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Salinization Trends in Water-Supply Lakes and Streams in the Triangle Area of North Carolina

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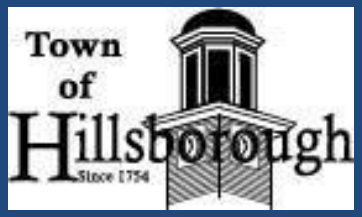
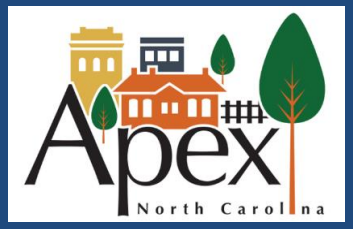
Triangle Area Water Supply Monitoring Project Partners





Giorgino, M.J., Cuffney, T.F., Harden, S.L., and Feaster, T.D., 2018, Trends in water quality of selected streams and reservoirs used for water supply in the Triangle area of North Carolina, 1989–2013: U.S. Geological Survey Scientific Investigations Report 2018–5077, 67 p., https://doi.org/10.3133/sir20185077

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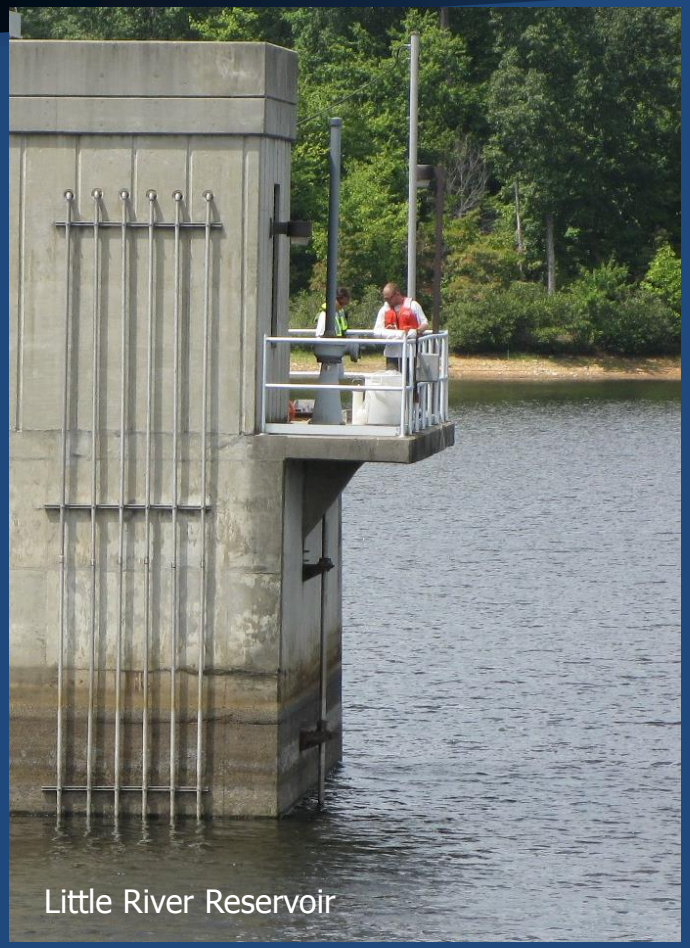
Since 1988, the project has tracked


Little River Reservoir

- Streamflow
- Field parameters
- Major ions
- Nutrients and TOC
- Metals
- Chlorophyll *a*
- Suspended sediment
- *Cryptosporidium* and *Giardia*
- Pesticides, PAHs and PCBs
- Emerging contaminants
- Cyanotoxins and T&O

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Why conduct a regional comparison of temporal trends in water quality?

- Urbanization continues to increase demand for drinking water while altering hydrology, water quality, and treatment costs
- Understanding WQ changes informs decisions about managing water resources
- Robust, long-term datasets are available

The USGS analyzed trends for the 25-year period 1989-2013.

