Meramec River Basin Nutrient Monitoring:
A Missouri Volunteer Water Quality Monitoring Program Project
September 2015 – August 2016

Background

Nutrient levels in streams, rivers and groundwater have been identified as a major concern for human health and for aquatic communities (Dubrovsky and Hamilton, 2010; United States Environmental Protection Agency, 2013). A recent University of Georgia study has demonstrated findings that report nutrient pollution as a significant potential cause for loss of forest-derived carbon from stream ecosystems, reducing the ability of streams to support aquatic life (University of Georgia, 2015). The United States Environmental Protection Agency (USEPA) (2013) has reported that biological communities are 50% more likely to be in poor condition when phosphorus levels are high and 40% more likely to be in poor condition when nitrogen levels are high.

The Meramec River Basin in Missouri has been identified as one of the "the most biologically significant river basins in mid-continental North America, with diverse and rare aquatic and terrestrial plants, animals, and natural communities" (The Nature Conservancy, 2014). The Nature Conservancy, Meramec River: Conservation Action Plan was developed to consolidate information and initiate a 10 year plan for defining current conditions and ranking stressors. The plan identifies nutrients as a low – medium stress in the watershed, however, no spatial data set exists to rank sub-watersheds within a comparable time frame.

The Missouri Stream Team's Volunteer Water Quality Monitoring (VWQM) Program has a 20 year history in training and equipping volunteers to monitor water quality. One of the most active areas for water quality monitoring is the St. Louis area, which encompasses the lower section of the Meramec Basin. All volunteers are trained and equipped to monitor nitrates (NO_3-N) and turbidity, and a smaller subset of volunteers are trained and equipped to monitor orthophosphate (PO_4^{3-}). Volunteer methods are considered to be acceptable for certain uses; one of which is considered screening level data for problem identification (Missouri Department of Natural Resources, 2014). The VWQM Program also has a history of tiered training levels and development of special projects for qualified volunteers. A project to gather spatial nutrient data that helps define current conditions across the Meramec Basin is a good fit for the VWQM Program.

Objectives

- Collect monthly nitrate (NO_3-N), orthophosphate (PO_4^{3-}), and turbidity data for 1 year
- Collect data within the first 10 days of each month
- Recruit volunteers to achieve the best possible geographic coverage from 10-digit Hydrologic Unit Codes (HUC10)
- Submit data to the VWQM database to assist in defining current nutrient conditions in the Meramec Basin

- Analyze average data values to symbolically rank sites and HUC10 within a GIS format
- Graphically present data using box plots (median, average, 25th percentile and 75th percentile)
- Graphically compare data to USEPA draft nutrient criteria
- Post data to the Stream Team website

Study Design

The Meramec Basin VWQM Nutrient Monitoring Project is designed to collect spatial data on a monthly basis in the major tributaries and main stem of the Meramec River. Monthly samples will be collected as close to the beginning of each month as practical. All efforts should be made to collect samples by the 10th of each month.

Data will be analyzed and average values will be symbolically ranked by site and by HUC10 within a GIS format. Minimum, maximum and average values will be calculated and samples will be graphically compared with each other and EPA draft nutrient criteria. It should be noted that draft nutrient criteria are based on total nitrogen and total phosphorus, while volunteer methods measure the nitrate fraction of total nitrogen and the orthophosphate fraction of total phosphorus. Due to analytical methodology, samples are not directly comparable to draft nutrient criteria. However, volunteer results that exceed criteria would only be higher if total levels were measured.

Study Area and Monitoring Sites

The Meramec River Basin drains approximately 3,963 square miles of east central Missouri (Missouri Department of Conservation 1997, 1998, 1999; Sowa et al., 2005). It originates near Salem, flowing approximately 218 miles northeast to its confluence with the Mississippi River south of St. Louis (Missouri Department of Conservation, 1998) with the Big and Bourbeuse Rivers as the largest tributaries. The Meramec, Bourbeuse and Big River watersheds are designated as unique 8-digit Hydrologic Unit Codes (HUC8) (see Table 1). The Meramec River watershed is divided into ten HUC10; the Bourbeuse River watershed is divided into four unique HUC10; and the Big River watershed is divided into four unique HUC10. HUC10 are not necessarily watersheds, but are often reporting units of similar sizes. The HUC10 reporting unit will form the basic framework for data analyses from this project.

HUC10 close to St. Louis will likely be disproportionately represented due to the presence of more local qualified volunteers. Small watersheds were volunteers have historically monitored may be added to the HUC10 units. Nutrient monitoring is planned for 25 sites (listed in Table 2 and graphically represented in Figure 1).

