# Interim Core Map Documentation for Winged Mapleleaf

**Version 1**
**Review Completed:** January 2025
**Core Map Developer:** U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs (OPP)

## Species Summary

The winged mapleleaf (*Quadrula fragosa*; Entity ID 328) is an endangered freshwater mussel. FWS has not designated a critical habitat for the winged mapleleaf. The mostly sedentary species occurs in fast-flowing riffles in medium-sized rivers, where it spends most of its time buried in sediments. The larval phase of this species relies on two species of catfish. Additional information is provided in **Appendix 1**.

## Description of Core Map

The core map for the winged mapleleaf is based on nine occupied waterbodies because all currently known locations with extant members of the species have been identified by FWS in the 2024 Five Year Review and are mappable. **Figure 1** depicts the interim core map for the winged mapleleaf. The core map includes the occupied river miles based on nine occupied waterbodies (Figure 1). The core map represents 216 river miles of known habitat spread out in the following states: Minnesota, Wisconsin, Oklahoma, Arkansas, Tennessee and Missouri.

Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly represented by open water areas.

The core map developed for the winged mapleleaf is considered interim. This core map can be used to develop pesticide use limitation areas (PULAs) that include the winged mapleleaf. This core map incorporates information developed by the U.S. Fish and Wildlife Service (FWS) in the 2024 Five-Year Review 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 interim core map has an “average” best professional judgment classification with respect to biological and GIS data interpretation because the core map is limited to known locations (waterbody segments), but the locations are well described in FWS documents.

