COOPERATOR SCIENCE SERIES

A Comprehensive Freshwater Mussel Database for the Duck River Drainage, Tennessee

Kristin Irwin Womble[1], and
Amanda E. Rosenberger[2]

1 Tennessee Cooperative Fishery Research Unit, Tennessee Tech University
2 U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit

Cooperator Science Series # 166-2025

About the Cooperator Science Series:

The Cooperator Science Series was initiated in 2013. Its purpose is to facilitate the archiving and retrieval of research project reports resulting primarily from investigations supported by the U.S. Fish and Wildlife Service (FWS), particularly the Office of Conservation Investment. The online format was selected to provide immediate access to science reports for FWS, state and tribal management agencies, the conservation community, and the public at large.

All reports in this series have been subjected to a peer review process consistent with the agencies and entities conducting the research. For U.S. Geological Survey authors, the peer review process (http://www.usgs.gov/usgs-manual/500/502-3.html) also includes review by a bureau approving official prior to dissemination. Authors and/or agencies/institutions providing these reports are solely responsible for their content. The FWS does not provide editorial or technical review of these reports. Comments and other correspondence on reports in this series should be directed to the report authors or agencies/institutions. In most cases, reports published in this series are preliminary to publication, in the current or revised format, in peer reviewed scientific literature. Results and interpretation of data contained within reports may be revised following further peer review or availability of additional data and/or analyses prior to publication in the scientific literature.

The Cooperator Science Series is supported and maintained by the FWS, National Conservation Training Center at Shepherdstown, WV. The series is sequentially numbered with the publication year appended for reference and started with Report No. 101-2013. Various other numbering systems have been used by the FWS for similar, but now discontinued report series. Starting with No. 101 for the current series is intended to avoid any confusion with earlier report numbers.

The use of contracted research agencies and institutions, trade, product, industry or firm names or products or software or models, whether commercially available or not, is for informative purposes only and does not constitute an endorsement by the U.S. Government.

Contractual References:

This document (USGS IPDS #: IP-174003) was developed in conjunction with the U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit in collaboration with the funding partner. The U.S. Fish and Wildlife Service provided funding for this project: Cooperative Agreement G21AC10827-02.

Recommended citation:

Womble, K.I. and A.E. Rosenberger. 2025. A comprehensive freshwater mussel database for the Duck River Drainage, Tennessee. U.S. Department of Interior, Fish and Wildlife Service, Cooperator Science Series FWS/CSS-166-2025, Washington, D.C. https://doi.org/10.3996/css36499787

For additional copies or information, contact:

Amanda Rosenberger
U.S. Geological Survey
Tennessee Cooperative Fishery Research Unit
mail: arosenberger@usgs.gov

A Comprehensive Freshwater Mussel Database for the Duck River Drainage, Tennessee

Kristin Irwin Womble[1] and Amanda E. Rosenberger[2][*]

1 Tennessee Cooperative Fishery Research Unit, Tennessee Tech University

2 U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit

[*] Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Abstract

We have developed a comprehensive database for freshwater mussels for the Duck River drainage in Tennessee, including its largest tributary, the Buffalo River. This database is intended to serve as an expandable template that could be applied statewide. The Duck River is one of the most biologically diverse rivers in the world, with historically over 70 mussel species, and it has been selected as a priority watershed by multiple management and conservation entities. The database for this system compiles over 7,000 mussel records, spanning 200 years, from multiple Federal, State, academic, and private entities, representing 77 native species. The database is spatially explicit and includes temporal and methodological data for each record, and notes of negative survey data were made when possible. The database can facilitate the creation of distribution maps for each species and temporal maps of species richness to show watershed-wide trends. This project addresses the present lack of a centralized mussel database in Tennessee for a critical system. It will be available to facilitate species status assessments, inform conservation planning, and serve as a model for similar databases for other Tennessee watersheds.

Introduction

Tennessee has the second most diverse freshwater mussel fauna in the United States, with 141 species of historical occurrence. Over fifty freshwater mussel species in Tennessee are designated as federally threatened or endangered (G. Dinkins, McClung Museum Database, oral comm., 2022); more are petitioned for listing under the Endangered Species Act (CBD 2010) or have pending status. Several Federal, State, and educational entities in Tennessee monitor and

study freshwater mussel populations. These include, but are not limited to, the U.S. Fish and Wildlife Service, U.S. Geological Survey, Tennessee Wildlife Resources Agency, Tennessee Valley Authority, The Nature Conservancy, the University of Tennessee, and consulting firms. While several databases exist for freshwater mussel research in Tennessee, most focus on listed or rare species (Tennessee Department of Environment and Conservation [TDEC] 2023) or museum records (McClung Museum). However, research and conservation objectives may require information regarding common species and/or data not typically included in these preexisting databases (e.g., quantitative monitoring results, historical reports, and/or consulting surveys). Tennessee lacks a comprehensive freshwater mussel database, requiring entities to outsource data requests to agencies individually. This arduous and time-consuming task inhibits efficiency in the beginning stages of research and conservation projects, including species status assessments or reviews. All entities would, therefore, likely benefit from a comprehensive, state-wide database of freshwater mussel collection and survey efforts.

To address this gap, we have proposed the creation of a statewide, comprehensive freshwater mussel database to serve the multiple agencies and stakeholders tasked with managing and conserving the state's biota or to inform multiple research and conservation initiatives. We began this initiative through a smaller, pilot project at the watershed level. From this, we can create an expandable template, preferably covering a watershed where the need for this information is of value for ongoing and future initiatives. We selected the Duck River as this priority watershed. This system is one of North America's most biologically diverse rivers, with historically over 70 species of mussels. Currently, 15 federally listed species are extant in the river (Wisniewski 2020). The Duck River has a long history of monitoring by

multiple entities using an array of sampling approaches. Monitoring and reintroduction activities are currently active in the drainage. However, these are mainly restricted to approximately 50 river miles between the city of Columbia and Lillard's Mill Hydroelectric Station, Milltown, Tennessee (hereafter, Lillard's Mill; Marshall County, 35° 35' 12" N / 86° 47' 5" W). The Tennessee Wildlife Resources Agency (TWRA) established a 5-year monitoring program in the river in 2010. The Cumberland River Aquatic Center in Gallatin, Tennessee, is managed and operated by TWRA to propagate and reintroduce freshwater mussels into areas where extirpations have occurred. Permitting for ongoing water withdrawals has highlighted the need for information on the location and status of the Duck River's most critical and vulnerable mussel assemblages, identification of sampling gaps along the system, and suggestions of where redundant assemblages may exist in the event of catastrophic drought or water withdrawals (Lee 2024). Therefore, this system was an opportune and relevant starting point and test case for the proposed statewide database for all freshwater mussel records.

Our primary objective for this project was to compile historic and current freshwater mussel records from the Duck River drainage and organize them into a concise, spatially explicit, expandable, and method-specific database. Additionally, we intended to use this project's structure and deliverables to initiate discussions and plans with our Federal, State, academic, and private partners for a statewide freshwater mussel database for Tennessee. This report serves as a support document for our Duck River database by summarizing its creation and structure.

Methods: Database Creation

We created a comprehensive database for freshwater mussel collection and observation data for the Duck River drainage, including its tributaries (Lower Duck HUC8, Upper Duck HUC8, and Buffalo HUC8). The database exists in a tabular format in Microsoft Access and as shapefiles (shp.) and can be disseminated by the database owner (U.S. Fish and Wildlife Service; refer to Acknowledgements for how to request data) based on the end user's format preference. This section offers a brief overview of the database creation process. However, for comprehensive information and analysis, the Access file "DuckDatabase.accdb" may be requested from the U.S. Fish and Wildlife Service.

Freshwater Mussel Presence Data

We compiled freshwater mussel records from the following sources: Tennessee Wildlife Resources Agency, U.S. Fish and Wildlife Service, McClung Museum of Natural History and Culture, North Carolina Museum of Natural Sciences, Invertebase, The Ohio State University Museum of Biological Diversity, Tennessee Valley Authority, Tennessee Department of Conservation, and published and unpublished reports and data sheets from multiple sources. Quality assurance was performed for all data prior to inclusion in the database. As a preliminary step, freshwater mussel records were assessed for locality accuracy. If a locality could not be discerned with the given information, the record was generally not included unless it represented a novel species occurrence (e.g., *Epioblasma torulosa*).

A record represents an observation of a species from one locality on a specific date. We specified the number of individuals collected and differentiated between live mussels, fresh

dead shells (tissue intact, shiny nacre), and relic shells (weathered and worn, chalky nacre). Single valve shell records were counted as one individual. If multiple sources gave duplicate records, those records were combined. We derived coordinates from the given locality information if the source provided no coordinates. If the coordinates provided by the source were erroneous (e.g., did not overlap the river or did not match the locality description), we corrected locations at our discretion using a combination of their site description and inference (corrections noted in metadata). Species observations were recorded as individual records for a site with multiple collection events. Taxonomic assignments follow the Freshwater Mollusk Conservation Society's 2023 Checklist of Bivalve Names (FMCS 2023), Williams et al. (2017), and Watters (2018). Historical names were updated as necessary. Sites with no observed mussels were included in the database as negative data. However, we note that mussels may be present in past or future sampling events at these locations.

We included as much data as possible to ensure complete species distribution information within the watershed. However, we omitted some records due to insufficient information, erroneous data, or data-sharing limitations. For instance, we omitted some data from the TDEC, Tennessee Valley Authority, and museums, as they were either replicated in other sources or lacked sufficient information to assess quality or determine reliable localities. Museum data were accessed in 2021; subsequent updates to those collections can be added to this database. While we inquired about identification verification for certain records, we note that not all museum records are verified; therefore, these records are subject to change. Although our goal was to develop a comprehensive freshwater mussel database for the Duck

River drainage, we recognize the existence of additional unaccounted records. This database remains a living project and will be updated as new records are discovered and collected.

Database Format and Attributes

The database housed at the McClung Museum of Natural History and Culture (Gerry Dinkins, curator) was used as a template for our database. We used additional freshwater mussel databases to inform our formatting (e.g., Western Freshwater Mussel Database, the Virginia Department of Wildlife Resources [Brian Watson], the Georgia Department of Natural Resources [Jason Wisniewski], Texas A&M Mussel database, Invertebase, NatureServe, TDEC [2023]). We built the database using Microsoft Access 2016, as this program is readily available to most of our colleagues and can be easily transferred to other software and formats.

We aimed to create a spatially explicit database specifically for freshwater mussels. Throughout this project, we discussed relevant attributes with malacologists in Tennessee and surrounding states to ensure the database included all relevant freshwater mussel conservation and research information. In February 2023, we presented our database at the Tennessee Endangered Mollusk Committee Meeting to our colleagues, many of whom will be end-users, and our selected attributes were approved. Selected attributes can be found in Table 1 of this document, and methodological descriptions of how we derived each attribute from the source data are provided. Although all records were assessed for these attributes, many did not have all attributes relevant to freshwater mussel collections (e.g., museum records often lack information on survey type and effort). We included records that lacked certain attributes if we

could verify the locality of the collection or observation and specified when the source did not provide an attribute.

Detailed metadata and data disclaimers are included as individual tables within the database. We kept the Access database format, table relationships, and queries simple to streamline future format adjustments. The database format is subject to change as this project develops, with future alterations, including additional tables and forms, changes to table relationships, and additional queries should additional funding become available for its expansion. This Access database was built for the utility of the database manager, and we envision disseminating it through export to Excel or GIS. The following section describes the contents of the database and additional formatting details.

Results: Database Contents

Database Structure

The main product of this project is the Access database titled “DuckDatabase.accdb,” housed with the U.S. Fish and Wildlife Service. The database is intended to be a living document and is subject to change as the database develops. Future alterations could include adding new freshwater mussel records and attributes, taxonomic changes, record reidentifications, and the addition of new river drainages. The Access database contains a primary " Mussels " table that includes the freshwater mussel data that will be disseminated to the end users (Table 1). Additionally, the Access database includes 10 support tables that are described in Table 2 of this document. Data disclaimers and detailed metadata regarding the table “Mussels” are provided as support tables and may be requested and included with any database

dissemination. Negative data are included as an individual table and represent collection events at sites where no freshwater mussels were observed; this table includes a subset of the attributes from the "Mussels" table, including survey type and effort. The "Negative Data" table may also be disseminated with the data disclaimers and metadata. The remaining Access tables are support tables with information relevant to data entry, including several tables connected to the "Mussels" form to streamline the data entry process. Several support tables (i.e. Authority, Common Names, Genus, Species, and Status and Ranks) are not restricted to Duck River mussel species but include information for all of Tennessee's species. We included this extraneous information to accommodate the expansion of this database beyond the Duck River drainage.

This product will serve a variety of data needs for freshwater mussel conservation and research. Therefore, we created a general query that enables the database manager to query the database for each data request individually. This general query is titled "Mussels Query" and includes all attributes from the table "Mussels". This query is intended not only for use by the data manager to process data requests but also to ensure that records are not duplicated during data entry. The database contains one form titled "Mussels" that serves as the point of data entry for the primary table.

Freshwater Mussel Data

As of March 2023, the "Mussels" table includes 7,029 freshwater mussel records representing the collection or observation of a species from a locality on a specific date. Records represent 76 native species collected or observed over a 200-year period (1800s to

2022) from the Duck River and its tributaries (Table 3). Several records in the database are reported as “sp.” and remain unidentified (Genera: *Cambarunio*, *Epioblasma*, *Leaunio*, *Pleurobema*, *Toxolasma*, and *Villosa*). These are not included in the total species count; however, they were retained due to their relevance to the species composition of sites. Records of the invasive clam native to Asia, *Corbicula fluminea*, were included in the database when provided by our sources.

The database includes mussel records from over 200 survey sites. We retained source coordinates whenever possible; therefore, reported sites may appear redundant. We prioritized reporting data in its original form to enable end users to organize data using unique objectives-based criteria for combining sites (e.g. Lillard Mill). The database includes collections and observations from over 100 unique collectors from various Federal, State, academic, and private entities and reflects various survey types and efforts. We included detailed reference information, allowing users to query the database based on data source type.

Common and scientific names of Freshwater mussels are based on the latest information available from The Freshwater Mollusk Conservation Society (FMCS 2023), which maintains lists of common and scientific names of freshwater gastropods and bivalves. This list serves as a consensus document for mussel conservation practitioners, hobbyists, scientists, and the public. It is based on taxonomic updates in the peer-reviewed literature as reviewed by a society subcommittee of experts on mollusks and taxonomy. FMCS periodically publishes these lists, and the next printing is anticipated in 2025; at the time of this report, Williams et al. (2017) serves as the authoritative document for this list. Coinciding with the FMCS biannual symposium every two years, the FMCS names subcommittees meet to update the lists.

Spatial Data and Availability

At the time of this report, the spatial components of this database are not open-access. They are owned by the U.S. Fish and Wildlife Service, which funded this project (see Acknowledgements for contacts within the U.S. Fish and Wildlife Service for data inquiries). Therefore, the data compiled for this report are provided as maps (Appendices A and B). One objective of this project was to create a template for what could become a publicly available spatial database for queries by individual users, with data privacy and protection in mind. Due to technology constraints and discussions with funding sources (i.e., the U.S. Fish and Wildlife Cookeville Field Office; see Acknowledgements for contact information for data inquiries), we created spatial components of the Access database using ESRI ArcGIS Pro V3.0 that can be disseminated with the tabular database at the request of end users. Spatial data are located in the folder titled "DuckDatabase_Spatial". The primary table "Mussels" and the table "Negative Data" are in possession of the U.S. Fish and Wildlife Service as shapefiles in their entirety (DuckDatabase.shp; NegativeData.shp). Additionally, we created individual distribution maps for each native freshwater mussel species reported in the database (Appendix B). These data are provided as shapefiles in the folder "Species Distribution Maps" within the Spatial folder owned by the U.S. Fish and Wildlife Service. The data disclaimers and metadata tables from Access may be included with any dissemination of the spatial data. Spatial components were derived in March 2023 and are, therefore, subject to change as future alterations are made to the Access database and additional data are available.

Table 1. Attributes selected during database creation and included in the final ”Mussels” table in the DuckDatabase.accdb file, including a detailed listing of all data fields and their descriptions for the freshwater mussel database created for the Duck River, Tennessee. This data dictionary explains how each attribute was defined, derived, and used within the database structure. Citations for sources used for statuses and ranks are provided in References. This complete data structure allows for thorough documentation of freshwater mussel occurrences while maintaining standardization across multiple sources and time periods. FMCS = Freshwater Mollusk Conservation Society; TDEC = Tennessee Department of Environment and Conservation

Attribute Name	**Description of Attribute**
Record	Automated number assigned by Access based on entry order. Missing numbers are a result of records removed from the database
Genus	Genus as assigned in 2023 FMCS Checklist of freshwater mussels (Mollusca:Bivalvia:Unionida) of the United States and Canada, Williams et al. (2017), and Watters (2018)
Species	Specific epithet as assigned in 2023 FMCS Checklist of freshwater mussels (Mollusca:Bivalvia:Unionida) of the United States and Canada, Williams et al. 2017, and Watters 2018)
Family	Taxonomic Family
Authority	Taxonomic Authority (Authority of most current species name)
CommonName	Common name as assigned in 2023 FMCS Checklist of freshwater mussels (Mollusca:Bivalvia:Unionida) of the United States and Canada, Williams et al. (2017), and Watters (2018)
FederalStatus	Federal listing under the U.S. Endangered Species Act. Statuses were assigned in February 2023 and are subject to change
StateRank	State rank of species in Tennessee. A non-legal rank that indicates the rarity and vulnerability of a species at the state level. Derived from the TDEC (2023) Data Viewers, NatureServe (2023) Explorer, and the 2015 Tennessee State Wildlife Action Plan
StateStatus	Legal listing in Tennessee. Derived from the TDEC (2023) Data Viewers, NatureServe (2023) Explorer, and the 2015 Tennessee State Wildlife Action Plan

GlobalRank	Global rank of species. A non-legal rank that indicates the rarity and vulnerability of a species at the global level. Derived from NatureServe (2023) Explorer
Collector(s)	Collector(s)/Observer(s) cited for record. If all collectors from a collection event are not specified, the main author will be listed with et al.
DateCollected	Date of collection or observation (MM/DD/YYYY). If only the year is given, the day and month are given values of 00. The earliest calendar date is listed if multiple dates are given for one collection or observation event.
Year	Year of collection or observation. If the decade or year is not specified, the record is given a value of xx00
Month	Month of collection or observation. If month of collection is not specified, the record is given a value of 00
Day	Day of collection or observation. If the day of the month is not specified, the record is given a value of 00
Latitude	Latitude of collection or observation given by source or derived from given locality information. Given in decimal degrees
Longitude	Longitude of collection or observation given by source or derived from given locality information. Given in decimal degrees
CollectionLocality	Description of collection or observation location given by source or derived from given locality details. Minimal errors (spelling, etc) were edited at the discretion of K. Womble (database manager, compiler, primary author)
County	County of collection or observation
State	State of collection or observation
HUC10	Hydrologic unit code 10 of collection or observation
HUC10Name	Name of HUC10 of collection or observation
HUC8	Hydrologic unit code 8 of collection or observation
HUC8 Name	Name of HUC8 of collection or observation
Live	Y/N/NS - live collected or observed; NS indicates that source did not specify whether live or fresh dead condition was collected or observed. User should look at NumberTotal and Condition remarks to discern the condition of records
FreshDead	Y/N/NS - fresh dead collected or observed. NS indicates that the source did not specify whether live or fresh dead condition was collected or observed. User should investigate NumberTotal and Condition remarks to discern the condition of records
NumberLive	Number of live collected or observed. NS=Not Specified
NumberFreshDead	Number of fresh dead collected or observed. NS=Not Specified

NumberRelic	Number of relic shells collected or observed. NS=Not Specified
NumberTotal	Total number (live, fresh dead, and relic) collected or observed. NS=Not Specified. If value is not given by source but can be calculated with given information, it was derived by K. Womble
Effort	Person hours (sampling time in hours x number of samplers) at the entire site. NS = Not Specified. If value is not given by source but can be calculated with given information, it was derived by K. Womble
CPUE_site	Catch per unit effort at site (mussels per hour). NS = Not Specified. If value is not given by source but can be calculated with given information, it was derived by K. Womble
Density_site	Mussels per square meter at the site. If density was given by source in a different format, it was converted to mussels/square meter by K. Womble. 95% confidence intervals are placed after density in parentheses if given by source. NS = Not Specified
Length	Total length in millimeters if specified. If any notes about size range or age are given, they will be included in this field as given by source. NS = Not Specified
Sex	Sex of specimens in record or sex ratios at entire site if given by source. NS = Not Specified
Gravidity	Presence of gravid females if given by source. NS = Not Specified
SurveyType	Type of survey conducted: Qualitative Timed Search;Quantitative;Quadrats;Transects;Semiquantitative;Opportunistic;Survey type not specified
SurveyTime	Length of sampling time in total hours. NS = Not Specified
CoordinatesSource	If the latitude and longitude listed by source are assigned to the record: Coordinates provided by source. If the source did not provide coordinates, they were derived using the given locality information. If coordinates are erroneous or do not overlap river, they were corrected by K. Womble.
ConditionRemarks	Additional information on specimen, shell condition, and specimen storage. Ex: Live or fresh dead counts combined. If shell condition is not specified: Shell condition not specified
IDRemarks	Information regarding species identification. Ex: old synonymy given by source, subsequent name changes, apparent identification errors
OtherRemarks	Additional remarks on the record (museum catalog number, estimated date, occurrence information, source errors, habitat information, ecological information, site descriptions)
Reference	Citation for record
Reference2	Additional reference if listed by source
DataShareAgreement	Y/N. Specifies whether a data share agreement was signed between the data source and the data enterer. Records assigned “Y” should be excluded from data requests unless an additional agreement is available between source and requestor.

Table 2. The structural organization of the Microsoft Access database of freshwater mussel collections (DuckDatabase.accdb) conducted in the Duck River Watershed, Tennessee, detailing each component table and its specific purpose.

Table Name	**Content Description**
Authority	List of taxonomic authorities for Tennessee freshwater mussels
Commons Names	List of common names for Tennessee freshwater mussels
Data Disclaimers	Disclaimers regarding the accuracy, completeness, and adequacy of the data.
Genus	List of Tennessee freshwater mussel genera
HUC10	Hydrologic Unit Code 10 and names
HUC8	Hydrologic Unit Code 8 and names
Mussels	Primary table including freshwater mussel data
Negative Data	Surveyed sites where no freshwater mussels were observed
“Mussels” Metadata	Detailed description of attributes and how they were derived in our primary table
Species	List of Tennessee freshwater mussel species
Status and Ranks	Global, Federal and State listing and ranks for freshwater mussel species

Table 3. List of native freshwater mussel species represented in the Duck River database (DuckDatabase.accdb). Common and scientific names of freshwater mussels are based on the latest information available from Williams et al. (2017) and FMCS (2023). An * denotes genetic uncertainty with the species at the time of this report.

No.	Species	Common Name
1	*Actinonaias ligamentina*	Mucket
2	*Actinonaias pectorosa*	Pheasantshell
3	*Alasmidonta marginata*	Elktoe
4	*Alasmidonta viridis*	Slippershell Mussel
5	*Amblema plicata*	Threeridge
6	*Arcidens confragosus*	Rock Pocketbook
7	*Cambarunio dactylus*	Cumberland River Rainbow
8	*Cambarunio taeniatus*	Painted Creekshell
9	*Cumberlandia monodonta*	Spectaclecase
10	*Cyclonaias nodulata*	Wartyback
11	*Cyclonaias pustulosa*	Pimpleback
12	*Cyclonaias tuberculata*	Purple Wartyback
13	*Cyprogenia stegaria*	Fanshell
14	*Ellipsaria lineolata*	Butterfly
15	*Elliptio crassidens*	Elephantear
16	*Epioblasma ahlstedti*	Duck River Dartersnapper
17	*Epioblasma aureola*	Golden Riffleshell
18	*Epioblasma brevidens*	Cumberlandian Combshell
19	*Epioblasma florentina*	Yellow Blossom
20	*Epioblasma obliquata*	Catspaw
21	*Epioblasma triquetra*	Snuffbox
22	*Epioblasma turgidula*	Turgid Blossom
23	*Eurynia dilatata*	Spike
24	*Fusconaia cuneolus*	Finerayed Pigtoe
25	*Fusconaia flava*	Wabash Pigtoe
26	*Fusconaia subrotunda*	Longsolid
27	*Hemistena lata*	Cracking Pearlymussel
28	*Lampsilis abrupta*	Pink Mucket
29	*Lampsilis cardium*	Plain Pocketbook
30	*Lampsilis fasciola*	Wavyrayed Lampmussel
31	*Lampsilis ovata*	Pocketbook
32	*Lampsilis teres*	Yellow Sandshell

33	*Lasmigona complanata*	White Heelsplitter
34	*Lasmigona costata*	Flutedshell
35	*Lasmigona sp.**	Barrens Heelsplitter*
36	*Leaunio vanuxemensis*	Mountain Creekshell
37	*Lemiox rimosus*	Birdwing Pearlymussel
38	*Ligumia recta*	Black Sandshell
39	*Medionidus conradicus*	Cumberland Moccasinshell
40	*Megalonaias nervosa*	Washboard
41	*Obliquaria reflexa*	Threehorn Wartyback
42	*Obovaria subrotunda*	Round Hickorynut
43	*Paetulunio fabalis*	Rayed Bean
44	*Pegias fabula*	Littlewing Pearlymussel
45	*Plectomerus dombeyanus*	Bankclimber
46	*Pleurobema clava*	Clubshell
47	*Pleurobema cordatum*	Ohio Pigtoe
48	*Pleurobema oviforme*	Tennessee Clubshell
49	*Pleurobema rubrum*	Pyramid Pigtoe
50	*Pleurobema sintoxia*	Round Pigtoe
51	*Pleuronaia barnesiana*	Tennessee Pigtoe
52	*Pleuronaia dolabelloides*	Slabside Pearlymussel
53	*Potamilus alatus*	Pink Heelsplitter
54	*Potamilus fragilis*	Fragile Papershell
55	*Potamilus ohiensis*	Pink Papershell
56	*Ptychobranchus fasciolaris*	Kidneyshell
57	*Ptychobranchus subtentus*	Fluted Kidneyshell
58	*Pyganodon grandis*	Giant Floater
59	*Quadrula apiculata**	Southern Mapleleaf*
60	*Quadrula fragosa*	Winged Mapleleaf
61	*Quadrula quadrula*	Mapleleaf
62	*Reginaia ebenus*	Ebonyshell
63	*Sagittunio subrostratus*	Pondmussel
64	*Simpsonaias ambigua*	Salamander Mussel
65	*Strophitus undulatus*	Creeper
66	*Theliderma cylindrica*	Rabbitsfoot
67	*Theliderma intermedia*	Cumberland Monkeyface
68	*Theliderma metanevra*	Monkeyface
69	*Toxolasma cylindrellus*	Pale Lilliput
70	*Toxolasma lividum*	Purple Lilliput
71	*Toxolasma parvum*	Lilliput
72	*Tritogonia verrucosa*	Pistolgrip
73	*Truncilla donaciformis*	Fawnsfoot

74	*Truncilla truncata*	Deertoe
75	*Utterbackia imbecillis*	Creeper
76	*Utterbackiana suborbiculata*	Flat Floater

Conclusions

This project documents over 7,000 freshwater mussel collections and observations from over 200 years in the Duck River and its tributaries, making it the most comprehensive collection of mussel records from this drainage. This project is intended to benefit agencies and stakeholders tasked with managing and conserving the state's biota, improving their efforts' efficiency, and informing multiple future research and conservation initiatives in the Duck River. The database streamlines the assembly of species distribution information in the Duck River drainage, which could improve the efficiency of Species Status Assessments and Five-year Status Reviews under the Endangered Species Act and other research and conservation objectives. This project highlights areas in the drainage that may warrant survey attention and informs future sampling prioritizations. Additionally, this database enables the assessment of long-term changes in the Duck River's mussel fauna, including species diversity and abundance trends. We constructed this database to evolve as a living document that will be updated with additional records as research and conservation work continues in the Duck River drainage.

Because the Duck River database is designed to serve as a template for Tennessee's statewide freshwater mussel database, its structure is intentionally scalable. As funding becomes available, new river drainages in Tennessee can be incorporated quickly. Expanding this database to additional river drainages in Tennessee will likely benefit all entities working to protect and conserve freshwater mussel resources in the state.

Acknowledgments

The U.S. Fish and Wildlife Service funded this project (Cooperative Agreement G21AC10827-02). At the time of publication, the raw data are not publicly available (see Spatial Data and Availability subsection for description of raw data). For inquiries, contact Anthony "Andy" Ford, Fish and Wildlife Biologist Classification and Recovery, U.S. Fish and Wildlife Service, Tennessee Ecological Services, 446 Neal Street in Cookeville, TN 38501; (931) 431-2485; anthony_ford@fws.gov.

We are particularly grateful to Gerry Dinkins, who worked with the McClung Museum of Natural History and Culture, for significant data contributions, technical assistance, and generous advice and information-sharing throughout this project. We thank Brittany Bajo, Andy Ford, Don Hubbs, Gerry Dinkins, and others for their assistance in compiling this dataset and the 2023 annual Tennessee Endangered Mollusk Meeting participants for their input into the data structure and dissemination. We thank Jenny Isham, a TN Tech undergraduate who aided with georeferencing and data compilation. Finally, we thank Don Hubbs and Jacob Westhoff for their comments and review of earlier drafts of this document.

References

CBD (Center for Biological Diversity). 2010. Petition to list 404 aquatic, riparian and wetland species from the southeastern United States as threatened or endangered under the Endangered Species Act. 1145 pp.

FMCS (Freshwater Mollusk Conservation Society). 2023. The 2023 FMCS checklist of freshwater mussels (Mollusca: Bivalvia: Unionida) of the United States and Canada. https://molluskconservation.org/Library/Committees/Names/Appendix_1_Bivalves_Revised_Names_List_20210825.pdf.

Lee, B. 2024. State of Tennessee Executive Order by the Governor 108. An Order to Conserve the Duck River Watershed. Nashville, Tennessee.

NatureServe. 2023. NatureServe Explorer. https://explorer.natureserve.org/.

Tennessee Department of Environment and Conservation (TDEC). 2023. Data Viewer: Rare Species by County. https://dataviewers.tdec.tn.gov/dataviewers/f?p=9014:3:118904174220701:::::

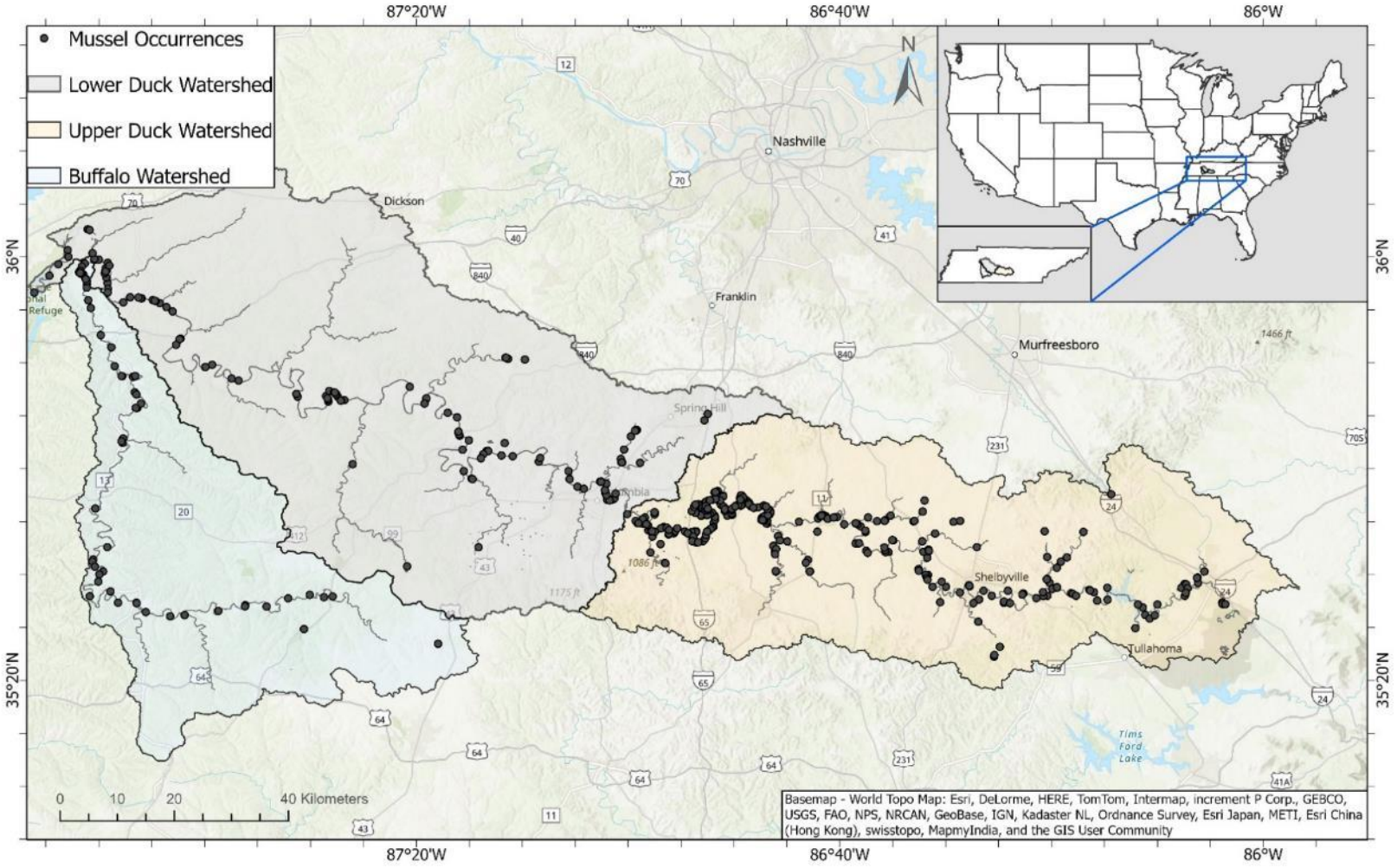
Tennessee State Wildlife Action Plan Team. 2015. Tennessee State Wildlife Action Plan 2015. Tennessee Wildlife Resources Agency. Nashville, TN. 506 pp.

Watters, G.T. 2018. A preliminary review of the nominal genus *Villosa* of freshwater mussels (Bivalvia, Unionidae) in North America. Conchology, Inc., LapuLapu, Philippines.

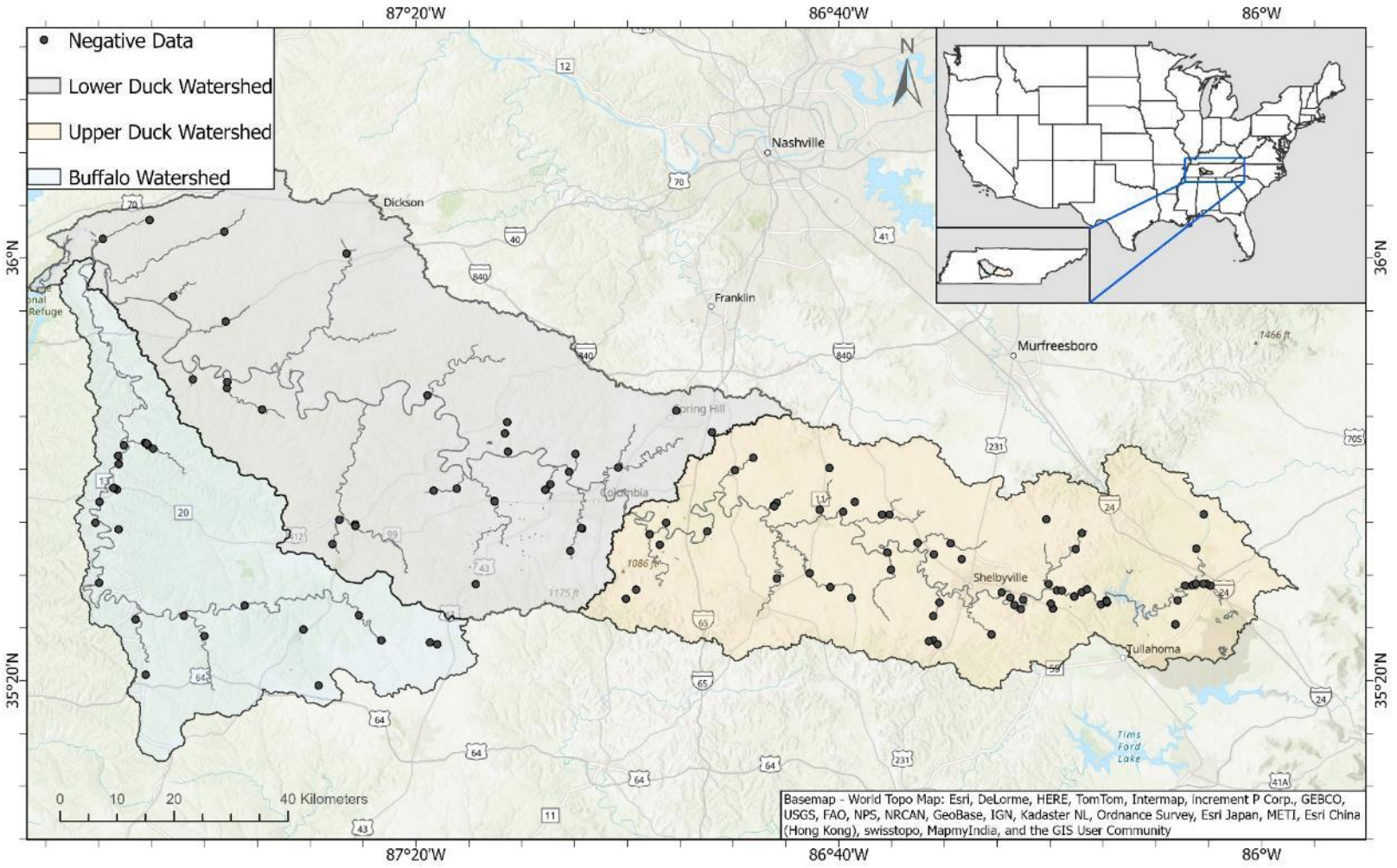
Williams, J.D., A.E. Bogan, R.S. Butler, K.S. Cummings, J.T. Garner, J.L. Harris, N.A. Johnson, and G.T. Watters. 2017. A revised list of the freshwater mussels (Mollusca: Bivaliva: Unionida) of the United States and Canada. Freshwater Mollusk Biology and Conservation 20:33-58.

Wisniewski, J. 2020. 2020 Duck River quantitative mussel survey. Tennessee Wildlife Resources Agency, Nashville, TN. Fisheries Report 16-06. 38 pp.

Appendix A. Spatial extent and components of the Duck River Drainage, Tennessee Freshwater Mussel Database.

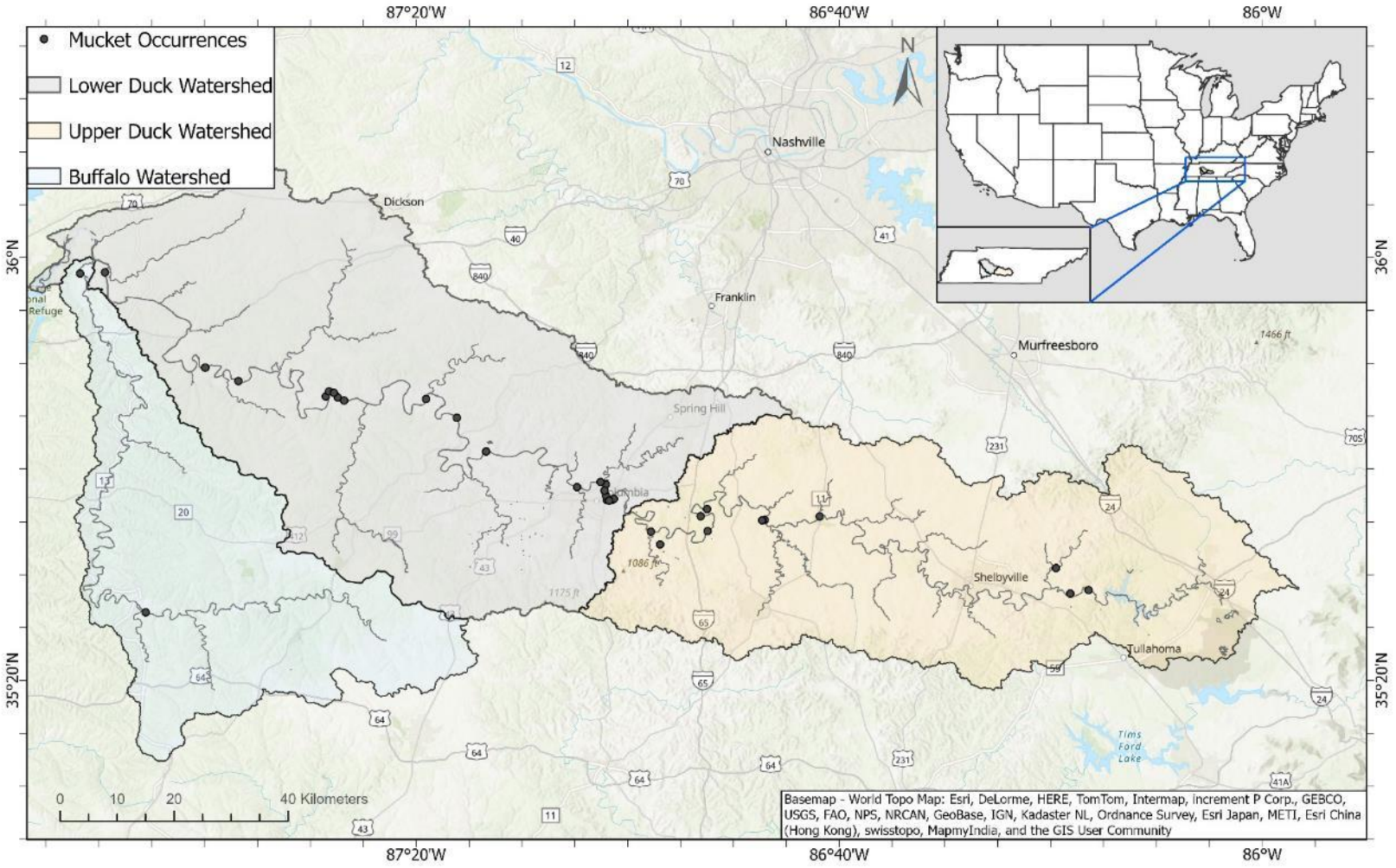


Appendix A1. Map of freshwater mussel collections and observations from the Duck River drainage (1800s-2022). This comprehensive map includes all species and conditions (live, fresh dead, and relic).