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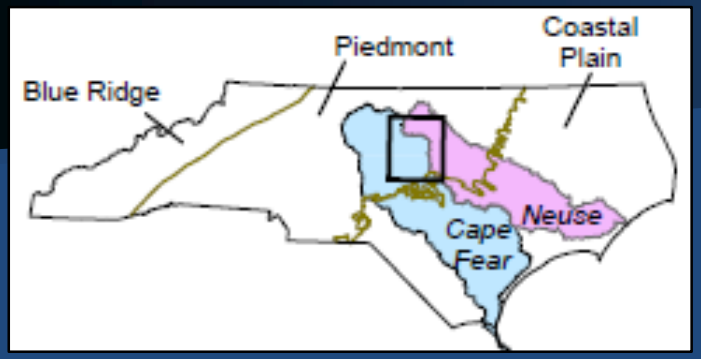
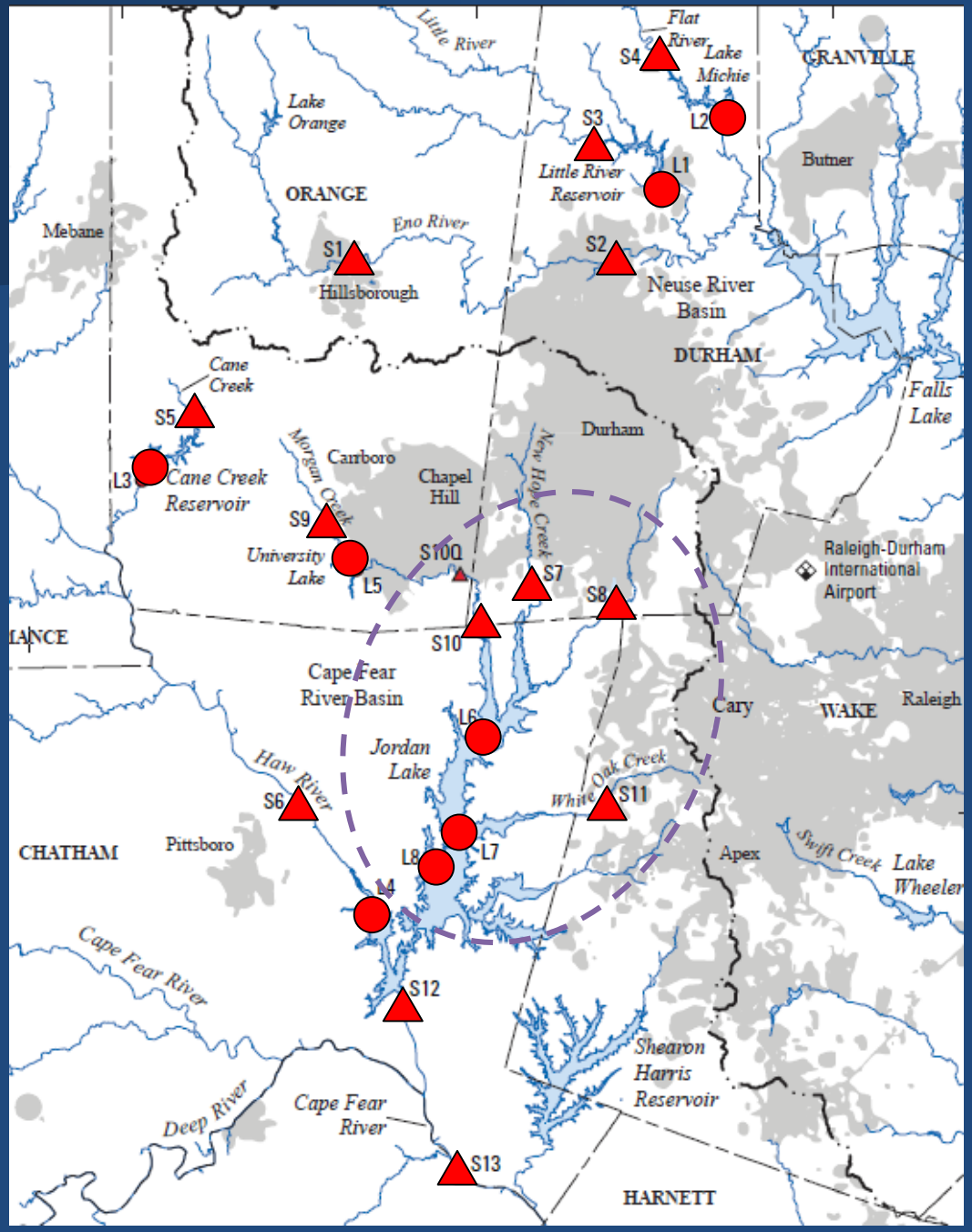
21 Trend Sites



- 13 Stream sites
  - 4 USGS only
  - 9 multiple agencies
- 8 Lake sites
  - 4 small lakes
  - 4 in Jordan Lake



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TRENDS: POPULATION AND LAND COVER

DATA SOURCES:

