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Atlanta-Area Piedmont Watersheds (Urban)

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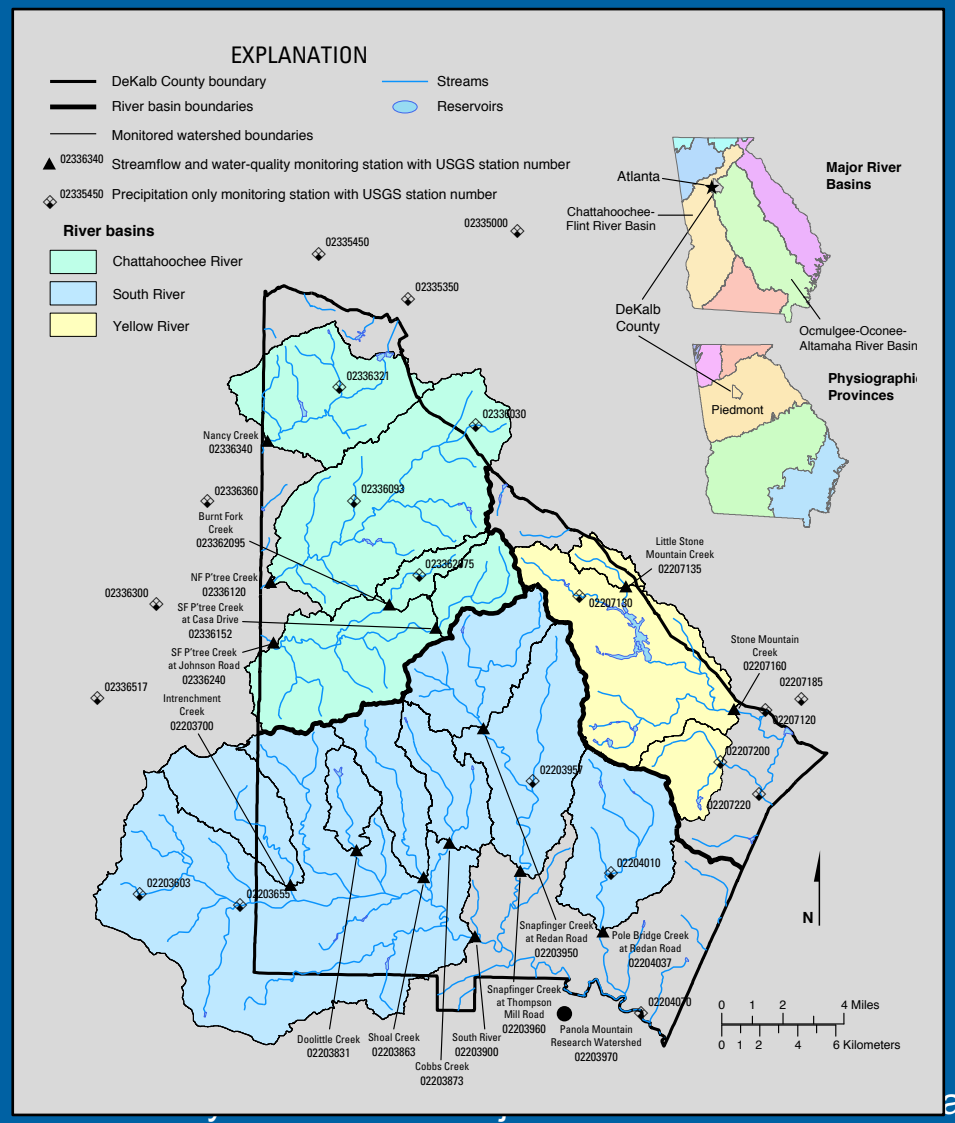
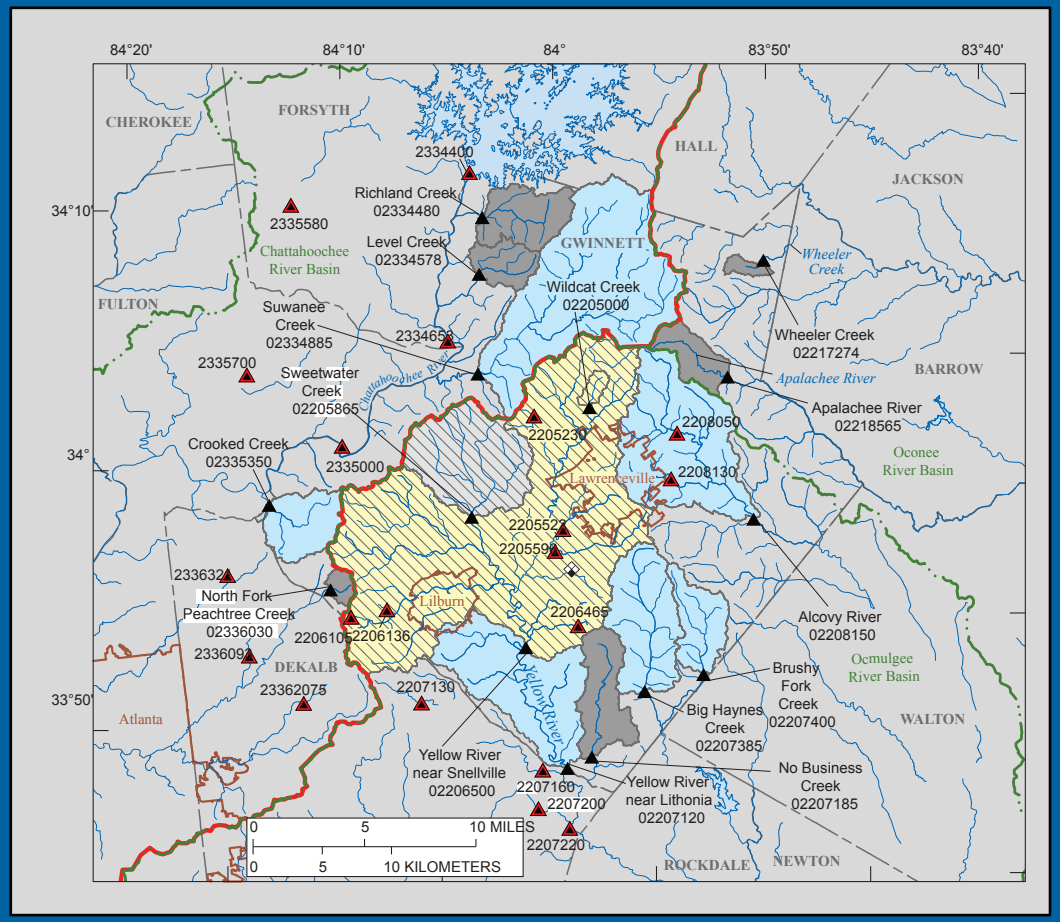
Chesapeake Bay Program's STAC Workshop: Using Local Monitoring Results to Inform the Chesapeake Bay Program's Watershed Model, Fairfax, VA, March 7–8, 2023

U.S. Department of the Interior
U.S. Geological Survey

30 watersheds in DeKalb & Gwinnett Counties monitored long-term for streamflow & water quality





DeKalb Co 2012–

15 watersheds; 8 nested

Gwinnett Co 1996–

15 watersheds; 3 nested

ation or Distribution.

Watershed monitoring

- Streamflow and precipitation
- Continuous water-quality (H_2O temp., pH, SC, turbidity, DO[1])
- Sampling
  - 2 base-flow and 6 stormflow composite samples per year
  - pH, SC, turbidity, Ca, Mg, TDS, BOD[1], COD[1]
  - Sediment (Total Suspended Solids, Suspended-Sediment Concentration)
  - Nutrients (TN, NO_3+NO_2, TKN, NH_3, TP, DP, TOC)
  - Trace metals (Cd[1], Cu[1], Pb, Zn)
  - Bacteria[1] (fecal coliform, *E. coli*)

[Loads estimated; [1]DeKalb Co. only]

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Load methodology

- Regression model approach
  - Moderate to strong concentration relations
  - Streamflow, turbidity (surrogate), baseflow, seasonal, trend
  - USGS LOADEST program
    - Handles censored values and provides error estimates
    - Model parameter & time-step modifications to accommodate composite stormflow samples
  - Trends
    - Trend terms for model w/o turbidity
- Beale Ratio Estimator
  - Weak concentration relations
    - Some TN, NO_3+NO_2, Mg, & TDS
  - No error estimates

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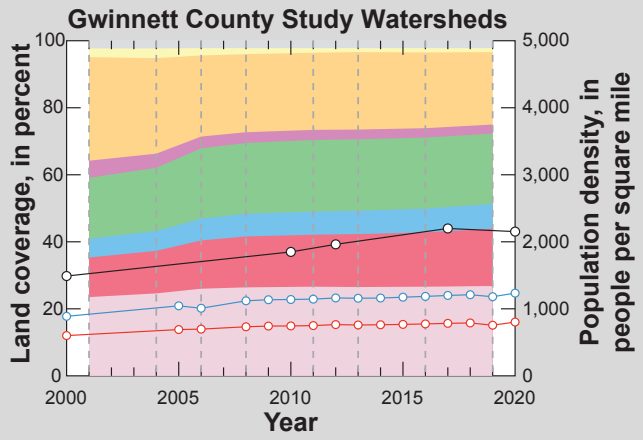
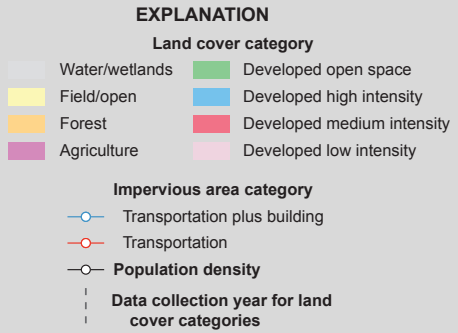
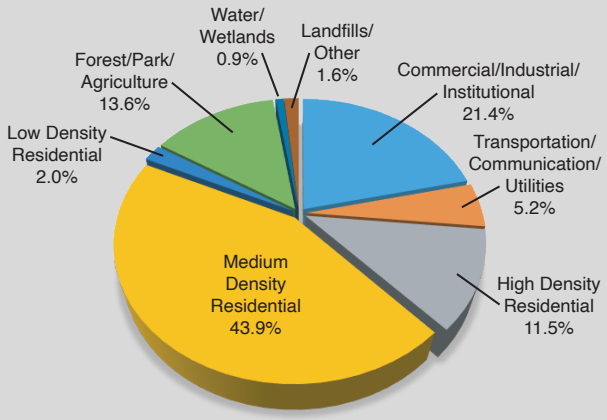
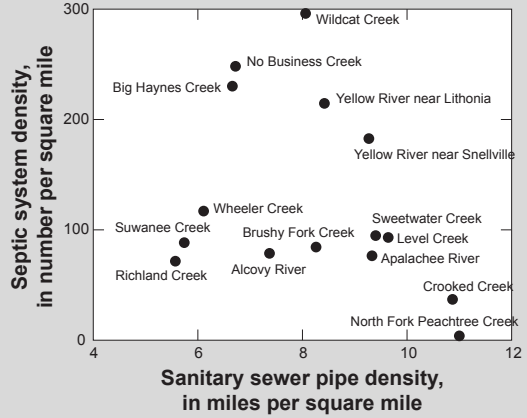
Watershed Characteristics: Land Cover/Use, Imperviousness, Population, Basin Slope, Detention Ponds, Storm & Sanitary Sewers, Septic Systems, Building Ages