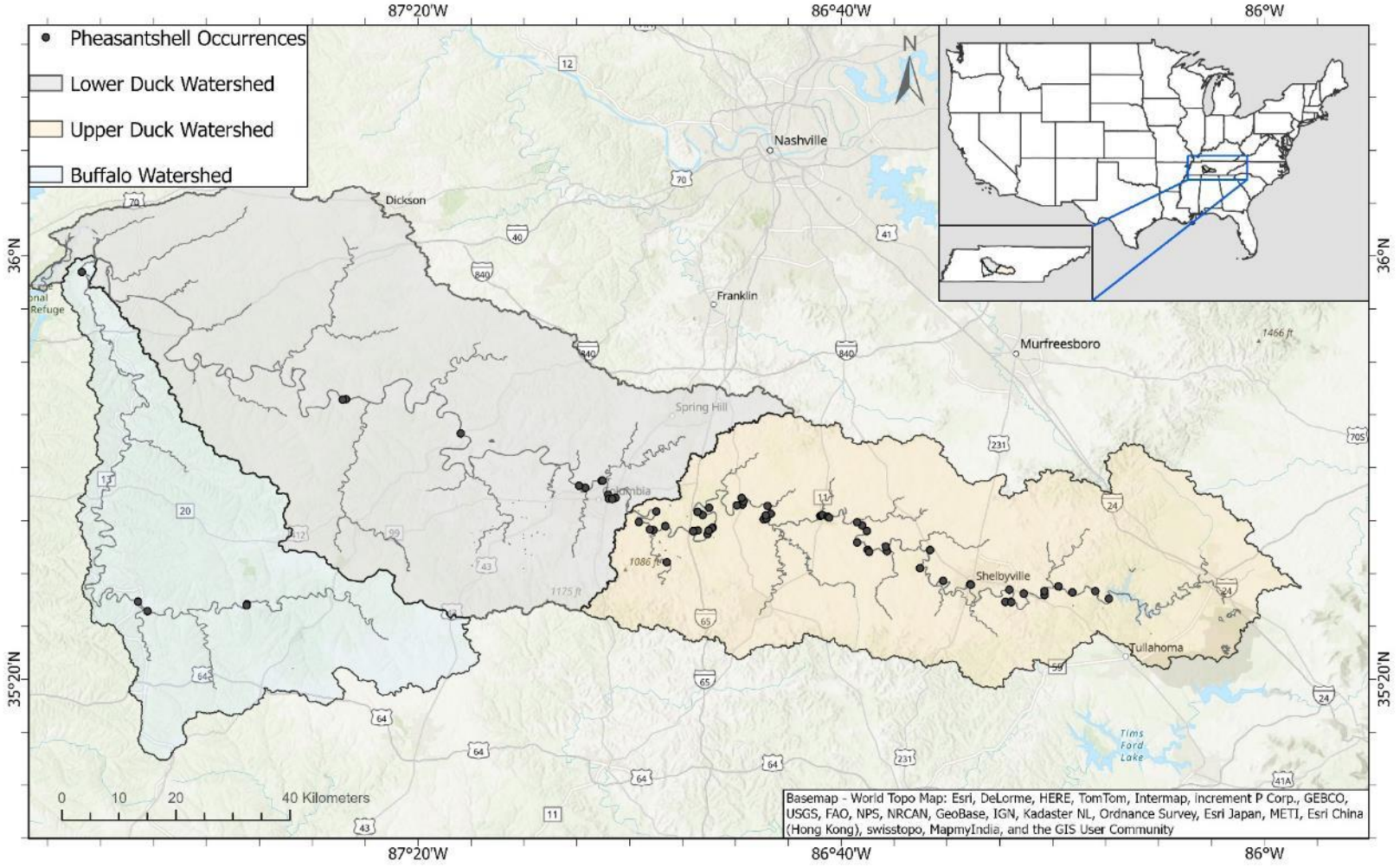


Appendix A2. Negative data from the Duck River Freshwater Mussel Database. Sites represent collection events where no freshwater mussels were observed.

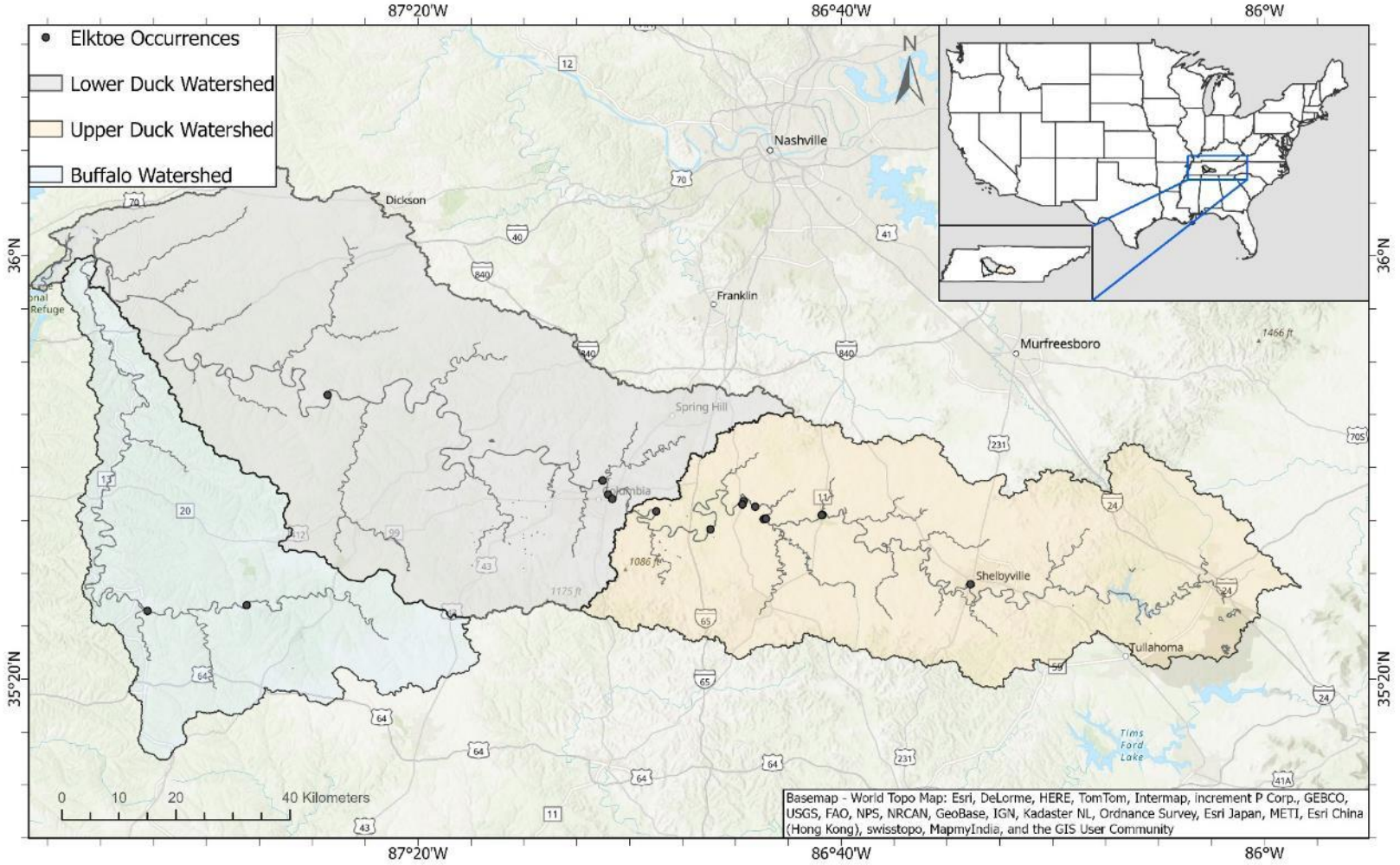
Appendix B. Species Distribution Maps from the Duck River Freshwater Mussel Database. Maps are in alphabetical order by genus and species. Collection dates range from the 1800s to 2022 and include all conditions (live, fresh dead, and relic).



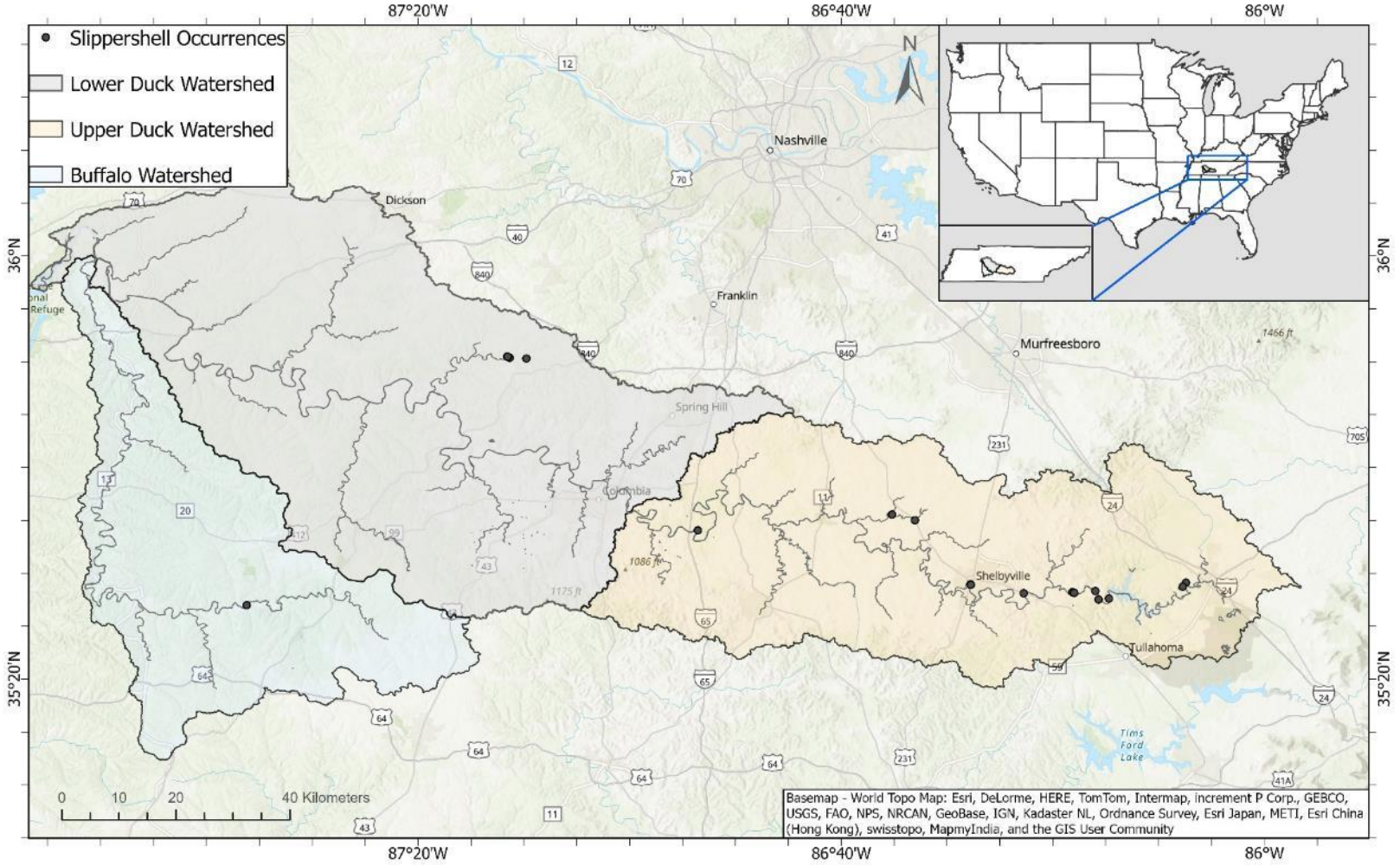
Appendix B1. *Actinonaias ligamentina* (Mucket) distribution in the Duck River Drainage.



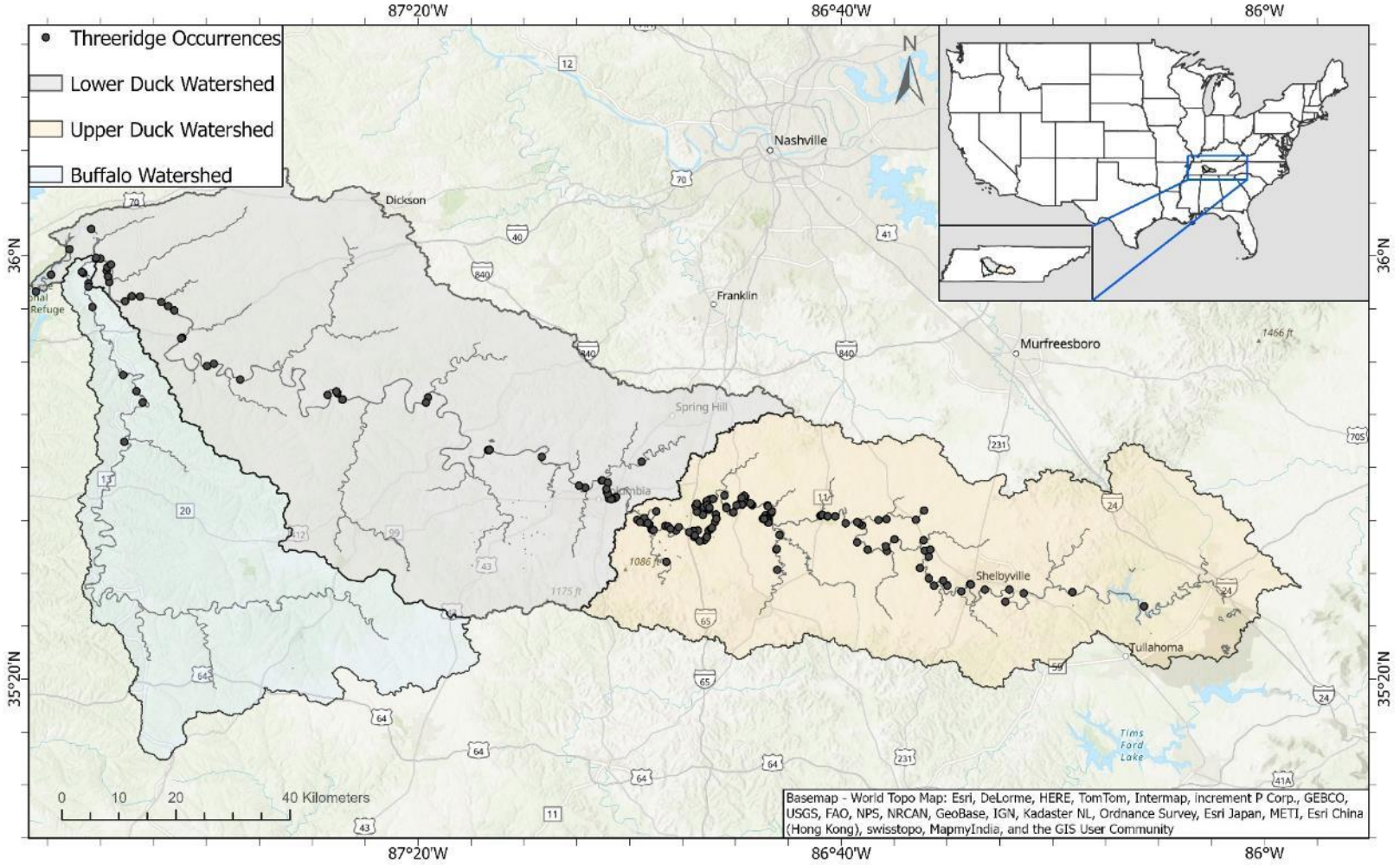
Appendix B2. *Actinonaias pectorosa* (Pheasantshell) distribution in the Duck River Drainage.



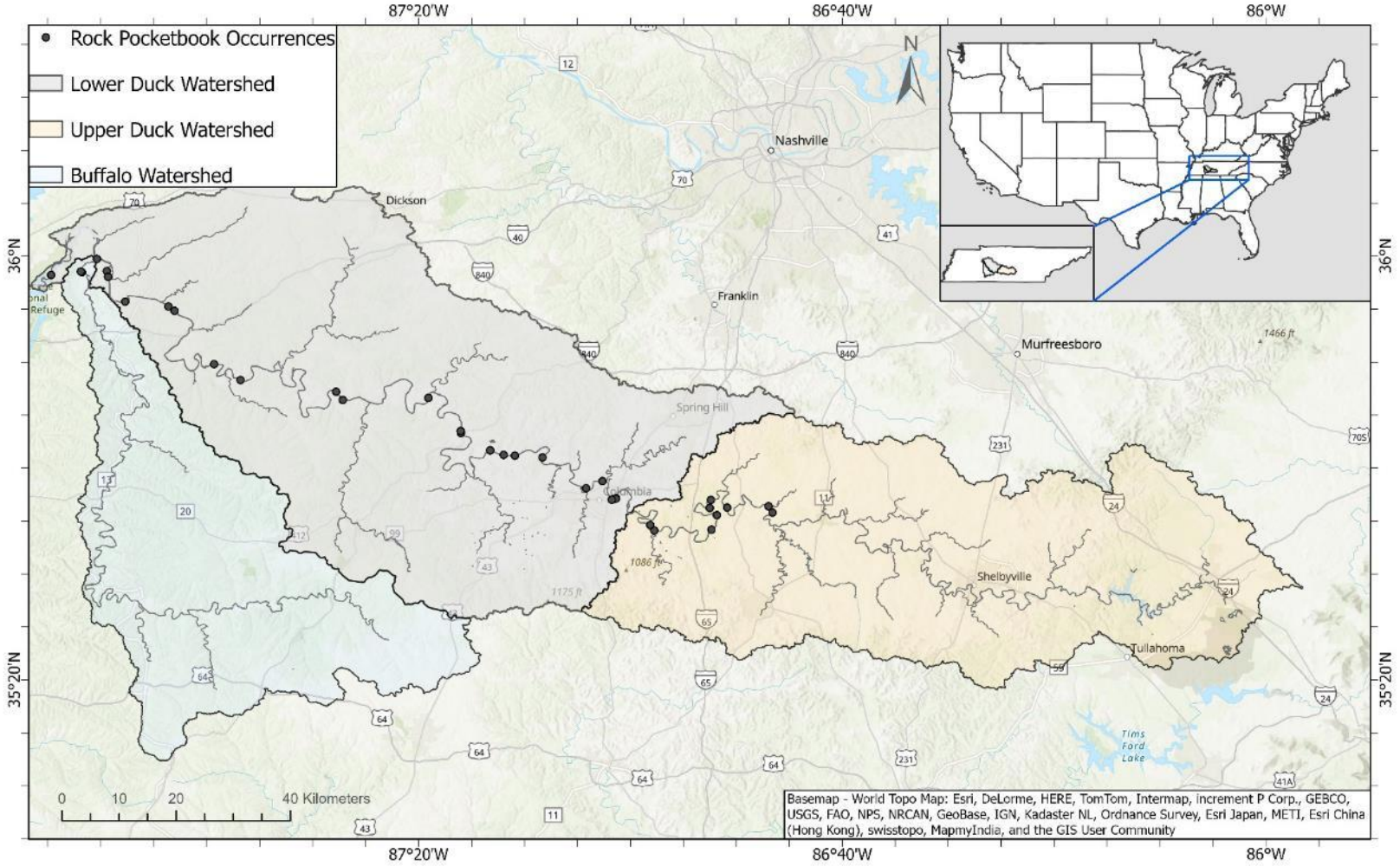
Appendix B3. *Alasmidonta marginata* (Elktoe) distribution in the Duck River drainage.



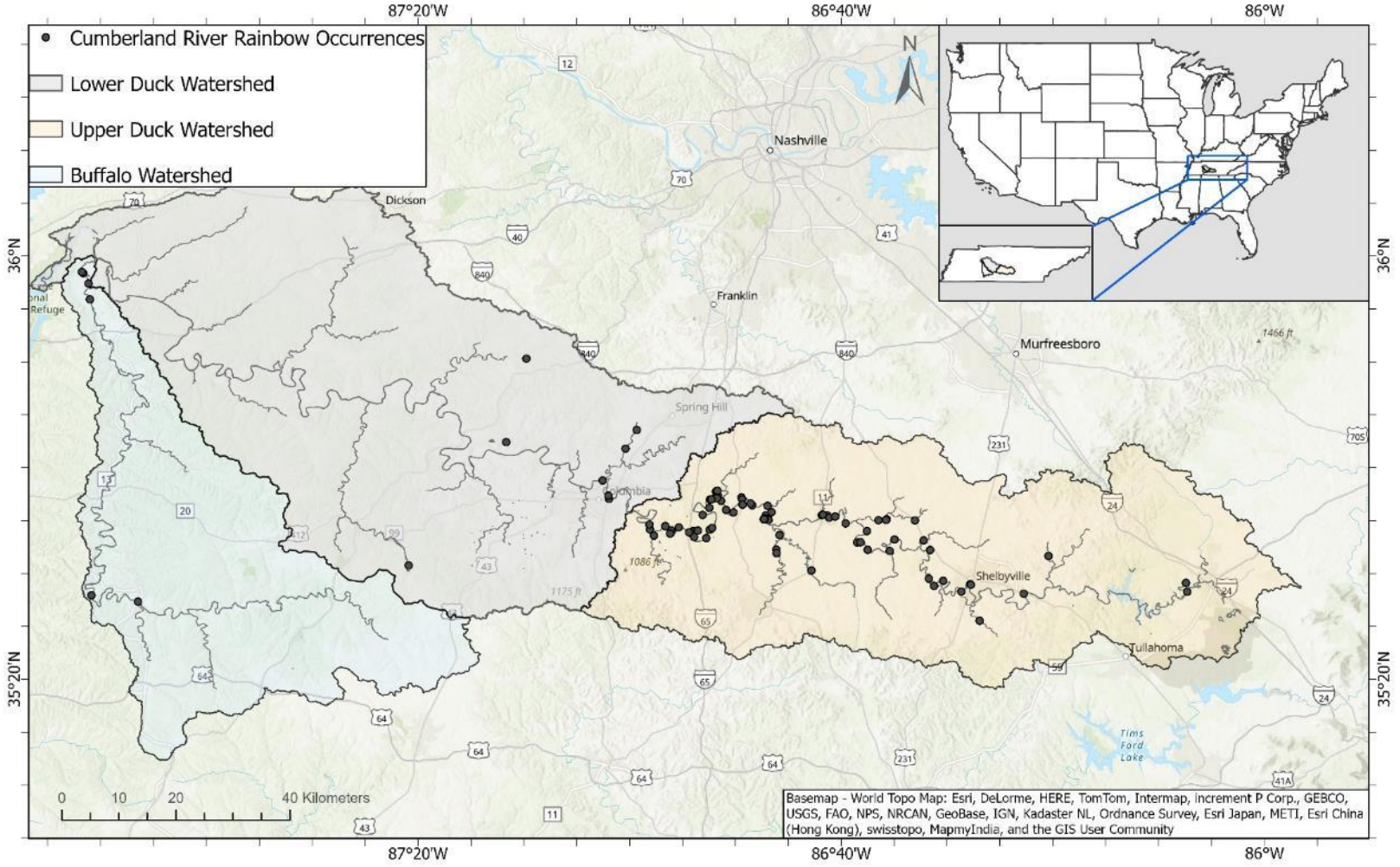
Appendix B4. *Alasmidonta viridis* (Slippershell Mussel) distribution in the Duck River drainage.



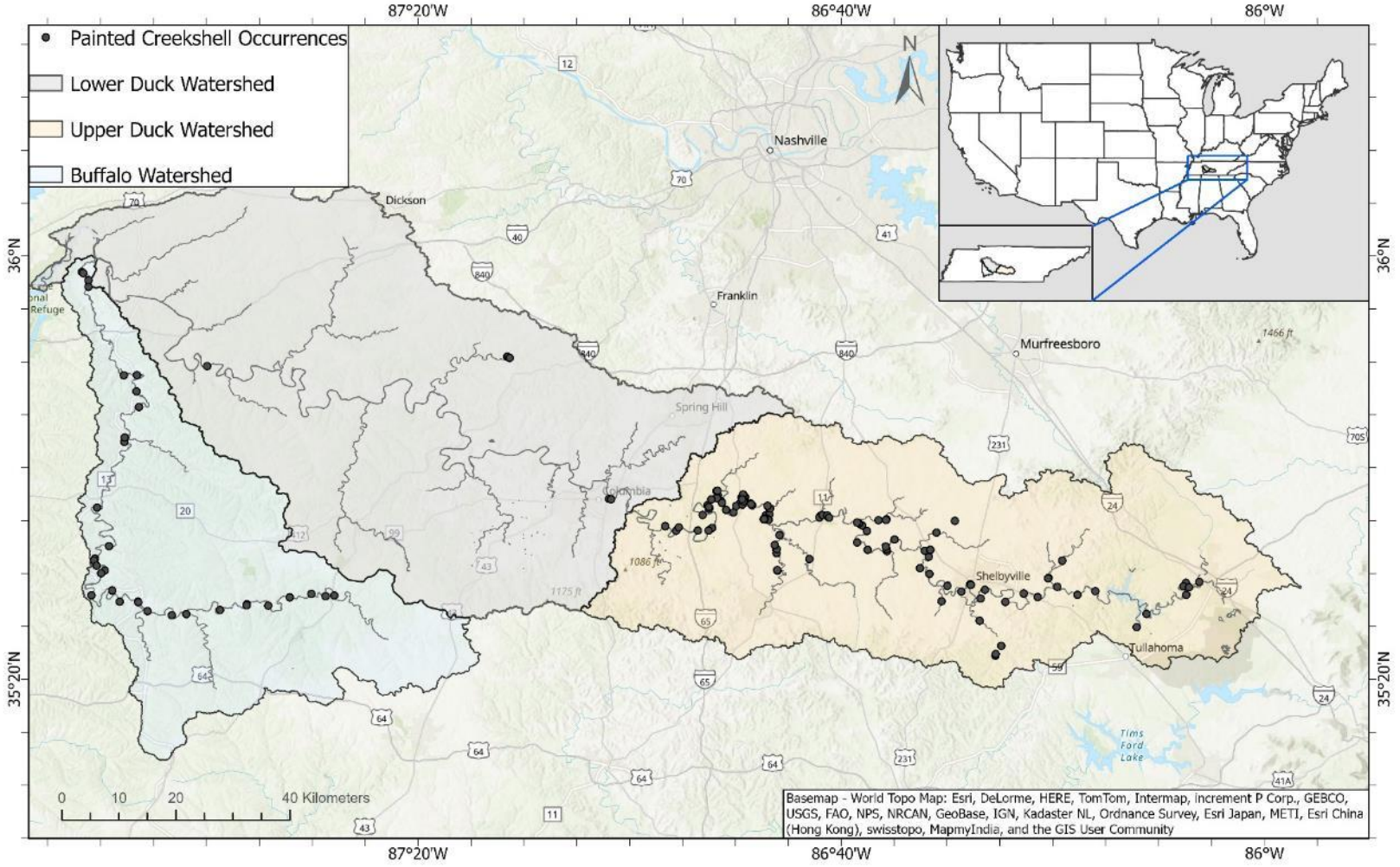
Appendix B5. *Amblema plicata* (Threeridge) distribution in the Duck River drainage.



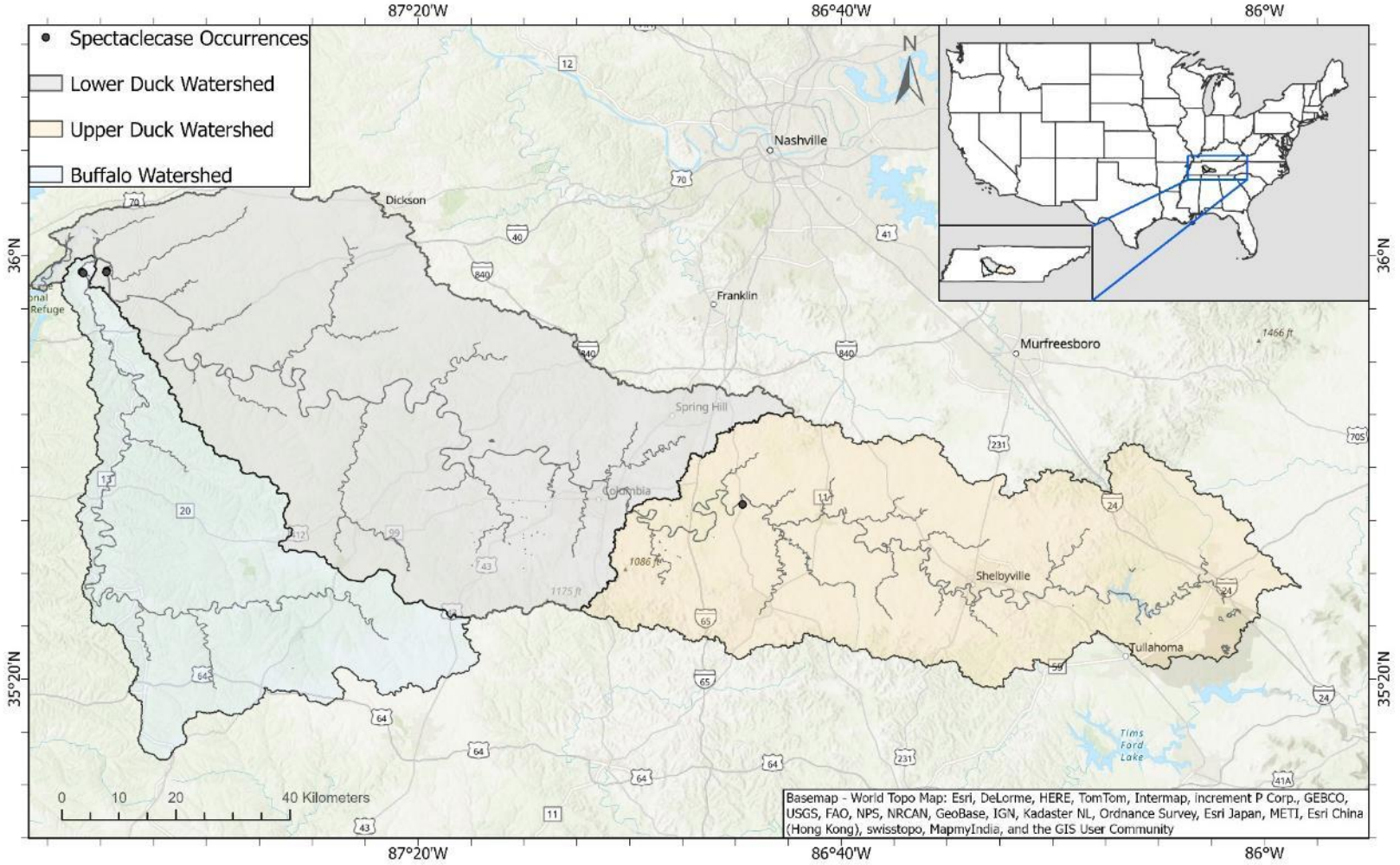
Appendix B6. *Arcidens confragosus* (Rock Pocketbook) distribution in the Duck River drainage.



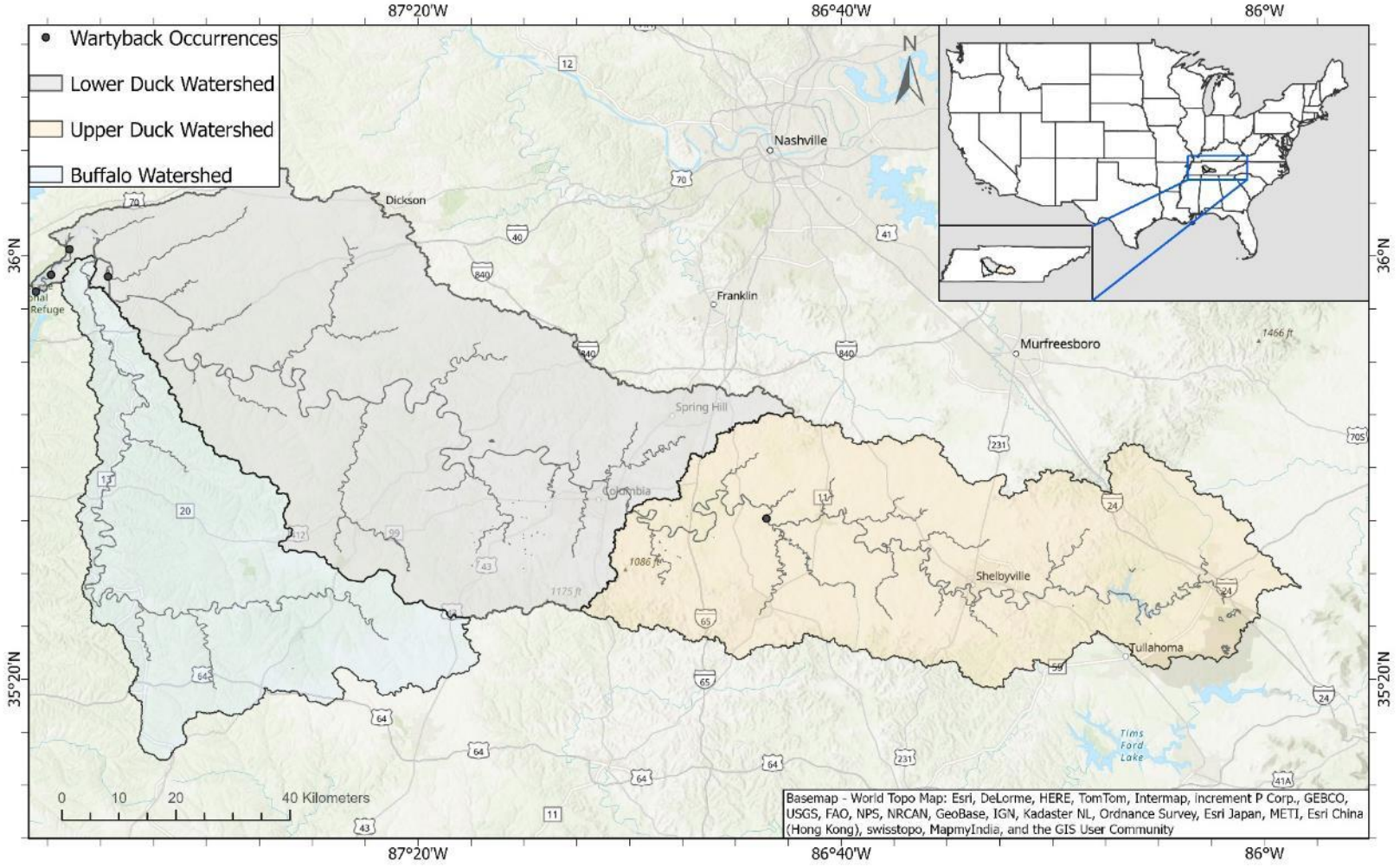
Appendix B7. *Cambarunio dactylus* (Cumberland River Rainbow) distribution in the Duck River drainage.



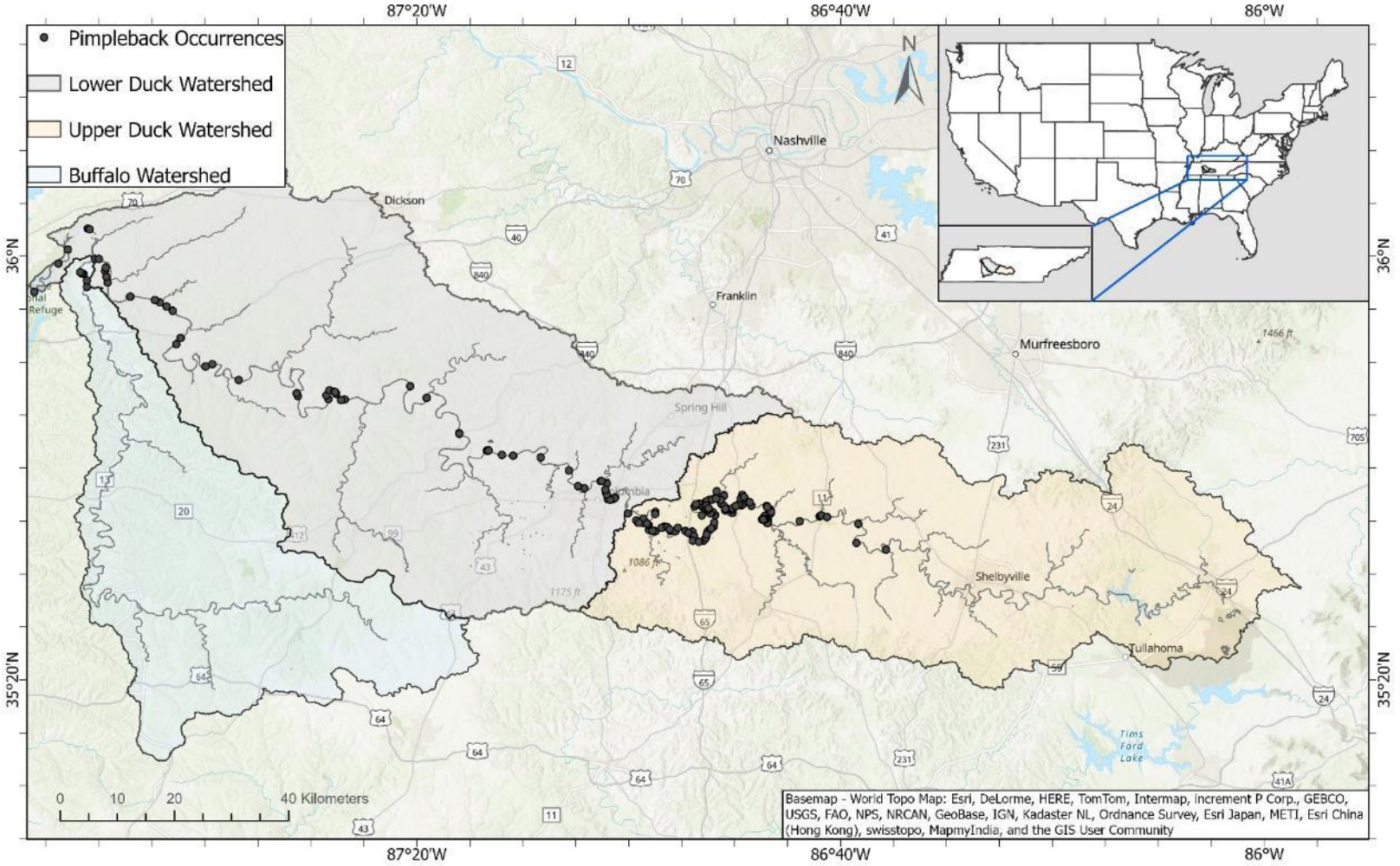
Appendix B8. *Cambarunio taeniatus* (Painted Creekshell) distribution in the Duck River drainage.



