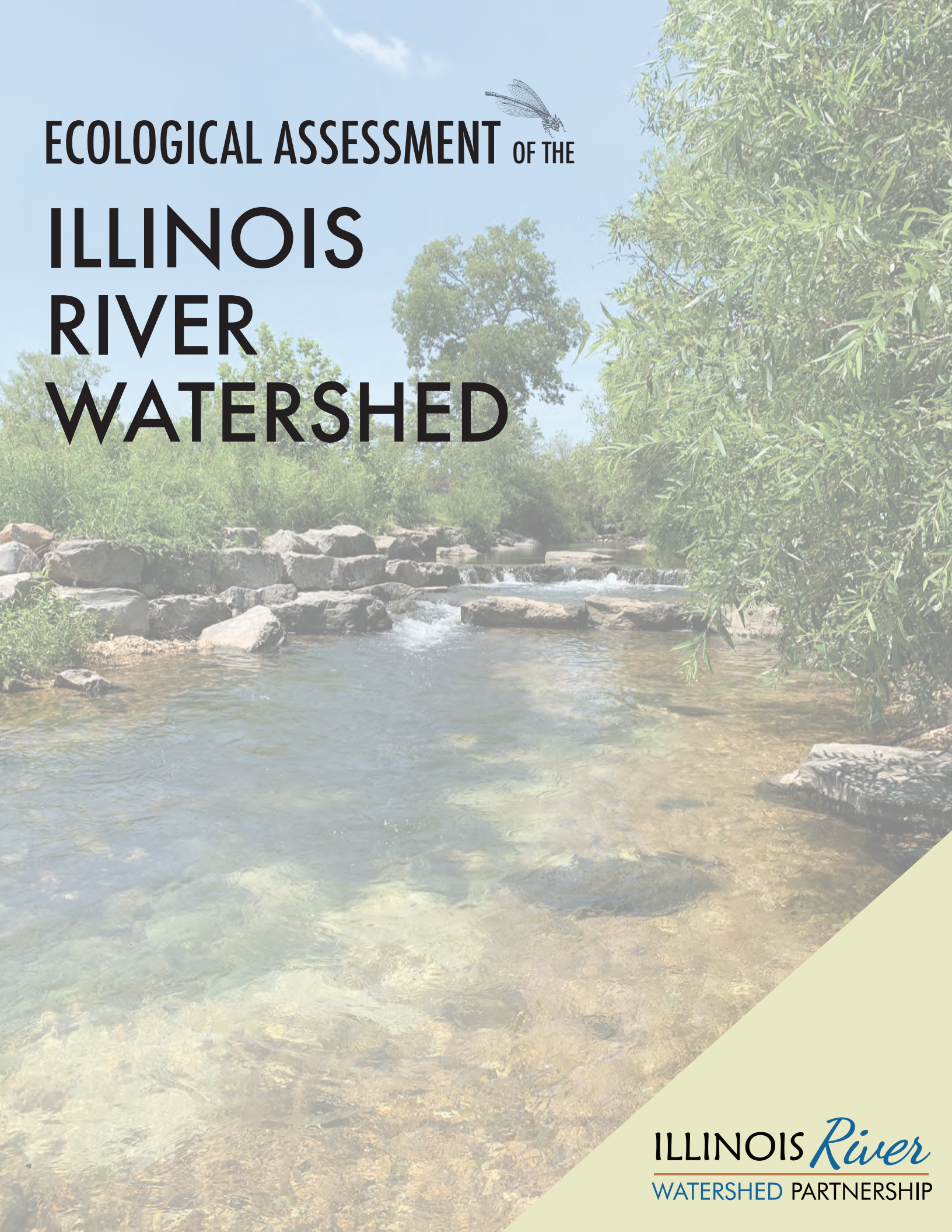

ECOLOGICAL ASSESSMENT OF THE ILLINOIS RIVER WATERSHED

ILLINOIS River
WATERSHED PARTNERSHIP

MISSION

IRWP works to improve the integrity of the Illinois River through public education, community outreach, and implementation of conservation and restoration practices throughout the watershed.

VISION

The Illinois River and its tributaries will be a fully functioning ecosystem, where ecological protection, conservation, and economically productive uses support diverse aquatic and riparian communities, meet all state and federal water quality standards, promote economic sustainability, and provide recreational opportunities.

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Introduction

The Illinois River Watershed (IRW), located in Northwest Arkansas and eastern Oklahoma, includes just over 1 million acres, one of the fastest growing metropolitan areas, and two of the top producing counties for livestock and poultry production in the country. The watershed is extremely diverse ecologically speaking, containing extensive cave systems, upland and lowland prairies, oak-hickory dominant forests, and the northern and western most portions of the Boston Mountains. The three primary management challenges in the watershed relate to phosphorus concentrations, the presence of threatened and endangered species, and bacteria impairments. While the watershed is mostly rural, consisting of forest and pasture lands, the development of the Fayetteville-Springdale-Rogers metropolitan area is placing additional strain on the river as the headwaters of several major tributaries are located in the area. In fact, many of the towns in the region were first established due to the presence of the many springs and creeks within the IRW.

The watershed is considered a priority subwatershed by the States of Arkansas and Oklahoma, as well as the Cherokee Nation, and it is monitored regularly by many state and federal agencies, but monitoring locations are widely dispersed geographically and it is difficult to make management decisions at the subwatershed scale based on monitoring data alone. The three main goals for this project were:

1. Gain an improved ecological understanding of the entire watershed,
2. Provide long-term trend analysis of watershed condition at small geographic intervals, and
3. Identify priority areas for management activities such as education and outreach campaigns, as well as conservation and restoration projects.

IRWP hopes this report will assist city and county elected officials, relevant staff, business leaders, and interested landowners when making decisions on land use, stormwater management, and natural resource issues in the watershed.

The project assessed in-stream, streambank, and riparian ecological condition as well as macroinvertebrate diversity in eight subwatersheds (four in Arkansas and four in Oklahoma). All subwatersheds are designated as impaired by each State's Departments of Environmental Quality and, in Arkansas, the four subwatersheds have previously been identified as high contributors to sediment and nutrient loading in modeling studies. In 2018 and 2019, IRWP partnered with local schools' Environmental and Spatial Technology (EAST) programs to assess twenty one locations in April, August, and November of each year. In 2020, IRWP partnered with Oklahoma Conservation Commission's Blue Thumb staff and volunteers to assess twelve locations during the same months. This report summarizes findings from the first three years of study. For next steps, assessment in Oklahoma will be repeated in 2021 and it is the goal of the program to assess the same Arkansas sites in even years and Oklahoma sites in odd years on an on-going basis.

Methods

Stream Habitat Assessment:

- Utilized EPA's Volunteer Stream Monitoring: A Methods Manual (publication number EPA 841-B97-003). Section 4.1: Stream Habitat Walk
- 300 feet stream reach subdivided into four, 75-foot sections.
- Each 75-foot section was observed by standing at the downstream-most end and looking upstream.
- For the purposes of data analysis, percent observations for each site were averaged across sections, then average across years.

Macroinvertebrate Diversity:

- Utilized EPA's Volunteer Stream Monitoring: A Methods Manual (publication number EPA 841-B97-003), section 4.2: Streamside Biosurvey.
- Sampling consisted of a composite of three, three-foot riffle locations across the entire 300 foot stream reach.
- Macroinvertebrate identification based on Izaak Walton League of America – Stream Insects and Crustaceans.
- Macroinvertebrate score calculated using Arkansas Game and Fish Commission's Stream Team method.
- One score was generated for each season and, for the purposes of data analysis, averaged across years.

