Arkansas Nutrient Criteria Development

EPA Region 6 Nutrient RTAG
Dallas, Texas
April 26-27, 2017

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Research and Field Programs-Office of Water Quality

Criteria Development Milestones

2015 Milestones

- Revised Wadeable Stream Nutrient AM
- Beaver Lake AM
- Nutrient Trading Bill

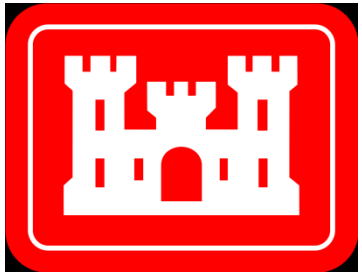
2016 Milestones

- NSTEPS Projects Completed
- Revised ERW Study Design
- HAB Workgroup
- Continuous Dissolved Oxygen AM

2017 Milestones

- HAB Workgroup
- Ouachita ERW
- Continuous D.O. AM
- Nutrient Criteria Stakeholder Process (*tentative*)

Arkansas HAB Workgroup



Beaver Water District

Arkansas Department of Health

ADEQ
ARKANSAS
Department of Environmental Quality

UNIVERSITY OF ARKANSAS

ARKANSAS WATER RESOURCES CENTER

Arkansas HAB Workgroup

Major points

1) Education - public awareness, public perception, how are we going to disseminate information, advisories, etc?

2) Funding for monitoring - Monitoring is going to be a must, how is this going to funded/coordinated?

3) Standards/triggers--What are the triggers that are going to require an alert, advisory, swim beach closure, etc?

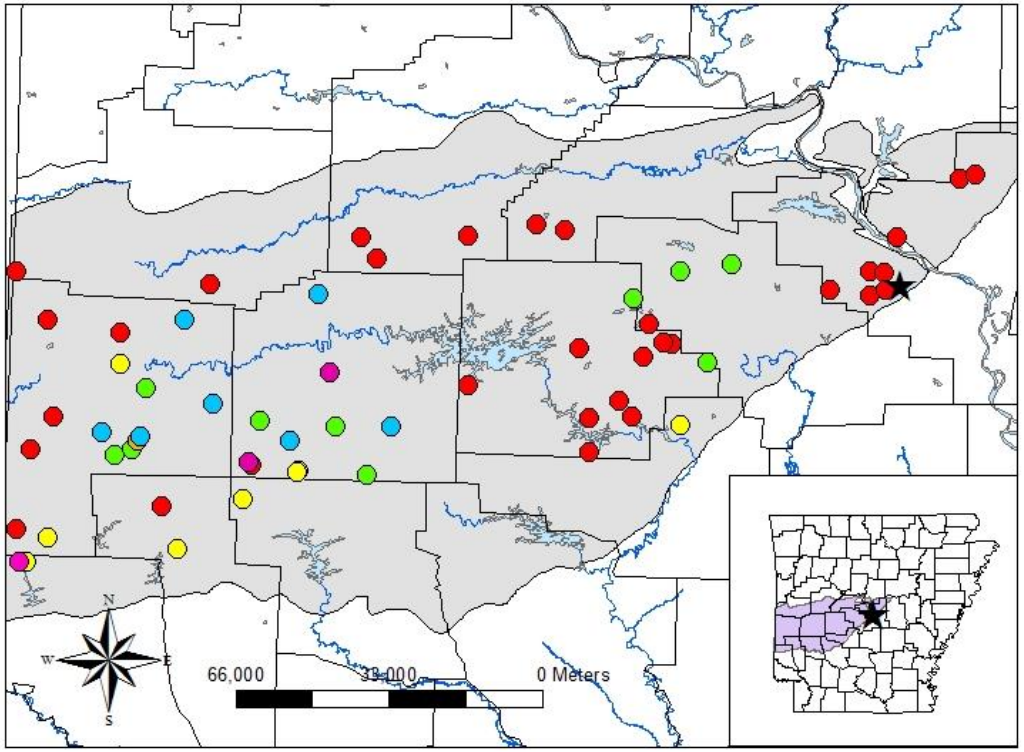
4) Communication - How are we going to communicate among groups HAB related information?

Arkansas HAB Workgroup

- Six meetings since November 2015
- Divided Recreation and Source Water Committees mid-2016
- Tentatively proposing acceptance of WHO tiered values for recreation response -*expected draft summer 2017*
- Lake volunteer monitoring program-*expected draft summer/fall 2017*