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

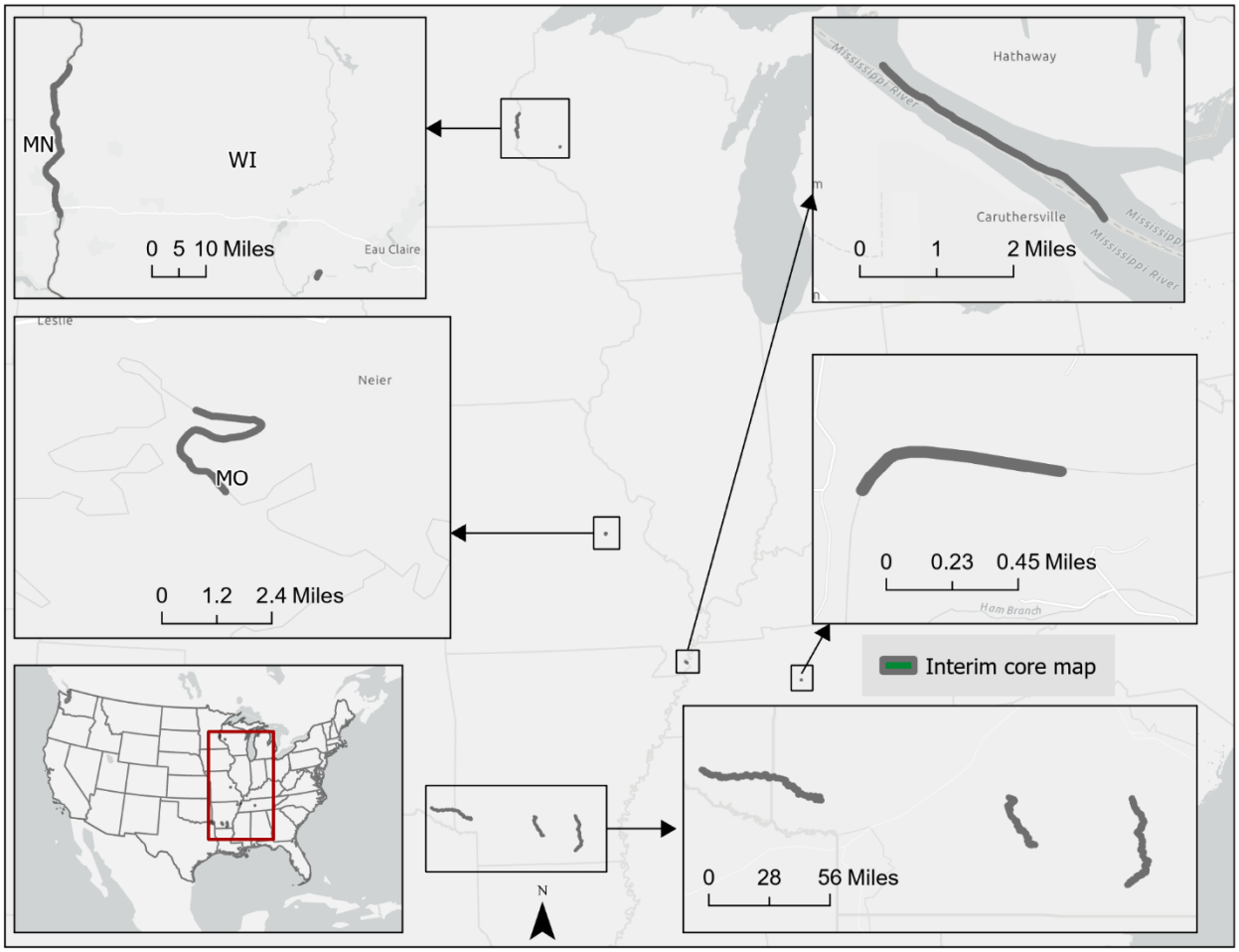


**Figure 1: Interim core map for the winged mapleleaf.**

**Table 1. Percentage of Interim Core Map Represented by NLCD[1] Land Covers and Associated Example Pesticide Use Sites/Types.**

| Example pesticide use sites/types | NLCD Class/Value | % Area |
|---|---|---|
| Forestry | Deciduous Forest (41) | 3 |
| Forestry | Evergreen Forest (42) | 1 |
| Forestry | Mixed Forest (43) | 1 |
| Agriculture | Pasture/Hay (81) | 0 |
| Agriculture | Cultivated Crops (82) | 0 |
| Mosquito adulticide, residential | Open space, developed (21) | 0 |
| Mosquito adulticide, residential | Developed, Low intensity (22) | 0 |
| Mosquito adulticide, residential | Developed, Medium intensity (23) | 0 |

[1] Dewitz, J., 2023, National Land Cover Database (NLCD) 2021 Products: U.S. Geological Survey data release, https://www.sciencebase.gov/catalog/item/647626cbd34e4e58932d9d4e

| Example pesticide use sites/types | NLCD Class/Value | % Area |
|---|---|---|
| Mosquito adulticide, residential | Developed, High intensity (24) | 0 |
| Invasive species control | Woody Wetlands (90) | 18 |
| Invasive species control | Emergent Herbaceous Wetlands (95) | 3 |
| Invasive species control | Open water (11) | 73 |
| Invasive species control | Grassland/herbaceous (71) | 1 |
| Invasive species control | Scrub/shrub (52) | 0 |
| Invasive species control | Barren land (rock/sand/clay; 31) | 0 |
| **Total Acres** | **Interim Core Map Acres** | **~ 2,890** |

## Evaluation of Known Location Information

There are four datasets with known location information:

- Descriptions of locations provided by FWS
- Occurrences provided in iNaturalist
- Occurrences provided in NatureServe
- Occurrences provided in the Global Biodiversity Information Facility (GBIF)

EPA evaluated these four sets of data before selecting the core map type and developing the core map. The 2024 Five-Year Review detailed the known occupied waterbodies and extant populations of this species, which formed the basis of this core map. FWS identifies the names and segments (defined using mile markers) of nine rivers where this species still occurs. iNaturalist had 14 research grade observations for this species, which aligned with the location information provided by FWS. GBIF data had 16 georeferenced occurrences since 1994; however, all but three of these were duplicates of iNaturalist occurrences. The three non-duplicates were all near the Saline River location already identified by FWS. Similarly, occurrences in NatureServe were in the same area as the occupied waterbodies identified by FWS. **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[2] (referred to as "the process"). This core map was developed by EPA using the four 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

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

4. Document the core map

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

- FWS provided location information on nine waterbodies with extant, known populations of Winged Mapleleaf, including names of the water bodies and segments that are occupied.
- The available occurrence data from iNaturalist, GBIF, and NatureServe aligned with the location information provided by FWS.

For step 2, EPA used the compiled information to identify the core map type. FWS identified the nine occupied waterbodies reported in its 2024 Five-Year Review of the species as the only places where the species is known to be extant. Based on this information, EPA selected the biological information core map type which will consist of these known locations identified by FWS. Other known location data from NatureServe, GBIF and iNaturalist were consistent with these locations given the precision of the data sources. Critical habitat was not considered as the core map type because no critical habitat has been designated for this species. The range of the species was not selected as the core map because it contains areas where the species does not live.

