Subwatershed Prioritization of the Lake Wister Watershed Using Baseflow Water Quality Monitoring Data

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Eutrophication

Process by which excess nutrients entering aquatic systems promotes increased aquatic plant and algal growth reducing water quality.

- **Point Source:** Single identifiable source from which pollutants are discharged
  - Pipe or outflow from a waste water treatment plant (WWTP)

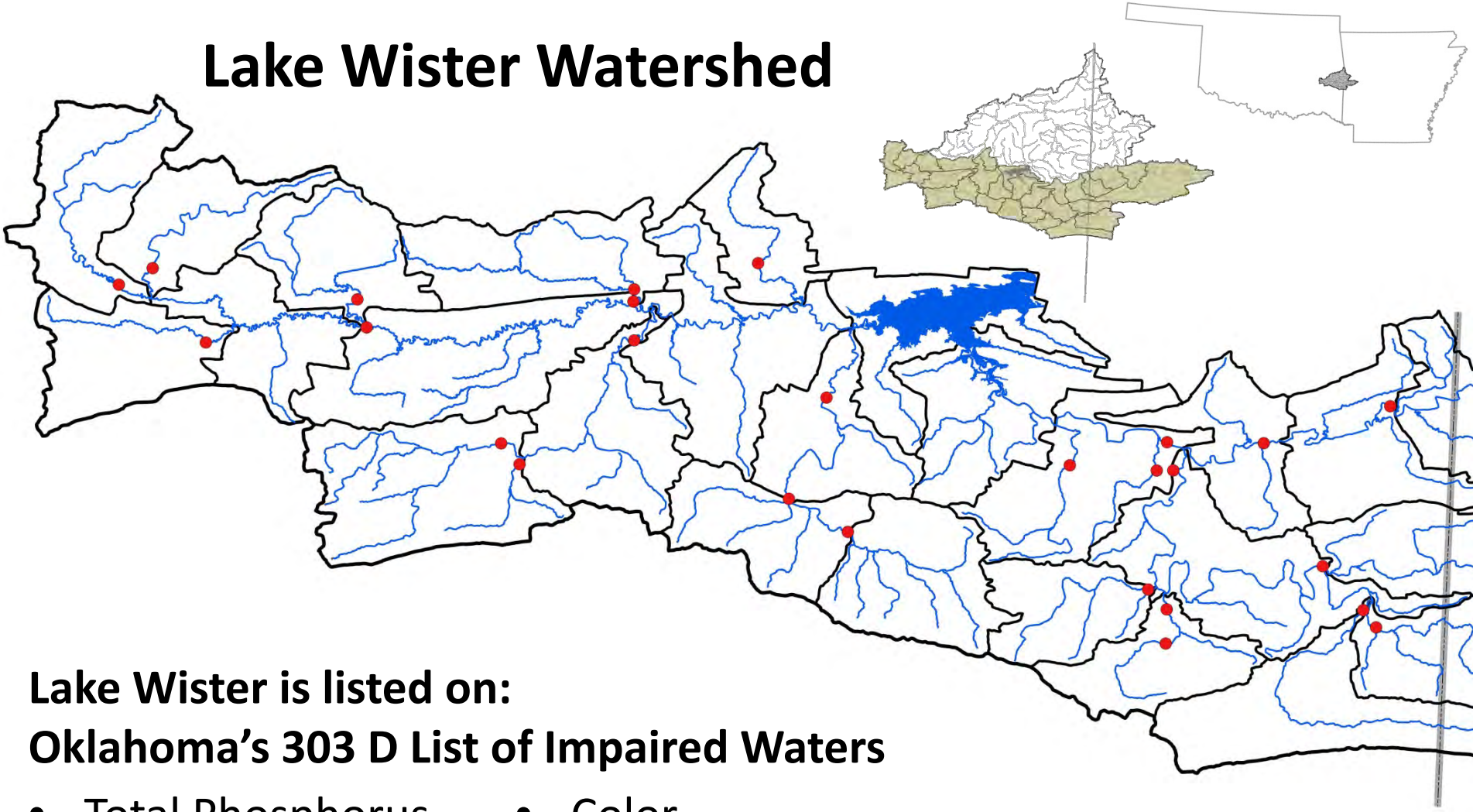
Eutrophication

Process by which excess nutrients entering aquatic systems promotes increased aquatic plant and algal growth reducing water quality.

- **Nonpoint Source:** Diffuse sources of pollutants from an altered landscape (agricultural and urban land use) that enter waterways during runoff events



Lake Wister Watershed



Lake Wister is listed on:
Oklahoma's 303 D List of Impaired Waters

- Total Phosphorus
- Turbidity
- Chlorophyll a
- Color
- pH
- Mercury

PVIA's
Strategic Plan to Improve Water Quality and Enhance the Lake Ecosystem

3 Zones of action:

1. Lake Wister
2. Quarry Island Cove – near PVIA's intake
3. The watershed

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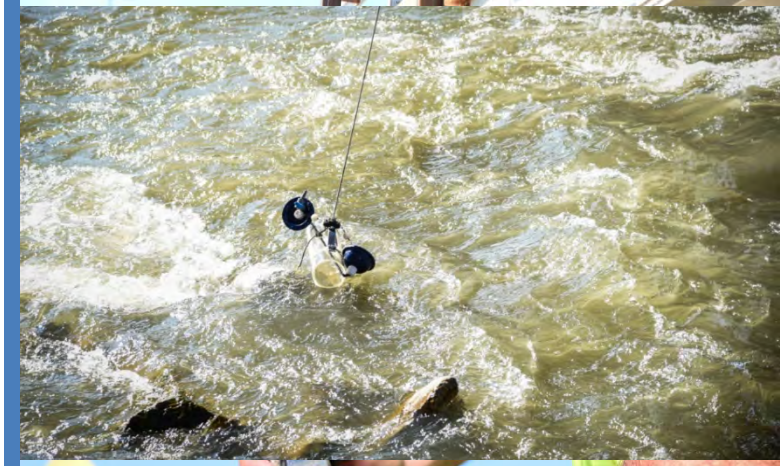
3. **The watershed**

The goal of this study was to collect water quality data that could be used by PVIA to prioritize where to invest resources to improve water quality in the watershed and ultimately Lake Wister.