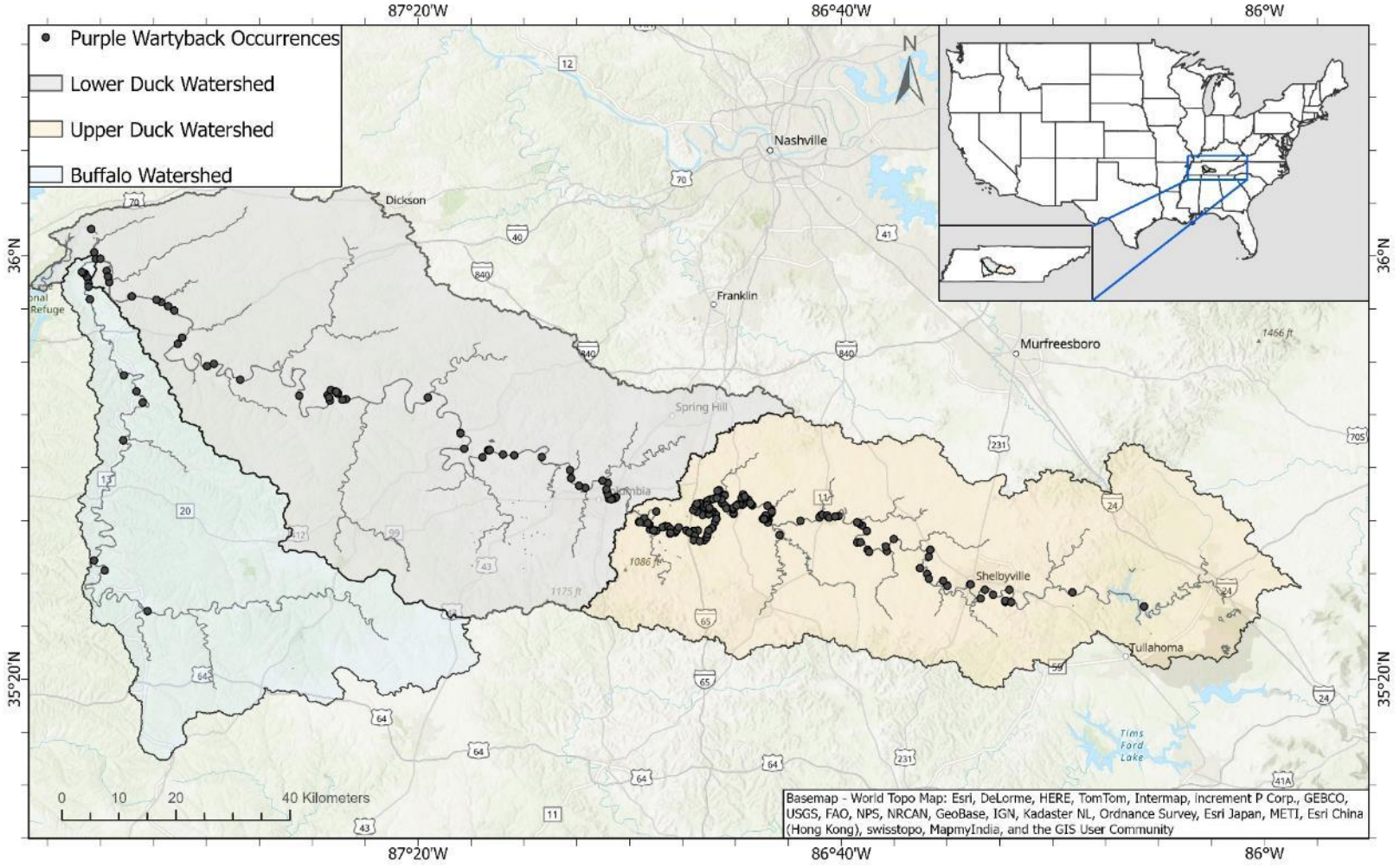
Appendix B9. *Cumberlandia monodonta* (Spectaclecase) distribution in the Duck River drainage.



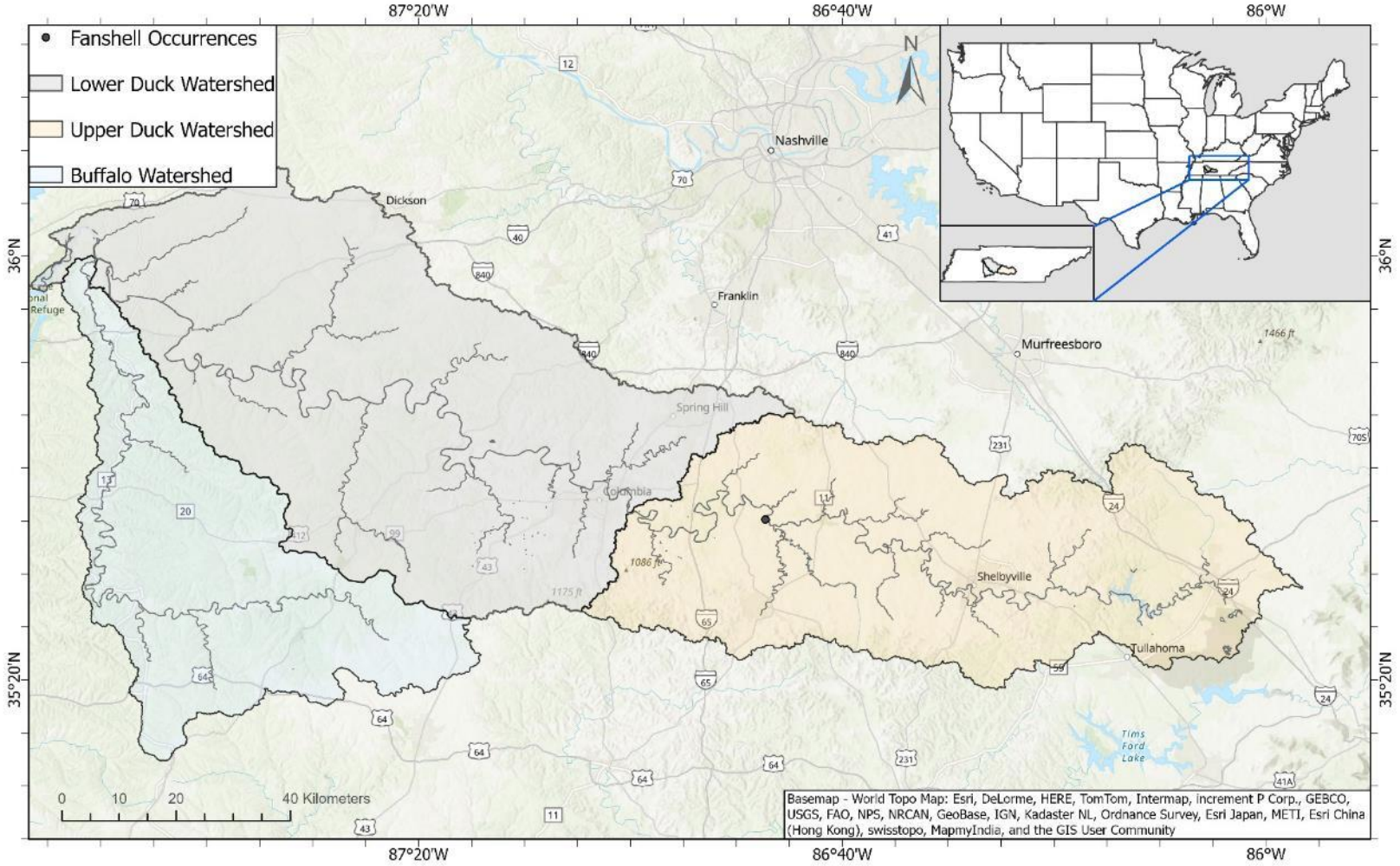
Appendix B10. *Cyclonaias nodulata* (Wartyback) distribution in the Duck River drainage.



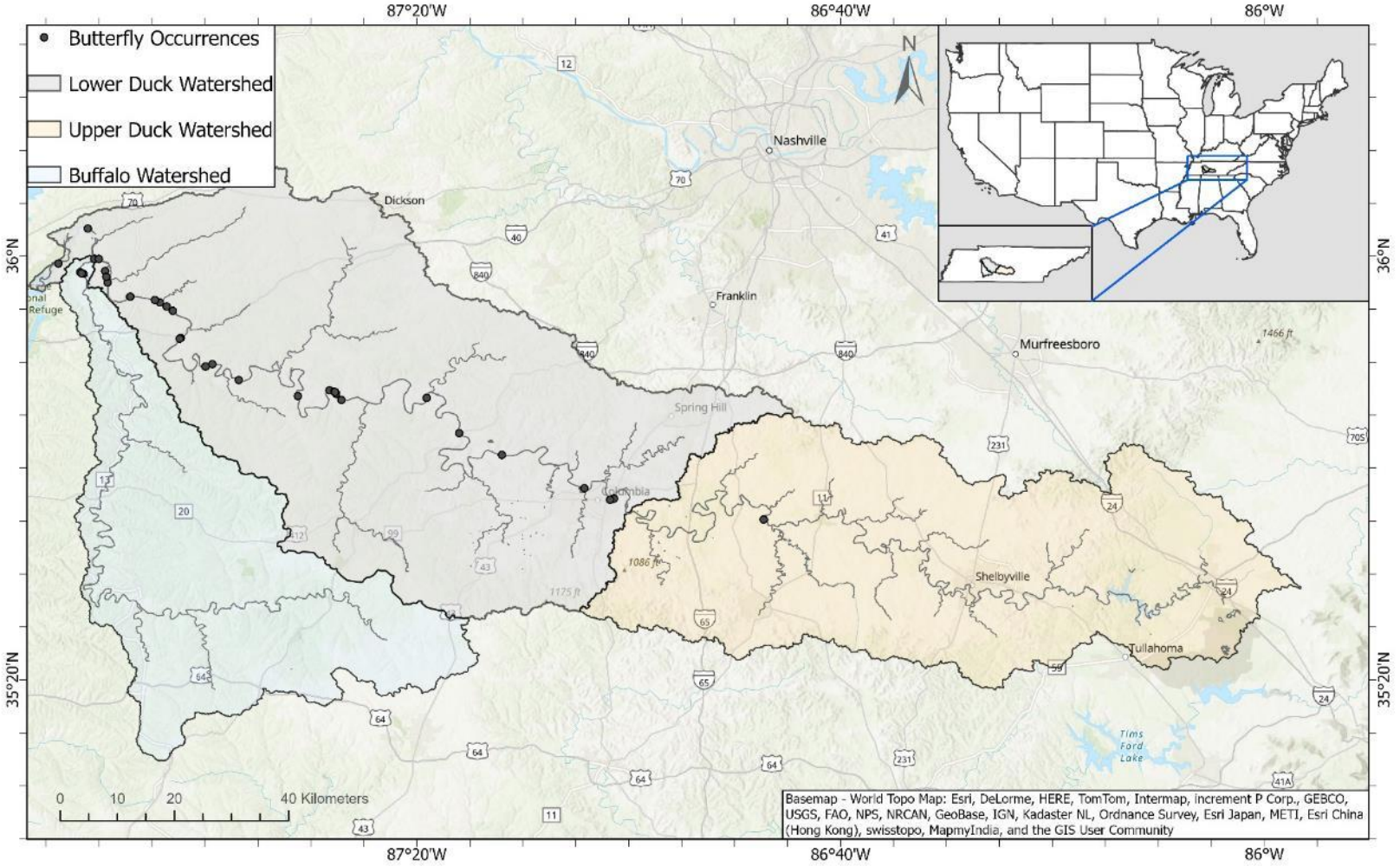
Appendix B11. *Cyclonaias pustulosa* (Pimpleback) distribution in the Duck River drainage.



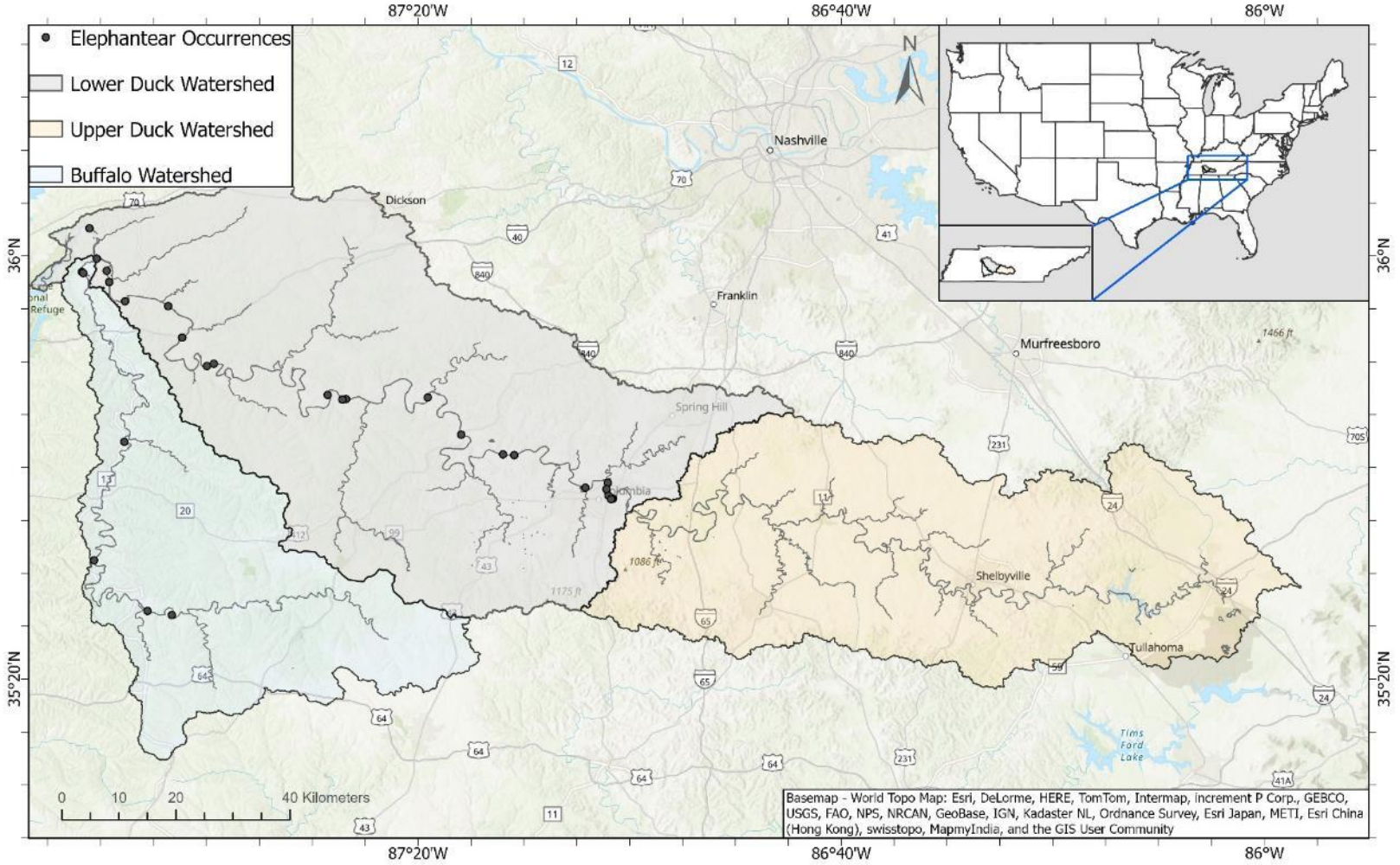
Appendix B12. *Cyclonaias tuberculata* (Purple Wartyback) distribution in the Duck River drainage.



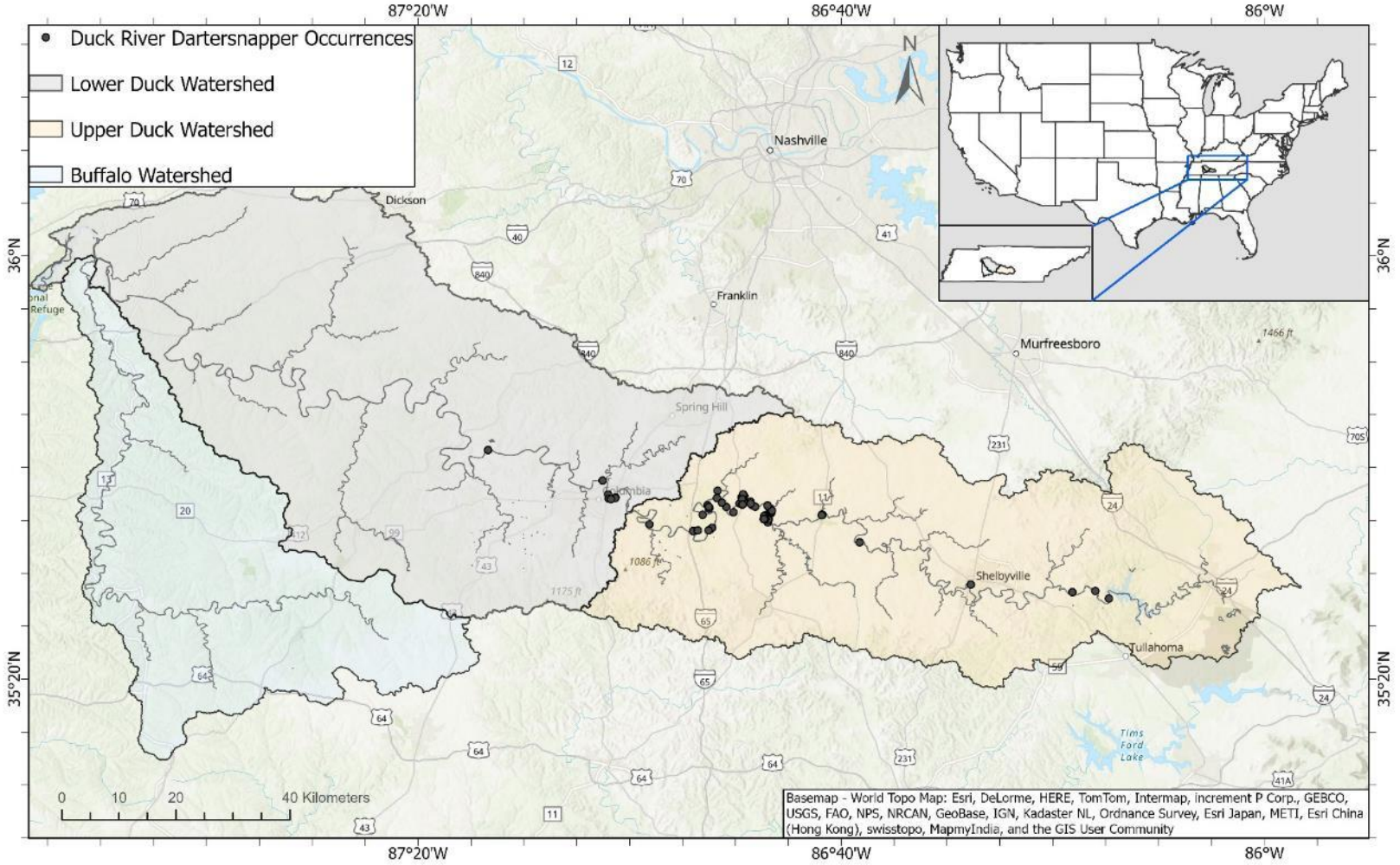
Appendix B13. *Cyprogenia stegaria* (Fanshell) distribution in the Duck River drainage.



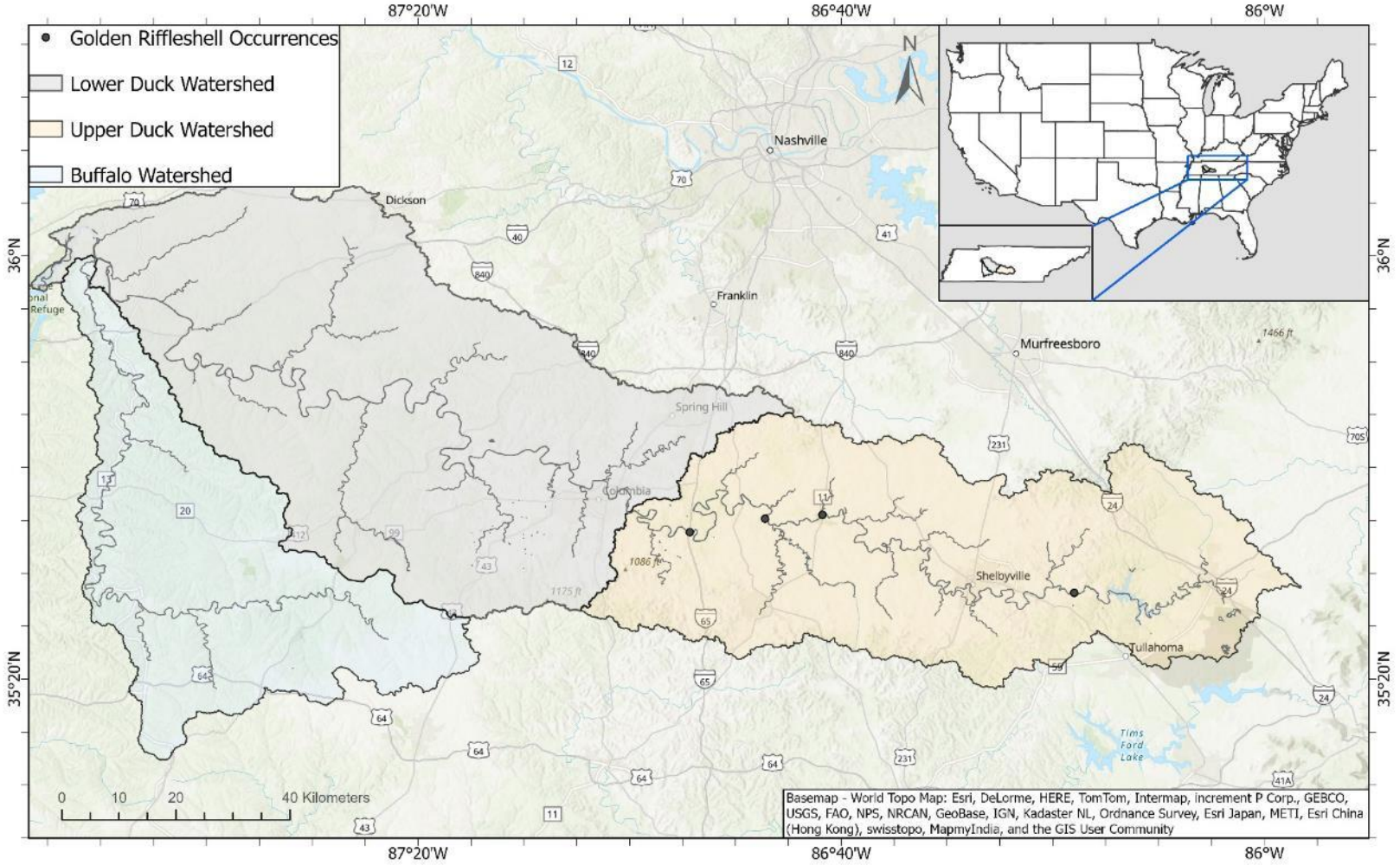
Appendix B14. *Ellipsaria lineolata* (Butterfly) distribution in the Duck River drainage.



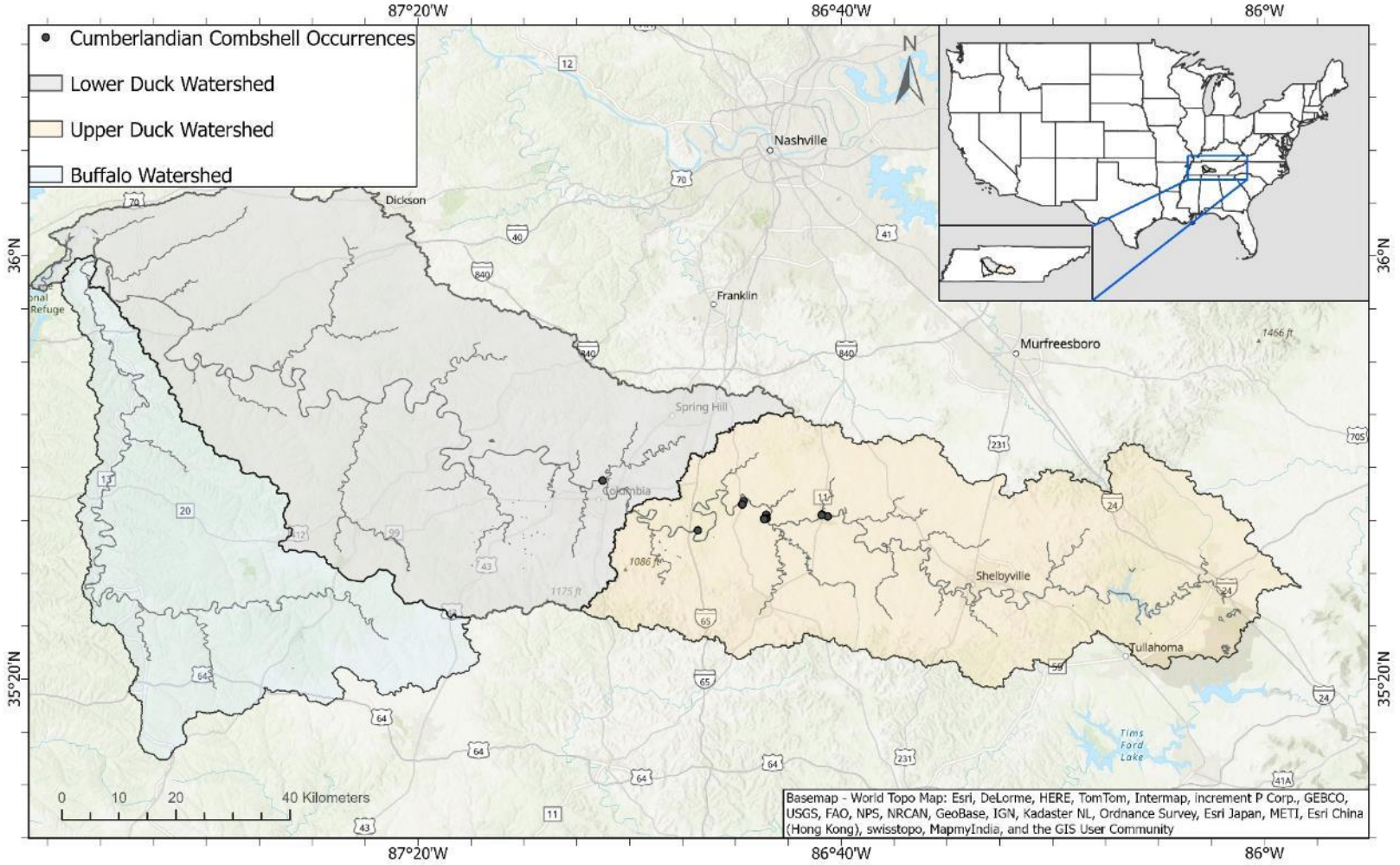
Appendix B15. *Elliptio crassidens* (Elephantear) distribution in the Duck River drainage.



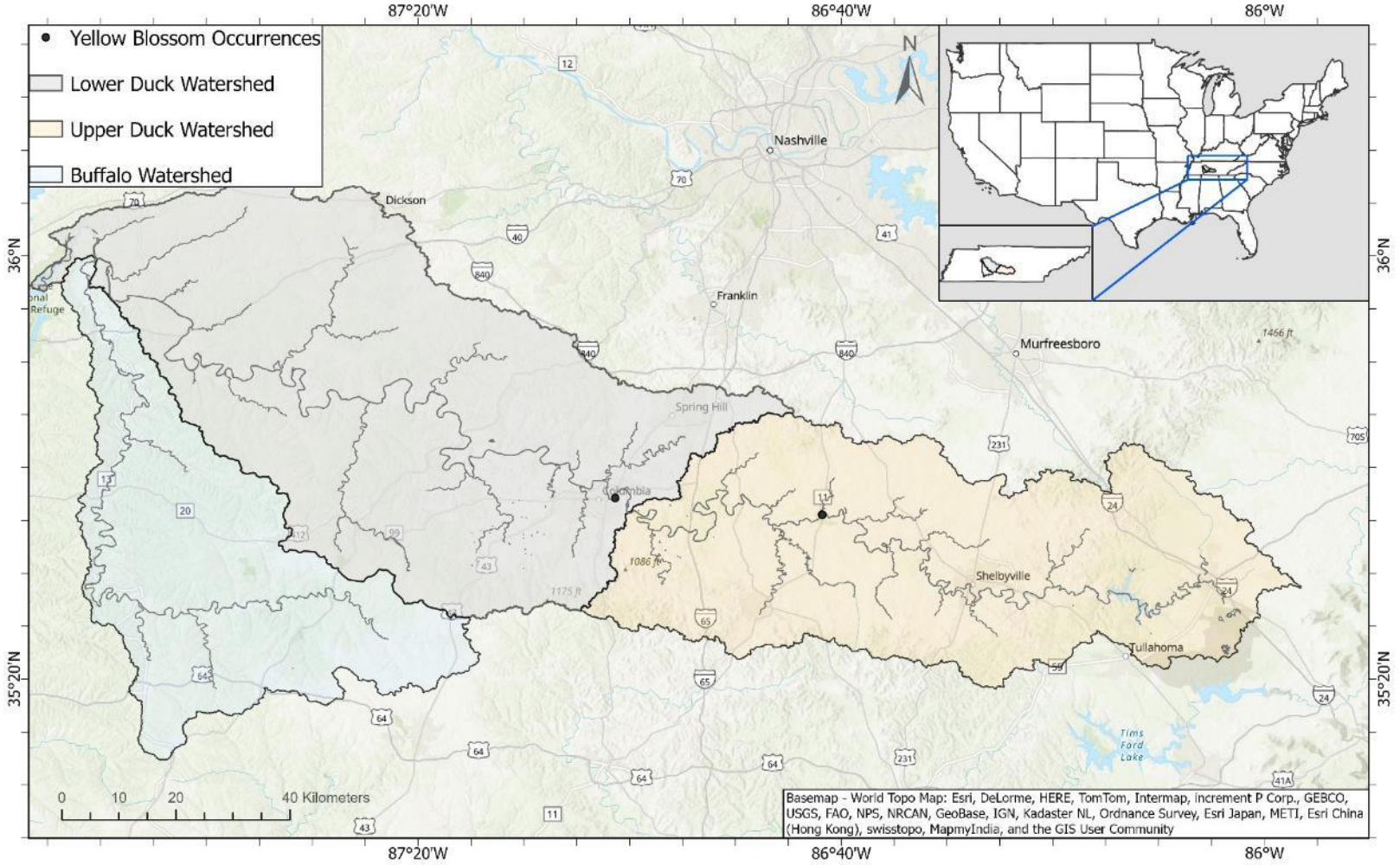
Appendix B16. *Epioblasma ahlstedti* (Duck River Dartersnapper) distribution in the Duck River drainage.



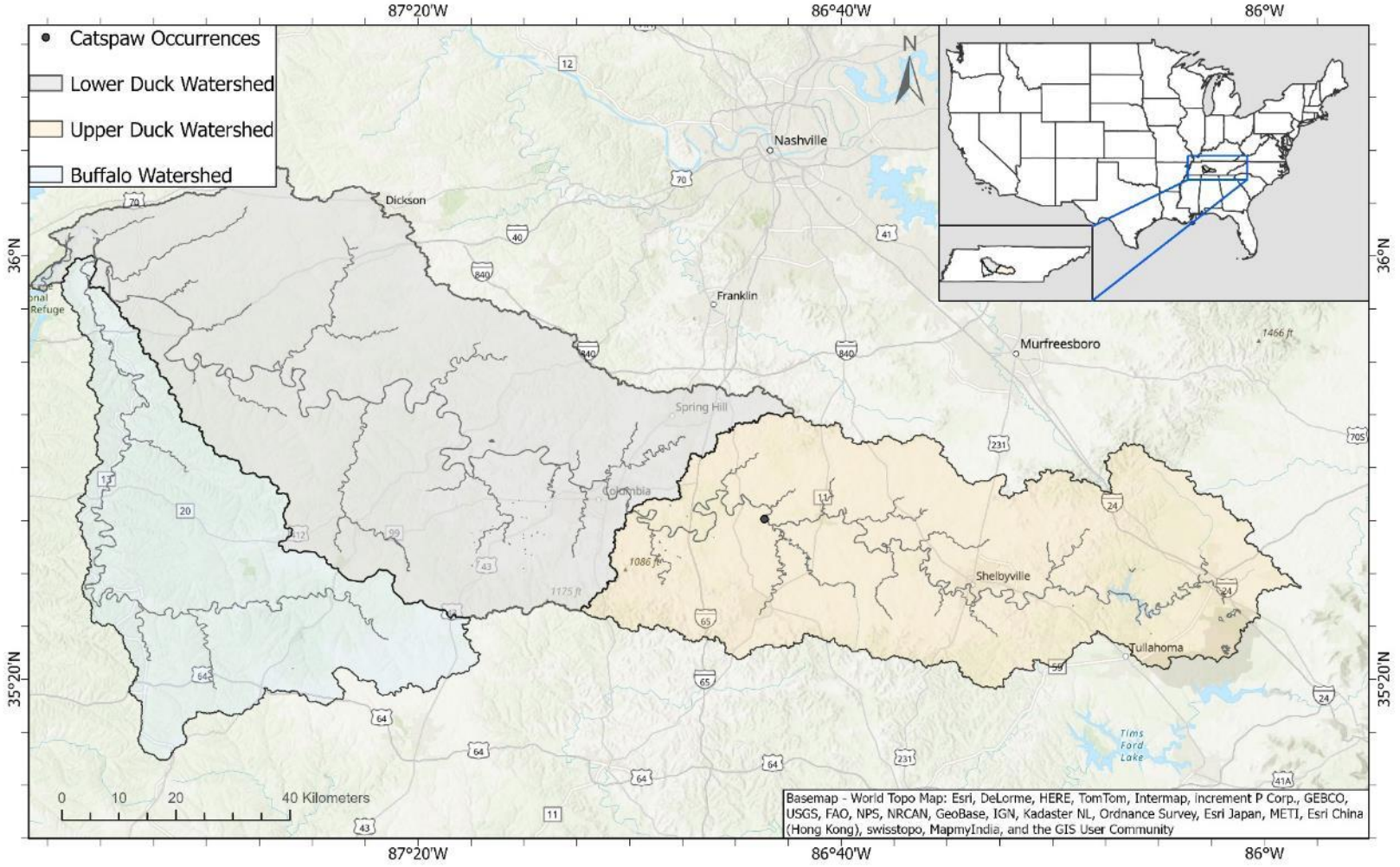
Appendix B17. *Epioblasma aureola* (Golden Riffleshell) distribution in the Duck River drainage.



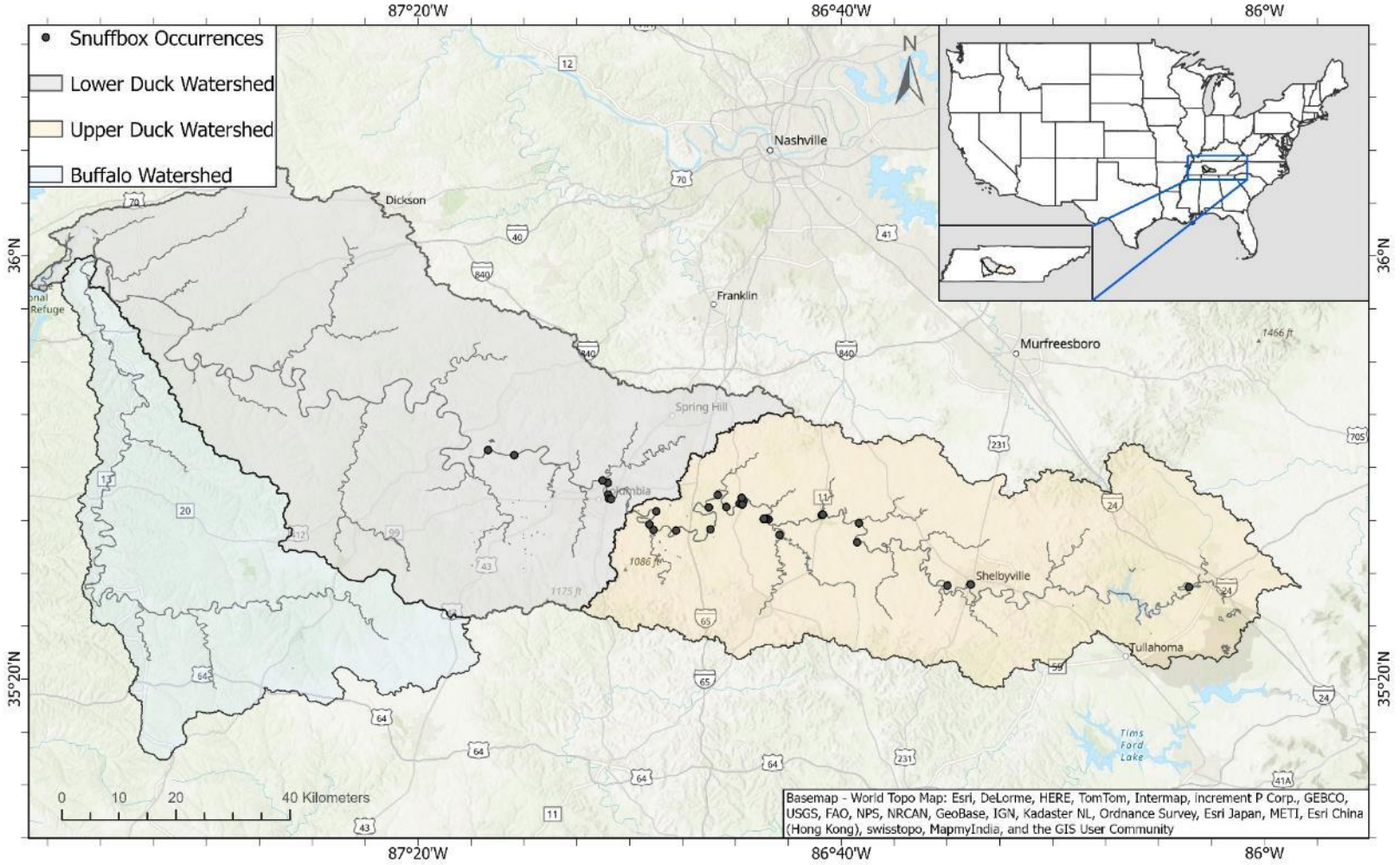
Appendix B18. *Epioblasma brevidens* (Cumberlandian Combshell) distribution in the Duck River drainage.



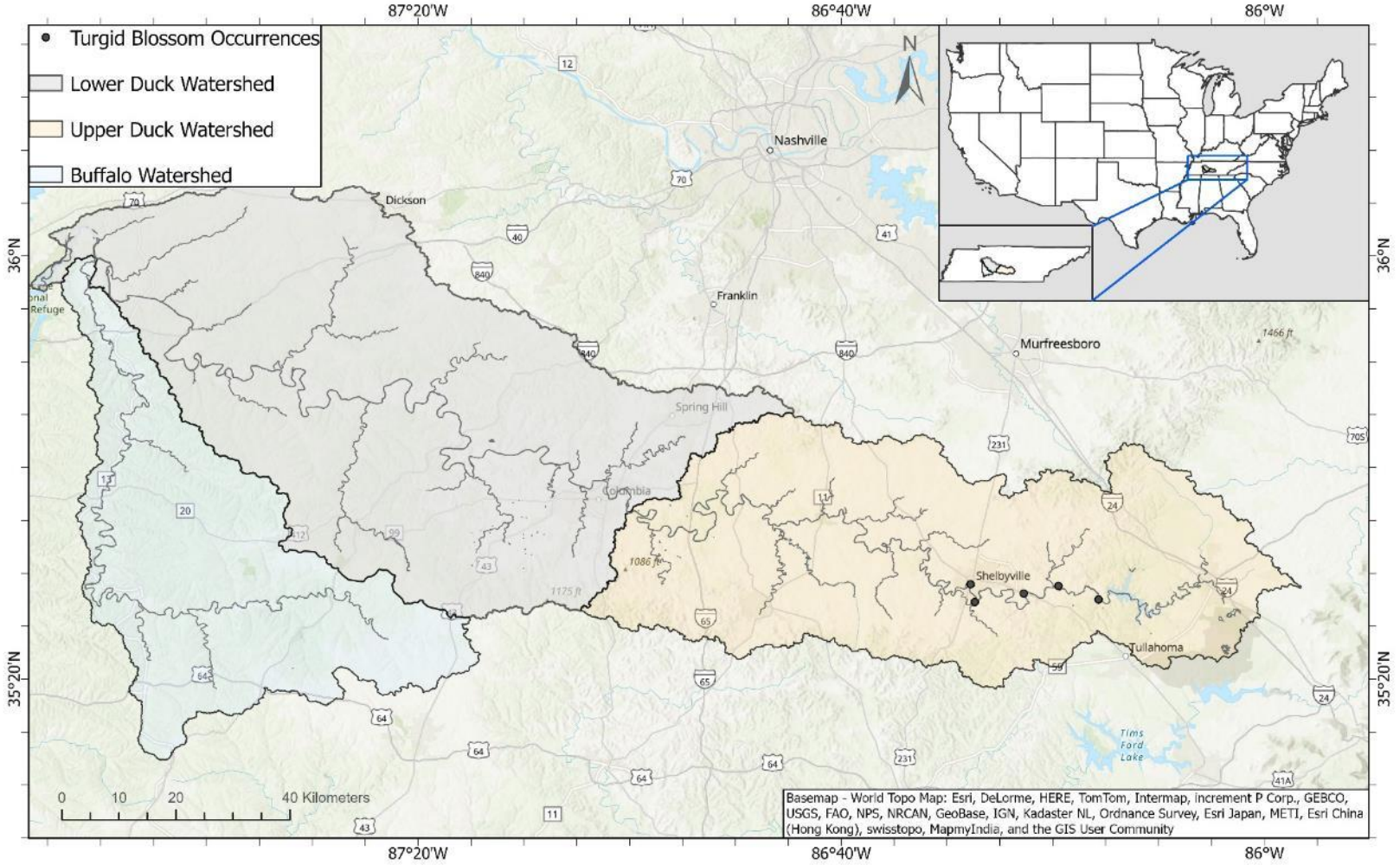
Appendix B19. *Epioblasma florentina* (Yellow Blossom) distribution in the Duck River drainage.



