Missouri Department of Conservation

Resource Science Division

Resource Assessment and Monitoring Program: Standard Operation Procedures -- Fish Sampling

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Introduction

The Missouri Department of Conservation (MDC) is charged with managing Missouri's aquatic resources, and is involved in a variety of activities to improve aquatic habitat and water quality. MDC is also concerned with activities that affect aquatic resources such as gravel mining, sewage treatment, CAFOs, and poor land management practices. However, prior to 2000, MDC did not have a standardized method for determining whether Missouri's aquatic resources were improving, remaining stable, or being further degraded. A statewide bioassessment program would provide MDC a baseline of the current condition of Missouri's aquatic resources, allowing us to determine the effectiveness of our management programs and the seriousness of present and future environmental threats. Thus MDC developed the Resource Assessment and Monitoring (RAM) Program to collect status and trend (change) data on Missouri's wadeable, warmwater streams. The goals and objectives of RAM are as follows --

- Aquatic Resources Status Report -- periodic reports to citizens, and in particular legislators, about the status, condition, and trends of Missouri's aquatic resources.

- Implement Standardized Sampling -- Allow agencies, regions, and divisions to make better decisions because they can more easily share data and make comparisons within and between watersheds. A systematic sampling approach would be legally defensible and more efficient, and would result in better problem identification and resolution through enforcement.

- Create a Reliable Statewide Database -- A common set of data would help many agencies identify, classify, inventory, and characterize aquatic habitats. A baseline would be established for future aquatic resource comparisons. Once enough reliable data are collected, models of aquatic ecosystems could be developed to predict the impacts of various land use practices and other activities within watersheds.

- Provide an Aid Toward Prioritization -- The data would facilitate prioritization of watersheds for conservation, preservation, management, and rehabilitation.

To achieve the program goals and objectives, the following *Standard Operating Procedures--Fish Sampling* manual was developed for the fish sampling component of MDC's RAM program. The RAM fisheries segment is designed to assess biotic integrity, or health, of the fishery based on the following measures:

1. A healthy fishery is defined as one "which has the ability to support and maintain a balanced, integrated, and adaptive community of organisms (fishes) having a species composition, diversity, and functional organization comparable to that of natural habitat of the same region." The biotic integrity of the fish community will be measured by modified versions of the Index of Biotic Integrity (IBI) (Karr et al. 1986) developed for EPA Region VII during the 1994-95 R-EMAP project (Table 1).

2. Habitat is a key component that will be included to further assess the biotic integrity of Missouri streams. Plafkin et al. (1989) stated that in the absence of confounding water quality effects, the relationship between habitat quality and biological impairment is roughly linear. A methodology for physical habitat assessment is presented in *Quantifying Physical Habitat in Wadeable Streams* (Kaufmann et al. 1999).

Reference Reaches

The use of reference reaches is essential for determining biotic health. For this program, reference reaches will be selected to represent the best available habitat, water quality, and biological communities (the reference conditions) of a sampling strata (i.e subregion, ecological drainage unit [EDU]). The characteristics of reference reaches will vary among sampling strata and stream order. Reference reaches / conditions must be selected with care because they establish the basis for making comparisons and for detecting use impairment. The overall goal in the characterization of reference conditions is to describe the optimal biological communities for the region and type of waterbody of interest.

One particularly problematic aspect about the use of reference reaches is what to do if an area (strata) is extensively degraded. Many aquatic systems have been altered through poor land management practices and in channel modifications (i.e., channelization, dredging). In fact, some EDU's may be so disturbed that no reference reach exists. In such cases, it may be necessary to use reference reaches from neighboring EDUs. If we do not allow ourselves this option we run the risk of setting expectations unnecessarily low in highly disturbed areas.

Some of the advantages of using EDU-specific reference reaches are that results can be used to establish reasonable standards, to predict local effects of management practices, to locate monitoring and special study sites, and to provide bounds for extrapolating site specific information. Subregion reference reaches must be selected with care because they also establish the basis for making comparisons and for detecting use impairment. The Missouri Aquatic Gap Program (Sowa 1999) developed a hierarchical classification framework for classifying Missouri's stream resources. At each level in the hierarchy, aquatic ecosystems with distinct biophysical potentials are separated; one such level is the Ecologic Drainage Unit (Figure 1). Such a framework can assist to minimize site variation *a priori*.

Two primary criteria must be used to guide the selection of reference sites:

1. Minimal impact: Sites that are not disturbed or only minimally disturbed by human activities are ideal as reference sites.

2. Representative: Reference reaches must be representative of the streams under investigation, (i.e., those expected to be found in that region).

Other general criteria for selecting stream reference sites include:

- Perennial flow
- Relatively high heterogeneity of substrate materials (fines, gravel, cobbles, boulders)
- Natural channel morphology (typical of the region)
- Natural hydrograph (flow patterns typical of the region)
- Natural water and color
- Benthic macroinvertebrate and fish assemblages typical of that region
- Land use stability (eg. MDC Conservation areas or Natural Areas)
- Geographic location clearly well within the boundaries of the ecoregion
- Biophysical attributes are representative of the EDU

These criteria are not all inclusive and additional information may need to be gathered concerning individual reference sites.

General Procedures for Locating and Assessing a Sample Site

Documentation

Documentation of site information is imperative to the long-term success of RAM. Precise location and stream condition information is needed to enable effective monitoring (i.e., repeat visits over time) and to maintain data integrity. A packet of site information should be generated for each site, and archived in the RAM files.

High Quality Maps:

One map should be of low enough resolution to indicate the sites position within a county. A photocopy of a map from *Missouri's Conservation Atlas* or a Delorme® *Missouri Atlas and Gazetteer*, or a computer generated map with a resolution of about 1:150,000 would be suitable. The names of towns and major highways near the site should be clearly indicated.

A second map of higher resolution (about 1:50,000) should be generated to show the site's position relative to some nearby landmark (e.g. town, highway intersection, stream intersection). Road names or numbers should be written on this map in black ink to allow navigation to the site by novices.

A third map (1:25,000 or less) should be generated to show the position of the site in relation to several bends in the stream. This map should indicate the upper and lower ends of the site.

Internet sites such as Terraserver (www.terraserver.com) and Topozone (www.topozone.com) provide free mapping services with adjustable resolution. However, the stream and county road names on these maps are sometimes incorrect, so be sure to provide the correct information.

Site Description Form:
A site description form (MOSITE1; Figure 2) should be completed for each site. Instructions for completing the form are attached to Figure 2. The site location portion of the form is especially important. A clear narrative description of the location should be provided, and should include features from the maps.

Private Property Access and Documentation:
Permission must be obtained from the property owner for all sites which are on private property, or for which private property must be crossed to access the site. The landowner's name, phone number, address, the date and method of contact, and any notes or instructions from the landowner must be recorded on Form MOPPC (Private Property Contact; Figure 3).

Previous Sample Notes:
Copies of all previous site information including maps, site description form, landowner contact information, species lists, and field notes should be attached to the documentation packet if the site is being revisited. A list of species potentially occurring in the watershed should be given to field crews to assist them in identification of species. These lists can be made by examining range maps in *The Fishes of Missouri*, or from previous sampling efforts in the watershed.

Field Notes:
Field notes about site assessment and sampling should be kept for each site. Notes on assessment should include any landowner comments, interesting features in the watershed (i.e., city sewer, CAFOs, trash dumps), obvious changes from previous visits, and qualitative statements about stream integrity. Sampling notes should include records of effort, electrofishing equipment output readings, equipment calibration values, a statement about the efficiency of sampling with both seine and electricity, and especially any variations from standard procedures. Feel free to record any information, thoughts, or impressions you might have about the site before, during, and after sampling. There is no limit to the amount you can write to describe each site.

Assessing the Stream Sample Reach:
Survey the site according to the following protocol with careful attention to minimize any disturbance to the site. The X-site is the center of the sample reach.

1. Determine channel width near the X-site by measuring the wetted width across the channel with a surveyor's rod or tape measure at 10 places considered to be of "typical width" within 100 m of the X-site. Average the 10 readings and round to the nearest 1 m (record on MOSITE1). Then multiply the average width by 40 to obtain the total sample site length (record on MOSITE1). **Note: In streams < 3.75 m (12 ft) wide, use 150 m (500 ft) as a minimum sample reach length.**

2. Starting from the X-site, measure a distance 20 channel widths in both an upstream and downstream direction from the X-site. Flag each end of the sample reach and block net it.

3. There are some conditions that may require "sliding" the site reach around features (i.e., lake, pond, stream confluence) we do not wish to sample. If such a feature falls within the sample reach, adjust the site (upstream or down) an equivalent distance from the X-site. **Note: For randomly selected sites, do not adjust the reach to avoid man-made features such as bridges, culverts, rip-rap, or channelization. These are features whose effects we are attempting to examine.**

4. Once the boundaries of the sample site have been determined, a semi-permanent marker (i.e., re-bar) should be installed on the stream bank near the X-site. The portion extending out of the ground should be spray-painted fluorescent orange to facilitate location at a later date. The upstream end (U), X-site (X), and downstream end (D) should also be marked on trees in the riparian zone with fluorescent orange paint. A high quality marking paint should be used to ensure persistence of the mark. Cheaper do-it-yourself paints tend to fade to invisibility within one year. The sample site should be sketched (Form MOHSM; Figure 4) and photographed.

To avoid disturbing the sight excessively before sampling, site assessment and marking should be completed prior to the sampling visit if possible.

General Sampling Guidelines

Site Sampling Protocol:

1. Refer to Table 2 for a list of equipment required to complete fish sampling, physical habitat assessment, and establishing site markers. All equipment should be operated in the most effective manner possible with the objective being to collect the entire fish fauna of the sample site in its relative abundance without bias toward taxa or size. Condition of the fish community had the strongest influence on precision of species richness estimates, but condition of the fish community is seldom known before sampling starts. The best way to ensure that samples reflect actual species richness is to use all gears appropriate for the habitat even if some of the gears produce no fishes. Attempt to sample until at least one unique species is captured by each gear. Keep track of species captured by each gear, and repeat sampling until unique species are captured.

2. No person should enter the stream until the sample area is identified and the upper and lower ends of the site are marked and block nets have been set. Deploy the downstream block net first, then walk back upstream overland (not in the stream) and deploy the upstream block net.

3. Seining will be used in conjunction with electrofishing to ensure sampling of those species which may otherwise be underrepresented by an electrofishing survey alone (e.g., darters, sculpins). A good way to do this is to sample each habitat with only the appropriate gear. At minimum, each site should be sampled by electrofishing in pools and runs, 6 ft seine in riffle areas, and 15 ft seine in runs and shallow pools. Any pools deeper than 3.5 ft (waist deep) should be sampled with both the 30 ft seine and a hand towed trawl. The seine will sample water column species and the trawl will sample benthic species. Don't electrofish the riffles, don't use the 15 ft seine in riffles or deep pools, and don't used the 30 ft seine in runs or shallow pools that have been sampled by other gears. Sites with depauperate communities (i.e., headwaters and degraded sites) should be sampled especially thoroughly because low abundance (reduced detection probability) of each species necessitates more effort to accurately estimate species richness. Larger wadeable sites and reference sites should receive more effort as well because occupancy is higher.

4. When all sampling is completed, but before leaving the sample site, the team leader will make sure all data have been collected and recorded on all data sheets or PDA tabs, and that all equipment and samples are accounted for. Additionally, the site maker should be installed and documented on Form MOSITE1 and a photograph taken from mid-stream at the X spot while facing upstream.

Sampling Time Frame:
Sampling of the fish community, water quality, sediment, fish tissue, and the physical habitat assessment should be conducted between 1 June and 15 September when stream flows are generally low, pollution stresses are potentially greatest, and the fish community is most stable and sedentary (Lyons 1992; EPA 1994; Hall et al. 1996; Rabeni et al. 1997). Benthic macroinvertebrates will be collected from 15 September through 15 October, which coincides with stable baseflow conditions prior to peak aquatic insect emergence (Rabeni et al. 1997; Sarver 2001).

Sampling during/after rain events:
We wish to avoid sampling during high flow episodic events because biological and chemical conditions during episodes are quite different from those during baseflow. On the other hand, we cannot restrict sampling to baseflow conditions because this is difficult to define and would greatly restrict the sampling window for RAM. Therefore, if you arrive at a site and it appears to be influenced by episodic conditions, do not sample the site that day -- reschedule another visit. The following general guidelines are provided to help you decide when and when not to sample:

1. The major indicator of episodic influence will be the condition of the stream itself. If it is running at bank full discharge or the water seems much more turbid than typical for the class of stream, do not sample that day.

2. Do not sample if it is unsafe to wade in the wadeable portion of the stream reach.

3. Do not sample during periods of prolonged heavy rains.

4. If the stream seems to be close to normal spring flows, and does not seem unduly influenced by episodic events, go ahead and sample, even if it has recently rained or is raining.

Scheduling:
All sampling should be done during daylight and completed, when possible, in the same workday to minimize temporal variability at the site.

Crew Members:
A fisheries sampling crew will consist of three to four persons. They will be responsible for fish collection, identification, and enumeration, and also for collecting water quality samples and conducting the habitat assessment procedure.

Safety procedures:
Safety is of paramount importance in any study, especially when sampling with electricity in water. All safety equipment (i.e., rubber gloves, waders, hearing protection) will be provided and used by the sampling crew.

General Guidelines for Electrofishing:
Electrofishing equipment should always be set to pulsed DC and should be equipped with a safety cutout switch. Always wear waders and heavy insulated rubber gloves when working with electricity in water.

