Project 17-600: Ecological Evaluation of Priority Subwatersheds in the Illinois River Watershed
FY 2017 CWA Section 319(h)

Final Report

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Executive Summary

The Illinois River Watershed (HUC 11110103), located in Northwest Arkansas and East Oklahoma, has several impaired subwatersheds, is considered a nutrient surplus area, and contains several threatened and endangered species. The watershed is monitored for water quality parameters by several agencies, but data are not consistently collected due to funding and capacity limitations and sites are usually located at the most downstream area of the watershed. Additionally, habitat and biological parameters are not commonly evaluated. In order to make specific management recommendations within a subwatershed, there is a need to perform more in-depth assessment at smaller geographic intervals.

This project unified two important areas of focus for IRWP: education and monitoring. Local students were educated about local creeks, rivers, and streams and student volunteer teams were trained on methods of assessment for biological and habitat parameters. As a result of this project, baseline data was collected for long-term monitoring at sites located on each major tributary in impaired subwatersheds, and potential hotspots with degraded habitat condition and/or low biological diversity were identified, and landowner outreach and education efforts become more targeted with the long-term goal of implementation of water-quality-improving practices.

To meet these project goals, local student volunteer teams from Environmental And Spatial Technology (EAST) Initiative Schools implemented an in-depth GIS and in-field evaluation of these impaired subwatersheds and student volunteers were trained in watershed evaluation methods and best management practices. Five to six locations within each impaired subwatershed were evaluated five times during the course of the project. As a result of data collected during this project, IRWP is able to recommend geographically specific management practices and communicate those recommendations to watershed stakeholders and landowners.

EAST Initiative programs at thirteen public schools from across the watershed participated in training sessions, field data collection, and data management. Arkansas Game and Fish Commission provided equipment funding via the Stream Team program and non-federal match for this project was provided by Walton Family Foundation.

Funding breakdown

Project Title:	Ecological Evaluation of Priority Subwatersheds in the Illinois River Watershed		
Project Number:	Project 17-600		
Original Project Period:	10/1/2017	**Completion Date:**	9/30/2019
Project Funding:	**Federal**	**State/Local**	**Total**
	$46,530	$35,200	$81,730

Project Background:

The Illinois River Watershed (IRW) is a 758 square mile watershed located in Northwest Arkansas and east Oklahoma (Figure 1). The subject of historic contention between the States of Arkansas and Oklahoma, the watershed not only contains the 14th fastest growing metropolitan area in the United States, but also two of the top livestock and poultry-producing counties in the country. Designated uses for the IRW include propagation of fish and wildlife, primary contact and recreation, and domestic, agricultural, and industrial water supplies, but segments of steams within the watershed are listed list as impaired, and the watershed is considered a nutrient surplus area by the Arkansas Natural Resources Commission. Additionally, there are several species of conservation concern within the IRW, including the Ozark cavefish, least darter, Oklahoma salamander, and Neosho mucket. The presence of these species has resulted in several streams being classified as extraordinary resource waters and ecologically sensitive waters.

The IRW is currently field monitored for water quality parameters by several agencies, to include Arkansas Department of Environmental Quality (ADEQ), United States Geological Survey (USGS), and University of Arkansas' Water Resources Center (AWRC), and the 2012 Upper IRW Management Plan incorporated water quality data from all of these organizations. Unfortunately, many of the stations used for the management plan are located at the downstream portions of larger subwatersheds and no assessment of habitat condition, streambank quality, or aquatic communities were incorporated into the management plan. The last study examining stream habitat and aquatic communities within the watershed was conducted in 2012 (Petersen et al., 2014), and sampling locations were also located at the downstream-most portion of the subwatersheds.

There is a need to assess ecological conditions at small geographic intervals along impaired subwatersheds. Using Muddy Fork Creek as an example, sampling for either water quality parameters or aquatic communities only occurs upstream from the confluence with the Illinois River main stem and includes three HUC 12 subwatersheds. In order to identify specific problem locations and subsequent management activities, evaluation needs to occur throughout the four main tributaries of the subwatershed.

This project assessed four priority subwatersheds (Figure 2). These priority subwatersheds included Moore's Creek, Sager Creek, Lower Muddy Fork, and Clear Creek. All four of these subwatersheds are considered high priority for sediment, total nitrogen, and total phosphorus in ANRC's 2011-2016 NPS Management Plan and all four are 303d listed as impaired in ADEQ's 2016 Integrated Water Quality Assessment Report. In the 2016 integrated report, Sager Creek is listed as impaired for nitrate, Moore's Creek is listed for both sulfate and pathogens, and both Lower Muddy Fork and Clear Creek are listed for pathogens. Goose Creek was also included for comparison as it is not currently considered impaired.