- StreamStats
- U.S. Census Bureau
- National Land Cover Datasets

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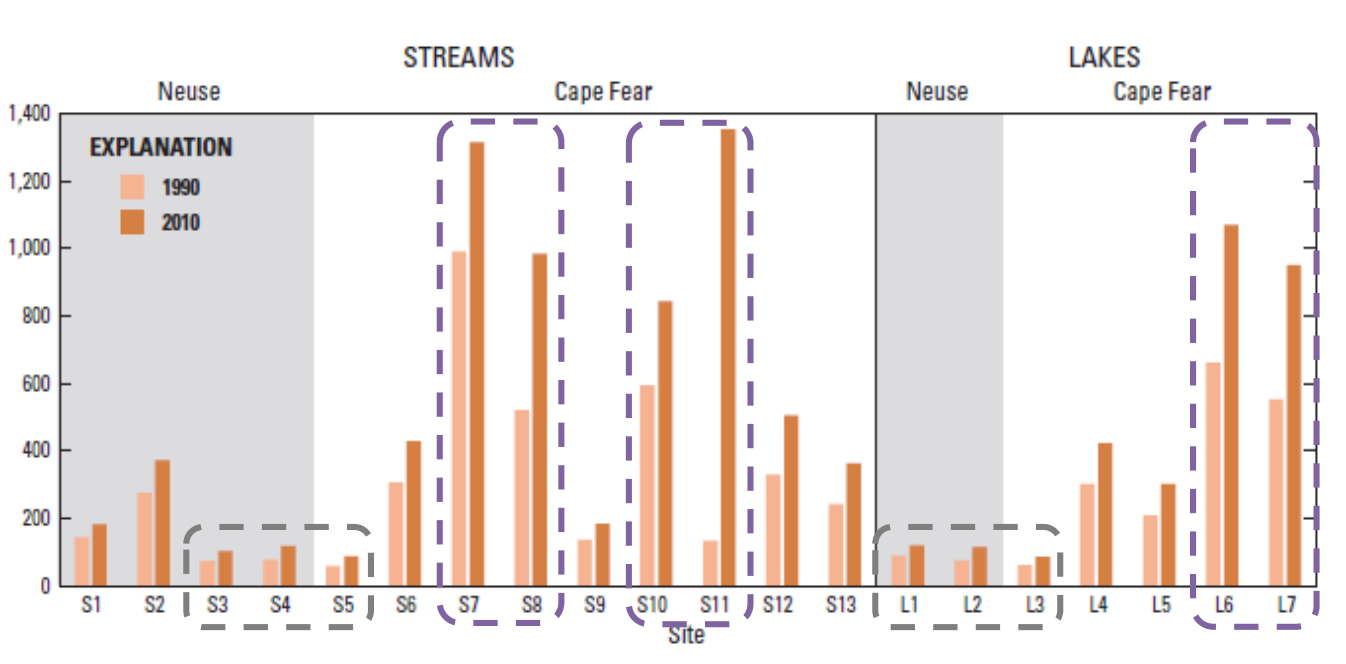
Population Density by Watershed

- Increased at all sites, from 26% to 919%
- Lowest upstream from 3 small lakes
- Highest in the New Hope arm of Jordan Lake

People per square mile, 1990 and 2010



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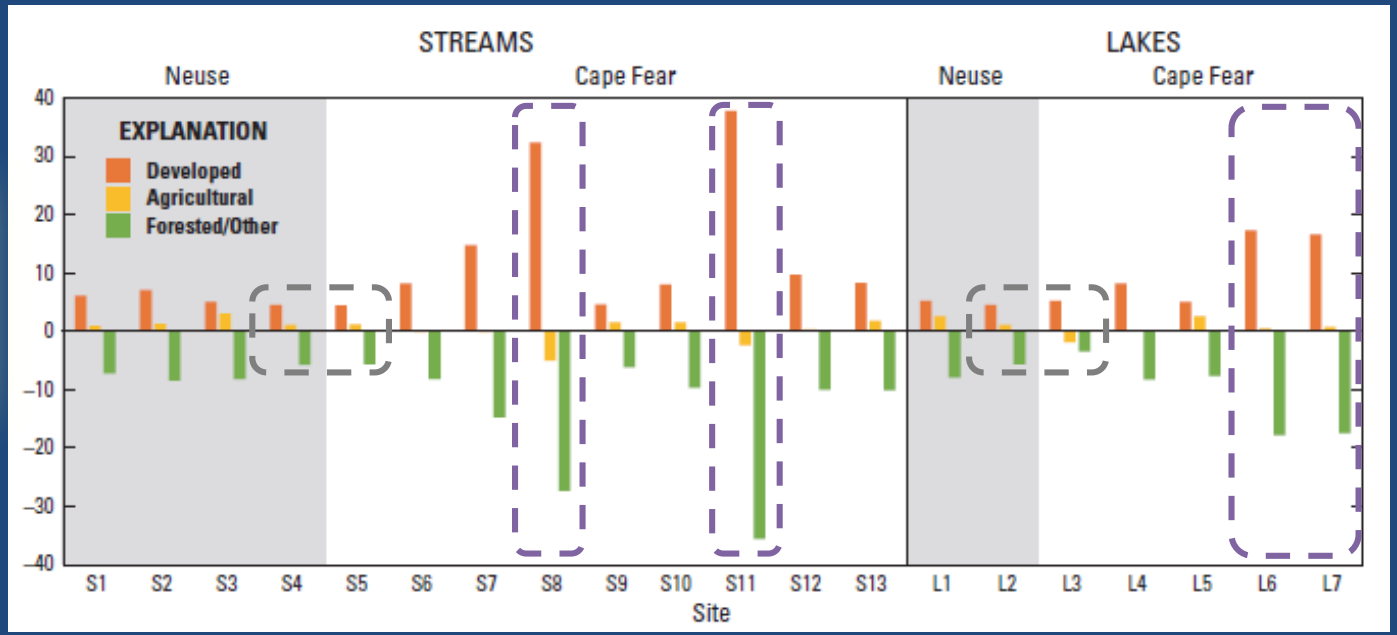
Land Cover by Watershed