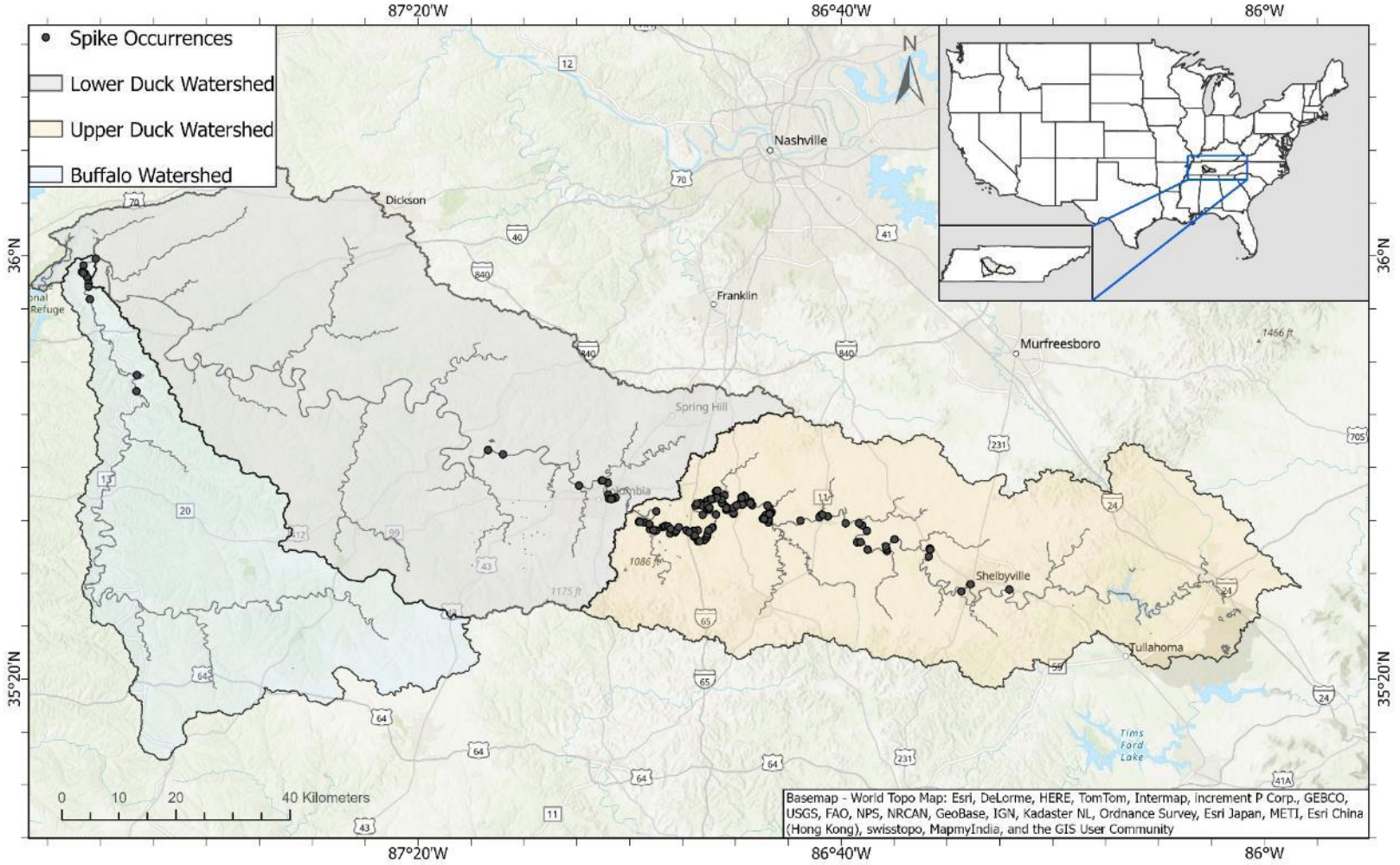
Appendix B20. *Epioblasma obliquata* (Catspaw) distribution in the Duck River drainage.



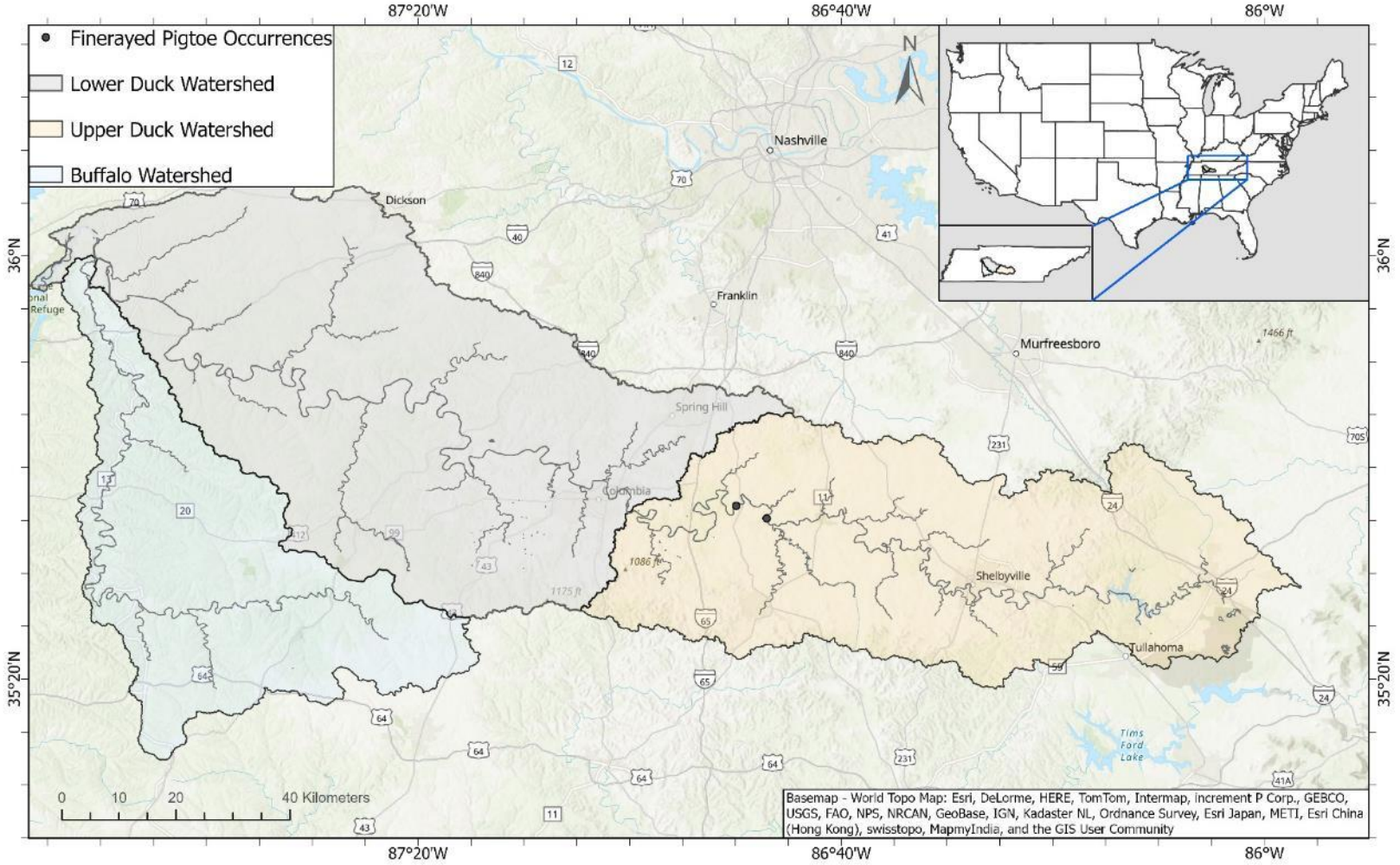
Appendix B21. *Epioblasma triquetra* (Snuffbox) distribution in the Duck River drainage.



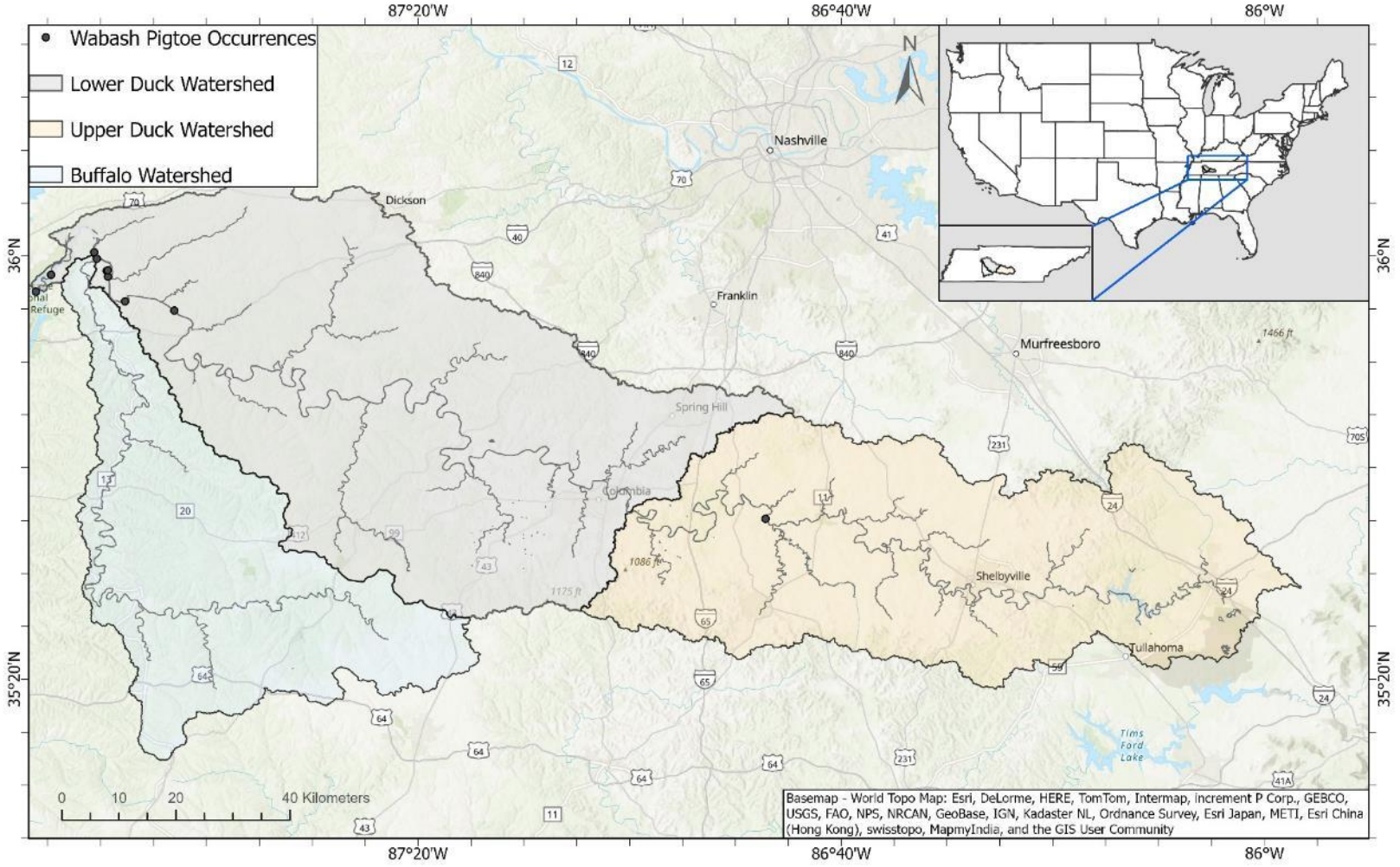
Appendix B22 *Epioblasma turgidula* (Turgid Blossom) distribution in the Duck River drainage.



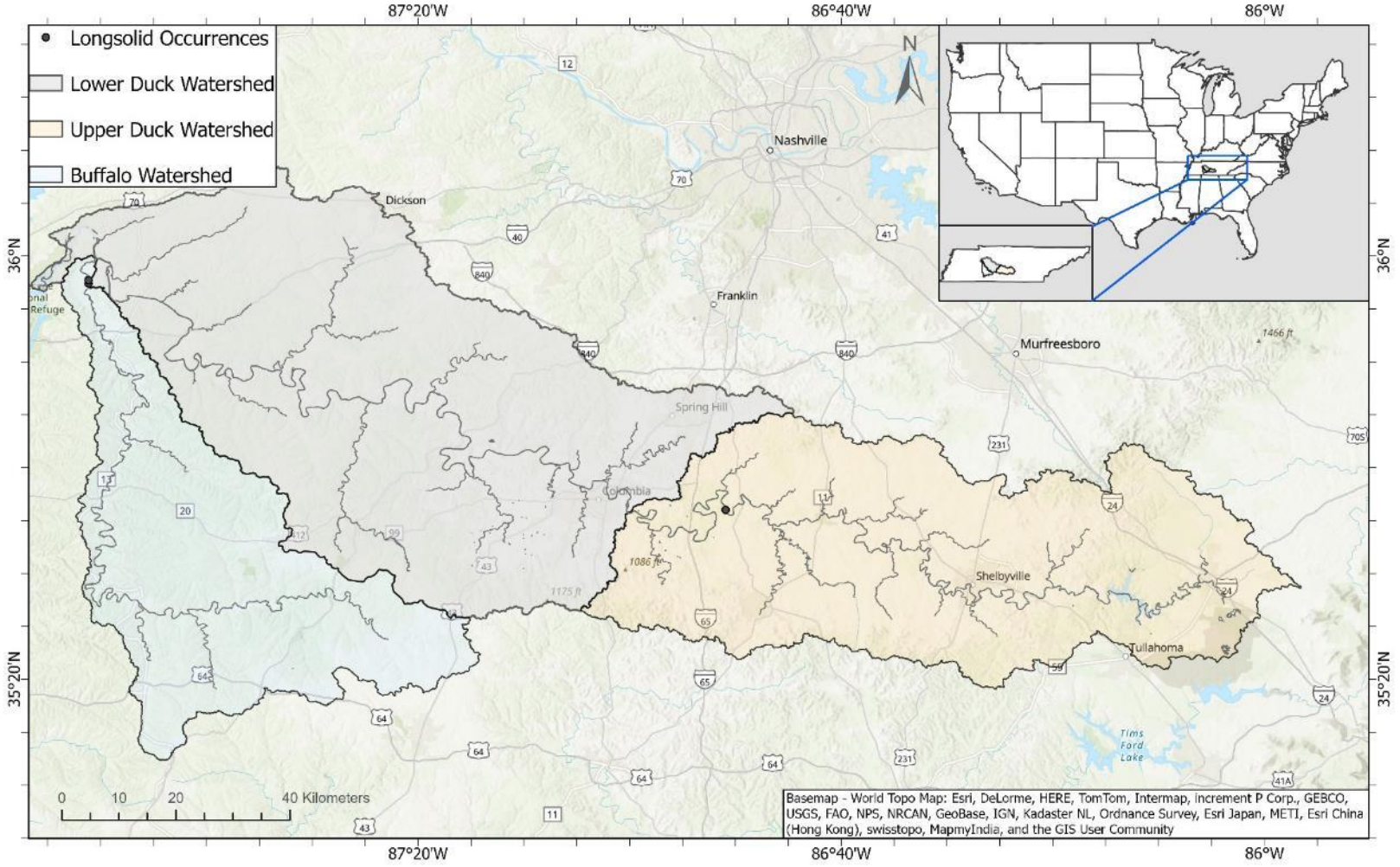
Appendix B23. *Eurynia dilatata* (Spike) distribution in the Duck River drainage.



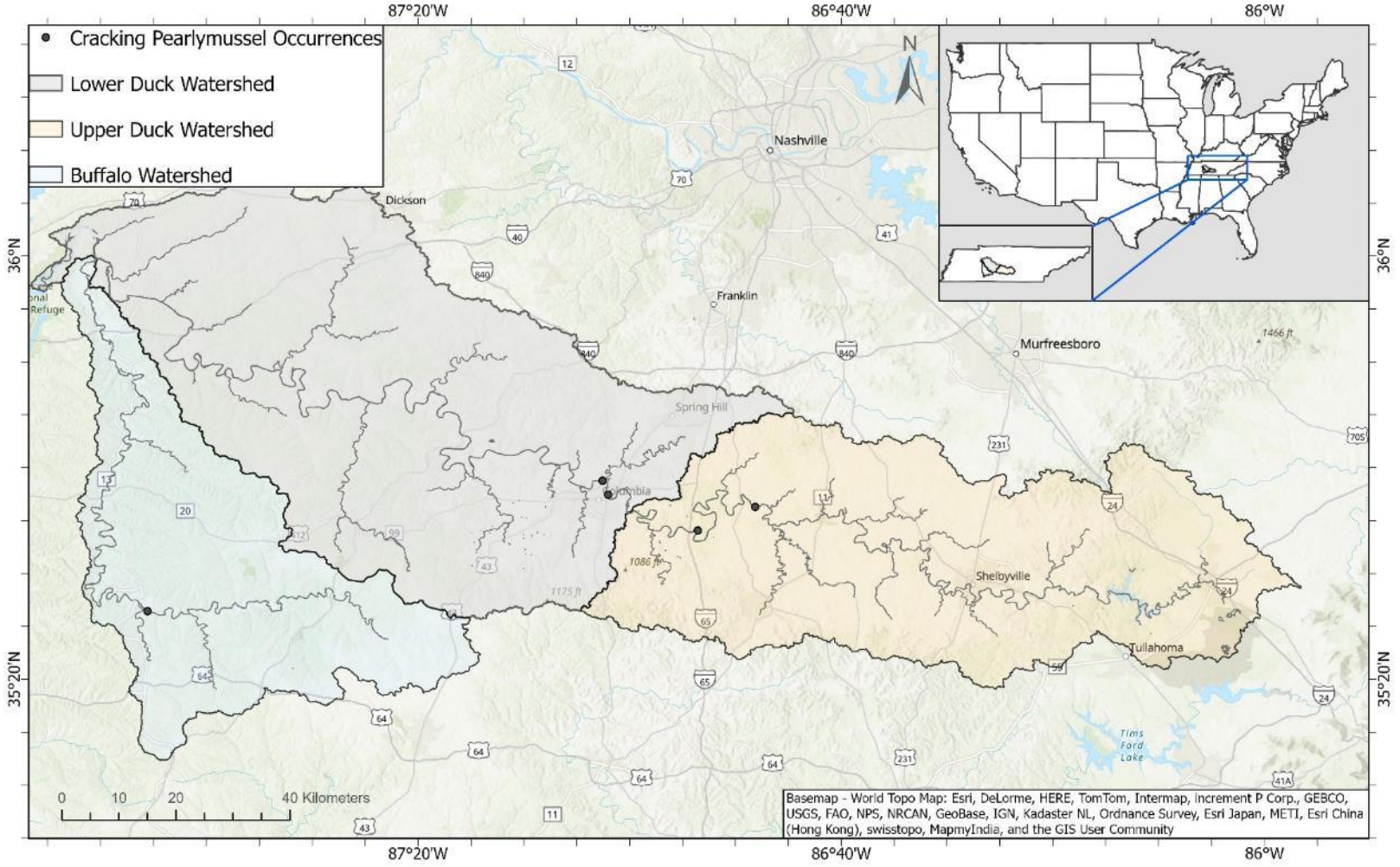
Appendix B24. *Fusconaia cuneolus* (Finerayed Pigtoe) distribution in the Duck River drainage.



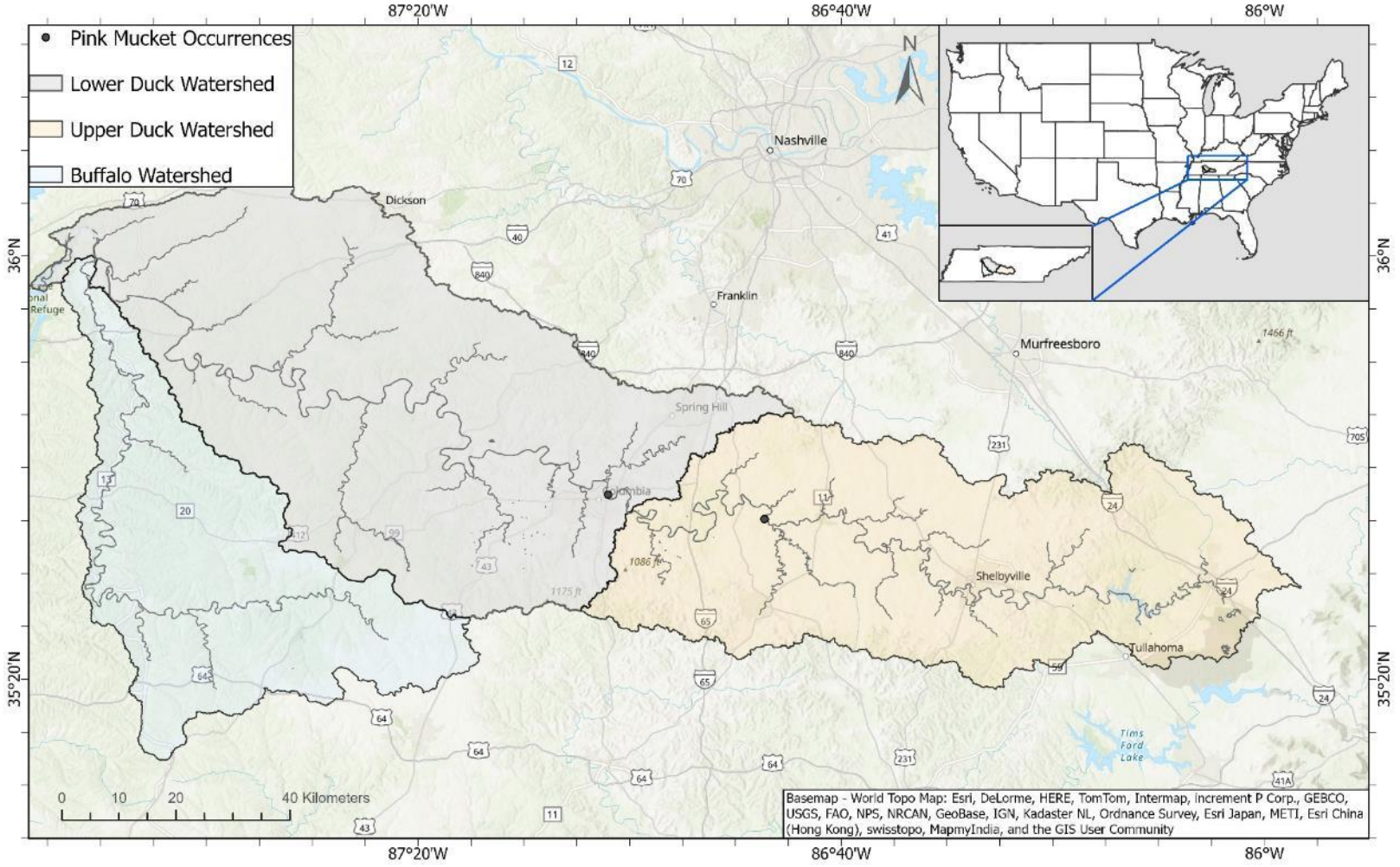
Appendix B25. *Fusconaia flava* (Wabash Pigtoe) distribution in the Duck River drainage.



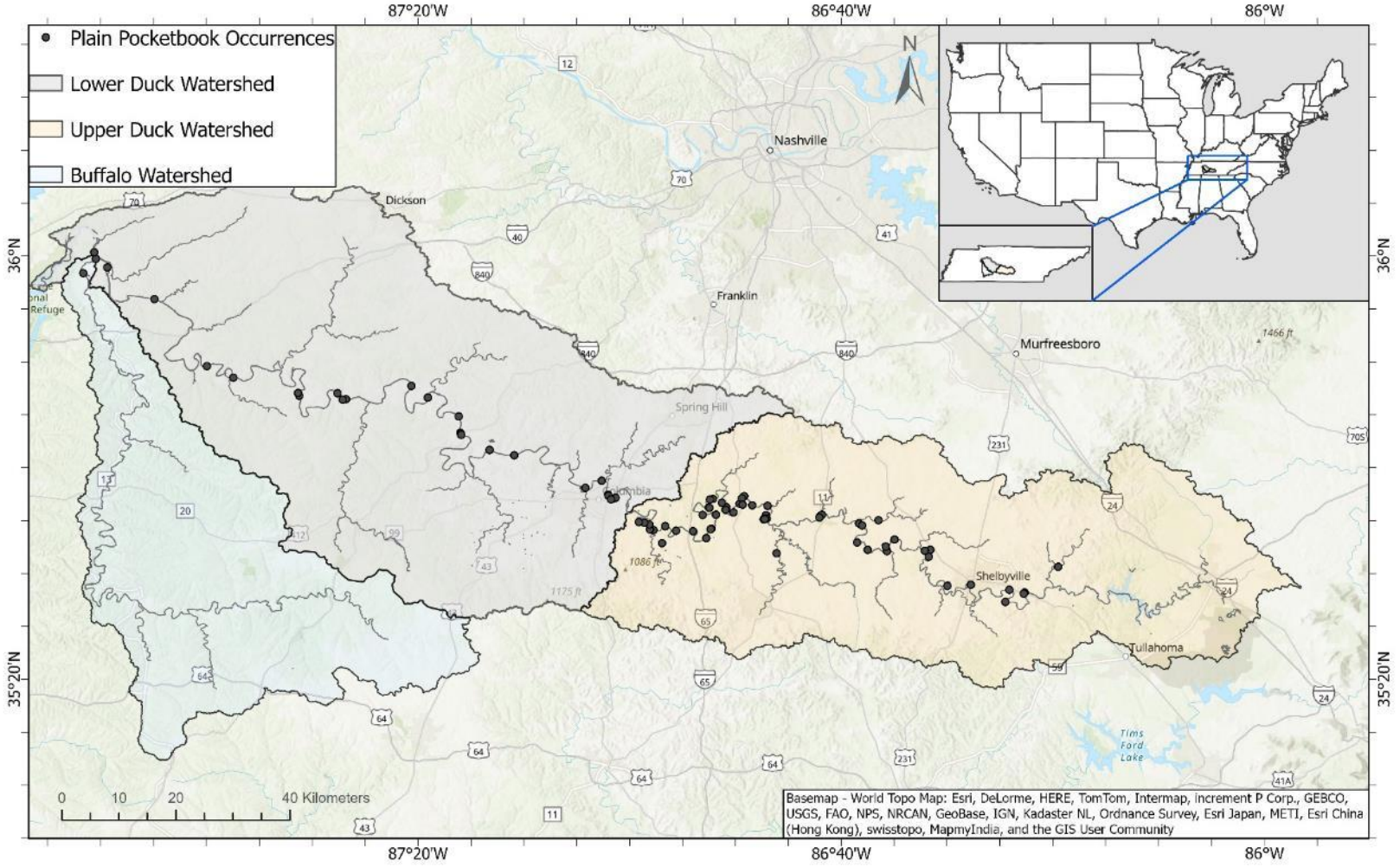
Appendix B26. *Fusconaia subrotunda* (Longsolid) distribution in the Duck River drainage.



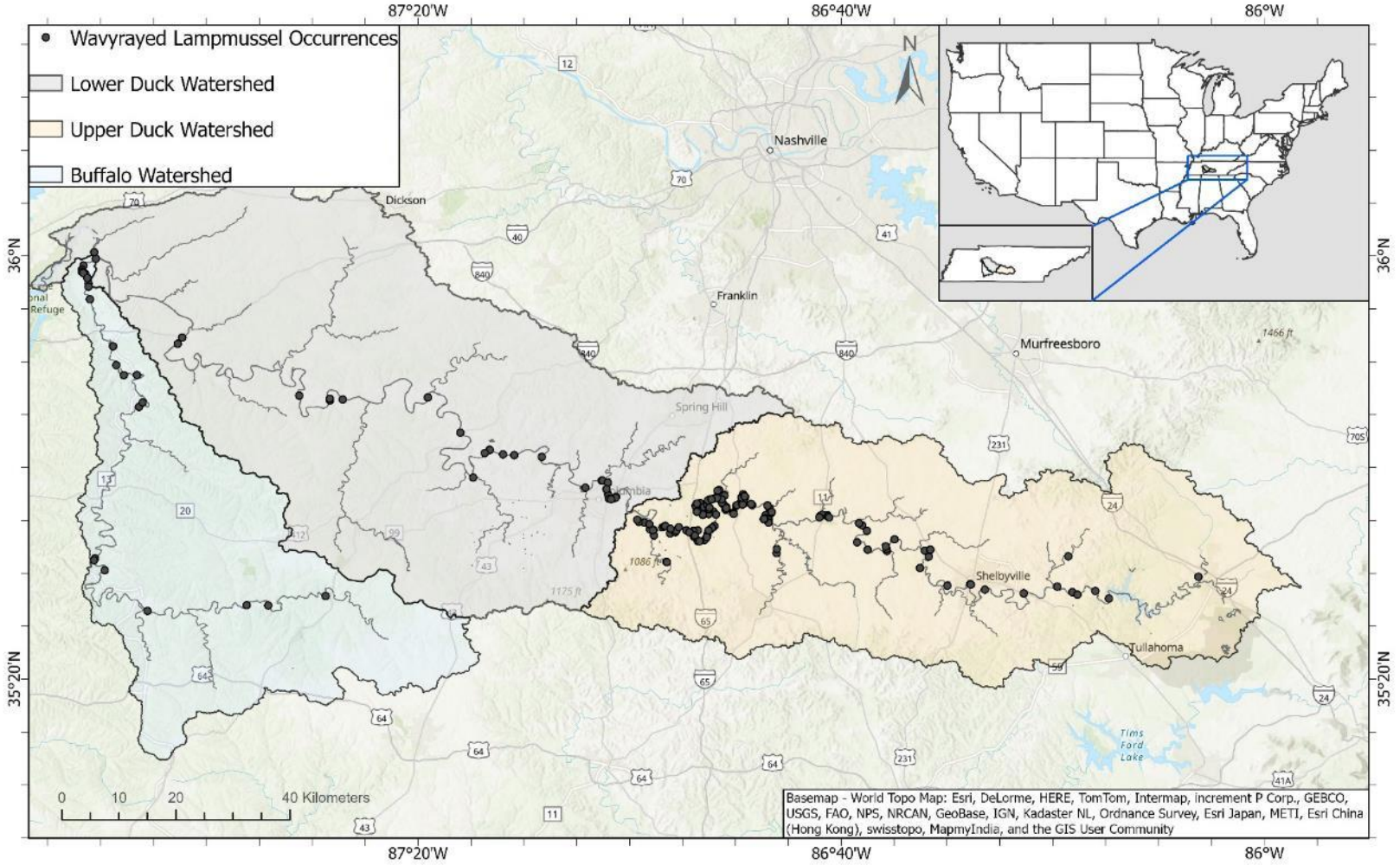
Appendix B27. *Hemistena lata* (Cracking Pearlymussel) distribution in the Duck River drainage.



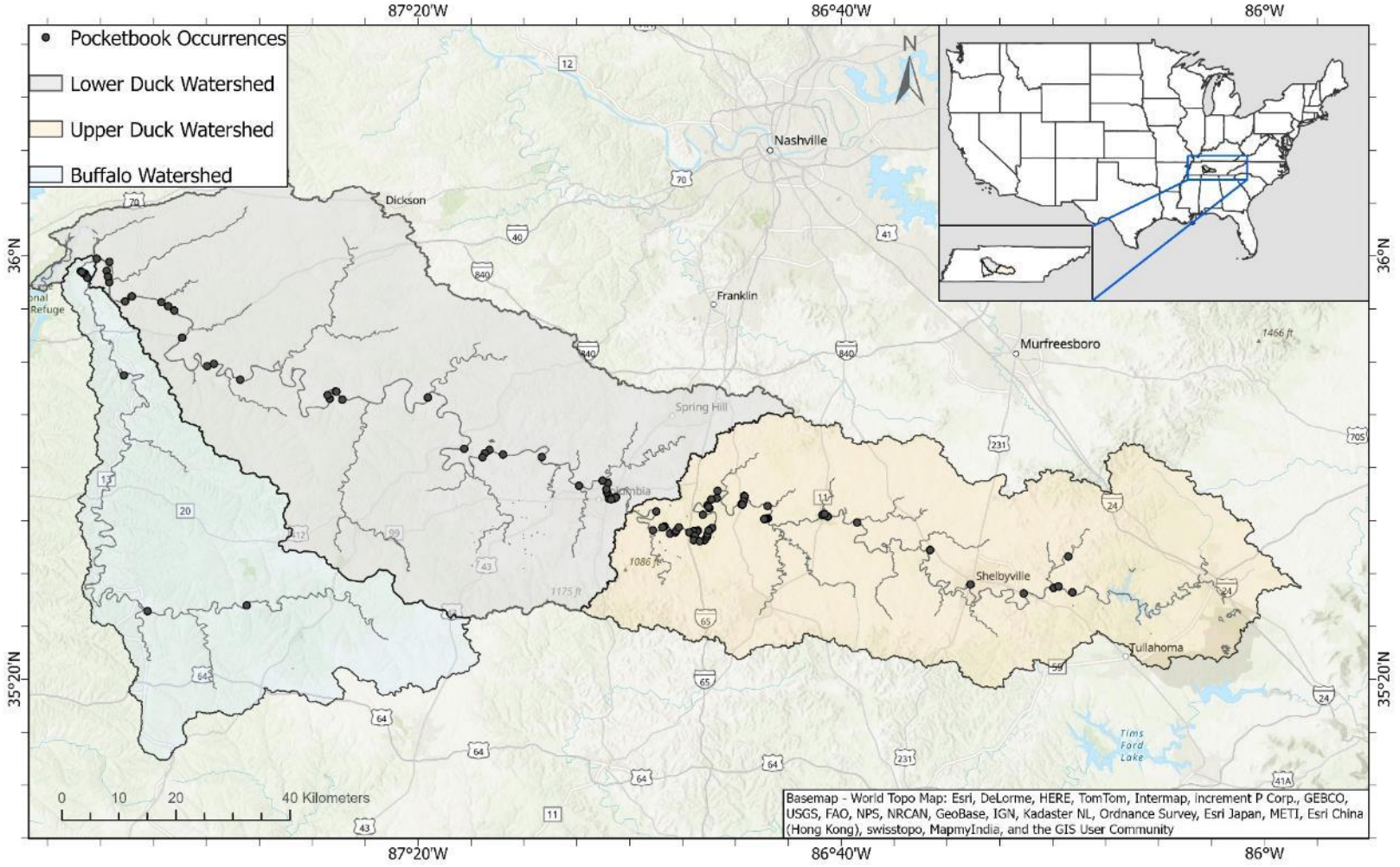
Appendix B28. *Lampsilis abrupta* (Pink Mucket) distribution in the Duck River drainage.



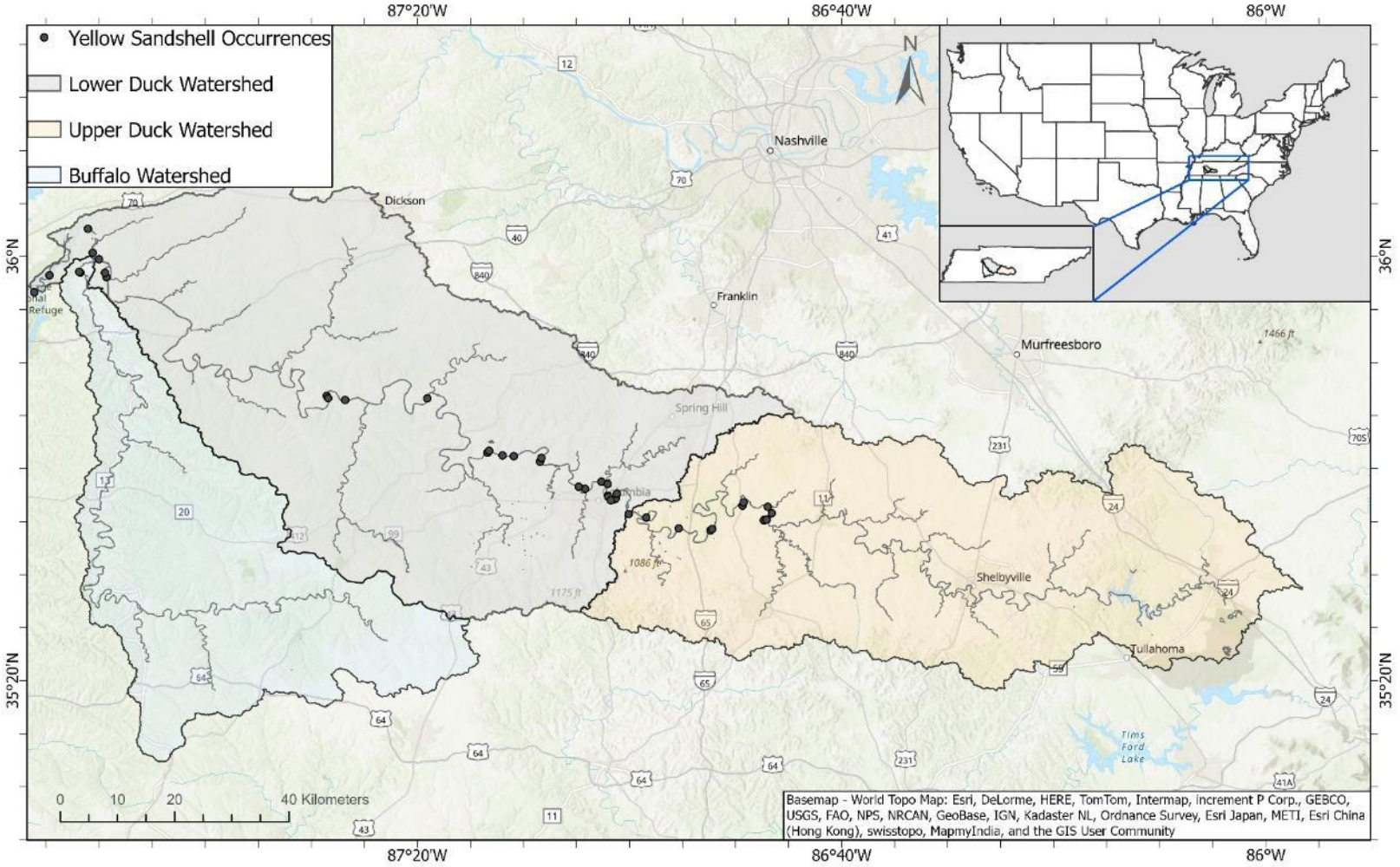
Appendix B29. *Lampsilis cardium* (Plain Pocketbook) distribution in the Duck River drainage.



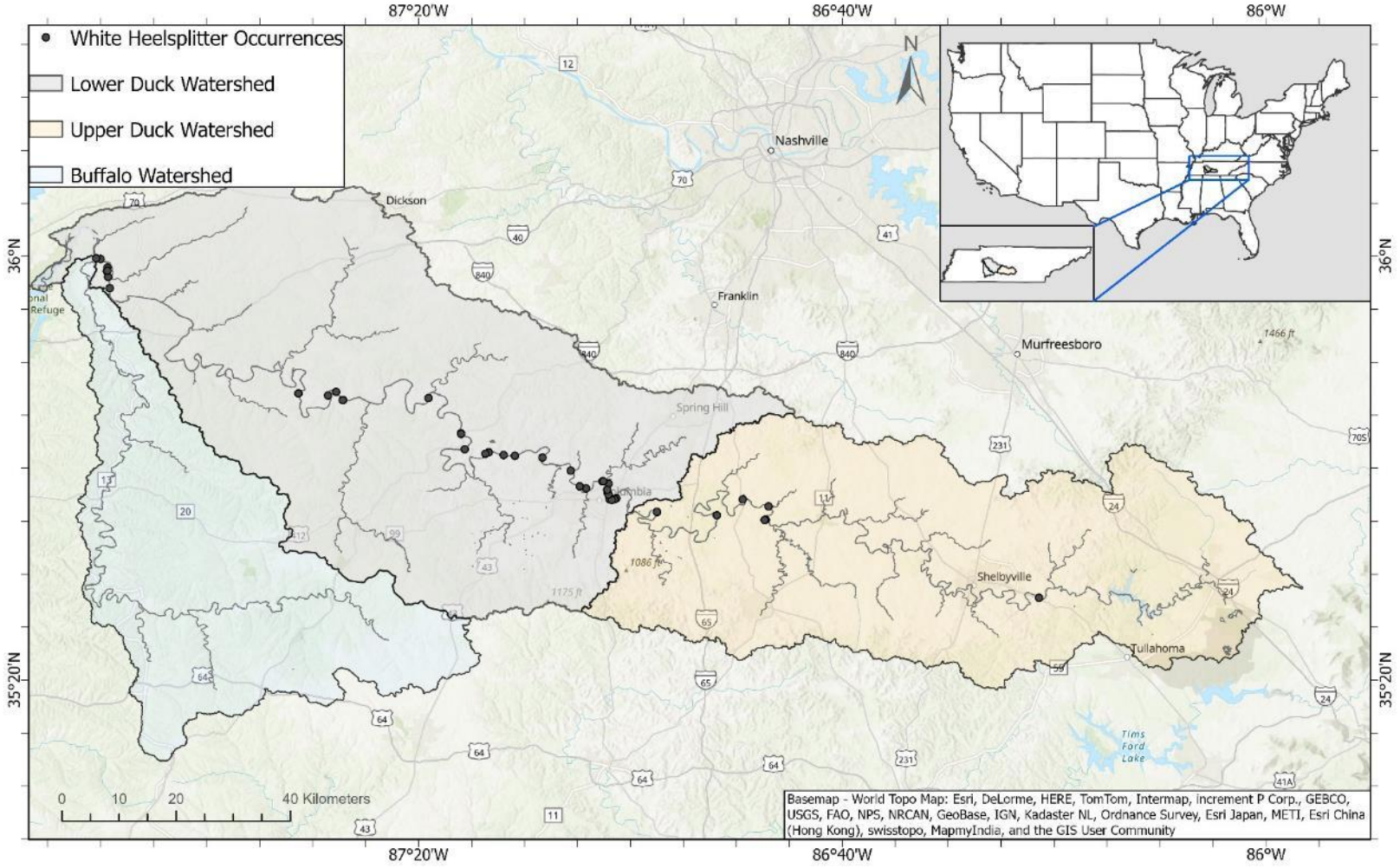
Appendix B30. *Lampsilis fasciola* (Wavyrayed Lampmussel) distribution in the Duck River drainage.