The overall goals of the project were to:

1. Educate local students about local creeks, rivers, and streams and train student volunteer teams on methods of assessment for biological and habitat parameters.
2. Establish baseline data for long-term monitoring at sites at small geographic intervals in impaired subwatershed.

3. Identify any potential hotspots, with degraded habitat condition and/or low biological diversity.
4. Target landowner outreach and education efforts with the long-term goal of water-quality-improving practice implementation.

Project Methodology and Results

Phase 1 of this project included GIS evaluation within each of the priority subwatersheds, and IRWP worked with local EAST school programs in order to complete this evaluation. IRWP staff educated and trained students on the importance of watershed protection and methods of watershed management during this initial phase. GIS assessment was conducted in cooperation with University of Arkansas's CAST program twice during the course of the project. At the training, student volunteers learned the basics of ArcMap, conducted land use assessment of priority subwatersheds using the 2011 National Land Cover Database, and identified sampling locations (Figure 3).

Phase 2 of the project was to conduct a field evaluation of sites identified in Phase 1. Using methodology given in the Environmental Protection Agency's "Volunteer Stream Monitoring: A Methods Manual", student volunteers were also trained on field methods of habitat and biological assessment throughout the project. Stream Teams evaluated each location for in-stream characteristics, riparian habitat condition, and macroinvertebrate community, as described in EPA's Manual. Field evaluations occurred in April, August, and November in 2018 and April and August in 2018. Following field evaluations, students were responsible for data management, input, and reporting to IRWP.

Summary of Findings:

Land use:
Using the 2011 National Land Cover Database, land use within each subwatershed was assessed via GIS (Table 1 and Figure 4). Clear Creek and Sager Creek contains the highest percentage of developed land, with 40.6% and 30.5%, respectively, considered urban. Muddy Fork and Moore's Creek are nearly completely devoid of urbanized lands (4.6% and 2.9%, respectively), with Moore's Creek containing the highest percentage of forested land at 33.5% and Muddy Fork containing the highest percentage of pasture lands (66.8%). Goose Creek, which is located in the transition zone from medium and low intensity urban lands to rural lands, contained mostly pastureland at 56.2%, forested land at 25.9%, and urban lands at 11.5%.

It is important to note that there has been rapid urban growth within the watershed since 2011 and the actual land cover in 2019 for these subwatersheds is probably significantly higher than is reflected in the 2011 database.

Macroinvertebrate Diversity:
When comparing macroinvertebrate diversity across subwatersheds (Figure 5) and seasons (Figure 6), there does not appear to be any significant differences. When average diversity scores are compared across all sites, several sites emerge as having lower than average diversity (Figure 7), which could indicate reduced water quality, flow that doesn't sustain

diverse macroinvertebrate communities, or lack of adequate habitat.

Relationships between land use, habitat assessments, and macroinvertebrate diversity Land use did not appear to have an influence on macroinvertebrate diversity (Figure 8). Clear Creek, the most urbanized subwatershed, had similar diversity scores to Goose Creek and Moore's Creek, which was the subwatershed containing the most forested land. Sager Creek contained the highest average diversity score but did not contain any over-riding land use type.

To investigate any significant relationships between parameters used for habitat assessment and macroinvertebrate diversity, regression analyses were conducted between diversity scores between habitat parameters (Table 2). Other than the presence of riffles and runs (in bold in Table 2), there were no other significant relationships identified between diversity scores and habitat parameters. This result could indicate that macroinvertebrate diversity is related to the habitat condition in the immediate vicinity within the stream, rather than the condition of streambanks or riparian areas.

Lessons Learned

Obstacles encountered
Evaluations of impaired watersheds are important to the understanding of overall water quality within a defined area. Scaling down monitoring projects to subwatershed (i.e., HUC 10 to HUC 12) levels can be beneficial for evaluating geographic variability within an area. Additionally, utilizing assistance in the form of established EAST/Stream Teams can be beneficial in creating interest and engagement within the assessed areas. There are, however, still challenges when working with school groups that have scheduling constraints and/or obligations. Obstacles encountered during the project include:

- Identifying easily accessible sites with willing landowners
- Student and teacher turn over within EAST/Stream Teams
- Consistent habitat assessment data collection across EAST/Stream Teams
- Data entry errors
- Timely data entry
- Scheduling sample dates that work with EAST Facilitators' school schedule