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 known locations provided by FWS in its 2024 Five-Year Review of the species. The EPA Waters application was used to locate the distance up and downstream to isolate the appropriate river segments with known winged mapleleaf populations. For some locations, NHD Plus data were used to find occupied river segments. These river segments were then opened in ArcGIS Pro as features and then converted into shapefiles to create the core map. **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 did not explore approaches other than those described in this documentation.

# Appendix 1. Information Compiled for Winged Mapleleaf

1. **Recent FWS documents**
   - Species information in ECOS. https://ecos.fws.gov/ecp/species/4127
   - Winged Mapleleaf Mussel Recovery Plan 1997. https://ecos.fws.gov/docs/recovery_plan/970625.pdf
   - Winged Mapleleaf (*Quadrula fragosa*) 2024 Five-Year Review. Winged Mapleleaf (*Quadrula fragosa*) Status Review: Summary and Evaluation. U.S. Fish and Wildlife Service Minnesota-Wisconsin Field Office Bloomington, Minnesota April 2024. https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/13014.pdf.
   - Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2015 (https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3379.pdf)

2. **Background information**
   - Status
     - Federally listed as endangered in 1991
   - Resiliency, redundancy, and representation (the 3Rs)
     - No direct information (no SSA for this species)
   - Habitat, Life History, and Ecology
     - **Habitat**: *Q. fragosa* habitat can vary in physical characteristics, such as substrate size, but the species seems to consistently inhabit relatively dense and diverse mussel beds. *Q. fragosa* habitats also had coarser and more compacted sediments then areas where mussels densities were low (Hornbach et al. 2010, p. 258). Allen and Vaughn (2008, p. 15) suggested that a high density of common mussels increases substrate stability and reduces the likelihood that mussels of rare species are displaced by high flows – "mussels themselves, by the presence of their shells and through their burrowing activities, stabilize streambed sediments, decrease shear stress, and thus create more appropriate microhabitat for other mussel species." Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2015.
     - **Diet**: "Considerable gaps remain in the knowledge of the feeding ecology of mussels. Mussels are thought to be generalist filter feeders, consuming suspended particulate matter (Bronmark and Malmqvist 1982). Most of the particulate matter is thought to be phytoplankton and small zooplankton (Fuller 1974), but there is a growing consensus that detritus forms a significant fraction of the diet of most mussels and may be obtained either from suspension or deposit feeding (Way et. al. 1990, Gordon 1992)." Winged Mapleleaf Mussel Recovery Plan 1997
   - Taxonomy
     - Aquatic Invertebrate – Family: Unionidae
   - Relevant Pesticide Use Sites
     - No information in existing documents

- Relevant Recovery Criteria and Actions
    - Recovery Criteria/Objectives obtained from Winged Mapleleaf Mussel Recovery Plan, 1997
    - "Recovery criteria: Specific delisting criteria are: (a) Five discrete populations in at least three tributaries of the Mississippi River, unless Task 2D4 [in the FWS recovery plan] determines otherwise; (b) A population must be viable as defined in Task 5A of this plan's [FWS recovery plan] narrative outline; (c) A population must demonstrate persistence as defined in the narrative outline under Task 5B [of the FWS recovery plan]; (d) A population must have long-term habitat protection as defined in the narrative outline [of the FWS recovery plan] under Task 5C."

        "Actions needed:

        - Maintain the St. Croix population of *Q. fragosa*.
        - Improve our understanding of *Q. fragosa* biology and ecology.
        - Increase the St. Croix population of *Q. fragosa*.
        - Reestablish four *Q. fragosa* populations in its historical range.
        - Reclassify and delist *Q. fragosa*."
    - "Specific reclassification criteria are:
        a) Three discrete populations in at least two tributaries of the Mississippi River drainage basin. For the purposes of this plan, two beds of mussels maybe considered discrete populations if they are sufficiently geographically isolated from each other, so both are unlikely to be affected by a single stochastic event, such as a toxic spill or a disease outbreak.
        b) All three populations must be viable as defined in the narrative outline of this document [FWS recovery plan] under Task 5A.
        c) All three populations must have demonstrated persistence as defined in the narrative outline of this document [FWS recovery plan] under Task 5B.
        d) All three populations must have long-term habitat protection as defined in the narrative outline of this document [FWS recovery plan] under Task 5C."
    - "Specific delisting criteria are:
        a) Five discrete populations in at least three tributaries of the Mississippi River drainage basin unless Task 2D4 [in the FWS recovery plan] indicates more populations or tributaries are required. For purposes of this plan, two beds of mussels may be considered discrete populations if they are sufficiently geographically isolated from each other that both are unlikely to be affected by a single stochastic event, such as a toxic spill or a disease outbreak.
        b) All five populations are viable as defined in the narrative outline of this document [FWS recovery plan] under Task 5A.
        c) All five populations must have demonstrated persistence as defined in the narrative outline of this document [FWS recovery plan] under Task 5B.
        d) All five populations must have long-term habitat protection as defined in the narrative outline of this document under Task 5C."

