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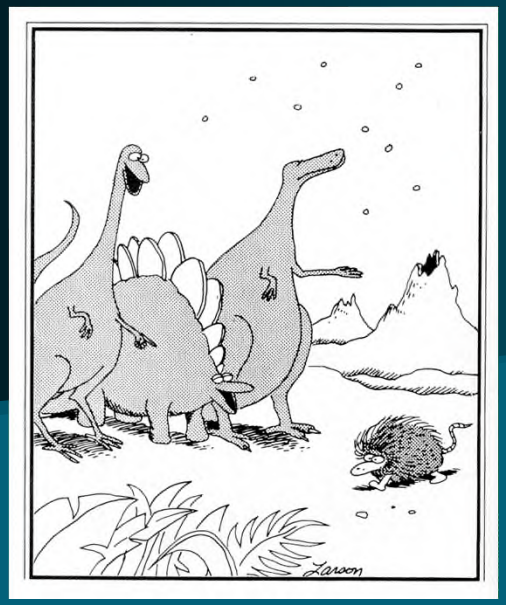
science for a changing world

Triangle Area Water Supply Monitoring Project

Tracking water-quality trends and emerging issues for 25 years



9th National Monitoring Conference
Cincinnati, Ohio, USA
April 30, 2014

Mary Giorgino
U.S. Geological Survey

Triangle Area of North Carolina

- Central NC (Raleigh, Durham, Chapel Hill)
- Cape Fear and Neuse River basins

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The story begins in 1988

- Drought + rapid growth
- Increasing water demand
- New nutrient controls


Photo by Orange Water And Sewer Authority

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Local governments

- Shared interest in protecting source-water quality
- Partnered with the USGS
- Currently 9 local partners

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Logistics

- Monitoring network of lakes and streams
  - Surveillance of key water-quality constituents
  - Streamflow gages
  - Support analysis of trends and loads
  - Document changes associated with management actions
- Special studies targeting emerging issues

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TAWSMP network has provided data & interpretation for


Little River Reservoir

- Streamflow
- Physical properties
- Nutrients
- Major ions
- Metals
- Chlorophyll *a*
- Total organic carbon
- Suspended sediment
- *Cryptosporidium* and *Giardia*
- Pesticides, PAHs and PCBs
- Emerging contaminants
- Cyanotoxins, T&O compounds

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Trends

- Land cover
- Population
- Instream concentrations of selected water-quality constituents

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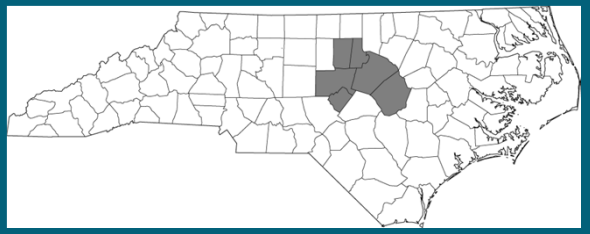
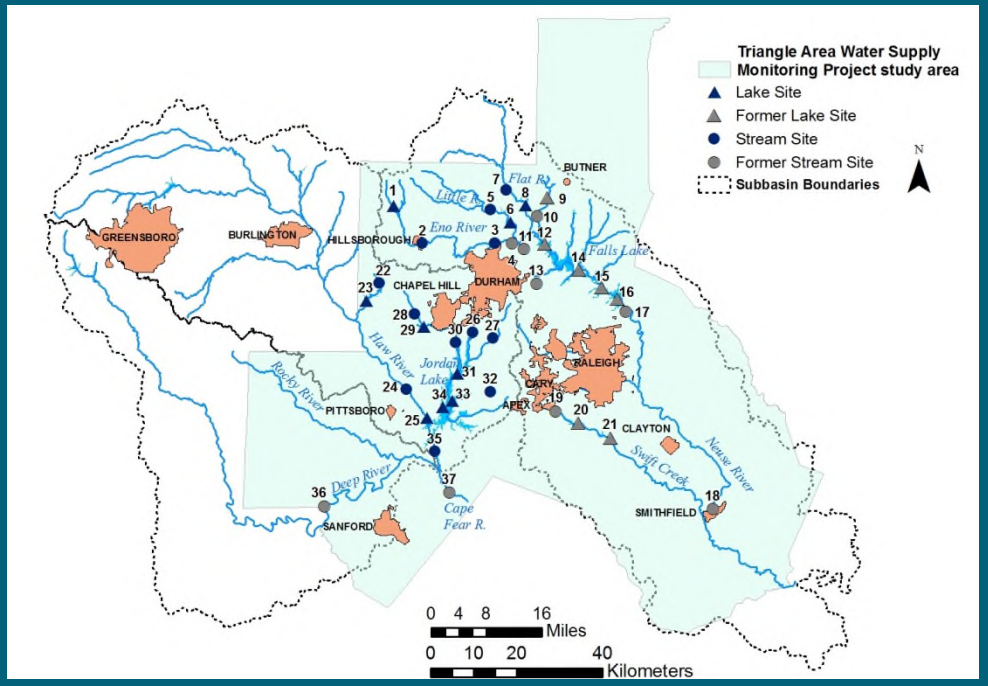
Sites selected for trend analysis