Measures of success
The ecological assessments of four impaired subwatersheds (i.e., Lower Muddy Fork, Moore's Creek, Sager Creek, and Clear Creek) within the IRW produced many successes in two different but related categories: public education and stream monitoring. Local students were educated on water quality within their communities and were trained as Stream Teams for potential long-term monitoring of the impaired subwatersheds. Additionally, data were collected from 5-6 established sites within each priority subwatershed and were analyzed for water quality and stream characteristics. Results were compiled in a publicly accessible watershed assessment report, shared with local government officials during a forum focused on water quality in the IRW, and are being used to effectively drive landowner outreach regarding riparian/streambank restorations. Measures of success for this project were:

- Sign-up of ~6 AGFC Stream Teams from already established local EAST school programs.
- Scientific training (i.e., ArcGIS and ecological assessments) of 484 primary-secondary school age students and facilitators participating in 13 EAST/Stream Team groups that can be used in future citizen science projects, stream cleanups, etc.
- Partnership building within priority subwatershed communities by teaming up with EAST/Stream Teams that consist of local students from the assessed subwatersheds.
- Participation in EAST/Stream Team media promotions based on the work they have contributed to the priority subwatersheds.
- Establishment and assessment of 23 sites located at small geographical intervals on tributary and main-stem stream segments within five HUC 12 priority subwatersheds.
- Numerical water quality rating determination of each assessed site based on macroinvertebrate community diversity.
- Establishment of baselines for in-stream, streambank, and land use characteristics and macroinvertebrate community and water quality rating for each assessed site that can be used to observe trends for any future monitoring projects.
- Comprehensive, public 2018 Ecological Assessment Report with the following subwatershed specific information provided: 303(d) impairment, Water Quality rating, common stream characteristics, land use characterization, and specific BMP recommendations.
- Dissemination of 2018 Ecological Assessment Report to local city and county elected and non-elected government officials/employees.
- Detailed macroinvertebrate community data collected within varying stream orders (i.e., est. 1-3), land uses (i.e., agriculture, urban, forested, etc.), and in-stream characteristics (i.e., riffles, runs, and pools).
- Correlation of in-stream characteristics (i.e., algae presence, sedimentation, habitat, etc.) and water quality rating.
- Internal use of collected data for effective outreach to landowners regarding riparian/streambank restoration options.

The success of the Ecological Evaluation of Priority Subwatersheds in the Illinois River Watershed project was made possible by the partnerships that were created along the way. Our partnership with ANRC allowed us the funding mechanism to:

- Set up monitoring sites in watersheds that are typically not a focus for general public outreach (i.e., Lower Muddy Fork and Moore's Creek) due to the rural nature of the subwatersheds.
- Select sites within small geographical distance of each other to assist in pinpointing areas of concern within a subwatershed.
- Create water quality and stream characteristic baselines for other organizations/agencies for a region that is still quickly urbanizing in the headwaters of the IRW.

The partnership with AGFC was instrumental in assisting with the set-up of Stream Teams local to the assessed subwatersheds. The Stream Team Program supported Stream Teams with equipment needed to conduct the ecological assessments, and IRWP's will continue to support the efforts of Stream Teams after the conclusion of the ANRC funded project.

Lastly, the partnership with the local EAST/Stream Teams was integral to the success of the project by collecting habitat assessment data and assisting in the collection, identification, and counting of macroinvertebrate communities for all 23 sites over 5 seasons. These student teams are engaged and local to the area, which creates a sense of ownership for the health of the local streams, which can be passed along to their school mates, parents, and local community.

Possible solutions to improve or enhance the effectiveness of future monitoring projects would be to partner with primary-secondary school groups, post-secondary school groups, or adult groups/organizations that are more tailored to the focus of the project. Examples would be extracurricular groups (i.e., Environmental Club, Outdoor Recreation Club, etc.) or established volunteer organizations (i.e., Master Naturalists, etc.). These partnerships would allow more flexibility on sample scheduling, more frequent training dates, and provide a base of support that is more equipped for outdoor work.

Technical Transfer

Information collected during the project can be passed along to many different types of stakeholders within the IRW and beyond. Examples of technical assistance that can be supplied from information obtained during the project period:

- Stream monitoring guidance, expertise, and some equipment to any existing or new group/organizations interested in monitoring regional streams.
- Creation of and distribution of a publicly accessible annual stream assessment report with subwatershed, and in some cases site, specific water quality ratings, land use characterization, and best management practices (BMPs) recommendations.
- Prepared presentations of water quality and stream characteristics baselines for specific impaired subwatersheds that can be used during stakeholder outreach events.
- Best practices, equipment, and gained in-situ experience for IRWP staff will be used in the establishment of new monitoring sites of the Lower IRW in Oklahoma, starting 2020.