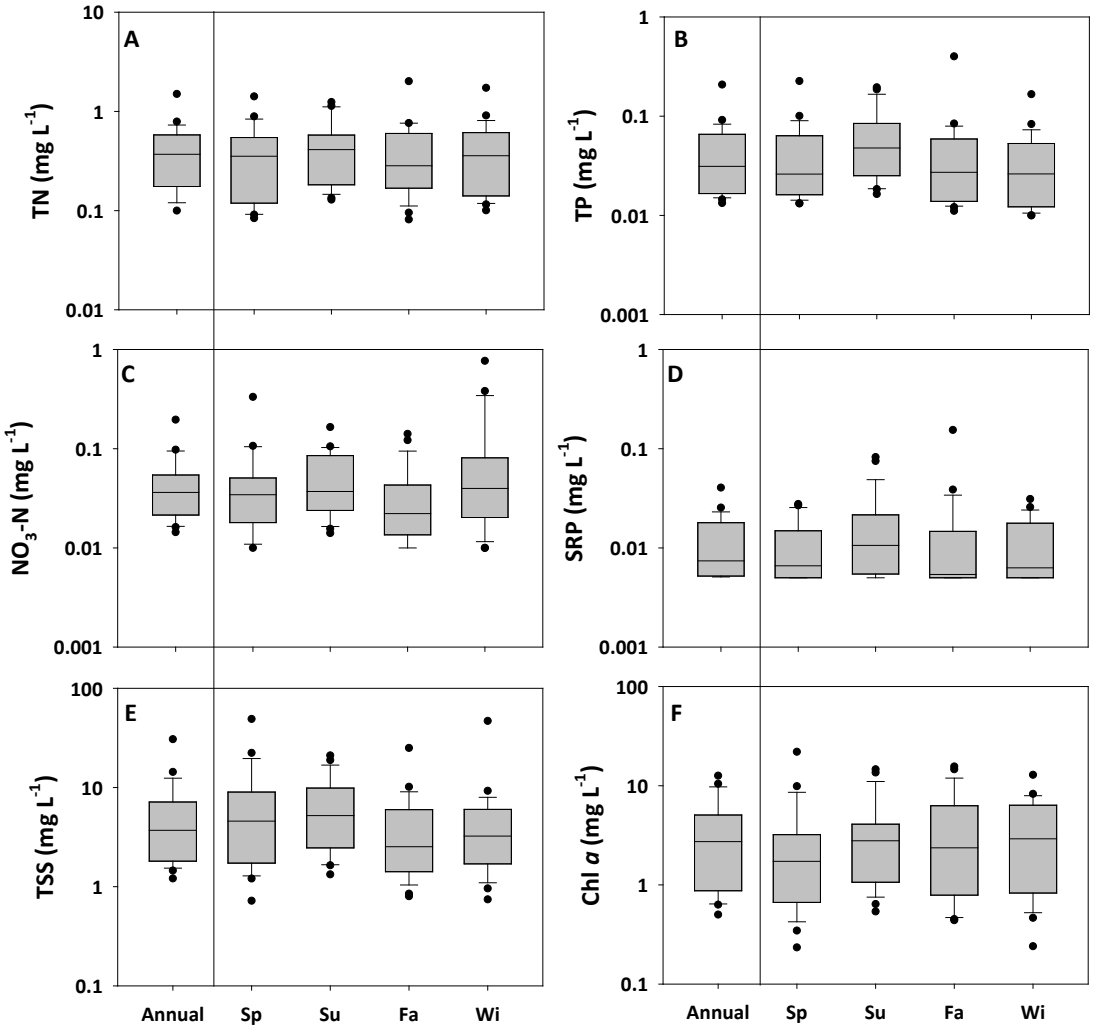


Field Monitoring

- 26 sites selected representing 23 HUC 12 subwatersheds flowing into Lake Wister.
- Sampled monthly during base flow conditions for a year.
- Samples were analyzed for:
  - **Total Phosphorus**
  - **Total Nitrogen**
  - Nitrate + Nitrite
  - Ammonia
  - Soluble Reactive Phosphorus
  - Turbidity
  - **Total Suspended Solids**
  - **Chlorophyll *a***
  - Fluoride
  - Chloride
  - Sulfate
- Geometric means of the constituents were compared to a Human Development Index (HDI)
  - This is just the total percentage of agriculture and urban land use in a watershed.

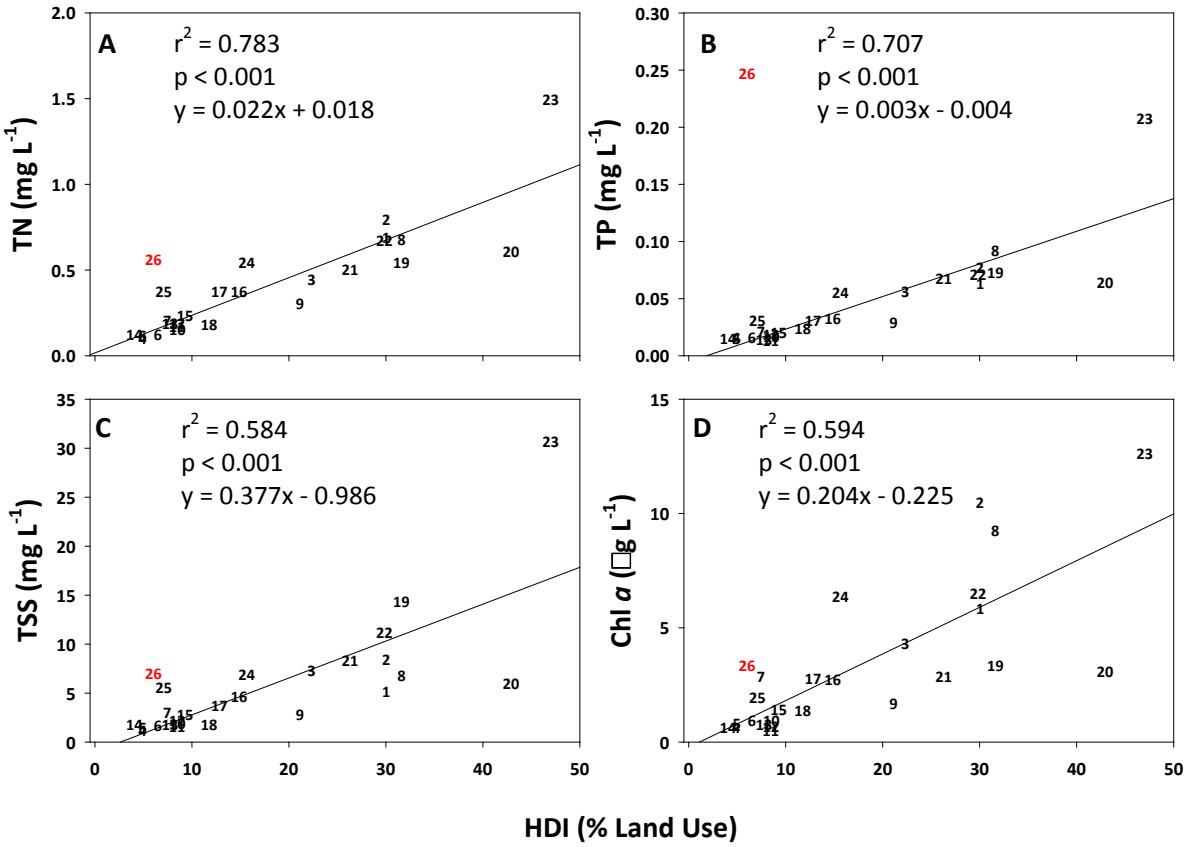
Seasonal Variability

- No seasonal patterns for N species.
- Both TP and SRP were slightly elevated in the summer.
  - Possibly due to elevated TSS in the summer.
- No seasonal pattern in chlorophyll *a*



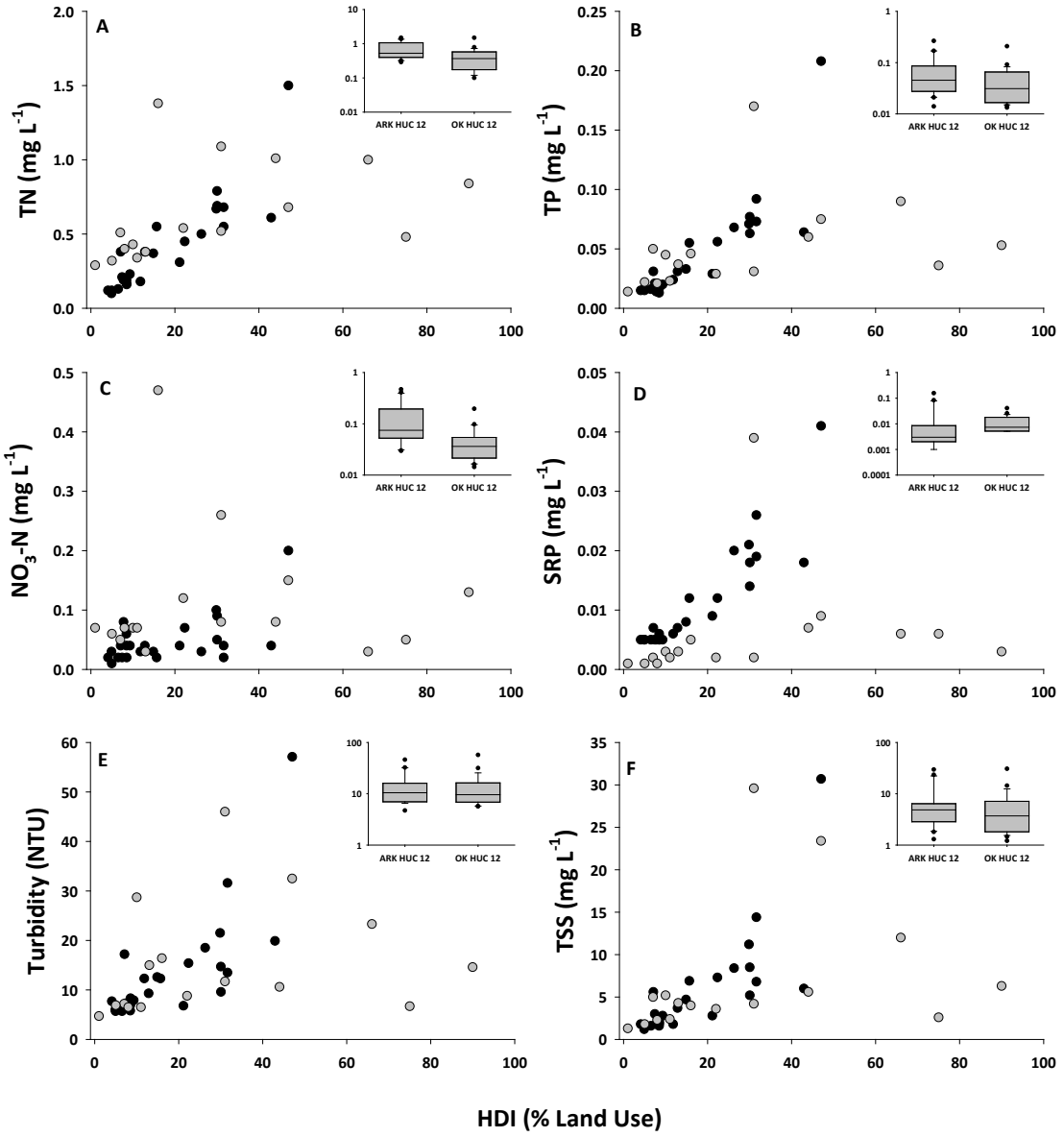
Regression Analysis looks at how water quality parameters respond to increasing human development in the watershed

