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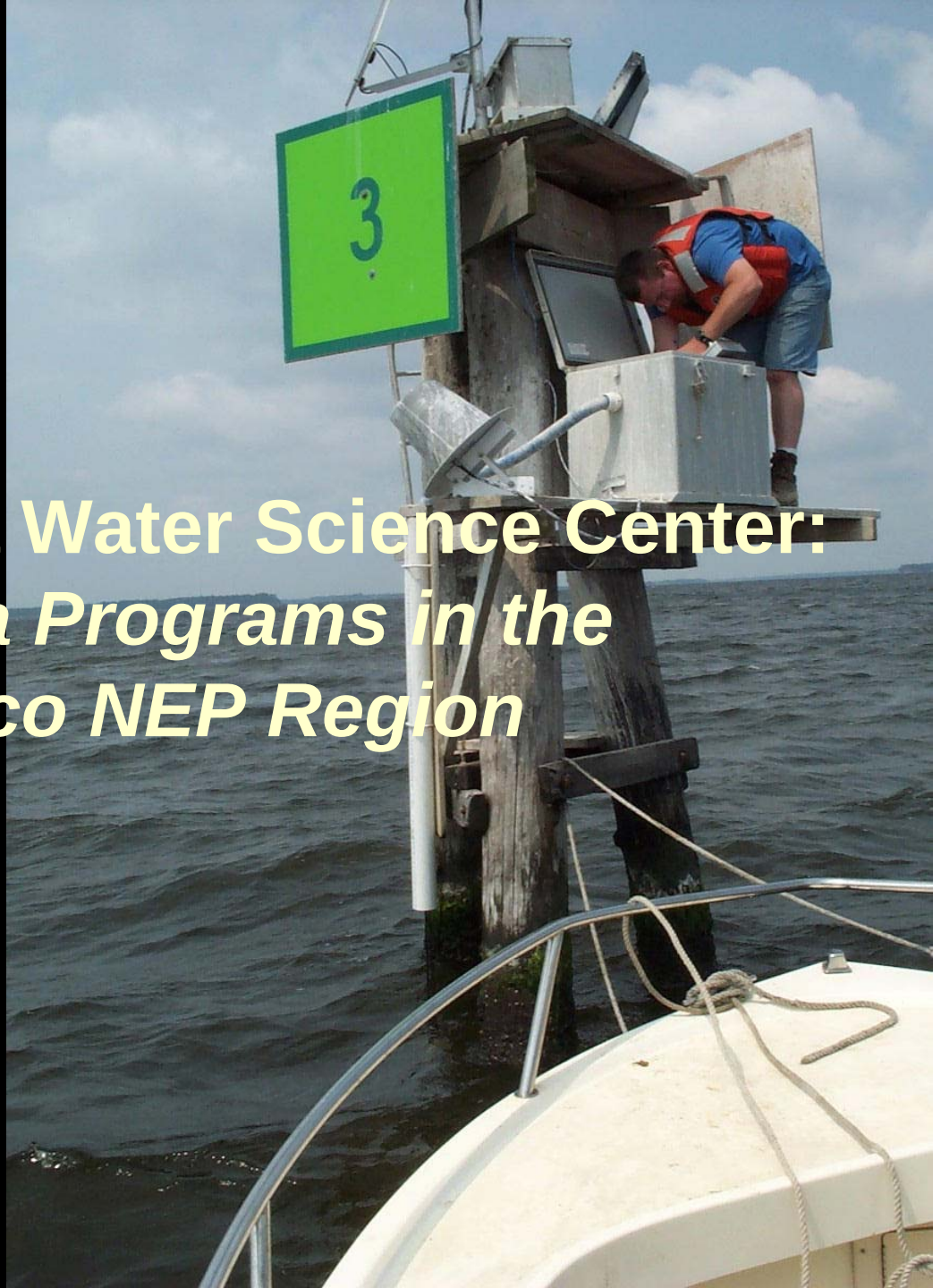
science for a changing world

USGS North Carolina Water Science Center:
Science and Data Programs in the Albemarle-Pamlico NEP Region



Jerad Bales

APNEP STAC Meeting
Greenville, NC
July 30, 2008

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

Organizational Relevance

- Nation's earth science agency
- Unbiased, non-regulatory Federal science agency
- Mission:
  - Support other Federal agencies
  - Work cooperatively with state and local agencies
- Multi-disciplinary capabilities
- Numerous local partners (>30 in NC alone)
- Strong, on-the-ground presence & good understanding of local conditions

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Long History . . .