1. Electrofishing should be conducted after block netting the site and completing all water quality sampling. Select electrofishing equipment based on stream conditions. A single backpack electrofisher (either a Smith-Root LR-24 [12 Ahr, 24V battery] or the SR-15-D [gas Honda generator]) is recommended for use in shallow, narrow (< 3 m) streams. Use tandem backpack electrofishers in wide (> 3 m), shallow streams, streams that are structurally homogenous, or even in streams that prohibit the use of a tote barge (i.e., inaccessible sites, sites with long shallow riffles and isolated pools). The tote barge electrofishing unit is preferred in deeper (0.5 m) wadeable streams that allow tote barge access.

2. Set frequency to 60 Hz, and adjust the voltage output according to sampling effectiveness and incidental mortality of specimens (max. of 6 amps). It is important to test the effectiveness of the unit's settings outside the block netted area before sampling. In case of overload, release the anode switch and adjust voltage and waveform and continue fishing.

3. Start at the downstream end of the sampling reach, and fish in an upstream direction, parallel to the current. Sweep electrodes from side to side in the water sampling all available habitat areas with special attention to undercut banks and snag habitat as well as riffles and pools. Move wand in and out of large snags or deep cuts to draw fish out.

4. Persons operating the shocker should net fish while shocking, and additional netters follow along beside or slightly behind the operator netting stunned fish which are then deposited in separate buckets or flow-through holding pens.

5. If fishes show signs of stress, stop at intervals and work up catch. Be sure to release fishes downstream of the block nets to reduce likelihood of resampling. This should only be necessary on very warm days, in long reaches, or if very large numbers of fishes are collected.

6. Separate and store fishes by capture gear.

General Guidelines for Seining:

Seine all the wadeable areas of the sample site once or twice using an appropriate length seine. Concentrate on habitat features that might produce species not captured with the electrofisher such as riffles, undercut banks, debris piles, boulder fields, and open water. Each of these habitats harbor species that are undersampled by electrofishing. If necessary, use additional block nets or seines to section-off small, seinable portions of the sample site.

Conduct kicknet sampling to capture benthic species that are difficult to capture while electrofishing. Set the net perpendicular to the current with the lead line on the bottom. In streambeds composed of cobble or boulder, take a few moments to push the lead line down into the substrate with your feet, and to move large stones to ensure the lead line is completely contacting the bottom. Tilt the net back slightly to form a pocket for trapping fish. One or 2 crew members start 2 m upstream from the net and disturb the substrate by shuffling their feet and overturning rocks while moving downstream to the lead line. The disturbance, or "kicking," should end at the lead line and not before. Raise the net quickly and then carefully examine it for fish. The entire operation from starting the kick to lifting the net should only take 30 to 60 seconds. A mobile variation of kick seining is useful for capturing benthic species in still, slow moving, or backwatering areas where net pocket formation is impossible. With this method, two people pull the seine rapidly through the water while one or more kickers disturb the substrate as described above while staying just in front of the seine. A third variation of kick seining is necessary for seining undercut banks and debris piles. Wrap enough net around each pole to eliminate the gap usually found there and surround a root wad or debris pile. If current is present, be sure to set the seine downstream of the target area. One or more seiners should then put one leg over the net and vigorously stomp the undercut bank or debris pile. Lift the seine rapidly after the entire area has been thoroughly stomped. Crew members will have to carefully sort through the gravel or detritus that often accumulates in the net. Kicknet sampling should be performed in all riffle and run areas of the stream reach, as well as wherever there are coarse substrates or detritus.

. Sweep seining is conducted to capture water column species that are difficult to capture while electrofishing. Sweep seining consists of pulling the net through an area in any direction with the lead line just above the substrate. In flowing areas, seine with or across the current. The seiner farthest from shore should be about one half seine length ahead of the near shore seiner when seining along the shore, but seiners should remain even while seining in open water. Try to end each haul in a backwater or against any feature that allows you to trap the fish and smoothly pull the seine to shore. It is also possible to lift the net in mid-water, but this must be done as fast as possible (usually at a run). The

species you capture are determined by the speed of your seine haul. Shiners, suckers, black bass, and temperate bass are most often captured only in fastest hauls, and minnows, topminnows, sunfish, catfish, and most other species are captured in slower hauls. Any pools deeper than 3.5 ft (waist deep) should be sampled with both the 30 ft seine and a hand towed trawl. The seine will sample water column species and the trawl will sample benthic species.

Fish Data Recording Procedures:

All fish species will be coded with MDC taxonomic codes for internal reporting purposes and database searches. Common fish names will be those referenced in Pflieger (1997), while taxonomic names will be those referenced in Nelson et al. (2004). Naming conventions will be updated as they occur and are generally accepted by MDC. MDC codes can be found in Appendix 1.

Once the sample reach has been completely fished, the sampling crew should record the fish field data using Form MOFISH1 (Figure 5). The sampling crew should also observe and record the following information:

- Electrofishing time: record in seconds
- Seining time by net: record in minutes
- Percentage of sample reach electrofished: estimate percent of area actually sampled
- Percentage of sample reach seined: estimate percent of area actually sampled
- Percentage of sample reach wadeable: estimate percent of site which was wadeable

Fish Processing Procedures (post-sampling):

It is essential to maintain data consistency and to maintain high data quality. Therefore, all data collection tasks (especially fish identification) should only be performed by personnel who are trained for that task and/or whom have had sufficient field experience to accomplish the task in a professional manner. Tasks may be delegated to less experienced personnel if direct training and oversight of the work is provided by trained professionals.

All fishes collected for this project will be considered to fall into one of two groups, "EZ" fishes and "ID" fishes. EZ fishes are those fishes which, based upon their large size and/or easily recognized characteristics, can easily and confidently be identified in the field. ID fishes are those which due to their small size and/or indistinguishable characteristics cannot be easily and confidently identified to species level in the field (such as Minnows and Darters). Fish need only be identified to species level in the field, as subspecies are generally found in mutually exclusive sub-basins in Missouri. Subspecies designations can be added later by program participants who wish to recognize this level of taxonomy. Maps of currently recognized subspecies distributions are provided in Appendix 2.

During sample collection, fishes captured by each gear type should be kept separated, and EZ fishes will be kept separate from ID fishes. One way to do this is to carry perforated Zip-lock bags and formalin jars during the seining effort and preserve ID fishes in bags labeled by gear as you sample. EZ fishes should be kept in a separate floating pen for each gear. Upon completion of sampling, all EZ specimens will be identified to species, counted, and the data recorded on Form MOFISH1. All EZ fishes not retained for vouchers should be released at the sample site.

All ID fishes will be preserved and identified by MDC staff at MDC's Resource Science Center. The data from this group should be added to that of the EZ fishes on Form MOFISH1.

Preservation of "ID" Fishes:

Preparation of a voucher sample of ID fishes will be performed for all sample sites where these fishes are collected. A voucher sample will consist of all the specimens within the ID holding pen. The fish ID sample should be preserved by gently placing the sample into a quart or gallon container(s) filled up to 50% full with concentrated (100%) formalin; dependent upon fish biomass in jar. The sample should be labeled, the data recorded, and the sample packed for storage and transport.

Collection of Tissue Samples for Genetic Analysis:
Genetic samples from certain fish and crayfish species are needed from various locations around the state. Crews participating in the RAM program may occasionally be asked to collect these samples. If so, the crew will be provided with a list of species and the areas that samples are needed from. Generally, a very small tissue sample (fin clip) is all that is needed, and individuals can be released. Every effort should be made to avoid contaminating the sample with foreign DNA. The standard procedure for collecting a clean DNA sample in the field involves sterilizing equipment at each step of use. Before collecting a sample, rinse all tools and hands in clear stream water and wipe with a clean cloth. Next select an individual for sampling and rinse it in clear stream water. Dip scissors and tweezers in denatured alcohol, then flame with a lighter. Properly sanitized tools will flame for several seconds as alcohol burns off. The crew member holding the subject should cut the sample while another crew member grasps the sample with tweezers and transfers it to a sample vial. Rinse and wipe all equipment after the sample has been collected. Make sure that each vial is labeled such that the species it contains and collection locality information can be traced. Samples should be stored in a cooler or freezer until delivered to Jeff Koppleman at the Resource Science Center in Columbia, MO.

Quality Assurance Procedures
To improve quality assurance procedures, all team members will receive training prior to each field season. The training will incorporate both a classroom setting and a practical exercise component. The class room segment will include reviewing the project plan, procedures, and SOP manuals. The practical exercise component will include a mock run of an actual sampling site.

The field team leader is responsible for the daily observance of field QA/QC procedures such as calibration of field instruments, following the procedures of the project plan, collection of duplicate samples, etc. In addition, at least one field audit will be performed on each sampling team per year by MDC's field audit person to assure compliance with the overall QA/QC procedures. The field audit will examine the following:

- Site entry and marking protocols and verification with GPS
- Sample collection procedures
- Sample preservation and handling procedures
- Correct identification of EZ group fish species
- Calibration of field instruments
- Flow measurement technique
- Habitat evaluation procedures

From these audits, an audit report will be prepared at the end of the project period by the RAM project coordinator. The audit report will summarize all the significant findings of each audit and will be included as part of the final project report. Also, when audits show unacceptable practices or performance, the project coordinator will require corrective actions be performed immediately.

Data Handling Procedures
Data can be recorded with 2 different media, paper forms or electronic forms (presently available for Trimble Rangers). All the field data forms, field sheets, and other documents generated by this project (raw field data) will be completed by the field team, then checked for accuracy and completeness by the field team leader. If 99% accuracy and 95% completeness are achieved for this raw field data, the field team leader will then validate (approve) the data for entry or download into an electronic database.

These electronic databases will then be checked for completeness and accuracy against the raw field data forms by the field team leader. This may be done by randomly spot-checking approximately 10% of the data and/or screening the upper and lower 5% of the data values. If 99% accuracy and completeness are achieved in the electronic databases, the team leader may approve the data for use in analysis.

The project coordinator will then check this data for accuracy and completeness. If 99% accuracy and 95% completeness are achieved in the database, the project coordinator may approve the data for use in analysis. This data will then be imported into SAS or other software packages for statistical analyses and graphical presentation.

Final data sets will include biological taxonomic codes from MDC's internal coding system for fish, and MDNRs internal species coding system for benthic invertebrates. The use of several taxonomic codes will allow for data transfer, compatibility, and use between agencies.

Data Analysis

It is important to note that the data collected in this project are observational data, and not the result of testing hypotheses by formal experiments. As a result, the data may be used to find associations, but are inappropriate for determining causality. Any associations found in the data will be discussed in terms of "possible cause" rather than "probable cause".

A stream fish IBI score will be calculated for each site using a series of SAS programs (SAS 1996) that were originally developed by EPA for the 1994-1995 R-EMAP Region 7 project. Fish species tolerance, spawning, and trophic guilds are presented in Appendix 1. Metrics are calibrated for stream size by using watershed area, and metrics are calibrated by Ecoregion. Physical habitat data will be analyzed with SAS programs developed by Kaufmann et al. (1999).

Data should be stored in Microsoft Access tables that are designed to be read by IBI and physical habitat programs. Templates of all tables are available from Matt Combes, matt.combes@mdc.mo.gov.

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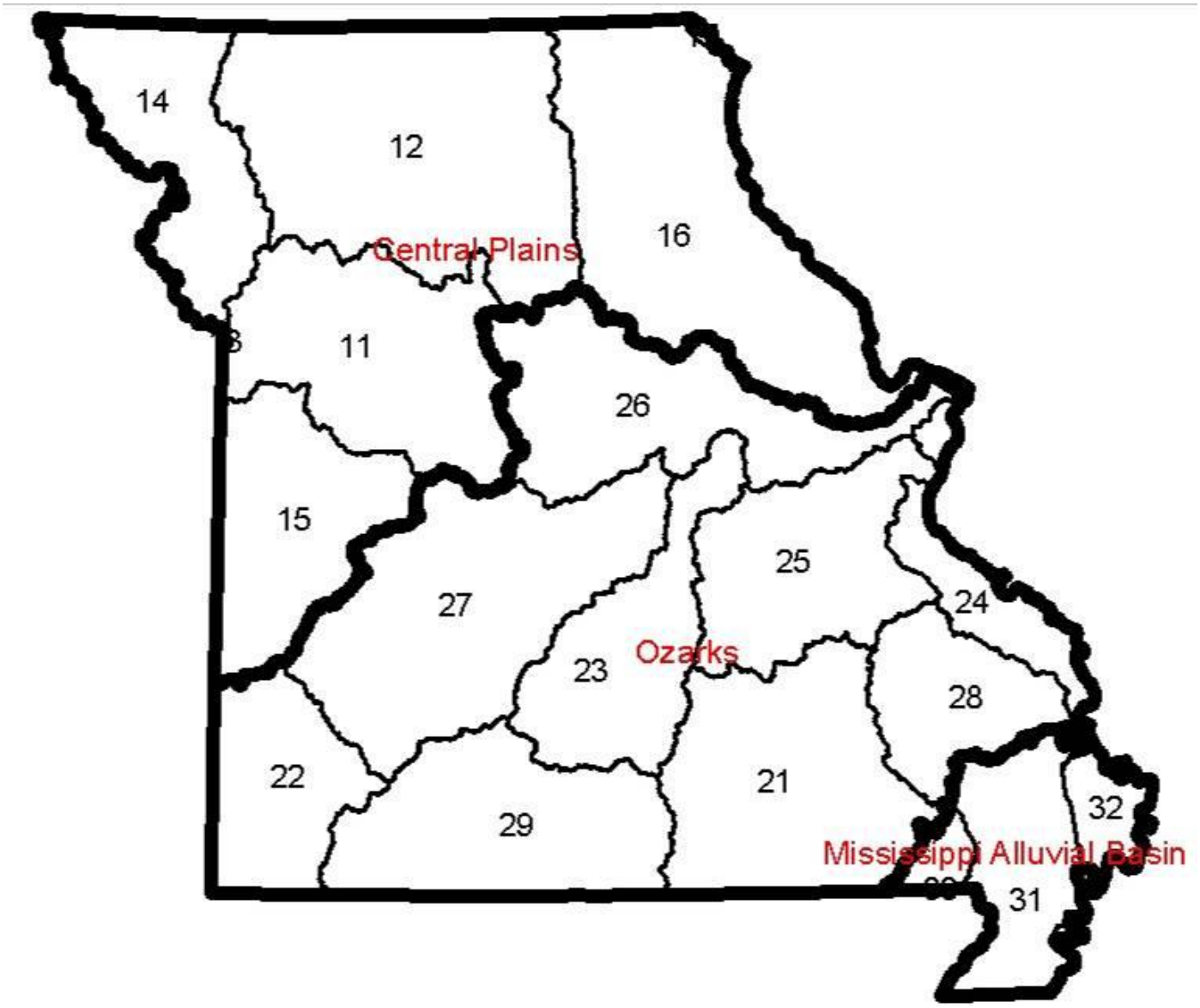


Figure 1. Map of Missouri's Subregions (in red) and Ecological Drainage Units (EDUs, numbers).