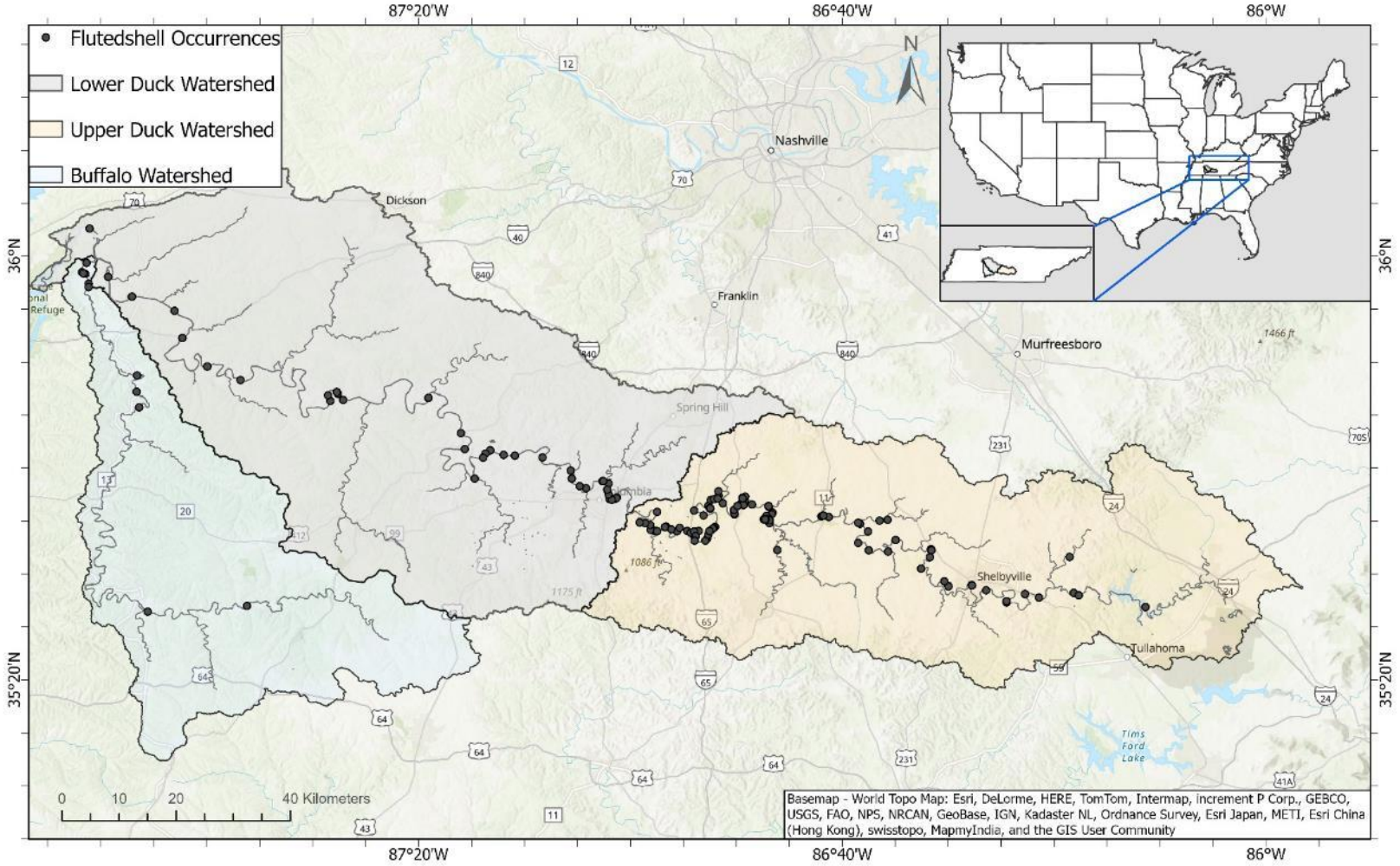
Appendix B31. *Lampsilis ovata* (Pocketbook) distribution in the Duck River drainage.



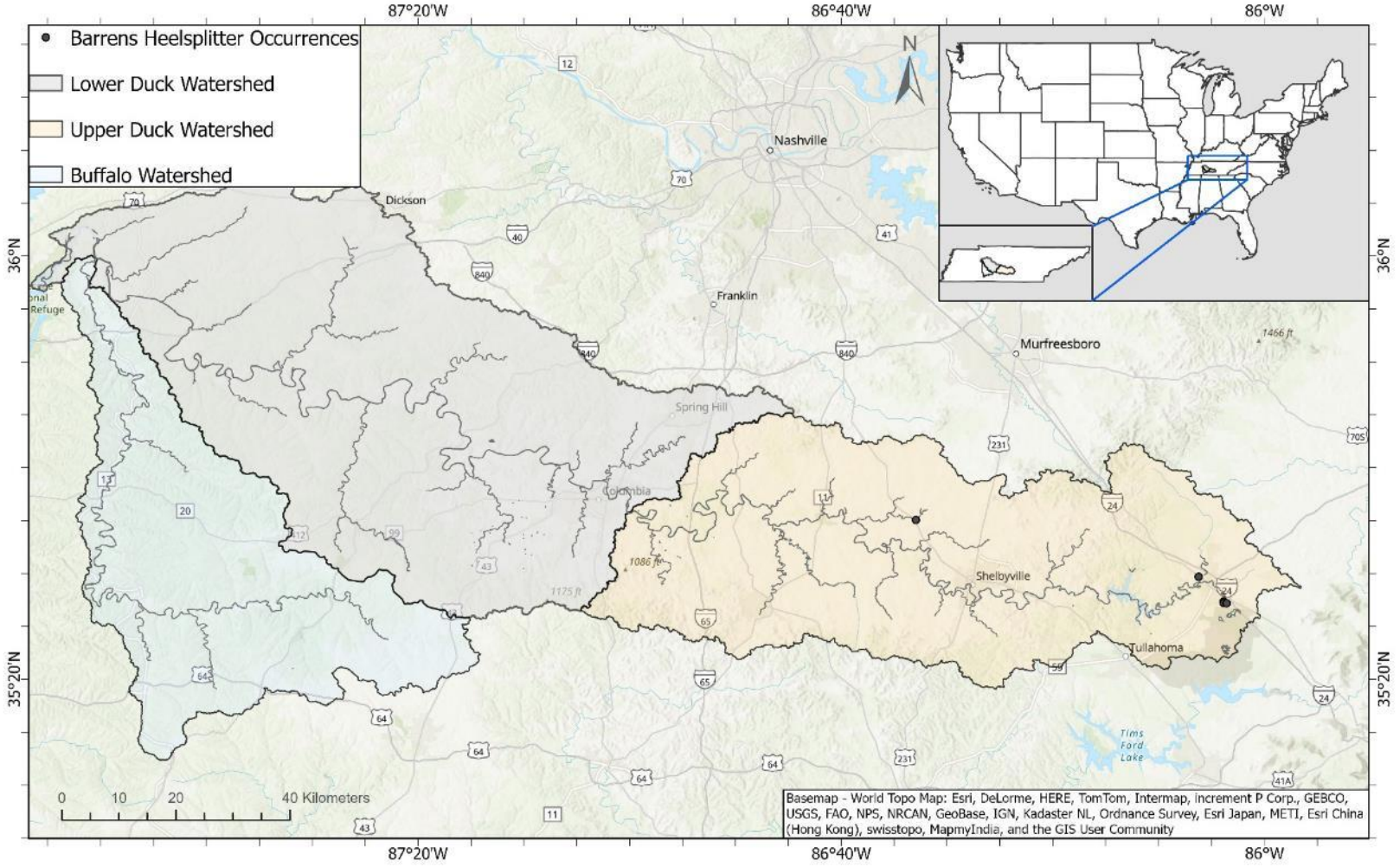
Appendix B32. *Lampsilis teres* (Yellow Sandshell) distribution in the Duck River drainage.



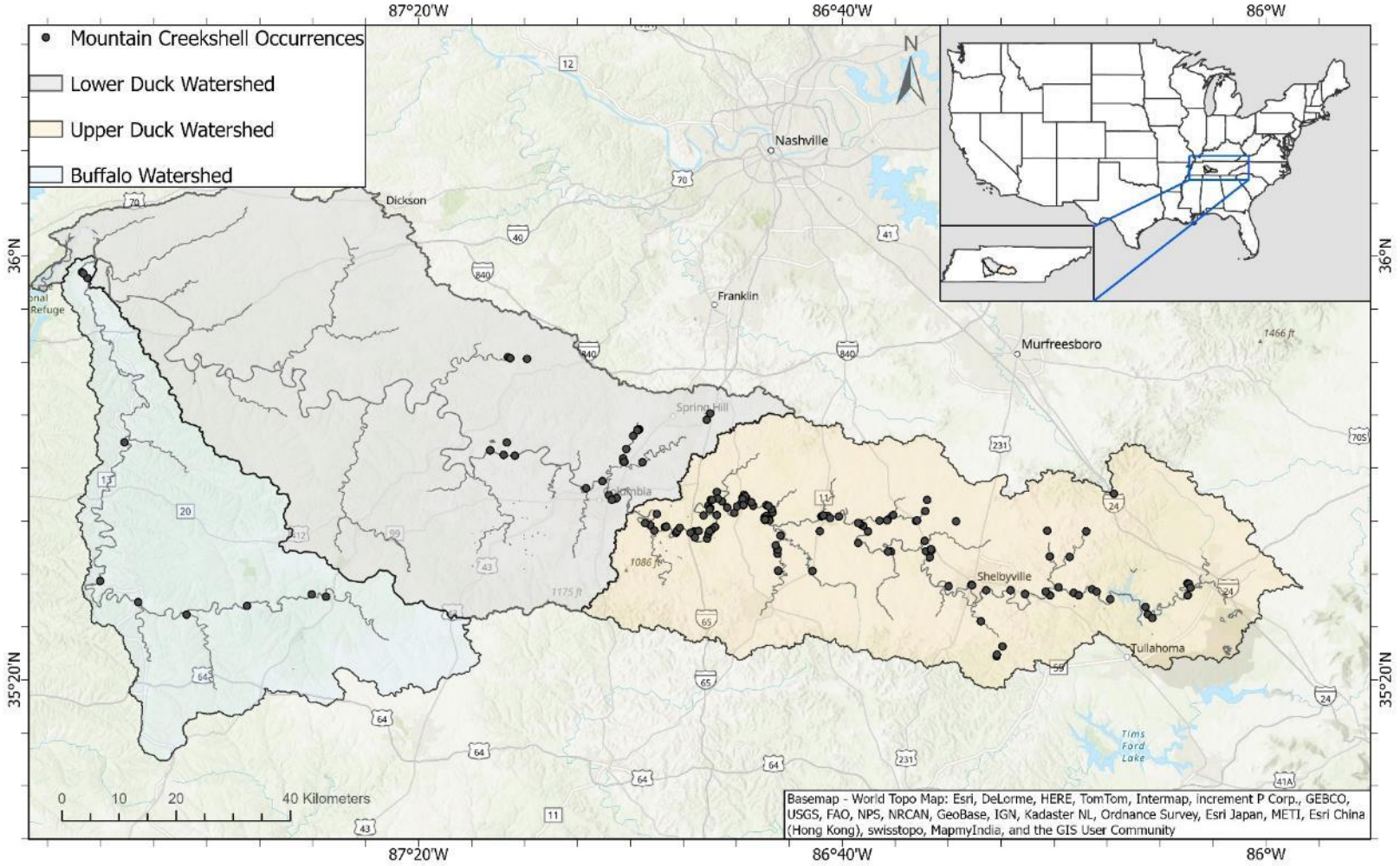
Appendix B33. *Lasmigona complanta* (White Heelsplitter) distribution in the Duck River drainage.



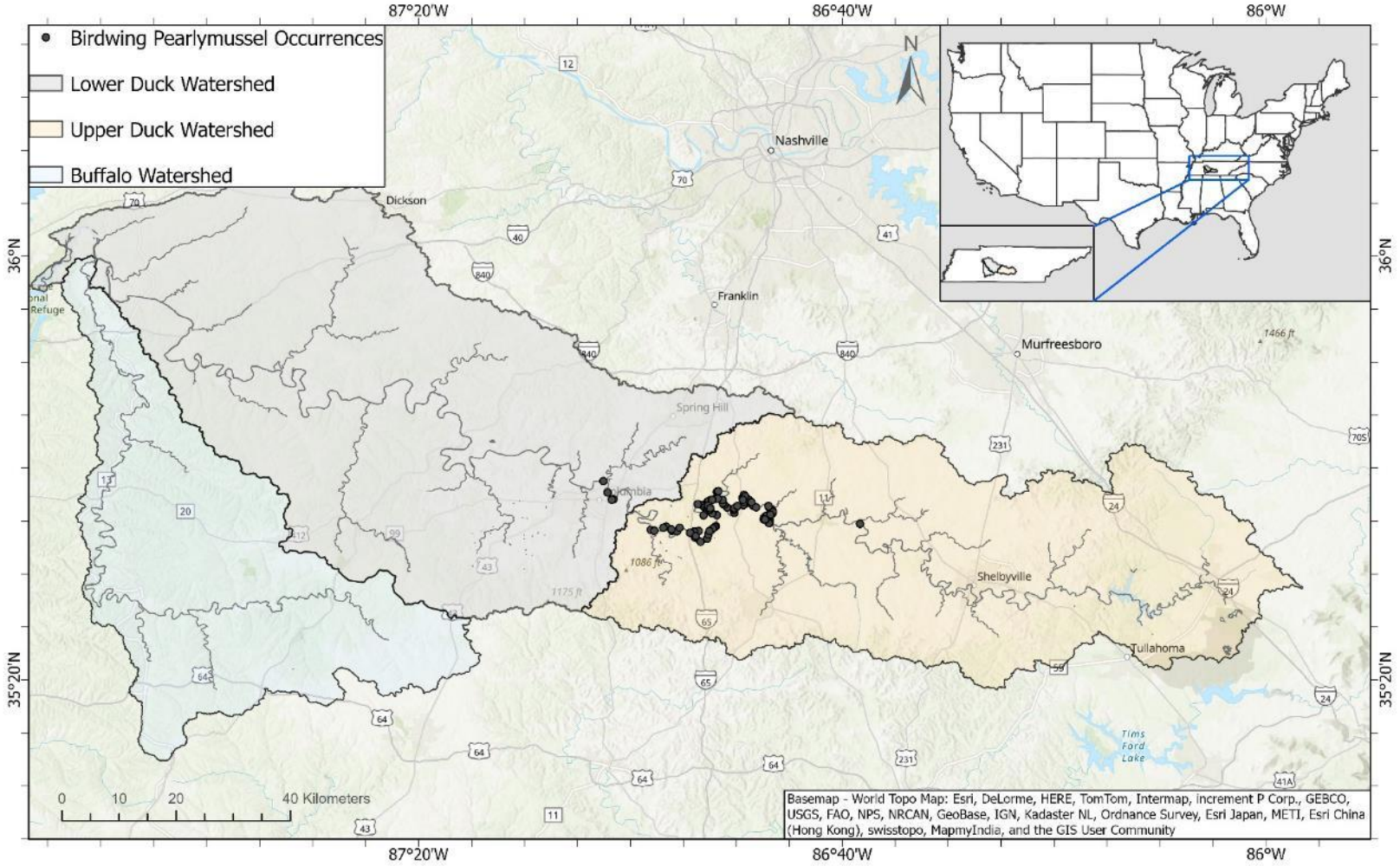
Appendix B34. *Lasmigona costata* (Flutedshell) distribution in the Duck River drainage.



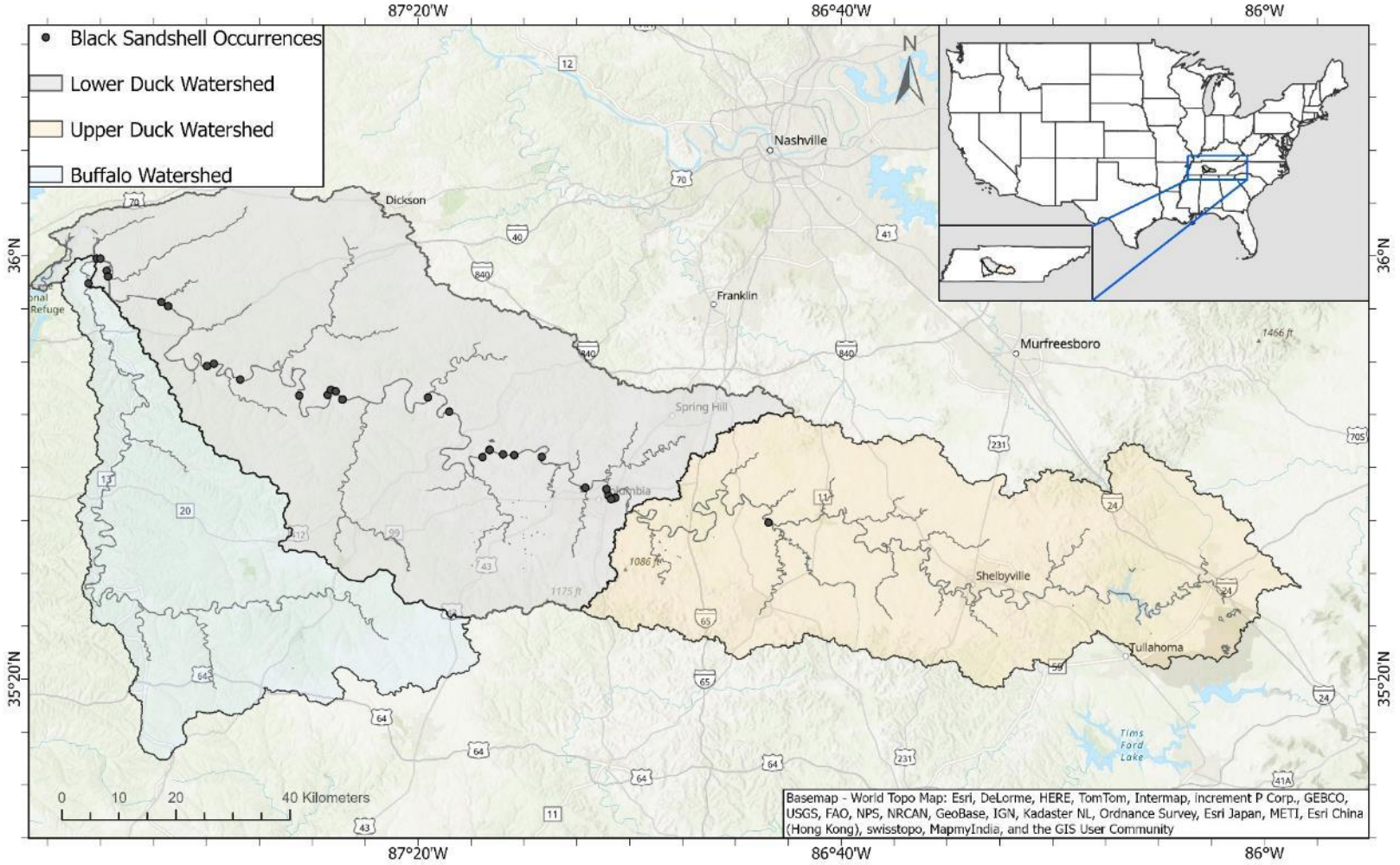
Appendix B35. *Lasmigona sp*. (Barrens Heelsplitter) distribution in the Duck River drainage.



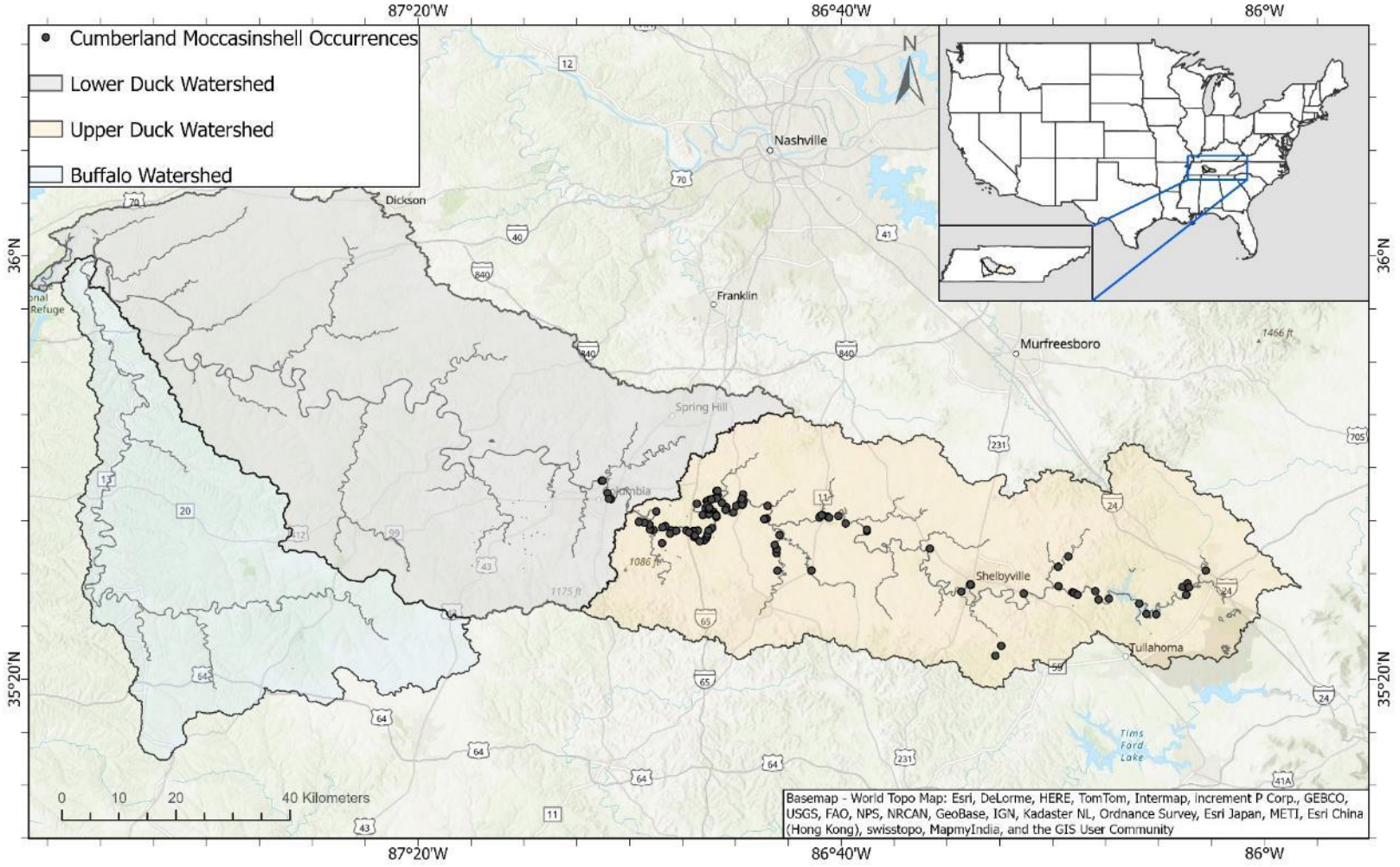
Appendix B36. *Leaunio vanuxemensis* (Mountain Creekshell) distribution in the Duck River drainage.



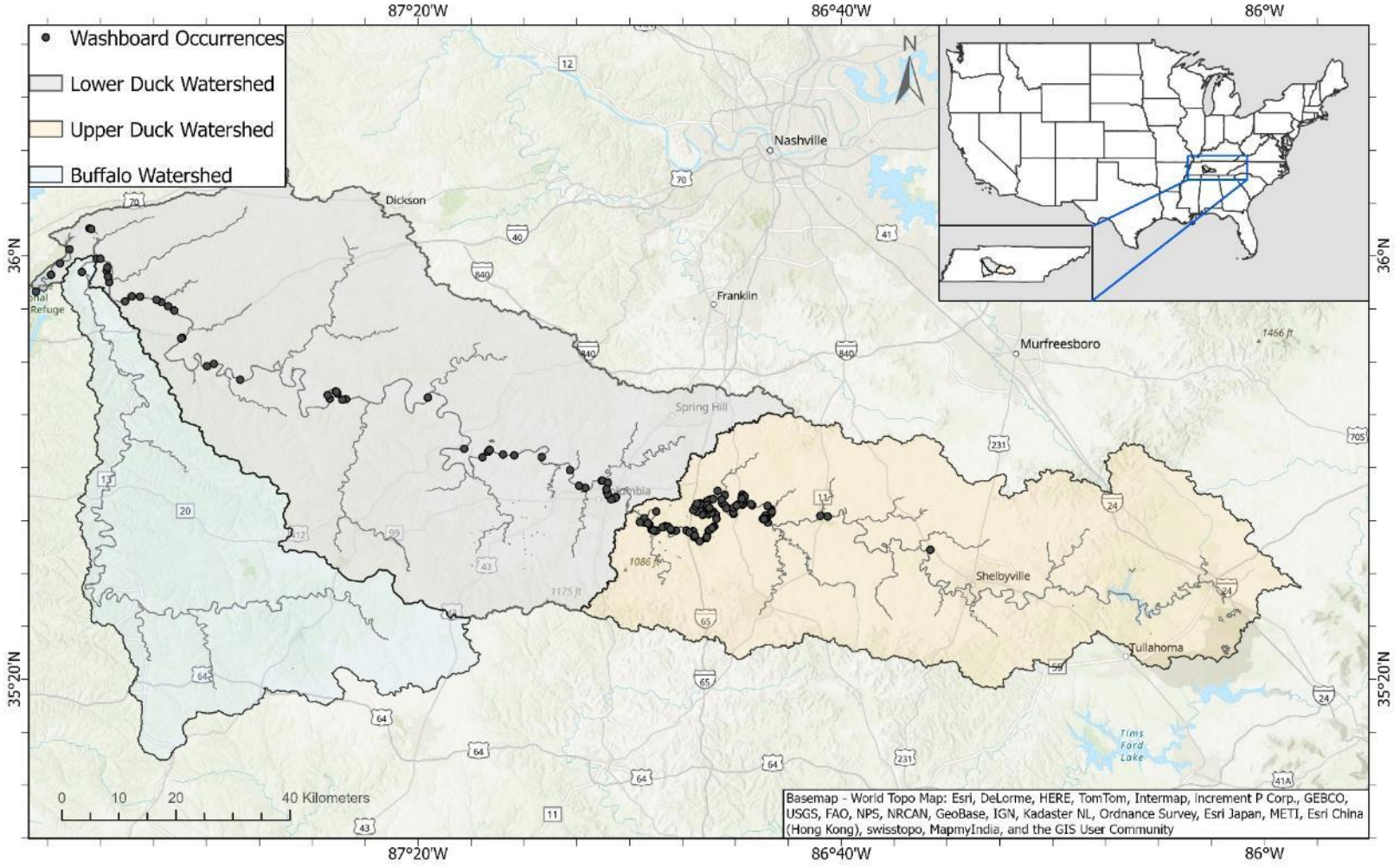
Appendix B37. *Lemiox rimosus* (Birdwing Pearlymussel) distribution in the Duck River drainage.



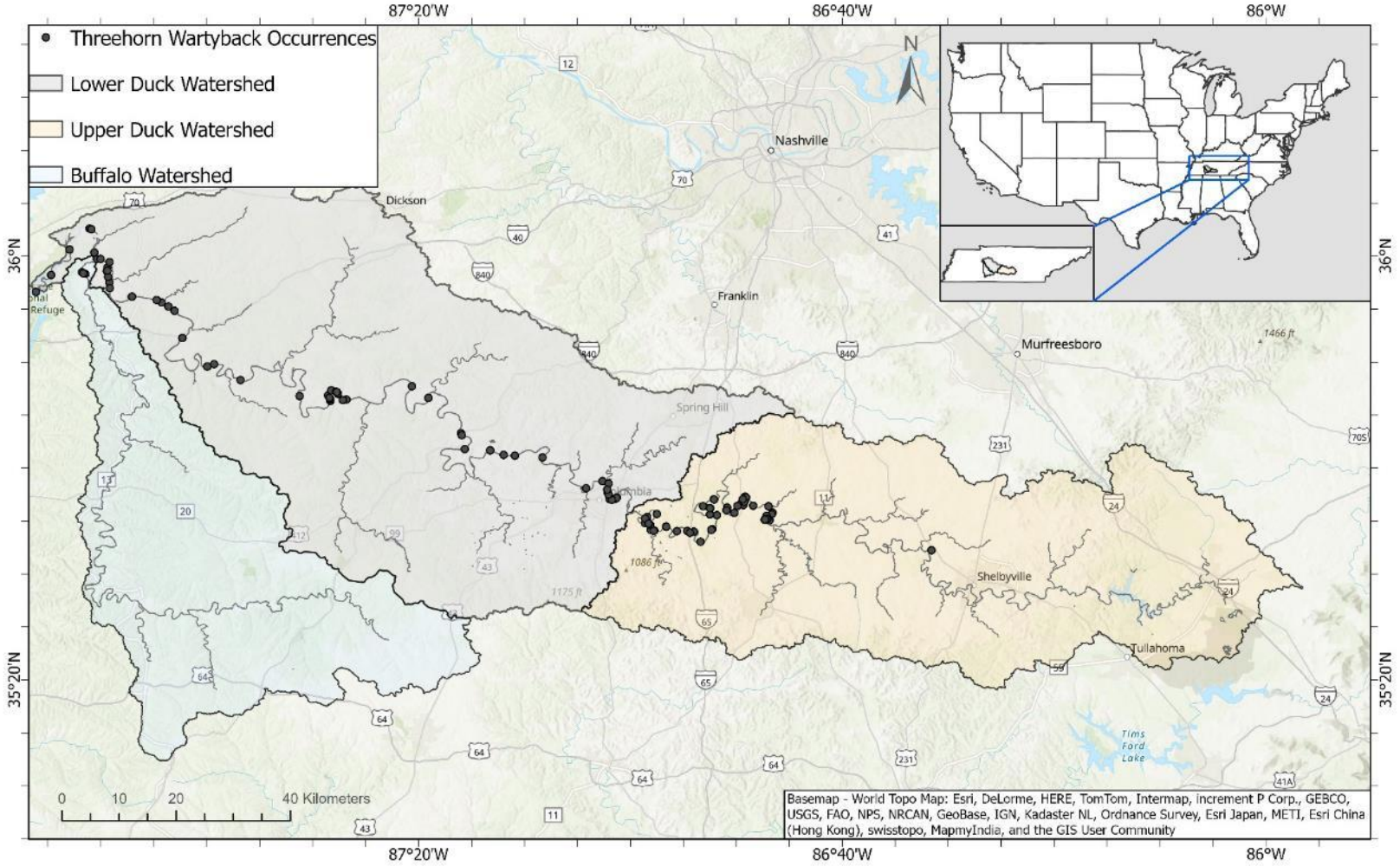
Appendix B38. *Ligumia recta* (Black Sandshell) distribution in the Duck River drainage.



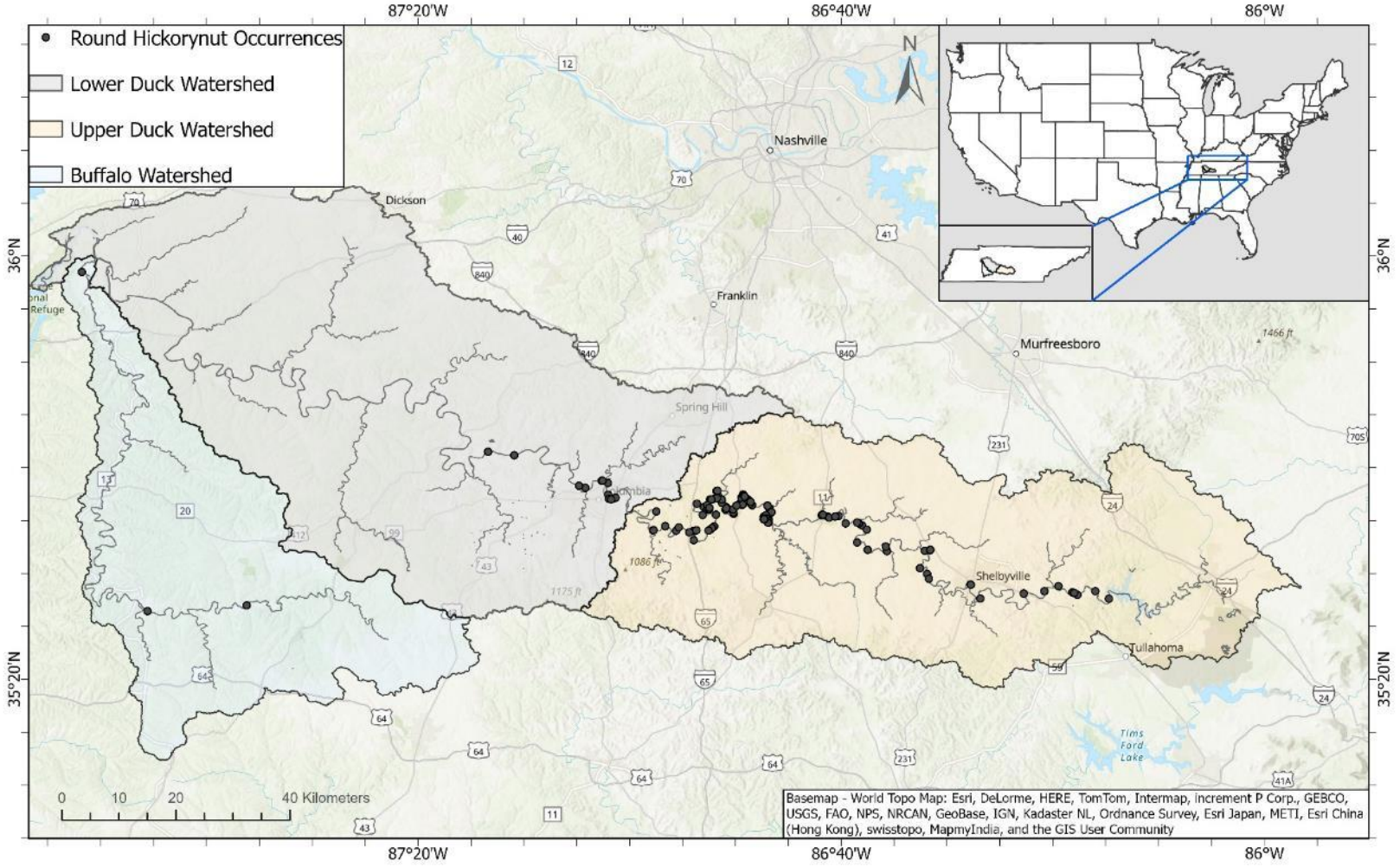
Appendix B39. *Medionidus conradicus* (Cumberland Moccasinshell) distribution in the Duck River drainage.



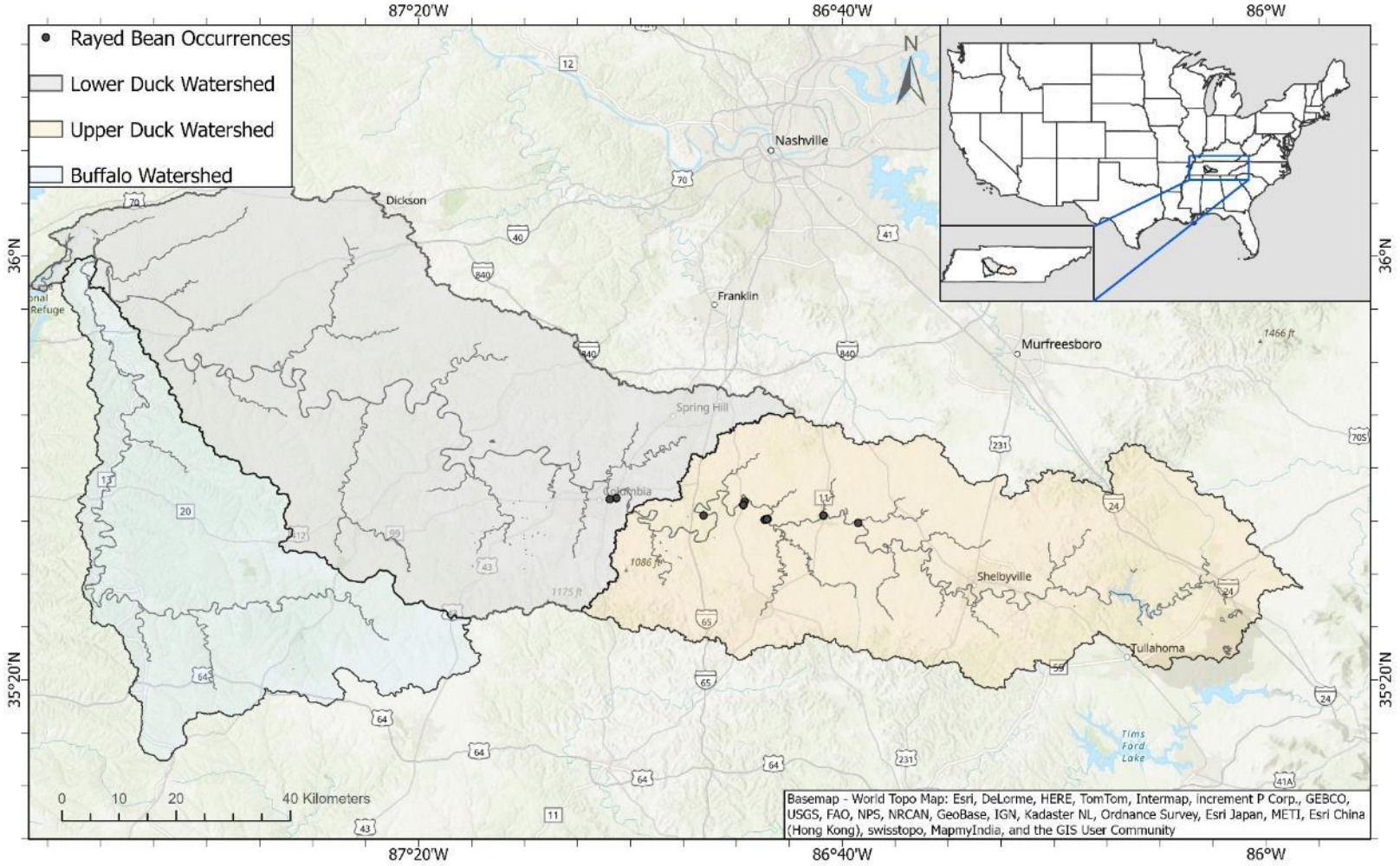
Appendix B40. *Megalonaias nervosa* (Washboard) distribution in the Duck River drainage.



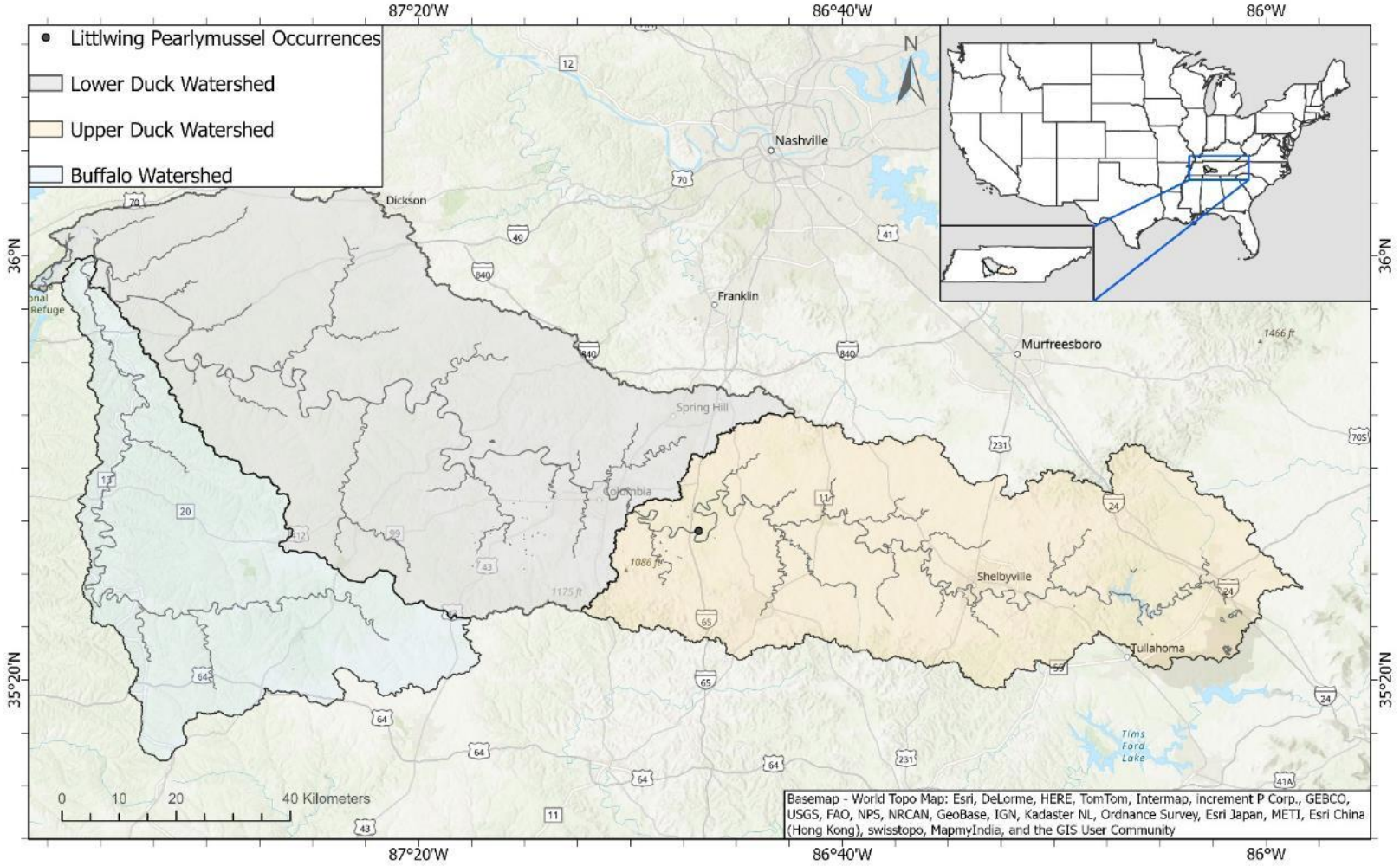
Appendix B41. *Obliquaria reflexa* (Threehorn Wartyback) distribution in the Duck River drainage.