Nutrients, sediment, and algal biomass increase with human development (HDI) in the watershed



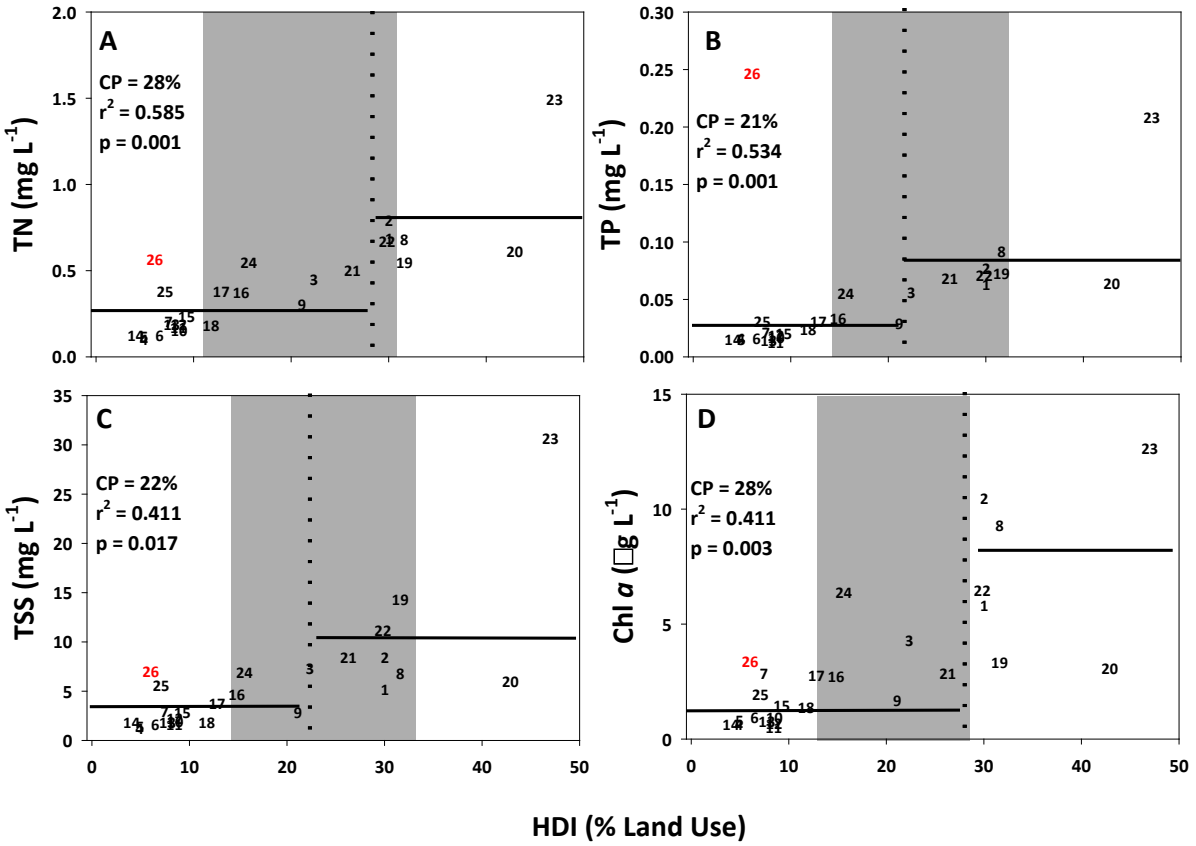
Across State Lines

- **Black Circles:**
  - LWW in Oklahoma (2016-2017)
- **Gray circles:**
  - Poteau Watershed in Arkansas (2011-2012)
- Slightly greater values reported for Arkansas streams than Oklahoma streams.
  - Except for SRP
- Likely due to greater human development in Arkansas .
- Data from both studies fit well together across the HDI gradient.

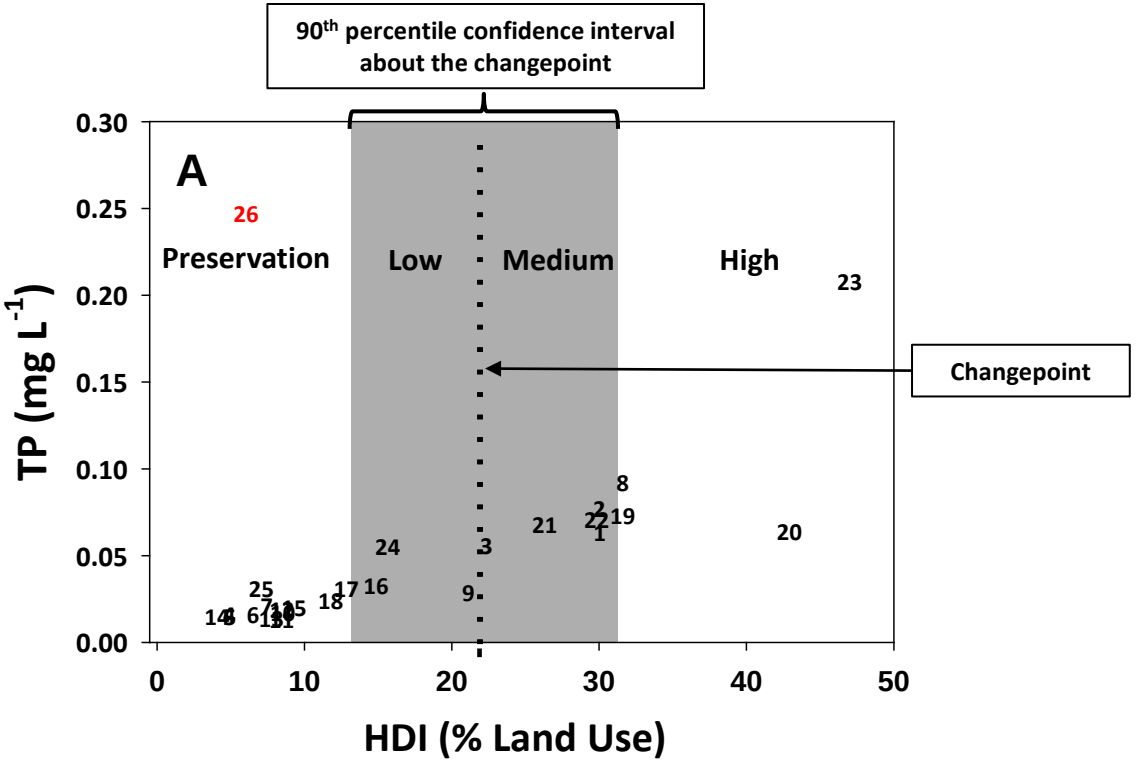


Changepoint Analysis allows us to see if and where a shift occurs in how water quality parameters respond to increasing human development in the watershed.