- 12 ***stream*** sites with gages, including 8 co-monitored by NCDENR
- 9 ***lake*** sites
- Sampled 4 to 6 times per year





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Trends in Land Cover

- Developed, Agricultural, and Forested/Other
- Land cover datasets
  - Mid-1970's GIRAS
  - 1992 NLCD
  - 2001 NLCD
  - 2006 NLCD
- Discrepancies in classifications among datasets can lead to misinterpretation

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Developed Land

Unlikely pattern

% Developed increased at all sites, especially after 1992

34%

31%

Provisional data, subject to revision

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USGS Station name	1970s GIRAS	1992 NLCD	2001 NLCD	2006 NLCD
Eno River at Hillsborough	9%	6%	12%	12%
Eno River near Durham	15%	10%	17%	17%
Little River near Orange Factory	1%	1%	6%	6%
Little River Reservoir	2%	2%	7%	7%
Flat River at Bahama	3%	3%	6%	6%
Lake Michie	3%	3%	6%	6%
Cane Creek near Orange Grove	0%	0%	4%	4%
Cane Cr Reservoir	0%	0%	5%	5%
Haw River near Bynum	13%	11%	18%	18%
Jordan Lake, Haw River Arm	13%	11%	18%	18%
New Hope Creek near Blands	24%	23%	39%	41%
Northeast Creek near Genlee	23%	29%	55%	57%
Morgan Creek near White Cross	2%	2%	5%	5%
University Lake	2%	3%	7%	7%
Morgan Creek near Farrington	13%	11%	19%	19%
Jordan Lake at Buoy 12	17%	17%	31%	33%
White Oak Cr near Green Level	2%	1%	27%	33%
Jordan Lake above US Hwy 64	14%	14%	28%	30%
Jordan Lake at Bells Landing	0%	0%	4%	4%
Haw R below Jordan Dam	12%	11%	19%	20%
Cape Fear River at NC Hwy 42	10%	8%	15%	16%

Trends in Population

- 1990, 2000, and 2010 Census data were compiled for each site's watershed
- Population increased in all monitored watersheds from 1990-2010

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Population change, 1990-2010

- Minimum: 27%
- Median: 45%
- Maximum: 915%

USGS Station name	Percent change 1990-2010
Eno River at Hillsborough	27
Eno River near Durham	35
Little River near Orange Factory	40
Little River Reservoir at Dam	36
Flat River at Bahama	53
Lake Michie at Dam	55
Cane Creek near Orange Grove	48
Cane Cr Reservoir at Dam	40
Haw River near Bynum	40
Jordan Lake, Haw River Arm	40
New Hope Creek near Blands	33
Northeast Creek 1100 near Genlee	89
Morgan Creek near White Cross	35
University Lake	45
Morgan Creek near Farrington	42
Jordan Lake at Buoy 12	62
White Oak Cr near Green Level	915
Jordan Lake above US Hwy 64	72
Jordan Lake at Bells Landing	159
Haw R below Jordan Dam	53
Cape Fear River at NC Hwy 42	49