Figure 2. Site Description Form (MOSITE1).

Stream _____ (County = _____)

1. Site #: _____ 2. Date surveyed: _____

3. USGS Quad Name: _____ 4. Ecoregion: _____ 5. EDU _____

6. Site location (Narrative and/or legal description):_____

_____

_____

_____

7. X-site lat/long (from map): _____

8. Township/Range/Section: _____

9. GPS UTM coordinates: _____

10. Avg. channel width: _____

11. Sample site length: _____

12. Sample site length based on (circle one): 1) width x 40; 2) 150m; or 3) 300m

13. Stream order: _____

14. Landowner name, address, phone #: _____

_____

_____

15. Landowner contact date and method: _____

16. Site photo taken: _____ 15. Backpack/Tote barge:_____

17. Land use in area:

18. Disturbances in area:

19. Misc. comments:

INSTRUCTIONS FOR COMPLETING THE MOSITE1 FORM

1. Stream name - Provide name of the stream.

2. County Code - Enter the correct county code (see next page).

3. Site # - Enter the 6-digit STORET number assigned for each sample site (refer to field sheet for a pre-assigned #). If the sample site is an existing reference site and has already been sampled and identified in STORET, provide the existing number.

4. Date surveyed - enter as year, month, day format.

5. USGS Quadrangle Name - Name of the USGS Quadrangle (Quad) map on which the sample site is located. If the site is on more than one quad, enter the quad which contains the X-site.

6. EDU Code: Enter the correct Ecological Drainage Unit code (See Attachment X).

7. Ecoregion code (assigned by EPA).

8. Site location - Provide a good description of the stream site location.

9. X-site lat/long from map: - Enter the longitude and latitude of the X-site from map.

10. Township/Range/Section - Enter legal description of site (T/R/S).

11. GPS UTM coordinates – Enter longitude and latitude of the X-site from GPS unit.

12. Avg. channel widths – Enter the average channel width of the reach.

13. Sample Site Length - Record the length of the sample reach in meters.

14. Sample Site Length Based on: check the appropriate category - avg. width X 40, the (min)imum distance of 150 meters, or the (max)imum distance 300 meters.

15. Stream order: Record the Strahler order of the stream within the sample reach.

16. Record the name, address and telephone number of the landowner or the person granting permission to access the sample site.

17. Contact date & method: T = telephone, P = in person, W = written communication

18. Site Photo - If a photo has been taken of the site, enter Y and submit the photo with the other site documents. If not, enter N.

19. Sample method: Indicate whether this site is suitable for 1 or 2 backpacks or totebarge electrofishing.

20. Report the land uses visible from the site, record any watershed disturbances visible from stream reach, and provide any miscellaneous comments including a description of the site markers.

EPA state and county codes.

State code (Missouri): 29

Code	County	Code	County	Code	County
001	Adair	067	Douglas	133	Mississippi
003	Andrew	069	Dunklin	135	Moniteau
005	Atchison	071	Franklin	137	Monroe
007	Audrain	073	Gasconade	139	Montgomery
009	Barry	075	Gentry	141	Morgan
011	Barton	077	Greene	143	New Madrid
013	Bates	079	Grundy	145	Newton
015	Benton	081	Harrison	147	Nodaway
017	Bollinger	083	Henry	149	Oregon
019	Boone	085	Hickory	151	Osage
021	Buchanan	087	Holt	153	Ozark
023	Butler	089	Howard	155	Pemiscot
024	Caldwell	091	Howell	157	Perry
027	Callaway	093	Iron	159	Pettis
029	Camden	095	Jackson	161	Phelps
031	Cape Girardeau	097	Jasper	163	Pike
033	Carroll	099	Jefferson	165	Platte
035	Carter	101	Johnson	167	Polk
037	Cass	103	Knox	169	Pulaski
039	Cedar	105	Laclede	171	Putnam
041	Chariton	107	Lafayette	173	Ralls
043	Christian	109	Lawrence	175	Randolph
045	Clark	111	Lewis	177	Ray
047	Clay	113	Lincoln	179	Reynolds
049	Clinton	115	Linn	181	Ripley
051	Cole	117	Livingston	183	St Charles
053	Cooper	119	McDonald	185	St Clair
055	Crawford	121	Macon	187	St Francois
057	Dade	123	Madison	189	St Louis
059	Dallas	125	Maries	193	Ste Genevieve
061	Daviess	127	Marion	195	Saline

063	De Kalb	129	Mercer	197	Schuyler
Code	County	Code	County	Code	County
065	Dent	131	Miller	199	Scotland
201	Scott	211	Sullivan	221	Washington
203	Shannon	213	Taney	223	Wayne
205	Shelby	215	Texas	225	Webster
207	Stoddard	217	Vernon	227	Worth
209	Stone	219	Warren	229	Wright

Figure 3. Private Property Contact Form (MOPPC).

Private Property Contact Form

Name:

Phone number:

Address:

Date Contacted:

Permission to access: Yes No

Need to contact for each visit: Yes No

Is property lock-gated: Yes No

Comments:

Figure 4. Habitat Sketch Map Form (MOHSM).

Habitat Sketch Map

Stream name:_____ Site #:_____

Date:_____ Biologists:_____

Site description:

Figure 5. Fish Field Data Sheet (MOFISH1).

MDC Resource Assessment & Monitoring Fish Data Sheet

Date: ____________ Time: ____________ County: ____________ Site # ____________

Stream: ______________________________ Locality: ______________________________

Biologists: ______________________________

EF time: %EF: Seine time: [on back] %Seined: BPJ @ sample rep: Yes / No [circle one] Tote barge / Backpack 1 or 2 [circle one]

Electrofishing Data

Total Species Total Species

individuals # species

Comments:

SEINE DATA ON BACK

Seine Data

#Riffles seined: ___ #Pools seined: ___ Seining time: ___ %Seined: ___ Seine size(s): ___

Total Species

Total Species

____ # individuals ____ # species

Comments:

Table 1. A multimetric index of biotic integrity (IBI) developed for Missouri. Metrics are calibrated for stream size by using watershed area and subregion.

Number of Individuals Collected
Number of Native Species
Number of Native Minnow Species
Number of Native Sunfish Species
Number of Native Benthic Species (including round bodied suckers)
Number of Native Water Column Species
Number of Long-lived species (expected life span $>$ 4 yrs)
Proportion of Tolerant Individuals
Proportion of Individuals as Carnivores
Proportion of Individuals as Insectivores and Invertivores
Proportion of Individuals as Omnivores and Herbivores

Table 2. Field equipment inventory list

- Backpack electroshocker
  - electrodes and anodes
  - battery charger
- Tote barge
  - generator (120 or 240 V AC with DC pulsed current)
  - shock box
  - electrodes
  - gasoline
  - oil
- Dip nets (4) with 1/4" mesh netting
- Floating fish holding pens with 1/4" mesh (2)
- Block nets
  - 2 - 60' x 6' x 1/4" mesh
  - 2 - 30' x 4' x 1/4" mesh
- Stakes and weights (3 sets) for setting block nets
- Seines:
  - 30' x 8' x 1/4" mesh drag seine
  - 15' x 6' x 1/4" mesh drag seine
  - 6' x 4' x 1/8" mesh kick seine
  - Mini Missouri trawl
- Formalin (approx 0.5 gal / site)
- Quart and gallon wide-mouth glass sample specimen containers with labels (2 / site)
- Fish taxonomic key (Fishes of MO)
- Ethanol, lighter, vials, and scissors for genetic samples if needed
- 100-m tape
- Directional compass
- GPS unit
- 6' re-bar stakes to mark site
- Safety equipment:
  - rubber gloves (5 pr) for insulation against electricity
  - waders
  - hearing protection
  - sunglasses
  - insect repellent
  - sunscreen
  - Technu
- Data sheets & clipboard or
- Trimble Ranger with current RAM data entry forms installed

Appendix 1. Fish species environmental tolerances, spawning guilds, trophic guilds, ITIS and MDC species codes.

IT IS Code	MDC Code	Common Name	Species Type	Foraghab	Tol	Trophic	Reproductive
	0	NO FISH					
159730	1	SILVER LAMPREY		SB		PISC	LITHO-A2
159725	2	CHESTNUT LAMPREY		SB	T	PISC	LITHO-A2
159708	3	AMERICAN BROOK LAMPREY		SB	I	FILT	LITHO-A2
159705	4	LEAST BROOK LAMPREY		SB	I	FILT	LITHO-A2
	5	ICHTHYOMYZON SP.					
159726	6	NORTHERN BROOK LAMPREY		SB	I	FILT	LITHO-A2
161088	7	PADDLEFISH		WC		FILT	LITHO_A1
159727	8	SOUTHERN BROOK LAMPREY		SB	I	FILT	LITHO-A2
	9	LAMPETRA SP.					
161071	10	LAKE STURGEON		LB		BINV	LITHO_A1
161082	11	SHOVELNOSE STURGEON		LB		BINS	LITHO_A1
161081	12	PALLID STURGEON		LB		BINS	LITHO_A1
	13	STURGEON FAMILY					
	14	AMMOCOETE					
161097	15	ALLIGATOR GAR		WC		PISC	PHYTO_A1
161096	16	SHORTNOSE GAR		WC	T	PISC	PHYTO_A1
161095	17	SPOTTED GAR		WC		PISC	LITHO_A1
161094	18	LONGNOSE GAR		WC		PISC	LITHO_A1
	19	GAR SP.					
161104	20	BOWFIN		G		INVPISC	PHYTO_B2
	21	HIODON SP.					
161906	22	MOONEYE		WC		PISC	LITHO_A1
161905	23	GOLDEYE		WC		PISC	LITHO_A1

161707	24	SKIPJACK HERRING		WC		PISC	
	25	ALOSA SP.					
161705	26	ALABAMA SHAD		WC		PISC	
	27	DOROSOMA SP.					
161737	28	GIZZARD SHAD		WC	T	MICOMNI	LITHO_A1
161738	29	THREADFIN SHAD		WC		MICOMNI	LITHO_A1
161989	30	RAINBOW TROUT		WC		INS	LITHO_A2
	31	TROUT SP.					
161997	32	BROWN TROUT		G		INVPISC	LITHO_A2
	33	BULL SHARK					
163956	35	BIGMOUTH BUFFALO	Catostomid	LB		BMACOMNI	PHYTO_A1
163957	36	BLACK BUFFALO	Catostomid	LB		BMACOMNI	PHYTO_A1
163955	37	SMALLMOUTH BUFFALO	Catostomid	LB		BMACOMNI	LITHO_A1
	39	BUFFALO SP.					
163917	40	QUILLBACK	Catostomid	LB		BMACOMNI	LITHO_A1
163919	41	RIVER CARPSUCKER	Catostomid	LB	T	BMACOMNI	LITHO_A1
163920	42	HIGHFIN CARPSUCKER	Catostomid	LB	I	BMACOMNI	LITHO_A1
	45	CARPSUCKER SP.					
163953	47	BLUE SUCKER	Catostomid	LB		BINS	LITHO_A1
163895	49	WHITE SUCKER	Catostomid	LB		BMACOMNI	LITHO_A1
163949	53	NORTHERN HOG SUCKER	Catostomid	LB		BINV	LITHO_A2
163922	55	LAKE CHUBSUCKER	Catostomid	WC		INV	PHYTO_A1
163924	56	CREEK CHUBSUCKER	Catostomid	WC		INV	LITHO_A1
163959	58	SPOTTED SUCKER	Catostomid	LB		BINV	LITHO_A2
163938	60	BLACK REDHORSE	Catostomid	LB		BINV	LITHO_A2
163928	61	SHORTHEAD REDHORSE	Catostomid	LB		BINV	LITHO_A2
163939	62	GOLDEN REDHORSE	Catostomid	LB		BINV	LITHO_A2
163933	63	SILVER REDHORSE	Catostomid	LB		BINV	LITHO_A2