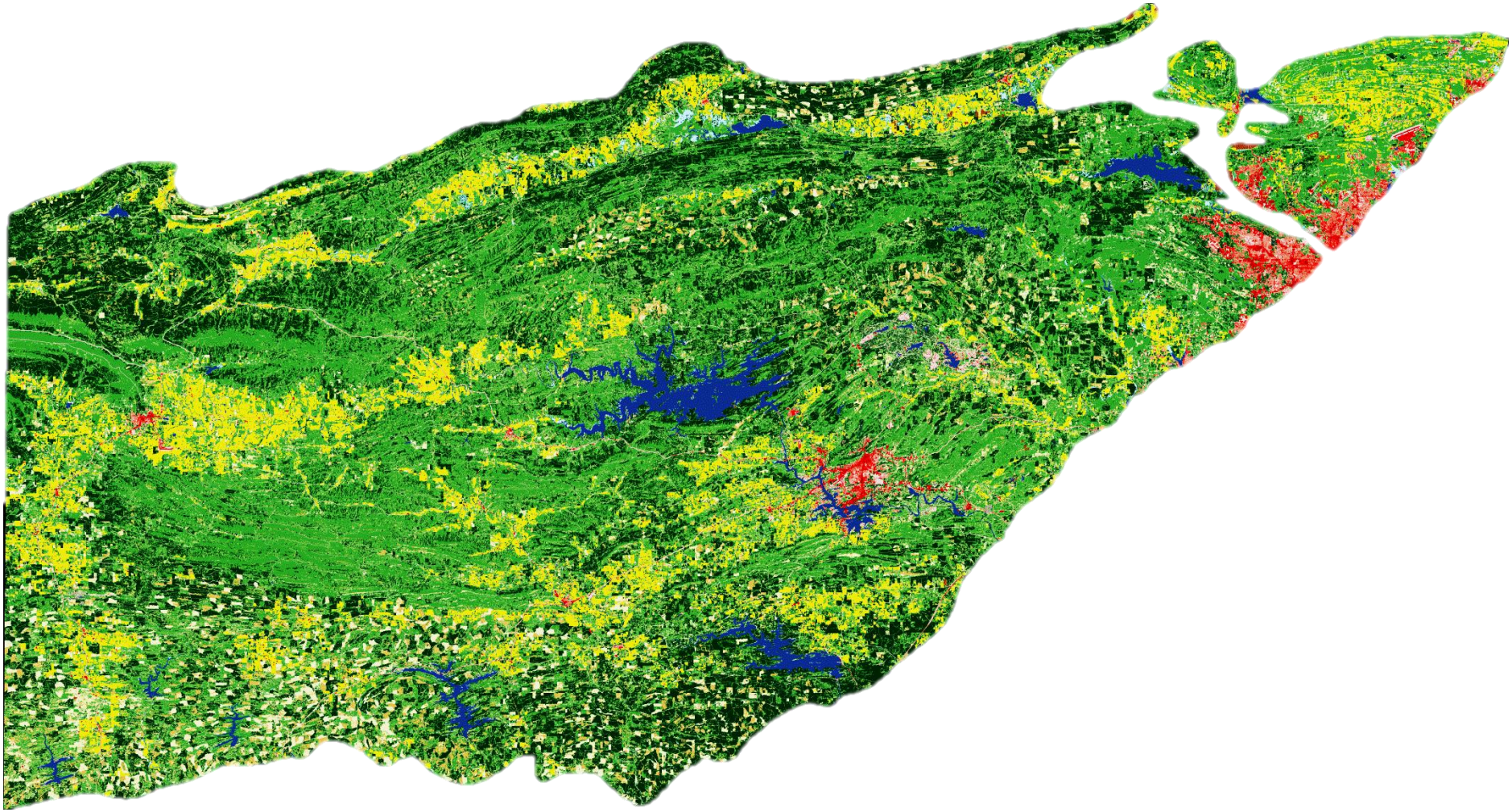
Ouachita ERW Stressor-Response

- 62 sites
- Physical site requirements:
  - Wadeable >50% of reach
  - Accessible year round
  - >4 sq. mi.



- ERW (11)
- Ambient stations (10)
- 1986 ecoregion reference sites (2)
- <10 mi² ecoregion reference sites (5)
- Random (34)

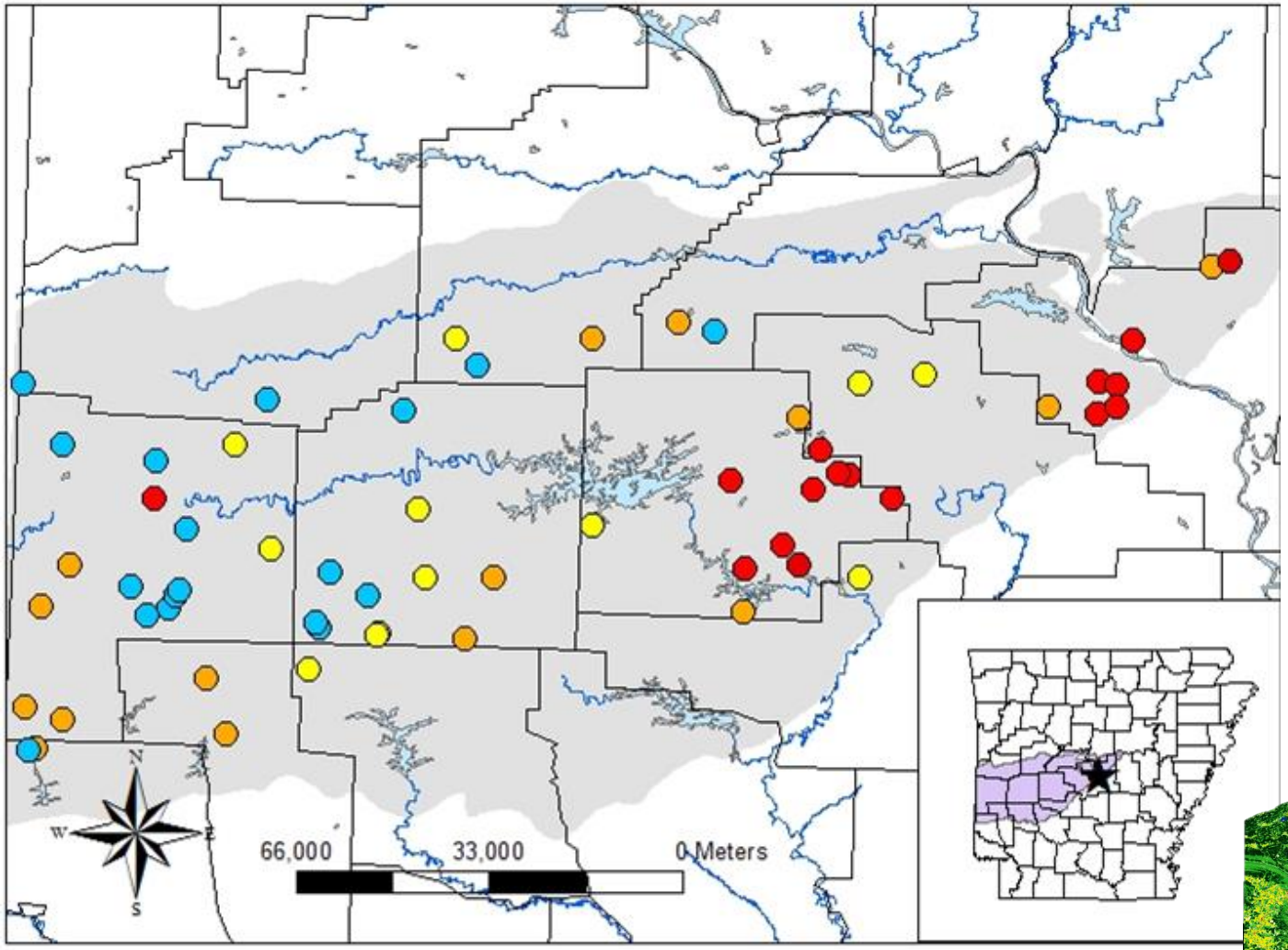
How to account for this?

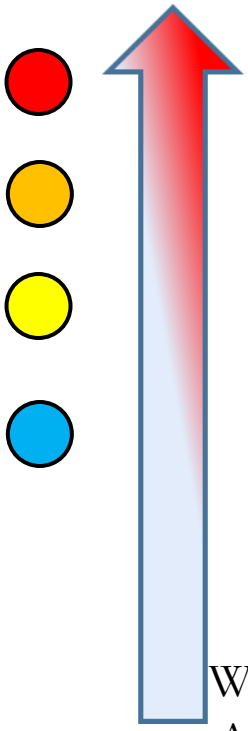


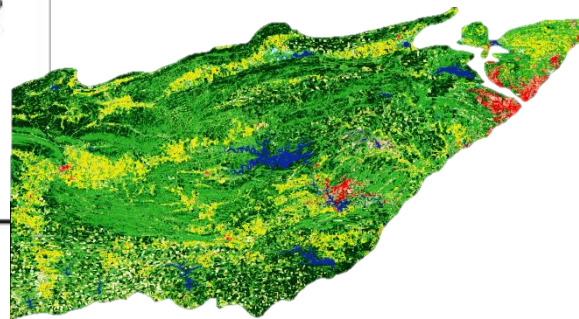
LULC ranking

- 270 sites were ranked from 1 to 10 for each variable:
- Watershed and 100m buffer
  - % alteration based on LULC polygons
  - Households #/sq. mi
  - Population #/sq. mi
  - All roads mi/sq. mi
  - Unpaved roads mi/sq. mi
  - CAFO #/sq. mi
- Watershed
  - NPDES #/sq. mi
  - Road crossings #/sq. mi
  - Dams #/sq. mi
- Final disturbance determined by summing all rank values.