For all of the parameters there is a shift or change point at around 20–30% human development, where sites above the changepoint have greater mean values and variability than the sites below this changepoint.

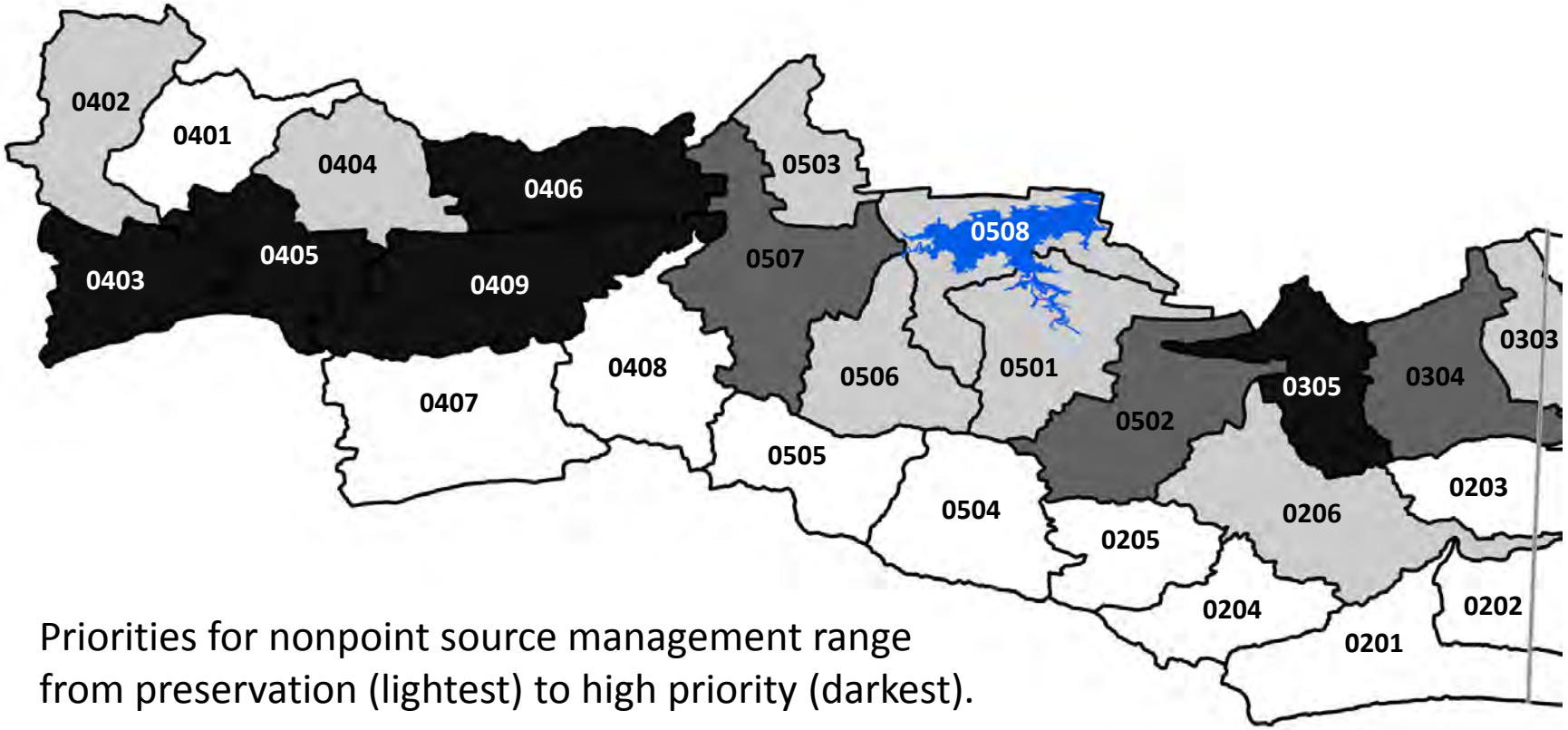


Option 1: If we do not have WQ data, or data is missing for a portion of the watershed, then HUC 12s can be prioritized based on the amount of human development within their watershed



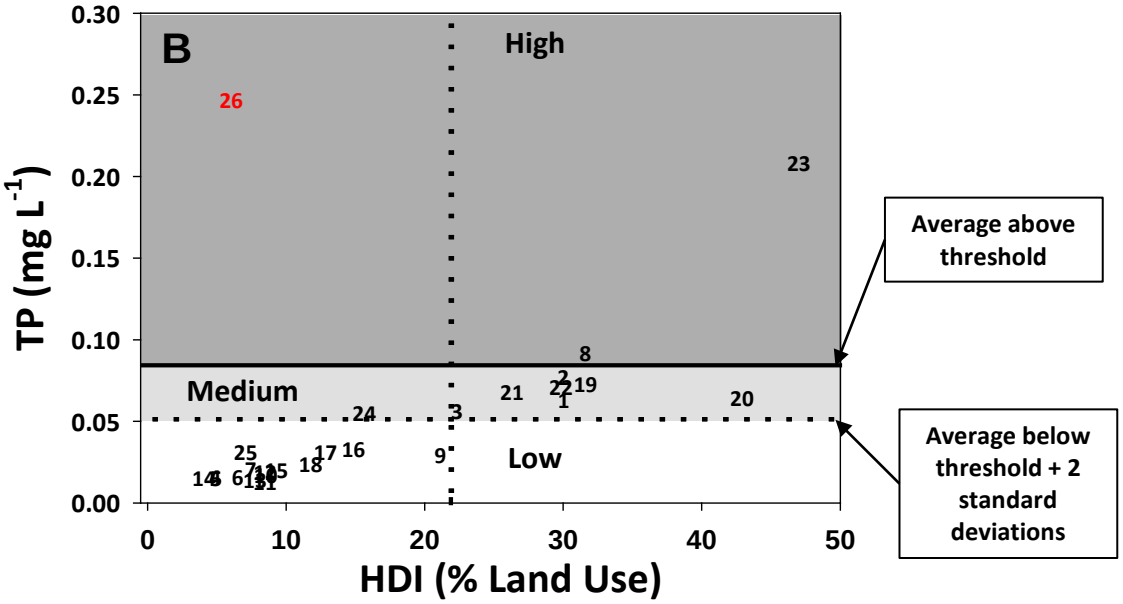
- **Preservation:** HUC 12s with %HDI < 90th percentile confidence interval
- **Low priority:** HUC 12s with %HDI within the 90th percentile confidence interval but less than the changepoint
- **Medium priority:** HUC 12s with %HDI within the 90th percentile confidence interval but greater than the change point
- **High priority:** HUC 12s with %HDI > 90th percentile confidence interval

Option 1: If we do not have WQ data, or data is missing for a portion of the watershed, then HUC 12s can be prioritized based on the amount of human development within their watershed



- Priorities for nonpoint source management range from preservation (lightest) to high priority (darkest).
- Based on this method, the subwatersheds along the main stem of the Fourche Maline and the Poteau River stand out as the highest priorities.
- Using this method, prioritization of subwatersheds is not influenced by subwatersheds upstream.