Provisional data, subject to revision

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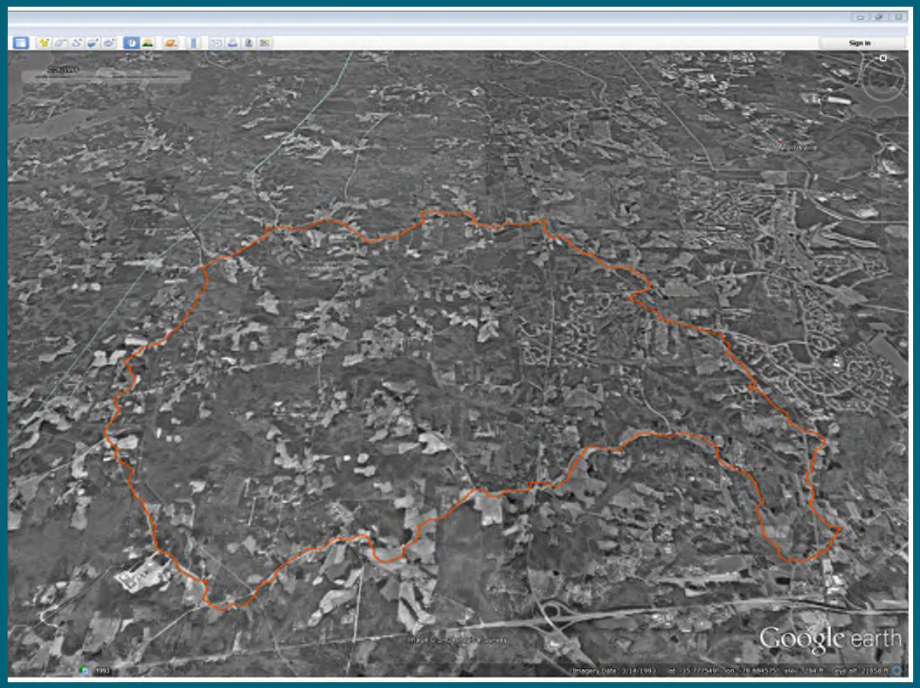
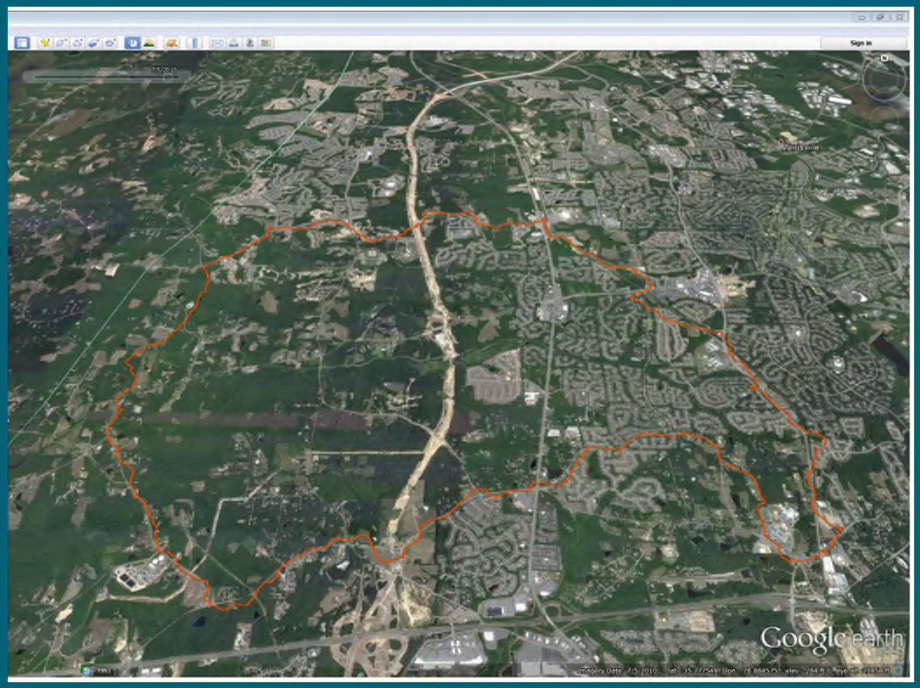
White Oak Creek
station number 0209782609