Information collected was passed along to various stakeholders in diverse ways:

- Media mentions for stream assessments of Clear Creek subwatershed with EAST/Stream Teams (https://www.facebook.com/sabrina.batesWX/videos/vb.1420926727954549/2117872831845811/?type=2&theater).
- Annual Assessment Report presentation at a local government forum for all local municipalities located within the IRW.
- Anticipated Annual Report upload to IRWP's website by the end of 2019 (irwp.org).
- Raw data distributed to any interested landowners of assessed sites.
- Raw data of macroinvertebrate communities and stream characteristics shared with ANRC and AGFC.

Currently, IRWP is utilizing data collected as a result of the project in our Riparian Restoration Program, with a goal of restoring 20 miles of riparian areas, establishing two square miles of rotational grazing systems, and installing 7 miles of cattle fencing near streams. The Riparian Restoration Program is utilizing land use characterization data, stream characteristics, and water quality ratings to focus on areas of concerns within the priority subwatersheds and,

therefore, areas of opportunity for effective restoration efforts. The methods established during this project will be used to expand monitoring efforts by IRWP in Oklahoma (2020) to compare land use characteristics, stream characteristics, and macroinvertebrate communities. Lastly, experience and data gained by participating EAST/Stream Teams can be used to drive local stream cleanup efforts and stream monitoring for AGFC.

EPA Feedback Loop

EPA's 319 program is integral to watershed management programs as it is one of the only tools to voluntarily implement assessment projects and best management practices for water quality improvement. IRWP's interaction with the Arkansas Natural Resource Commission and Arkansas Game and Fish state agencies were productive, open, and instructive. This project directly addressed priorities outlined in ANRC's Non-Point Source Management plan by using to GIS to perform land use assessment and identify potential assessment sites at small geographical intervals (ANRC NPS Management Plan, Section 13, Objective 13.5), and six local AGFC stream teams were created to assist in potential long term monitoring of impaired subwatersheds (ANRC NPS Management Plan, Section 13, Objective 13.19).

Conclusions /Outcomes

The defined goals and objectives of the project were not established to directly reduce, control, or abate NPS pollution but to monitor impaired stream segments listed on the 2016 Arkansas 303(d) list, and educate local school age students in water quality assessments. However, the data ascertained from this project can be used as a data driven road map for local residents, conservation minded organizations, and municipalities to help focus outreach events, activities, and projects in areas that could have the most impact on the water quality of the IRW. Data driven decisions have the potential to get more local support and financial assistance to improve the water quality of the rapidly urbanizing region of Northwest Arkansas.

The project can be sustainable with the assistance of established Stream Teams and expanding to other conservation minded local organizations. By promoting the results of this project with the annual stream assessment reports, we hope that will engage volunteers to take up the seasonal monitoring of stream segments until future funding is available.

IRWP plans to continue this project through private funding sources, when possible. In 2020 and 2021, IRWP will expand this project into Oklahoma and implement a similar methodology. In subsequent years, IRWP plans to continue assessments in each state every other year.

Figures and Tables

Figure 1: Map of the Illinois River Watershed and its location within the State of Arkansas.

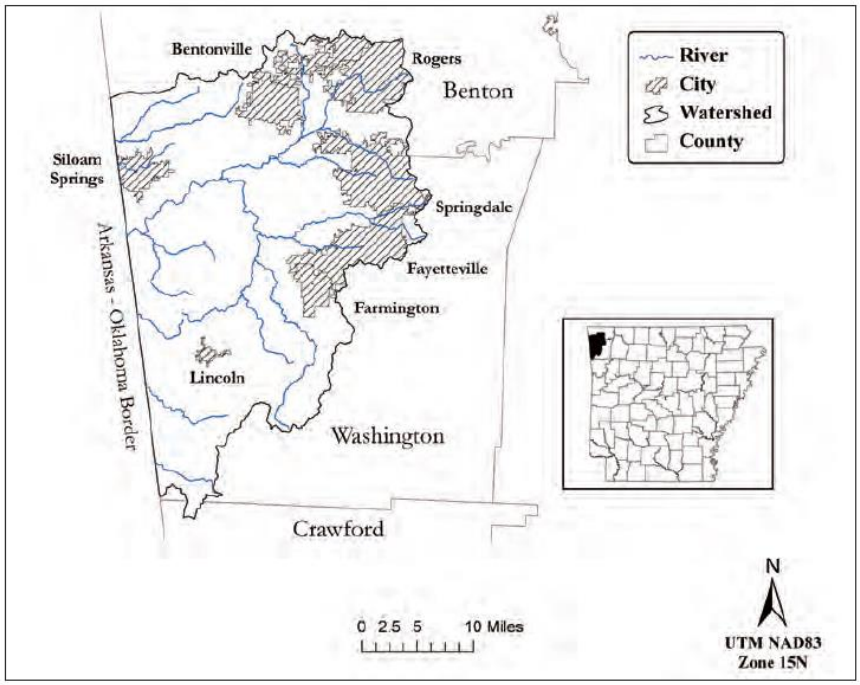


Figure 2: Priority HUC 12 subwatersheds (bold outline) within the Upper IRW. Goose Creek, located east of Muddy Fork and Clear Creek, was also assessed for comparison purposes.