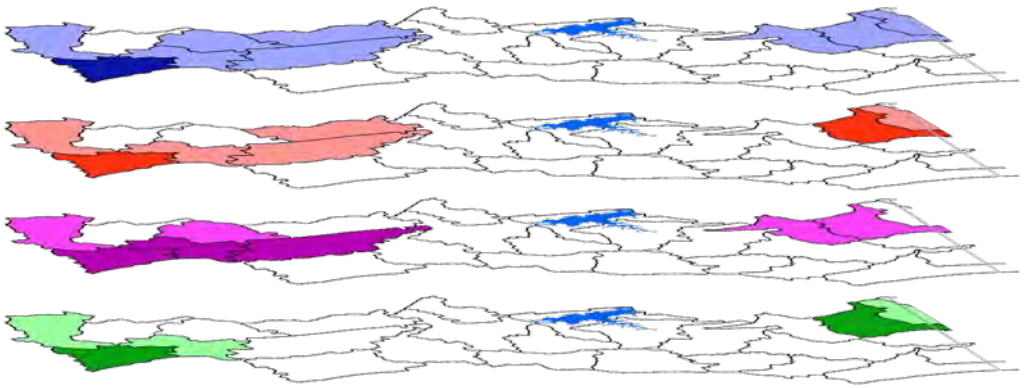
Option 2: When water quality data is available



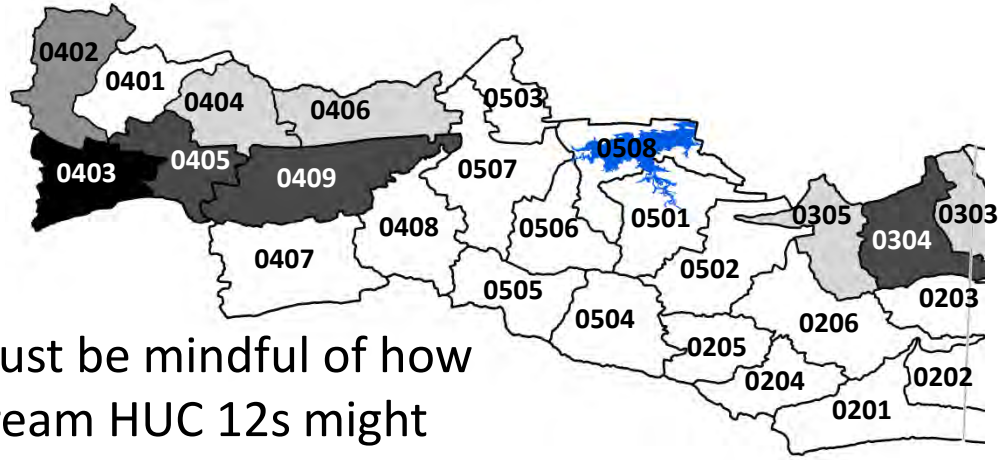
- **Low priority**: HUC 12s with measured values less than the horizontal dashed line.
- **Medium priority**: HUC 12s with constituent concentrations greater than the horizontal dashed line but less than upper solid line
- **High Priority**: HUC 12s with constituent concentrations greater than upper solid line.

Option 2: When water quality data is available

- We can use this method to prioritize subwatersheds based on specific water quality parameters.

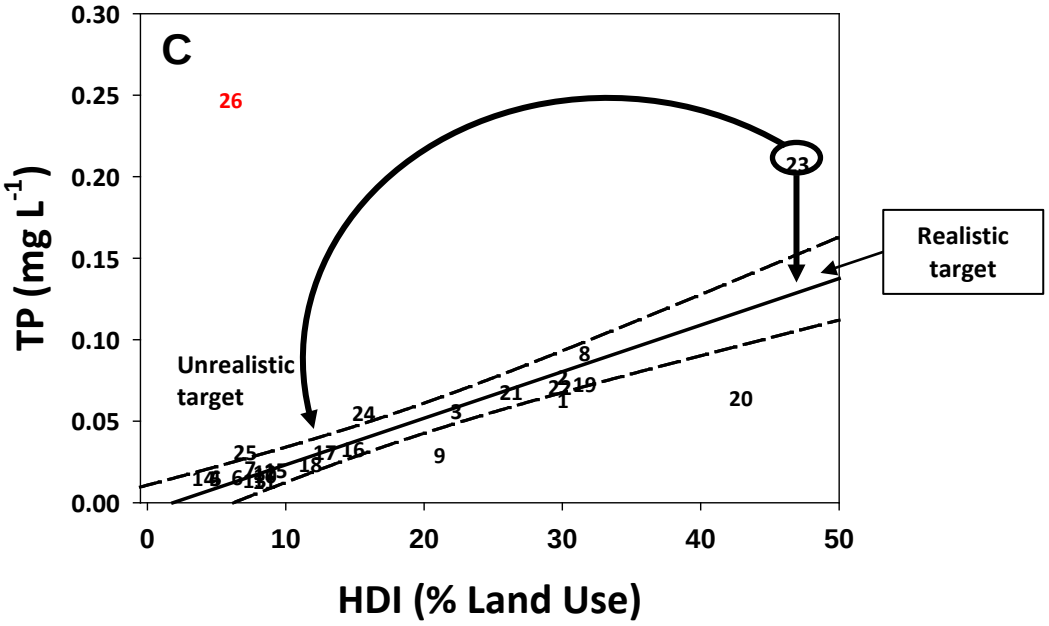


- Or, priorities for each parameter can be added up to create a cumulative rank for each HUC 12



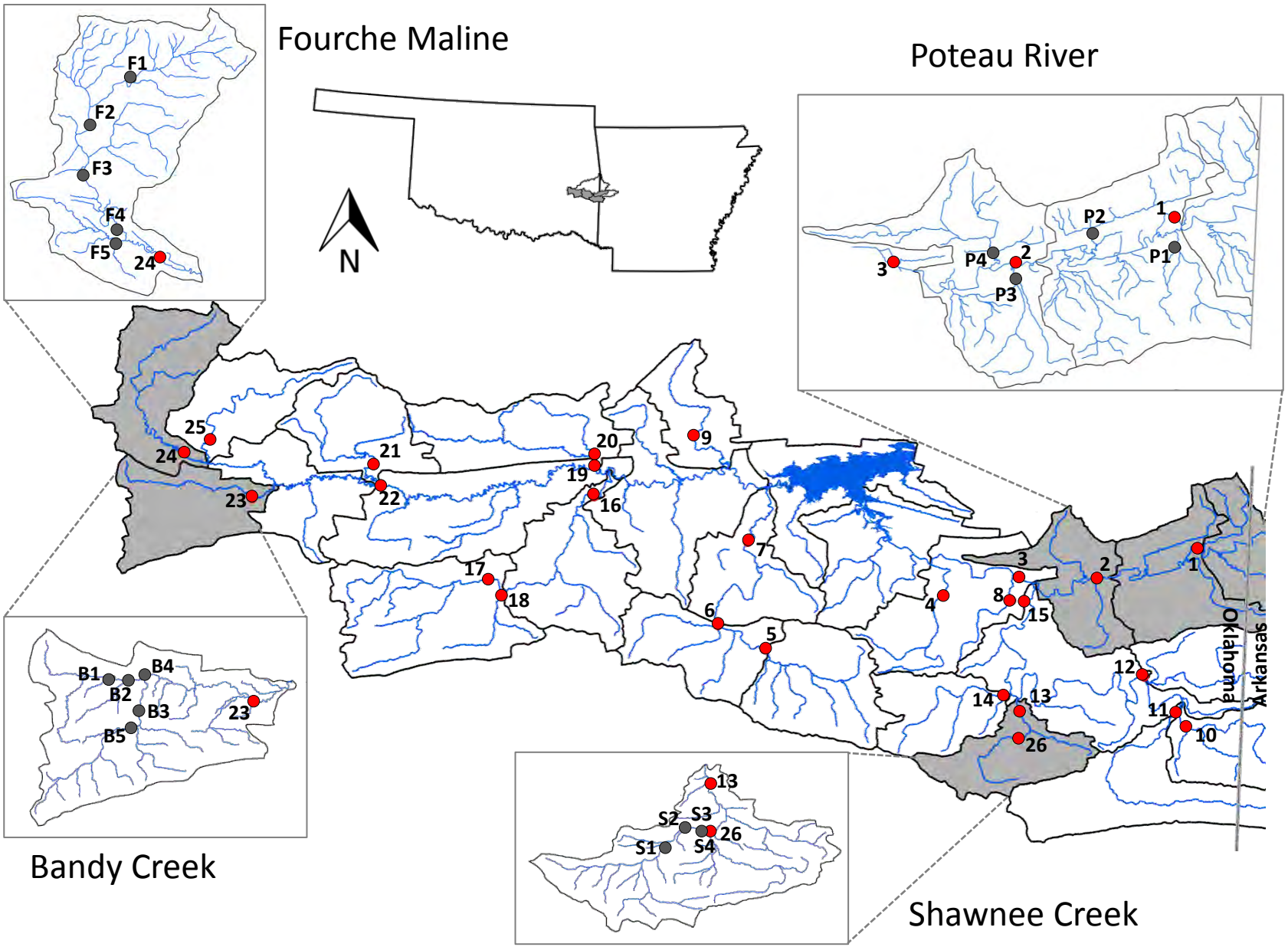
- With this approach we must be mindful of how water quality in the upstream HUC 12s might influence the water quality in the downstream HUC 12s

Regression analysis can be useful in setting realistic targets for improving water quality.