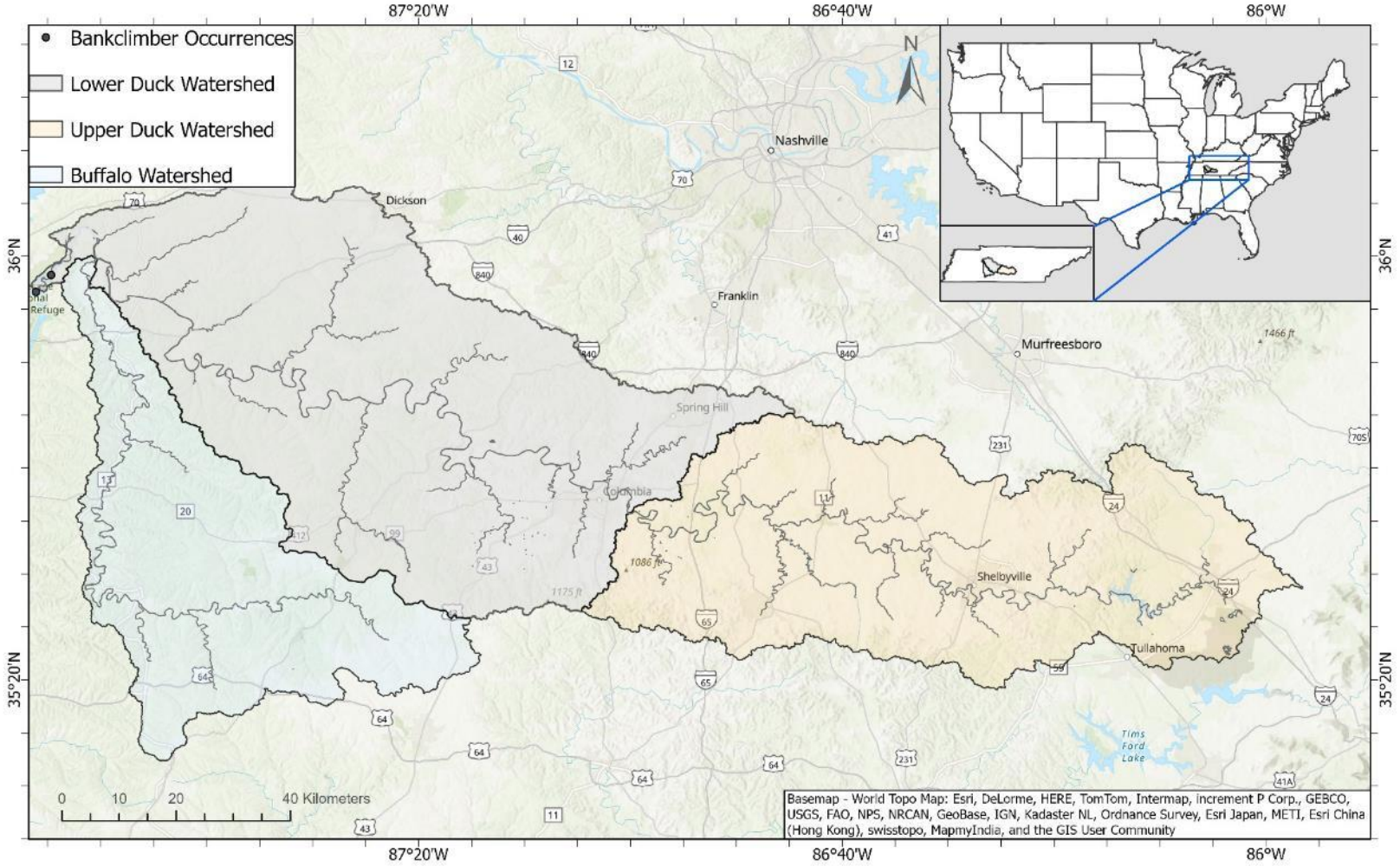
Appendix B42. *Obovaria subrotunda* (Round Hickorynut) distribution in the Duck River drainage.



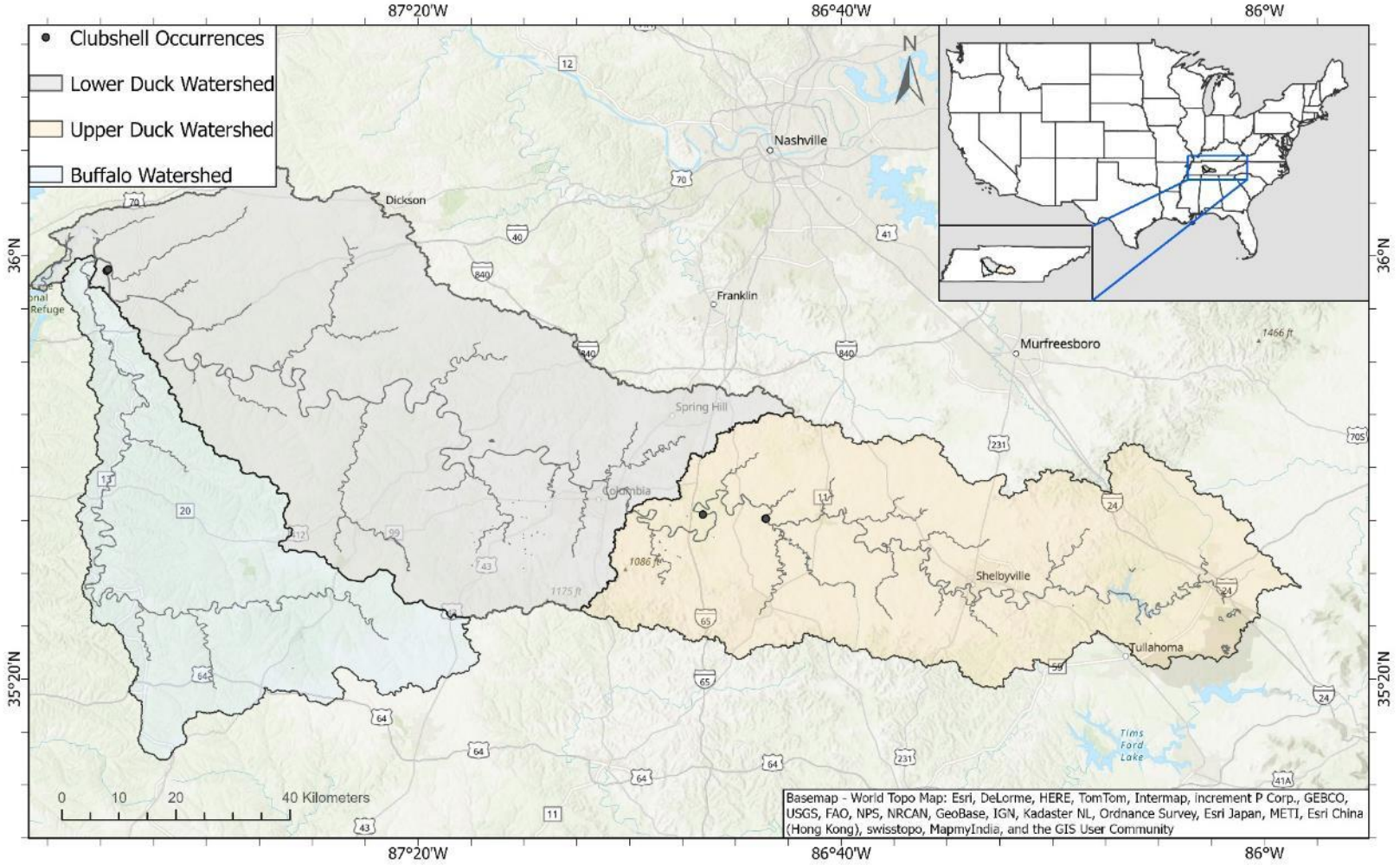
Appendix B43. *Paetulunio fabalis* (Rayed Bean) distribution in the Duck River drainage.



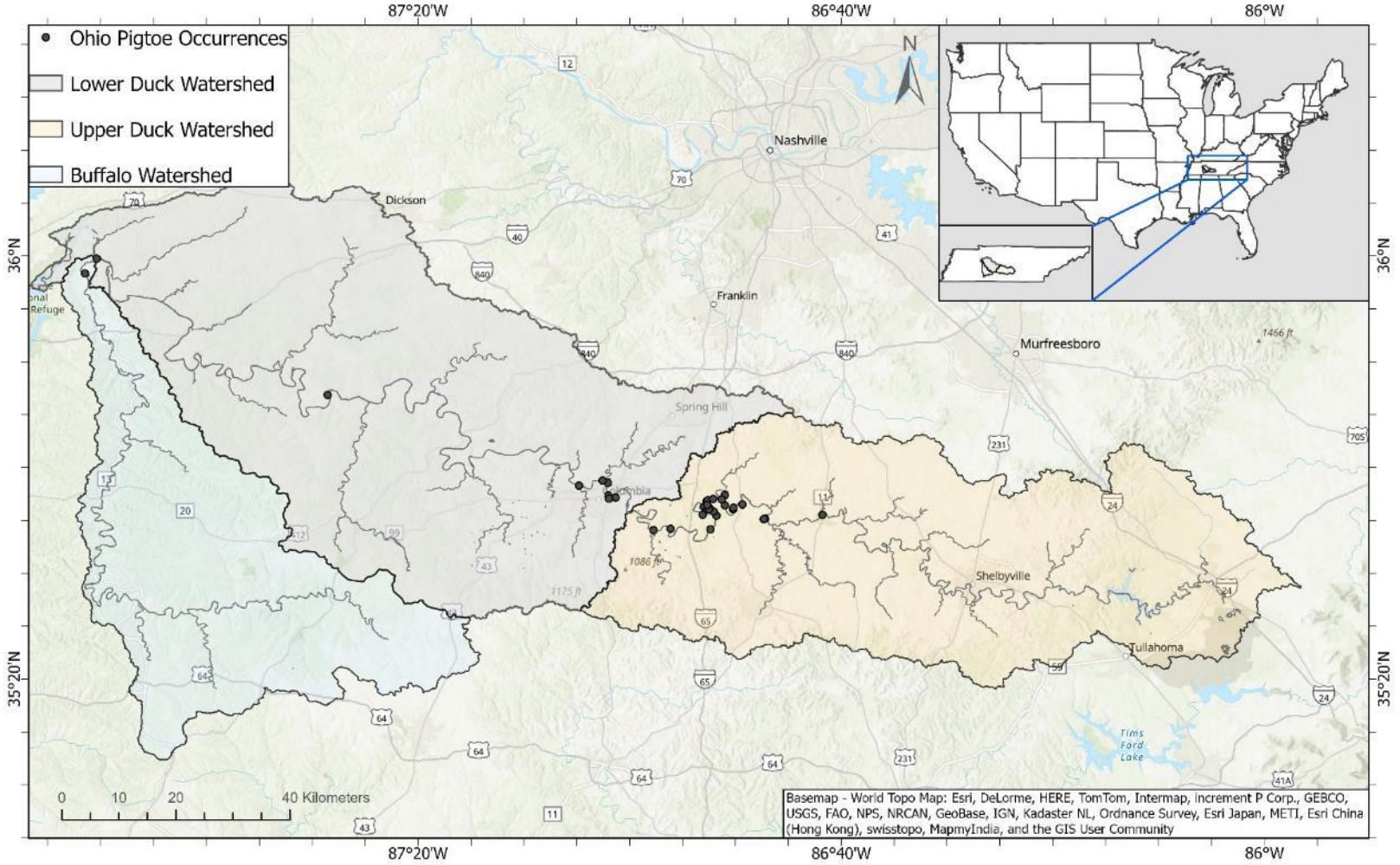
Appendix B44. *Pegias fabula* (Littlewing Pearlymussel) distribution in the Duck River drainage.



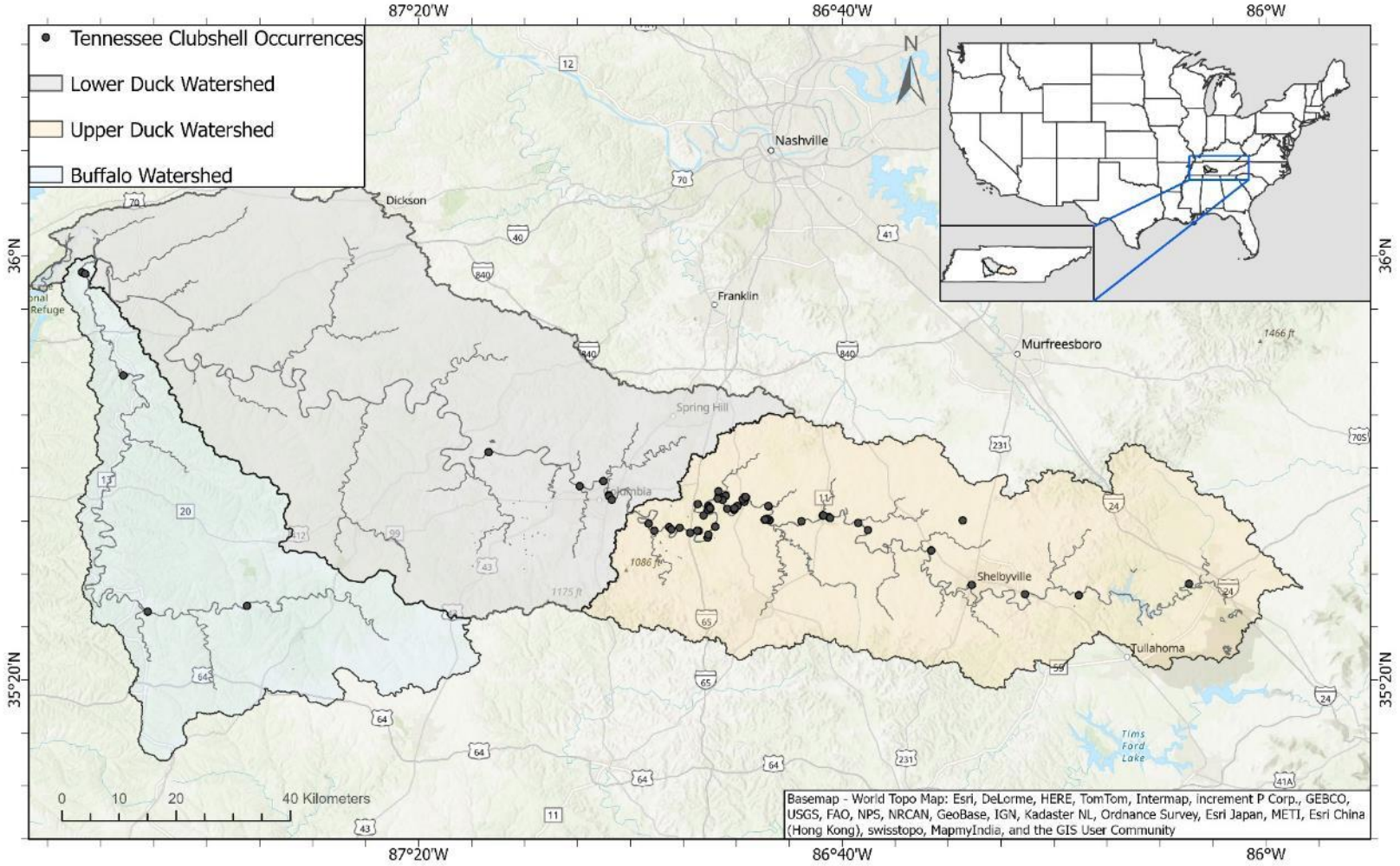
Appendix B45. *Plectomerus dombeyanus* (Bankclimber) distribution in the Duck River drainage.



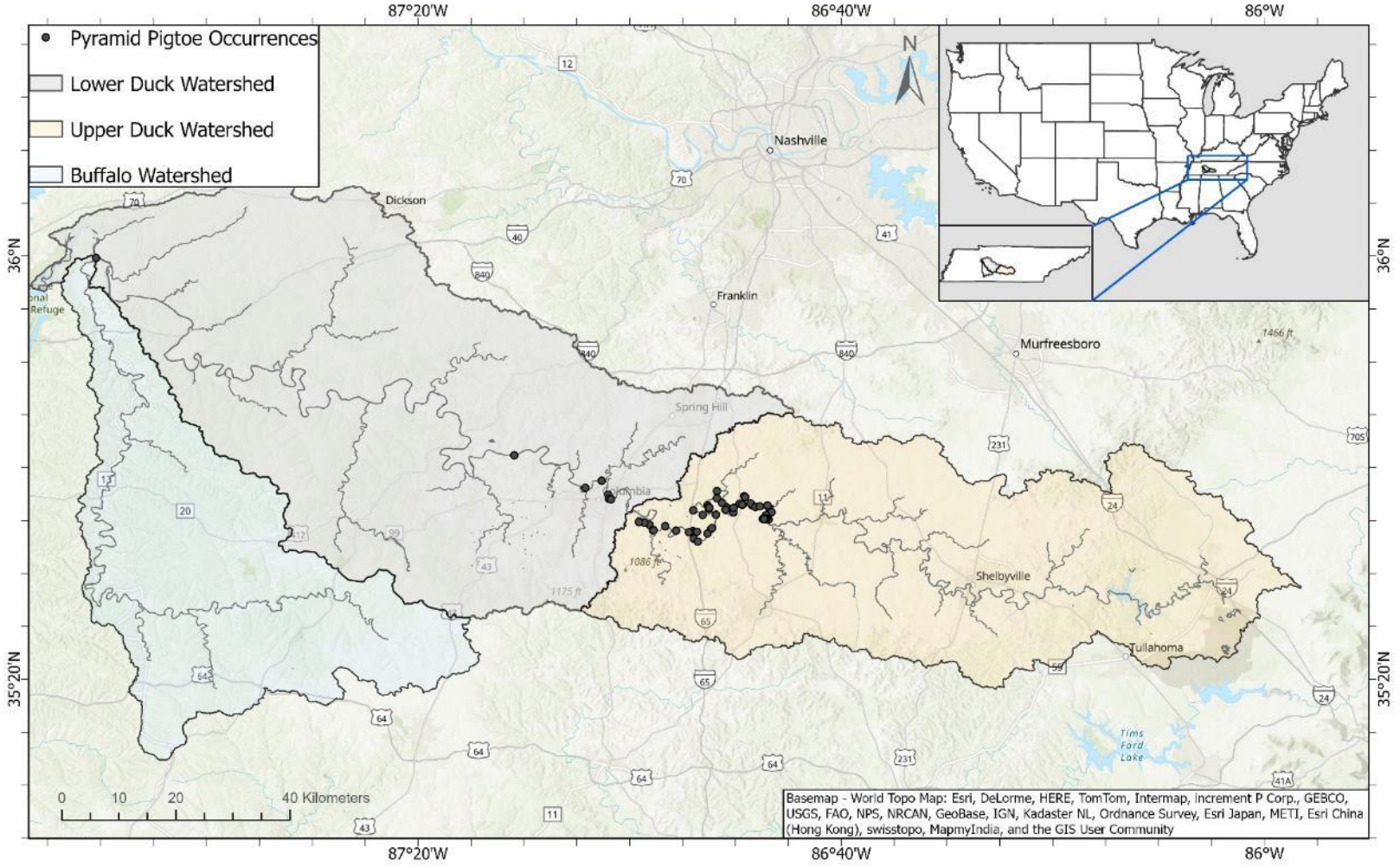
Appendix B46. *Pleurobema clava* (Clubshell) distribution in the Duck River drainage.



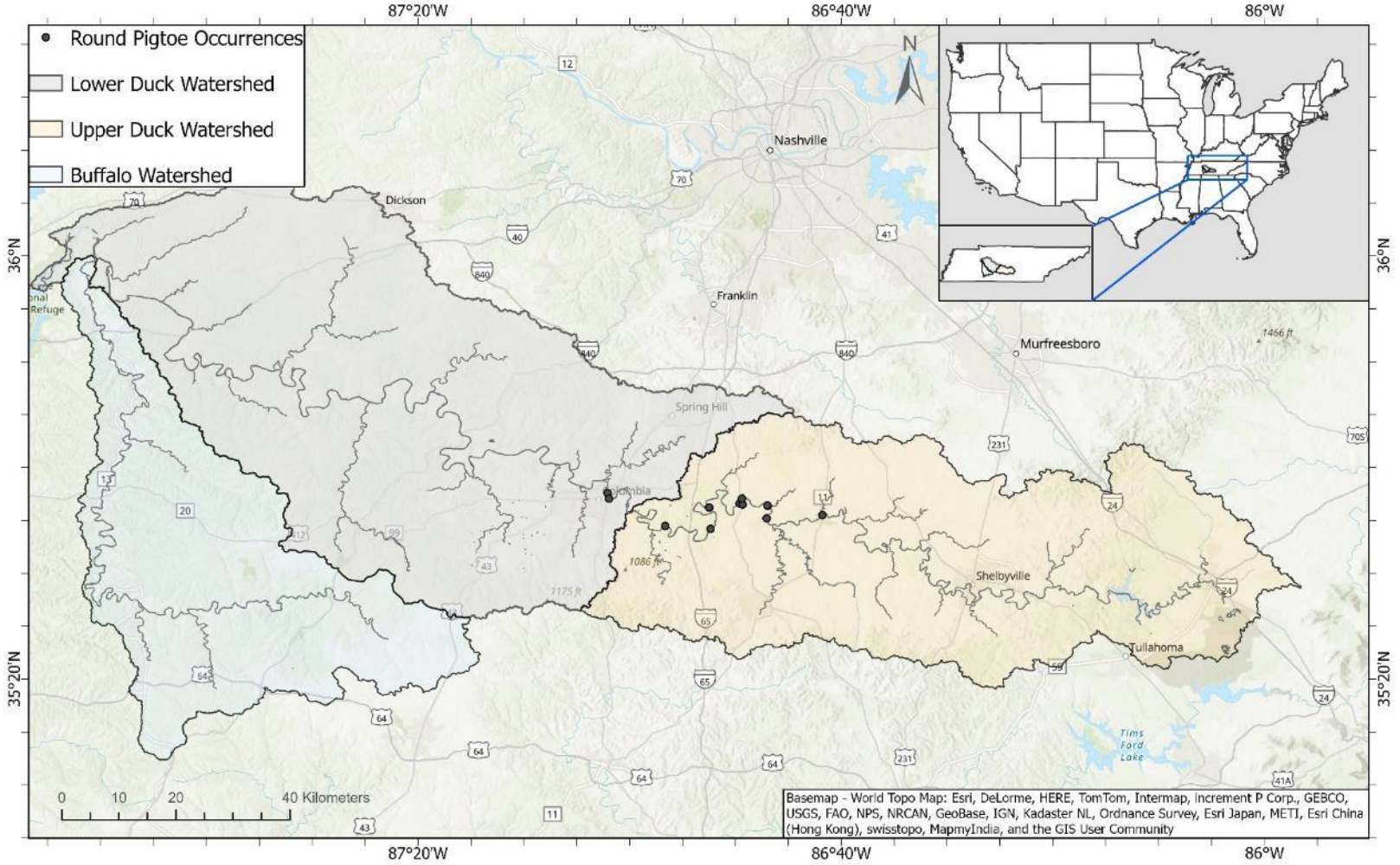
Appendix B47. *Pleurobema cordatum* (Ohio Pigtoe) distribution in the Duck River drainage.



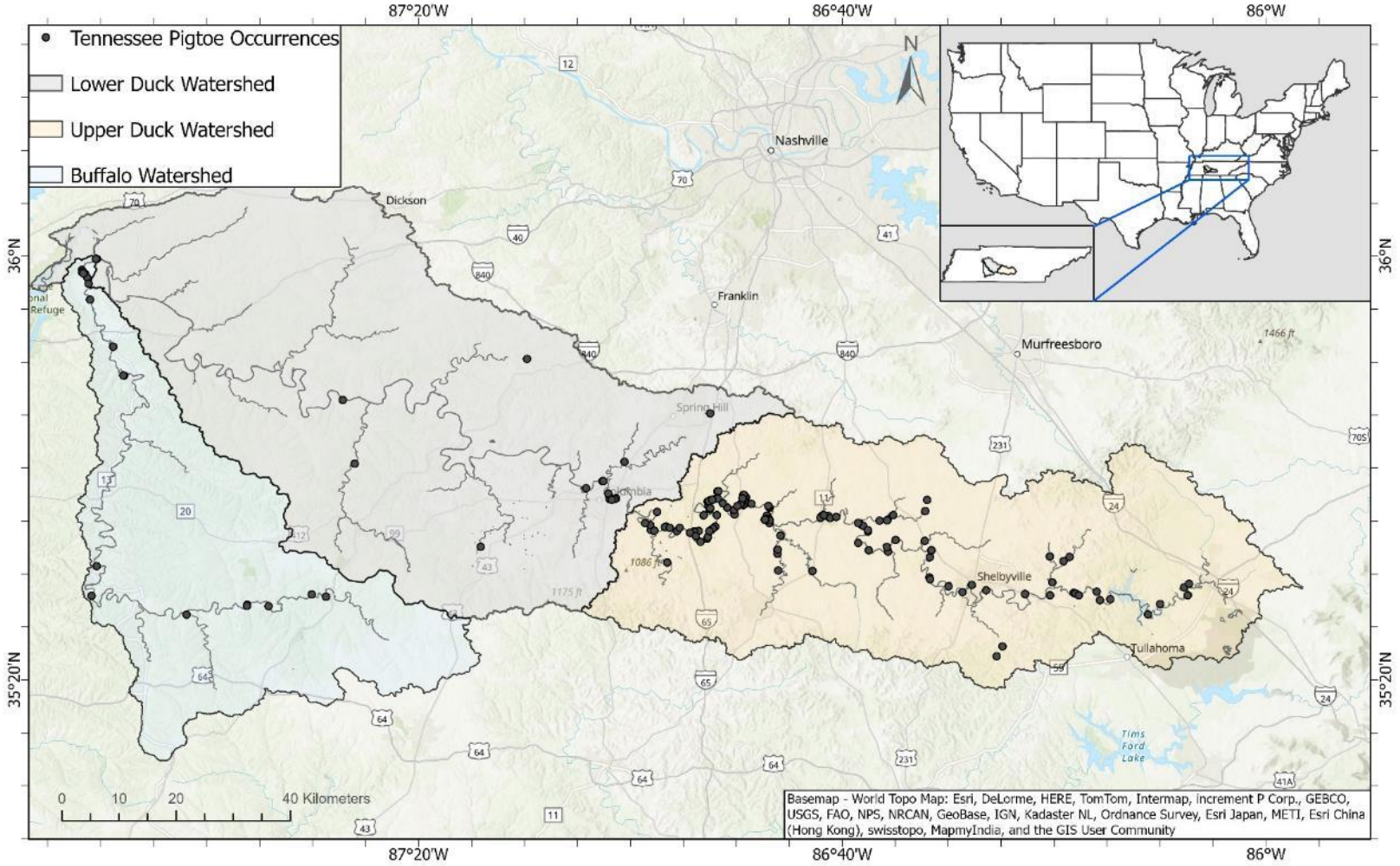
Appendix B48. *Pleurobema oviforme* (Tennessee Clubshell) distribution in the Duck River drainage.



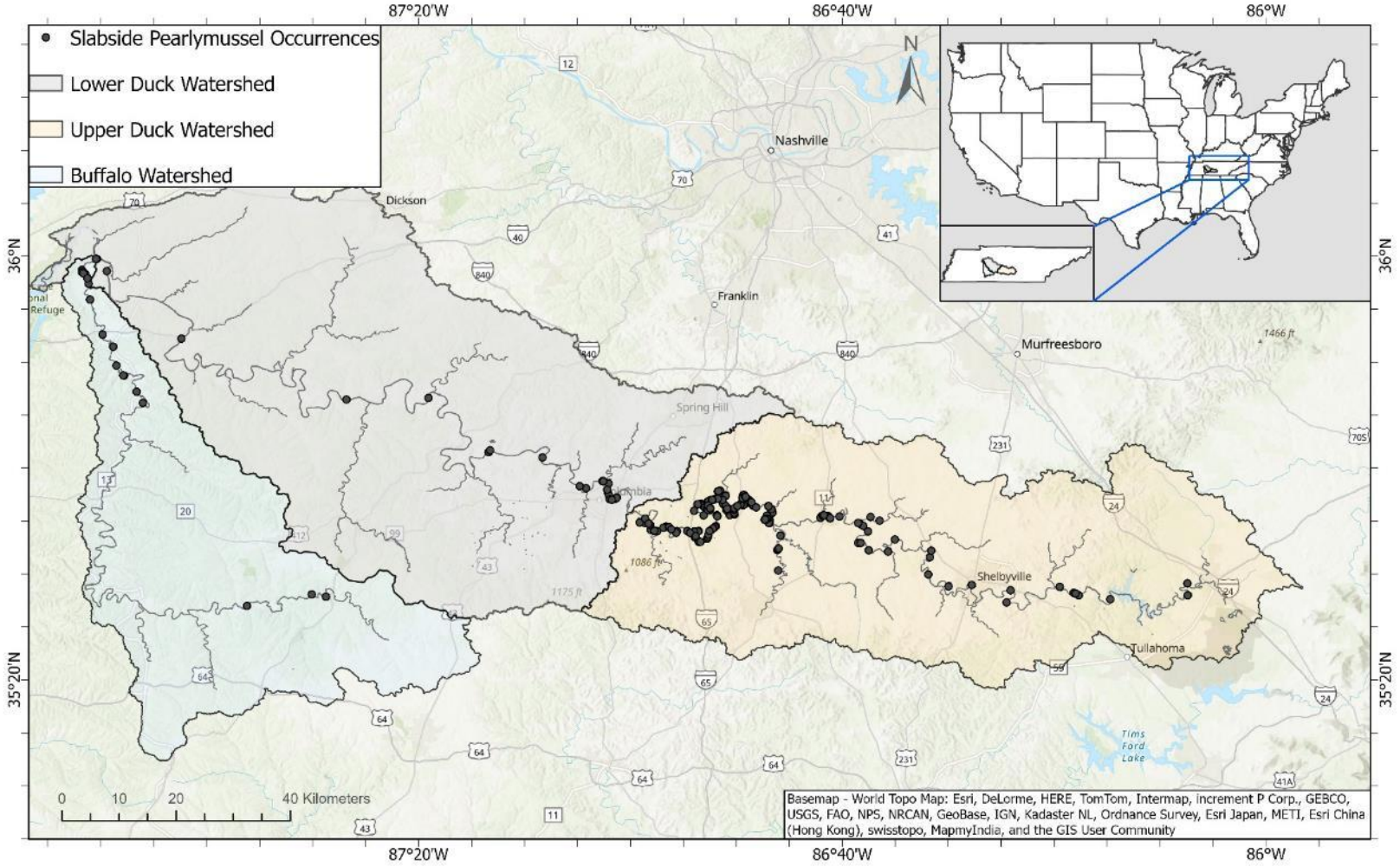
Appendix B49. *Pleurobema rubrum* (Pyramid Pigtoe) distribution in the Duck River drainage.



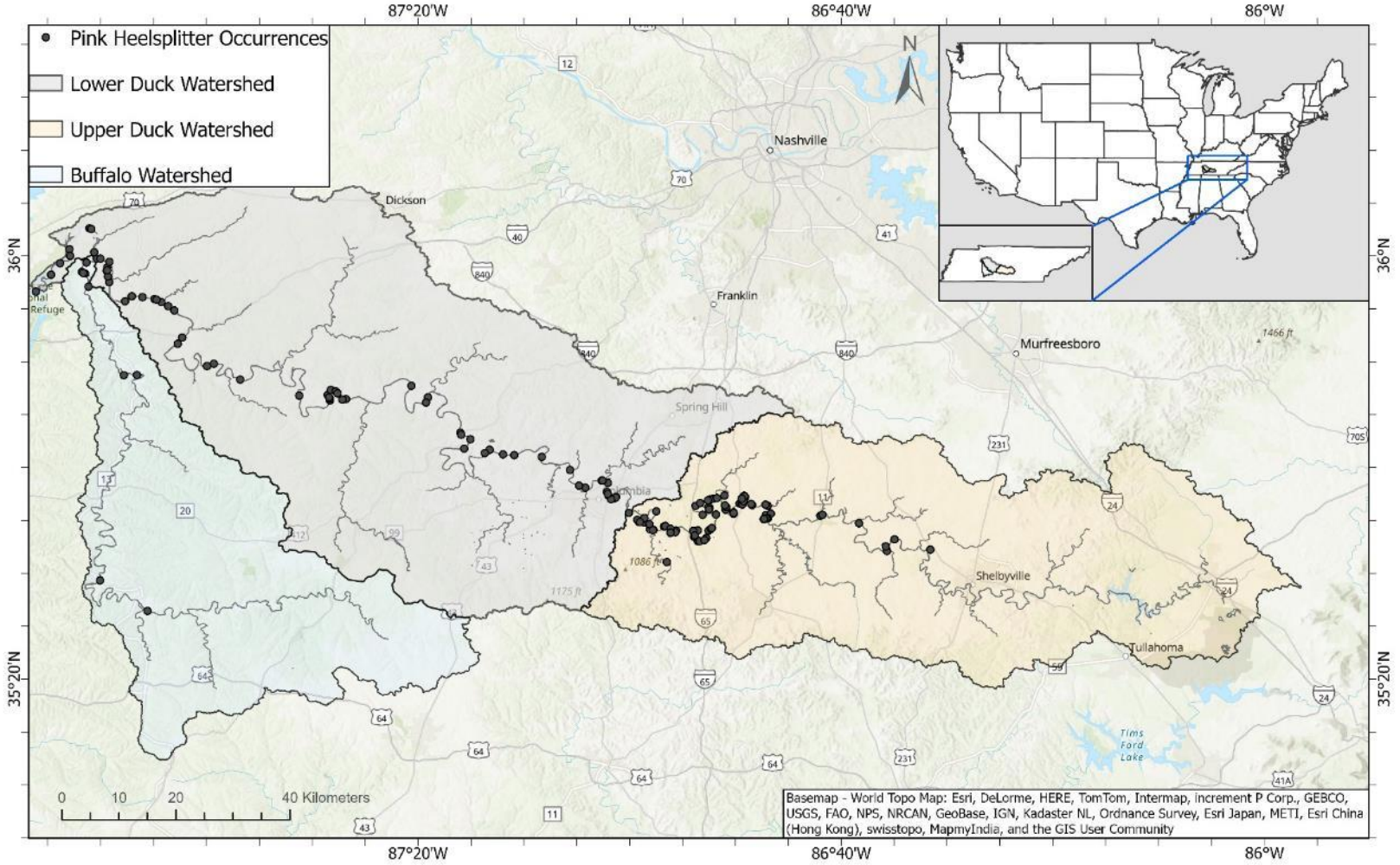
Appendix B50. *Pleurobema sintoxia* (Round Pigtoe) distribution in the Duck River drainage.



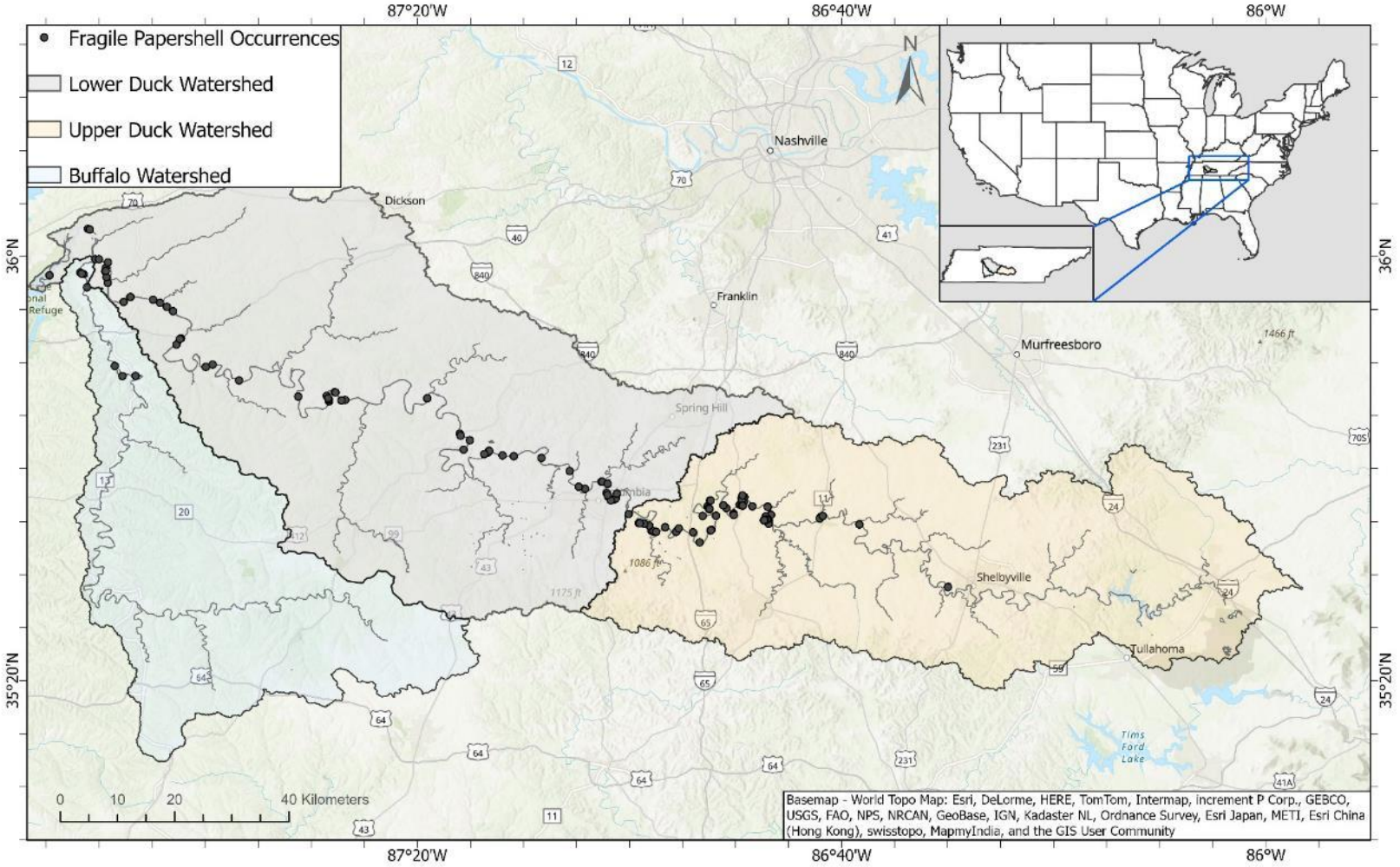
Appendix B51. *Pleuronaia barnesiana* (Tennessee Pigtoe) Distribution in the Duck River drainage.



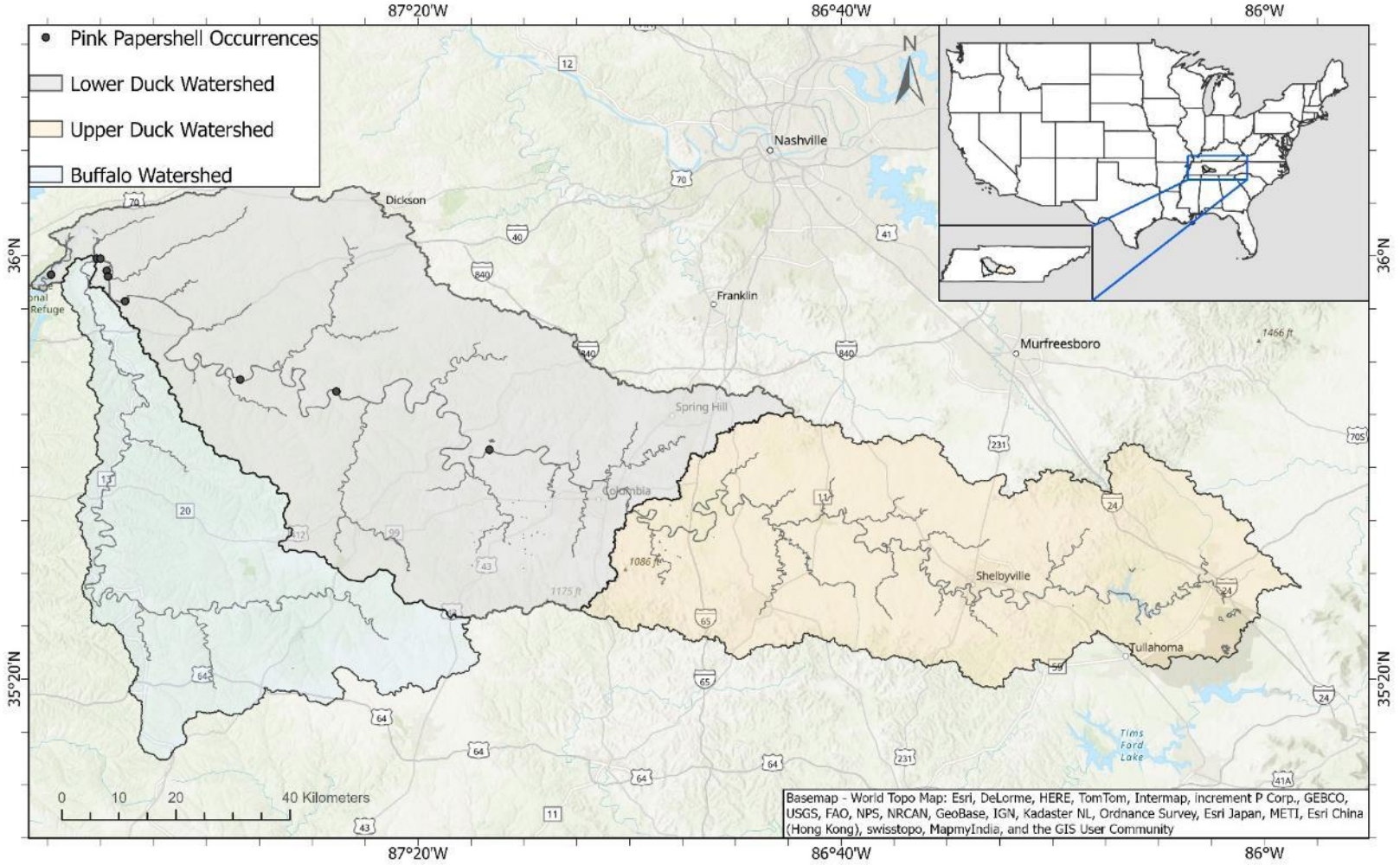
Appendix B52. *Pleuronaia dolabelloides* (Slabside Pearlymussel) distribution in the Duck River drainage.