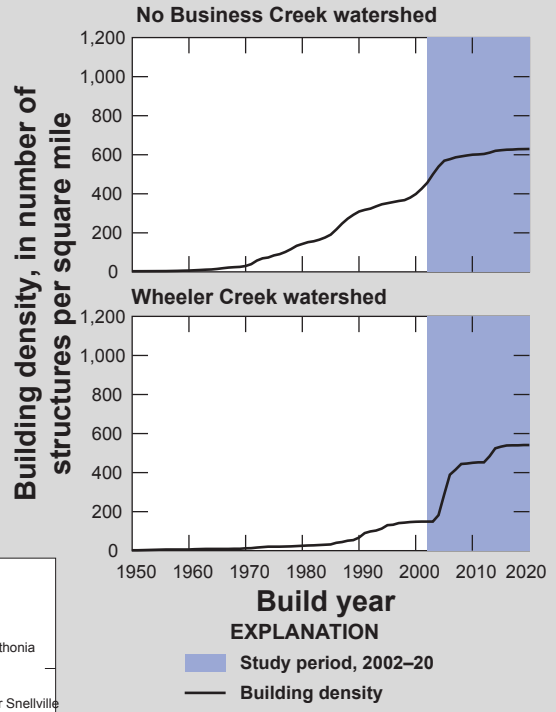


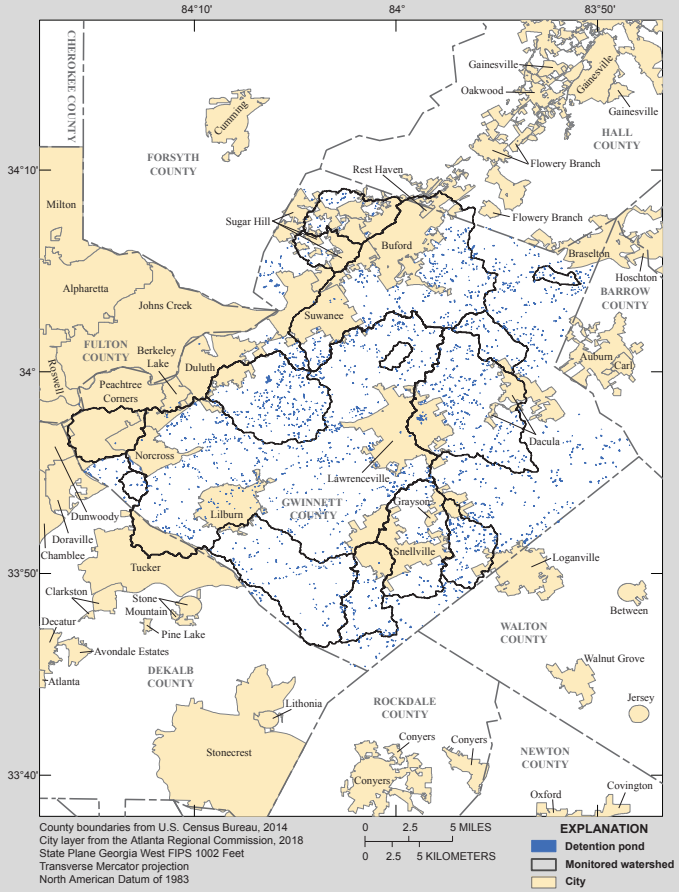




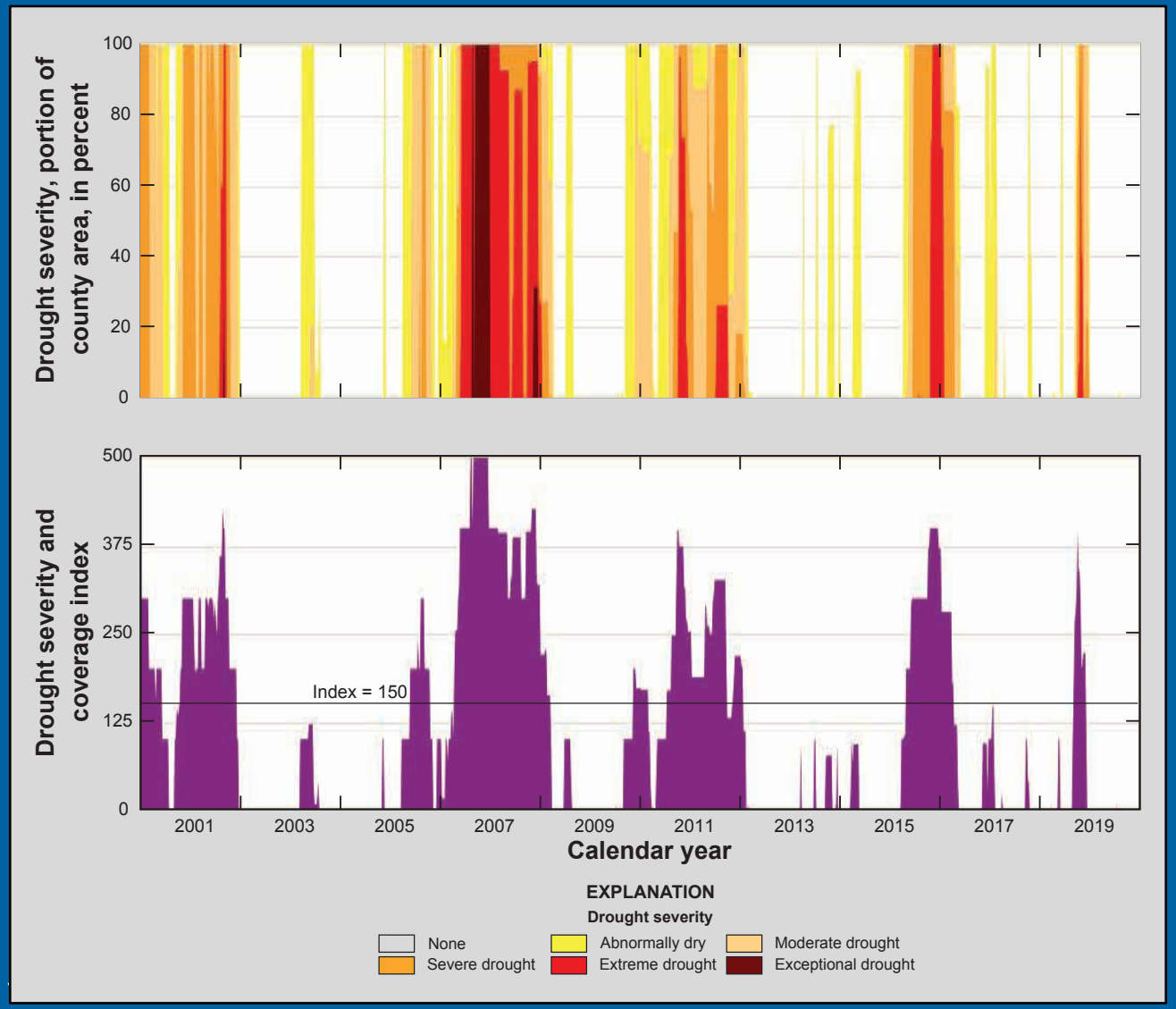
DeKalb County Study Watersheds Area







Study area has experienced reoccurring droughts that affect annual loads and could result in trends.



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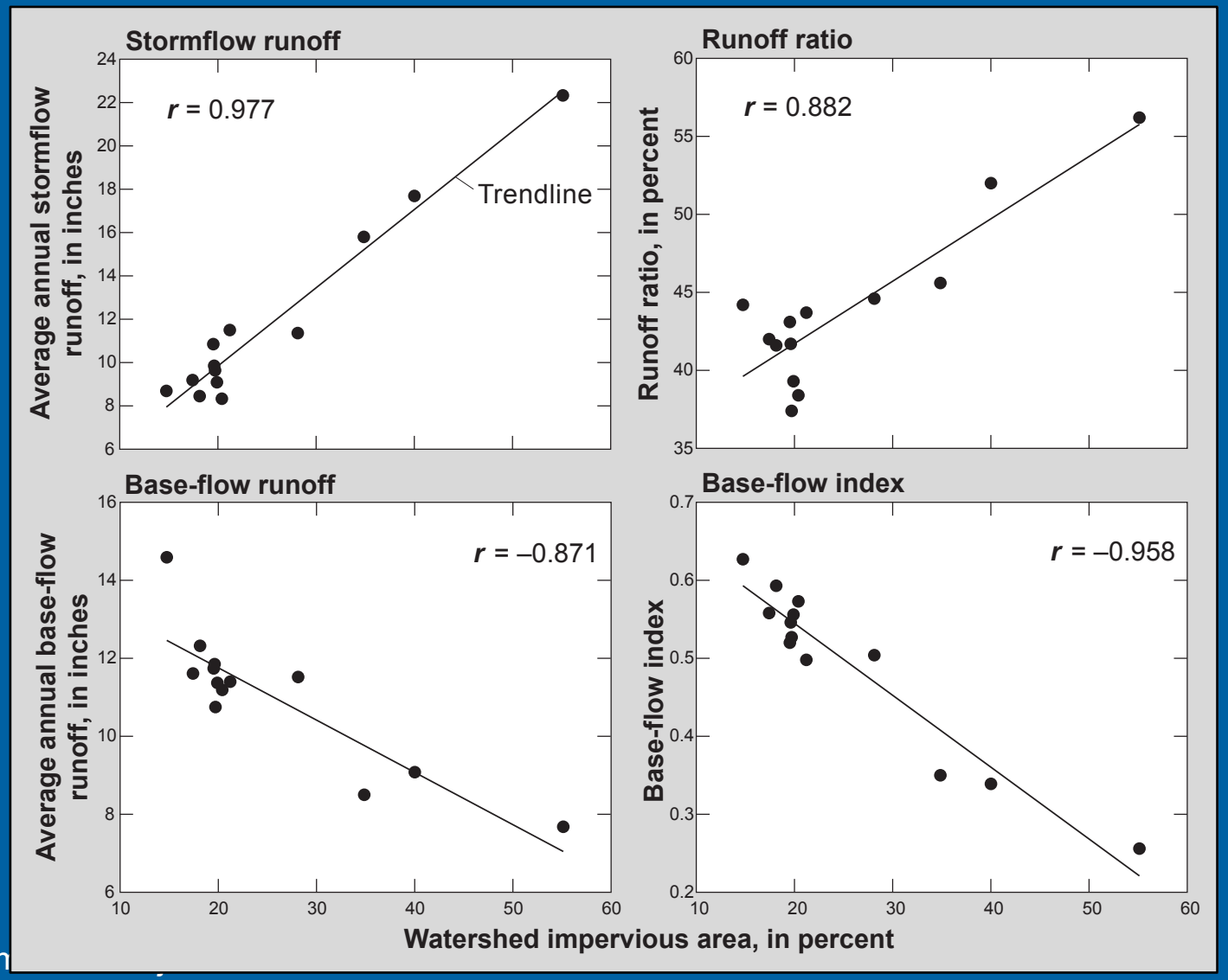
Higher stormflow runoff and lower base flow strongly related to higher percent imperviousness.