Imagery: 2/26/1994 **7/5/2010**





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Trends in Water Quality

- Seasonal Kendall test for monotonic trends (and associated risks for interpretation)
- Concentrations in lakes (near surface)
- Flow-adjusted concentrations in streams

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"Significant" WQ trends

PRELIMINARY TREND RESULTS; SUBJECT TO REVISION

Lakes

USGS No.	Lake Sites	Secchi	pH	Cond	Ca	K	Na	Cl	SO4	DS	TKN	NH3	NOX	PO4	TP	Chla	Fe	Mn	Zn
0208524845	Little River Reservoir at Dam near Bahama, NC																		
02086490	Lake Michie at Dam near Bahama, NC																		
0209684980	Cane Cr [illegible] hite Cross, NC																		
02096999	Jordan La[illegible] aw [illegible] ver [illegible] ear Hanks Chapel, NC																		
02097499	Un[illegible], Lake at Intakes nr Chapel Hill, NC																		
0209768310	Jordan Lake at Buoy 12 at Farrington, NC																		
0209799150	Jordan Lake above U.S. Highway 64 near Wilsonville, NC																		
0209801100	Jordan Lake at Bells Landing near Griffins Crossroads, NC																		

Streams

USGS No.	USGS Stream Sites Sites	Secchi	pH	Cond	Ca	K	Na	Cl	SO4	DS	TKN	NH3	NOX	PO4	TP	Chla	Fe	Mn	Zn
02085000	Eno River at [illegible] N																		
0209684[illegible]	[illegible] eek [illegible] ar [illegible] ge Grove, NC																		
0209746[illegible]	[illegible] an [illegible] reek near White Cross, NC																		
0209782[illegible]	White Oak Cr at mouth near Green Level, NC																		

	Upward trend
	Downward Trend

Period varies: 1989-2012, 1991-2013, 2000-2012

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Provisional data, subject to revision

Which trends are "real?"

- Inevitable that changes will occur in field collection, sample processing, or analytical techniques
- Prudent to assume that detected trends are due to method changes

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Methods for NO_2+NO_3

Constituent	NWIS Method code	USGS method ID	Period of record	Reporting level	Analytical method
Dissolved nitrite plus nitrate, in mg/L as N (parameter code 00631)	CL045	I-2545-90	1988-1991	0.1	Cadmium reduction-diazotization, ASF, colorimetry
			1991-1994	0.05	Cadmium reduction-diazotization, ASF, colorimetry
	CL048	I-2545-90	1994-1996	0.05	Cadmium reduction-diazotization, ASF, colorimetry, dropped HgCl preservative
	CL050	I-2546-91	1996-2011	0.005 - 0.016	Cadmium reduction-diazotization, ASF, colorimetry, low-level
	RED02	I-2548-11	2011-present	0.01	Enzyme reduction-diazotization, DA, colorimetry, low-level

- Methods and reporting levels changed
- Method code is stored in NWIS with each result

