to the selected features in the previous step (“NS_noGA”) to obtain a subset of the NHD streams network in North Carolina. Save as a new layer “NHD_pcNS_noGA”.
4. Use the Select by Location tool to select features from the previous step “NHD_pcNS_noGA” that intersect the layer created in Step 1 (“NCDOT_sel”). Export features as a new layer, “NHD_intNCDOT_sel”.
5. Use the Pairwise Buffer tool to apply a 22.5 m buffer to the previous layer (“NHD_intNCDOT_sel”). Select the “Dissolve all output features into a single feature” menu option. Save as a new layer, “NHD_intNCDOT_sel_pb22pt5m.”
6. Use the Pairwise Clip tool to clip the previous layer (“NHD_intNCDOT_sel_pb22pt5m”) to just the species extent (“Harperella_extent”). Save as a new layer, “NHD_intNCDOT_sel_pb22pt5m_pcExtent.”

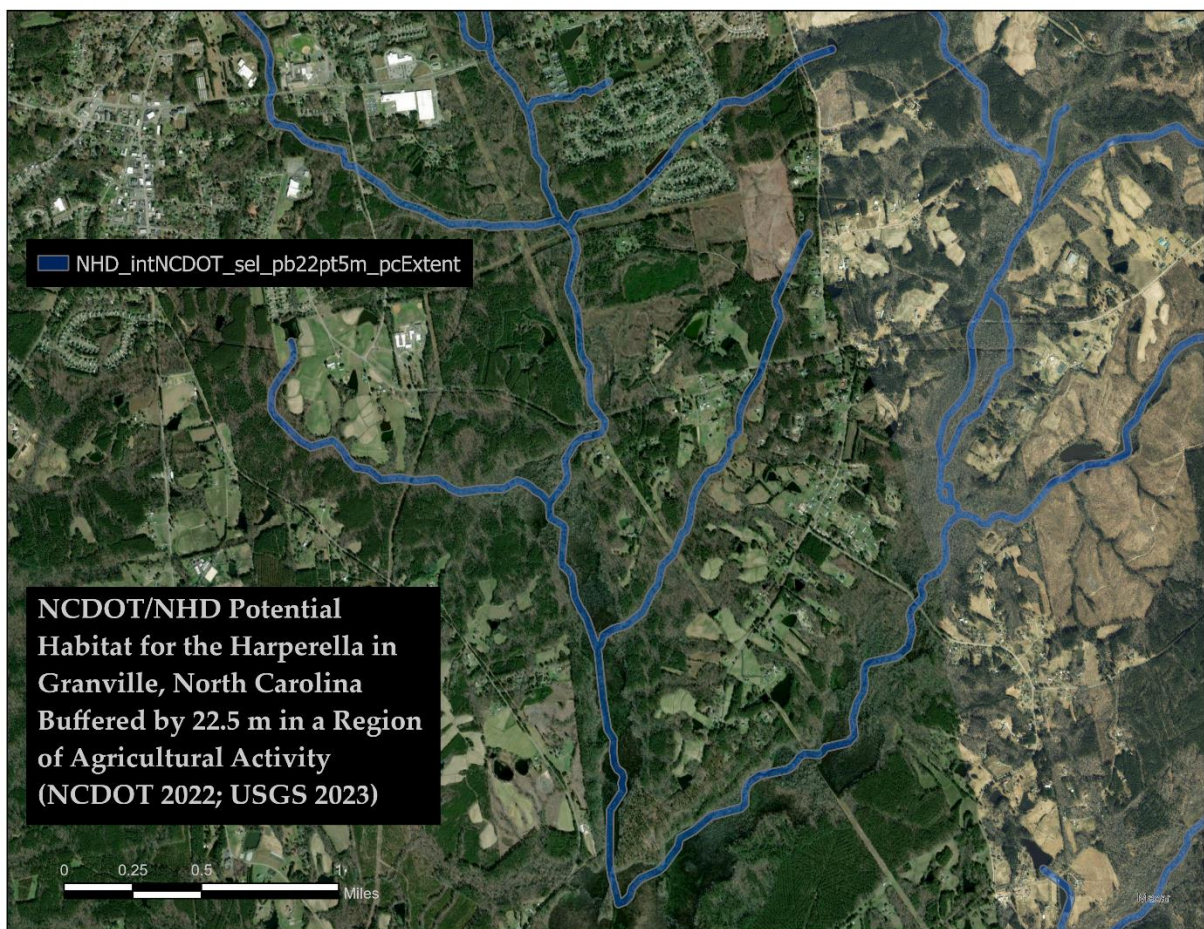


Figure 14. Potential habitat for the harperella with a 22.5-meter buffer in an agricultural area in North Carolina (NCDOT 2022).

3.3. Combining Habitat-Suitable Datasets Across All States

The following procedure was used to combine datasets into a finalized (interim) core map:

1. The Merge tool was used to merge the “final” habitat layers (“LF_crExtent_rec_r2p_noNC_pd”) with

the buffered potential habitat model from North Carolina (“NHD_intNCDOT_sel_pb22pt5m_pcExtent”) to create a single feature layer representing the core map (“Harperella_Habitat_merge”).

2. The Pairwise Dissolve tool was used to dissolve the previous layer (“Harperella_Habitat_merge”) into one with a single feature (“Harperella_Habitat_merge_pd”).

3.4. Cultivated Lands-based Refinement

The species is not considered to be “on-field.” That is, it is unlikely the species would be found in agricultural fields and its natural habitat—seasonally flooded rocky streams, coastal plain ponds, granite outcrops—does not account for this land use type. To account for off-field species like the harperella, EPA developed and published its own cultivated layer for use in core map development as a potential refinement of extent, comprising areas of agriculture > 25 acres (EPA 2025). This refinement was applied using the Pairwise Erase tool on the previous layer “Harperella_Habitat_merge_pd” and saving to a file geodatabase as a finalized core map layer (“Harperella_CoreMap”). This step removed 0.64% of area. The resulting core map layer spans 127,633 acres.

4. Datasets Considered but Not Used in Core Map Development

4.1. SSURGO

The U.S. Geological Survey (USGS) SSURGO database could have been used to find areas consistent with harperella habitat, but the species habitat was better-defined by land cover descriptions that could be matched to habitat type. Specifically, the SSURGO database could be used as a further refinement of the core map layer. The NCDOT layer references “peat muck” as a soil consistent with this species; however, the species is known to grow in other soil types that were not all listed in the documentation.

The SSURGO database indirectly contributes to LANDFIRE’s EVT classifications by providing detailed soil characteristics, which influence vegetation patterns and ecosystem dynamics. While LANDFIRE EVT is primarily derived from remote sensing, field plot data, and ecological models, SSURGO data can be incorporated into predictive models to refine vegetation mapping, especially in areas where soil properties strongly determine vegetation types (*e.g.*, wetlands, grasslands, and forested ecosystems). However, SSURGO is not a direct input to EVT mapping in LANDFIRE’s core methodology.

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