- The regression line represents the average conditions for a given level of human development.
- The goal should be to improve water quality at high priority watersheds so that they fall below this regression line.

Based on these potential methods of HUC 12 prioritization we selected 4 HUC 12 subwatersheds for further investigation.



Special Studies

- Both Shawnee and Bandy Creek watersheds had poor water quality due to known WWTPs in their watersheds.

"Are the WWTPs the only source of nutrients to these watersheds?"

- In the Fourche Maline and Poteau River watersheds we wanted to know:

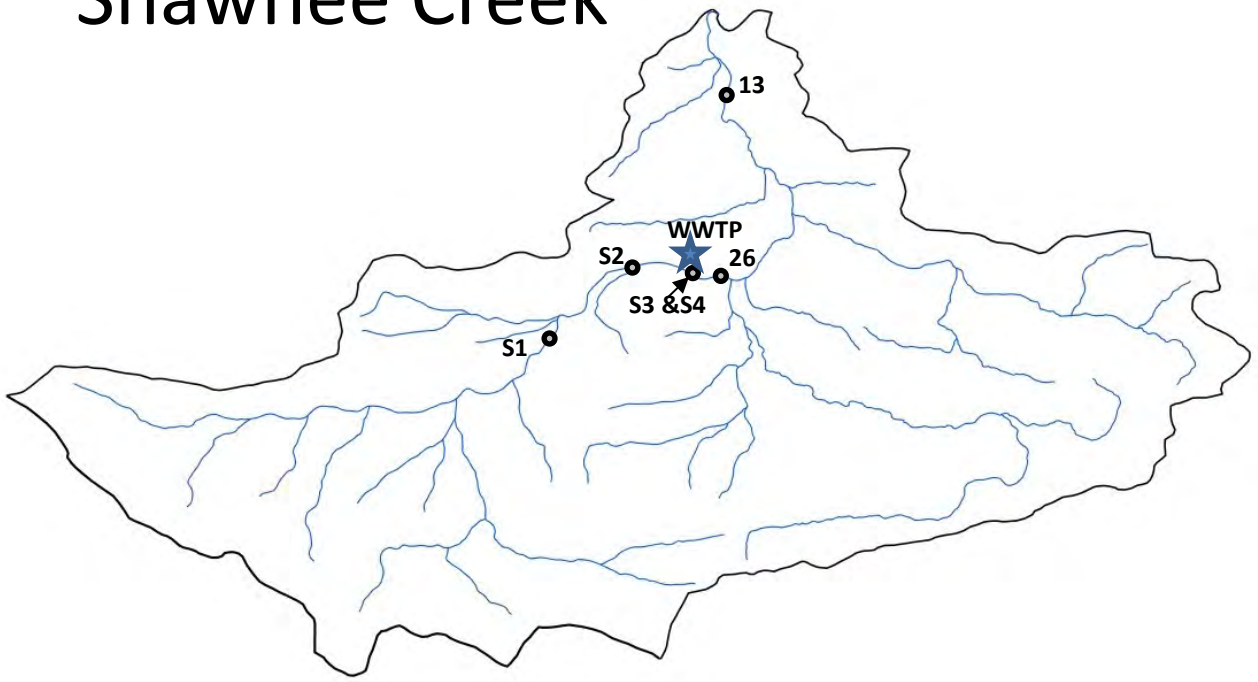
"How far does high nutrient and sediment concentrations extend into the headwaters of the Fourche Maline Watershed?"

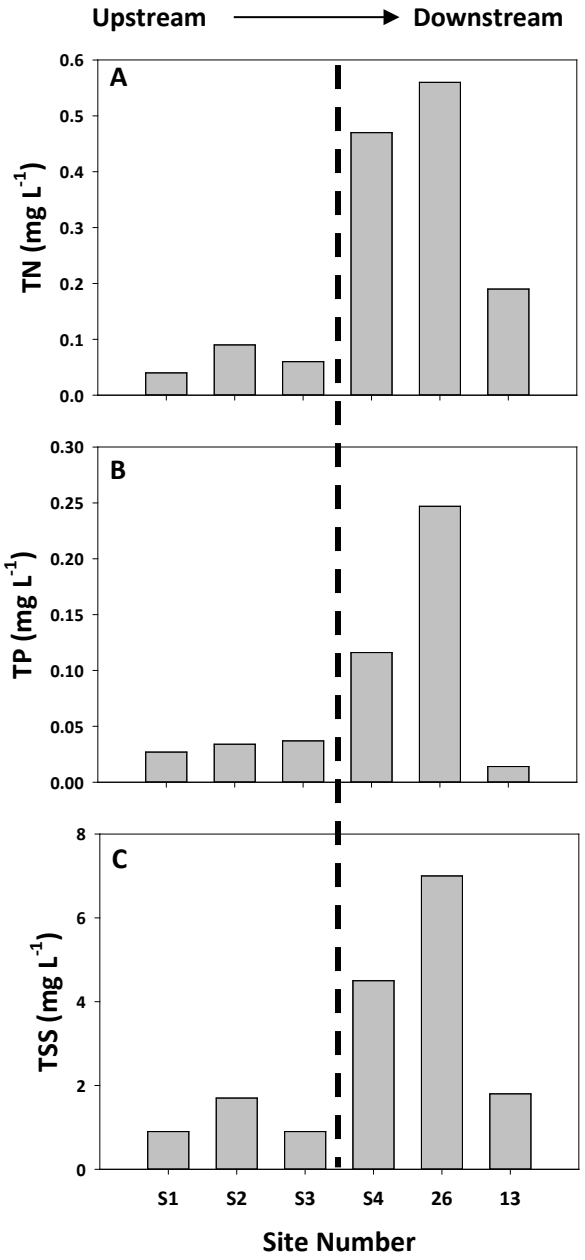
"Is Arkansas the only source of sediment and nutrients to the Poteau River, or are Oklahoma tributaries sources of sediment and nutrients as well?"

- Additional sites within each of these watersheds were sampled following the same methods used before.

Are the WWTPs the only source of nutrients to these watersheds?