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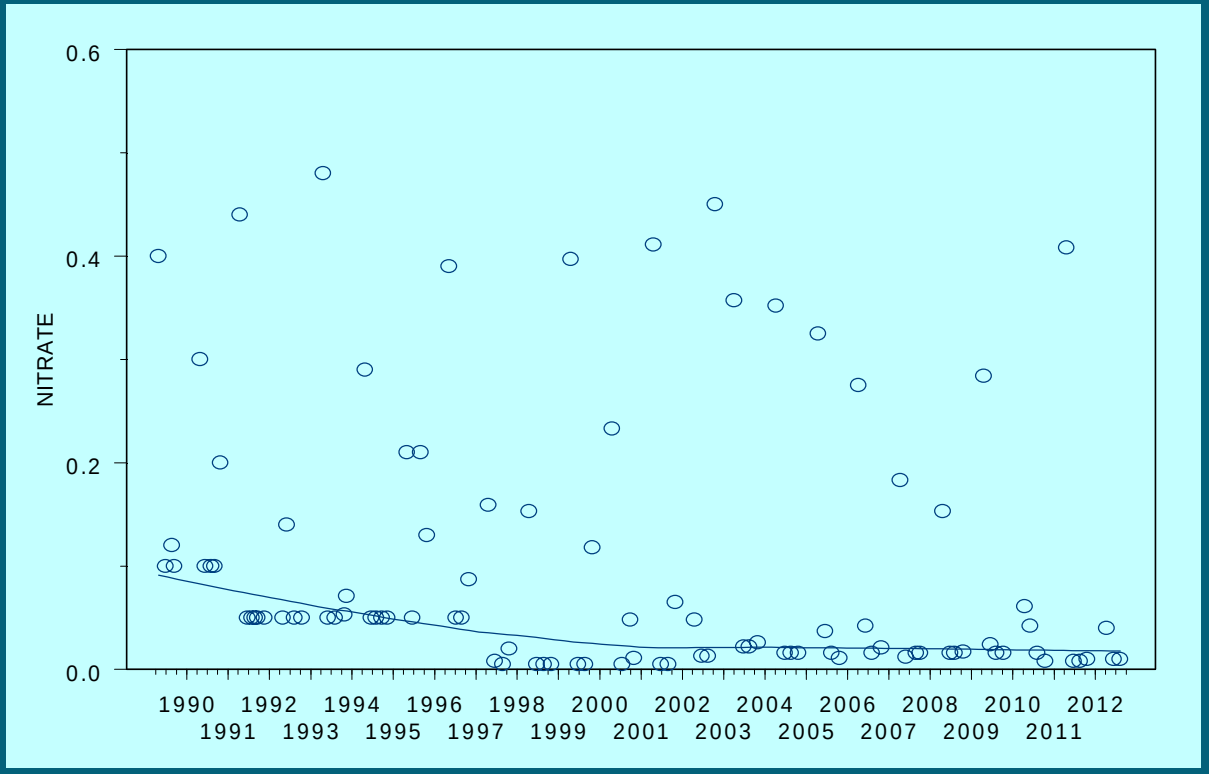
Trend in NO_2+NO_3? Lake Example