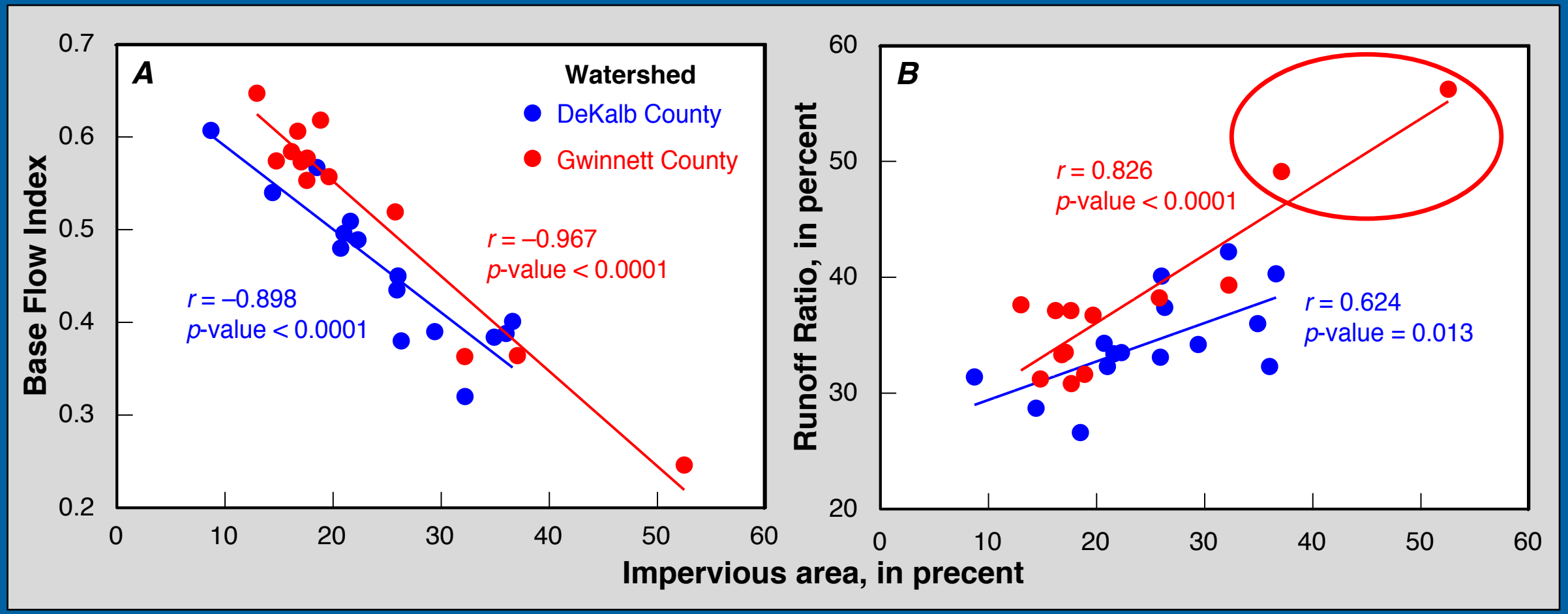


Gwinnett County Watersheds

USGS

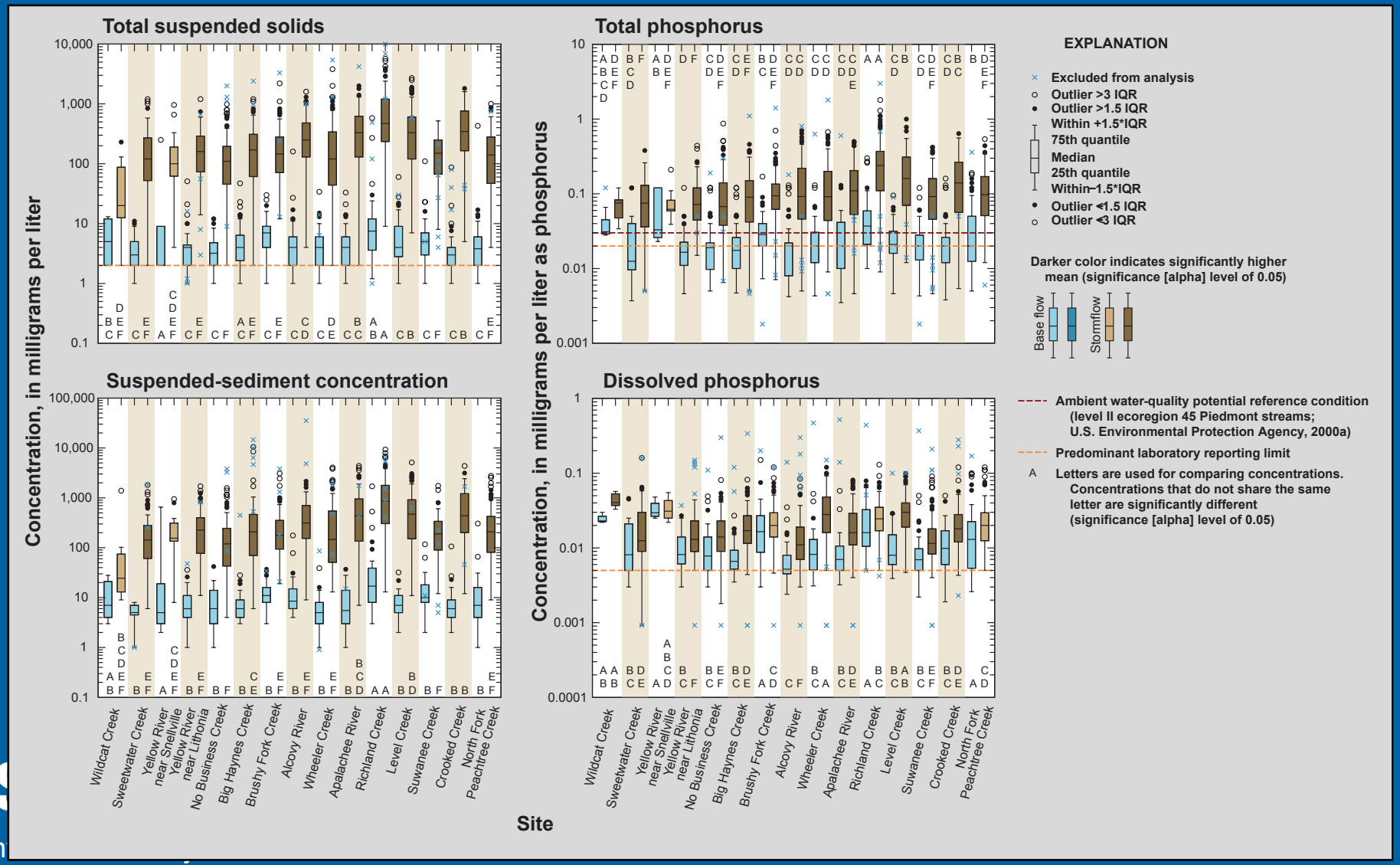
Preliminary Inform

DeKalb County likely has lower groundwater recharge for similar watershed imperviousness.



USGS

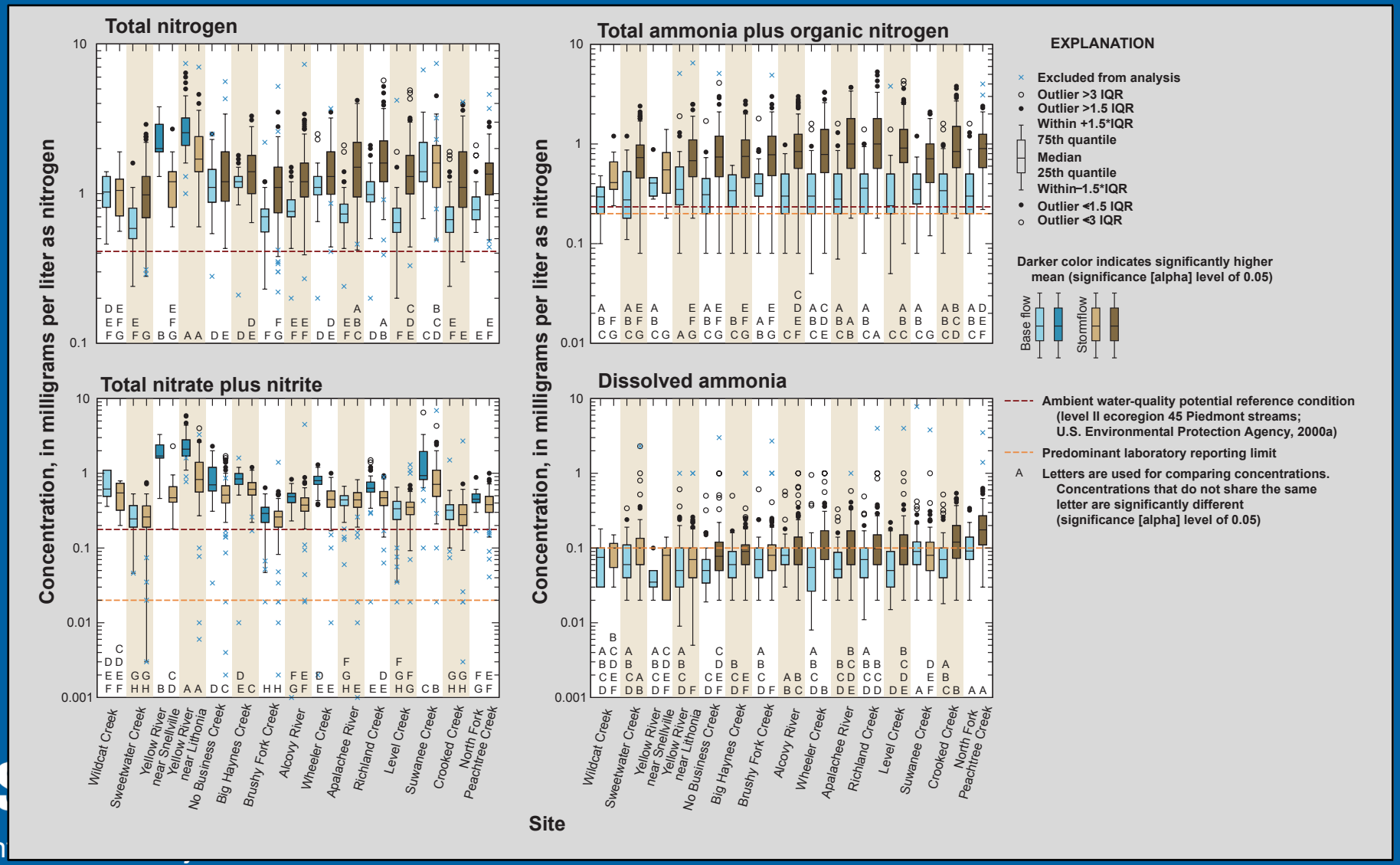
Average stormflow concentrations higher than base flow for suspended sediment and phosphorus species.