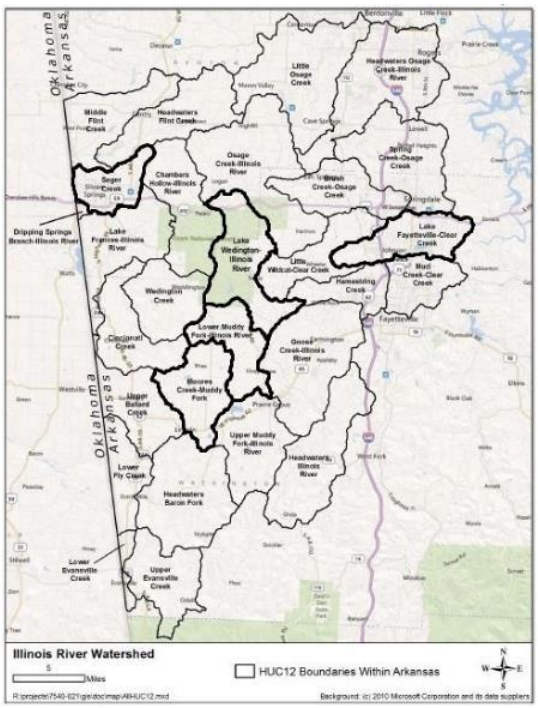
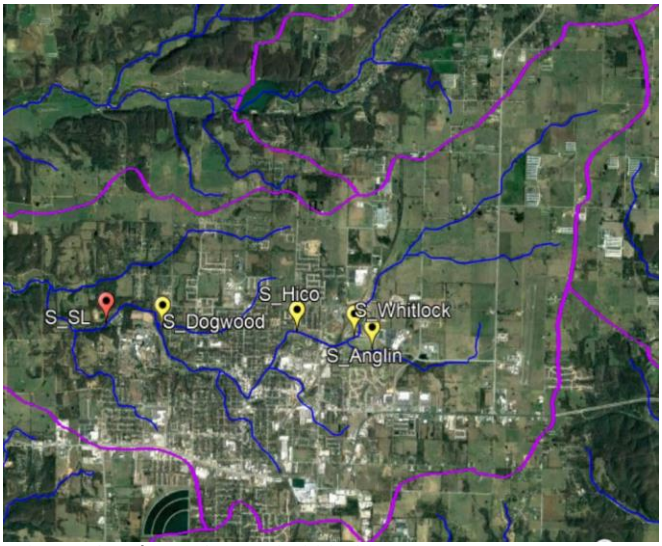
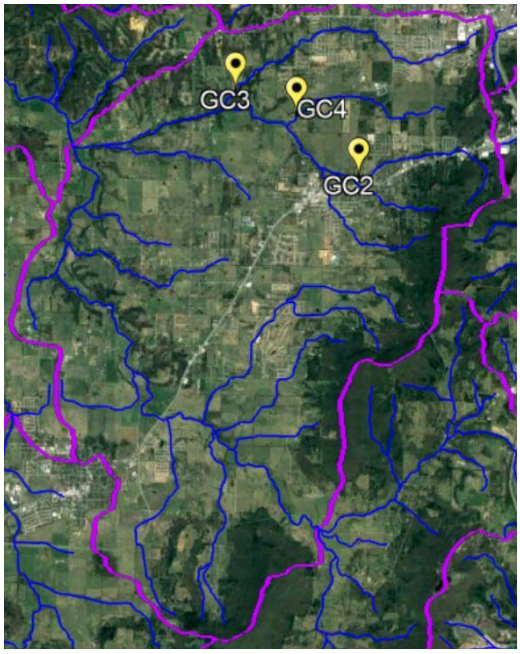