163936	67	RIVER REDHORSE	Catostomid	LB		BINV	LITHO_A2
	69	REDHORSE SP.					
163344	70	COMMON CARP	Cyprinid	LB	T	BMACOMNI	PHYTO_A1
163350	71	GOLDFISH	Cyprinid	LB	T	BMACOMNI	PHYTO_A1
	72	CHUB SP.					
163395	73	HORNYHEAD CHUB	Cyprinid	WC		INV	LITHO_B2
163864	74	SHOAL CHUB	Cyprinid	SB		BINS	
163870	75	SILVER CHUB	Cyprinid	SB		BINS	UNKNOWN
163475	76	BIGEYE CHUB	Cyprinid	WC		INS	UNKNOWN
163537	77	GRASS CARP	Cyprinid	WC		HERB	
163691	78	SILVER CARP	Cyprinid	WC	T	MACOMNI	
163692	79	BIGHEAD CARP	Cyprinid	WC	T	MACOMNI	
163824	80	GRAVEL CHUB	Cyprinid	SB		BINS	LITHO_A1
163822	82	OZARK CHUB	Cyprinid	SB	I	BINS	LITHO_A1
	83	BLACK CARP	Cyprinid	WC	T	MACOMNI	
163882	84	FLATHEAD CHUB	Cyprinid	SB		BINS	UNKNOWN
163866	85	STURGEON CHUB	Cyprinid	SB		BINS	UNKNOWN
163868	87	SICKLEFIN CHUB	Cyprinid	SB		BINS	UNKNOWN
163394	89	REDSPOT CHUB	Cyprinid	WC		INV	LITHO_B2
163376	90	CREEK CHUB	Cyprinid	G		INVPISC	LITHO_B2
	91	TENCH					
163593	92	SOUTHERN REDBELLY DACE	Cyprinid	SB		BMICOMNI	NESTASSO
163876	94	PUGNOSE MINNOW	Cyprinid	WC		INS	LITHO_B1
163613	95	RUDD	Cyprinid	WC		OMNI	PHYTO_A1
163368	96	GOLDEN SHINER	Cyprinid	WC		MACOMNI	PHYTO_A1
163853	97	RIBBON SHINER	Cyprinid	WC		UNKNOWN	UNKNOWN
163861	98	WESTERN REDFIN SHINER	Cyprinid	WC		INS	NESTASSO
163861	99	EASTERN REDFIN SHINER	Cyprinid	WC		INS	NESTASSO

163412	105	EMERALD SHINER	Cyprinid	WC		INS	LITHO_A1
163828	108	CARDINAL SHINER	Cyprinid	WC		INS	NESTASSO
163840	109	BLEEDING SHINER	Cyprinid	WC		INS	NESTASSO
163838	111	DUSKYSTRIPE SHINER	Cyprinid	WC		INS	NESTASSO
	112	LUXILUS SP.					
163409	114	CARMINE SHINER	Cyprinid	G		INS	NESTASSO
163836	115	COMMON SHINER	Cyprinid	WC		MACOMNI	NESTASSO
163832	116	STRIPED SHINER	Cyprinid	WC		MACOMNI	NESTASSO
163429	122	RIVER SHINER	Cyprinid	WC		INS	LITHO_A1
163443	124	WEDGESPOT SHINER	Cyprinid	WC		INS	LITHO_A1
163417	125	SILVERBAND SHINER	Cyprinid	WC		UNKNOWN	UNKNOWN
163470	126	TELESCOPE SHINER	Cyprinid	WC		INS	LITHO_A1
	129	NOTROPIS SP.					
163403	130	IRONCOLOR SHINER	Cyprinid	WC	I	INS	LITHO_A1
163420	132	WEED SHINER	Cyprinid	WC		MICOMNI	UNKNOWN
	133	CYPRINELLA SP.					
163809	134	BLACKTAIL SHINER	Cyprinid	WC		INS	LITHO_B1
163782	136	WHITETAIL SHINER	Cyprinid	WC	I	INS	LITHO_B1
163803	138	SPOTFIN SHINER	Cyprinid	WC		INS	LITHO_B1
163811	140	STEELCOLOR SHINER	Cyprinid	WC		INS	LITHO_B1
163776	142	BLUNTFACE SHINER	Cyprinid	WC		INS	LITHO_B1
163792	144	RED SHINER	Cyprinid	G	T	INV	NESTASSO
163463	145	SABINE SHINER	Cyprinid	SB		BINS	LITHO_A1
163411	146	PALLID SHINER	Cyprinid	WC		UNKNOWN	UNKNOWN
163439	148	BIGMOUTH SHINER	Cyprinid	SB		BINS	LITHO_A1
163430	150	BIGEYE SHINER	Cyprinid	WC		INS	UNKNOWN
163454	152	TAILLIGHT SHINER	Cyprinid	WC		INV	UNKNOWN
163458	154	OZARK SHINER	Cyprinid	WC	I	INS	UNKNOWN

163446	156	BLACKNOSE SHINER	Cyprinid	WC	I	INS	LITHO_A1
163471	158	TOPEKA SHINER	Cyprinid	WC		INS	NESTASSO
163404	160	SPOTTAIL SHINER	Cyprinid	WC		GEN	PHYTO_A1
163419	162	SAND SHINER	Cyprinid	SB		BINS	LITHO_A1
163421	170	MIMIC SHINER	Cyprinid	WC		INS	PHYTO_A1
163491	172	CHANNEL SHINER	Cyprinid	WC		INS	UNKNOWN
163414	174	GHOST SHINER	Cyprinid	WC		INS	LITHO_A1
163502	180	SUCKERMOUTH MINNOW	Cyprinid	SB		BINS	LITHO_A1
163478	182	SILVERJAW MINNOW	Cyprinid	WC		BINS	UNKNOWN
163456	184	OZARK MINNOW	Cyprinid	SB		BHERB	NESTASSO
163364	186	CYPRESS MINNOW	Cyprinid	SB		BMICOMNI	LITHO_A1
163360	187	MISSISSIPPI SILVERY MINNOW	Cyprinid	SB		BMICOMNI	LITHO_A1
163362	188	WESTERN SILVERY MINNOW	Cyprinid	SB		MICOMNI	LITHO_A1
163361	190	PLAINS MINNOW	Cyprinid	SB		BMICOMNI	UNKNOWN
163363	192	BRASSY MINNOW	Cyprinid	SB		BMICOMNI	PHYTO_A1
	193	HYBOGNATHUS SP.					
163518	194	BULLHEAD MINNOW	Cyprinid	SB		BINS	LITHO_B1
163519	196	WESTERN SLIM MINNOW	Cyprinid	G		INS	UNKNOWN
163519	197	EASTERN SLIM MINNOW	Cyprinid	G		INS	UNKNOWN
163516	198	BLUNTNOSE MINNOW	Cyprinid	SB		BMACOMNI	LITHO_B1
163517	200	FATHEAD MINNOW	Cyprinid	SB	T	BMACOMNI	LITHO_B1
	201	PIMEPHALES SP.					
	205	STONEROLLER SP.					
163509	206	LARGESCALE STONEROLLER	Cyprinid	SB		BHERB	LITHO_B2
163508	207	CENTRAL STONEROLLER	Cyprinid	SB		BHERB	LITHO_B2
163998	230	CHANNEL CATFISH	Ictilurid	LB		BGEN	LITHO_B2
163997	232	BLUE CATFISH	Ictilurid	LB		PISC	LITHO_B2
	233	CATFISH SP.					

164039	235	BLACK BULLHEAD	Ictilurid	LB	T	BMACOMNI	LITHO_B2
164037	236	WHITE CATFISH	Ictilurid	LB		OMNI	LITHO_B2
164041	240	YELLOW BULLHEAD	Ictilurid	LB		BMACOMNI	LITHO_B2
164043	241	BROWN BULLHEAD	Ictilurid	LB		BMACOMNI	LITHO_B2
	242	BULLHEAD SP.					
164029	245	FLATHEAD CATFISH	Ictilurid	LB		INVPISC	LITHO_B2
164023	246	NEOSHO MADTOM	Ictilurid	SB		BINS	LITHO_B2
164013	247	STONECAT	Ictilurid	SB		BINS	LITHO_B2
164003	248	TADPOLE MADTOM	Ictilurid	SB		BINS	LITHO_B2
164005	249	FRECKLED MADTOM	Ictilurid	SB		BINS	LITHO_B2
164010	250	SLENDER MADTOM	Ictilurid	SB		BINS	LITHO_B2
164020	251	BRINDLED MADTOM	Ictilurid	SB		BINS	LITHO_B2
164011	252	CHECKERED MADTOM	Ictilurid	SB		BINS	LITHO_B2
164006	253	OZARK MADTOM	Ictilurid	SB		BINS	LITHO_B2
164009	254	MOUNTAIN MADTOM	Ictilurid	SB		BINS	LITHO_B2
	255	NOTURUS SP.					
162153	259	CENTRAL MUDMINNOW		WC		INS	PHYTO_A1
162142	260	GRASS PICKEREL		WC		PISC	PHYTO_A1
162143	262	CHAIN PICKEREL		WC		PISC	PHYTO_A1
162144	263	MUSKELLUNGE		WC		PISC	PHYTO_A1
162139	264	NORTHERN PIKE		WC		PISC	PHYTO_A1
	268	ESOX SP.					
161127	270	AMERICAN EEL		SB		INVPISC	
	274	FUNDULUS SP.					
165660	275	NORTHERN STUDFISH		G		INV	LITHO_A1
165666	277	PLAINS TOPMINNOW		WC		INS	PHYTO_A1
165652	278	GOLDEN TOPMINNOW		WC		INS	
165672	280	STARHEAD TOPMINNOW		WC		INS	UNKNOWN

165663	282	BLACKSTRIPE TOPMINNOW		WC		INS	PHYTO_A1
165655	284	BLACKSPOTTED TOPMINNOW		WC		INS	PHYTO_A1
165658	286	NORTHERN PLAINS KILLIFISH		G		INS	LITHO_A2
165878	290	WESTERN MOSQUITOFISH		WC	T	INV	BEARERC2
162041	291	RAINBOW SMELT		WC		OMNI	LITHO_A1
164394	295	OZARK CAVEFISH		WC		GEN	
164399	296	SOUTHERN CAVEFISH		WC		PLANK	
201968	297	SPRING CAVEFISH		WC		GEN	
164409	300	TROUT-PERCH		SB		BINS	LITHO_A1
164405	305	PIRATE PERCH		WC		INV	LITHO_B2
	309	WHITE PERCH		WC		PISC	LITHO_A1
167682	310	WHITE BASS		WC		PISC	LITHO_A1
167683	312	YELLOW BASS		WC		PISC	LITHO_A1
167680	313	STRIPED BASS		WC		PISC	LITHO_A1
	314	MORONE SP.					
168469	315	YELLOW PERCH		WC		INVPISC	PHYTO_B1
168509	316	SAUGER		WC		INVPISC	LITHO_A1
168508	318	WALLEYE		WC		INVPISC	LITHO_A1
168482	322	BLUESTRIPE DARTER	Darter	SB		BINS	LITHO_A2
168503	323	SADDLEBACK DARTER	Darter	SB		BINS	UNKNOWN
168414	324	NIANGUA DARTER	Darter	SB	I	BINS	LITHO_A2
168497	326	RIVER DARTER	Darter	SB		BINS	UNKNOWN
168500	328	STARGAZING DARTER	Darter	SB	I	BINS	UNKNOWN
168475	330	DUSKY DARTER	Darter	SB		BINS	LITHO_A1
168488	332	BLACKSIDE DARTER	Darter	SB		BINS	LITHO_A1
168494	334	SLENDERHEAD DARTER	Darter	SB		BINS	LITHO_A1
168489	336	LONGNOSE DARTER	Darter	SB	I	BINS	
168483	338	GILT DARTER	Darter	SB		BINS	LITHO_A1

168472	339	OHIO LOGPERCH	Darter	SB		BINS	LITHO_A1
168472	340	OZARK LOGPERCH	Darter	SB		BINS	LITHO_A1
168472	341	NORTHERN LOGPERCH	Darter	SB		BINS	LITHO_A1
168480	342	CHANNEL DARTER	Darter	SB		BINS	LITHO_A1
201982	344	CRYSTAL DARTER	Darter	SB	I	BINS	UNKNOWN
	345	AMMOCRYPTA SP.					
168515	346	WESTERN SAND DARTER	Darter	SB		BINS	LITHO_A2
	347	DARTER SP.					
168518	348	SCALY SAND DARTER	Darter	SB		BINS	UNKNOWN
168437	350	SPECKLED DARTER	Darter	SB		BINS	LITHO_A2
168365	351	BLUNTNOSE DARTER	Darter	SB		BINS	PHYTO_A1
168398	352	HARLEQUIN DARTER	Darter	SB		BINS	UNKNOWN
168358	353	SWAMP DARTER	Darter	SB		BINS	PHYTO_A1
168369	354	JOHNNY DARTER	Darter	SB		BINS	LITHO_B2
168368	355	NORTHERN ORANGETHROAT DARTER	Darter	SB		BINS	LITHO_A2
168368	356	ARKANSAS RIVER ORANGETHROAT DARTER	Darter	SB		BINS	LITHO_A2
168368	357	PLAINS ORANGETHROAT DARTER	Darter	SB		BINS	LITHO_A2
168441	358	MISSOURI SADDLED DARTER	Darter	SB		BINS	LITHO_A1
168441	358	MISSOURI SADDLED DARTER (MERAMEC FORM)	Darter	SB		BINS	LITHO_A1
	360	WHITE RIVER ORANGETHROAT DARTER	Darter	SB		BINS	LITHO_A2
168392	361	ARKANSAS SADDLED DARTER (WHITE R FORM)	Darter	SB		BINS	LITHO_A1
168392	362	CURRENT SADDLED DARTER (CURRENT R FORM)	Darter	SB		BINS	LITHO_A1
168421	363	GOLDSTRIPE DARTER	Darter	SB	I	BINS	PHYTO_A1
9001	364	BROOK DARTER	Darter	SB		BINS	LITHO_A2
9002	365	CURRENT DARTER	Darter	SB		BINS	LITHO_A2