Statistical Analysis:

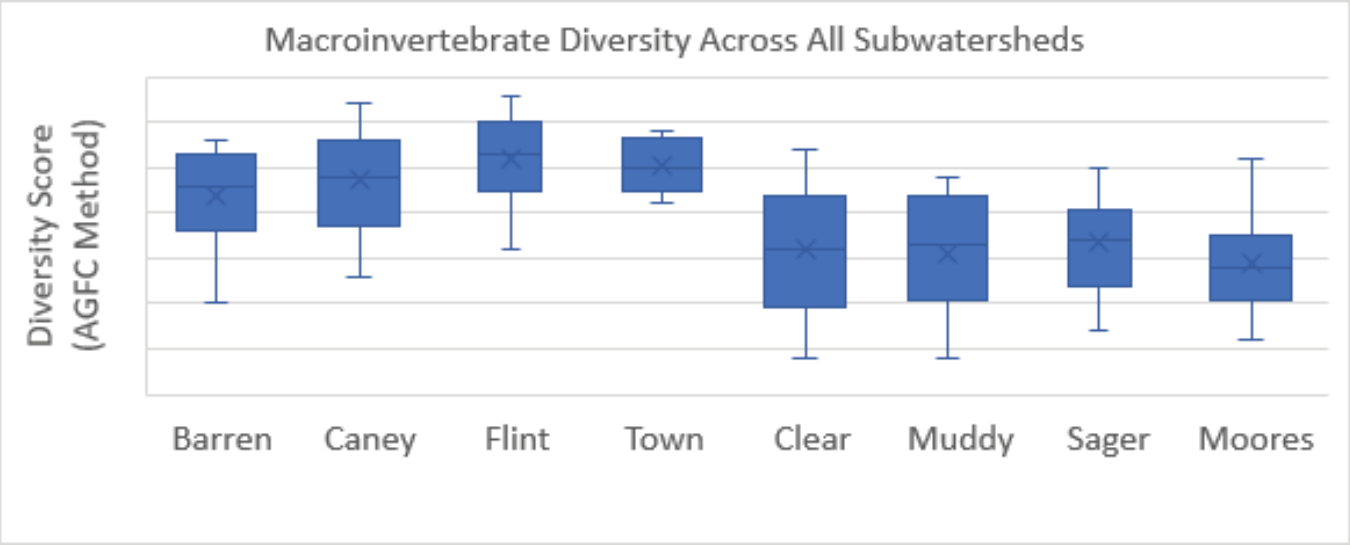
- All analyses were performed in Microsoft Excel.
- Compared variables included macroinvertebrate diversity, composition of stream bottom, streamside cover, surrounding land use, and types of algae present.
- Regression analysis was used to examine relationships between each of the above habitat variables and diversity scores.
- T-tests were used to compare variables between Arkansas and Oklahoma.

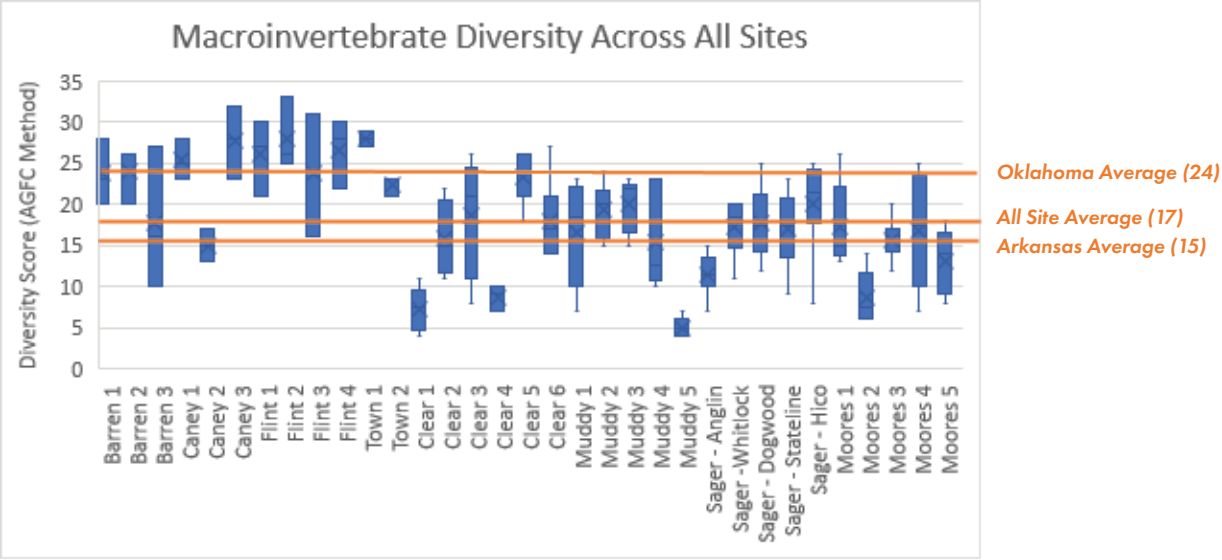
Summary of Findings

- Macroinvertebrate diversity was significantly higher across Oklahoma sites when compared to Arkansas.

- In Arkansas, the sites with the lowest diversity scores were found in Muddy Fork and Clear Creek subwatersheds. Ironically, the site with the highest diversity score was also found in Clear Creek sub-watershed.

- In Oklahoma, the site with the lowest average diversity score was found in Barren Fork and the site with the highest average diversity score was found in Flint Creek.





Summary of Findings

When examining relationships between diversity scores and habitat parameters:

- All significant relationships were weakly related.

- There were positive relationships between diversity and presence of gravel and cobbles within the streambed. There were negative relationships between diversity and presence of silt, clay, and mud within the streambed, filamentous algae in the water column, and (oddly) presence of trees along the streambank banks.

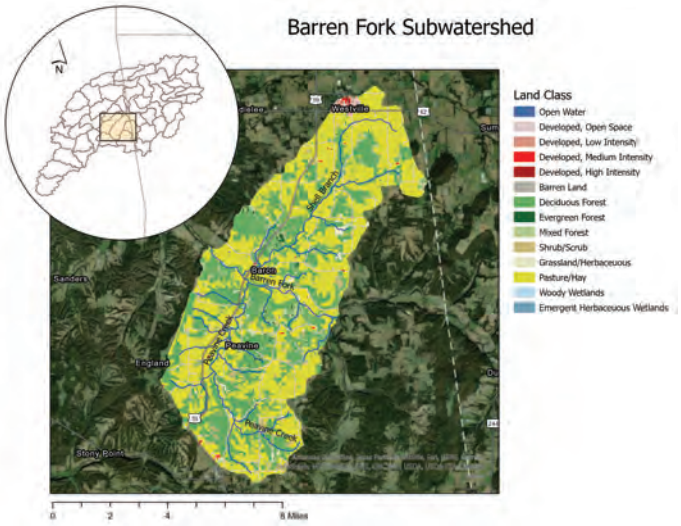
- Due to the number of significant relationships, we have chosen to focus on the three significant streambed types for subwatershed analyses. Those are: gravel, silt/clay/mud, and cobbles.

- The positive relationships between gravel, cobbles, and water bug diversity make sense as these species use spaces between rocks as places for protection and egg-laying. The negative relationship with silt, clay, and mud is also supported in that small soil particles can impact species' respiration as well as fill those spaces between rocks that are important to these species' survival.

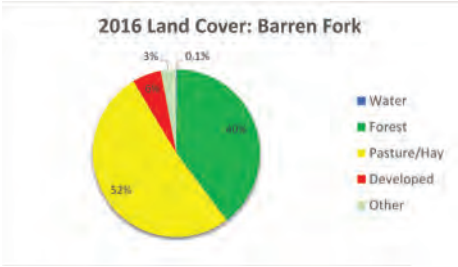
- For purposes of this report and its findings, management recommendations focus on reduction of silt, clay, and mud from the immediate site and upstream land uses (which presumably contribute silt, clay, and mud to the sampling site).

		Relationship to Diversity		
		Strong or Weak?	**Significant ?**	**Positive or Negative?**
Composition of Streambottom	**Gravel**	**Weak**	**Yes**	**Positive**
	Silt/Clay/Mud	**Weak**	**Yes**	**Negative**
	Cobbles	**Weak**	**Yes**	**Positive**
	Sand	None	Yes	None
	Bedrock	None	Yes	Negative
	Boulders	None	No	None
Surrounding Land Use	Roads	None	Yes	Negative
	Residential	None	No	None
	Recreation	None	No	None
	Agriculture	None	No	None
	Construction	None	No	None
	Other	None	No	None
Streamside Cover	**Trees**	**Weak**	**Yes**	**Negative**
	Boulders/Rocks	None	Yes	Negative
	Gravel/Sand	None	Yes	Negative
	Tall Grasses/Ferns	None	No	None
	Bushes	None	No	None
	Pavement/Structures	None	No	None
	Lawn	None	No	None
	Bare Soil	None	No	None
Types of Algae Present	Surface Coating	None	Yes	Positive
	Filamentous	**Weak**	**Yes**	**Negative**
	None	None	Yes	Negative
	Clumped/Matted	None	No	None

Barren Fork (Oklahoma)



The headwaters of Barren Fork begin in southern Washington County in Arkansas, but the watershed is mostly located in Oklahoma and actually occupies more land area than the main stem of the Illinois River. The subwatershed contains the largest piece of conserved land in the watershed, the J.T. Nickel Preserve, which is owned and managed by The Nature Conservancy. At 17,000 acres, the Preserve includes upland prairies, upland and lowland, oak/hickory dominant forest, and sustainably managed pasture lands.