USGS

Preliminary In

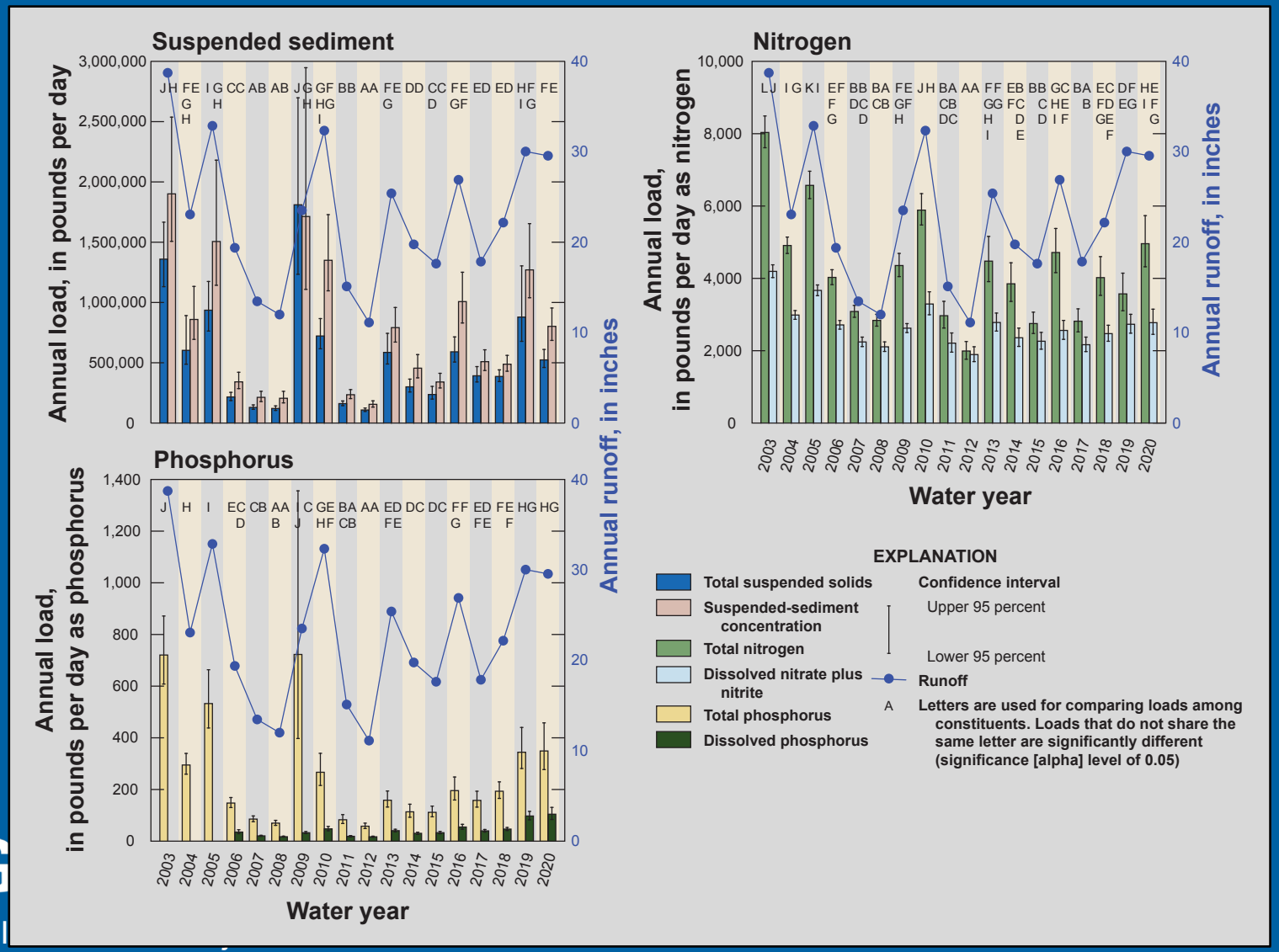
Average stormflow concentrations higher than base flow for TKN, varied by watershed for other nitrogen species.



USGS

Preliminary In

Higher annual constituent loads when higher annual runoff.



Gwinnett County study watersheds area (307 mi²)

USG

Preliminary I

Concentration enhancement at higher flows results in several-fold increase in TSS, SSC & TP loads compared to runoff.

Constituent	Ratio (range in annual loads) : (range in annual runoff)	Concentration vs. streamflow
TSS	**4.8**	
SSC	**3.5**	
TN	1.2	
NO_3+NO_2	0.6	
TP	**3.6**	
DP	1.8	

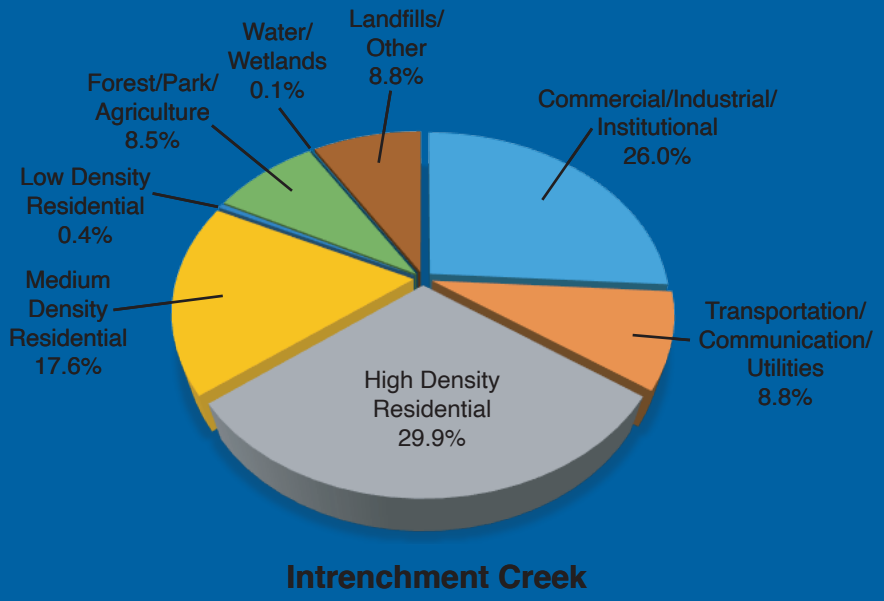
Gwinnett County

Water Years 2003–20

USGS

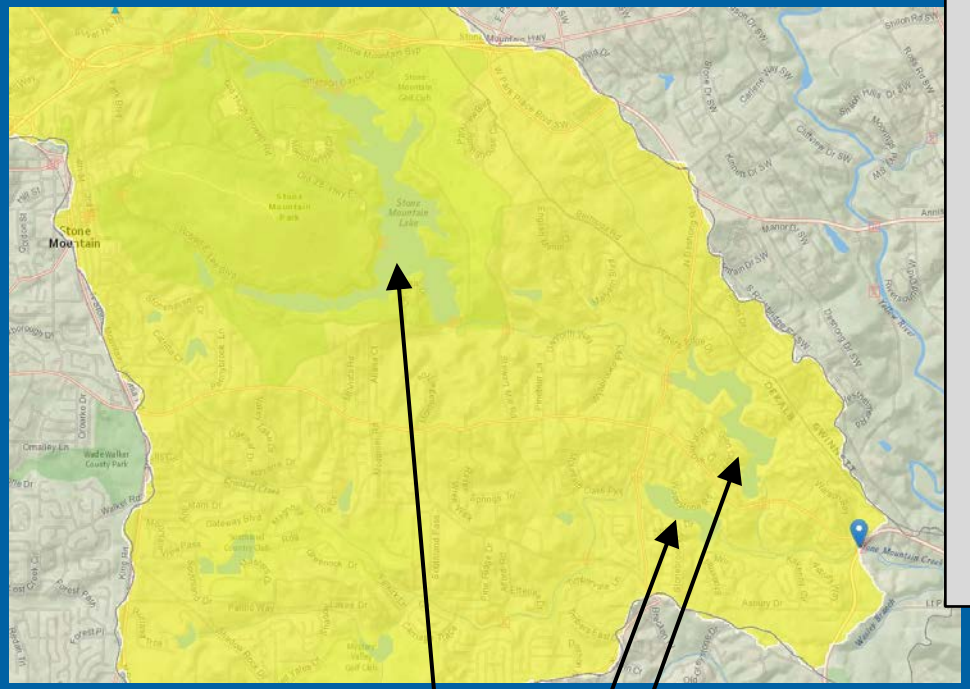
Relations with Constituent Yields

- TN vs. Developed Medium Intensity (r = 0.60)
- DP vs. developed Developed High Intensity (r = 0.85)
- DP vs. Imperviousness (r = 0.76)
- TP & DP vs. Septic Density (r = –0.70 & –0.69)
- Intrenchment Creek
  - Among highest yields except for NO_3+NO_2
  - Highest high density residential and high Commercial/Industrial/Institutional

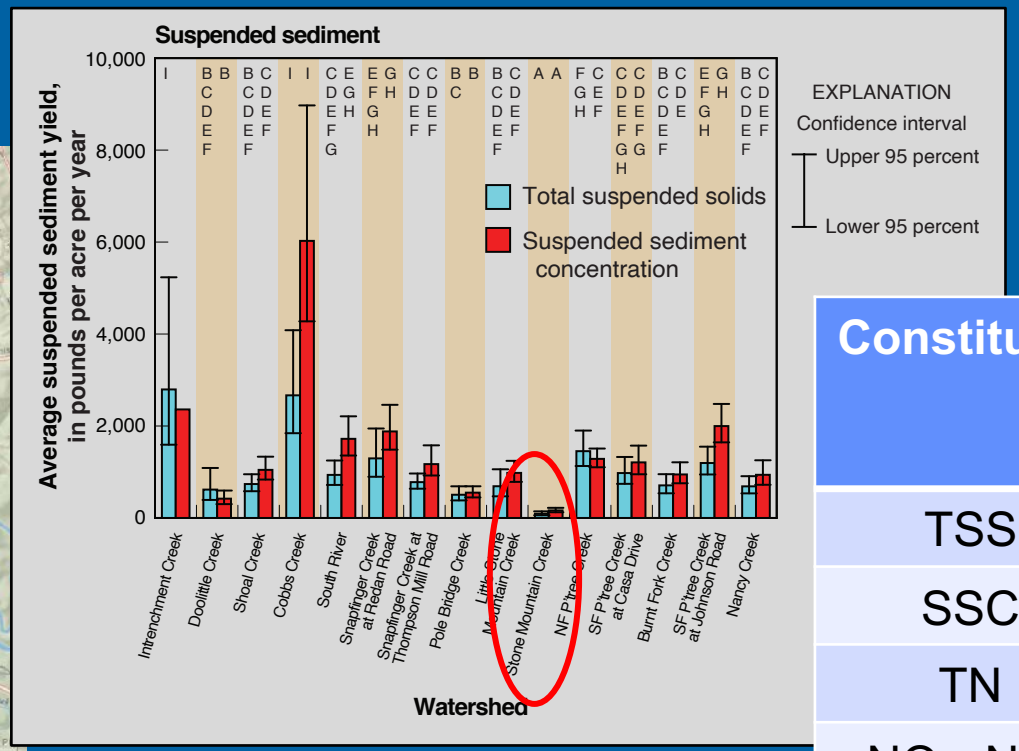


USGS

Stone Mtn. Creek watershed had among the lowest constituent yields and reflected the drainage area of upstream reservoirs.