Shawnee Creek

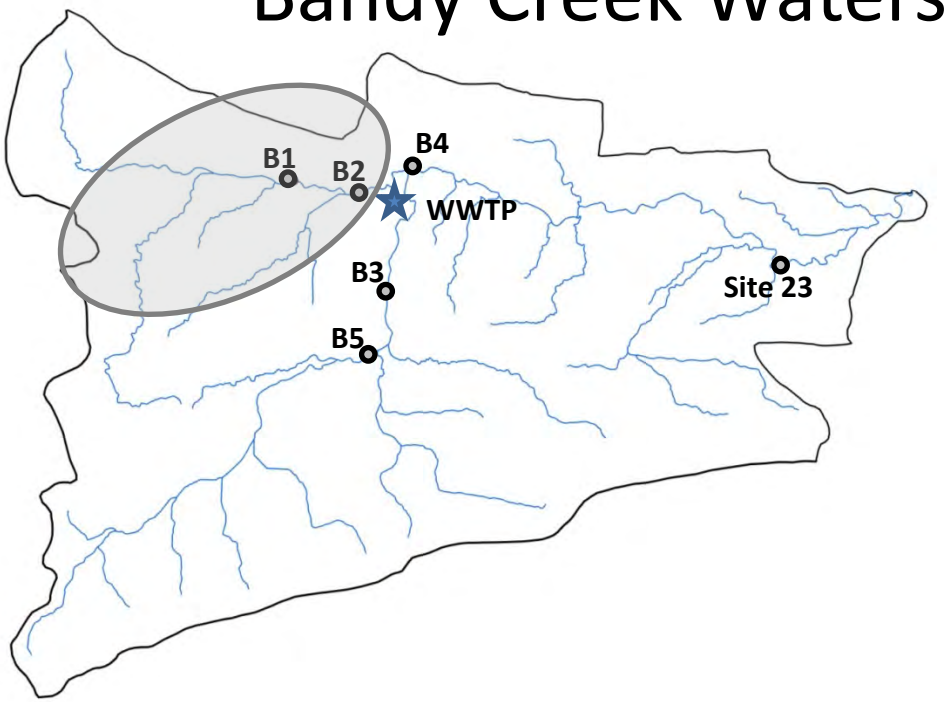


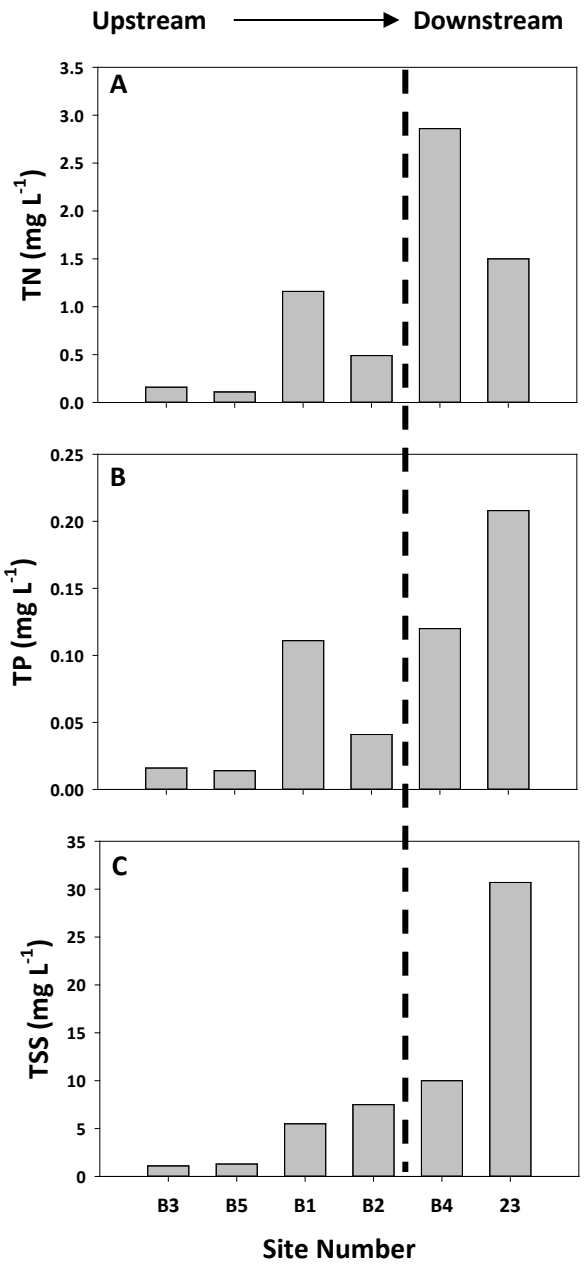


- Yes! As you move from upstream to downstream there is an increase in both nutrients and sediment below the WWTP.
- The effect from the WWTP was localized, as can be seen by lower concentrations at the most downstream site.

Are the WWTPs the only source of nutrients to these watersheds?

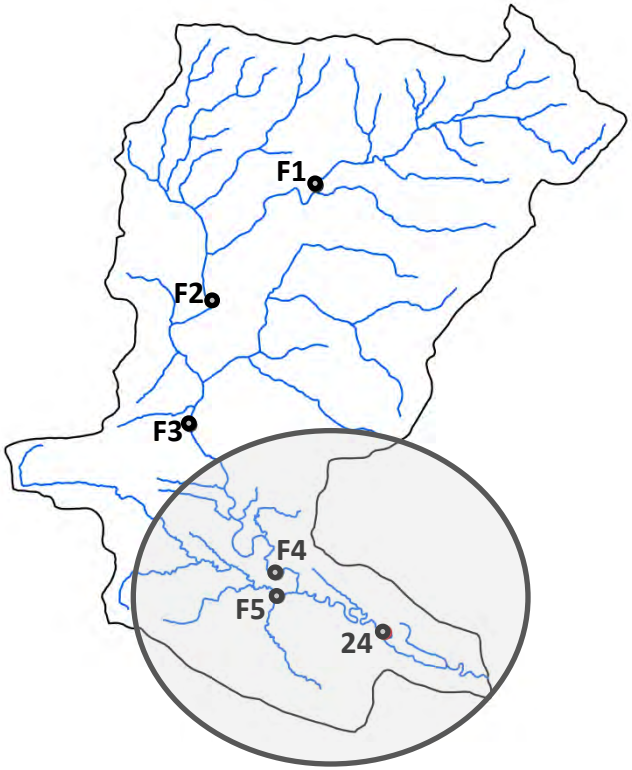
Bandy Creek Watershed

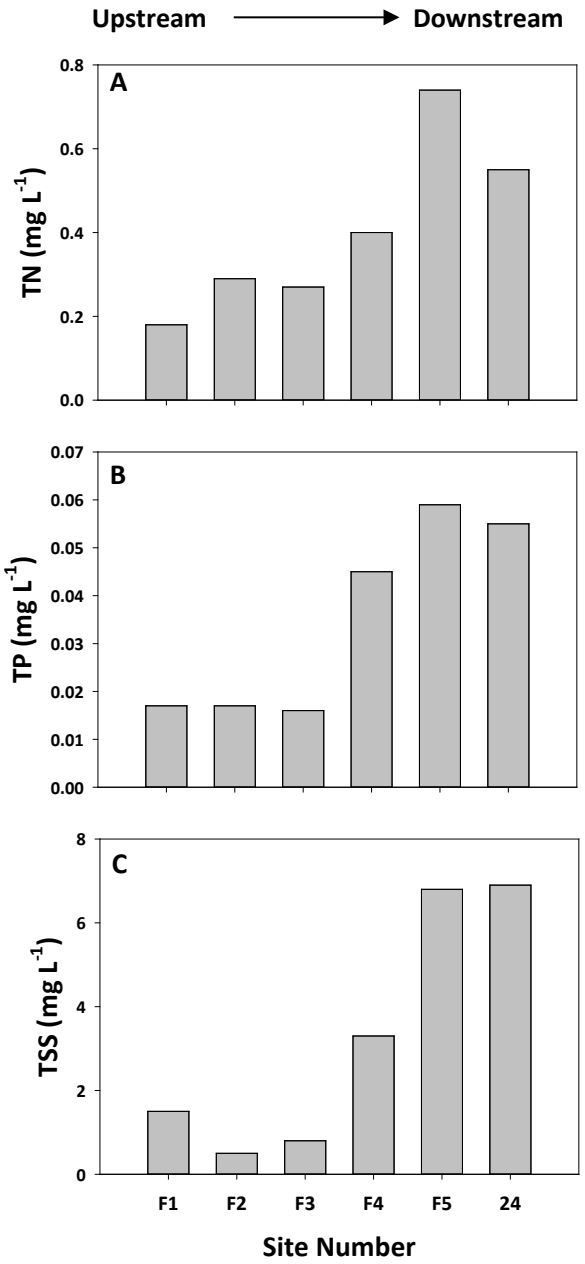




- Nutrients and TSS were greatest below Wilburton's WWTP
- However, two sites upstream of the WWTP (B1 and B2) had increased nutrient and sediment concentrations that reflected greater human development in their catchment.
  - Installation of best management practices (BMPs) in this portion of the watershed may be helpful in reducing nutrients and sediments.

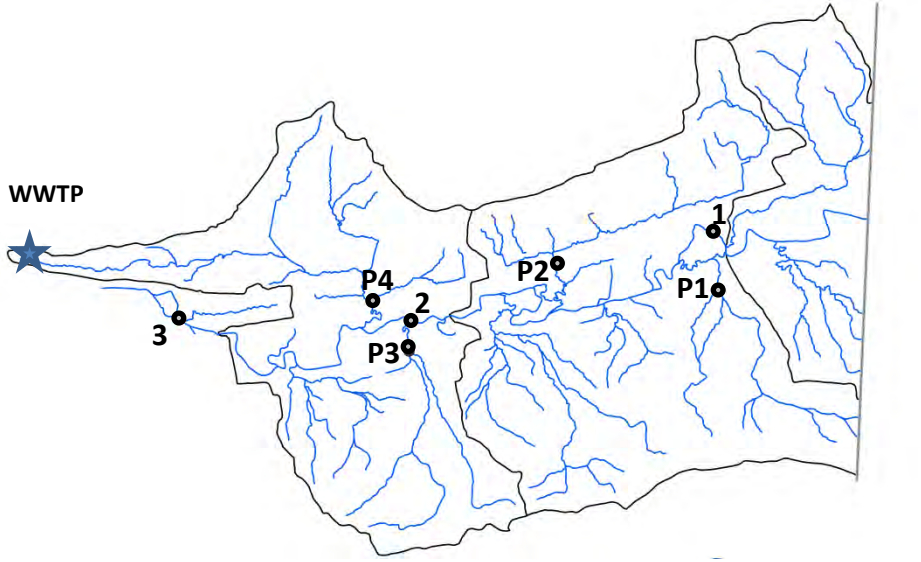
How far does high nutrient and sediment concentrations extend into the headwaters of the Fourche Maline Watershed?