Barren Fork Land Use Comparison

	1992 (%)	2016 (%)	Change
Pasture/Hay	57	52	-5
Forest	40	40	0
Developed	1	6	5
Water	0.3	0.1	-0.2
Other	2	3	1

2018 Impairments (Oklahoma DEQ):

Phosphorus

Bacteria

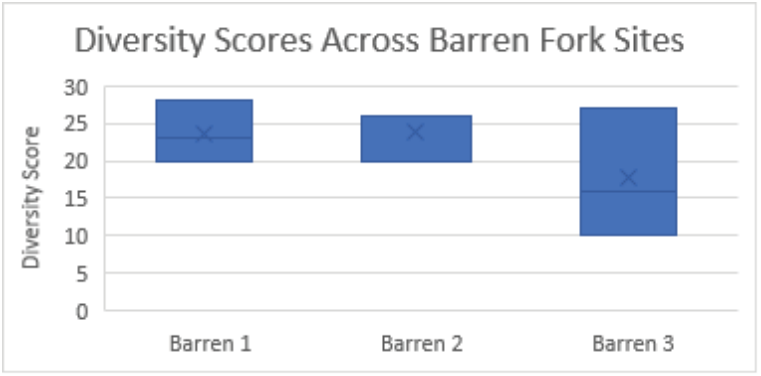
Data summary:

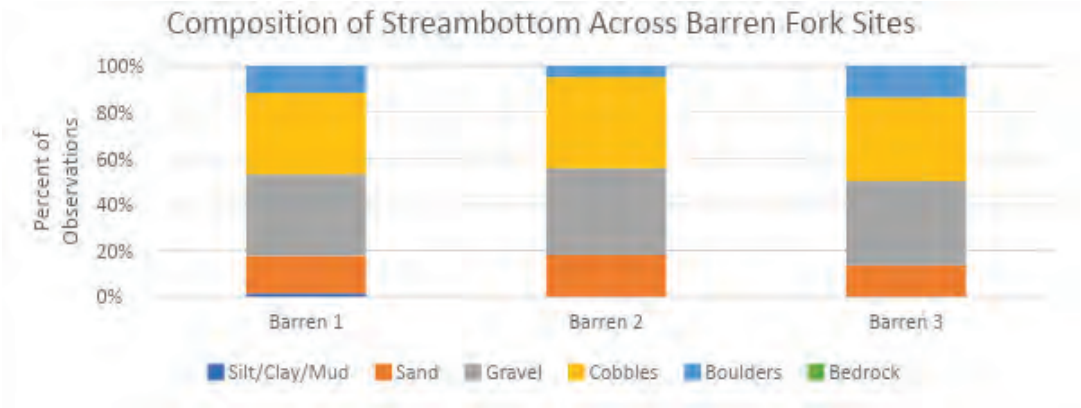
- This portion of Barren Fork, which is located in Oklahoma, experienced a 5% increase in developed land use, which is likely due to conversion of pasture lands.

- Barren Fork had the lowest average diversity scores across the four Oklahoma subwatersheds.

- The percent of observations that found silt, clay, and mud were also low and it was only observed at the Barren 1 site.

- Converse to expectation, Barren 1 also had the highest average diversity score, while Barren 3 had the lowest diversity score and the highest ratio of cobbles and gravel.





Barren Fork (Oklahoma)

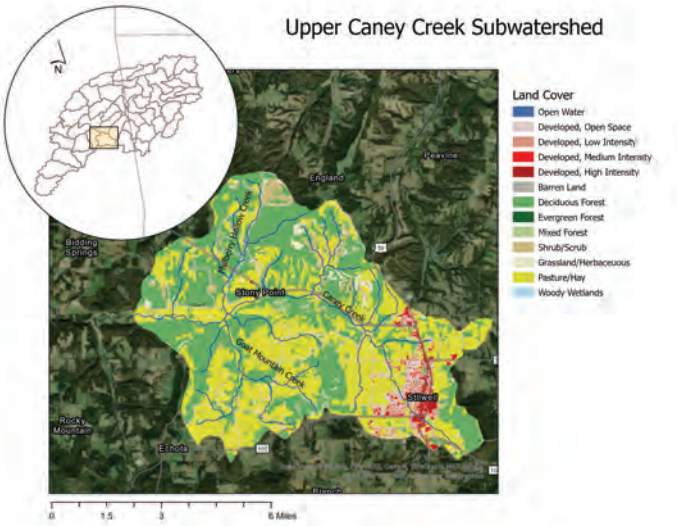
Visual Comparison of Sites with High and Low Numbers of Gravel and Cobbles Observations:

The Barren Fork site at left shows no active signs of erosion, though the gravel bar at left indicates erosion upstream from this site. The right-hand photo shows active signs of erosion, though at fairly low rates. This particular site did have high macroinvertebrate diversity, indicating that despite the active erosion, there is still enough diversity of in-stream habitat to maintain relatively healthy communities.

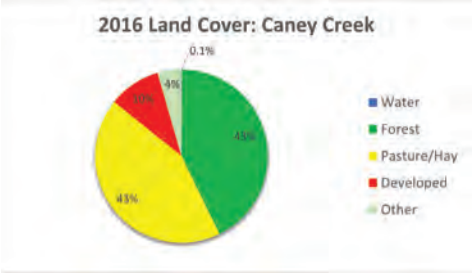
Management Recommendations:

1. Permanent or semi-permanent land conservation
2. Restoration of riparian forests, wetlands, and floodplains
3. Sustainable livestock practices such as rotational grazing and fencing cattle out of streams.

Caney Creek (Oklahoma)



Caney Creek is a largely rural watershed, dominated by forested hillsides and agricultural pastures. The headwaters of the Creek begin along Highway 59, close to Stilwell in Adair County, Oklahoma. The Creek flows west and eventually drains into Lake Tenkiller. It does not have a confluence with either the Illinois River or Barren Fork tributary.



Caney Creek Land Use Comparison

	1992 (%)	2016 (%)	Change
Pasture/Hay	44	43	-1
Forest	49	43	-6
Developed	6	10	4
Water	0.2	0.1	-0.1
Other	1	4	3

2018 Impairments (Oklahoma DEQ):

Macroinvertebrates

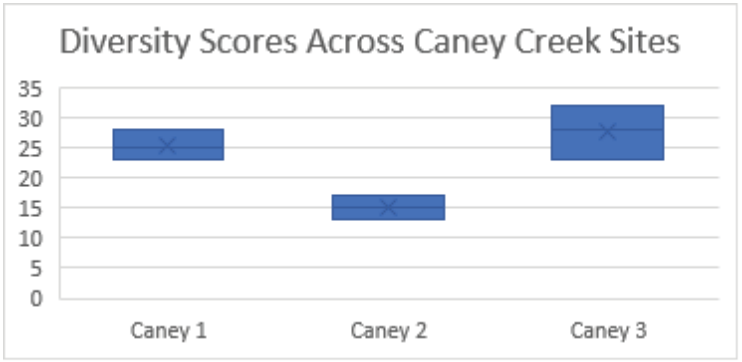
Bacteria

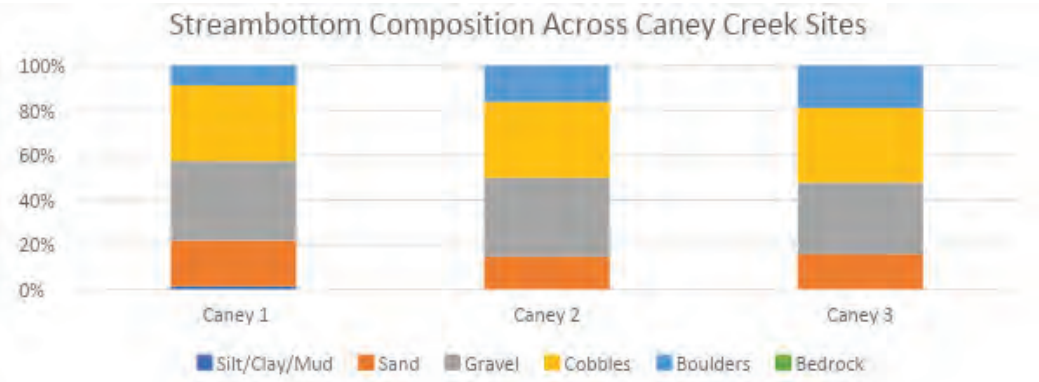
Data Summary:

- From 1992 to 2016, Caney Creek lost 6% of forested lands to development. Deforestation is concerning as this watershed contains high-quality ecological conditions, as well as the western-most portions of the Boston Mountains.