Figure 3: Field assessment locations



Sager Creek, HUC 111101030502



Goose Creek, HUC 111101030102

Clear Creek, HUC 111101030201

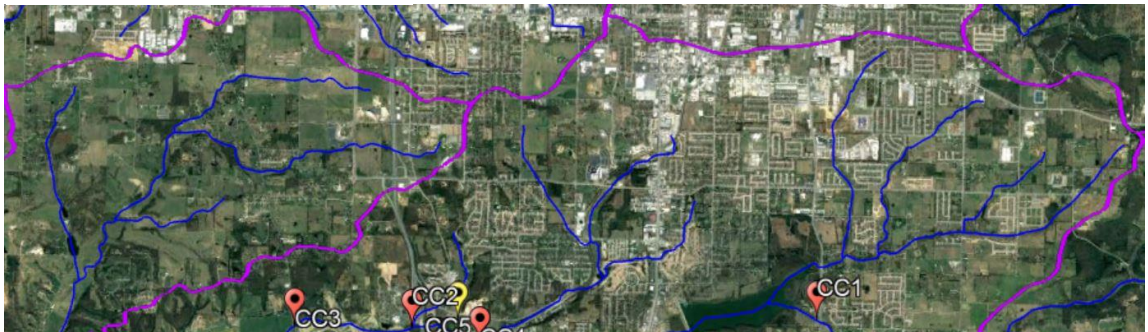
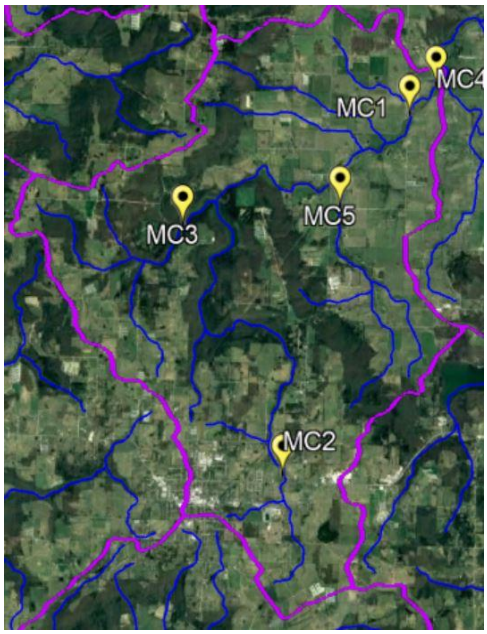
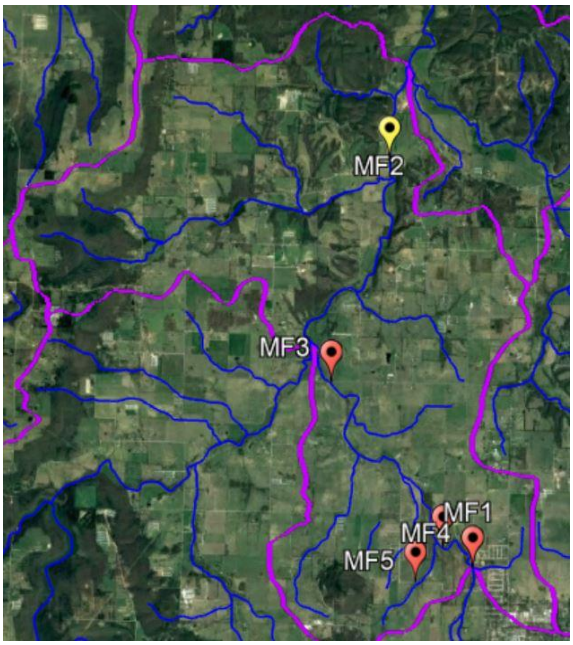


Figure 3 (continued): Field assessment locations



Moore's Creek, HUC 111101030402



Muddy Fork, HUC 111101030403

Table 1: Percent land use within assessed subwatersheds

Subwatershed	% Urban	% Pasture	% Forest
Clear	40.6	28.8	21.5
Moore's	4.6	56.9	33.5
Muddy	2.9	66.8	25.9
Sager	30.5	54.5	11
Goose	11.5	56.2	25.9