168449	366	BANDED DARTER	Darter	SB		BINS	PHYTO_B1
168372	368	MUD DARTER	Darter	SB		BINS	PHYTO_A1
168378	370	RAINBOW DARTER	Darter	SB		BINS	LITHO_A2
168386	374	ARKANSAS DARTER	Darter	SB		BINS	LITHO_A2
168425	376	STIPPLED DARTER	Darter	SB		BINV	LITHO_A2
168403	378	YOKE DARTER	Darter	SB		BINS	LITHO_A2
168448	380	REDFIN DARTER	Darter	SB		BINS	UNKNOWN
168394	381	BARRED FANTAIL DARTER	Darter	SB		BINS	LITHO_B2
168394	382	STRIPED FANTAIL DARTER	Darter	SB		BINS	LITHO_B2
168366	384	SLOUGH DARTER	Darter	SB		BINS	PHYTO_A1
	385	GOLDEN FANTAIL DARTER (WHITE R FORM)	Darter	SB		BINS	LITHO_B2
168424	386	CYPRESS DARTER	Darter	SB		BINS	PHYTO_A1
168411	388	LEAST DARTER	Darter	SB		BINS	PHYTO_A1
168375	390	GREENSIDE DARTER	Darter	SB		BINS	PHYTO_B1
168161	400	SPOTTED BASS	Centrarcid	WC		INVPISC	LITHO_B2
168159	402	SMALLMOUTH BASS	Centrarcid	WC		INVPISC	LITHO_B2
168160	406	LARGEMOUTH BASS	Centrarcid	WC		INVPISC	LITHO_B2
	407	BLACK BASS SP.					
168139	410	WARMOUTH	Centrarcid	G		INVPISC	LITHO_B2
168156	411	BANTAM SUNFISH	Centrarcid	WC		INV	LITHO_B2
168132	412	GREEN SUNFISH	Centrarcid	G	T	INVPISC	LITHO_B2
168152	413	DOLLAR SUNFISH	Centrarcid	G		INV	LITHO_B2
168157	414	REDSPOTTED SUNFISH	Centrarcid	WC		INV	LITHO_B2
168144	415	PUMPKINSEED	Centrarcid	G		INV	LITHO_B1
168154	416	REDEAR SUNFISH	Centrarcid	G		INV	LITHO_B2
168151	418	ORANGESPOTTED SUNFISH	Centrarcid	WC		INV	LITHO_B2
168153	420	LONGEAR SUNFISH	Centrarcid	WC		INV	LITHO_B2
	422	SUNFISH SP.					

168141	424	BLUEGILL	Centrarcid	G	T	MACOMNI	LITHO_B2
168097	426	ROCK BASS	Centrarcid	WC		INVPISC	LITHO_B2
168099	427	SHADOW BASS	Centrarcid	WC		INVPISC	LITHO_B2
168100	428	OZARK BASS	Centrarcid	WC		INVPISC	LITHO_B2
	429	AMBLOPLITES SP.					
168167	430	BLACK CRAPPIE	Centrarcid	WC		INVPISC	LITHO_B2
168166	431	WHITE CRAPPIE	Centrarcid	WC		INVPISC	LITHO_B2
	432	CRAPPIE SP.					
168102	434	FLIER	Centrarcid	WC		INV	LITHO_B2
168171	440	BANDED PIGMY SUNFISH	Centrarcid	WC		INS	LITHO_A1
166016	445	BROOK SILVERSIDE		WC		INS	LITHO_A1
165993	446	INLAND SILVERSIDE		WC		INS	PHYTO_A1
169364	450	FRESHWATER DRUM		LB		BGEN	LITHO_A1
167263	454	OZARK SCULPIN (NIANGUA R FORM)	Cottid	SB		BINS	LITHO_B2
167263	454	OZARK SCULPIN	Cottid	SB		BINS	LITHO_B2
167263	454	WHITE RIVER SCULPIN	Cottid	SB		BINS	LITHO_B2
167237	455	MOTTLED SCULPIN	Cottid	SB		BINS	LITHO_B2
167239	456	BANDED SCULPIN	Cottid	SB		BINS	LITHO_B2
	457	SCULPIN SP.					
	458	GROTTO SCULPIN	Cottid	SB		BINS	LITHO_B2
164725	465	BURBOT		LB		PISC	LITHO_A1
170335	466	STRIPED MULLET		WC		GEN	

Legend for Appendix 1

ITIS code = Integrated Taxanomic Information System numeric code

MDC code = Missouri Department of Conservation taxanomic code

Common name = species common name from Fishes of Missouri.

Species type = type of species based on taxanomic group (family).

Foraghab = principle foraging habitat (SB = small benthic species, WC = water column species, LB = large benthic species, G = generalsit)

Tol = species tolerance to environmental degradation (I = intolerant, T = tolerant)

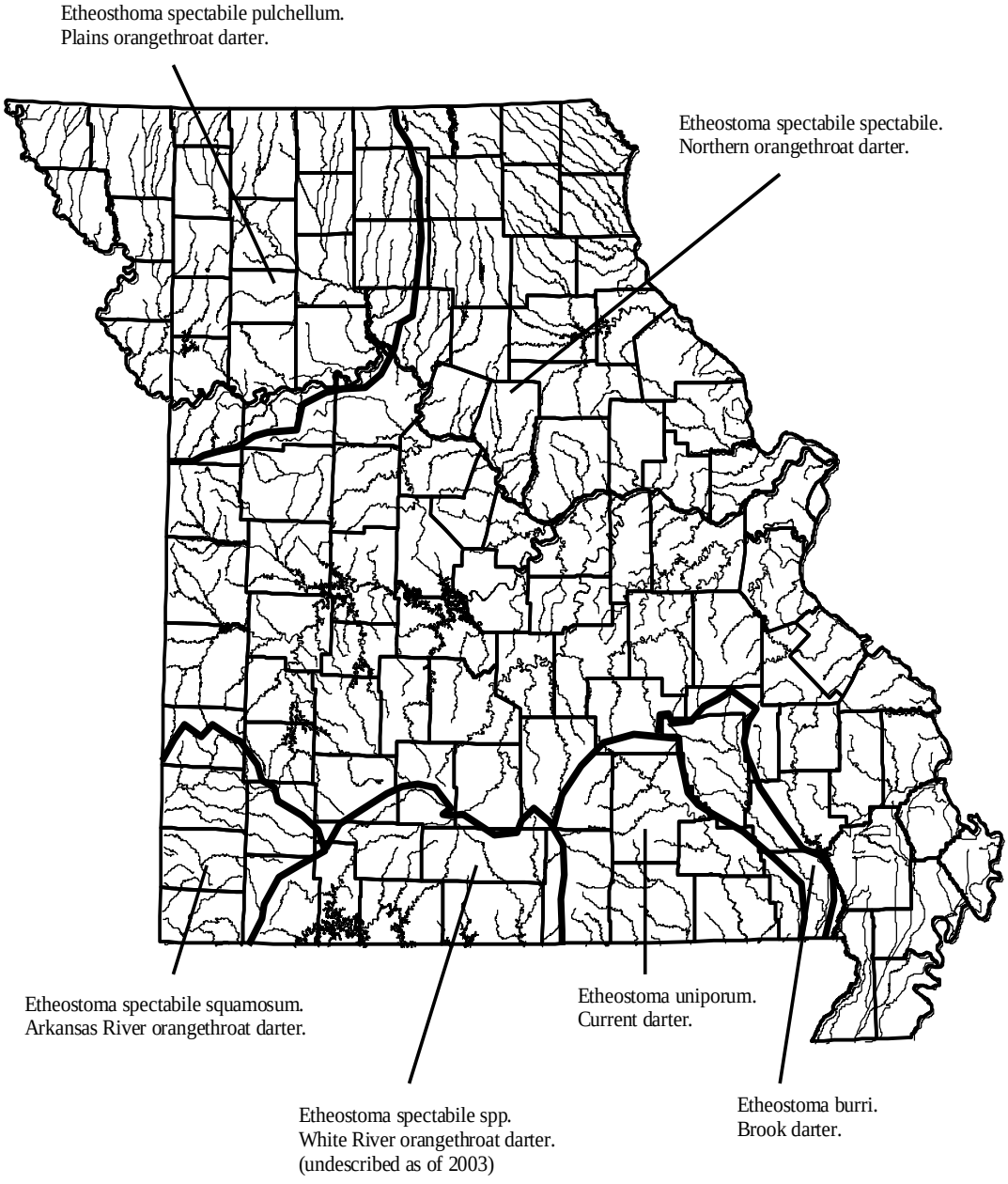
Trophic = trophic category (HERB = herbivore; BHERB = benthic herbivore; INV = invertivore; BINV = benthic invertivore; INS = insectivore; BINS = benthic insectivore; OMNI = omnivore; MICOMNI= microphagic omnivore; BMICOMNI = benthic microphagic omnivore; MACOMNI = macrophagic omnivore; BMACOMNI = benthic macrophagic omnivore; GEN = generalist; BGEN = benthic generalist; PISC = piscivore; FILT = filter feeder; PLANK = planktivore, INVPISC = invertivore / piscivore;)

Reproductive = reproductive guilds (LITHO_A1 = non-guarding open substrate; LITHO_A2 = non-guarding eggs buried; LITHO_B1 = guarding eggs attached; LITHO_B2 = guarding eggs laid in nest; PHYTO_A1 = non-guarding eggs broadcast; PHYTO_B1 = guarding eggs attached; PHYTO_B2 =guarding eggs in nest; NESTASSO = nest associate)

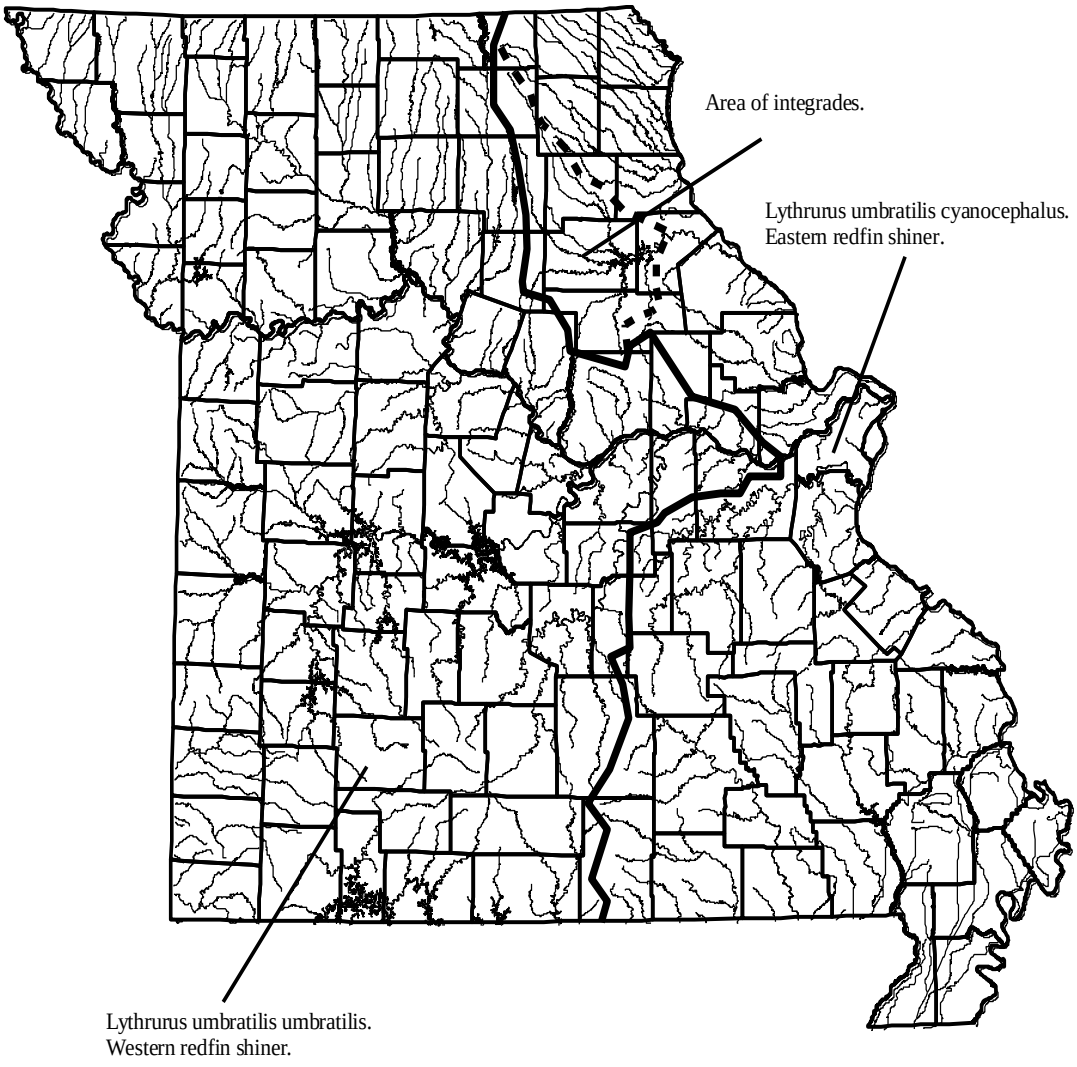
Appendix 2. Subspecies distribution maps for 5 fish species: fantail darter (*Etheostoma flabellare*), logperch (*Percina caprodes*), Missouri saddled darter (*Etheostoma tetrazonum*), orangethroat darter (*Etheostoma spectabile*), and redfin shiner (*Lythrurus umbratilis*).