3. **Range**

The range of the winged mapleleaf is illustrated in Figure A1-1. It represents approximately 6,751,000 acres.

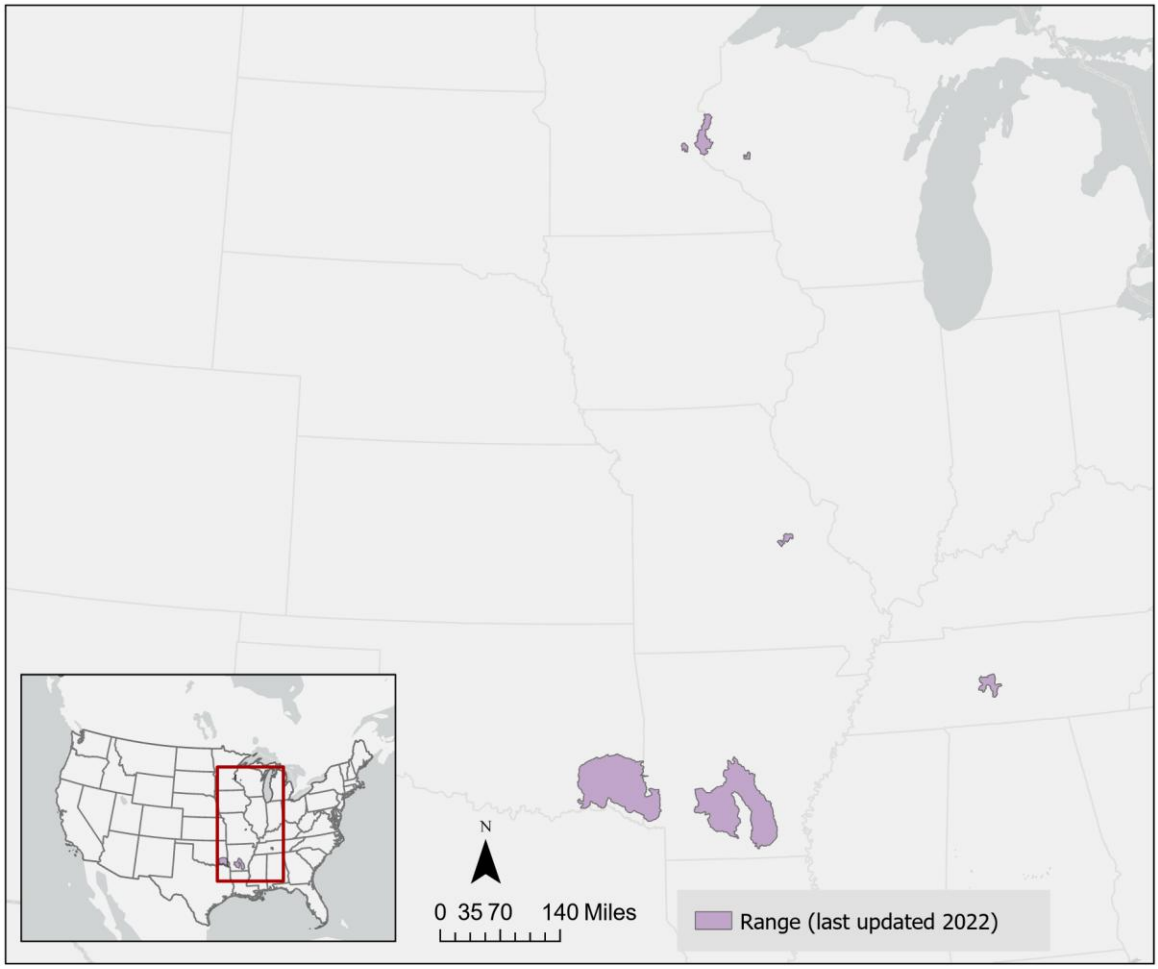


**Figure A1-1.** ECOS range of the winged mapleleaf, last updated 02/13/2022. Total acreage of range is approximately 6,751,000.