- Shales, N.S., 1890, General account of the fresh-water morasses of the United States, with a description of the Dismal Swamp district of Virginia and North Carolina, *in* Powell, J.W., Tenth annual report of the United States Geological Survey, 1888–89, part 1 Geology: Washington, D.C., p. 255–339.
- Darton, N.H., 1896, Artesian-well prospects in the Atlantic Coastal Plain Region: U.S. Geological Survey Bull. 138, 232 p.
- Grover, N.C., 1907, Surface water supply of middle Atlantic states, 1906, Susquehanna, Gunpowder, Patapsco, Potomac, James, Roanoke, and Yadkin River drainages: U.S. Geological Survey Water-Supply Paper 203, 100 p.
- Parker, H.N., 1912, The quality of some waters of the Coastal Plain of North Carolina *in* Clark, W.B., and others, The Coastal Plain of North Carolina: North Carolina Geological and Economic Survey, v. III, pt. II, p. 484–509.

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Topics

- Loadings
- Modeling
  - River and floodplain models
  - Agricultural watershed modeling
  - SPARROW modeling
  - Regional and local ground-water models
- Monitoring
- National Capabilities

Monitoring dissolved oxygen in Coniott Creek

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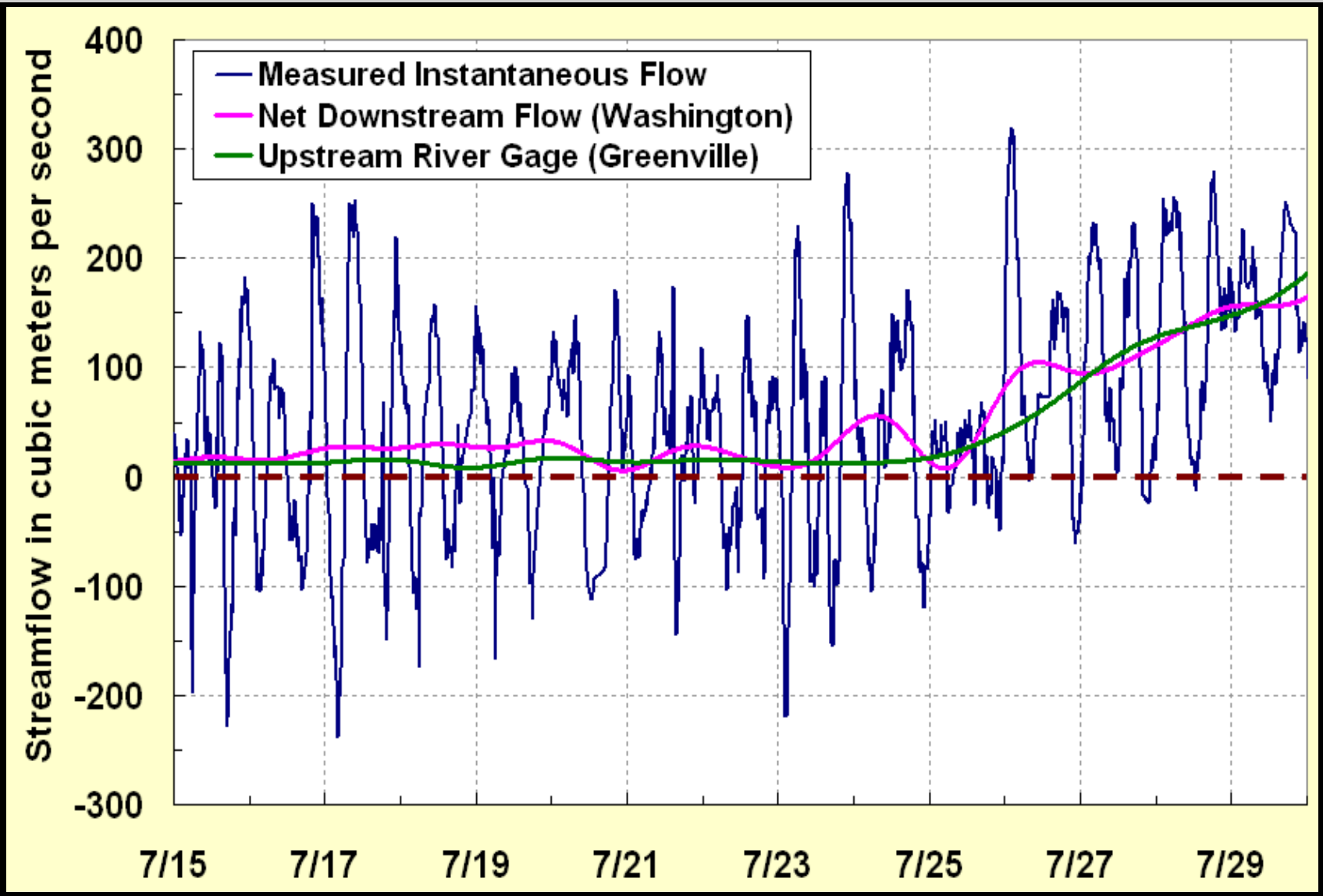
Loads