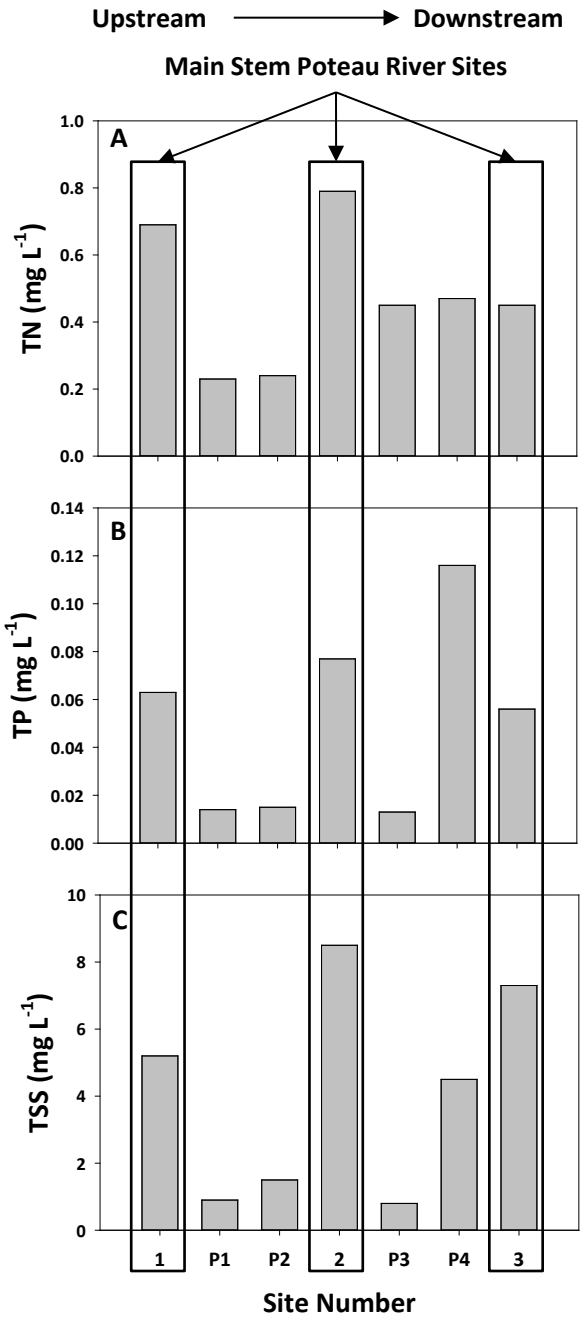




- The headwaters of the Fourche Maline have relatively low nutrient and sediment concentrations.
- Both nutrient and sediment concentrations begin to increase in the lower portion of the watershed as %HDI increases.
  - BMPs installed in the lower portion of the watershed are likely to have the greatest effect.

Is Arkansas the only source of sediment and nutrients to the Poteau River, or are Oklahoma tributaries sources of sediment and nutrients as well?





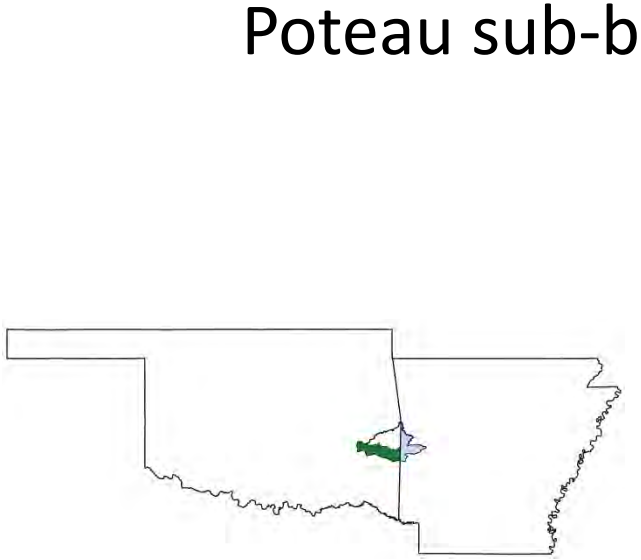
- Nutrient and sediment concentrations were greatest along the main stem of the Poteau River.
- However, site P4 also had elevated TP and TSS relative to the other tributaries.
  - This was likely driven by effluent discharge out of Heavener, Oklahoma.

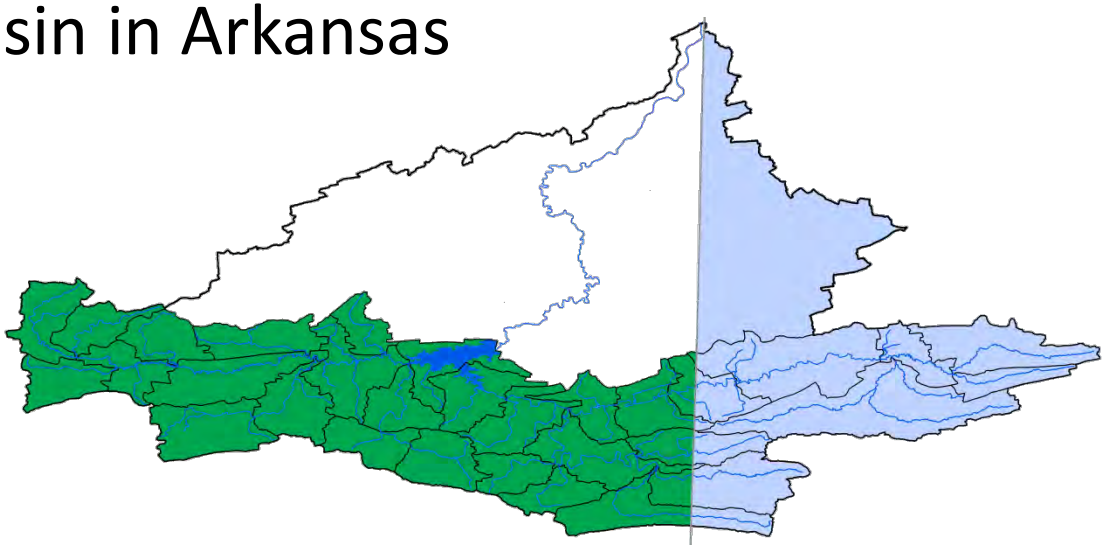
Summary

- Routine baseflow water quality monitoring was useful:
  - For developing potential frameworks for prioritizing the HUC 12s within the Lake Wister Watershed, both with and without water quality data.
  - In developing linear relationships between water quality parameters and human development, that can be used to set realistic targets for assessing water quality improvements in the watershed.
- Following these sampling methods within individual HUC 12 subwatersheds can be useful in pinpointing specific areas in need of NPS best management practices.

Future Directions

- 2nd year of LWW water quality monitoring
  - Examine:
    - Interannual variability
    - Seasonal variability over multiple years
  - Compare LWW water quality in Oklahoma to Poteau sub-basin in Arkansas





Poteau Sub-basin Monitoring

- ANRC 319h funded project to monitor water quality within the Poteau sub-basin of Arkansas.
  - Baseflow water quality monitoring.
  - Stage to discharge rating curve development.
  - HUC 12 load estimation.

Acknowledgements

- This project was funded by Poteau Valley Improvement Authority and Oklahoma Conservation Commission through the 319(h) EPA grant # C9-996100-17.
- Laboratory Technicians
  - Keith Trost
  - Jennifer Purtle

Questions?

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