4. **Critical Habitat**
   - This species does not have critical habitat designated.

5. **Known Locations**
   - Summary from FWS reports
     - The 2024 5-year review included a list of the 9 occupied waterbodies (see **Table A1-1**).
     - In additional to the following description for each river, maps of the recent records locations along the St. Croix River in Minnesota/Wisconsin, Bourbeuse River, Missouri, Ouachita River and Saline River, Arkansas and Little River in Oklahoma and Arkansas were also included in the 2024 5-year Review (see **Figures A1-2 through A1-5** below).
     - **Ouachita River – Arkansas**: In 2013, three new sites containing *Q. fragosa* were found on the Ouachita River, mostly within a few river miles of known occupied sites. A total of 9 live *Q. fragosa* were collected at the new sites (C. Davidson, FWS,

pers. comms., 7/22/2022). Assemblages of *Q. fragosa* reported in Harris (2006) have not been resampled. The shell lengths of *Q. fragosa* found in the Ouachita River ranged from 30-64 mm in 2006 and from 20-74 mm at different sample sites in 2013, showing evidence of recruitment since 2006.Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024.

- **Saline River – Arkansas**: "Sites containing *Q. fragosa* continue to be documented in the Saline River.). Populations of *Q. fragosa* have expanded in spatial distribution and abundance since 2015 and are thought to be stable to increasing (C. Davidson, FWS, pers. comms., 7/26/2022)." Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024.
- **Little River – Arkansas and Oklahoma**: In 2013, one live *Q. fragosa* was collected by Davidson et al. (2014) along the Little River at Pond Creek National Wildlife Refuge in Arkansas.). No live or dead *Q. fragosa* were collected in repeat sampling efforts at that site in 2016 (Davidson 2017). In Oklahoma, populations of *Q. fragosa* were found at new sites near the Little River National Wildlife Refuge. The known distribution of *Q. fragosa* has increased in the Little River since the previous 5-year review was completed (D. Martinez, FWS, pers. comm., 9/17/2022). Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024.
- **Cossatot River – Arkansas**: "One fresh dead *Q. fragosa* was among 5,463 of all live mussels collected during the 2013 comprehensive survey of the Cossatot River, which is a tributary of the Little River. Based on the condition of the specimen, it appears likely that *Q. fragosa* is also extant, albeit rare, in the Cossatot River in Arkansas." Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024.
- **Duck River – Tennessee**: "In 2013, 103 juvenile *Q. fragosa* cultured from females captured in the Saline River were released in the Duck River near Littleton, Tennessee. The release site was surveyed in 2016, however it is not clear how many were recovered." Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024.
- **St. Croix River – Minnesota and Wisconsin:** Q. fragosa were observed at multiple sites along the St. Croix River between 2015 and 2021 (Winged Mapleleaf (Quadrula fragosa) 5-year Review 2024).

**Table A1-1.** Summary of extant *Q. fragosa* populations. Large populations as *Q. fragosa* densities are defined as 0.05 individuals per meter$^2$ or greater on average or populations of at least 500 individuals (Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024).

| Population (River) | State | River Mile (Up) | River Mile (Down) | Year of Last Live or Fresh Dead | Evidence of Recruitment (Juveniles <4 yrs) | Population Size | Estimated Number of Occupied River Miles | 2015 Status | 2022 Status | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| St. Croix River | MN/ WI | 48 | 15 | 2022 | Yes | Large | 33 | Unknown | Stable | Table 1 |
| Mississippi River | MN | 847 | 844 | 2011 | No | Small | 4 | N/A | Newly Established | M. Bradley, FWS, pers. comm., 8/29/22 |
| Chippewa River | WI | 36 | 35 | 2022 | No | Small | 1 | N/A | Newly Established | M. Bradley, FWS, pers. comm., 8/29/22 |
| Bourbeuse River | MO | 57 | 53 | 2009 | Unknown | Small | 4 | Unknown | Unknown | M. Bradley, FWS, unpublished data, 2022 |
| Duck River | TN | 86 | 85 | 2016 | No | Small | 1 | Newly Established | Unknown | Barnhart, 2021 |
| Little River | AR/ OK | 115 | 42 | 2021 | Yes | Large | 73 | Unknown | Stable | D. Martinez, FWS, pers. comm. 9/17/22 |
| Saline River | AR | 81 | 9 | 2015 | Yes | Large | 72 | Unknown | Stable to Increasing | C. Davidson, FWS, pers. comm., 8/17/22 |
| Ouachita River | AR | 350 | 322 | 2013 | Unknown | Small | 28 | Unknown | Stable | C. Davidson, FWS, pers. comm., 8/17/22 |
| Cossatot River | AR | 4 | 3 | 2013 | Unknown | Small | 1 | Unknown | Unknown | C. Davidson, FWS, pers. comm., 8/17/22 |