Sample sites



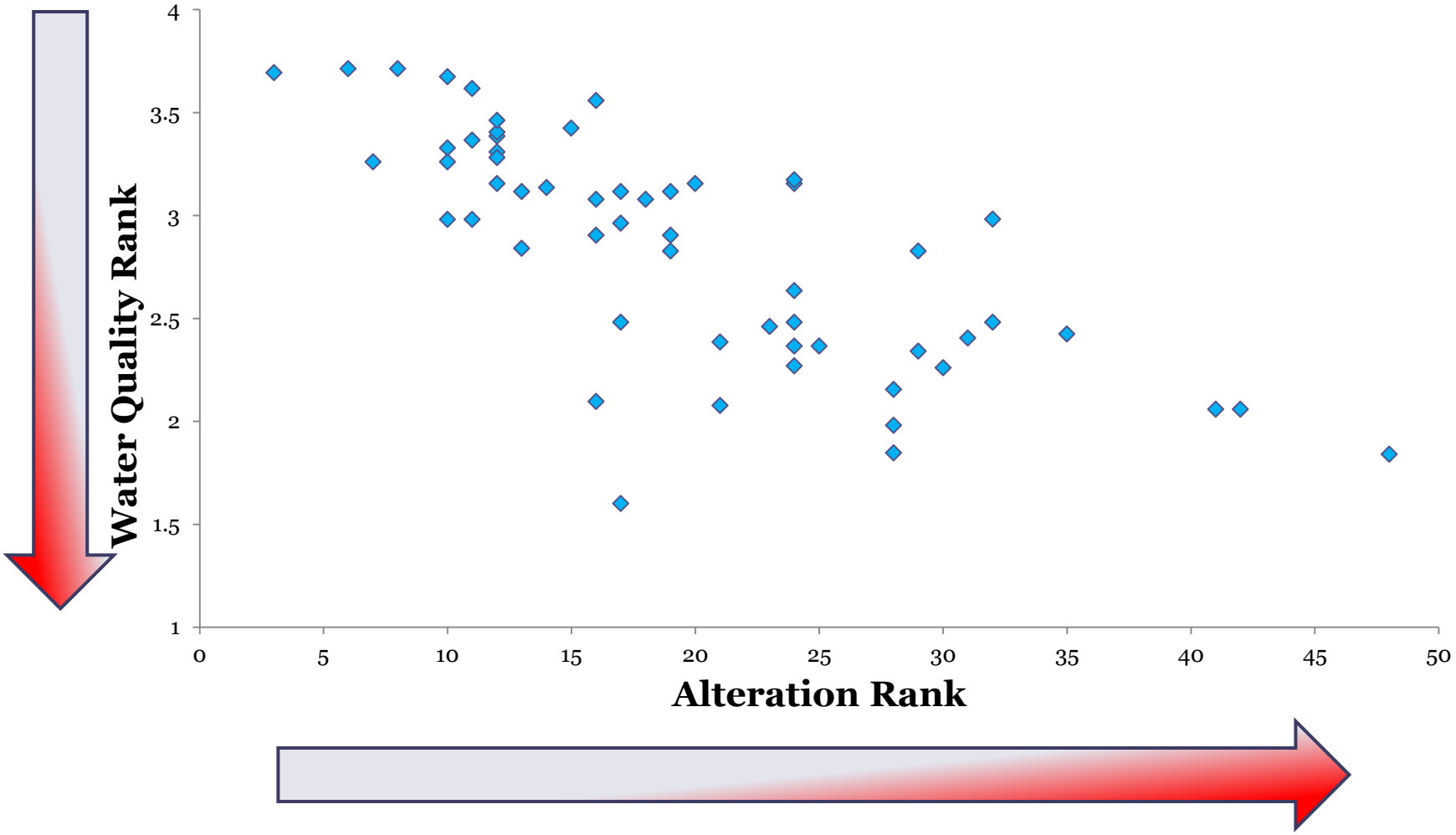




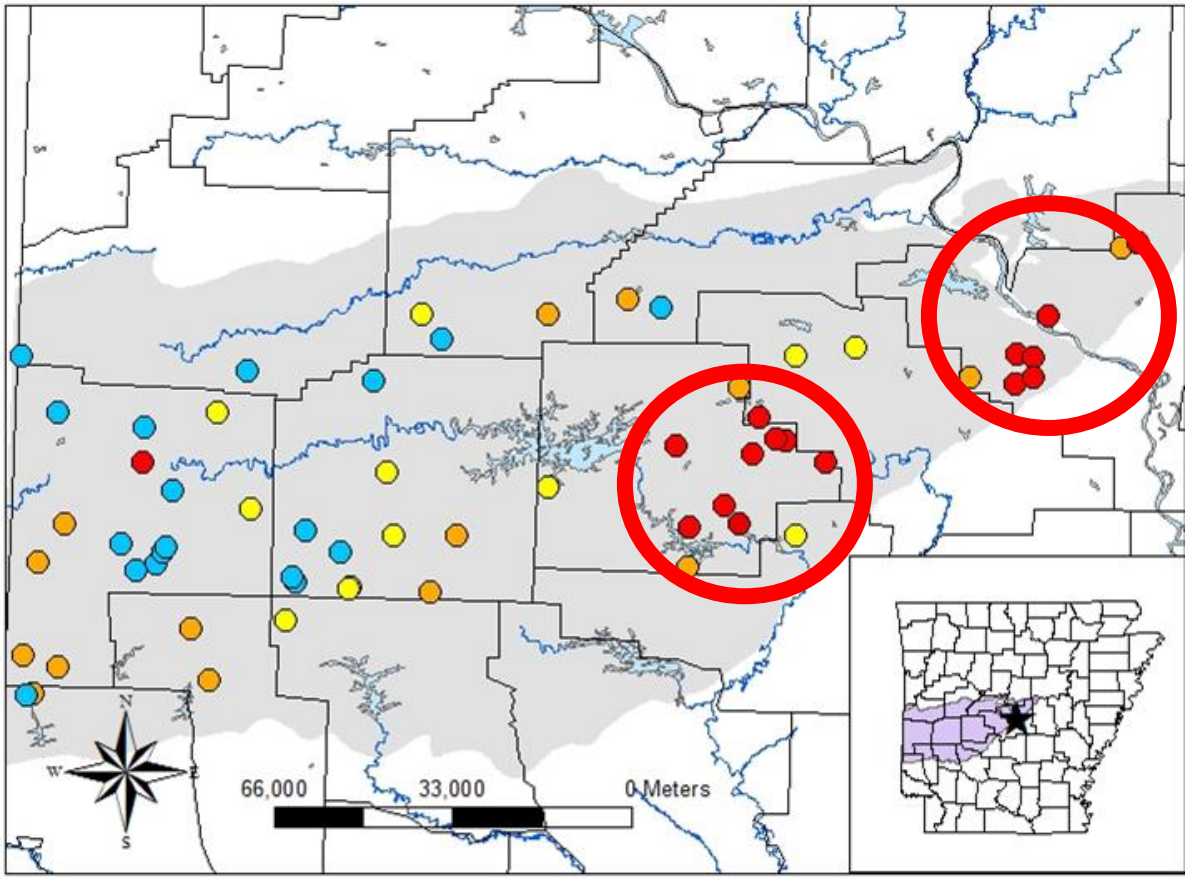
Water quality ranking

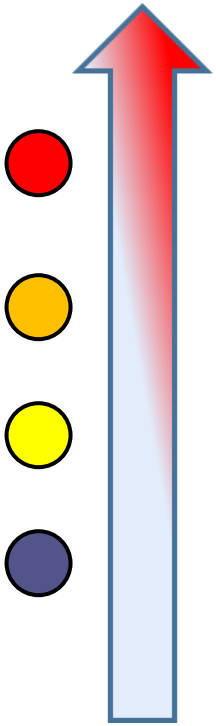
- Each site received water quality score.
- Ranked on site-specific medians for 52 variables:
  - Temperature
  - pH
  - DO
  - Nutrients
  - Minerals
  - Metals
- Each variable given rank value of 1 to 4 based on quartiles.
  - Low rank = high chemical concentrations.
    - Exception pH and DO
    - Does not distinguish between natural or man-made alterations
    - Does not mean impairment
- Final score reported as site-specific mean of rank values.

If you like charts



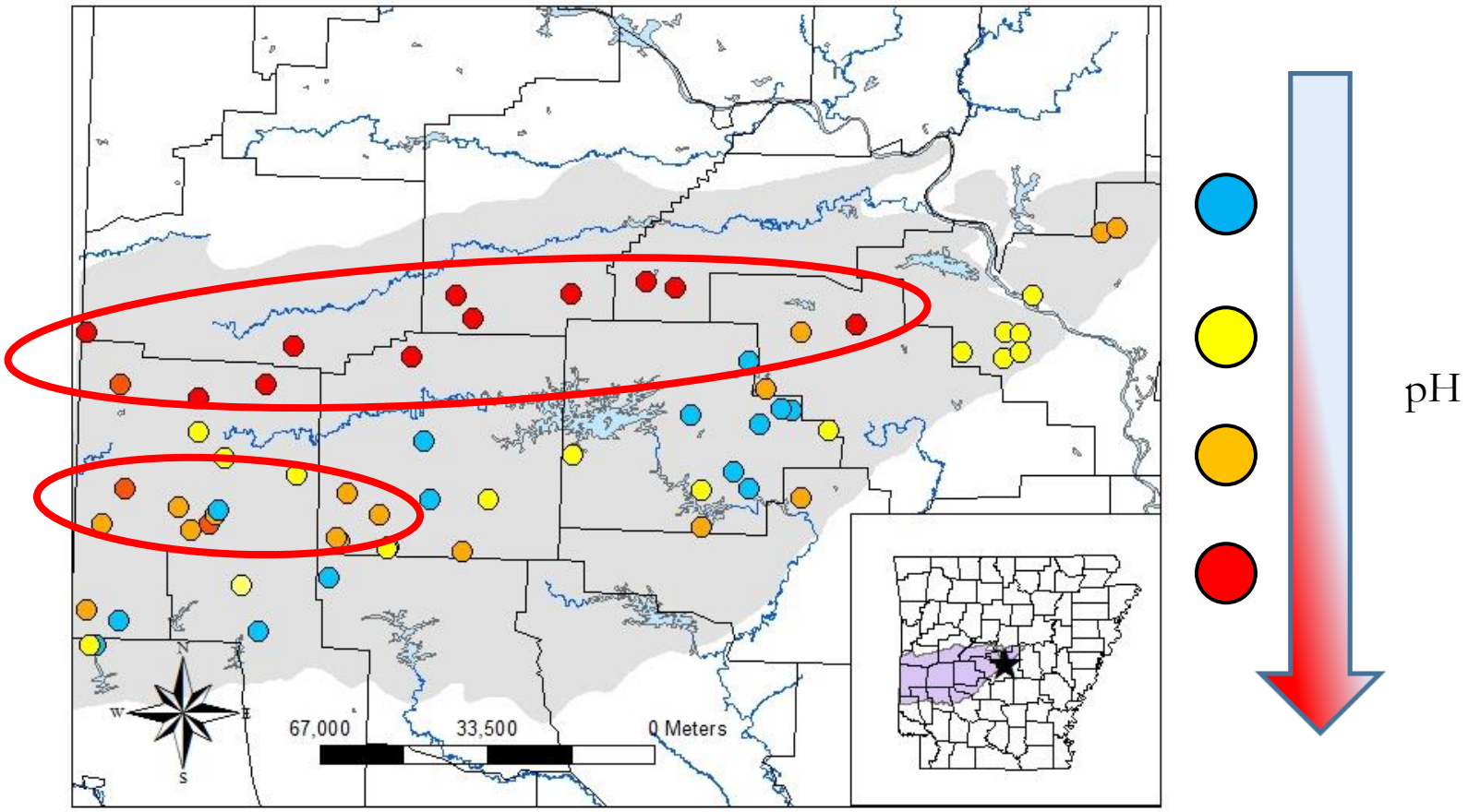
If you like maps





Chemical Concentrations

Just the start



What we hope the data can tell us

- Determine Least-altered conditions for:
  - Water Chemistry
  - Biology
  - Habitat
- Determine appropriate scale.
- Determine biological degradation.
  - One of our main attainment concerns of Clean Water Act
    - Fishable and Swimmable
    - Impacted by many variables
- Reassess criteria and IBI's.
  - Many ways to do this

An Evaluation of Continuous Monitoring Data for Assessing Dissolved-Oxygen in the Boston Mountains

Billy Justus and Lucas Driver
U.S. Geological Survey
Lower Mississippi-Gulf Water Science Center
Little Rock, Arkansas

This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government may be held liable for any damages resulting from the authorized or unauthorized use of the information.