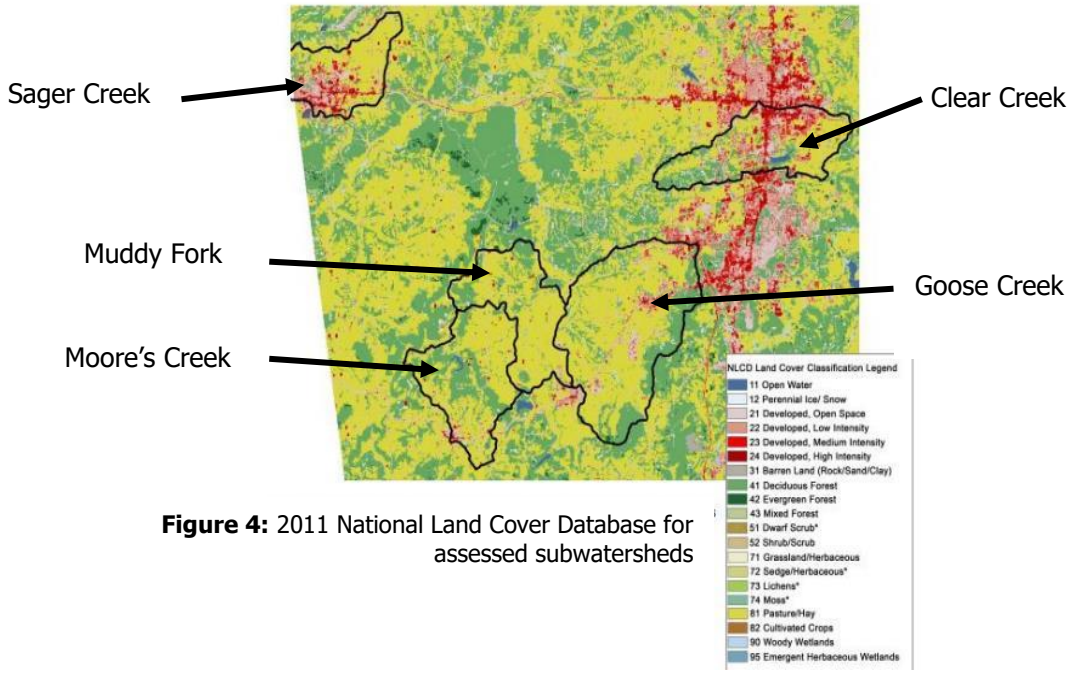


Figure 4: 2011 National Land Cover Database for assessed subwatersheds

Figure 5: Macroinvertebrate diversity across subwatersheds

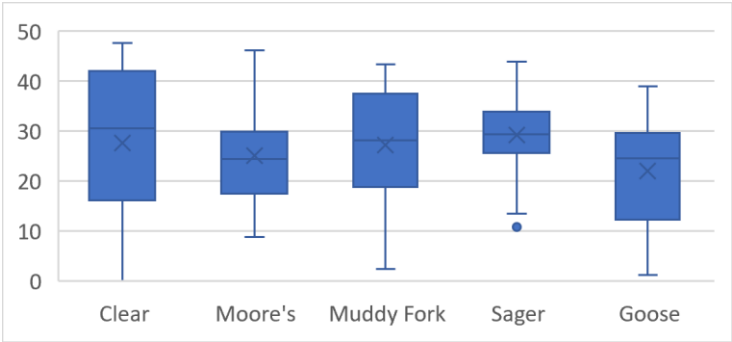


Figure 6: Macroinvertebrate diversity across subwatersheds

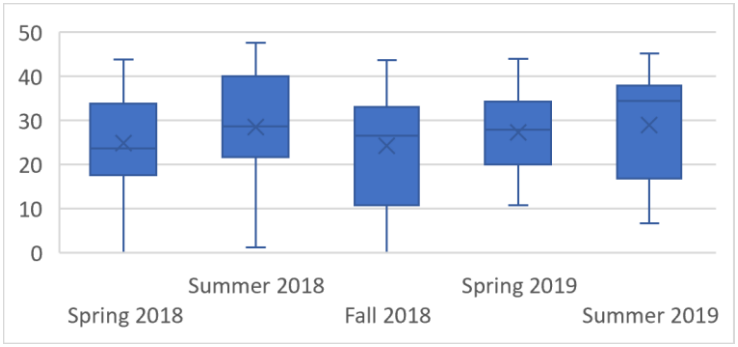


Figure 7: Macroinvertebrate Diversity across Sites. The red line represents average diversity across all sites (equal to 26.7).