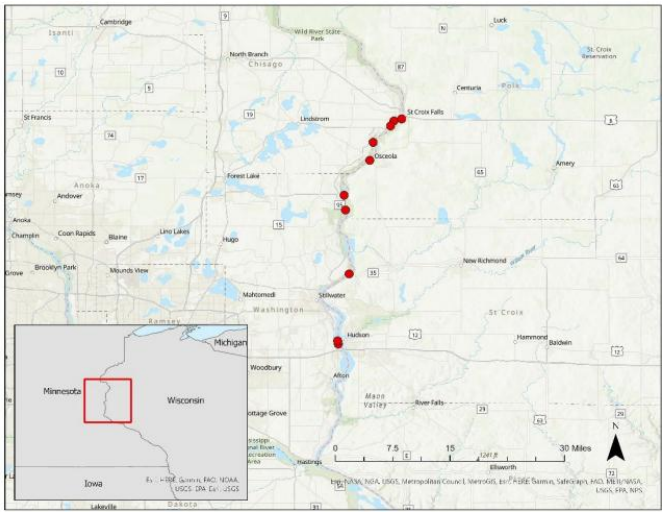


**Figure A1-2.** Recent records of live *Q. fragosa* in the St. Croix River, Minnesota/Wisconsin (Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024).

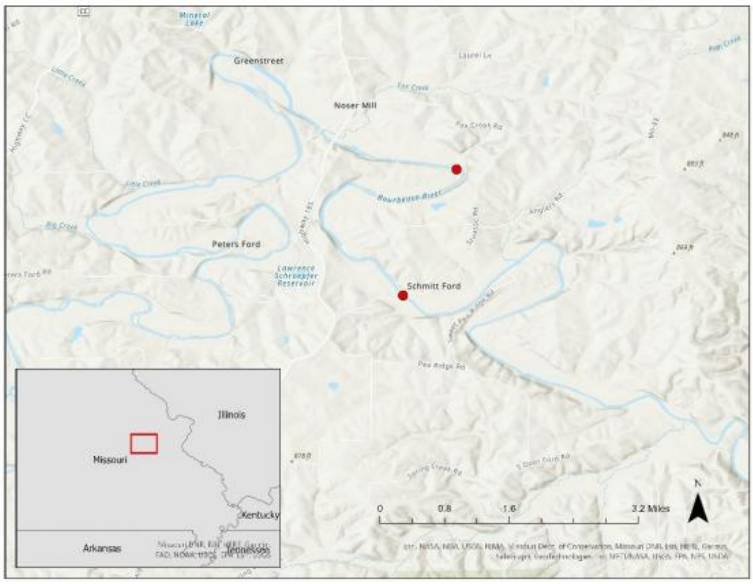


**Figure A1-3:** Records of live *Q. fragosa* in the Bourbeuse River, Missouri (Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024).

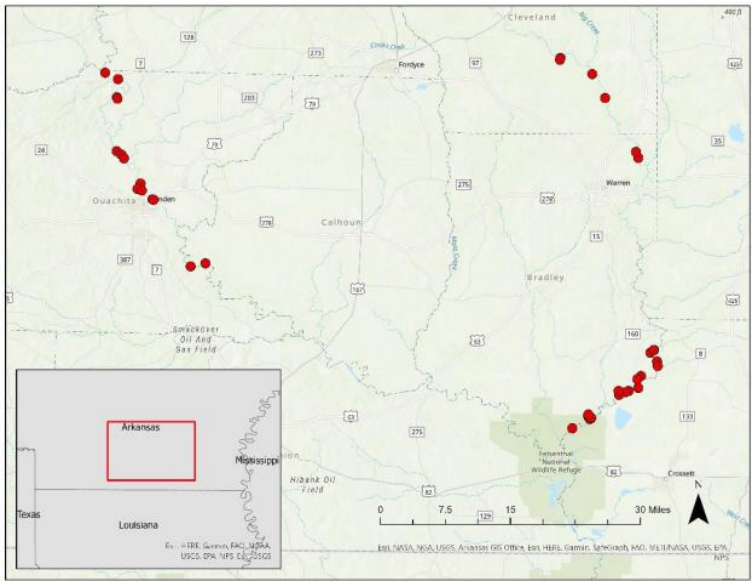


**Figure A1-4:** Recent records of live *Q. fragosa* in the Ouachita River and Saline River, Arkansas (Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024).