- Artifact of reporting level changes
- Inappropriate test – 50% censored values

RL = 0.10
RL = 0.05
RL = 0.01



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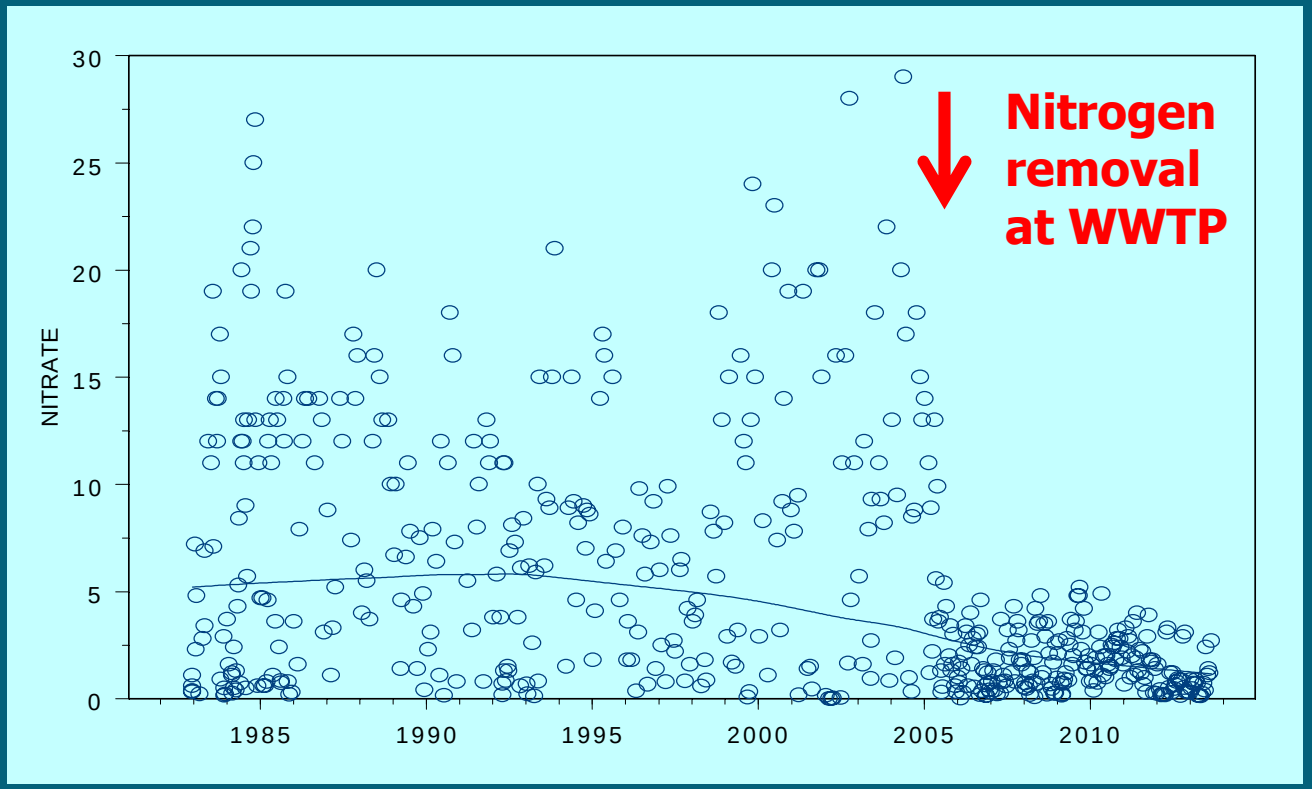
Trend in NO_2+NO_3? Stream Example