- 1992 and 2011 classes aggregated into Developed, Agricultural, and Forested/Other
- Developed ↑ and Forested ↓
  - Least change in rural watersheds of 2 small lakes
  - Greatest change in two watersheds of Jordan' s New Hope arm

Percent change for aggregated land-cover categories



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TRENDS: WATER-QUALITY CONCENTRATIONS

DATA SOURCES:

- NC Dept. of Environmental Quality
- Upper Cape Fear RBA
- Middle Cape Fear RBA
- USGS

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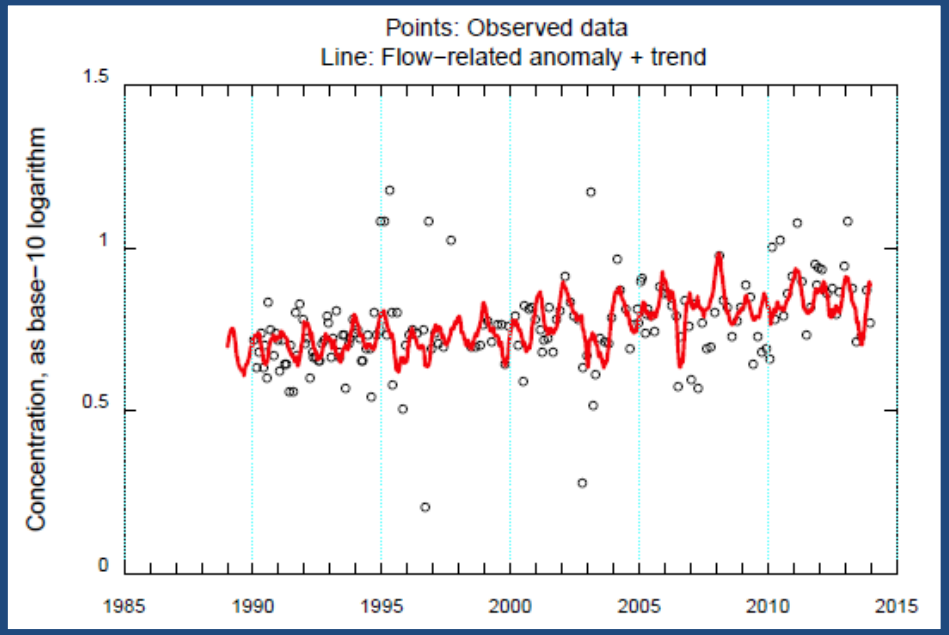
QWTREND Time-Series Analysis

- Time-series trend model that accounts for daily, seasonal, and annual variations in streamflow
- Complex non-monotonic and step trends
- Accounts for serial correlation and data gaps