Measured Instantaneous Flow
Net Downstream Flow (Washington)
Upstream River Gage (Greenville)
Streamflow in cubic meters per second
400
300
200
100
0
-100
-200
-300
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29

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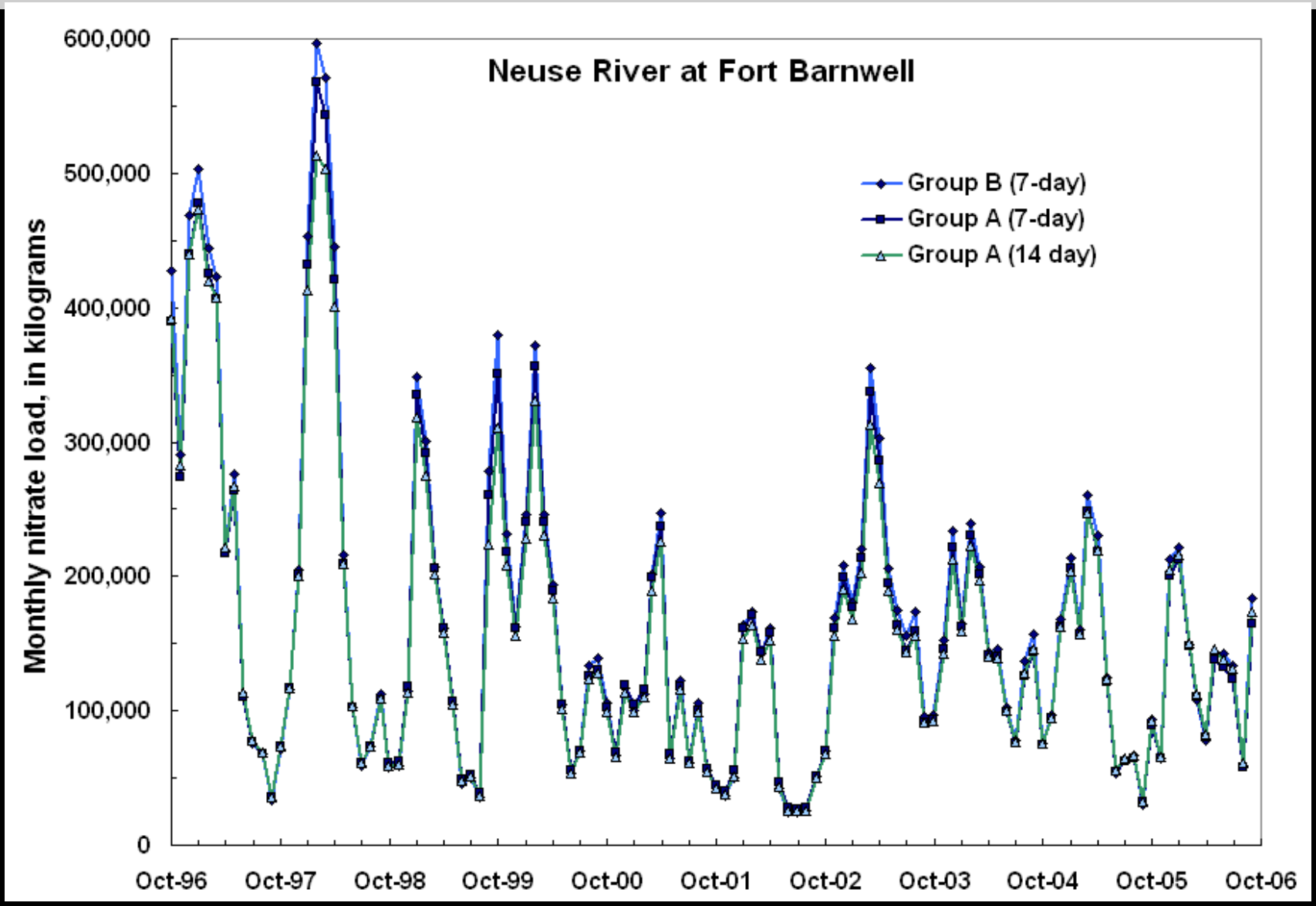
Effects of Sampling Interval on Estimated Load