Problem

- An increasing amount of continuous DO data has resulted in the need for Arkansas to appropriately assess those data to better meet requirements defined in the Clean Water Act

- There is no guidance for how States should assess continuous DO data

- States who use continuously monitored DO data for regulatory purposes are challenged to determine the amount of DO variability that can be expected across space (e.g. a range of stream disturbance) and time (e.g. diurnally, seasonally)

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Current Arkansas Dissolved Oxygen (DO) Standards

Arkansas DO standards for 3 Ecoregions

Watershed size	Primary (November-April)	Critical (May-October)
	mg/L	mg/L
Ozark Highlands		
<10-mi^2	6	2
10- to 100-mi^2	6	5
>100-mi^2	6	6
Boston Mountains		
<10-mi^2	6	2
>10-mi^2	6	6
Arkansas River Valley		
<10-mi^2	5	2
10- to 150-mi^2	5	3
151-400 mi^2	5	4
>400 mi2	5	5

*Concentrations are in milligrams per liter (mg/L).

- Primary season < 22 °C
- Critical season > 22 °C
- Data collected during discrete samples
- Short-term continuous data (e.g. 72 hours)

"Stream and river monitoring segments will be listed as non-support when more than 10 percent of the total samples for primary or critical season within the period of record fail to meet the minimum applicable dissolved oxygen standard listed in APC&EC Reg. 2.505"

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Study Objectives

(1) To compare DO variability at least-disturbed (best available) and disturbed (non-reference quality) streams in the Boston Mountains for the critical season

(2) To evaluate the current DO standard and determine if the exceedance value used in the current assessment methodology is appropriate

(3) To evaluate the degree of DO variability that may be explained by other constituents (e.g. pH, specific conductivity, and water temperature).

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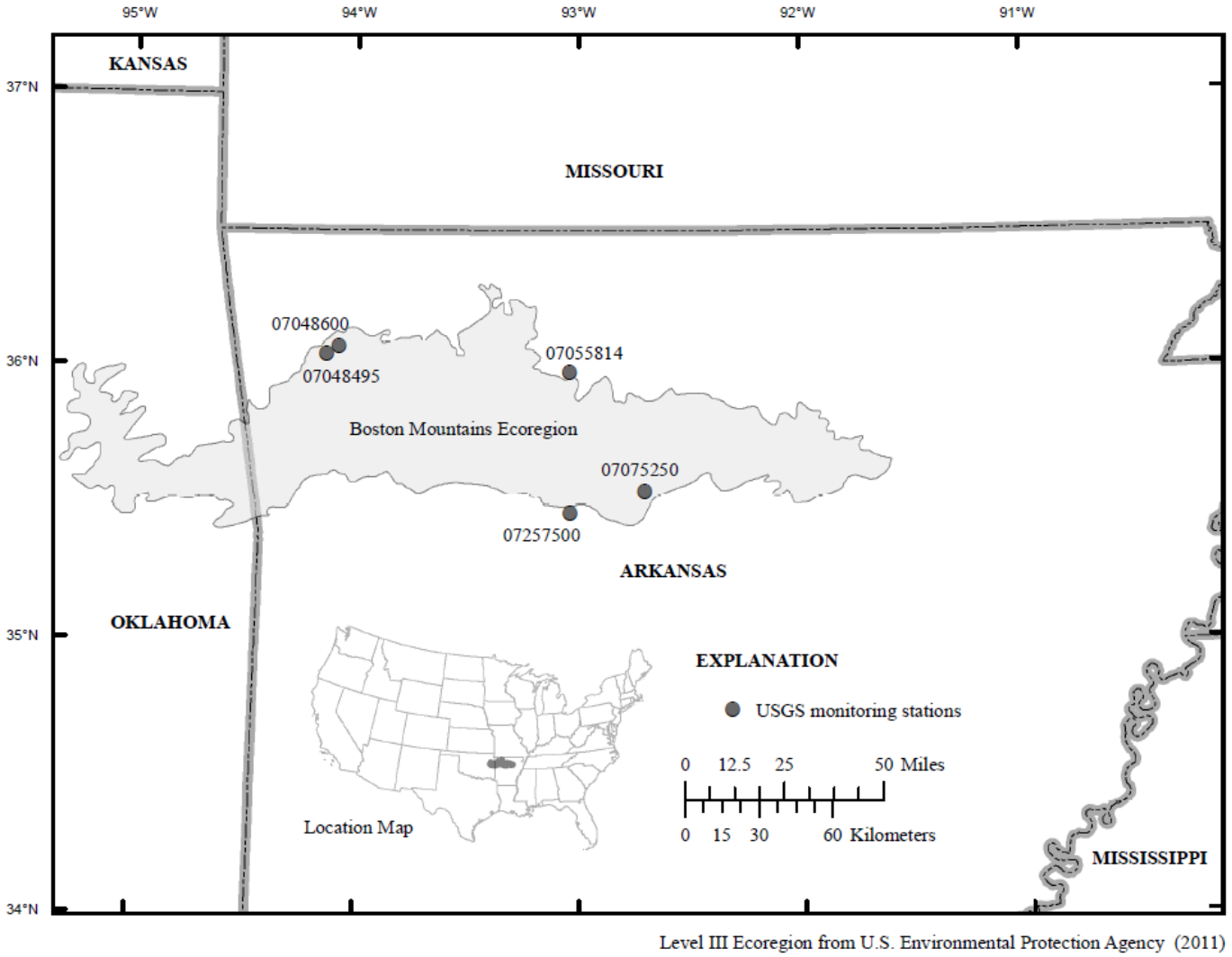
Locations of 5 continuous monitoring locations in the Boston Mountains, Arkansas



Level III Ecoregion from U.S. Environmental Protection Agency (2011)

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Sample Characteristics for DO data for Critical Temperature Days (water temperatures were > 22°C)

Stream name	Site no.	Drainage area (mi^2)	Start of period	End of period	Critical temp. days	No. of unit values
South Fork Little Red River	07075250	47.6	2013-06-12	2015-09-30	313	21,715
Illinois Bayou	07257500	241	2013-05-14	2015-09-30	323	27,986
Big Creek	07055814	89.9	2014-06-02	2015-09-30	202	14,623
White River	07048600	400	2014-05-03	2015-09-30	127	11,007
Town Branch	07048495	30	2015-06-17	2015-09-30	96	7,488

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Characteristics of the 5 sites

- Watersheds >10 mi^2
- Gradient of land use and nutrient concentrations

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Relations among Dissolved Oxygen, Nutrients, and Land Use

Intensified land use can increase stream nutrient concentrations….