Developed by
Skip Vecchia, USGS

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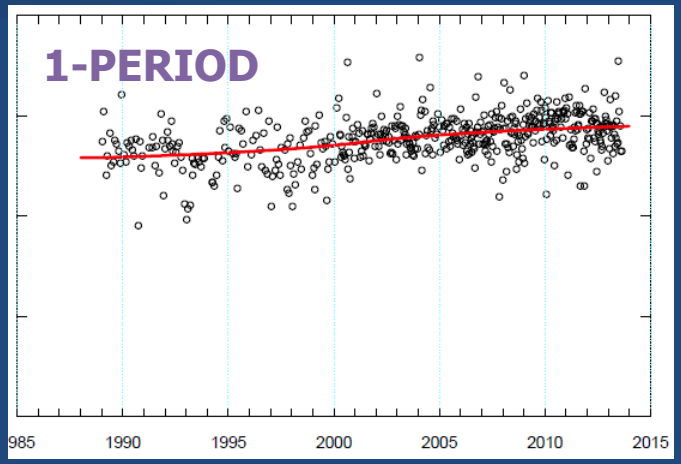
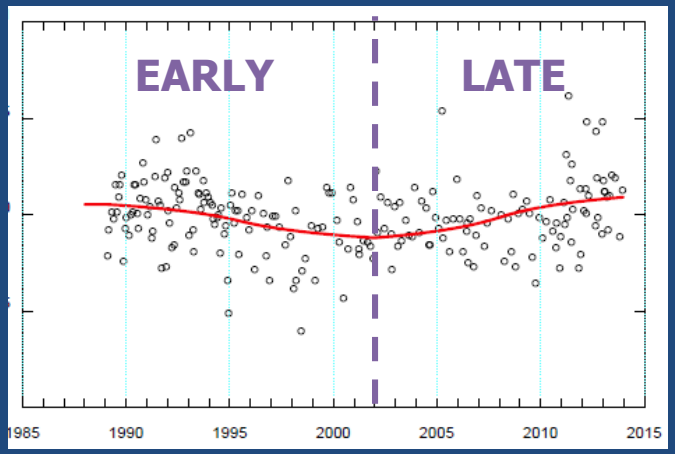
Triangle Area QWTREND Models

- Multiple trend models for each Site/Constituent pair
  - Null, "no trend"
  - 1-period, 1989-2013
  - 2-period, "Early/Late" hinged at 2002
- Best-fit model selected





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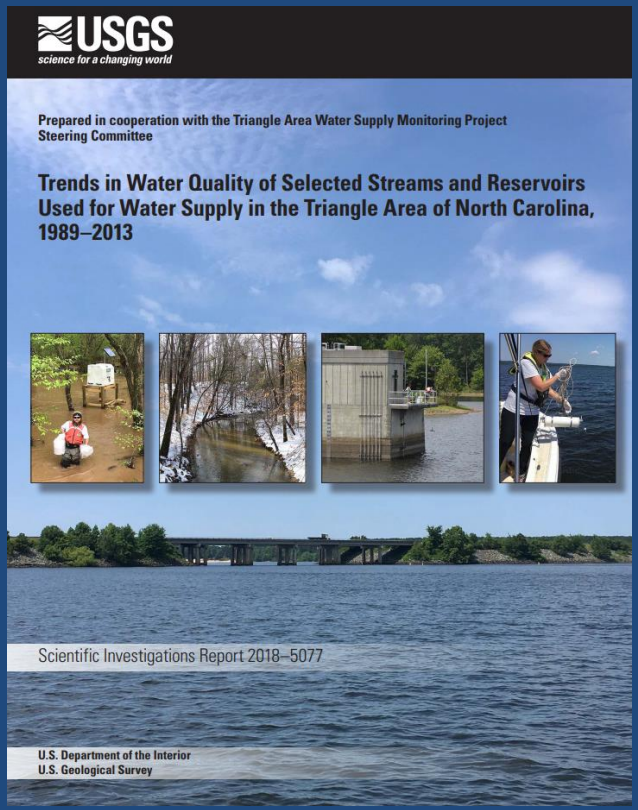
17 Water-Quality Constituents

- Specific conductance and major ions
- Nutrients
- Suspended sediment and solids
- Secchi and chlorophyll *a*