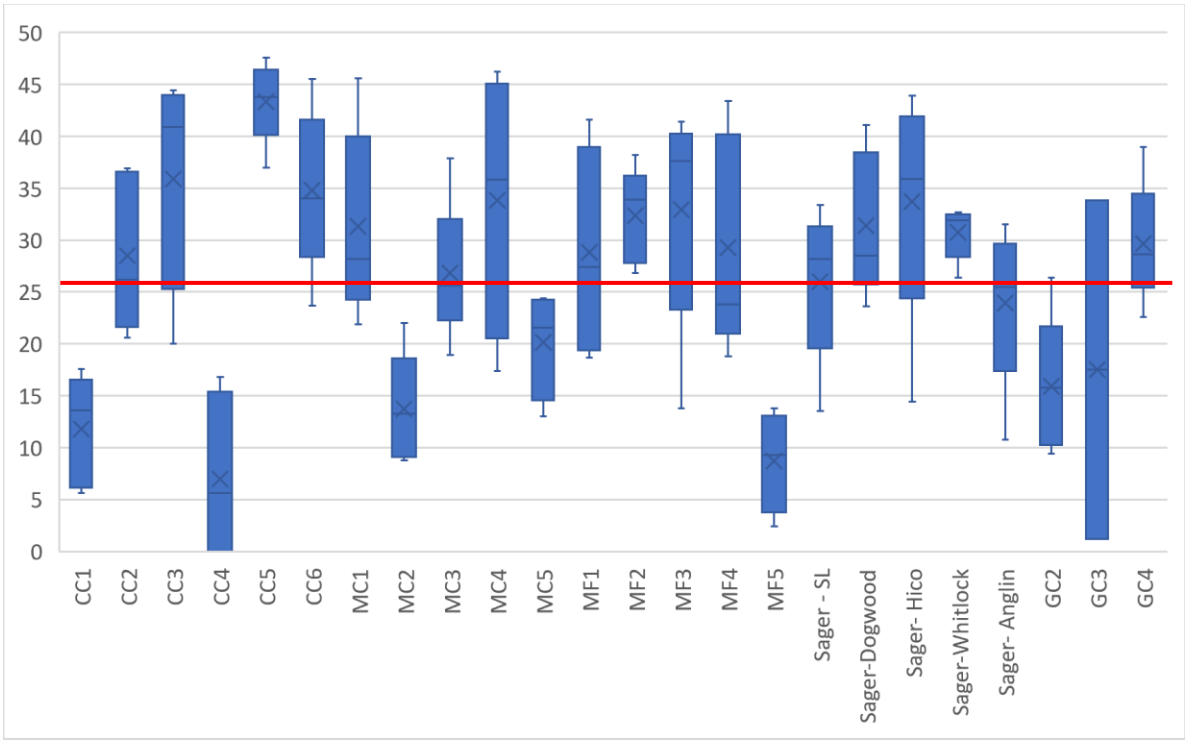


Figure 8: Macroinvertebrate diversity compared to land use type.

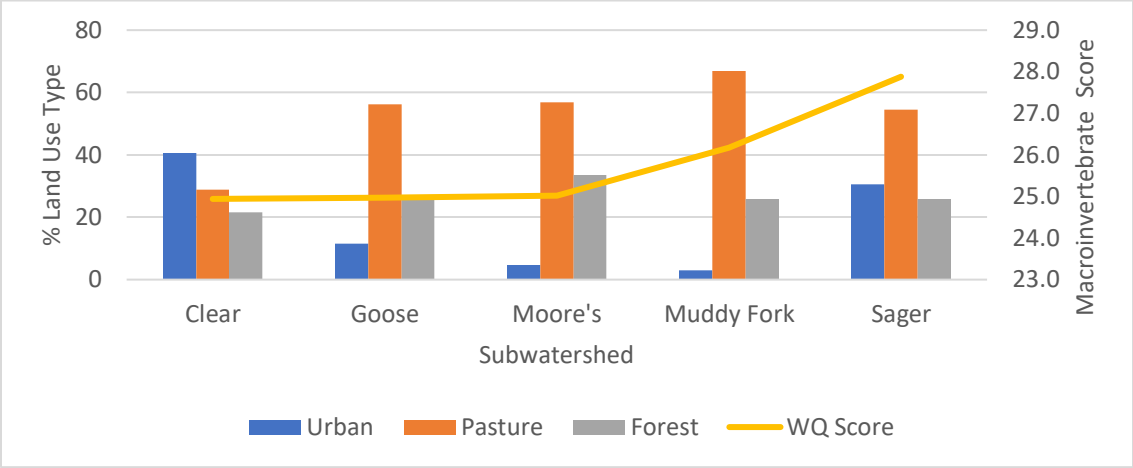


Table 2: Regression statistics between macroinvertebrate diversity and within-stream, streambank, and riparian parameters

Macroinvertebrate Diversity vs. % presence of:	Relationship	R^2	P value
Riffles	Positive	0.043	0.33
Riffles & runs	**Positive**	**0.026**	**0.01**
Runs	Positive	0.164	0.05
Pools	Negative	0.066	0.23
Some silt	Negative	0.004	0.76
Most silt	Positive	0.004	0.75
Some sand	Positive	0.006	0.71
Most sand	Positive	0.288	0.18
Some clay, slit, and sand	Positive	0.022	0.49
Streambank trees	Positive	0.003	0.78
Riparian tress	Positive	0.000	0.91
Riparian lawn	Positive	0.007	0.68
Algae present	Negative	0.002	0.80