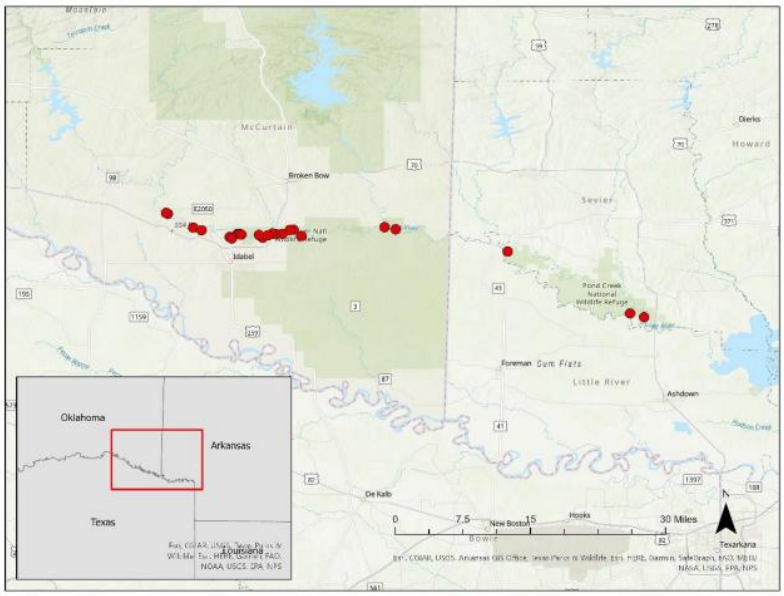


**Figure A1-5:** Recent records of live *Q. fragosa* from the Little River in Oklahoma and Arkansas and of one dead specimen found in 2013 in the Cossatot River in Arkansas (Allen and Vaughn 2008; Galbraith et al. 2008, C. Vaughn, Oklahoma Biological Survey, unpublished data; Davidson et al. 2014; J. Harris, pers. comm. 2013) (Winged Mapleleaf (*Quadrula fragosa*) 5-year Review 2024).

- iNaturalist: Link for research grade observation:
    - Fifteen research grade observations are available on iNaturalist dated between August 2020 and May 2024.
    - Two occurrences are in Arkansas, three are in Wisconsin, one is in South Dakota/Minnesota border, six are in Minnesota, and one private location. These areas align this the named waterbodies identified by FWS. No additional areas were considered based on these occurrence data.

    - Based on the information from the 2024 5-year review, these areas have been extirpated.
        - One occurrence in Kentucky from 2023 (no official extant documentation from FWS but historically found)
        - One occurrence in Nebraska/Iowa from 2022 border (no official extant documentation from FWS but historically found)
- GBIF: Link for species
    - A total of 21 human observation or occurrences are available in GBIF since 2009. Fourteen of these occurrences are georeferenced all of which are duplicates of the iNaturalist research grade occurrences. The remaining occurrences are from NatureServe and do not have coordinates. No additional areas were considered based on this dataset.

- NatureServe Explorer Pro[3]: Link for species
    - Available public occurrences from NatureServe Explorer Pro are in Arkansas, Oklahoma, Missouri and Minnesota. These areas align with the location names by FWS. No additional areas are identified by these occurrences, see map below.

[3] https://explorer.natureserve.org/pro/Welcome

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

The biological information core map for this species is based on the named occupied waterbodies identified in the available FWS documents. Specifically, known locations are taken from the FWS 5-Year Review (9 sites; **Table A1-1**). After reviewing additional sources of occurrence information including iNaturalist, GBIF, and NatureServe Explorer Pro, additional areas beyond the named waterbodies did not appear to be warranted. These additional occurrence data aligned with the information from the FWS documents given precision of the data, see **Appendix 1** for additional information on these datasets.

A shapefile with the named waterbodies identified in the 5-Year review was unavailable. For this reason, this core map was created by identifying these named rivers using the WATERS App[4] and the NHDPlus. The WATERS App was used for all but one of the river segments: the Duck River. For the Duck River, it is difficult to visually find the whole extent of the River within EPA's Waters App; therefore, the NHDPlus was used to map the extent of the occupied segment of Duck River. Additional detail on data and steps used to generate the core map for the winged mapleleaf are provided below.