Map 2. Distribution of logperch subspecies in Missouri.

Map 3. Distribution of Missouri saddled darter subspecies in Missouri.

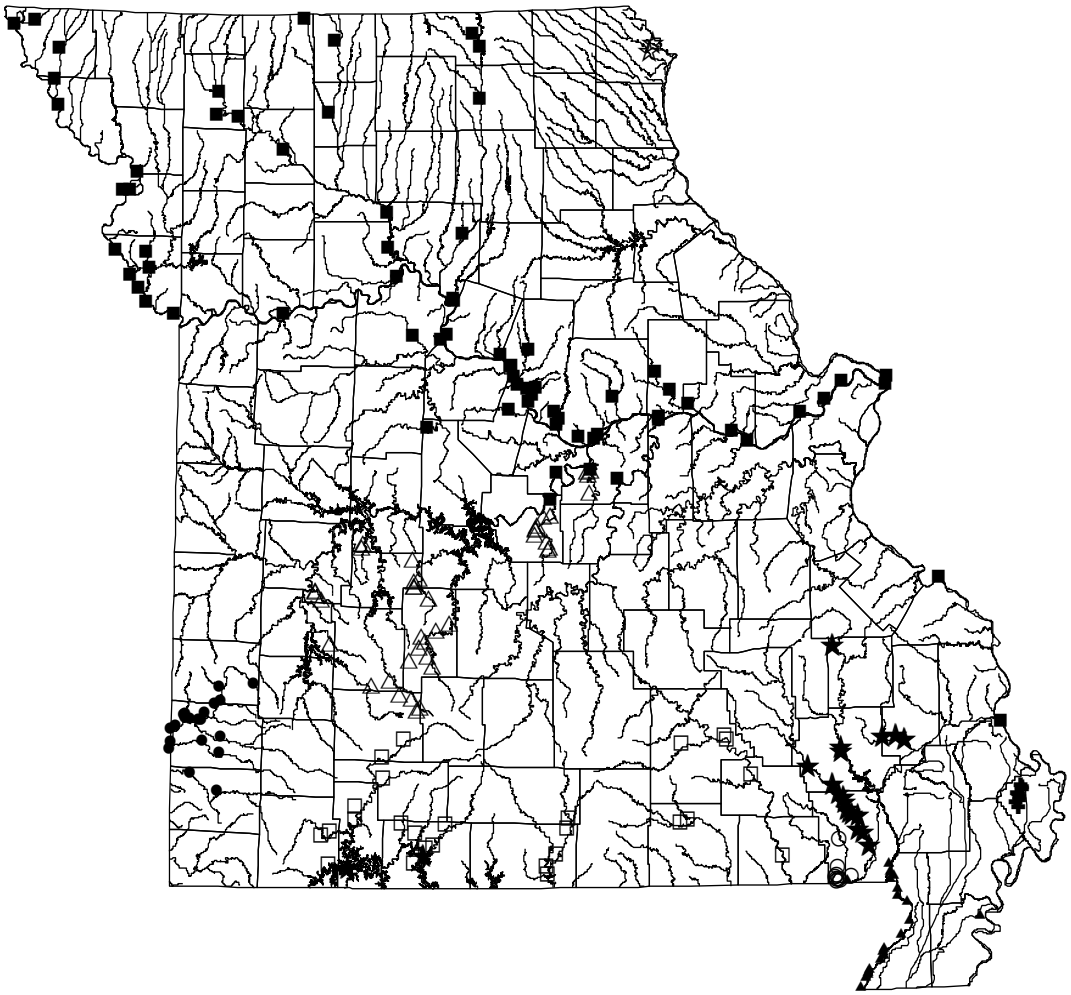


Map 4. Distribution of orangethroat darter subspecies in Missouri.



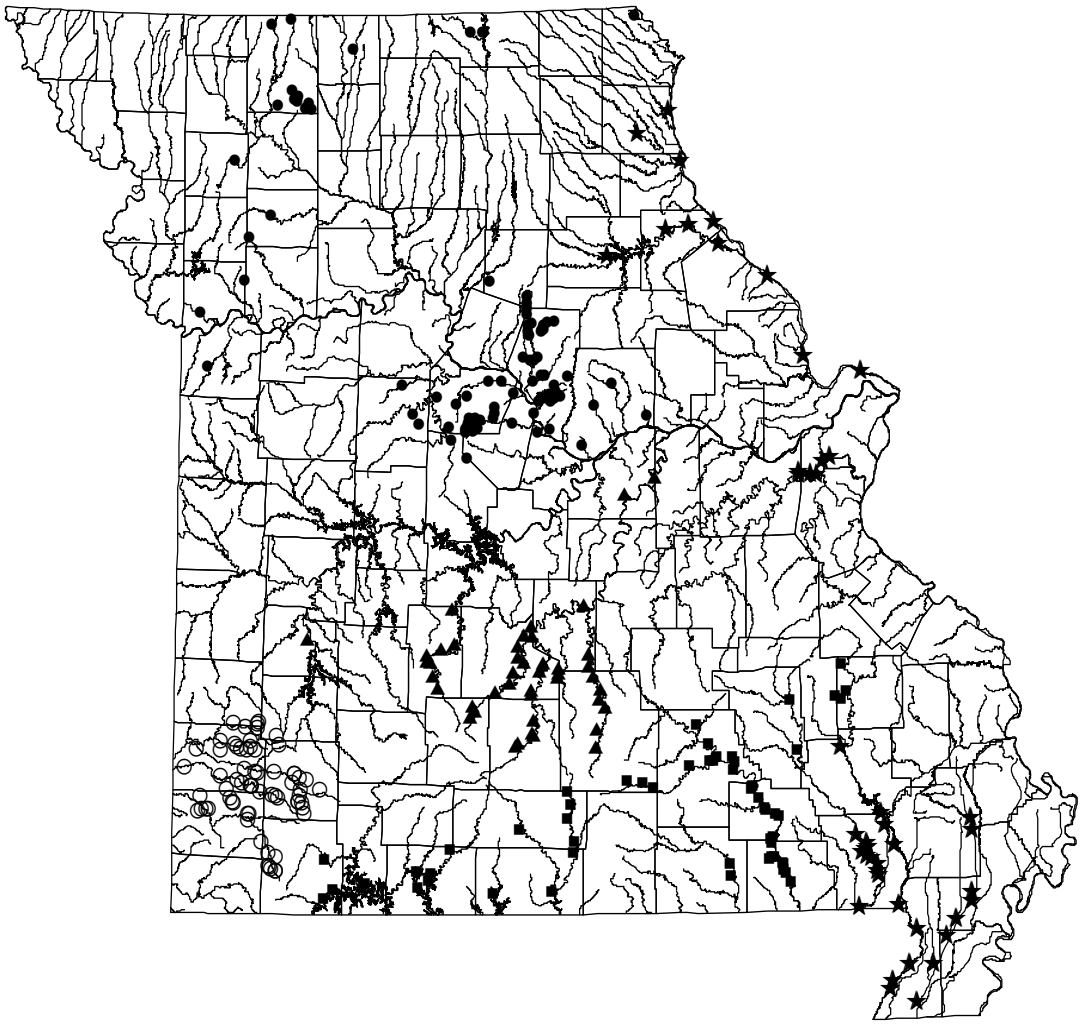
Map 5. Distribution of redfin shiner subspecies in Missouri.

Appendix 3. Distribution maps for endangered species, threatened species, and species of conservation concern in Missouri as of 2003. Consult *Missouri Species and Communities of Conservation Concern Checklist* for species status and recent changes.



Map 1. Distribution of 9 rare fish species in Missouri.

- ● **Western slim minnow**
- ■ **Western silvery minnow**
- ○ **Swamp darter**
- △ **Niangua darter**
- ✚ **Golden topminnow**
- ★ **Eastern slim minnow**
- ▲ **Cypress minnow**
- □ **Checkered madtom**
- ☆ **Central mudminnow**



Map 2. Distribution of 5 rare fish species in Missouri.

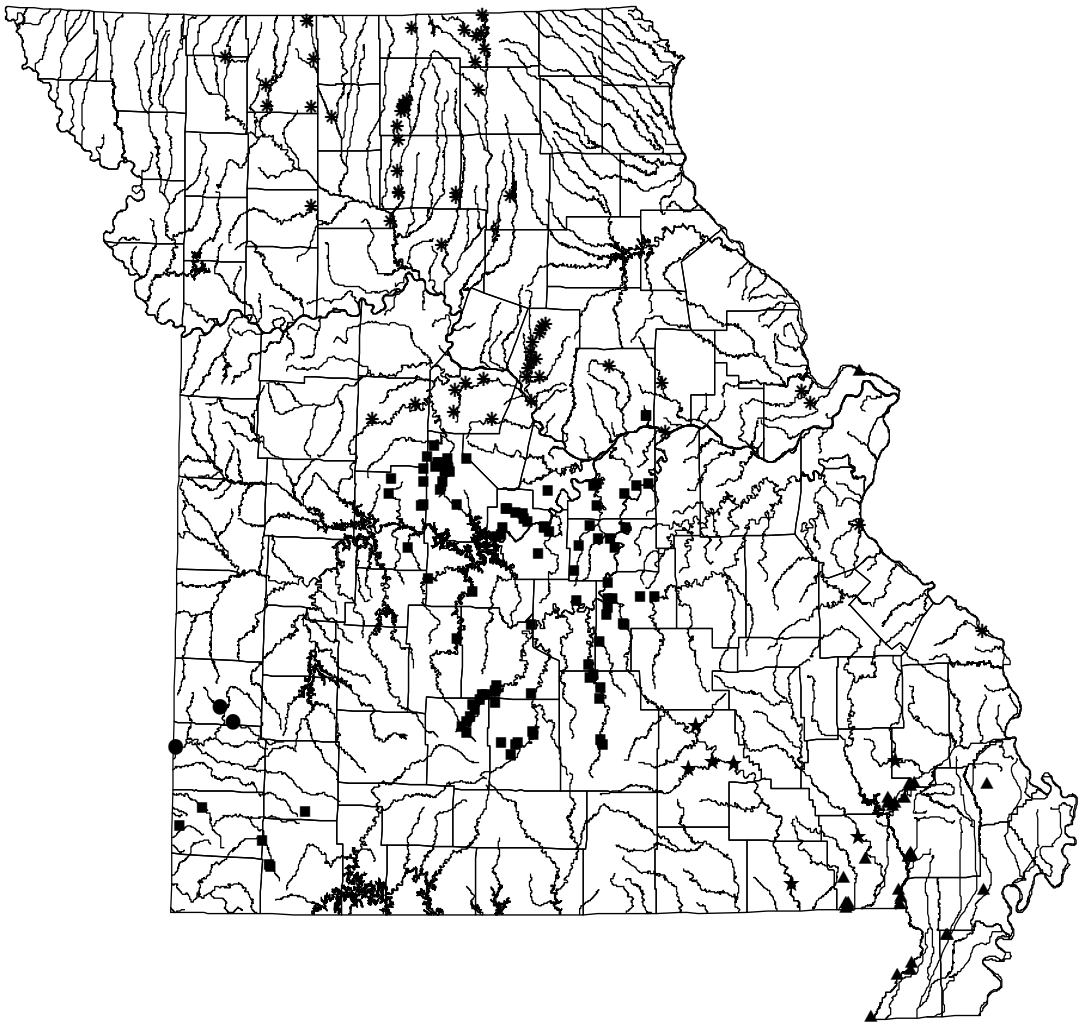
★ **Western sand darter**

● **Topeka shiner**

■ **Ozark shiner**

▲ **Bluestripe darter**

○ **Arkansas darter**



Map 3. Distribution of 5 rare fish species in Missouri.