Giorgino et al., 2018 ,
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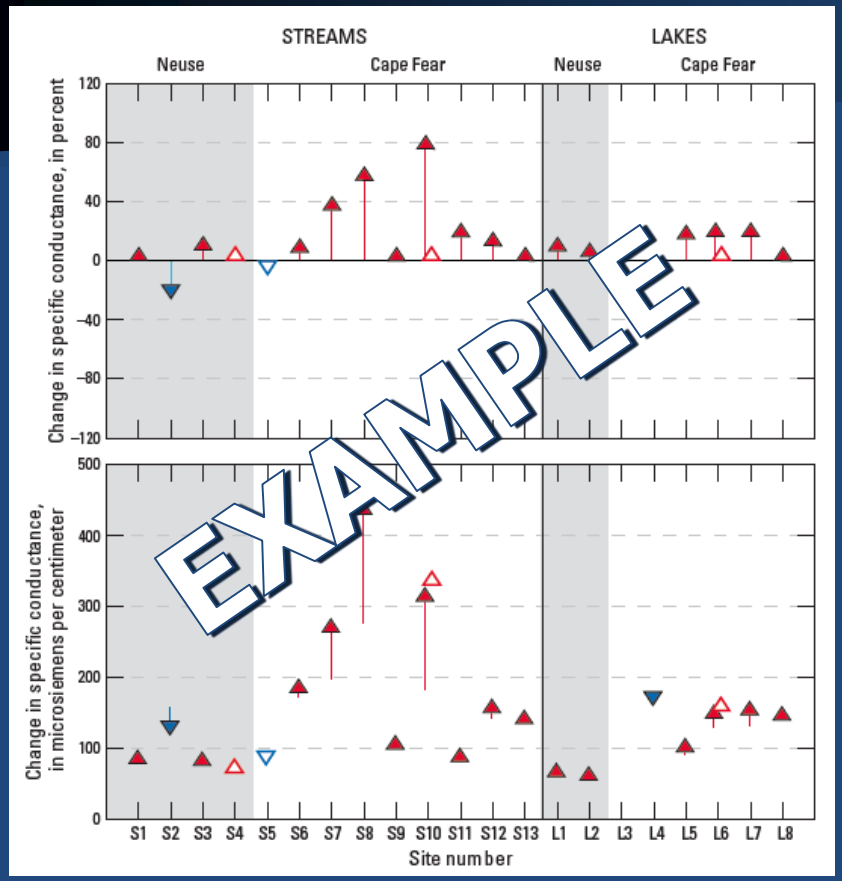
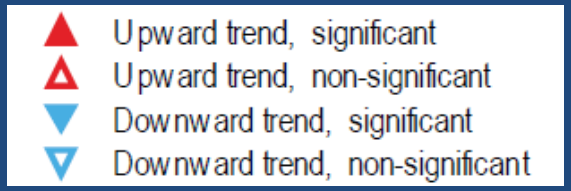
Regional Trend Plots





- Arrows = change from first to last year in period
  - Percent (top)
  - Concentration (bottom)
- Best-fit model
  - Single arrow: 1989-2013
  - Side-by-side arrows: 2-period, Early/Late

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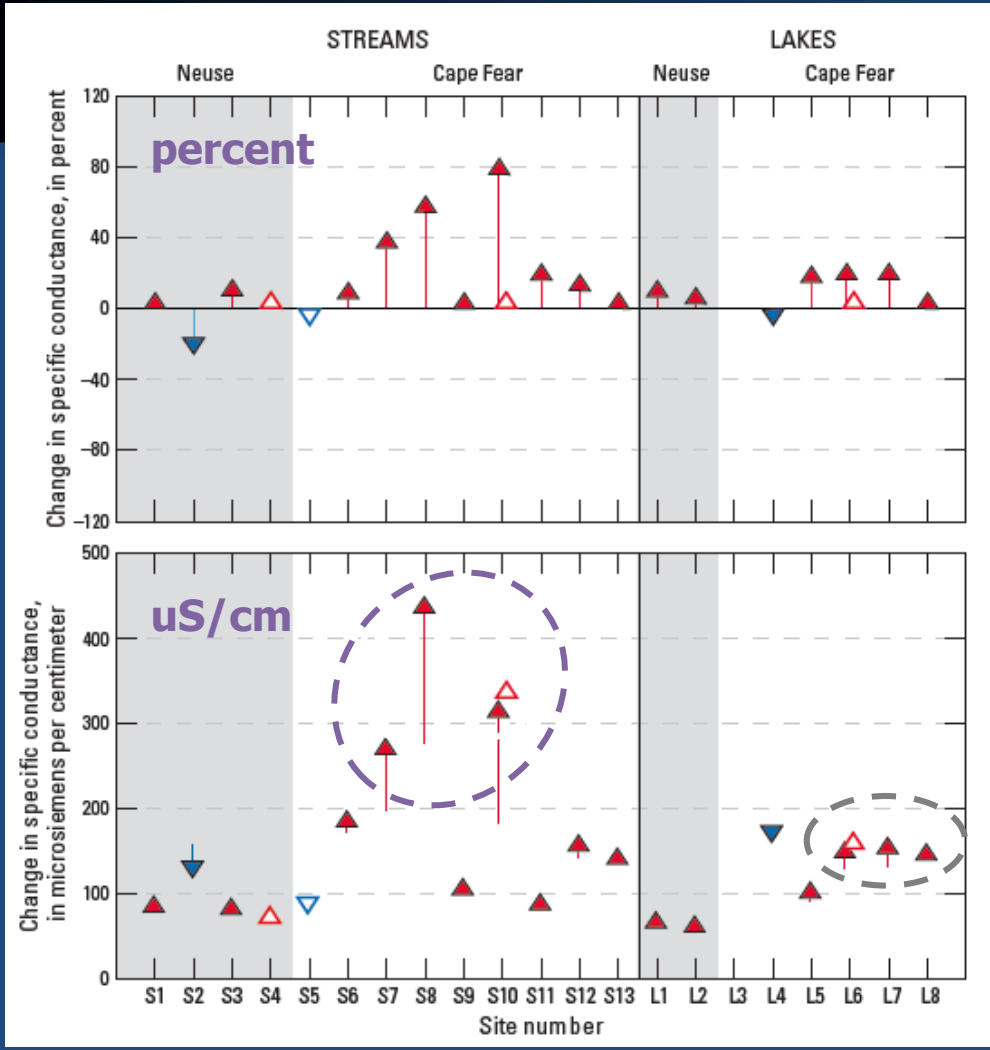
Salinization: Conductance Trends