- In regard to macroinvertebrate diversity, Caney Creek contained two sites that were quite high in diversity and one site that measured the lowest diversity in Oklahoma. It should be noted this site was dry in the summer, which indicated subsurface flow and likely contributed to low diversity measures.

- All three sites had high percent observations of cobbles and boulders (all sites were greater than 80%) and no sites had observations of silt, clay, or mud.





Caney Creek (Oklahoma)

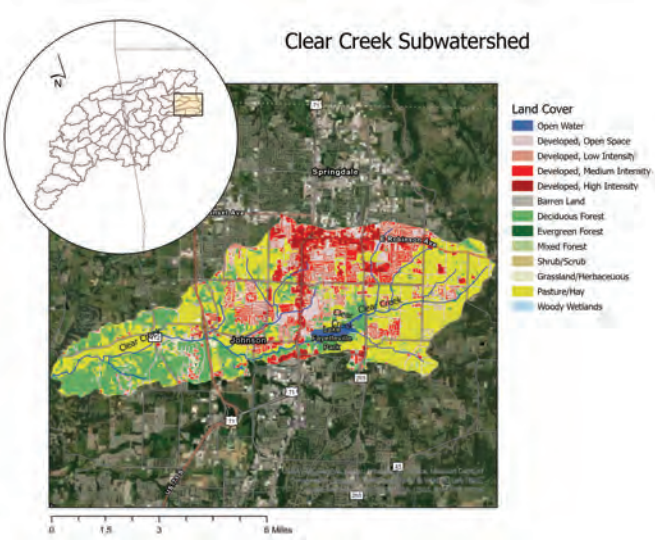
Visual Comparison of Sites with High and Low Numbers of Gravel and Cobbles Observations:

The site at left, located on the main stem of Caney Creek, is showing active signs of erosion and cattle have open access to the stream. Interestingly, the site was dry in August, but water was present at an upstream site, indicating subsurface flow for at least part of the year. The Caney site to the right is located on a tributary that is small, remote, and amid a large, forested parcel. Little to no active erosion is indicated by vegetation growing on the gravel bar and on the left streambank.

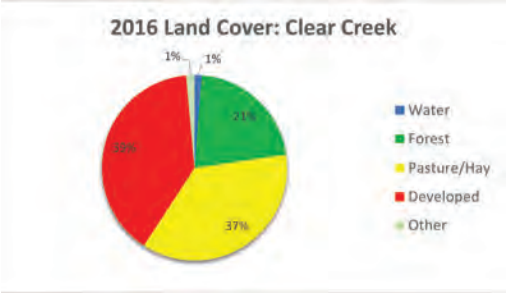
Management Recommendations:

1. Permanent or semi-permanent land conservation of forested areas along waterways
2. Agriculture practices for cattle production
3. Wetland and floodplain restoration

Clear Creek (Arkansas)



The assessed tributaries of Clear Creek included sites upstream and downstream of Lake Fayetteville. This is the most urbanized subwatershed assessed in this project and the area continues to urbanize throughout the headwaters of all major tributaries. Lake Fayetteville is a reservoir created in 1949 as a drinking water supply for the City of Fayetteville. Today the Lake features extensive recreational amenities that are owned and managed by the City. A 2019 assessment of the watershed found extensive prairie and wetland features in undeveloped areas of the watershed.



Clear Creek Land Use Comparison

	1992 (%)	2016 (%)	Change
Pasture/Hay	58	37	-21
Forest	18	21	3
Developed	17	39	22
Water	3	1	-2
Other	5	1	-4

2018 Impairments (Arkansas DEQ):

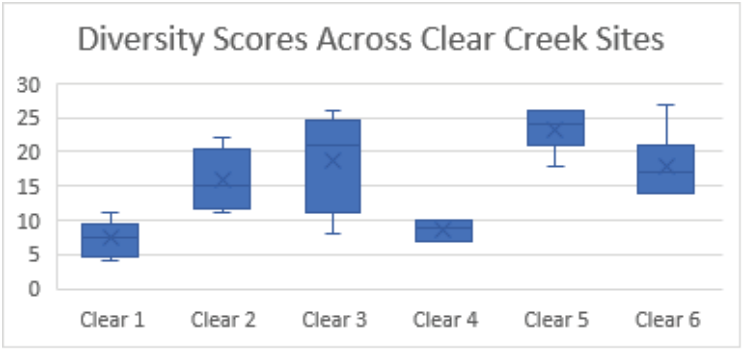
Bacteria

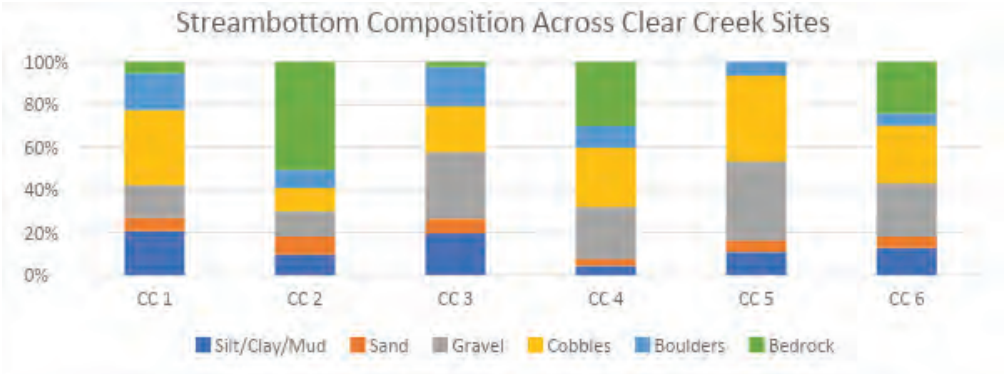
Data Summary:

- Urban development in the Clear Creek subwatershed increased by 22% from 1992 to 2016. Areas upstream of Lake Fayetteville (on the east side of the watershed) are particularly vulnerable, as old family farms and, in some cases, remnant prairies are converted to suburban, medium to low density urban development.

- Clear Creek had two of the least diverse sites across the entire study, but also one of the highest scoring sites within Arkansas.

- The percent of observations in Arkansas that found silt, clay, or mud were lowest in Clear Creek, but still higher than all sites in Oklahoma.





Clear Creek (Arkansas)

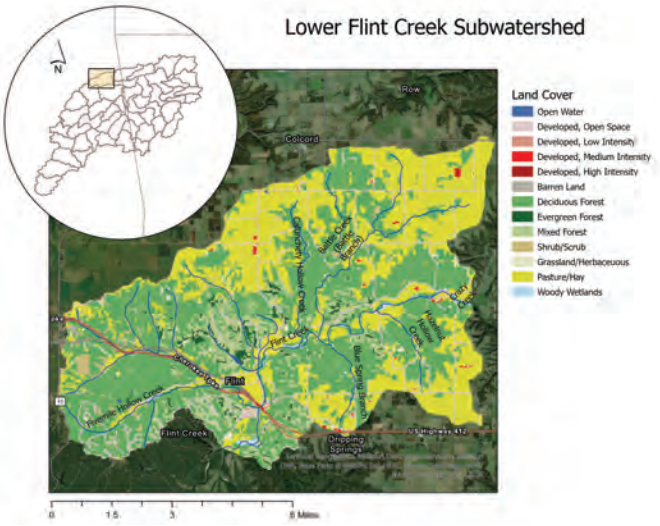
Visual Comparison of Sites with High and Low Numbers of Gravel and Cobbles Observations:

The Clear Creek site at the left recorded higher diversity and presence of gravel and cobbles than the site at the right, but both indicate "incision". Incision is a common occurrence in urban creeks and streams and occurs when a creek or stream loses access to a wetland or floodplain. This leads to larger quantities and velocities of water, resulting in a snowball effect of erosion not only laterally along the streambank but also to lower elevations below the original stream-bed.