- Concentrations well above RL
- Step trend—not a monotonic trend



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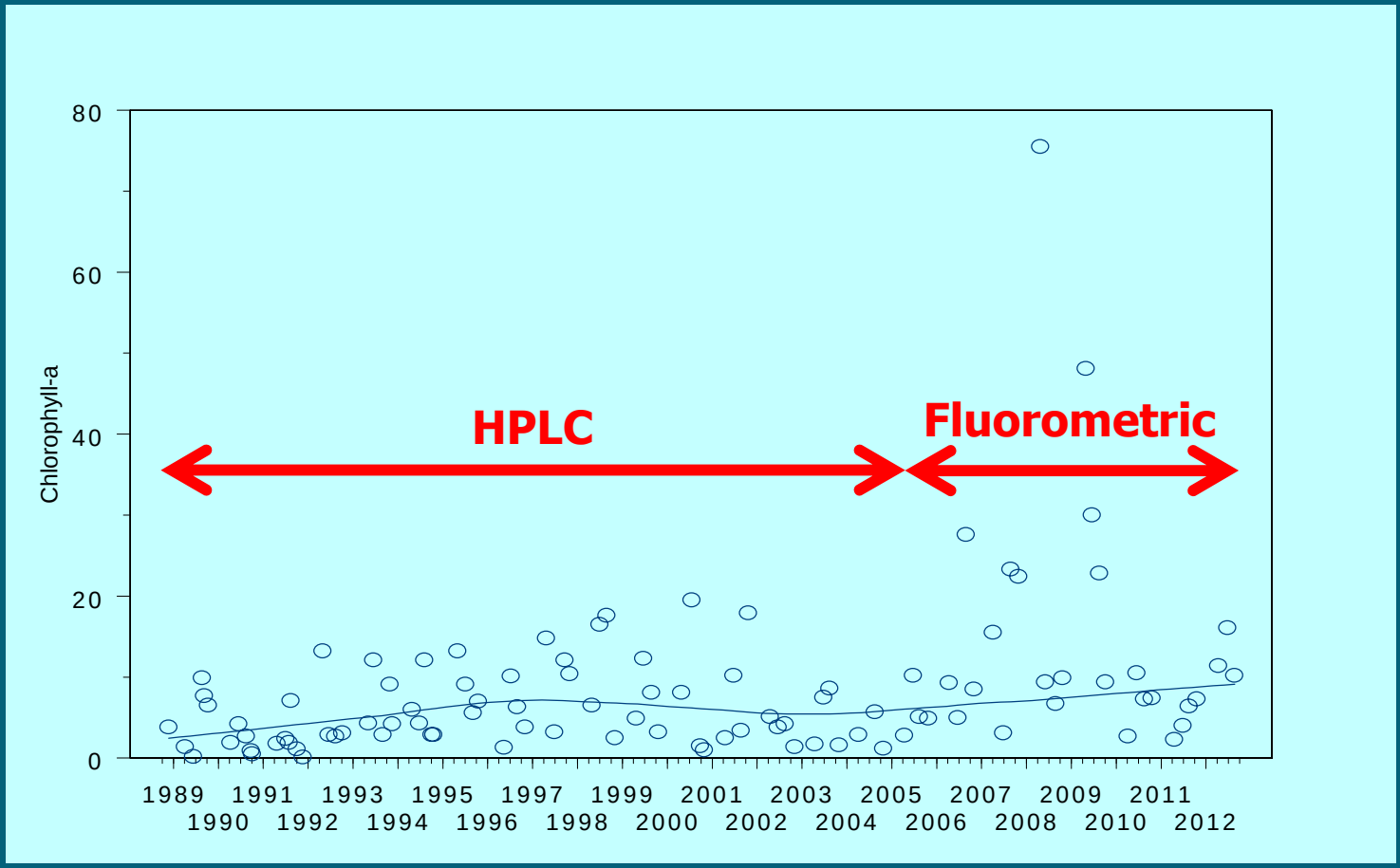
Chlorophyll *a* - Little River Reservoir

- Another example of method change



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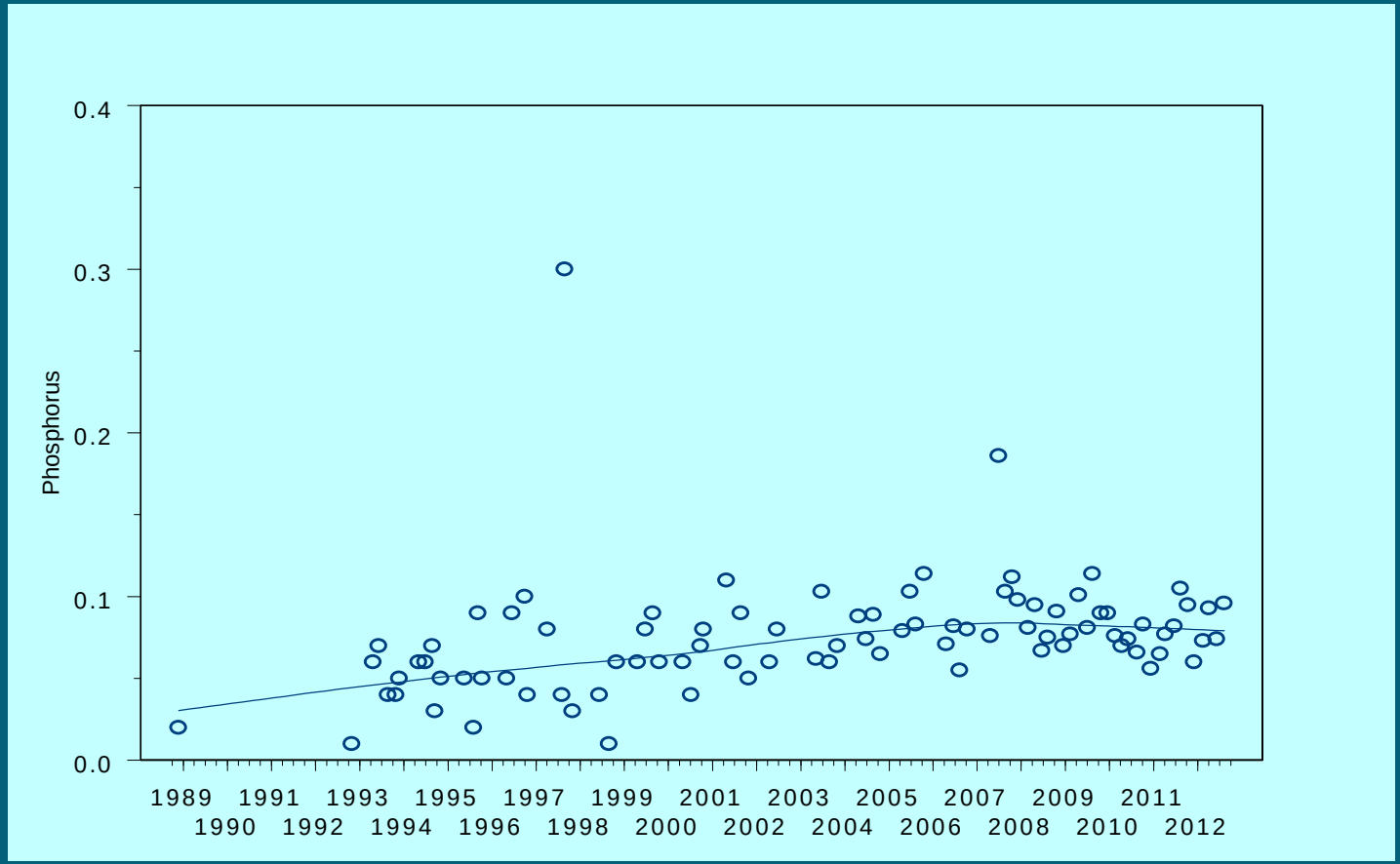
Real trend in phosphorus