Reservoirs

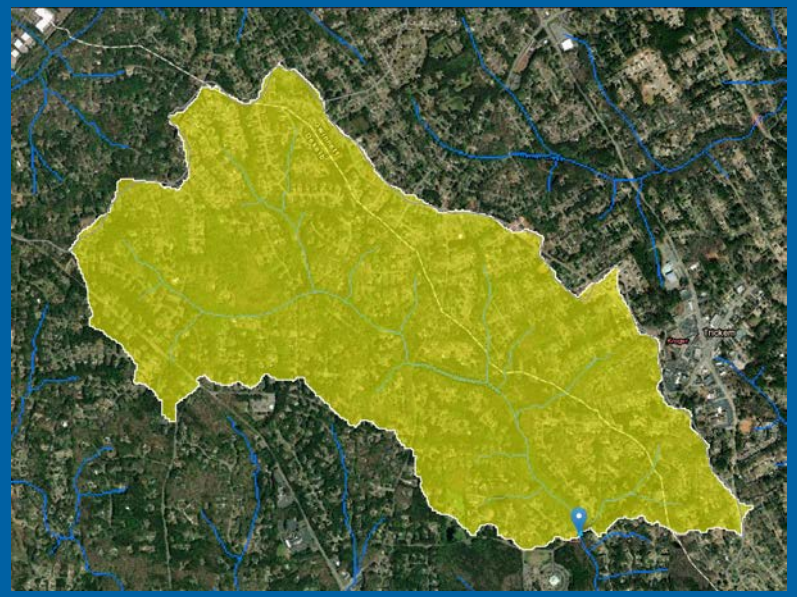


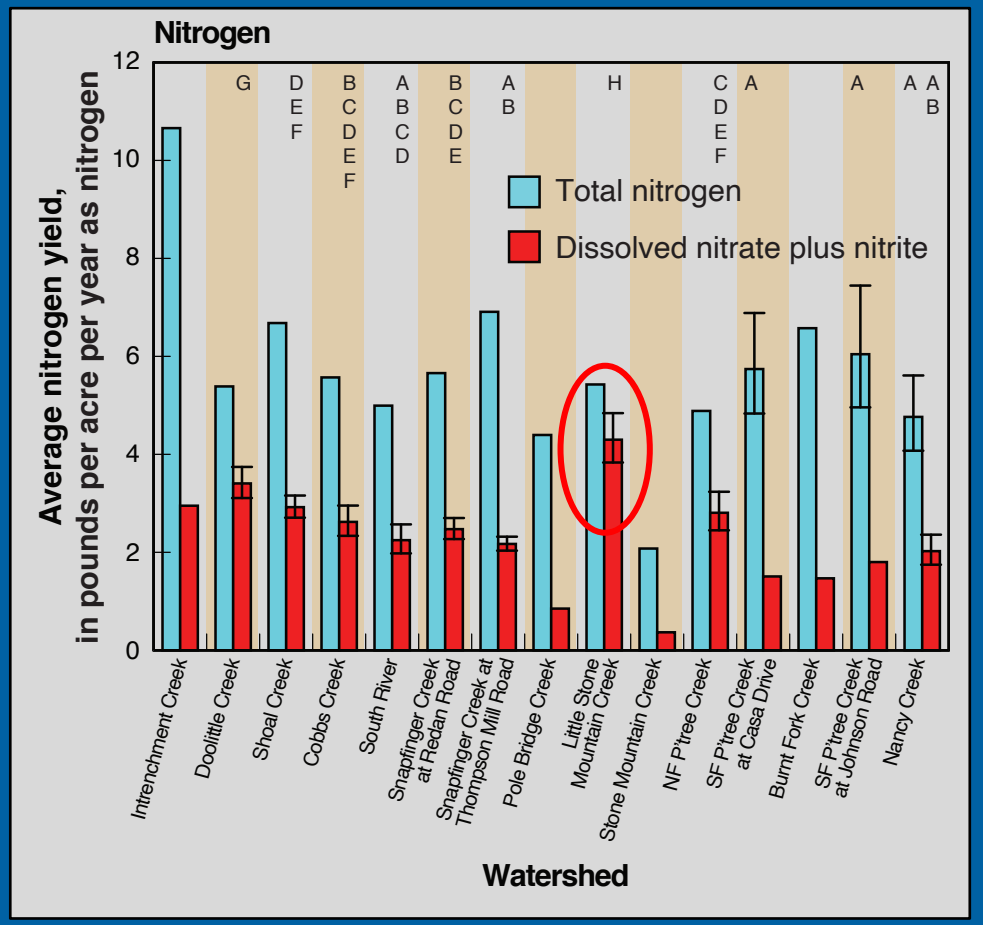
94.7% of watershed upstream of reservoirs

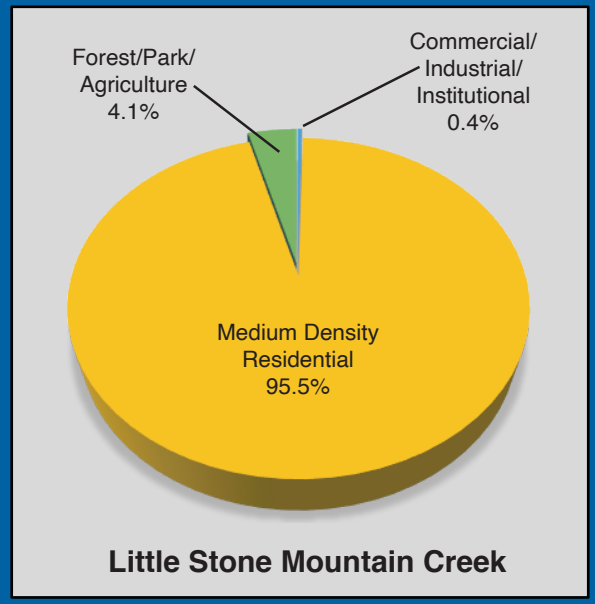
Constituent	Yields lower than other watersheds
TSS	90.7%
SSC	88.8%
TN	60.9%
NO_3+NO_2	83.0%
TP	83.8%
DP	76.0%

USGS

Little Stone Mtn. Creek watershed had low constituent yields except for NO_3+NO_2. Source: fertilizers? septic?







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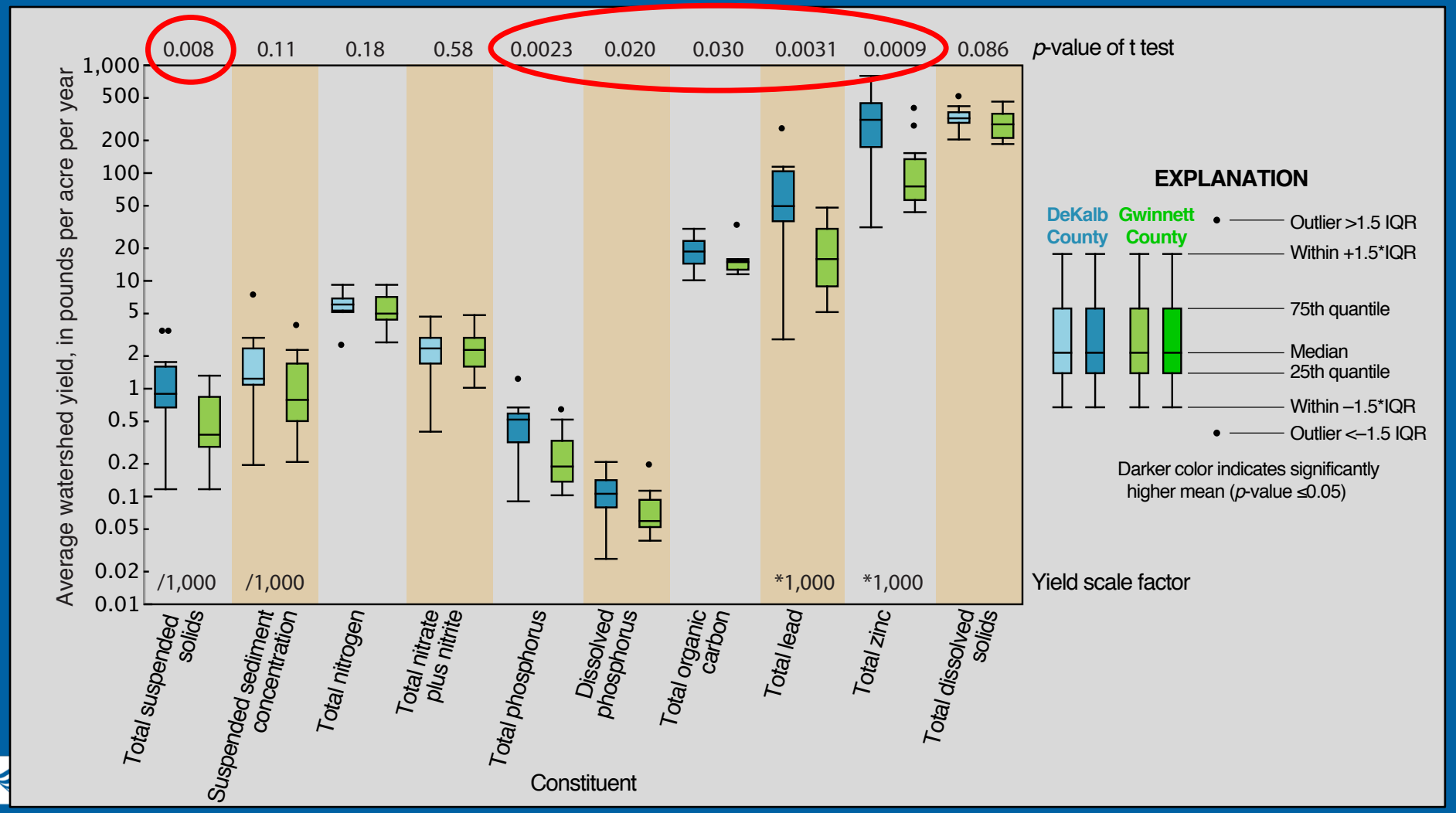
Preliminary Information-Subject to Revision. Not for Citation or Distribution.

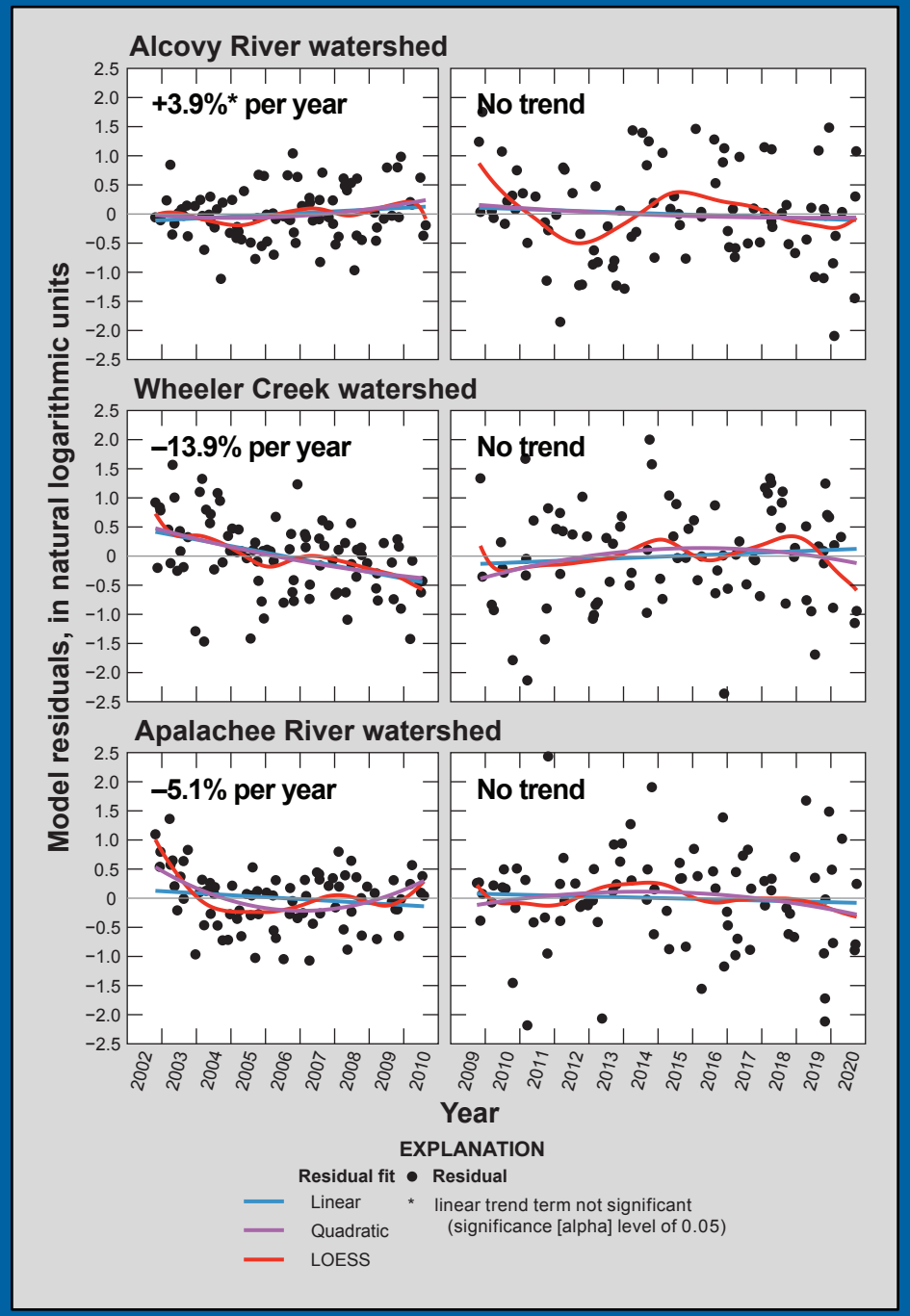
DeKalb Co has higher watershed constituent yields, but highest watershed yields are similar.