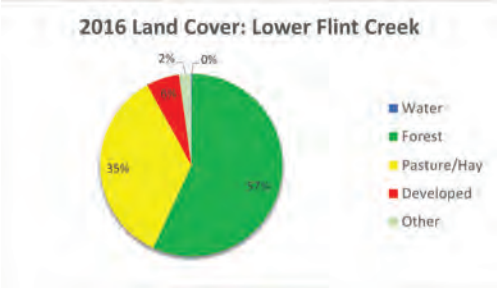
Management Recommendations:

1. Permanent or semi-permanent conservation of undeveloped areas around waterways.
2. Low Impact Development practices for all parcels with residential or commercial development
3. Restoration of all incised stream reaches using natural channel design, followed by permanent conservation of surrounding land.

Flint Creek (Oklahoma)



The headwaters of Flint Creek are located in rural parts of Benton County, Arkansas, and the Creek flows into Oklahoma where it confluences with Sager Creek, then the Illinois River main stem. While a relatively small and unknown tributary, it is arguably one of the most scenic with high-quality creeks and streams and surrounding forested lands.



Flint Creek Land Use Comparison

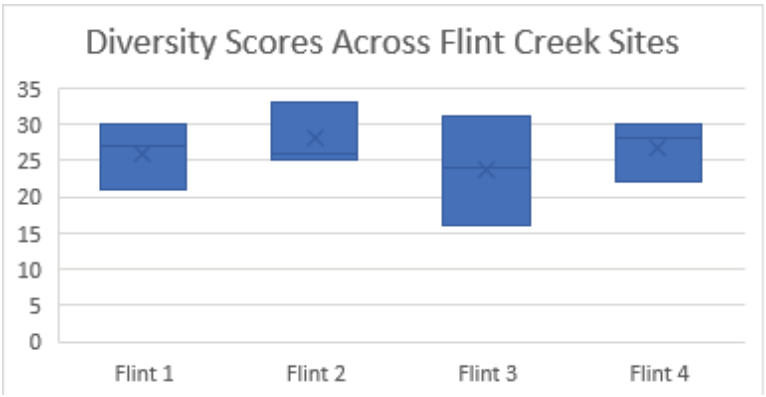
	1992 (%)	2016 (%)	Change
Pasture/Hay	44	35	-9
Forest	53	57	4
Developed	0.5	6	5.5
Water	0.3	0	-0.3
Other	2	2	0

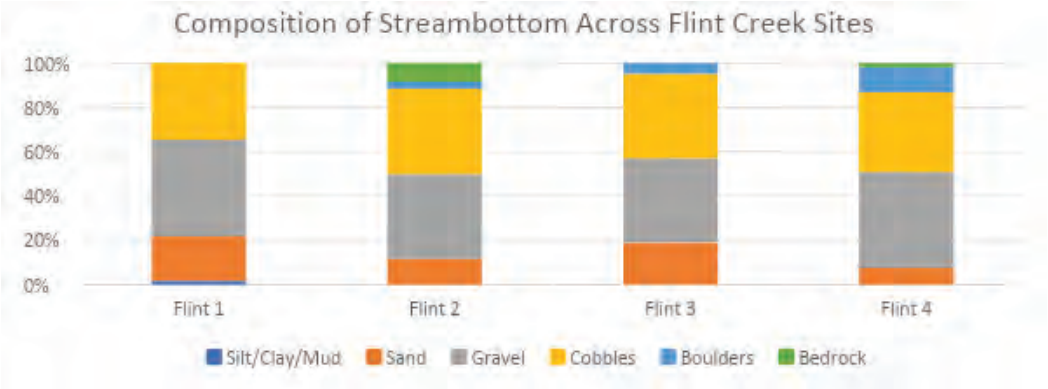
2018 Impairments (Oklahoma DEQ):

Phosphorus
Bacteria
Dissolved Oxygen

Data Summary:

- 9% of pasture lands in Flint Creek were converted to urban/suburban development (+5%) and, interestingly, forest (+4%). This is likely due to establishment of young forests after farm operations have been reduced or ceased.
- Flint Creek contained the most diverse sites across all locations and had the highest average diversity across all subwatersheds.
- Very little silt, clay, or mud were observed at any site across all assessed seasons.





Flint Creek (Oklahoma)

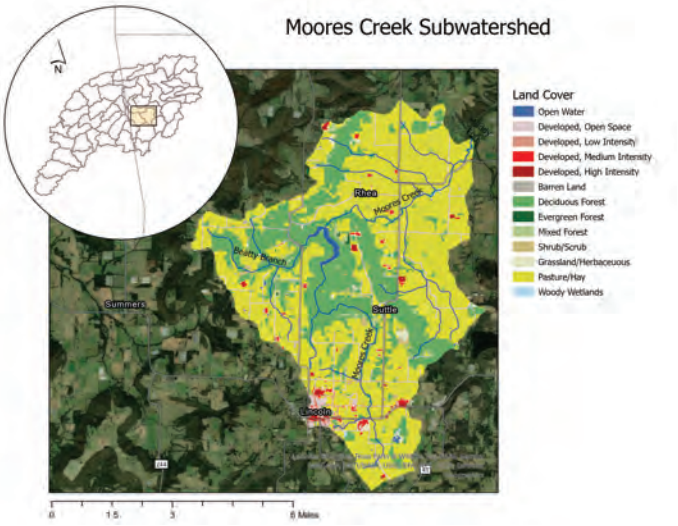
Visual Comparison of Sites with High Numbers of Gravel and Cobbles Observations:

There was little variation in quantities of silt, gravel, and cobbles or diversity among Flint Creek sites. Despite the eroded bank in the left-hand photo, the site still scored well, likely indicating that the rural land use types upstream of the site preserves streambottom composition, prevents silt and mud loading, and protects macroinvertebrate communities.

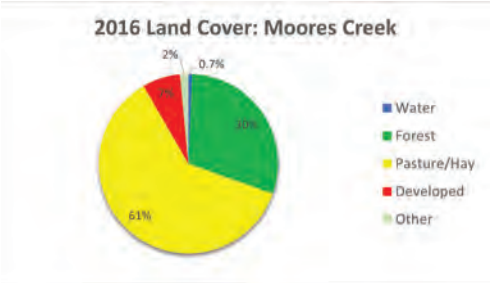
Management Recommendations:

1. Permanent or semi-permanent conservation of all forested parcels (upland and lowland) throughout the subwatershed.
2. Sustainable practices for livestock production such as rotational grazing and fencing cattle out of streams.

Moores Creek (Arkansas)



Moores Creek is a rural subwatershed located in southern Washington County, Arkansas. The City of Lincoln (population 2,444) is located in the watershed and includes the 90-acre Lincoln Lake, which is a reservoir originally used as the City's water supply. The Lake features many recreational amenities including mountain biking, hiking, rock climbing, non-motorized boating, and fishing. Land use is largely agricultural, but large tracks of forests exist at upper elevations, which is the northern boundary of the ecologically unique Boston Mountains.



Moore's Creek Land Use Comparison

	1992 (%)	2016 (%)	Change
Pasture/Hay	59	61	2
Forest	31	30	-1
Developed	2	7	5
Water	1	0.7	-0.3
Other	6	2	-4

2018 Impairments (Arkansas DEQ):

Sulfate

Bacteria

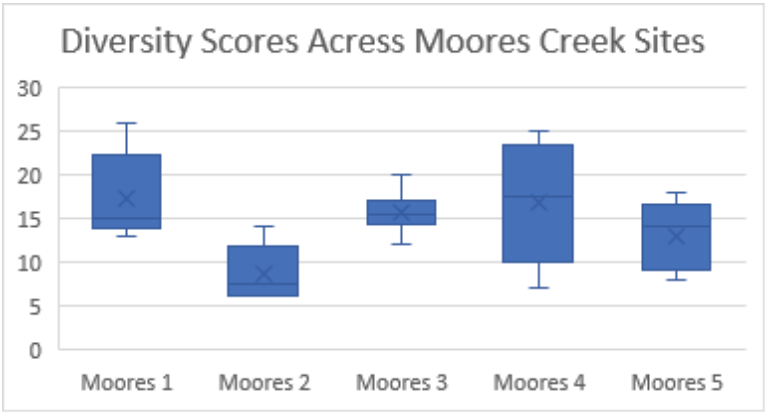
Data Summary:

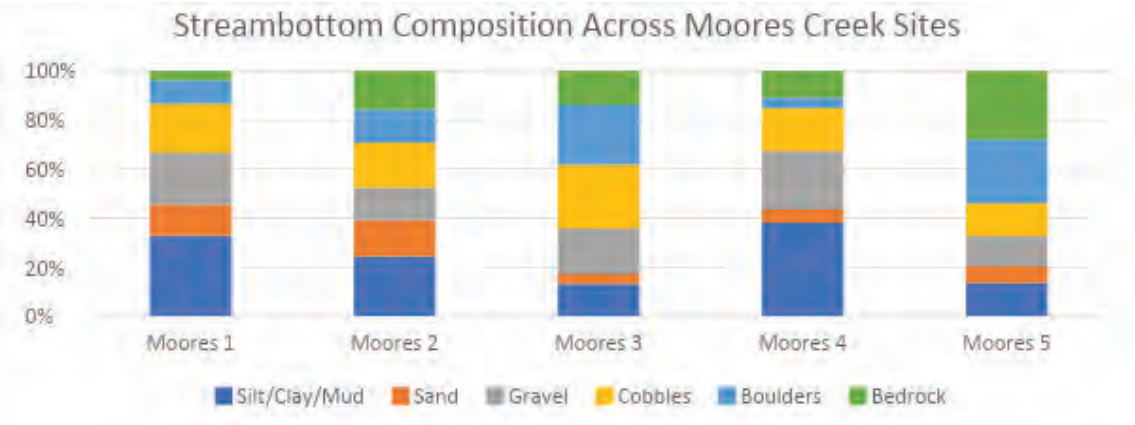
- When comparing 1992 to 2016, development in Moore's Creek appears to have occurred in land uses designated as "Other". This designation includes row crops, grassed or shrub "scrub", and barren land.

- Moores Creek contained two sites with below average diversity and two with average diversity.

- The average percent of silt, clay, or mud observations were high and Moore's Creek had the lowest average observation of cobbles across all locations.

- Despite its rural setting, incision and erosion are commonplace across the watershed indicating historic channel straightening, loss of wetlands, loss of riparian forests, and/or damage from livestock access (which contribute to erosion and increasingly steep streambanks).





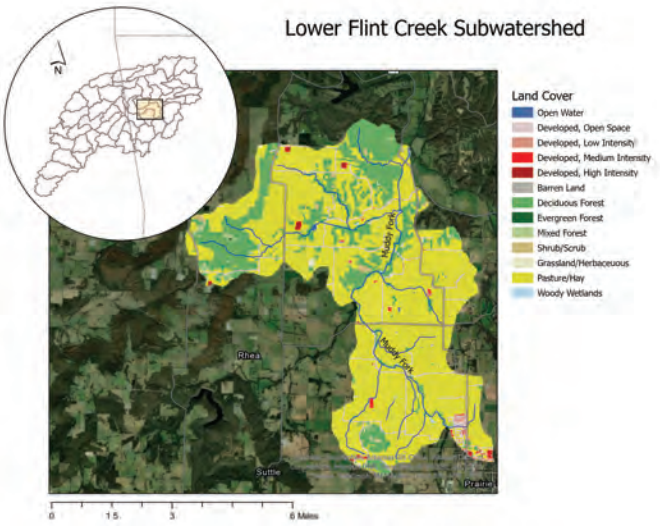
Visual Comparison of Sites with High and Low Numbers of Gravel and Cobbles Observations:

The site of the left, located upstream of Lincoln Lake, is a good example of the diversity of stream habitat that is needed to support diverse macroinvertebrate communities. The creek is on the same elevation as the surrounding land use, indicating no incision or erosion is occurring. And there is a wide variety of rock sizes, surface types, and flow regimes that macroinvertebrates can utilize. The site on the right, on the other hand, is incised and eroding, contains turbid water (indicating deposition of silt and mud), and lacks variation in habitat (i.e. no riffles, runs, or pools).

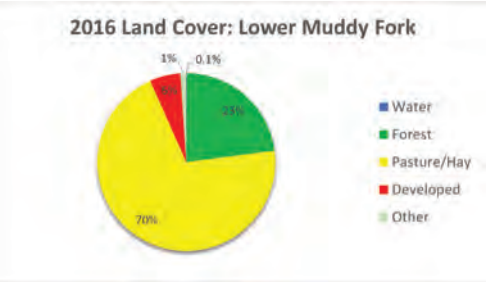
Management Recommendations:

1. Re-establish riparian forests, wetlands, and floodplains.
2. Permanent or semi-permanent conservation of areas around headwaters and/or forested hillsides.
3. Sustainable livestock practices such as rotational grazing and fencing cattle out of streams.

Muddy Fork (Arkansas)



Muddy Fork subwatershed is located just east of the Moores Creek subwatershed. The headwaters are located just south of the city of Prairie Grove (population 5,845) and the stream flows north until its confluence with the Illinois River mainstem at Savoy. Land use is similar to Moores Creek, with pasture lands dominating flat, low-lying areas and forested hillsides towards the south end of the watershed.



Muddy Fork Land Use Comparison

	1992 (%)	2016 (%)	Change
Pasture/Hay	69	70	1
Forest	22	23	1
Developed	1	6	5
Water	1	0.1	-0.9
Other	8	1	-7

2018 Impairments (Arkansas DEQ):

Sulfate

Bacteria

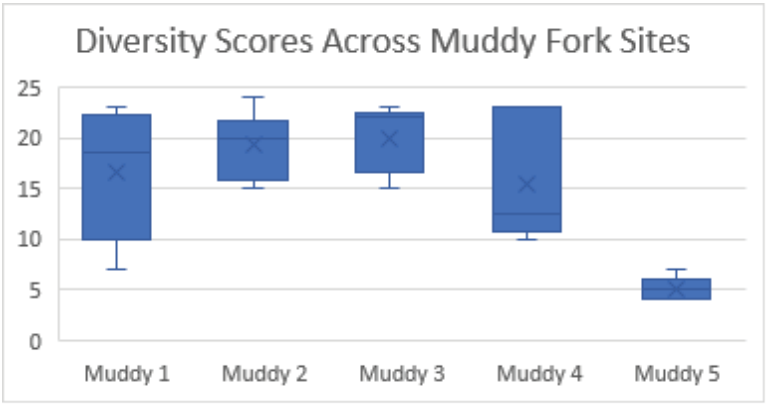
Data Summary:

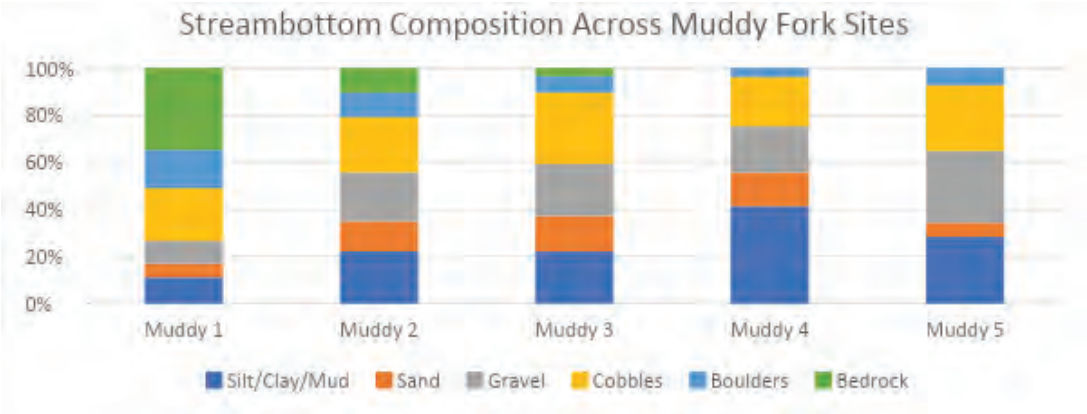
- Similar to Moores Creek, Muddy Fork also experienced a 5% increase in urban land use (likely from expansion of Prairie Grove to the North), which occurred in the "Other" land use designation.

- The overall average diversity score across all sites in the subwatershed was average for Arkansas sites, but Muddy Fork did contain one of the least diverse sites across the entire project.

- Muddy Fork had the second highest percent observations of silt, clay, and mud; second only to Moores Creek.

- Also like Moores Creek, erosion and incision are common in the subwatershed.