- Upward trends at 17 of 21 sites
- Largest trends at 3 urban streams with treated municipal wastewater inputs
- Muted up-trends at downstream lake sites

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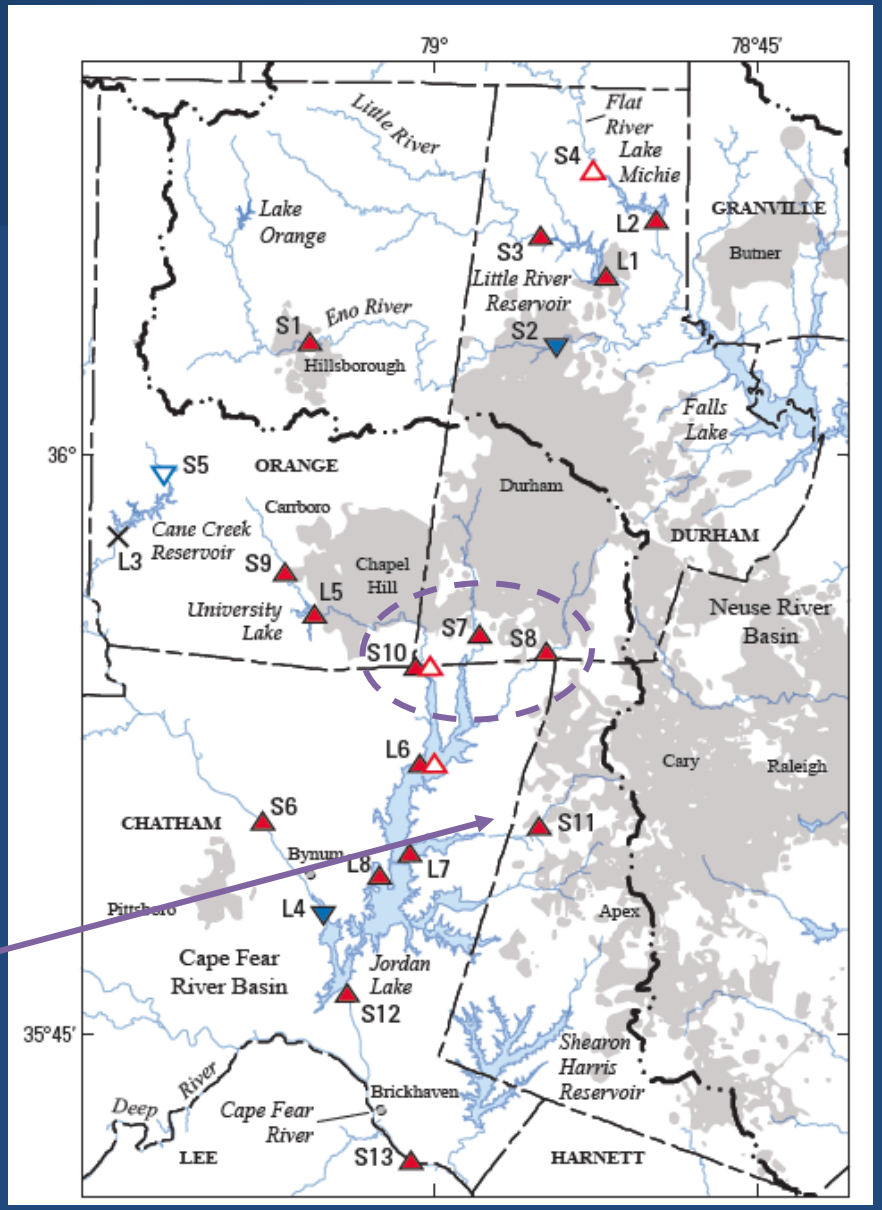
Map view