- Total P (mg/L) at Jordan Lake Buoy 12



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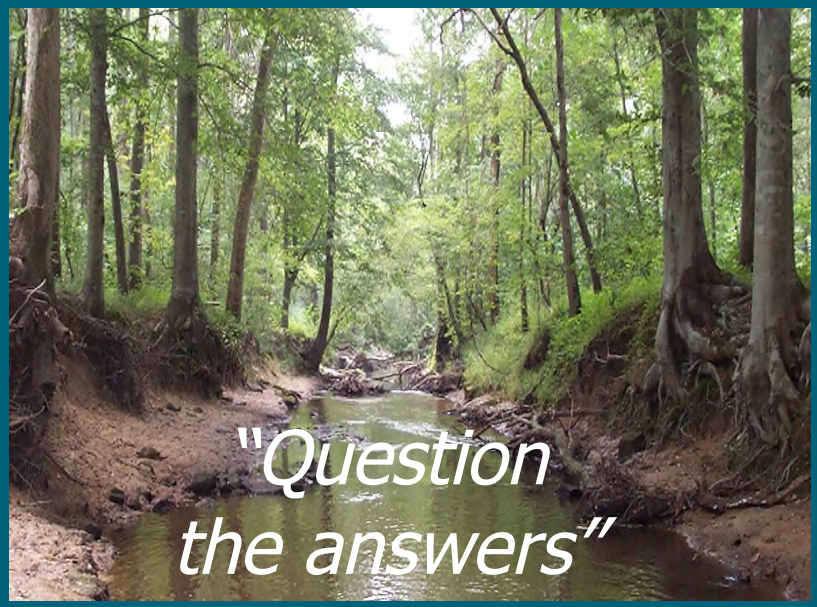
Closing thoughts

- Analysis of trends in WQ is challenging but worthwhile
- Keys to success are familiarity with
  - Data quality
  - Sampling and analytical methods
  - Study area
  - Underlying science
  - Statistical techniques



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For more information

- Triangle Area Water Supply Monitoring Project: http://nc.water.usgs.gov/projects/triangle/
- Mary Giorgino: giorgino@usgs.gov

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