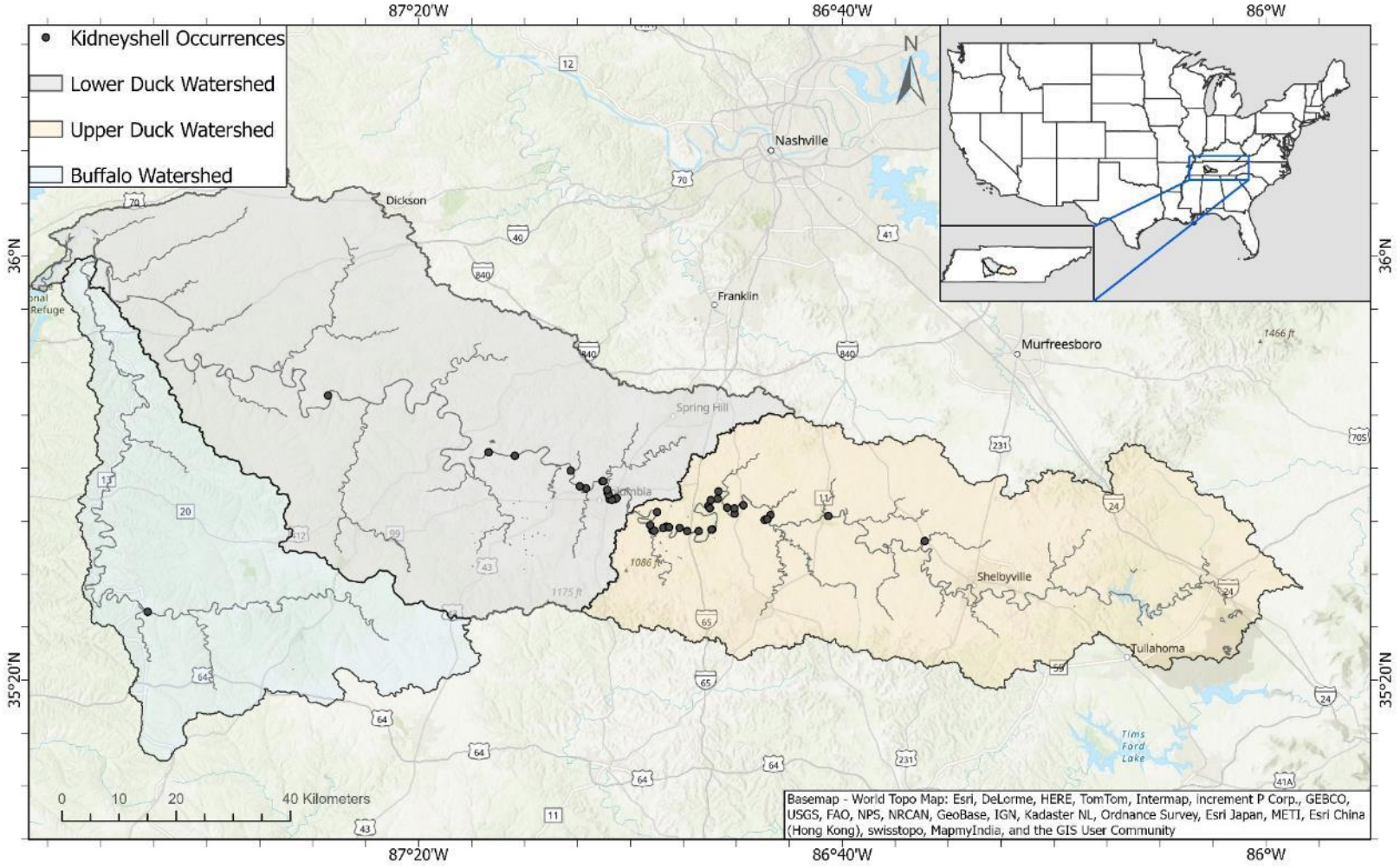
Appendix B53. *Potamilus alatus* (Pink Heelsplitter) distribution in the Duck River drainage.



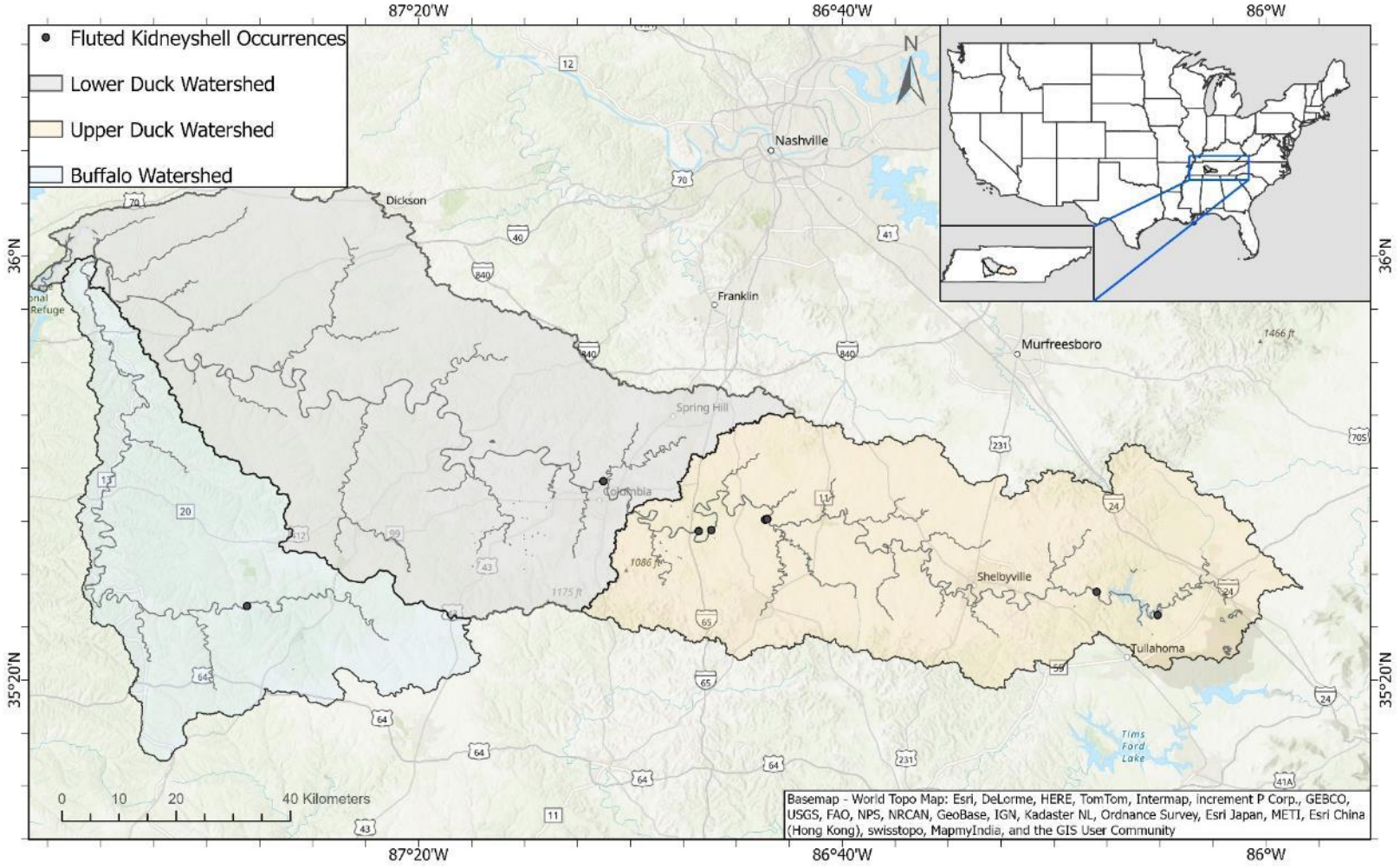
Appendix B54. *Potamilus fragilis* (Fragile Papershell) distribution in the Duck River drainage.



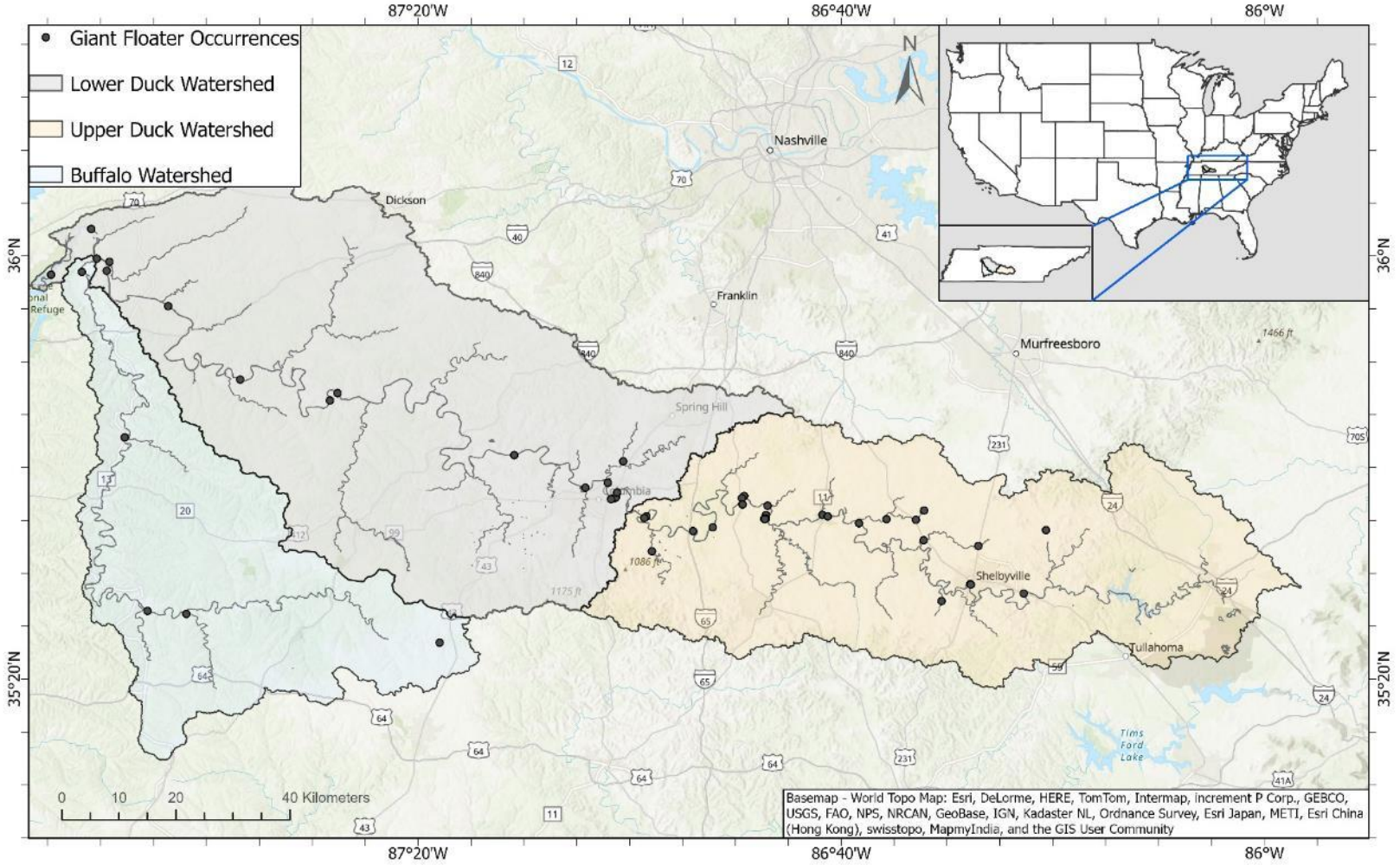
Appendix B55. *Potamilus ohiensis* (Pink Papershell) distribution in the Duck River drainage.



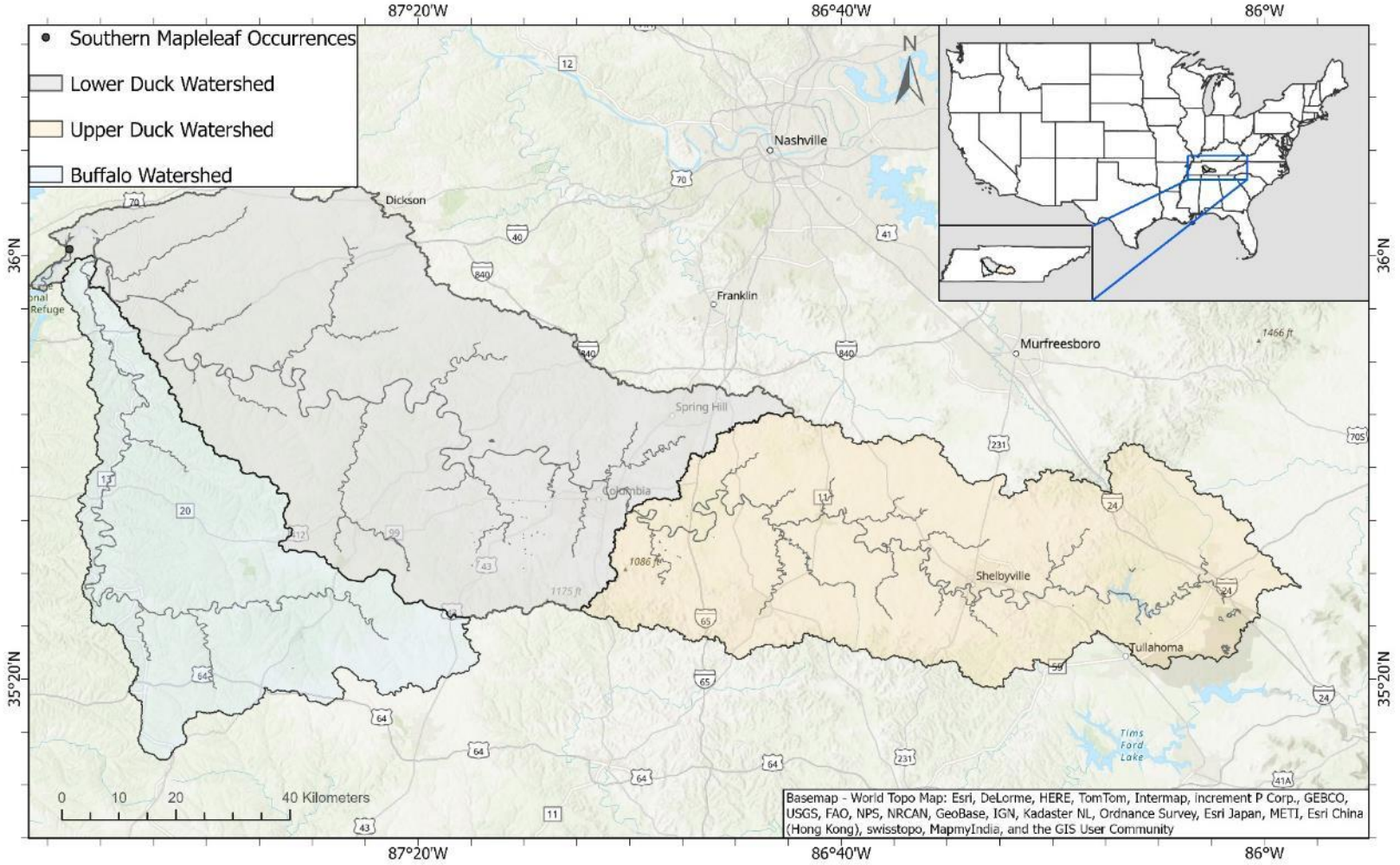
Appendix B56. *Ptychobranchus fasciolaris* (Kidneyshell) distribution in the Duck River drainage.



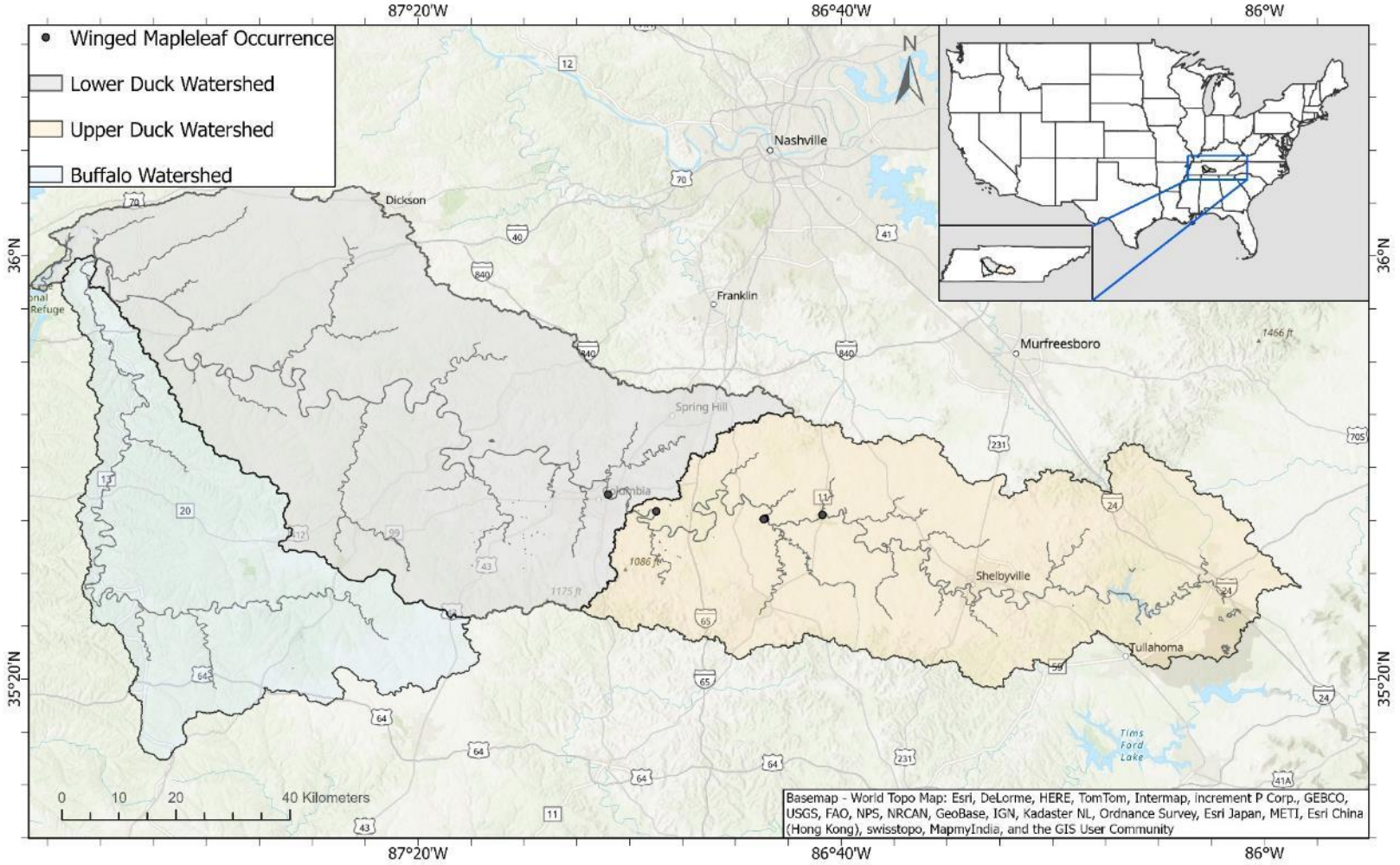
Appendix B57. *Ptychobranchus subtentus* (Fluted Kidneyshell) distribution in the Duck River drainage.



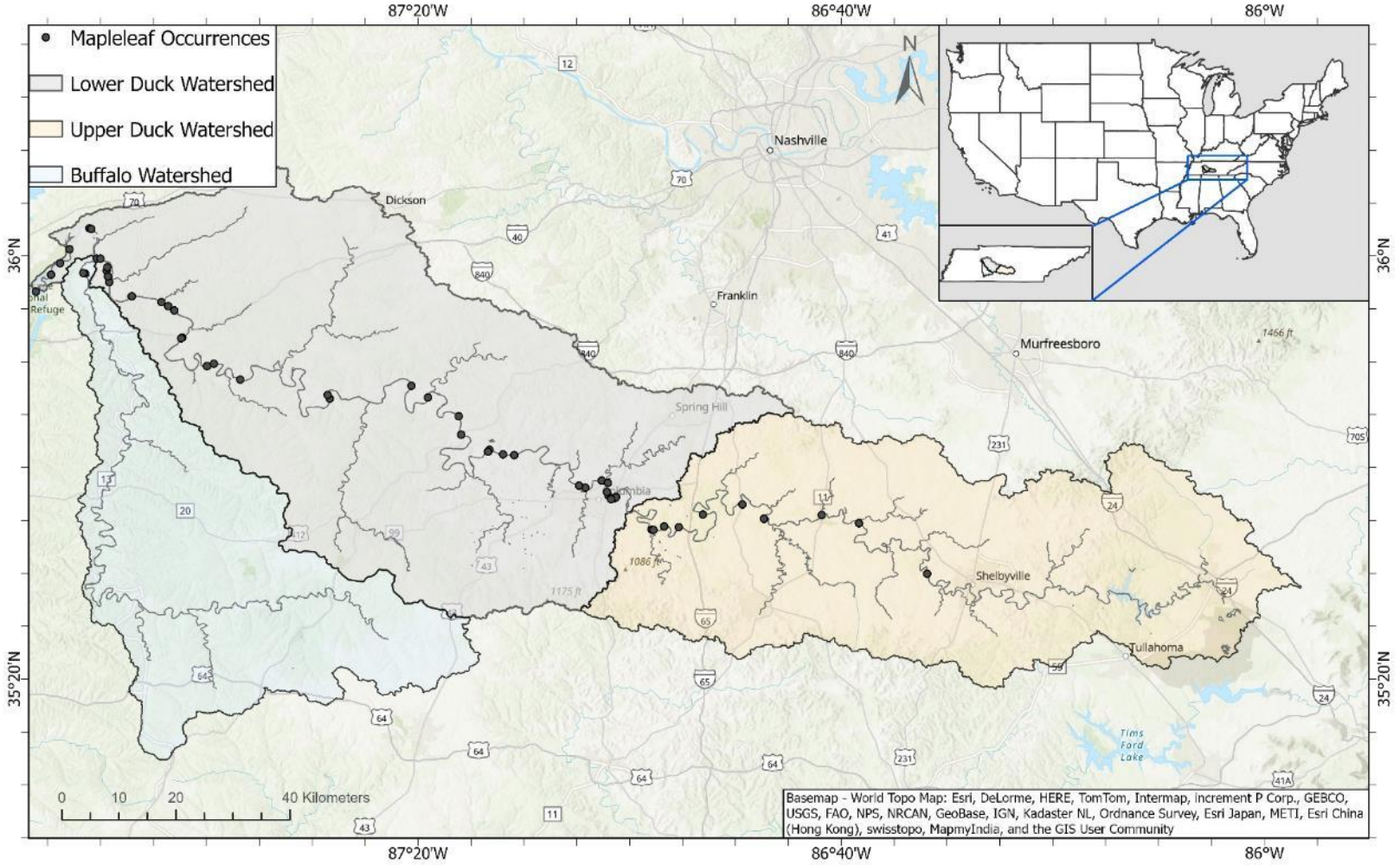
Appendix B58. *Pyganodon grandis* (Giant Floater) distribution in the Duck River drainage.



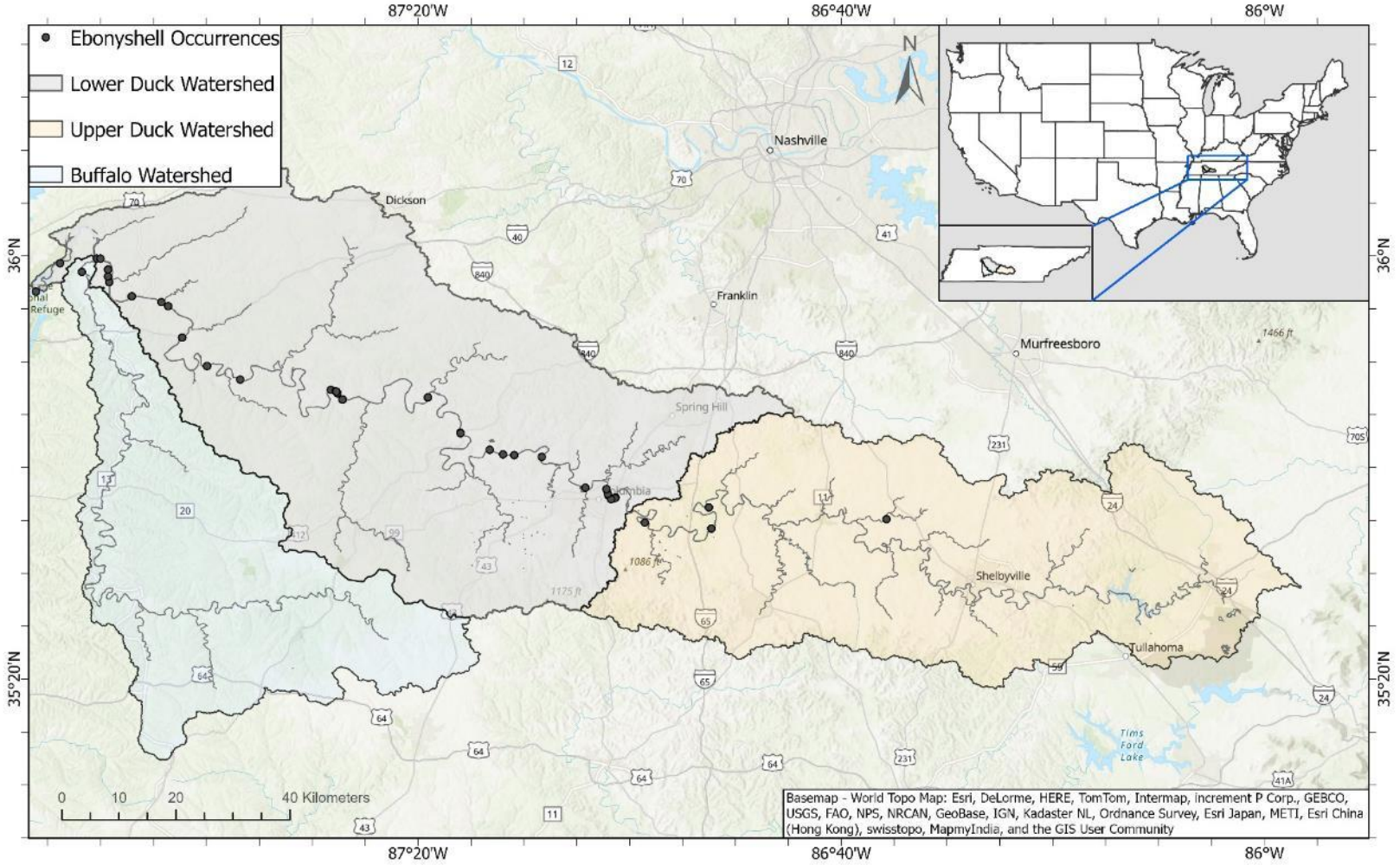
Appendix B59. *Quadrula apiculata* (Southern Mapleleaf) distribution in the Duck River drainage.



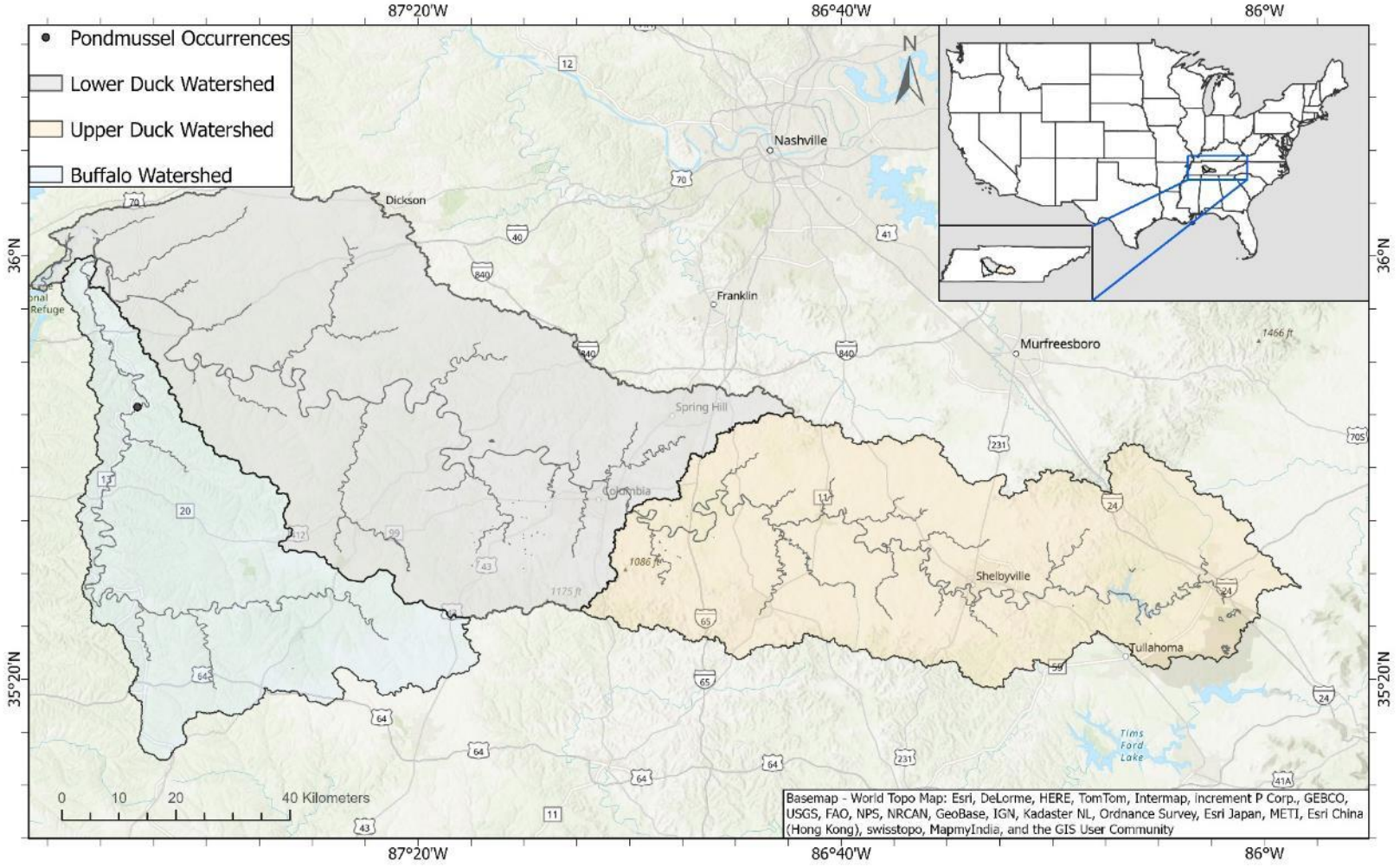
Appendix B60. *Quadrula fragosa* (Winged Mapleleaf) distribution in the Duck River drainage.



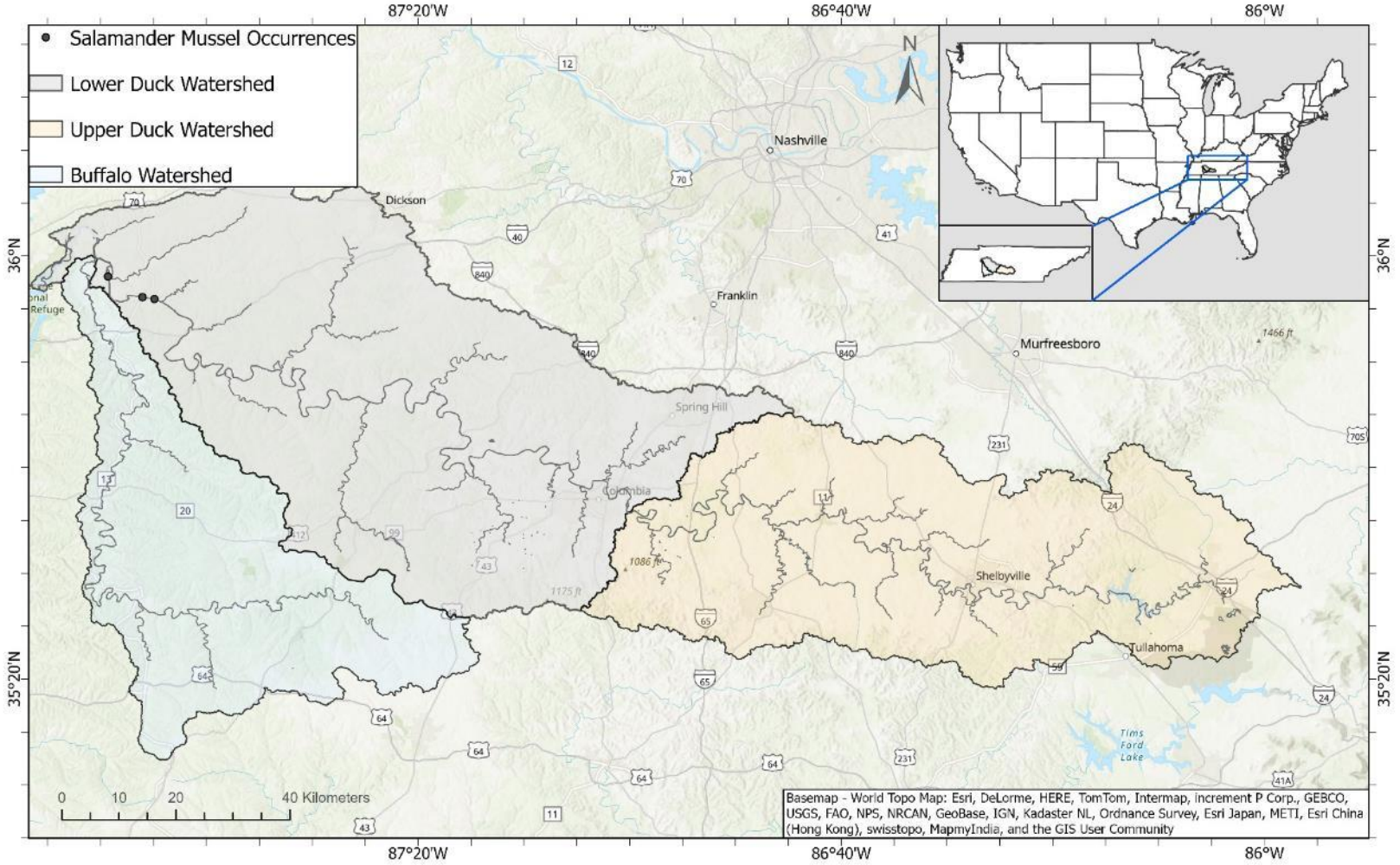
Appendix B61. *Quadrula quadrula* (Mapleleaf) distribution in the Duck River drainage.



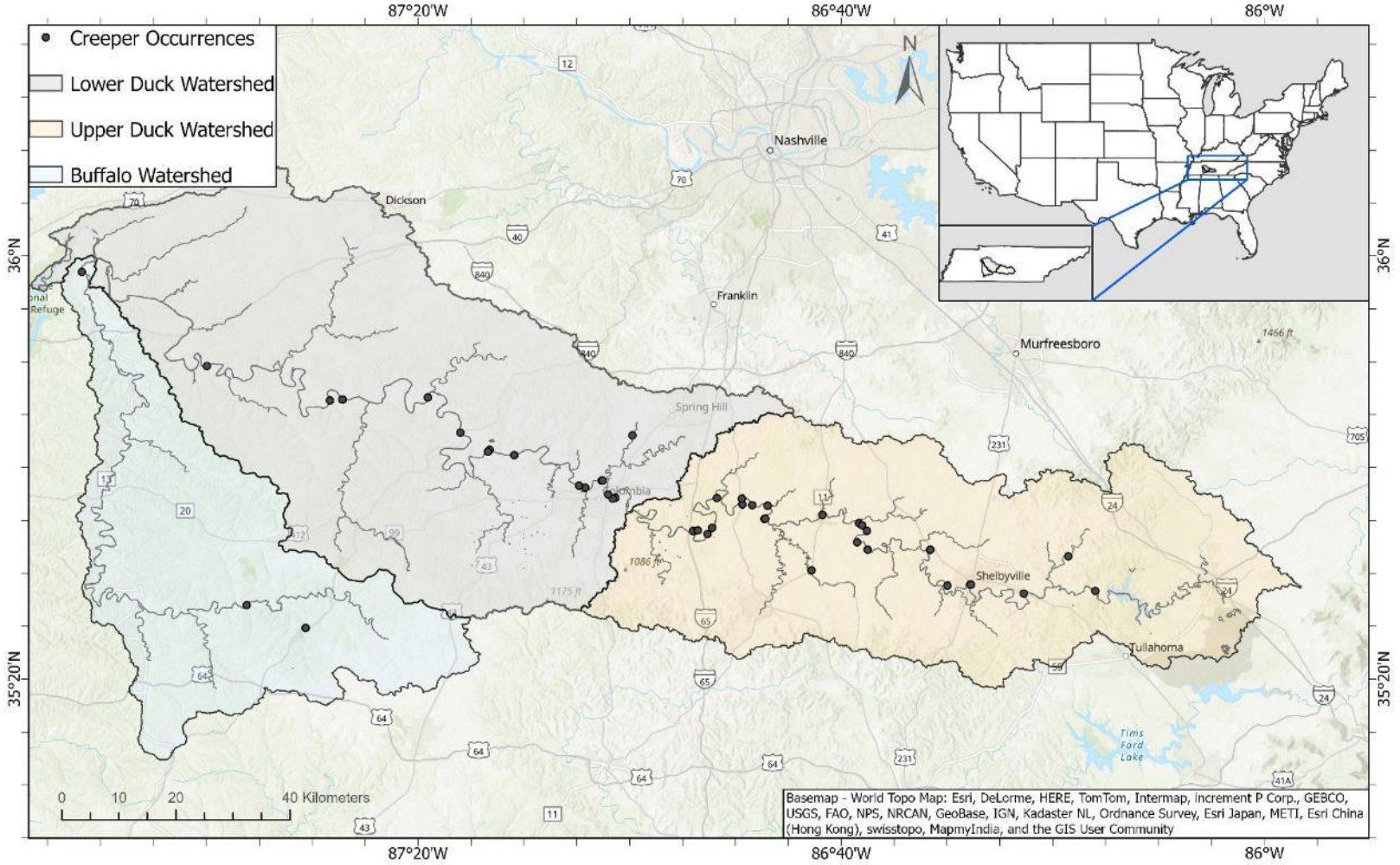
Appendix B62. *Reginaia ebenus* (Ebonyshell) distribution in the Duck River drainage.