Yields 2014–15

Gwinnett County trends in concentrations and loads

- Split into 2 periods
  - WYs 2003–10
  - WYs 2010–20
  - Don’t start or end on drought year
- Trends fit without turbidity surrogate
- Residuals shown without trend-fitting terms



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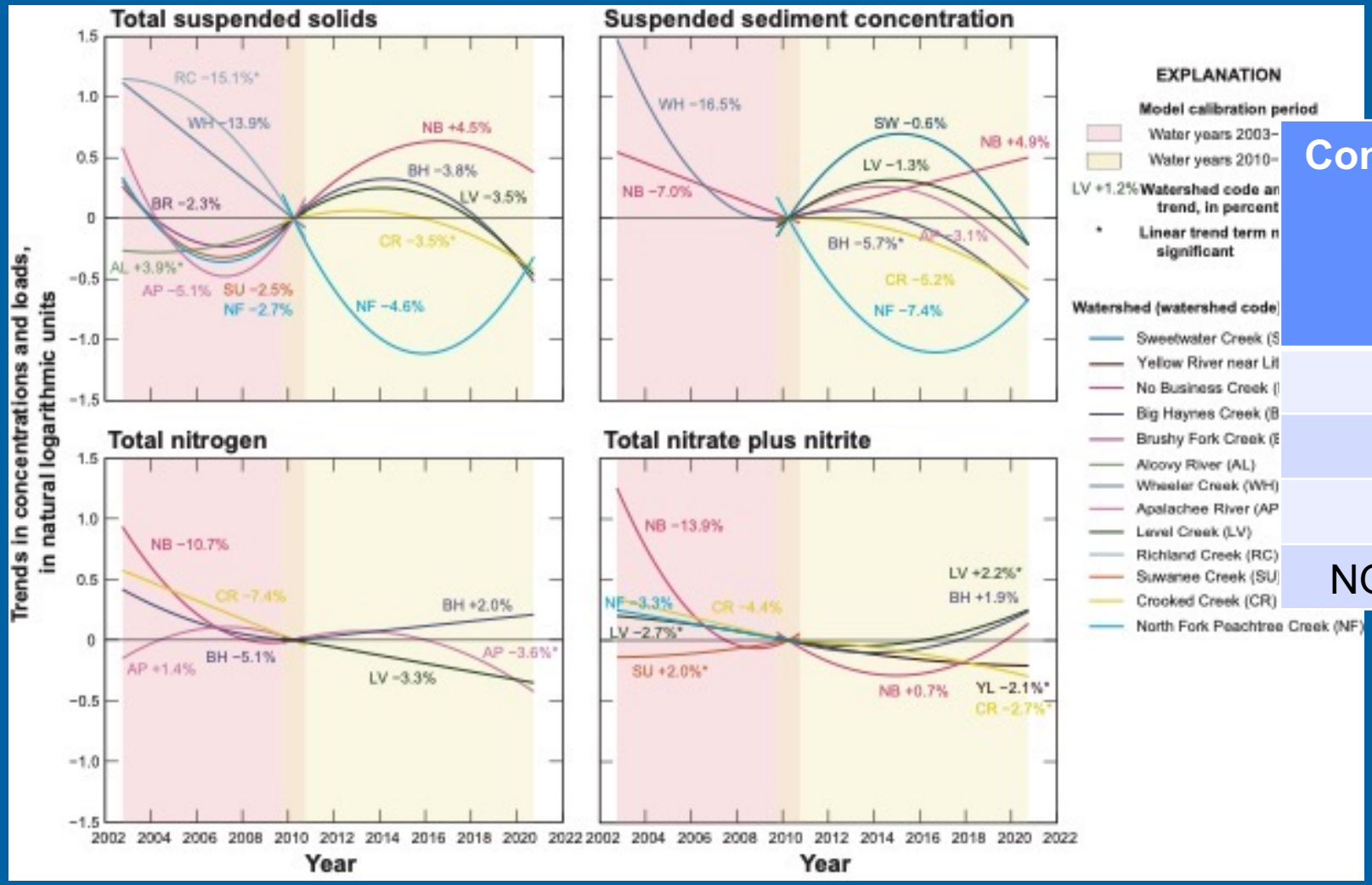
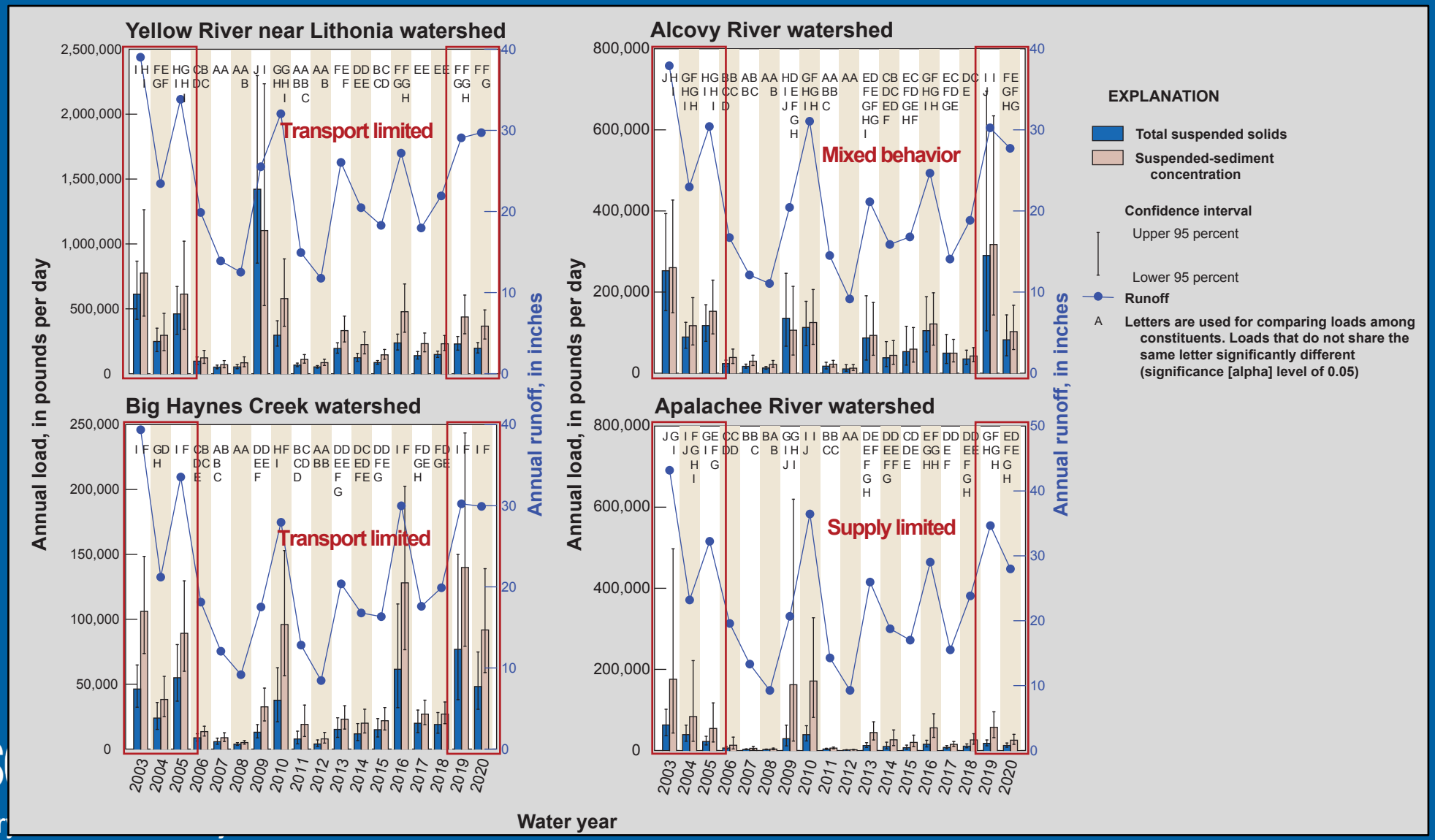
Gwinnett County trends indicated more improvements in water quality despite continued development.



Constituent	WYs 2003–2010		WYs 2010–2020	
	+	–	+	–
TSS	0	5	1	3
SSC	0	2	1	5
TN	1	3	1	1
NO_3+NO_2	0	3	2	0

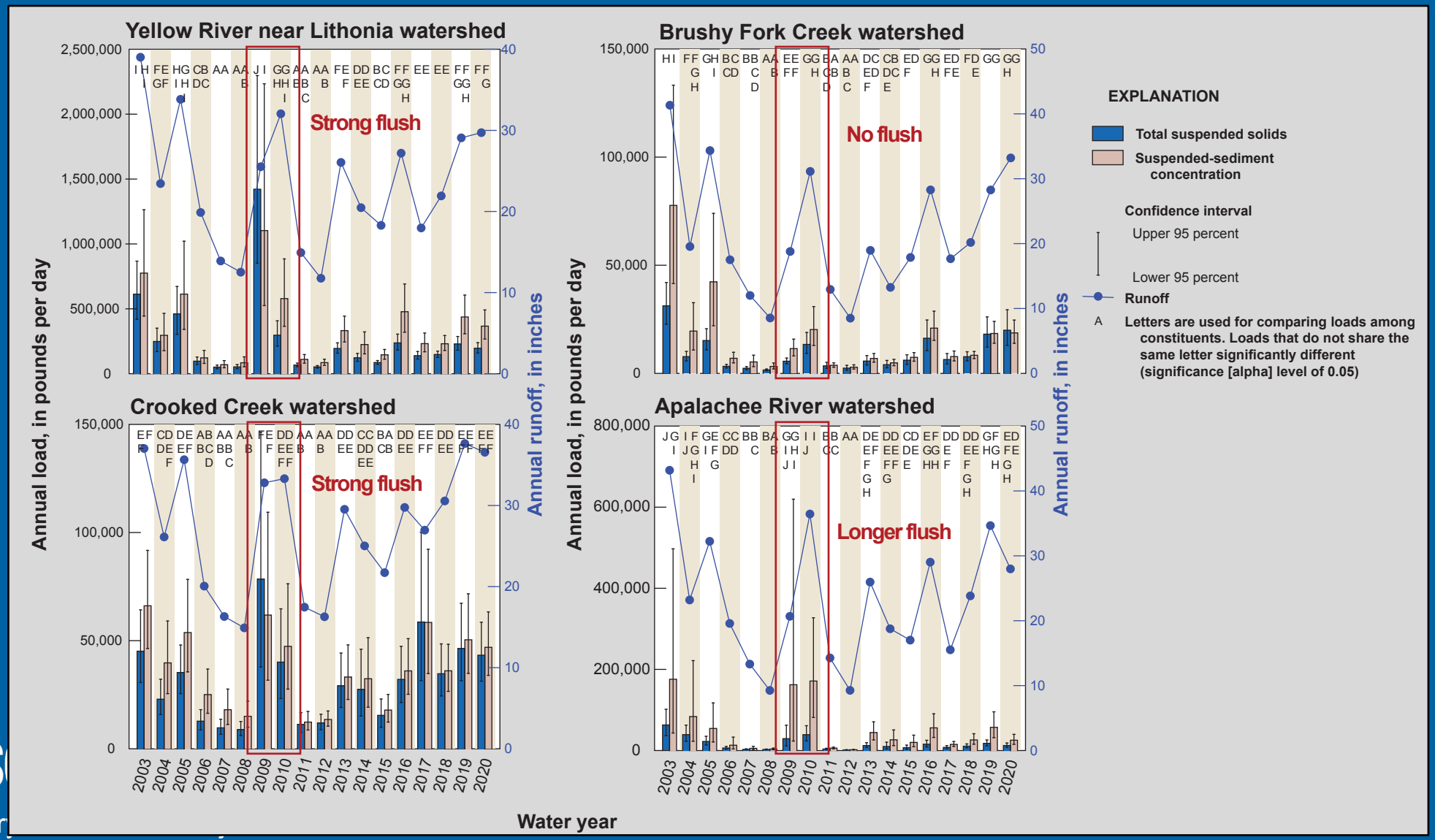
N = 13 watersheds

Gwinnett Co: 8 watersheds transport-limited, 1 supply-limited, 3 mixed behavior.