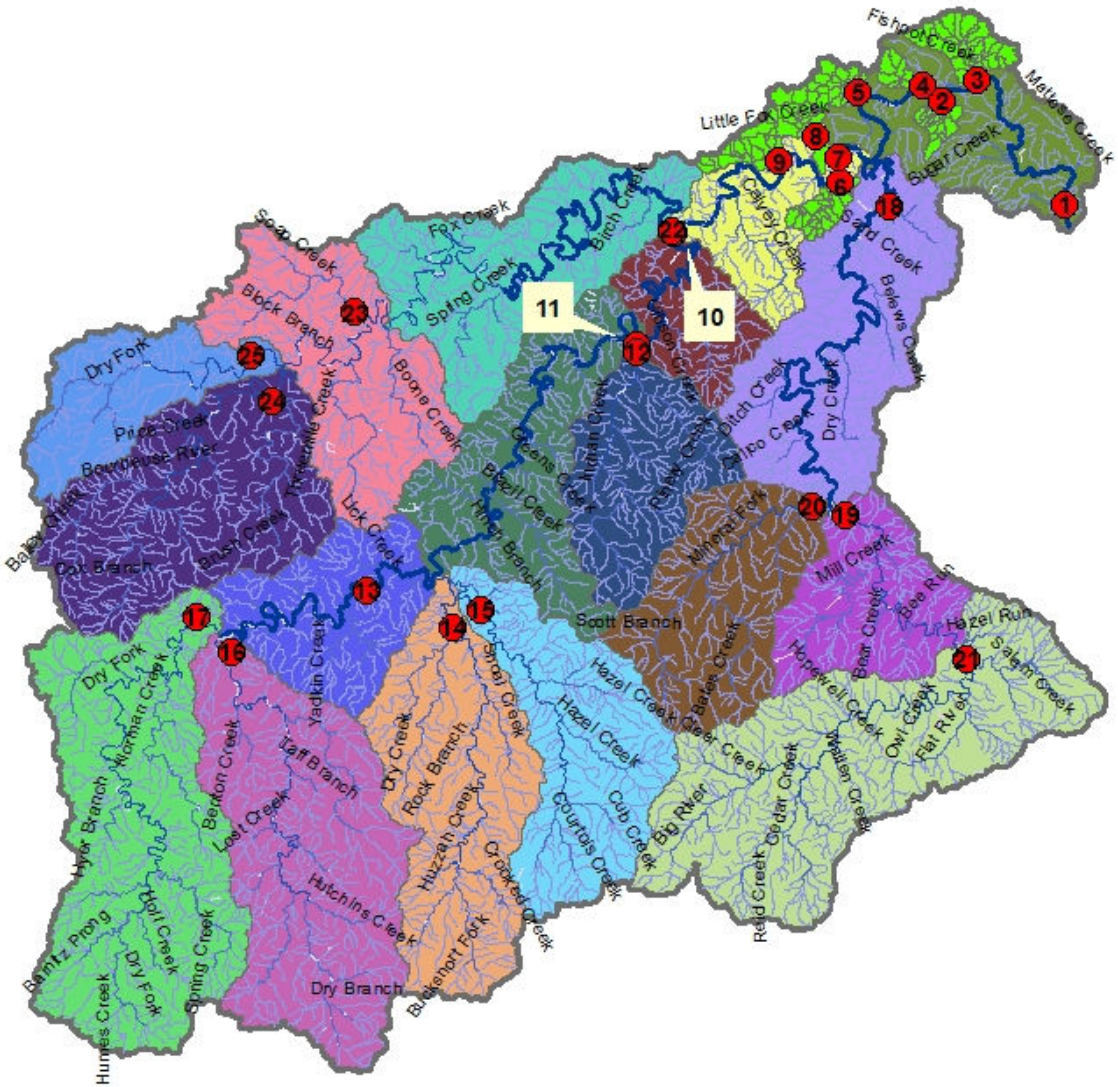
Table 1 - Meramec Basin HUC 10

HUC 8 Name	HUC 8 Code	HUC 10 Name	HUC 10 Code
Meramec	07140102	Meramec River	0714010210
Meramec	07140102	Calvey Creek – Meramec River	0714010209
Meramec	07140102	Little Meramec River – Meramec River	0714010208
Meramec	07140102	Brazil Creek – Meramec River	0714010207
Meramec	07140102	Indian Creek	0714010206
Meramec	07140102	Whittenburg Creek – Meramec River	0714010205
Meramec	07140102	Huzzah Creek	0714010204
Meramec	07140102	Courtois Creek	0714010203
Meramec	07140102	Headwater Meramec River	0714010202
Meramec	07140102	Dry Fork	0714010201
Bourbeuse	07140103	Lower Bourbeuse River	0714010304
Bourbeuse	07140103	Middle Bourbeuse River	0714010303
Bourbeuse	07140103	Upper Bourbeuse River	0714010302
Bourbeuse	07140103	Dry Fork	0714010301
Big	07140104	Lower Big River	0714010404
Big	07140104	Middle Big River	0714010403
Big	07140104	Mineral Fork	0714010402
Big	07140104	Upper Big River	0714010401