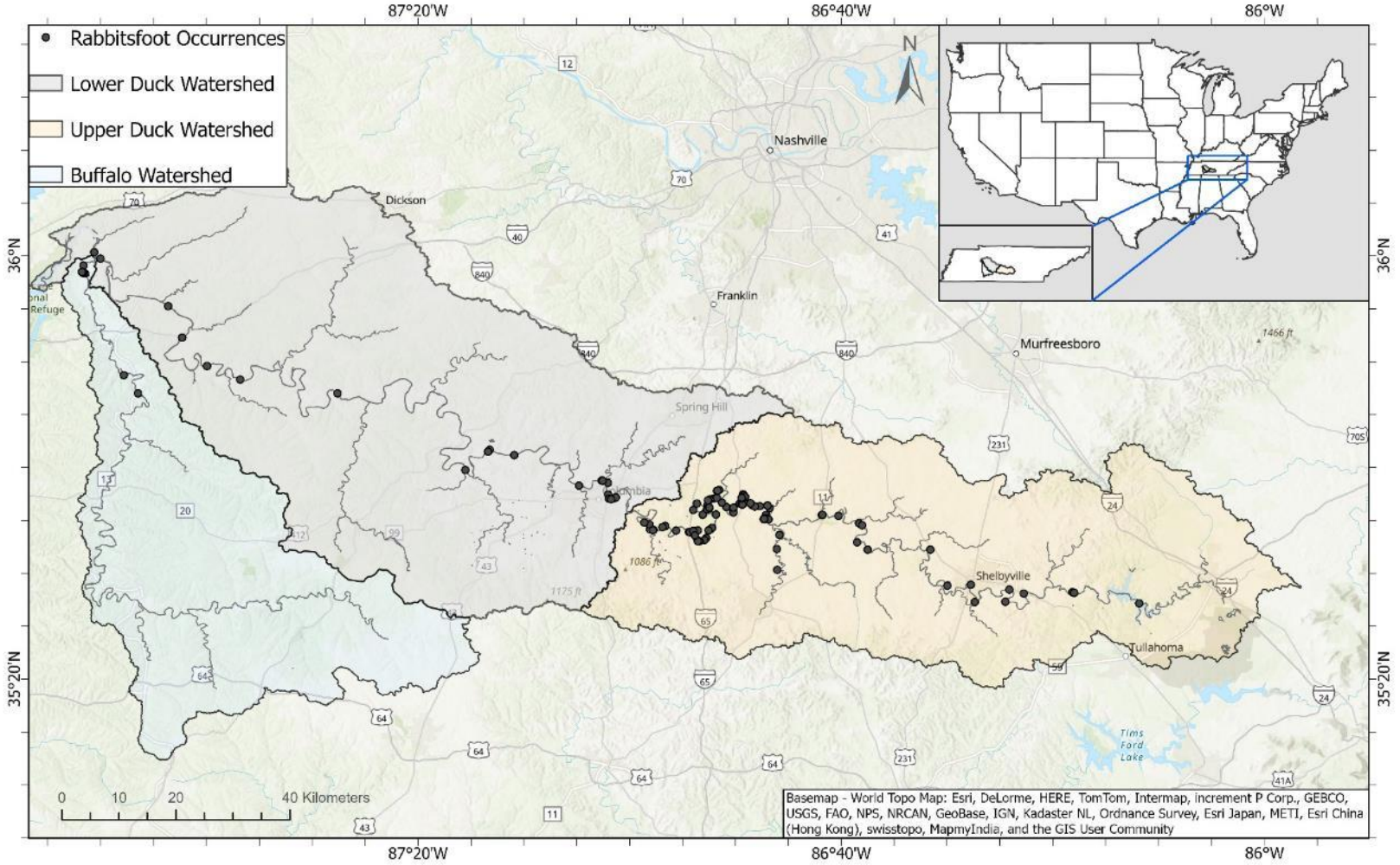
Appendix B63. *Sagittunio subrostratus* (Pondmussel) distribution in the Duck River drainage.



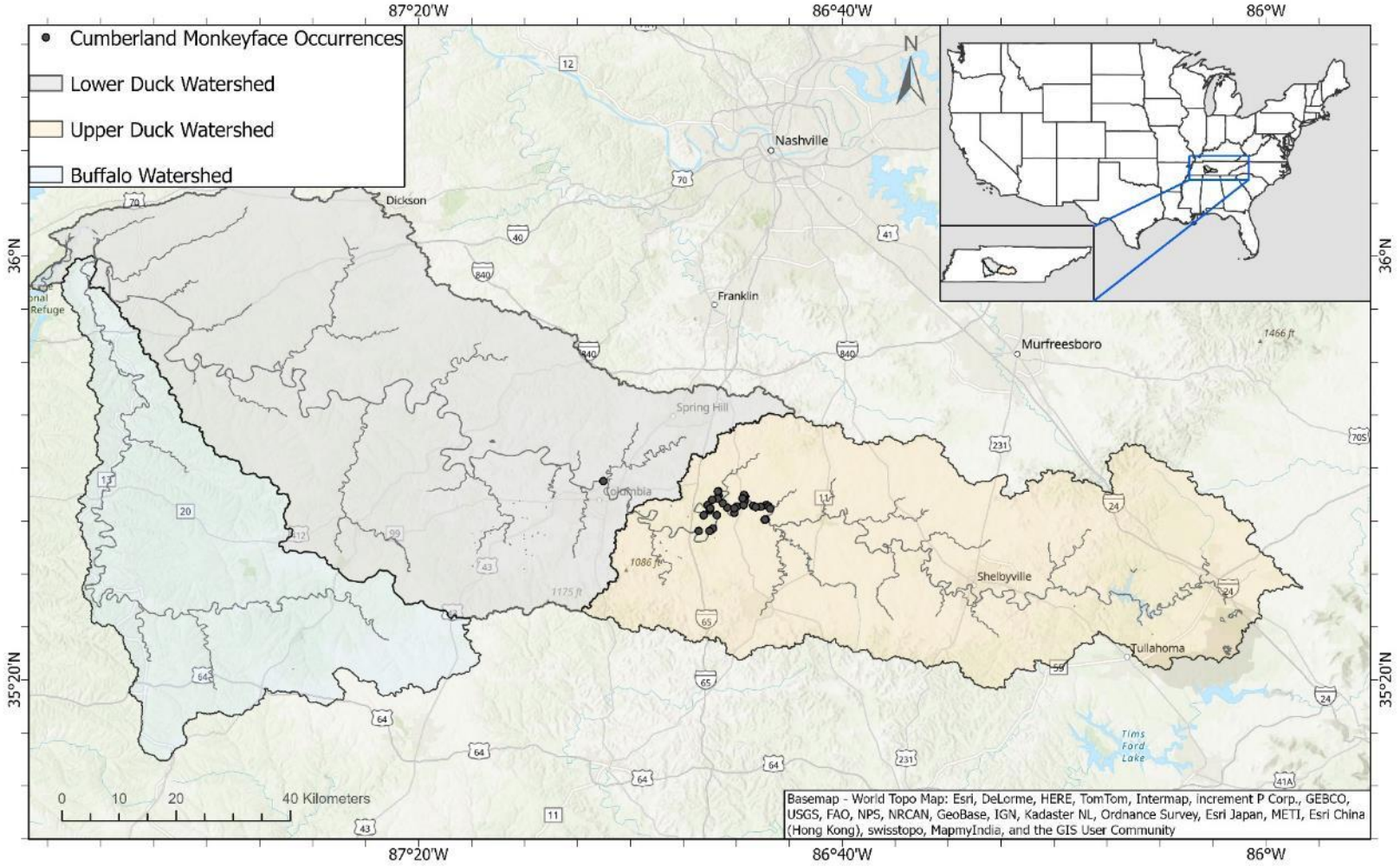
Appendix B64. *Simpsonaias ambigua* (Salamander Mussel) distribution in the Duck River drainage.



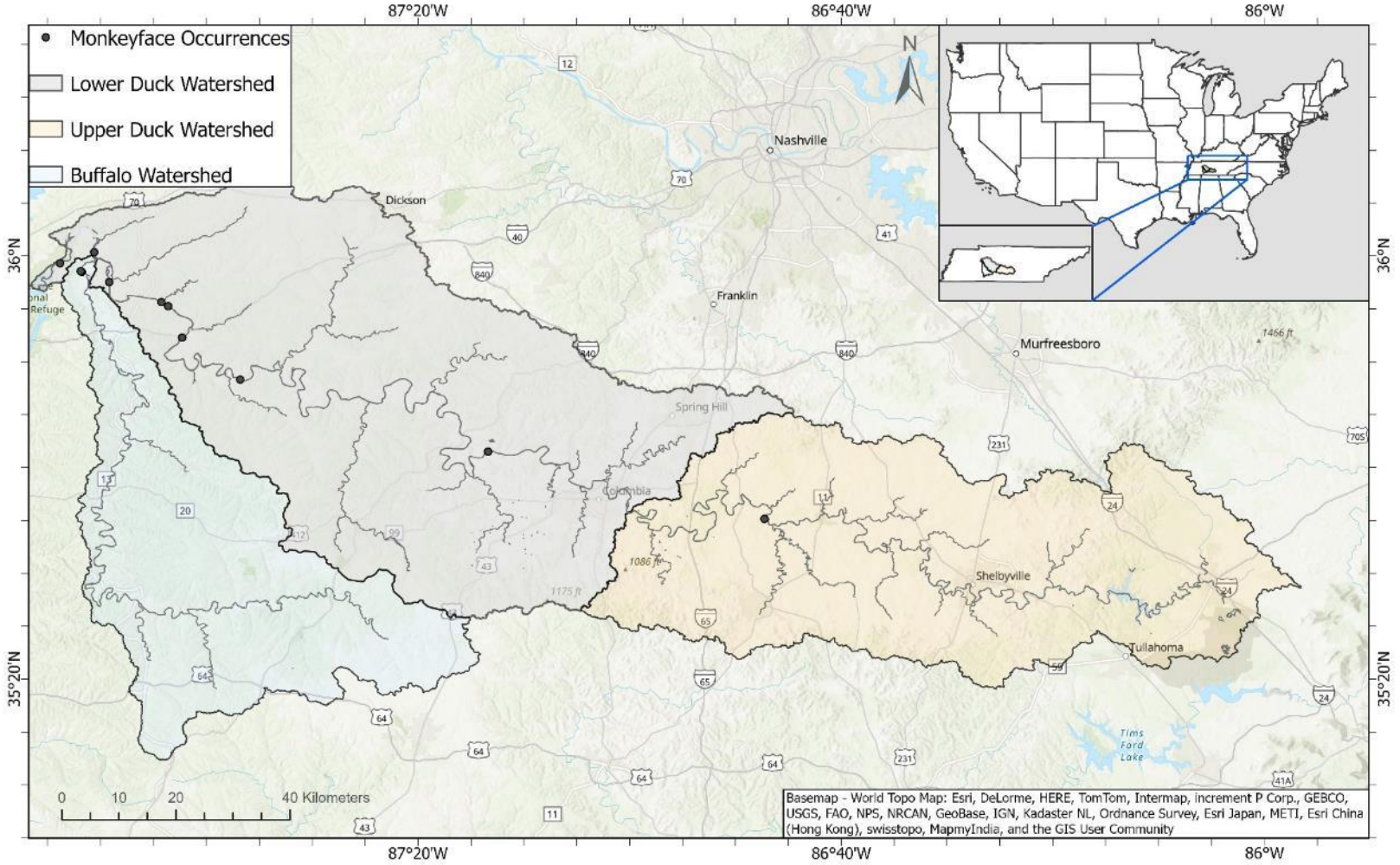
Appendix B65. *Strophitus undulatus* (Creeper) distribution in the Duck River drainage.



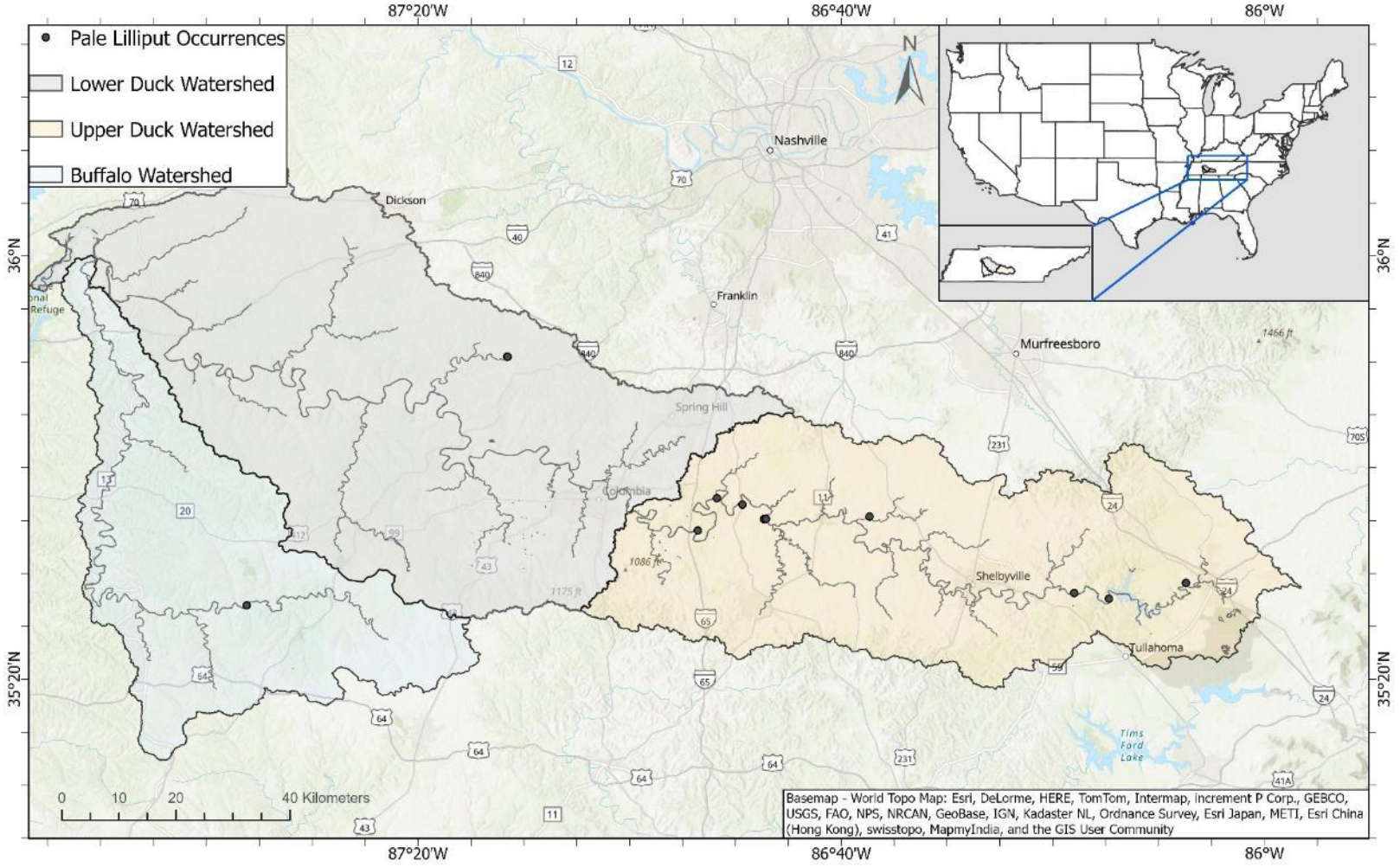
Appendix B66. *Theliderma cylindrica* (Rabbitsfoot) distribution in the Duck River drainage.



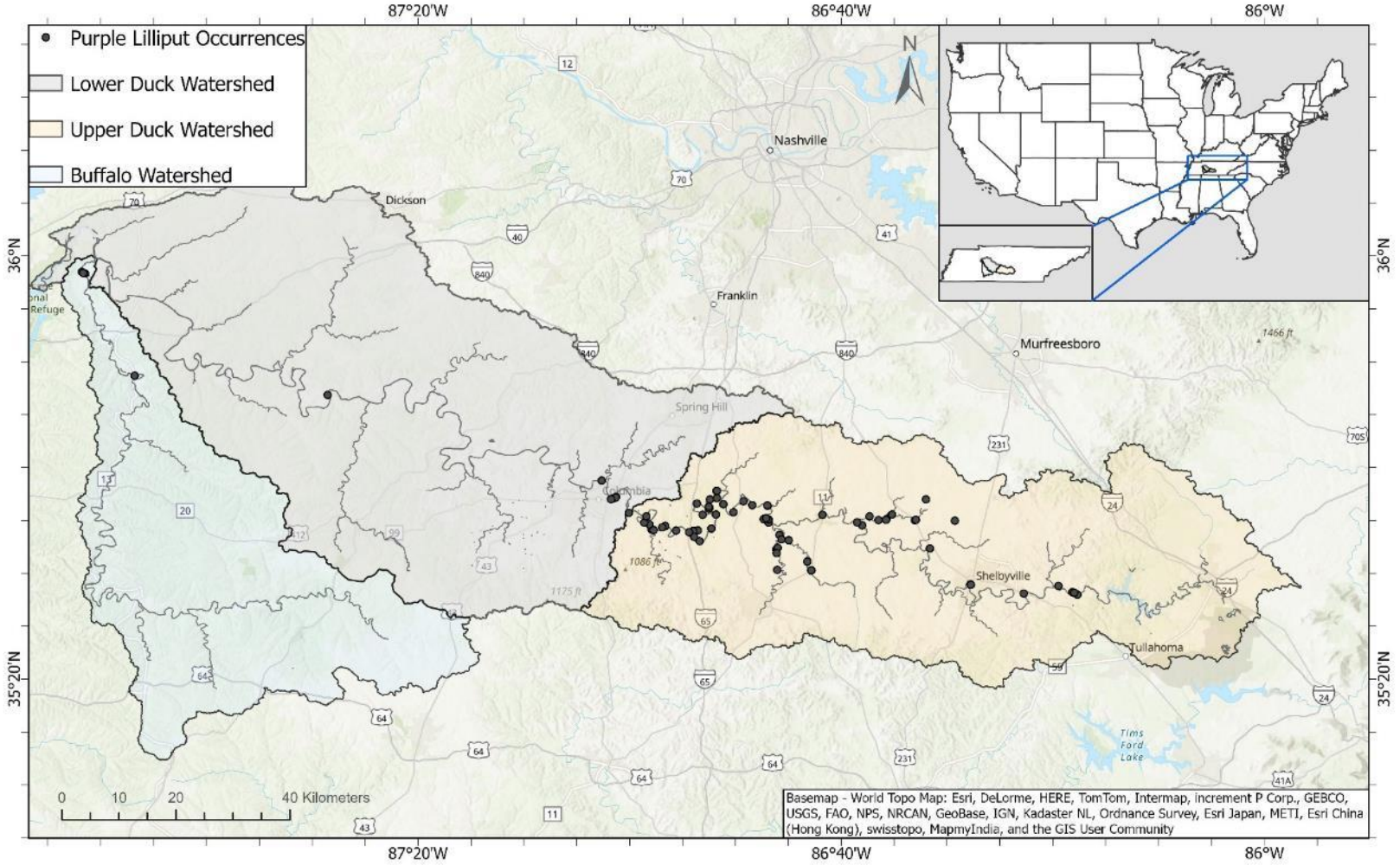
Appendix B67. *Theliderma intermedia* (Cumberland Monkeyface) distribution in the Duck River drainage.



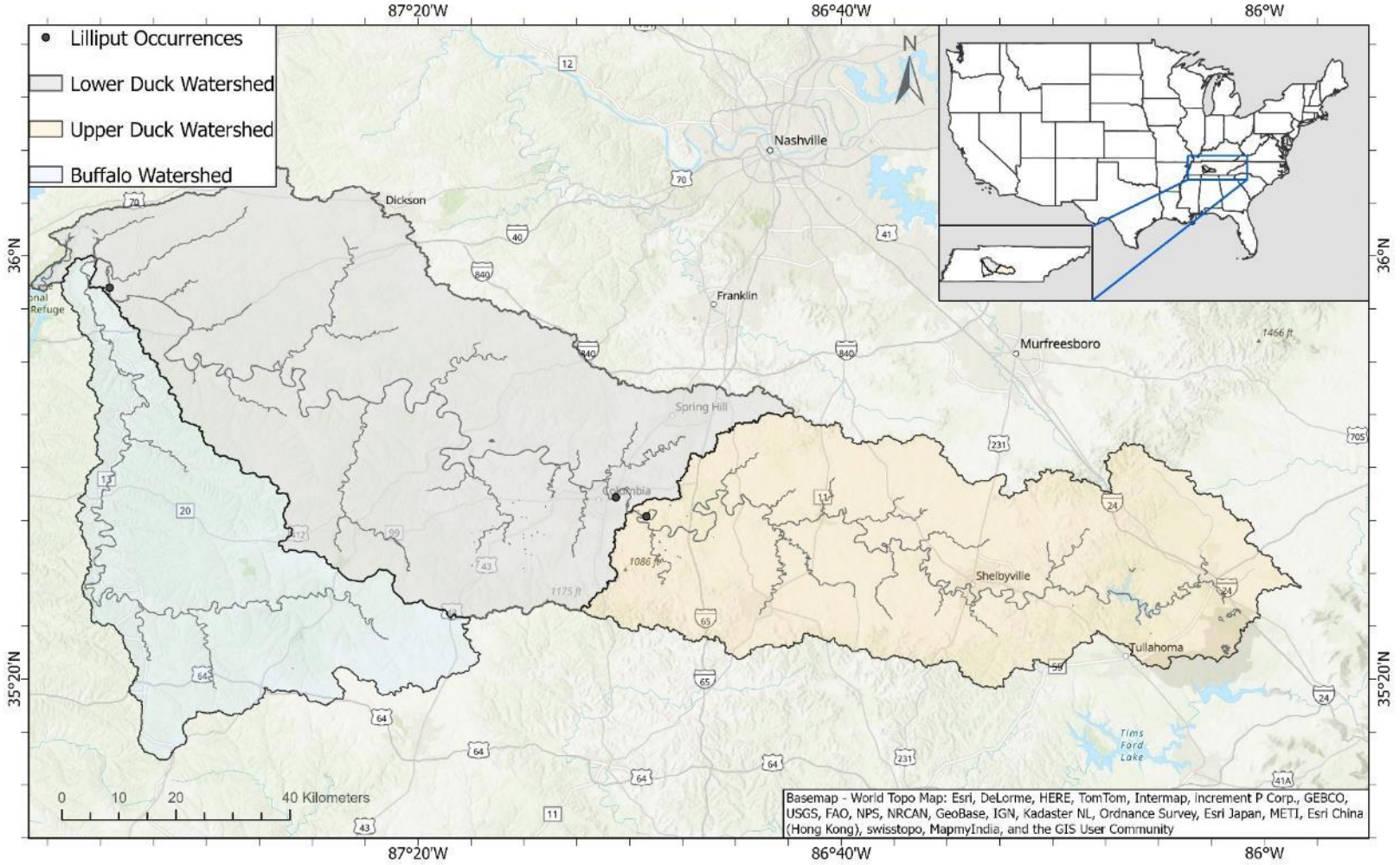
Appendix B68. *Theliderma metanevra* (Monkeyface) distribution in the Duck River drainage.



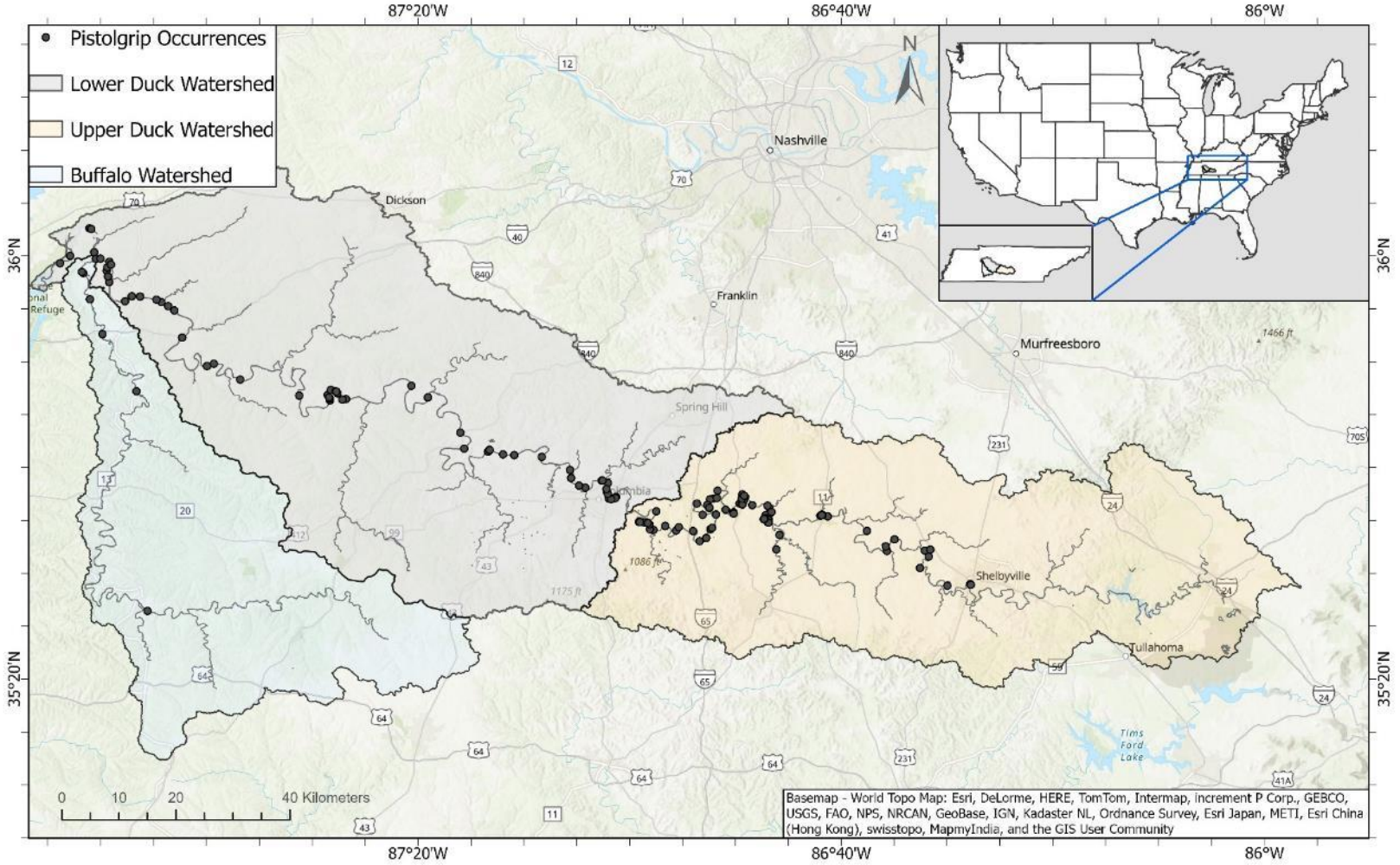
Appendix B69. *Toxolasma cylindrellus* (Pale Lilliput) distribution in the Duck River drainage.



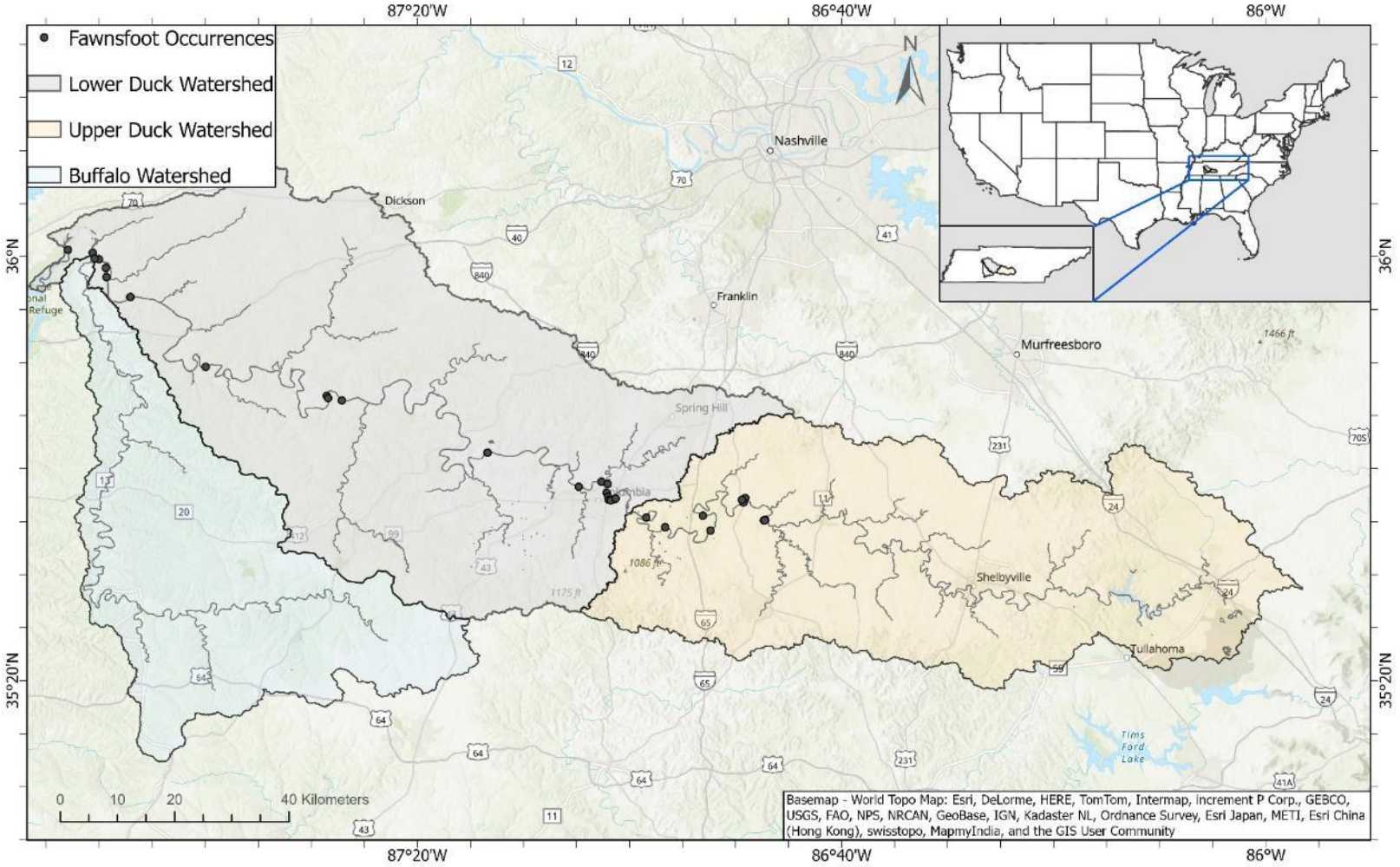
Appendix B70. *Toxolasma lividum* (Purple Lilliput) distribution in the Duck River drainage.



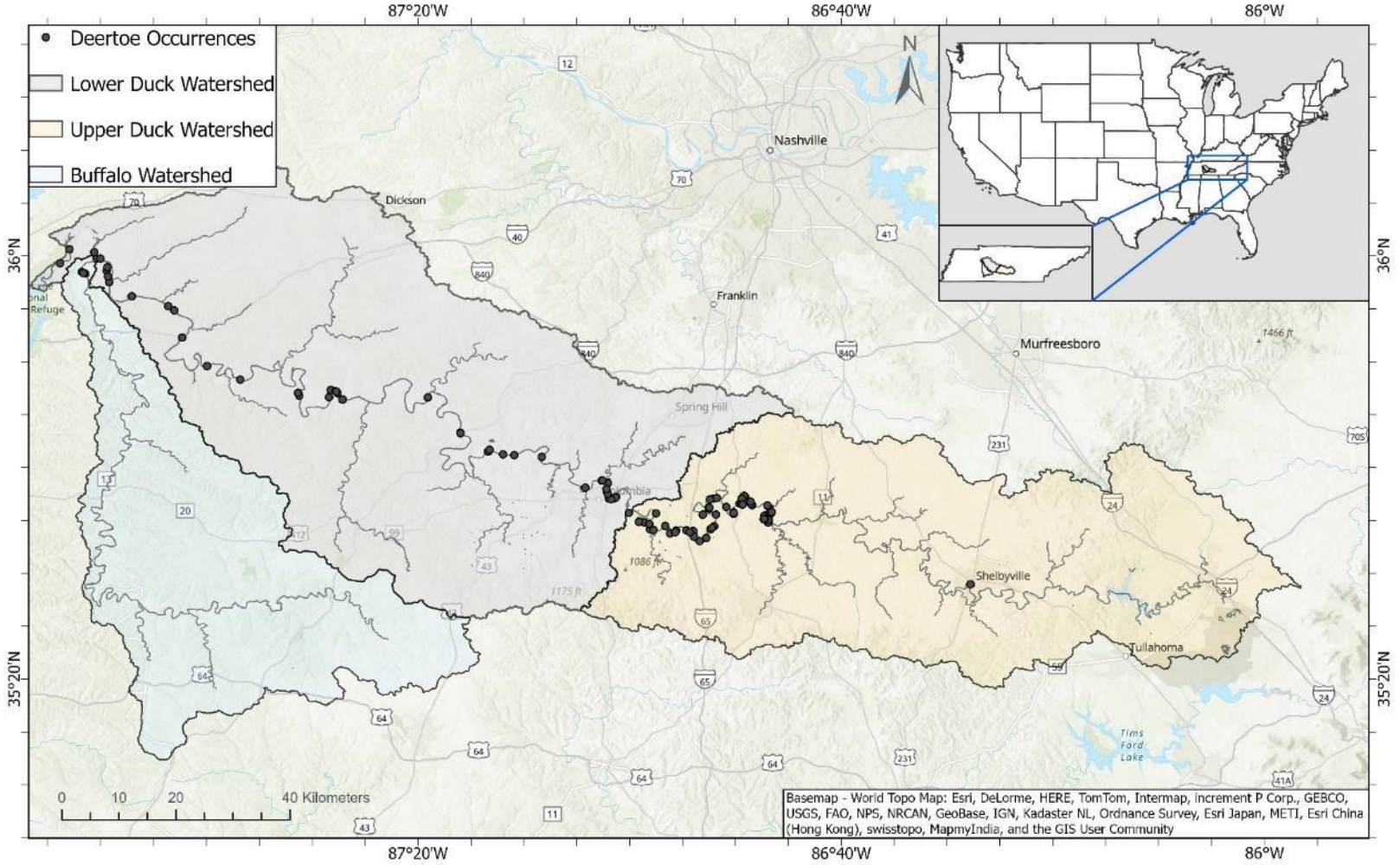
Appendix B71. *Toxolasma parvum* (Lilliput) distribution in the Duck River drainage.



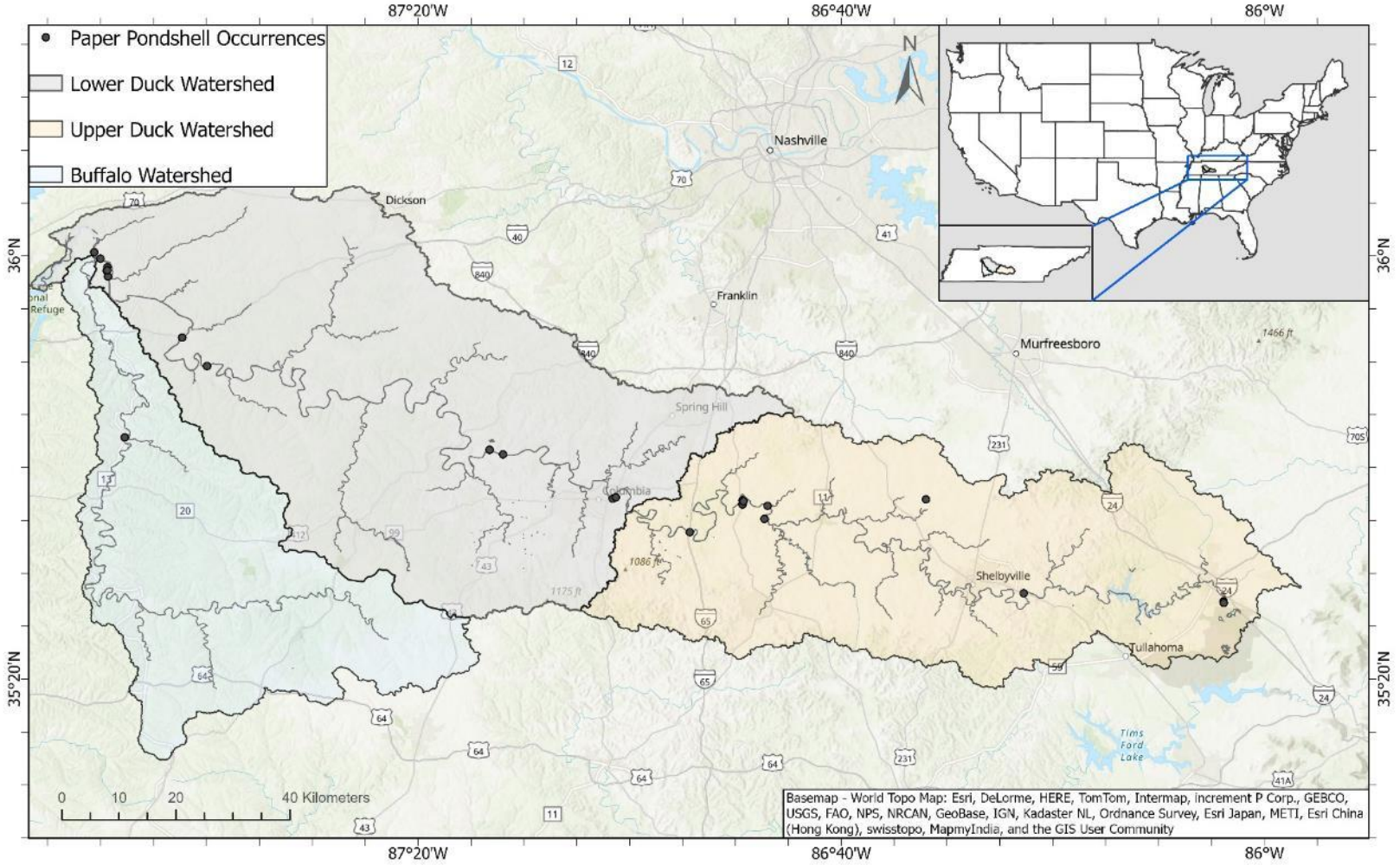
Appendix B72. *Tritogonia verrucosa* (Pistolgrip) distribution in the Duck River drainage.



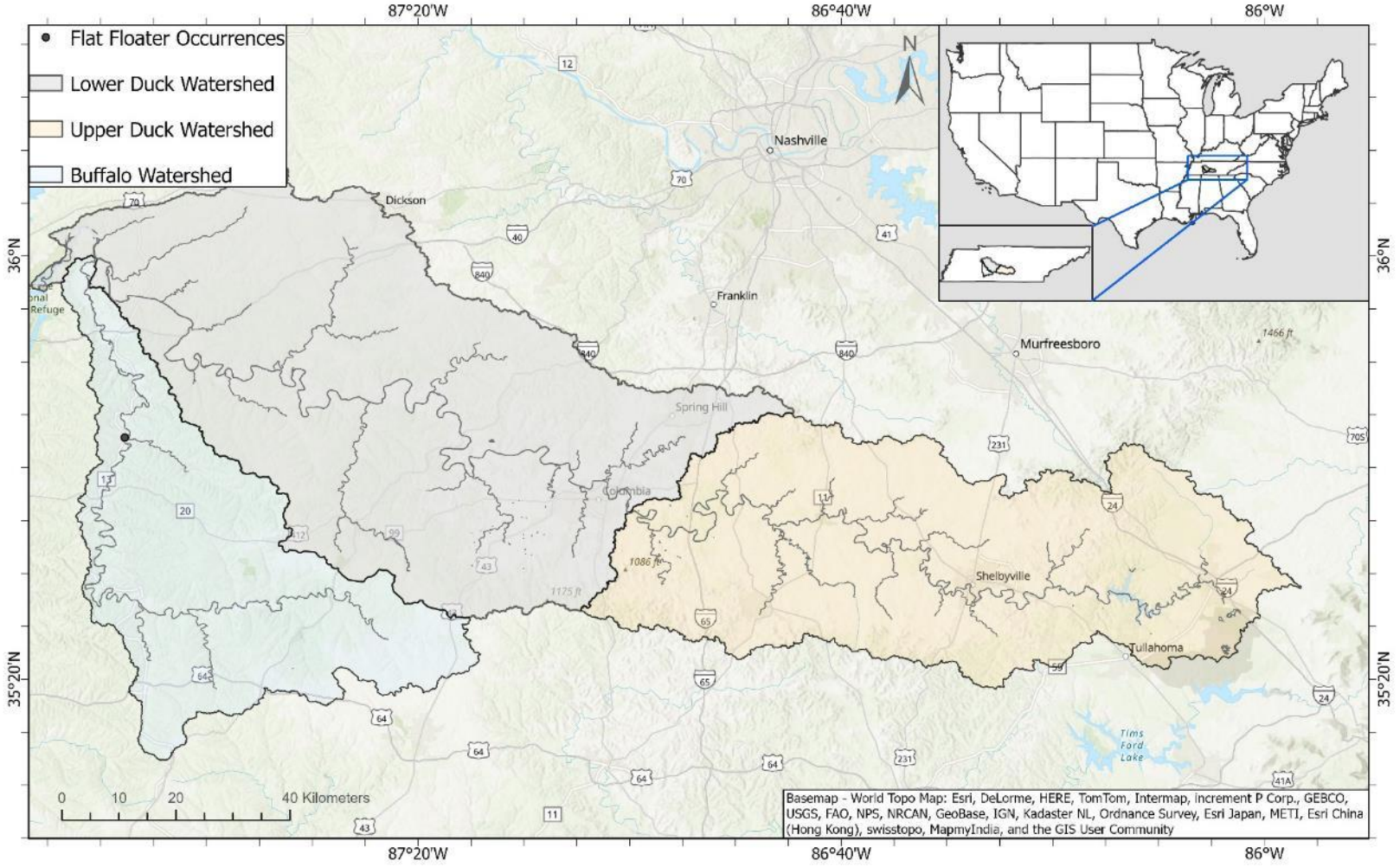
Appendix B73. *Truncilla donaciformis* (Fawnsfoot) distribution in the Duck River drainage.



Appendix B74. *Truncilla truncata* (Deertoe) distribution in the Duck River drainage.



Appendix B75. *Utterbackia imbecillis* (Paper Pondshell) distribution in the Duck River drainage.



Appendix B76. *Utterbackiana suborbiculata* (Flat Floater) distribution in the Duck River drainage.