Increasing stream nutrient concentrations can stimulate aquatic plant productivity (i.e. benthic algae, phytoplankton, and macrophytes)

Increasing plant productivity results in a higher rate of photosynthesis and respiration that can result in greater variability in DO concentrations over time

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Study Design Considerations

- *A priori* designation

- Gross divisions in nutrients and land use were used to classify sites into three impairment classes
  (Least, Moderate, and Most-disturbed)

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Study Design Considerations (continued)

- The 5 Sites were ranked based on discrete nitrate and total phosphorus data (collected for past projects)

	Nitrate						Total Phosphorus						Nutrient Index	
	Baseflow			Stormflow			Baseflow			Stormflow				
Stream name	No. of samples	Mean (mg/l)	Rank	No. of samples	Mean (mg/l)	Rank	No. of samples	Mean (mg/l)	Rank	No. of samples	Mean (mg/l)	Rank	Sum of Ranks	Final Rank
South Fork Little Red River	24	0.057	1	26	0.096	1	24	0.015	2	26	0.081	1	5	1
Illinois Bayou	9	0.086	2	17	0.202	2	9	0.013	1	17	0.242	2	7	2
Big Creek	5	0.171	3	9	0.242	3	4	0.016	3	10	0.254	3	12	3
White River	23	0.309	4	12	0.399	4	23	0.032	4	12	0.255	4	16	4
Town Branch	8	0.513	5	9	0.472	5	8	0.036	5	9	0.623	5	20	5

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Study Design Considerations (continued)

- The 5 sites were also ranked based on 7 land-use metrics

Pasture (%)

Forest (%)[1]

Evergreen forest (%)

Urban (%)

Unpaved Roads (miles/sq.miles)

All Roads (miles/sq.miles)

Confined animal feeding operations (no./sq.mi)

Stream name	Rank	**Assigned Rank**
South Fork Little Red River	2	Least disturbed
Illinois Bayou	1	Least disturbed
Big Creek	3	Moderately disturbed
West Fork White River	4	Most disturbed
Town Branch	4	Most disturbed

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Other Important Constituents (Surrogate Relations)

Specific conductance and water temperature *often can be surrogates for groundwater influence on water-quality in a stream……*

- during low-flow periods (baseflow), large parts of the flow in a stream are contributed by groundwater

- USGS studies indicate that specific conductance in groundwater (GW) can be twice that of surface water (SW)

- Reduced atmospheric exposure results in lower DO concentrations in GW compared to SW

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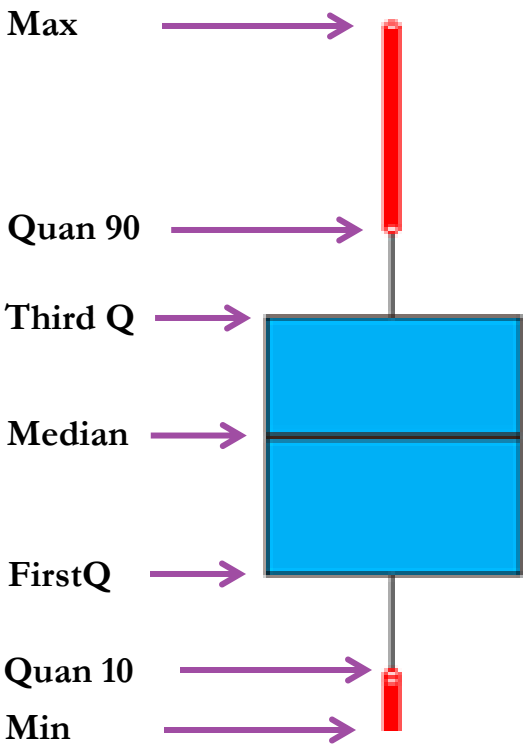
Box Plot Description

Table 4a. Descriptive statistics for DO data (concentrations are in milligram per liter)

Stream name	site_no	min	quan10	firstQ	med	mean	thirdQ	quan90	max
South Fork Little Red River	07075250	5.4	6.8	7.2	7.7	7.7	8.2	8.6	9.9
Illinois Bayou	07257500	4	6.3	6.8	7.4	7.4	7.9	8.4	9.9
Big Creek	07055814	4	5.4	6.2	7.3	7.5	8.7	10.1	12.2
White River	07048600	3	5.1	5.8	6.6	6.5	7.2	7.8	10.3
Town Branch	07048495	4.6	5.4	5.8	6.4	6.4	6.9	7.3	8.5



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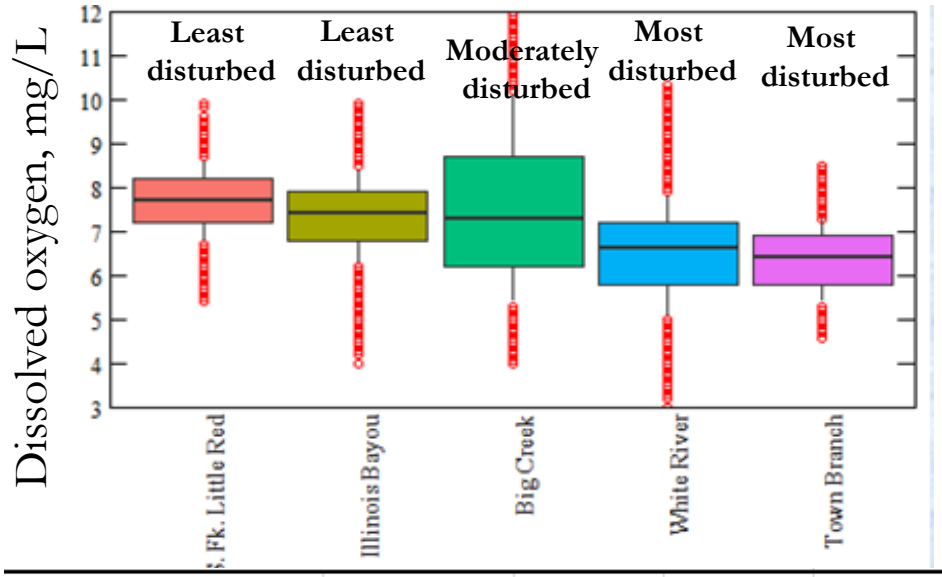
Continuous DO statistics indicated a strong connection between the nutrient and land-use indices and DO concentrations



Stream name	Site no.	No. of unit values	No. of unit values < 6 mg/L	Percent of unit values < 6 mg/L
South Fork Little Red River	07075250	21,715	75	0.03
Illinois Bayou	07257500	27,986	1,046	3.7
Big Creek	07055814	14,623	2,992	20.5
White River	07048600	11,007	2,976	27.0
Town Branch	07048495	7,488	2,494	33.0