1. **References and Software**
   - List of occupied waterbodies from the FWS 5-year review see **Table A1-1**
   - NHDPlus Version 2: https://www.epa.gov/waterdata/get-nhdplus-national-hydrography-dataset-plus-data
   - Software used:
     - EPA Waters App: https://www.epa.gov/waterdata/waters-geoviewer
     - ArcGIS Pro Version 3.2

2. **Datasets and Procedures Used in Core Map Development**

   **2.1. Selection of named waterbodies based on FWS 5-year review for all locations (except Duck River) using EPA's Waters Tool to find distance up/down river.**

   - For each river segment, use the following steps:
     1. Center map over region of interest (e.g., St. Croix River in MN/WI). Can use search bar.
     2. Use Upstream/Downstream Search V4 tool
     3. Select Stream Selection Type = Upstream Main Path Only
     4. Select the Starting Point icon then place it (visually) at the mouth of the river.
     5. Set Maximum Distance (km) to River Mile up from table in 5-year Review (NOTE: ***Convert from miles upriver to kilometers upriver! For example,*** Upstream = 77 km for St. Croix River)
     6. Unselect all Search For These Linked Data boxes
     7. Attribute handling = separated (NOTE: For the current purpose, any choice seems to work.)
     8. Select Show Selected Streams
     9. Run
     10. After it runs, select the 3 dots to the right of "Result: Streams Selected" -> Export to GeoJSON and save in directory where other datasets for the project are kept
     11. In ArcGIS Pro use the tool "JSON to Features" to import this layer, with Geometry Type = Polyline.

[4] https://www.epa.gov/waterdata/waters-geoviewer

12. Repeat steps c -> k using the River Kilometer (Down) distance.
13. Use “Pairwise Dissolve” tool to combine river segments for both up-river and down-river features -> UpRiverDistance_dissolve and DownRiverDistance_dissolve
14. Use “Symmetrical Difference” tool with input=UpRiverDistance_dissolve, Update Features = DownRiverDistance_dissolve -> WingedMapleleaf_locations_[name of river segment]
15. Check this new feature layer by adding field for total length of river potentially occupied by WingedMapleleaf then run Calculate Geometry Attributes to fill this field with the length in kilometers. This length (after converting to miles) should match the value in the Estimated Number of Occupied River Miles column of the table in the 5-year review (**Table 2 of Appendix 1**).
16. To capture surrounding areas, add buffer of 15 meters to the selected flowlines using “Pairwise Buffer” geoprocessing tool to convert lines to an area.

### 2.2. Process for Identifying and Selecting the Duck River

- It is difficult to visually find the whole extent of the Duck River from within EPA’s Waters App; therefore, this river was identified using the NHDplus dataset.

1. Use dropdown menu in the State and State-Equivalent section at the bottom of the website (“Download NDHPlus High Resolution EPA Snapshot 2022 Data”).
2. Select Esri File Geodatabase.
3. Use Select By Attributes for GNIS Name does not equal NULL then delete selected rows.
4. Use Select By Attributes for GNIS Name does not equal Duck River then delete selected rows.
5. Now that river can be traced, use Waters App to get GeoJSON datafiles for both the Upstream and downstream segments.
6. In ArcGIS Pro use the tool “JSON to Features” to import this layer, with Geometry Type = Polyline.
7. Repeat steps for down-river distance.
8. Use “Pairwise Dissolve” tool to combine river segments for both up-river and down-river features -> UpRiverDistance_dissolve and DownRiverDistance_dissolve
9. Use “Symmetrical Difference” tool with input=UpRiverDistance_dissolve, Update Features = DownRiverDistance_dissolve -> WingedMapleleaf_locations_Duck
10. Check this new feature layer by adding Field for total length of river potentially occupied by WingedMapleleaf then run Calculate Geometry Attributes to fill this field with the length in kilometers. This length should match the table in the 5-year review.
11. To capture surrounding areas, add buffer of 15 meters to the selected flowlines using “Pairwise Buffer” geoprocessing tool to convert the line into an area.

## 3. Creating the Core Map

### 3.1. Merging the named waterbodies into a single file

- The layers containing the buffered named waterbodies were combined into a single file using the merge tool in ArcPro. Core map file name is: Winged_Mapleleaf_Interim_core_map.shp

The resulting core map represent all the named river segments provide by FWS in the 5-Year review, **see Figure 1** of this document for an image of the core map.