Muddy Fork (Arkansas)

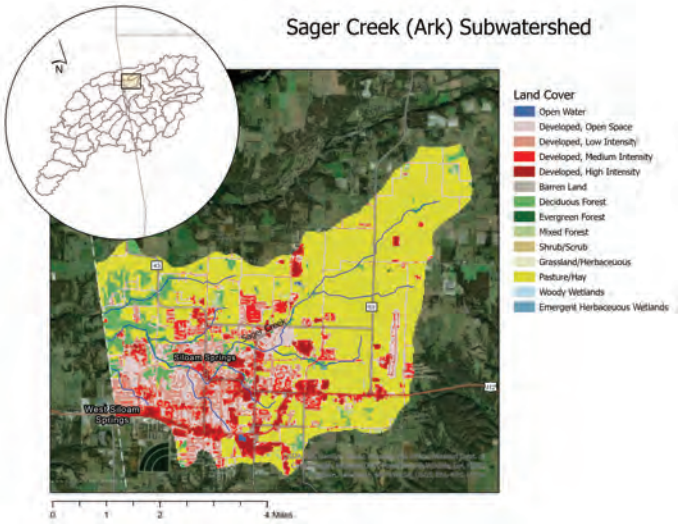
Visual Comparison of Sites with High and Low Numbers of Gravel and Cobbles Observations:

The left-hand site is a small creek that runs through pasture lands with little riparian forest. The streambank is somewhat incised and the reach may have been trenched at sometime in the past. The right-hand site is a good example of stable streambanks with little incision. On the other hand, the stream is deep throughout with few riffles, which indicates degradation of the stream bottom composition that is necessary for diverse communities.

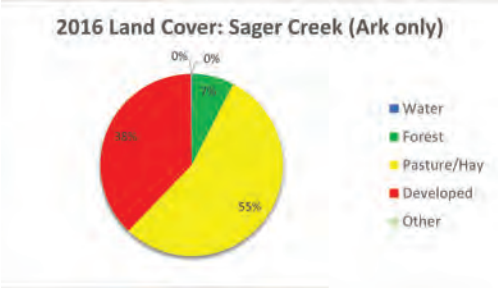
Management Recommendations:

1. Re-establish riparian forests, wetlands, and floodplains.
2. Permanent or semi-permanent conservation of areas around headwaters and/or forested hillsides.
3. Sustainable livestock practices such as rotational grazing and fencing cattle out of streams.

Sager Creek (Arkansas)



Sager Creek is technically a tributary of the Flint Creek subwatershed and is located in and around Siloam Springs, Arkansas. The historic ecology of the area were upland prairie and oak savannah which was subsequently converted to pasture lands. The City has also experienced rapid urban growth recently, but has taken steps to conserve and protect Sager Creek as it has grown. Much of the land surrounding Sager Creek is owned by the City, has been annexed for paved trail use, and an extensive riparian reforestation effort took place in the early 2000's.



Sager Creek Land Use Comparison

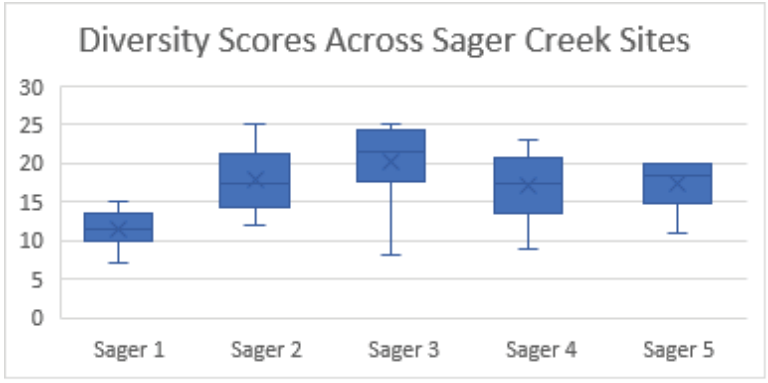
	1992 (%)	2016 (%)	Change
Pasture/Hay	68	55	-13
Forest	8	7	-1
Developed	18	38	20
Water	0.5	0	-0.5
Other	6	0	-6

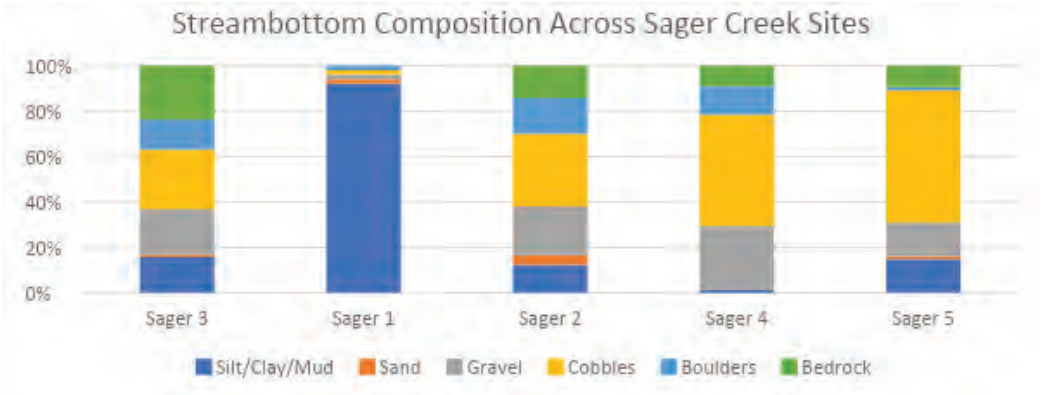
2018 Impairments (Arkansas DEQ):

None (Was impaired for Nitrate in 2016, but was removed in 2018)

Data Summary:

- Urban land use in the Sager Creek subwatershed increase by 20% from 1992 to 2016, which appears to be due to loss of pasture lands and "other" land uses. This urban expansion is expected to continue over the coming decades.
- Sager Creek had the highest average diversity across all Arkansas subwatersheds, but all sites were still below the Oklahoma average.
- The Sager 1 site is an outlier in terms of diversity and stream bottom composition as it is composed of a mix of stream, wetland, and stormwater retention features.
- Sager Creek had the highest percentage observance of cobbles across all Arkansas subwatersheds.





Sager Creek (Arkansas)

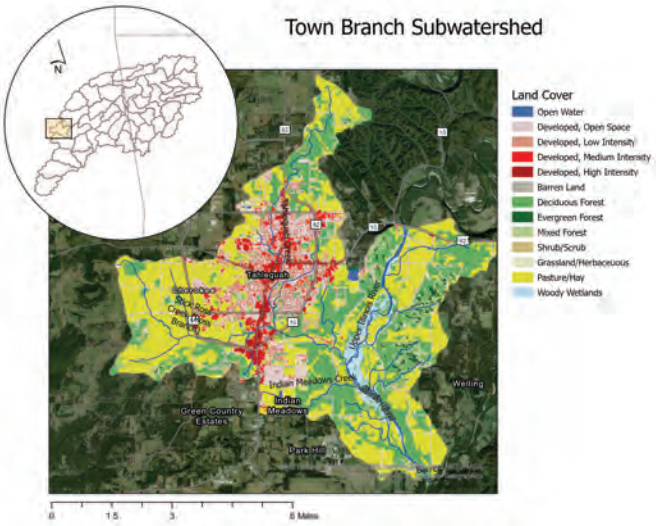
Visual Comparison of Sites with High and Low Numbers of Gravel and Cobbles Observations:

The site in the left-hand photo demonstrates healthy riparian vegetation that has been re-established in the last 15 years by the City of Siloam Springs. There is no active erosion and little silt, clay, or mud in the streambed. While not aesthetically pleasing, the photo at right is a site that is a mix of wetland, stream, and stormwater detention feature that is located upstream of the left-hand photo site. The presence of silt, clay, and mud at this site was very high, but not unexpected given its function.

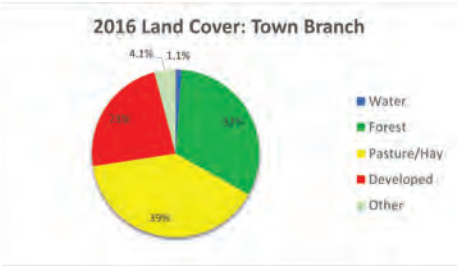
Management Recommendations:

1. Low impact development features on all parcels with impervious surface.
2. Permanent or semi-permanent land conservation on headwaters and upstream portions of the watershed.
3. Continued stream and riparian restoration projects.

Town Branch (Oklahoma)



Town Branch flows from north to south, through the City of Tahlequah, Oklahoma (population 16,667), where it confluences with the Illinois River just south east of the City. While the stream has experienced impacts from urbanization, the City has also embarked on several stream and riparian area restoration projects.