- ✳ **Trout-perch**
- ● **Redfin darter**
- ▲ **Starhead topminnow**
- ■ **Plains topminnow**
- ★ **American brook lamprey**

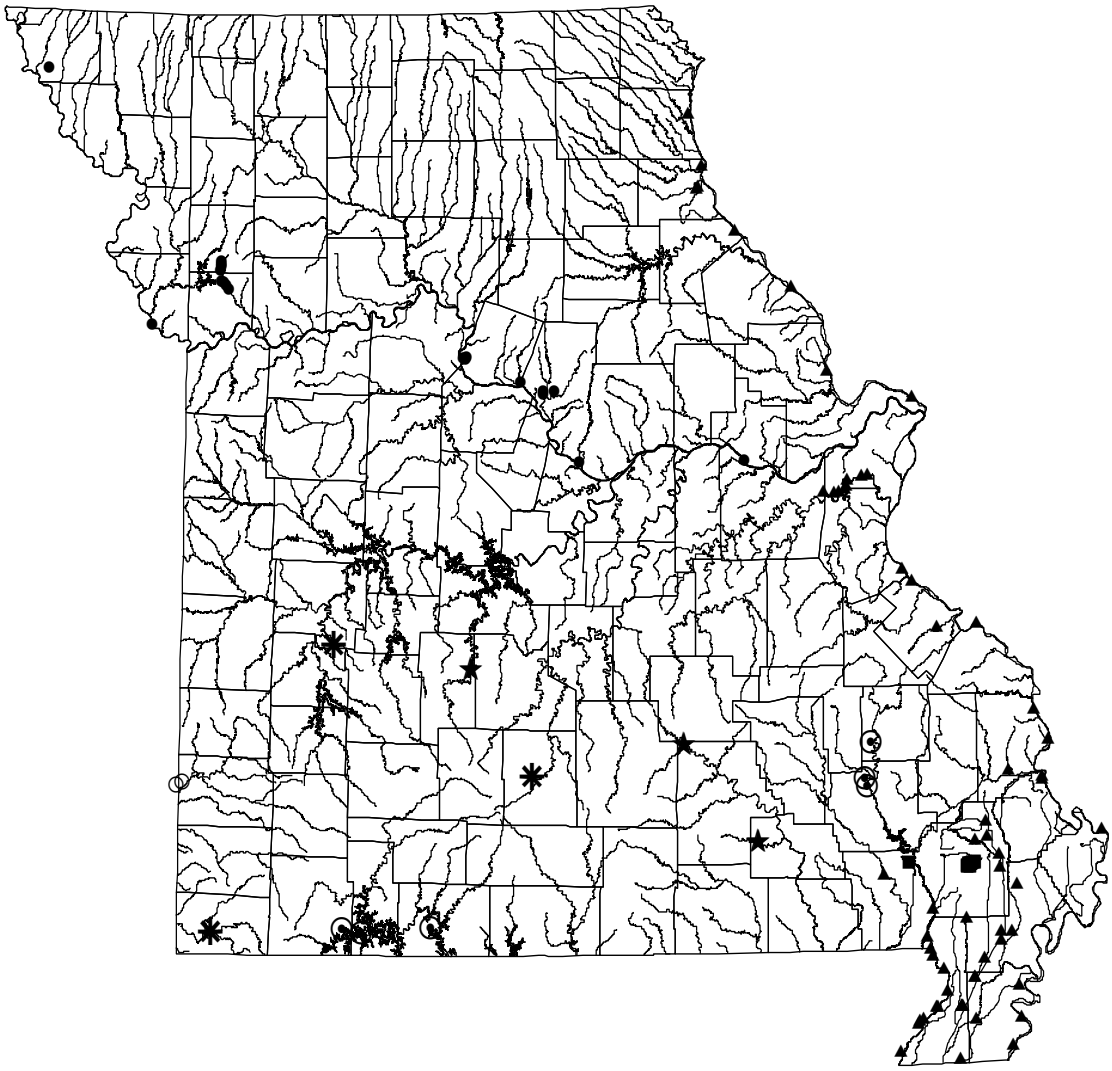
Map 4. Distribution of 4 rare fish species in Missouri.

▲ **Taillight shiner**

✱ **Stargazing darter**

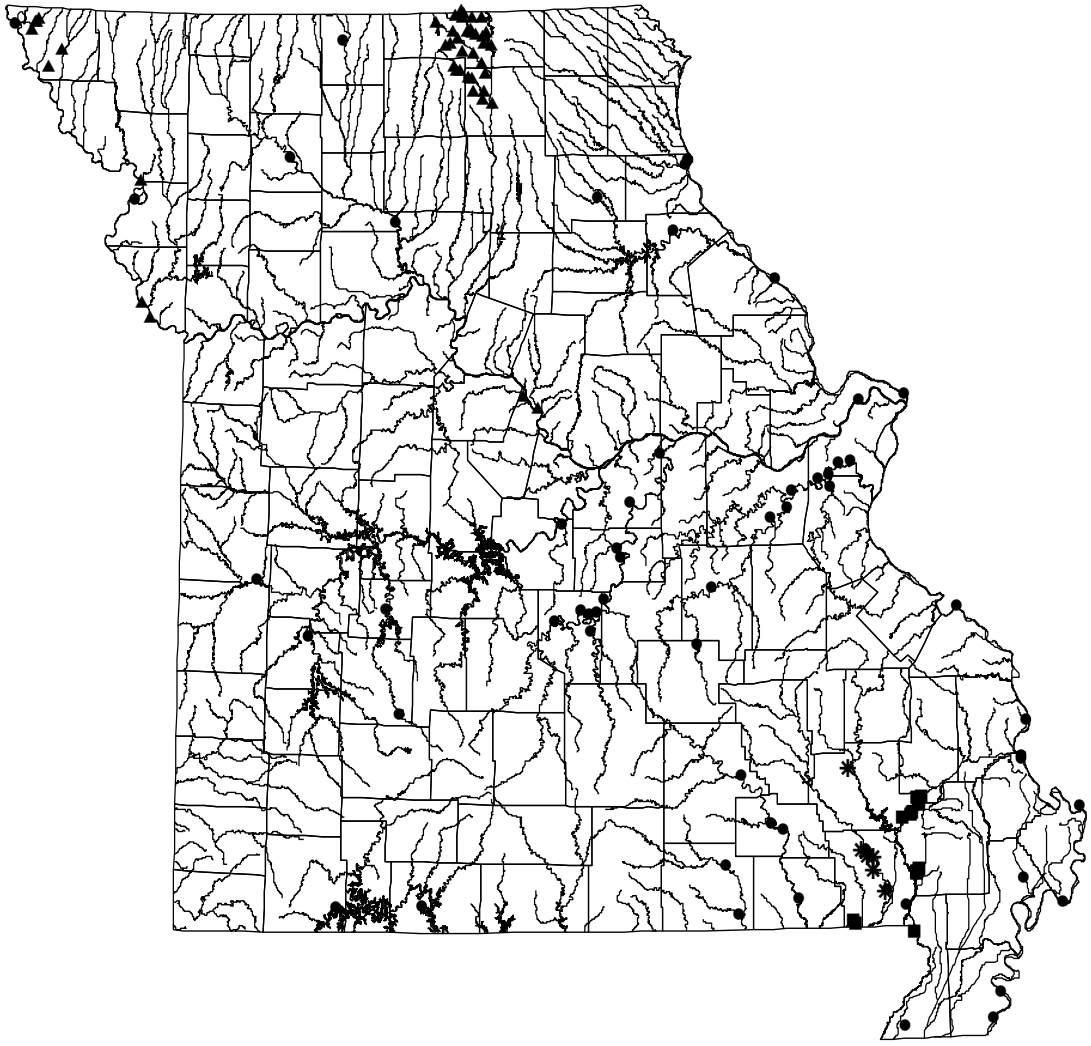
● **Silver chub**

■ **Bluntface shiner**



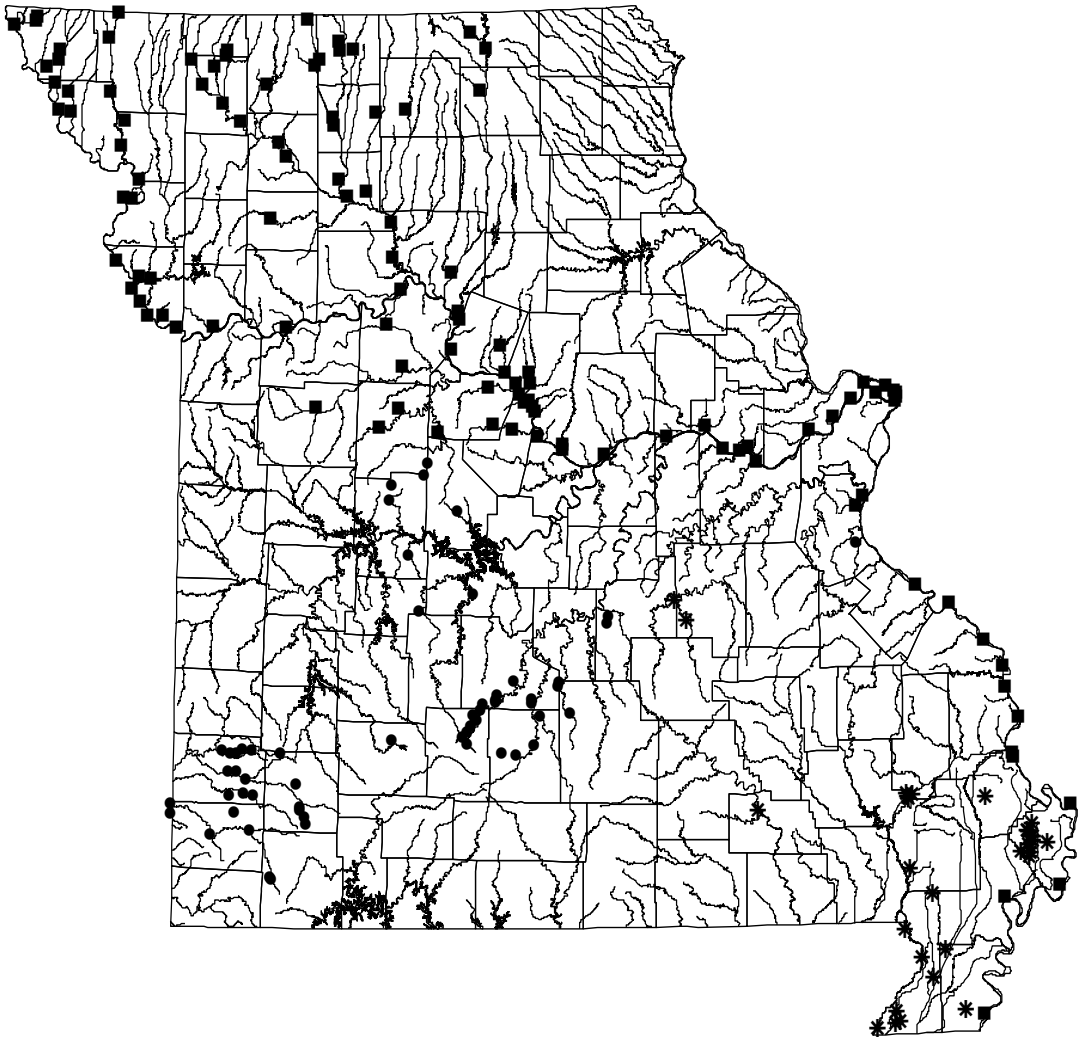
Map 5. Distribution of 7 rare fish species in Missouri.

- ★ **Southern cavefish**
- ✱ **Southern brook lamprey**
- ▲ **River darter**
- ● **Plains killifish**
- ○ **Neosho madtom**
- ⊙ **Longnose darter**
- ■ **Goldstripe darter**



Map 6. Distribution of 4 rare fish species in Missouri.

- ✳ **Mountain madtom**
- ● **Mooneye**
- ▲ **Brassy minnow**
- ■ **Bantam sunfish**

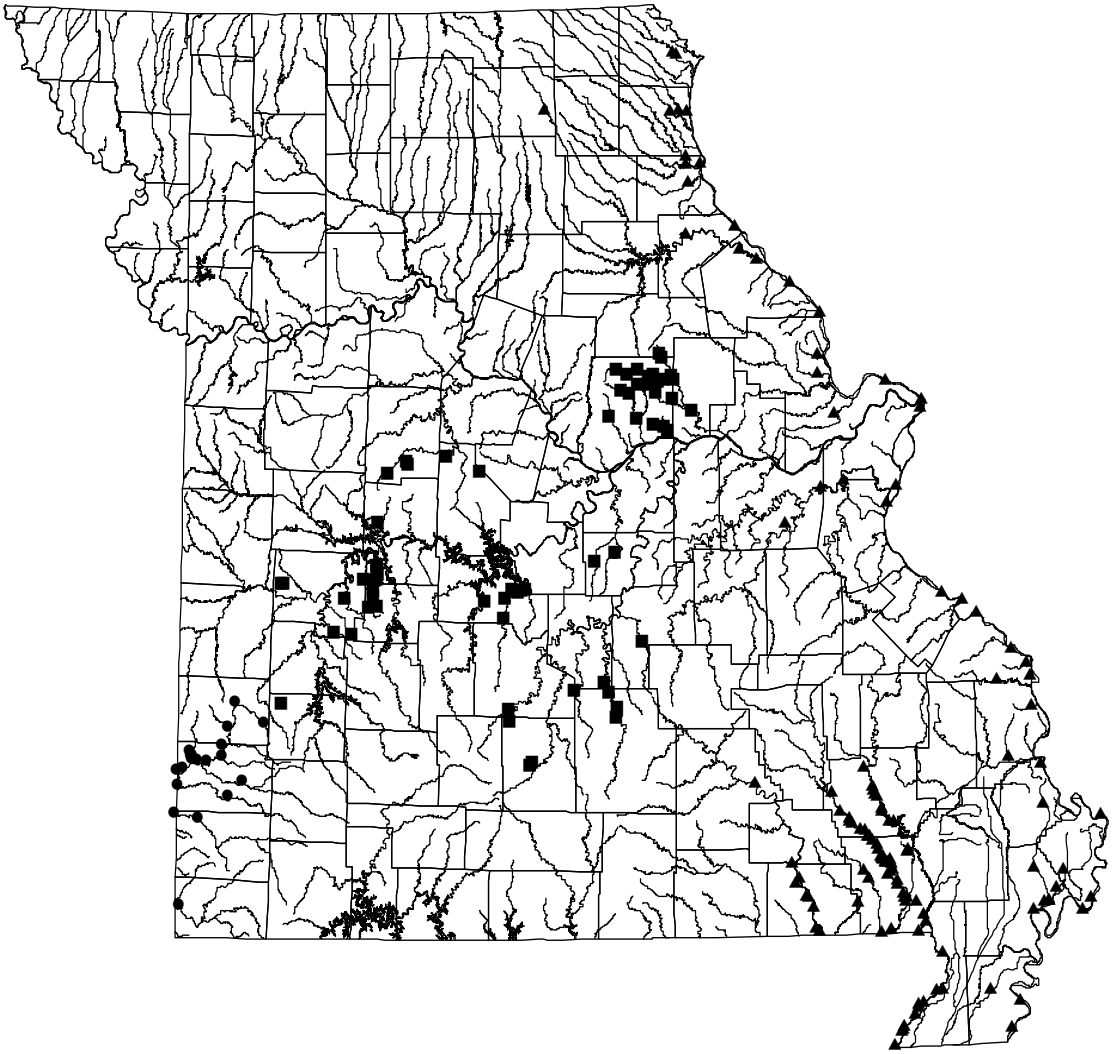


Map 7. Distribution of 3 rare fish species in Missouri.