- Largest trends at 3 streams (circled)
- In contrast, nutrients decreased after WRFs implemented controls.
- S11, with highest rate of urbanization, had only a small upward trend in conductance



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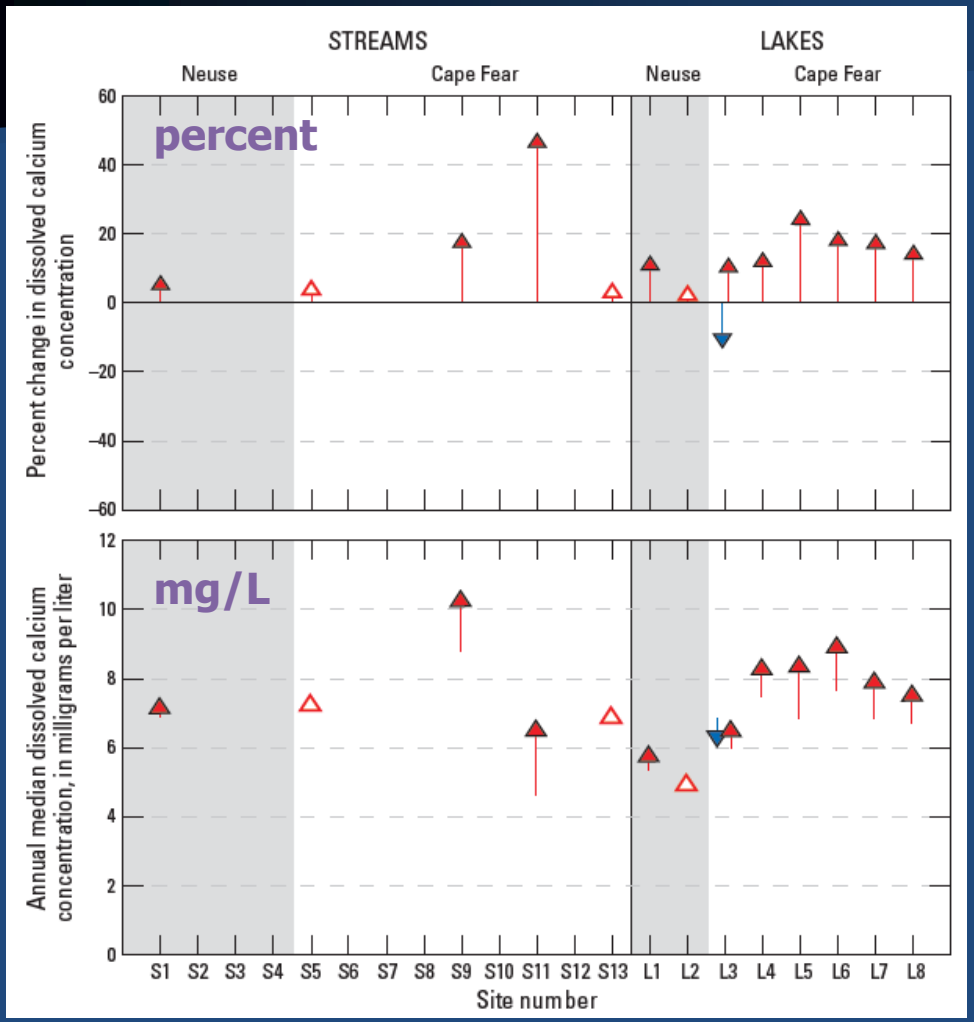
Major ions for 13 sites



- Sufficient data for all lakes and 5 streams
- Insufficient data for remaining streams
- Upward trends for Ca (shown), Mg, K, Na, and Cl
- Downward SO_4 trends at many sites

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Summary of Regional Trends

- Population density & developed lands increased in the study area, varying widely among sites
- Specific conductance and several major ions trended upward throughout the area in response to urbanization
  - Calcium and magnesium (concrete and other carbonate building materials?)
  - Sodium and chloride (road salt?)
  - Wastewater?

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Lessons Learned

- Salinization of freshwater streams and lakes is occurring in the Southeast as well as in other areas of the U.S.
- Expanded monitoring of major ions is needed to understand trends at all scales and implications

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Closing Thoughts

"Is WQ getting better or worse?"

"Yes!"

- Better: *"How is WQ changing over time?"*
  - Drivers in flux -- population, land use, streamflow, withdrawals, inflows, WRF upgrades, BMP's, etc.
  - Water quality responds in a non-uniform manner
- Long-term monitoring and flexible analytical approaches are critical for ensuring resiliency of water supplies for the future

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Questions?

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