Town Branch Land Use Comparison

	1992 (%)	2016 (%)	Change
Pasture/Hay	45	39	-6
Forest	36	32	-4
Developed	16	23	7
Water	1	1.1	0.1
Other	2.2	4.1	1.9

2018 Impairments (Oklahoma DEQ):

Bacteria

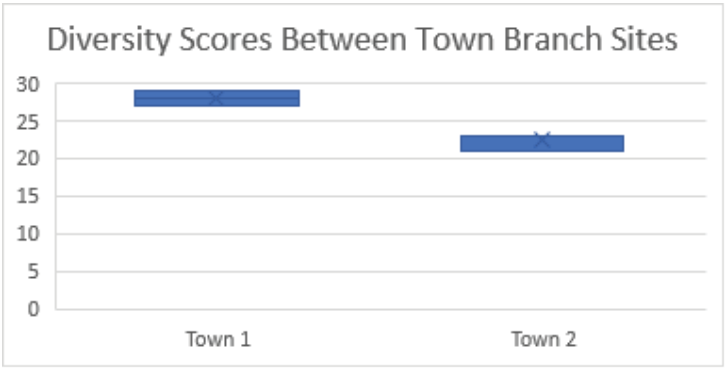
Data Summary:

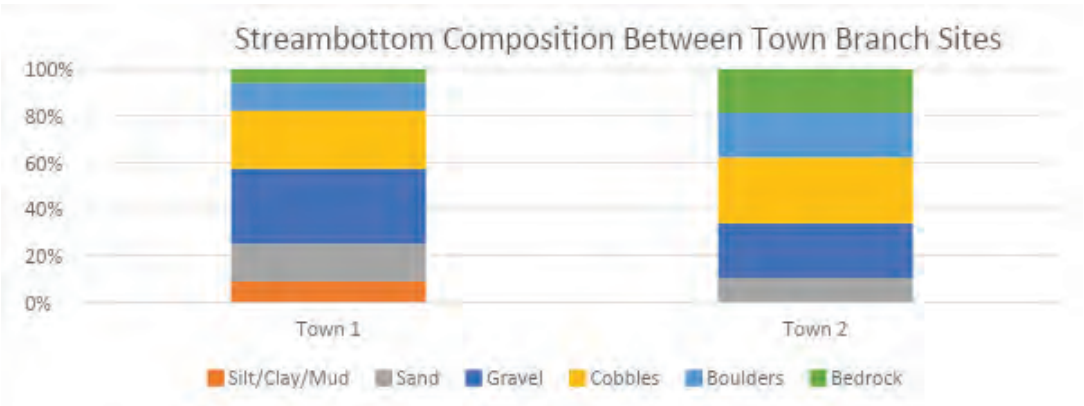
- Town Branch experienced a 7% increase in developed land use, which appears to be from a 6% loss of pasture and a 4% loss of forested land uses.

- Town Branch contained an unexpected diversity of macroinvertebrate communities for an urban stream and had one of the highest diversity scores across all assessed subwatersheds.

- Converse to expectation, Town Branch had the highest percent observations of silt, clay or mud and lowest percentages of gravel and cobbles when compared to other sites in Oklahoma (but not compared to Arkansas subwatersheds).

- The high diversity scores may be a reflection of stream restoration efforts in recent years, which focused introduced variability of in-stream and riparian habitat that can benefit macroinvertebrate communities.





Town Branch (Oklahoma)

Visual Comparison of Sites:

The site at left represents a typical Town Branch stream reach in Tahlequah: a mix of lawn, urban forest, and low density residential or commercial development. The site at right is the restored site, with in-stream features, structured pools, runs, and riffles, and re-established riparian vegetation.

Management Recommendations:

1. Low impact development features on all parcels with impervious surface.
2. Permanent or semi-permanent land conservation on headwaters and upstream portions of the watershed.
3. Continued stream and riparian restoration projects.

Conclusions

As discussed in the introduction, our objective in performing this assessment is to provide decision makers within each subwatershed with information to make informed decisions regarding land use, urban planning, stormwater mitigation, and natural resource conservation. The Illinois River is of historic, cultural, recreational, and economic importance to Northwest Arkansas and Eastern Oklahoma and it our hope that stakeholders, landowners, and the general public will recognize it as such.

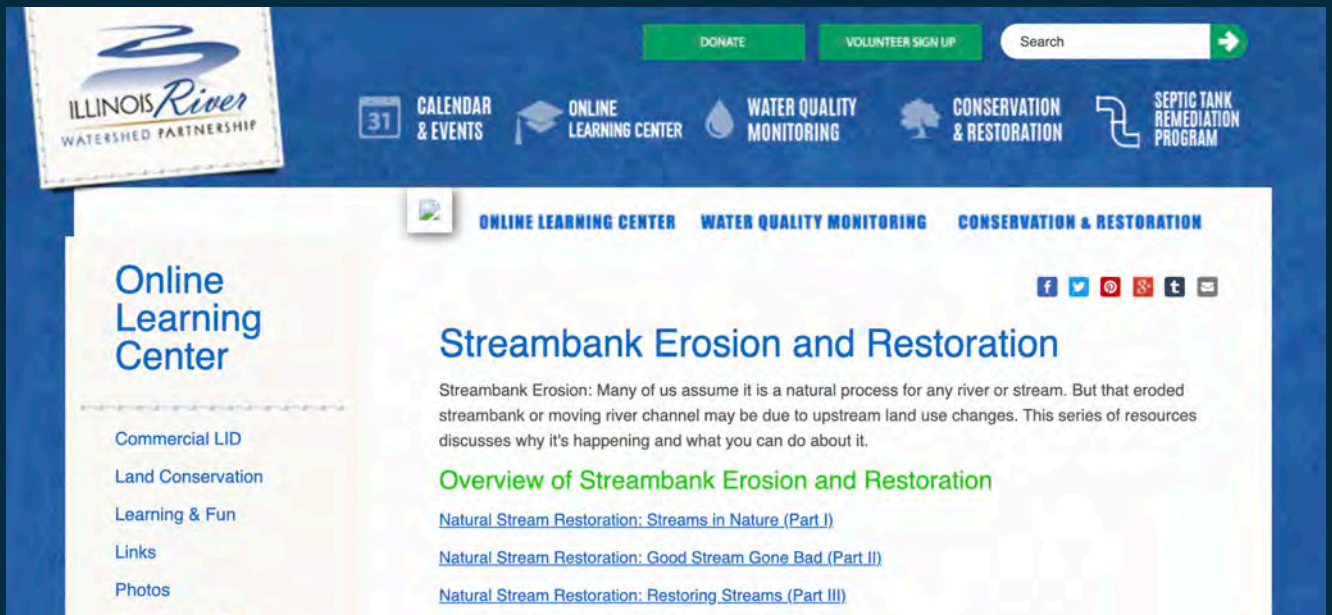
For this three-year study, macroinvertebrate diversity was most related to components of the streambed and not necessarily related to components of the streambank or surrounding land use. Diversity was positively related to the presence of cobbles and gravel in the streambed and negatively related to the presence of silt, clay, and mud. Assuming the presence of cobbles and gravel is the "natural" state (i.e. would be present at all sites if it were not for the presence of silt, clay, and mud), management recommendations include practices that have been shown to reduce the presence of these small, light, and highly erodible soil particles that are introduced to the stream via either over-land flow during rain events or streambank erosion. Other studies conducted by IRWP indicate that streambank erosion from both urban and rural settings is one of the largest contributors of phosphorus to the watershed.

Land use has not changed significantly across the entire watershed but is changing significantly in specific areas of the watershed. The population of Northwest Arkansas is expected to almost double over the next 20 years and most of the resulting land use change will occur in the Illinois River Watershed. It will likely occur in the form of pasture lands and farms converting to low density residential and commercial developments. Conserving and restoring high-value natural resources needs to happen now as prevention is (generally) much less expensive than remediation. Interestingly, two urban subwatersheds, Sager Creek and Town Branch, that recently embarked on urban stream restoration projects had relatively high macroinvertebrate diversity, indicating that such projects can prevent erosion and deposition of sediment, as well as restore ecological function.

Thank You to our Sponsors and Partners

To learn more about the management practices recommended here, visit our Online Learning Center at

IRWP.org/OnlineLearningCenter



Many thanks to Arkansas's EAST Initiative and Oklahoma's Blue Thumb program!

265 students engaged in 815 hours of learning.
531 volunteers contributed 2,001 hours of stream habitat field assessment, macroinvertebrates collection and identification, and data management and analysis assistance.