■ **Plains minnow**

● **Least darter**

✱ **Lake chubsucker**



Map 8. Distribution of 3 rare fish species in Missouri.

- ▲ **Mississippi silvery minnow**
- ● **Channel darter**
- ■ **Blacknose shiner**

Map 9. Distribution of 3 rare fish species in Missouri.

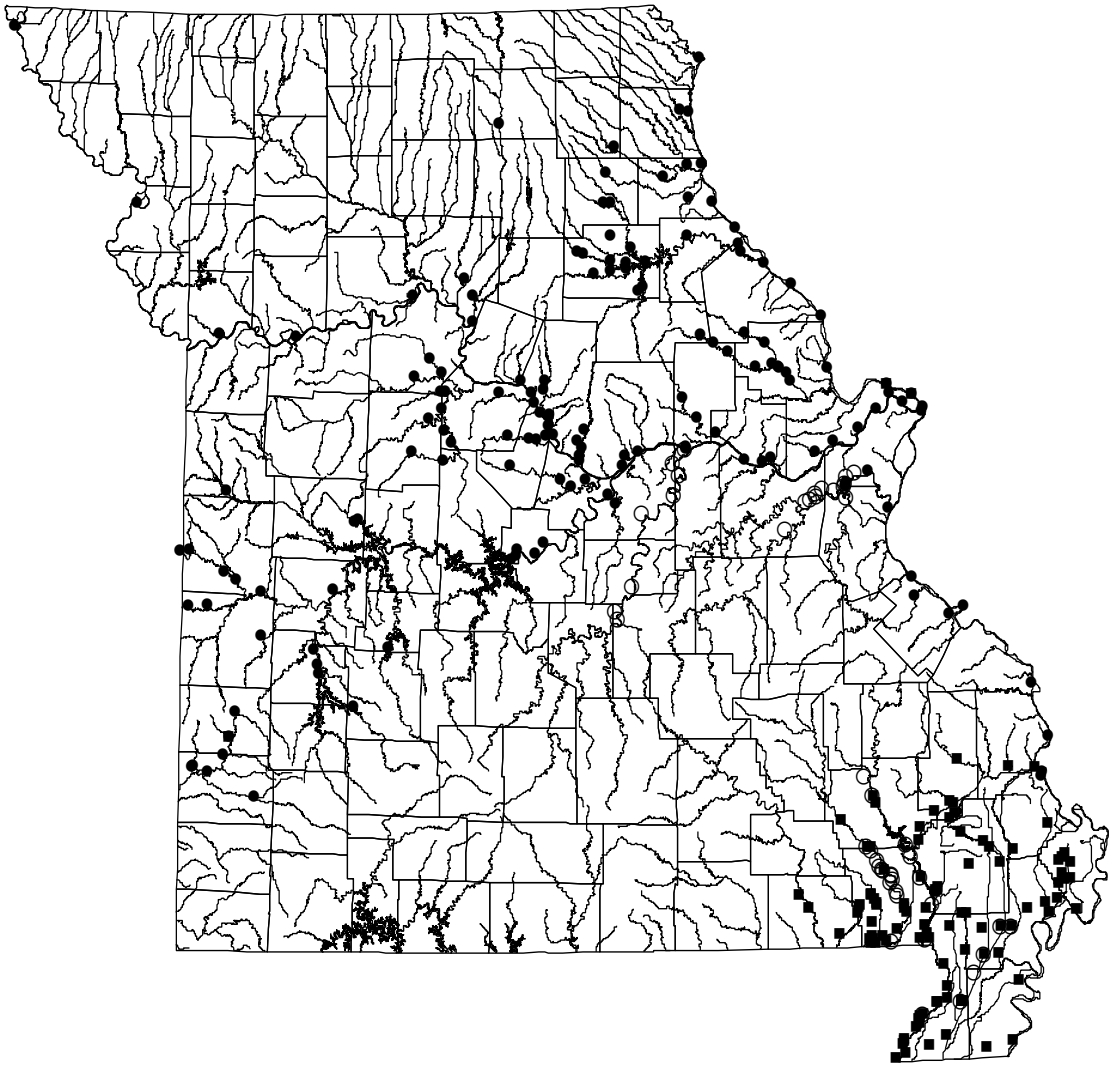
□ **Ironcolor shiner**

○ **Dollar sunfish**

• **Blue sucker**

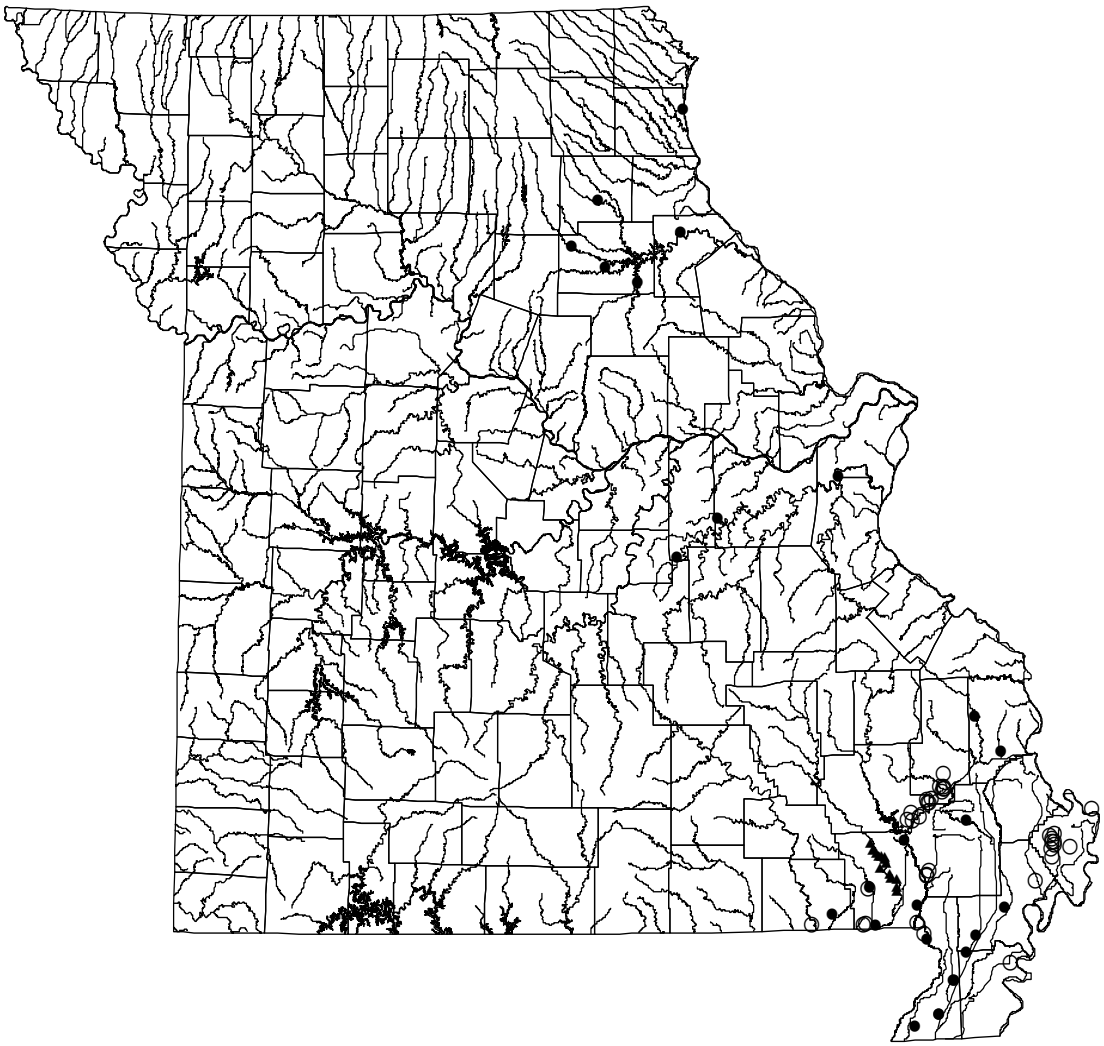
Map 10. Distribution of 4 rare fish species in Missouri.

- ● **Highfin carpsucker**
- □ **Harlequin darter**
- ○ **Flathead chub**
- ▲ **Brown bullhead**



Map 11. Distribution of 3 rare fish species in Missouri.

- ■ **Pugnose minnow**
- ● **Ghost shiner**
- ○ **Crystal darter**

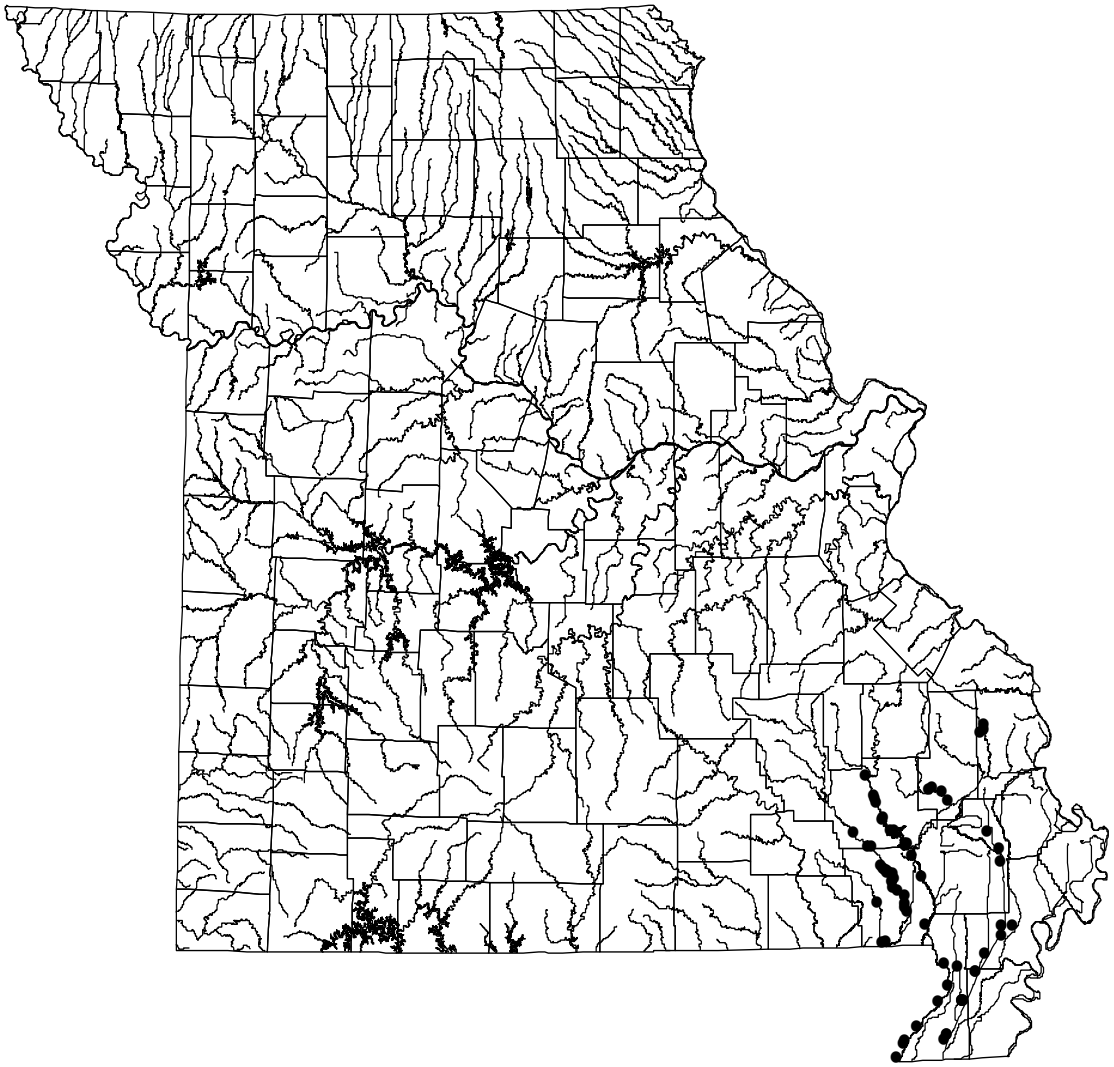


Map 12. Distribution of 3 rare fish species in Missouri.

○ **Flier**

● **Pallid shiner**

▲ **Sabine shiner**



Map 13. Distribution of scaly sand darter in Missouri.

- **Scaly sand darter**