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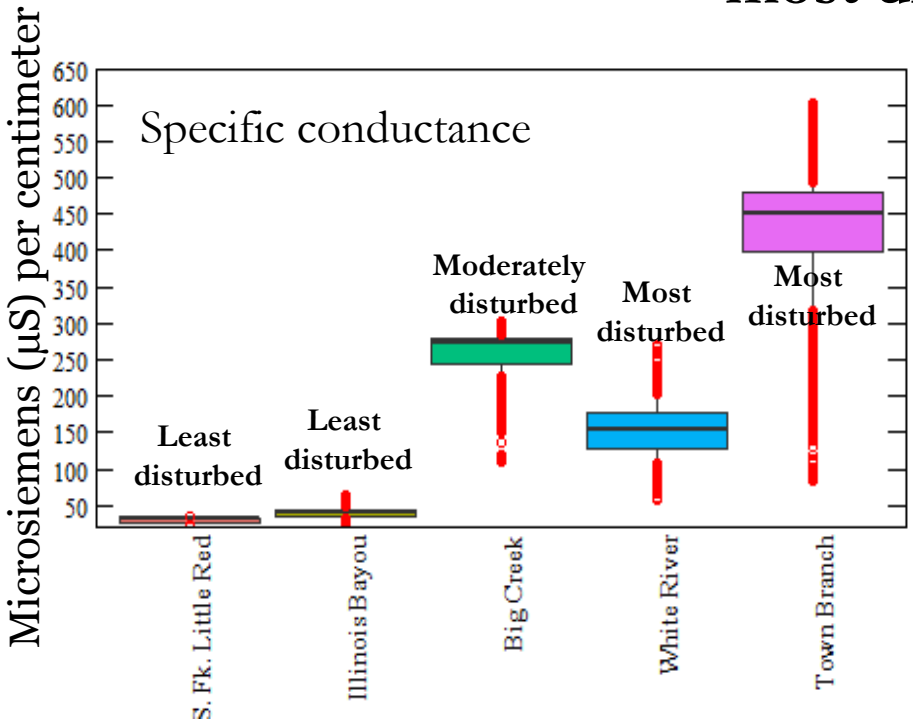
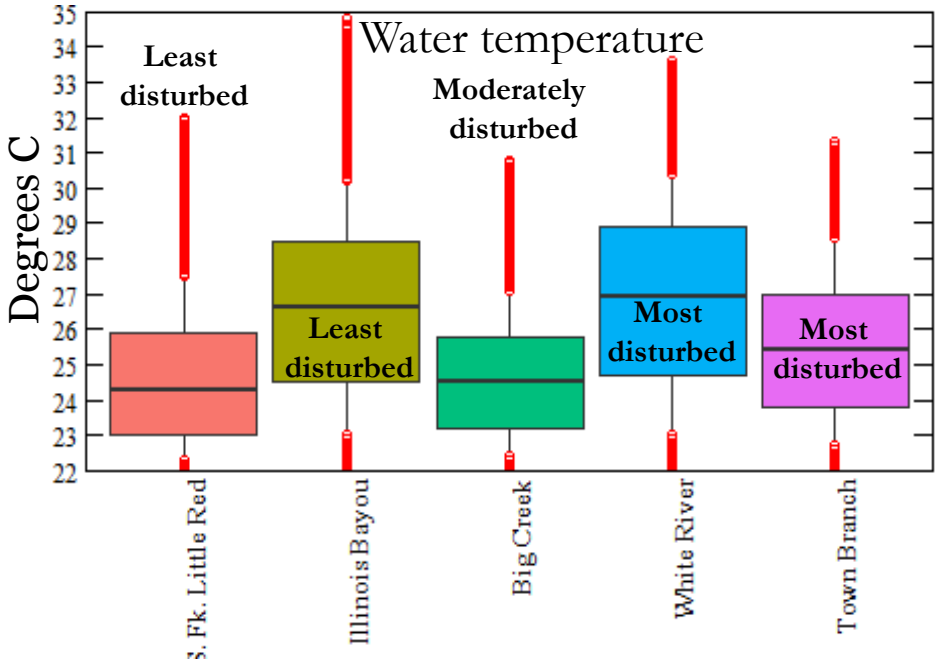
Specific conductance and water temperature generally indicated some degree of GW influence at two of the three sites that were most disturbed





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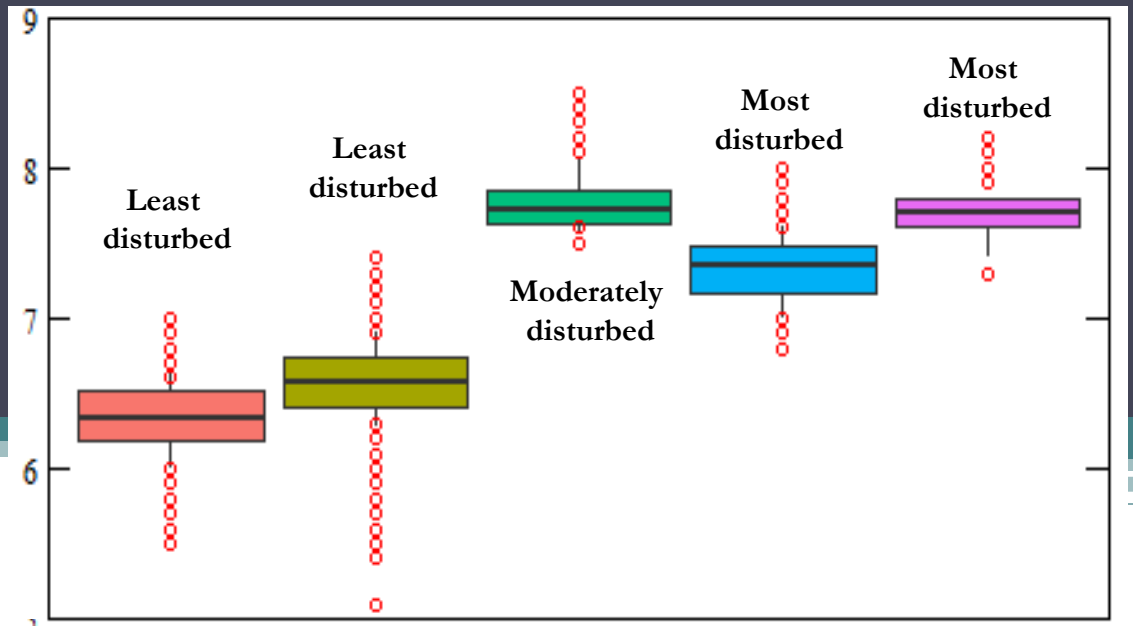
pH was much lower at the two least-disturbed sites compared to sites that were more disturbed