Preliminar

Gwinnett Co: 6 watersheds show sediment buildup during 2-year drought followed by flushing when wetting up.



Preliminar

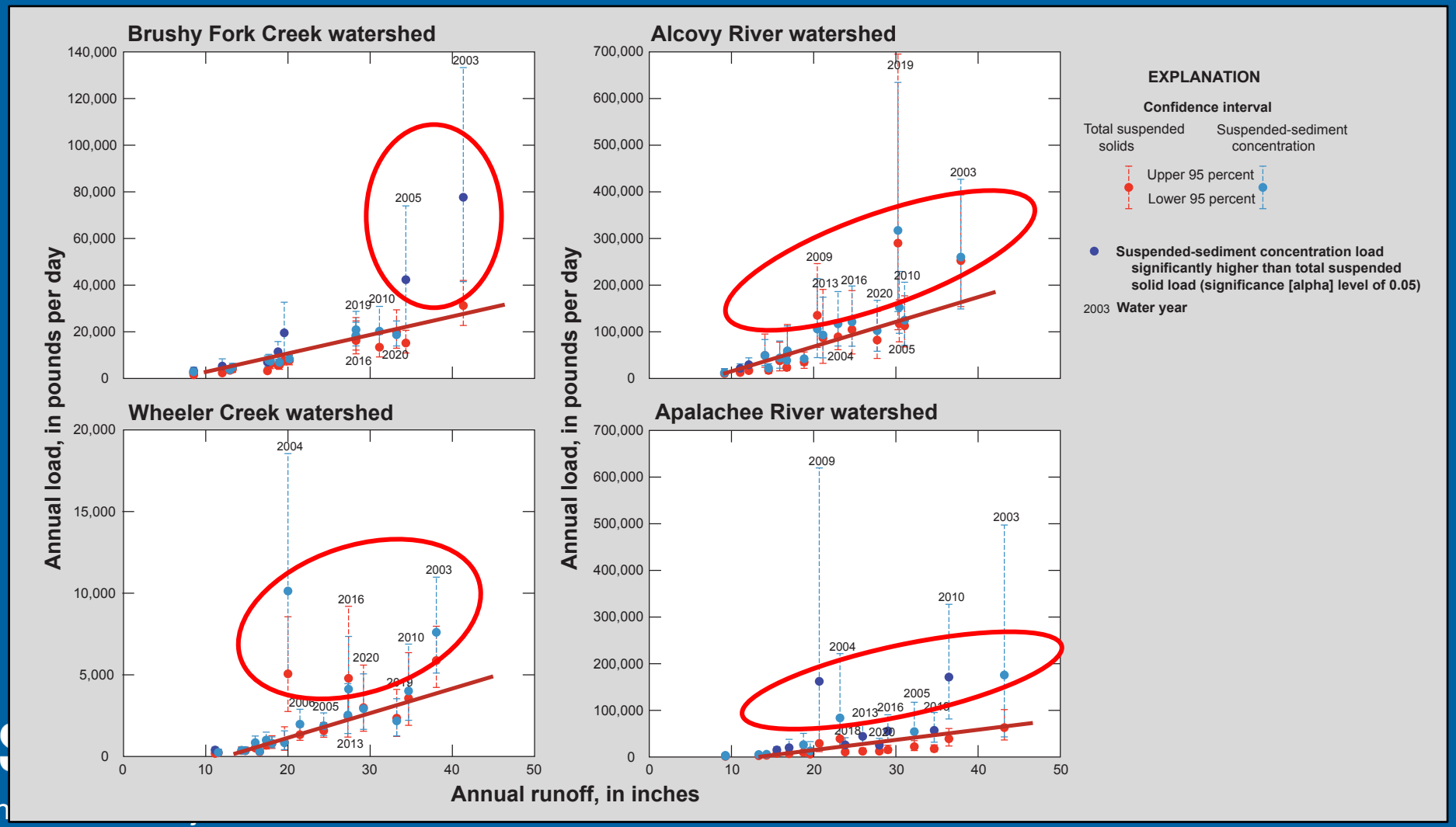
SSC greater than TSS loads indicates a larger coarse-grained fraction of sediment. Not related to an individual watershed characteristic.

- SSC > TSS loads (coarser grained sediment)
  - 4 of 12 Gwinnett Co watersheds
  - 6 of 15 DeKalb Co watersheds
  - Transport requires higher streamflow velocities
  - Short term: active construction near stream channels

Little Stone Mountain Creek

USGS

Almost every watershed exhibited years where either SSC or both TSS & SSC loads were much higher than expected from the annual sediment-runoff relation.



USGS

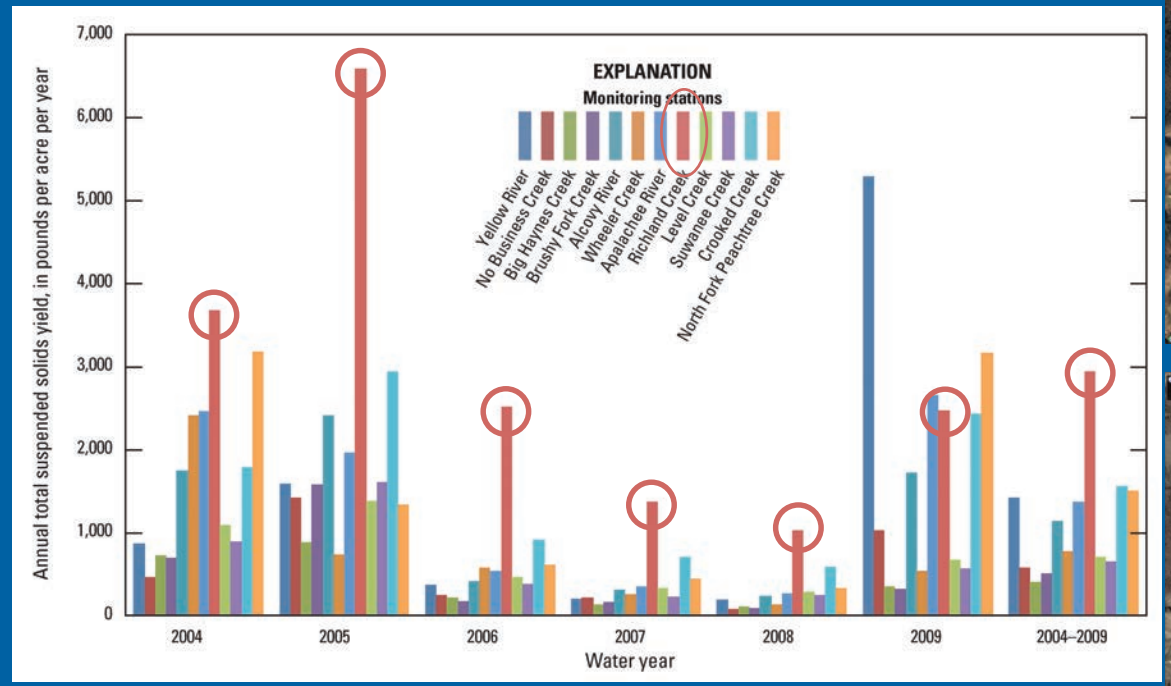
Preliminary In

Greater than half of higher-than-expected annual SSC & TSS loads are associated with years with some of the highest peak flows.

- Identified 33 years with higher-than-expected SSC or TSS loads
  - SSC 22 years (coarse grained sediment; high stream velocities)
  - SSC & TSS 11 years
- 33 of 233 years had peak flow >70% of maximum peak flow for period (15% of years)
- 18 of years with higher-than-expected SSC or TSS loads were associated with years with high peakflows (56% of years)
  - 8 with watershed maximum peak flow
  - 10 >70% of maximum peak flow

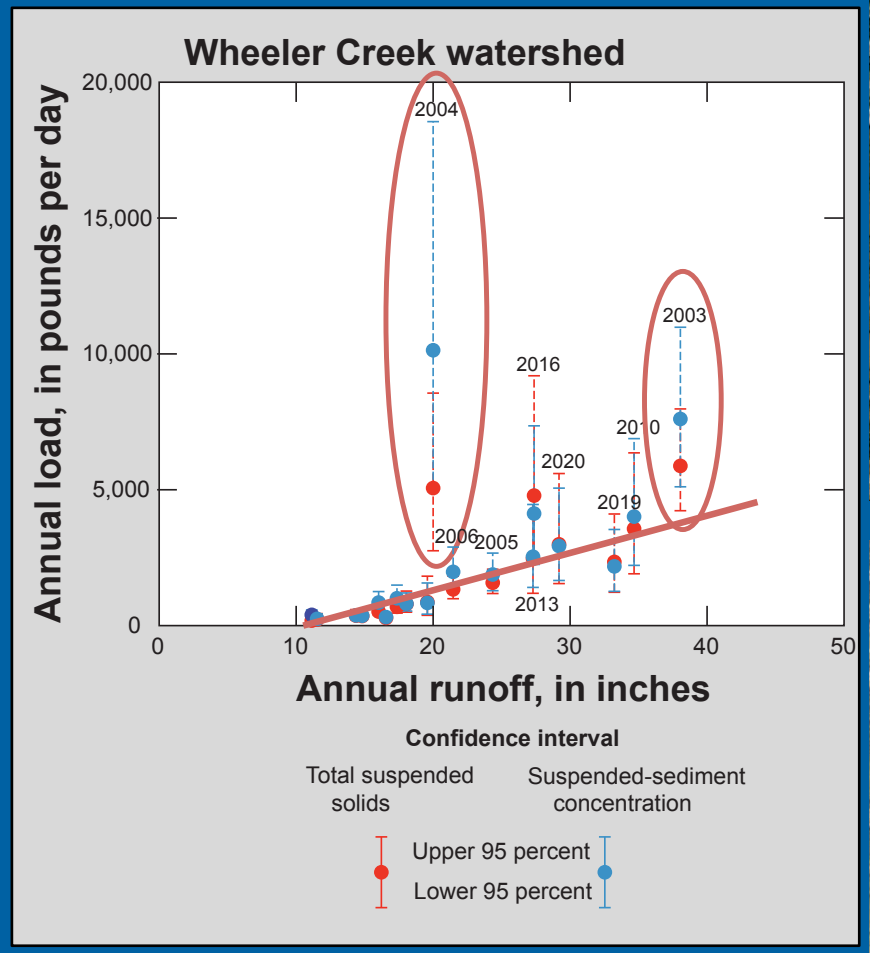
USGS

High TSS yields at Richland Creek watershed appear to be related to construction projects near the stream.