Table 2 - Meramec Basin Nutrient Monitoring Locations

Stream Name	Site Code	HUC 10 Name	HUC10 Code	UTM Easting	UTM Northing	County	Road Access
Meramec River	1	Meramec River	714010210	731591	4255450	St. Louis	Hwy 231
Williams Creek	2	Meramec River	714010210	716673	4268044	St. Louis	Meramec Station Road
Grand Glaize Creek	3	Meramec River	714010210	720950	4270447	St. Louis	Marshall Road
Kiefer Creek	4	Meramec River	714010210	714381	4269846	St. Louis	Kiefer Creek Road
Hamilton Creek	5	Meramec River	714010210	706567	4269102	St. Louis	Hwy 109
LaBarque Creek	6	Calvey Creek - Meramec River	714010209	704074	4257852	Jefferson	Hwy FF
Meramec River	7	Calvey Creek - Meramec River	714010209	699296	4261227	St. Louis	Dozier Crossing
Fox Creek	8	Calvey Creek - Meramec River	714010209	701273	4263721	St. Louis	Business I-44
Brush Creek	9	Calvey Creek - Meramec River	714010209	697064	4260639	Franklin	Hwy F
Meramec River	10	Little Meramec River	714010208	684250	4252179	Franklin	St. Mary's Road
Meramec River	11	Brazil Creek - Meramec River	714010207	680126	4238363	Franklin	Shady Beach Lane
Indian Creek	12	Indian Creek	714010206	679797	4237683	Franklin	Old Hwy K
Meramec River	13	Whittenburg Creek -Meramec River	714010205	647413	4208795	Crawford	Hwy TT
Huzzah Creek	14	Huzzah Creek	714010204	657712	4204494	Crawford	Hwy 8
Courtois Creek	15	Courtois Creek	714010203	661103	4206540	Crawford	Butts Road
Meramec River	16	Headwaters Meramec River	714010202	631035	4201451	Crawford	Hwy 8
Dry Fork	17	Dry Fork	714010201	626736	4205844	Phelps	CR 3620
Big River	18	Lower Big River	714010404	710437	4255151	Jefferson	Hwy W
Big River	19	Middle Big River	714010403	705009	4217946	Washington	Hwy 21
Mineral Fork	20	Mineral Fork	714010402	702001	4219502	Washington	Dugout Road
Big River	21	Upper Big River	714010401	716046	4204145	St. Francois	Hwy 67
Bourbeuse River	22	Lower Bourbeuse River	714010304	684174	4252170	Franklin	St. Mary's Road
Bourbeuse River	23	Middle Bourbeuse River	714010303	648338	4243897	Franklin	Mill Rock Road
Bourbeuse River	24	Upper Bourbeuse River	714010302	637880	4234461	Gasconade	Hog Trough Road (5301)
Dry Fork	25	Dry Fork	714010301	636166	4236390	Gasconade	Branch Block Road

Figure 1
Meramec Basin HUC 10s and Nutrient Monitoring Locations



Nitrate Method

Nitrate samples are collected as surface water grab samples that are then analyzed immediately. The volunteer analytical methodology is based on Cadmium Reduction in combination with an Octet Comparator with Axial Reader. Nitrate is reduced to nitrite by cadmium, which undergoes diazotization/coupling to form a pink color. The Octet Comparator has color standards representing 0, 0.25, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 ppm NO_3-N. Results are reported in mg/L NO_3-N.

Orthophosphate Method

Orthophosphate samples are collected as surface water grab samples that are then analyzed immediately. The volunteer analytical methodology is based on a UV-catalyzed oxidation of phosphonate to orthophosphate in combination with a pre-programmed portable colorimeter (photometer). The orthophosphate reacts with the molybdate in the PhosVer 3 reagent to form a mixed phosphate/molybdate complex. This complex is reduced by the ascorbic acid in the PhosVer 3, which gives a blue color that is proportional to the amount of phosphonate in the original sample. The orthophosphate in the original sample is removed when the blank is used to set the zero concentration. The measurement wavelength is 610 nm for colorimeters. Results are reported in mg/L PO_4^{3-}.

Turbidity Method

The device used to measure turbidity in streams is a calibrated turbidity tube (available through http://www.forestry-suppliers.com/product_pages/products.asp?mi=50731). The turbidity tube is composed from a clear polycarbonate tube with numeric centimeter scale on the side and a 4.5 cm standard secchi disc in the bottom of tube. The secchi disc is screwed to a rubber stopper which can be removed for easy cleaning. After the tube is filled with a stream water sample a drain hose allows the sample to be drawn off until the secchi pattern is visible. Once the pattern is visible the reading from the numeric centimeter scale is reported as Nephelometric Turbidity Units (**NTU**). The minimum reported value is 10 NTU.

Data Reporting

Monitoring results will be entered into the VWQM database. The Login page for online data entry is available at http://mdc4.mdc.mo.gov/applications/StreamTeam/Default.aspx.

Data Use

Data will be used to identify and rank nutrients by site and HUC10. Results will be posted to the Stream Team web site http://www.mostreamteam.org/ and will be made available to the Missouri Department of Natural Resources and the Missouri Department of Conservation for water quality planning and assessment.

QA/QC

All participants will have successfully completed a Level 2 VWQM Program QA/QC workshop and been validated for use of a phosphate colorimeter; including the ability to perform orthophosphate analysis that is within 10% of a certified standard.

References

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