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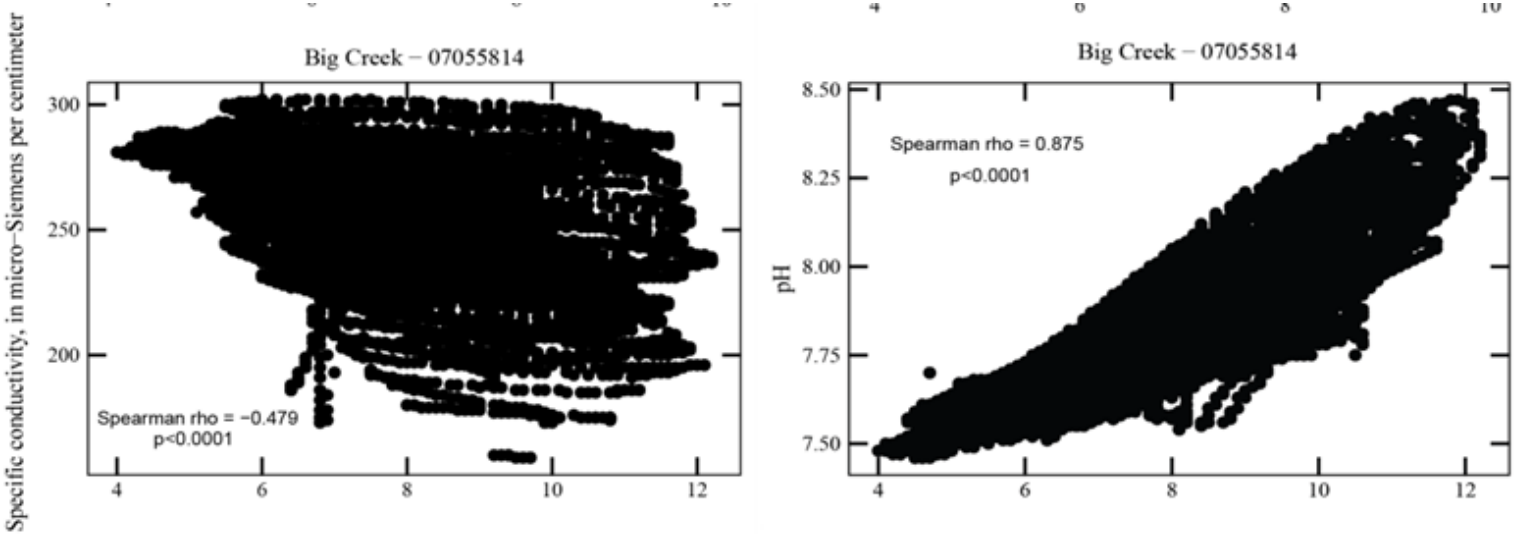
DO was negatively correlated to specific conductance and positively correlated to pH

Stream name	Site no.	Dissolved oxygen x Specific conductance	Dissolved oxygen x pH
South Fork Little Red River	07075250	-0.26	0.13
Illinois Bayou	07257500	-0.33	0.19
Big Creek	07055814	-0.48	0.87
White River	07048600	-0.20	0.50
Town Branch	07048495	-0.17	0.41

An indication of high productivity



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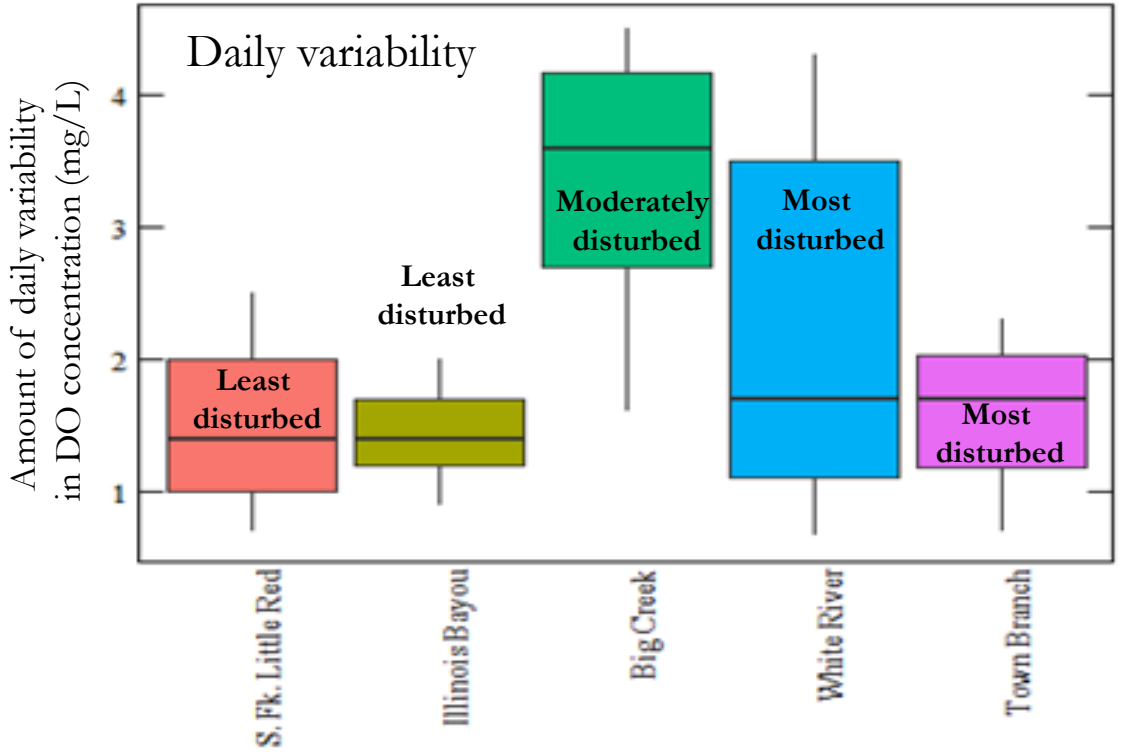
Even though some low-end variability can be explained by GW influence, sites with the highest amount of DO variability generally had highest nutrient concentrations and more intense land use



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Preliminary Conclusions

- DO concentrations at the two least-disturbed sites exceeded the Arkansas standard of 6 mg/L for less than 4% of the unit values indicating

  1) that the current standard is obtainable (i.e. not too high), and

  2) that continuous DO data (e.g 15-minute unit values) can be used appropriately with the current assessment methodology (10% allowable exceedance of the 6 mg/L standard)

- Some of the DO variability at the low end of the data range (near the 6 mg/L standard) for some sites in the Boston Mountains may be explained by GW influence; however, a high degree of variability at the upper end of the range indicates a relation with nutrient concentrations

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Future Directions

- Developing R code and scripts
  - streamlining the data evaluation process so that the Arkansas Department of Environmental Quality (ADEQ) can access and use USGS continuous data

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We would like to acknowledge:

Brian Breaker (USGS, for data retrieval)

Tate Wentz and Jessie Green (Arkansas Department of Environmental Quality - for review comments and partial funding)

Questions???