USGS

High sediment loads at Wheeler Creek watershed appear to be related to construction projects near the stream.



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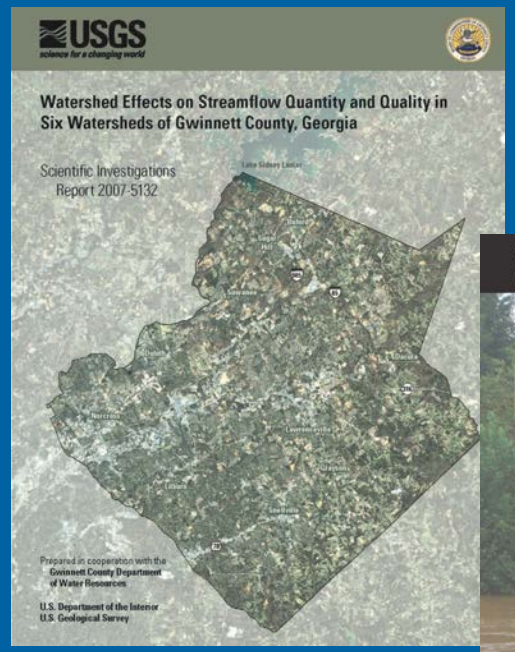
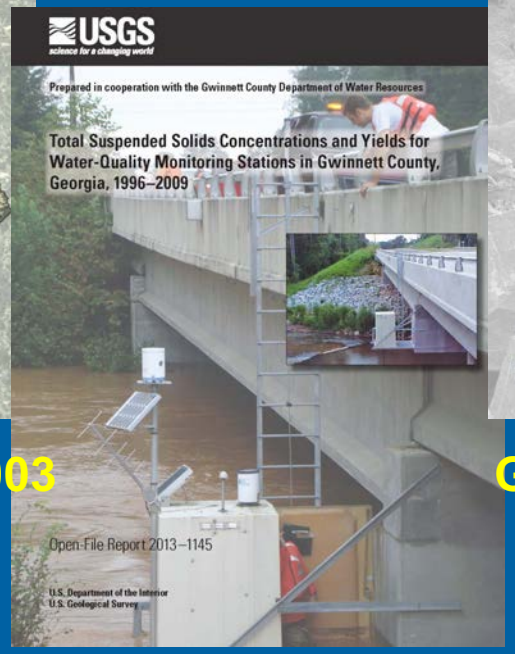
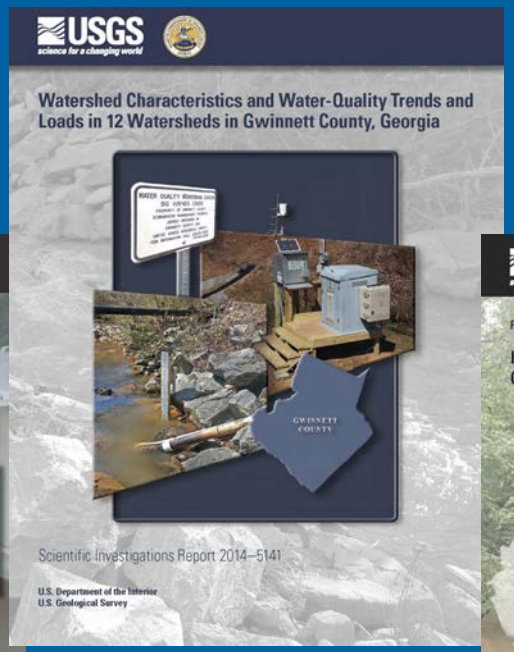
5-year USGS Scientific Investigations Reports



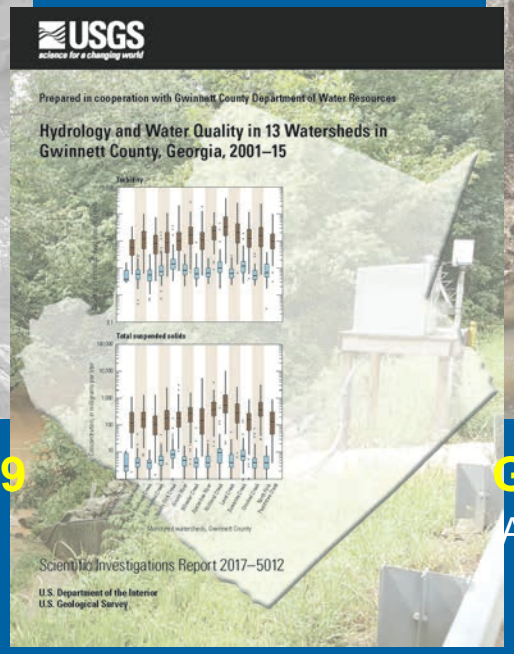
Gwinnett Co 1996–2003
Landers and others, 2007



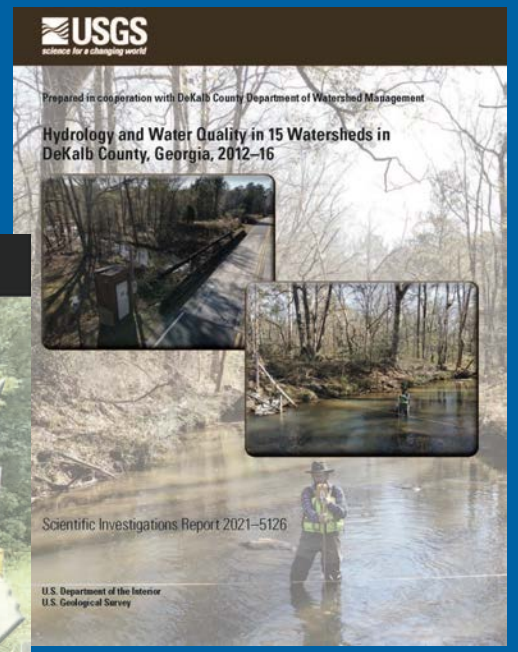
Gwinnett Co TSS 1996–2009
Landers and others, 2013



Gwinnett Co 2004–09
Joiner and others, 2014



DeKalb Co 2012–16
Aulenbach and others, 2022



Gwinnett Co 2001–15
Aulenbach and others, 2017

Gwinnett Co 2002–20
Aulenbach and others, 2023

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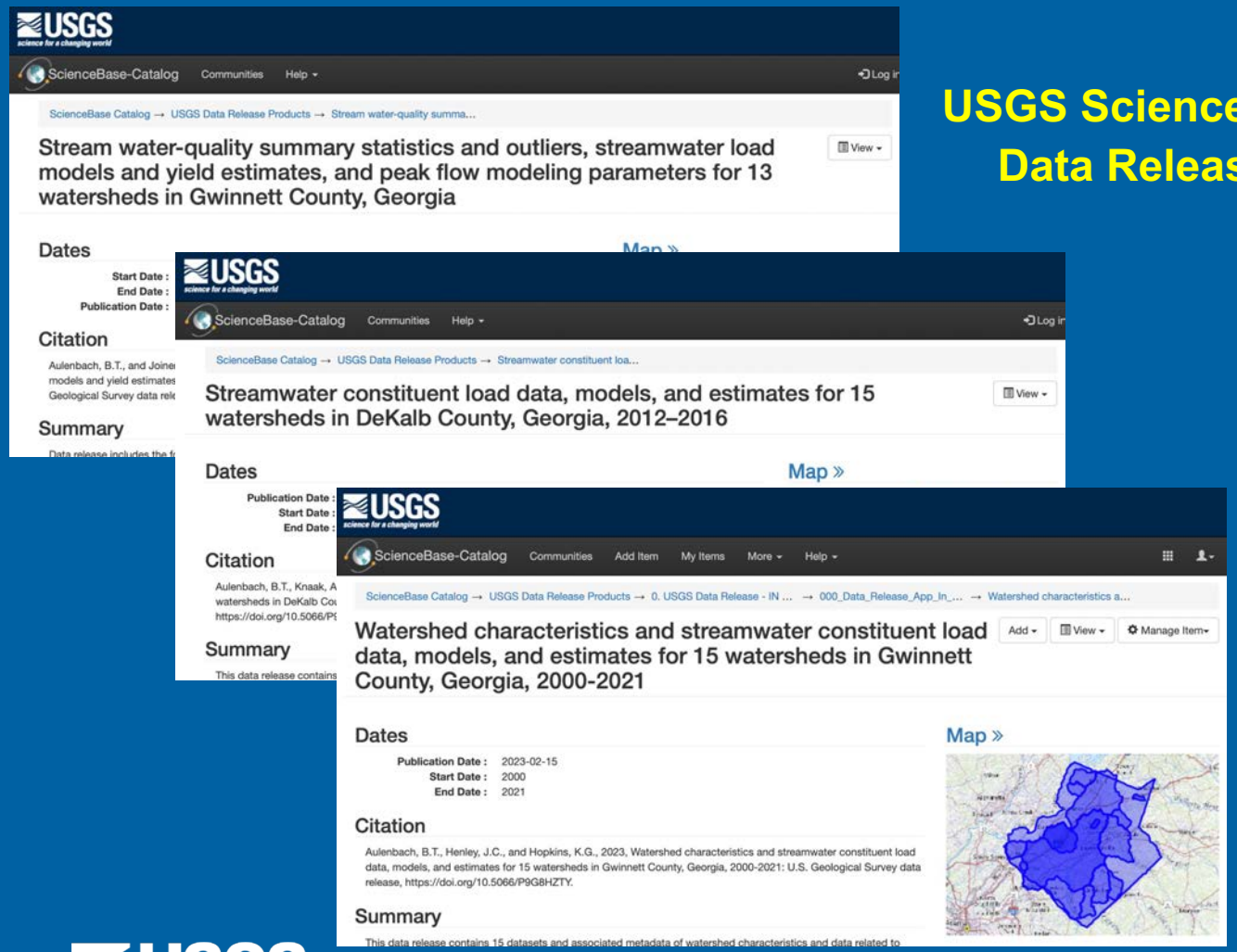
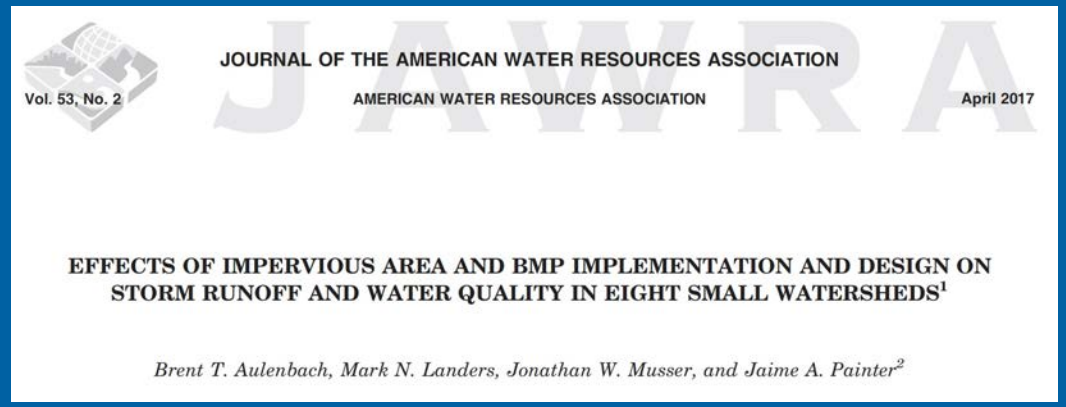
Data releases and other publications



USGS ScienceBase Data Releases



Gwinnett Co BMPs

Aulenbach and others, 2017, JAWRA

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