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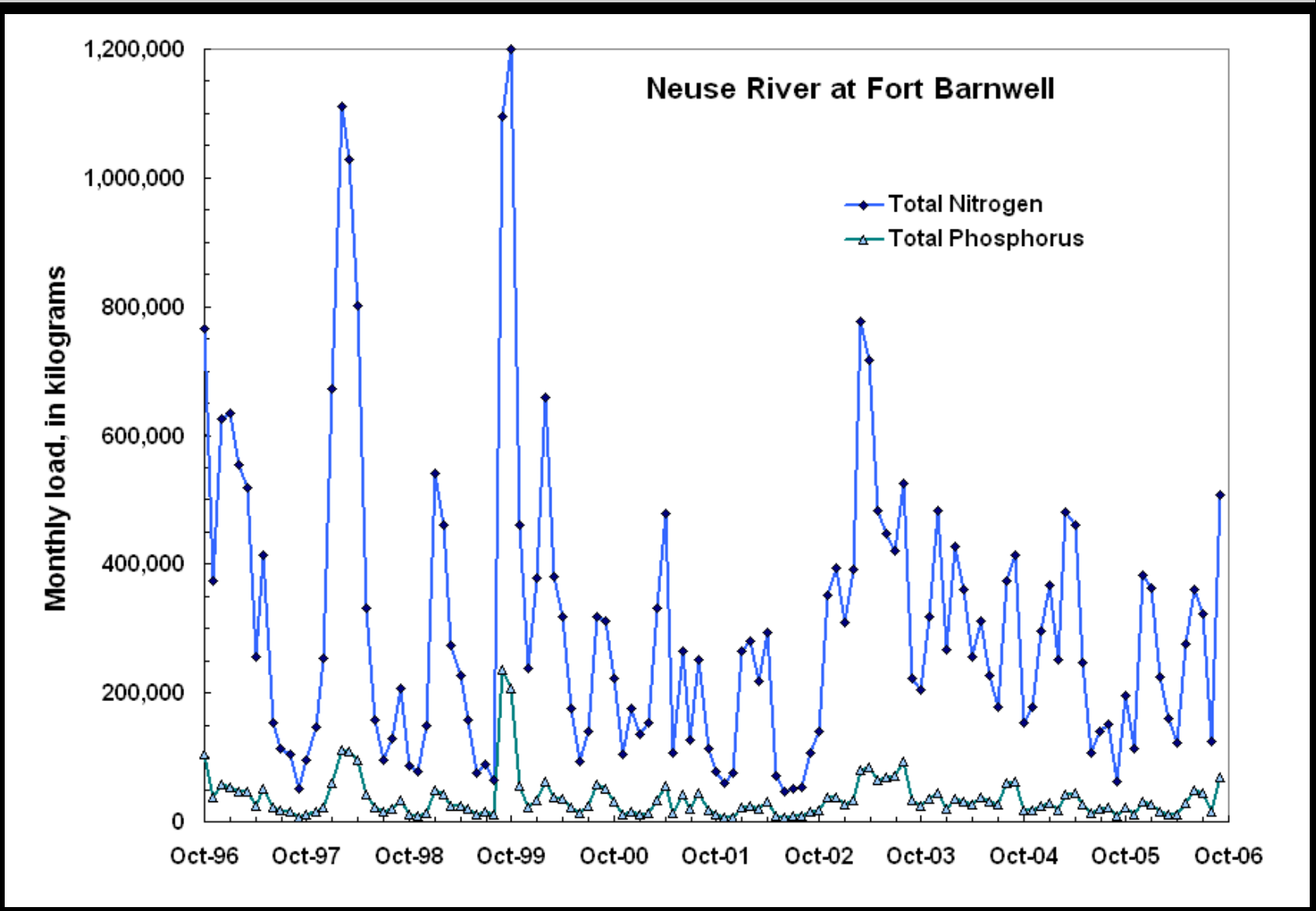
Fort Barnwell TN and TP Load



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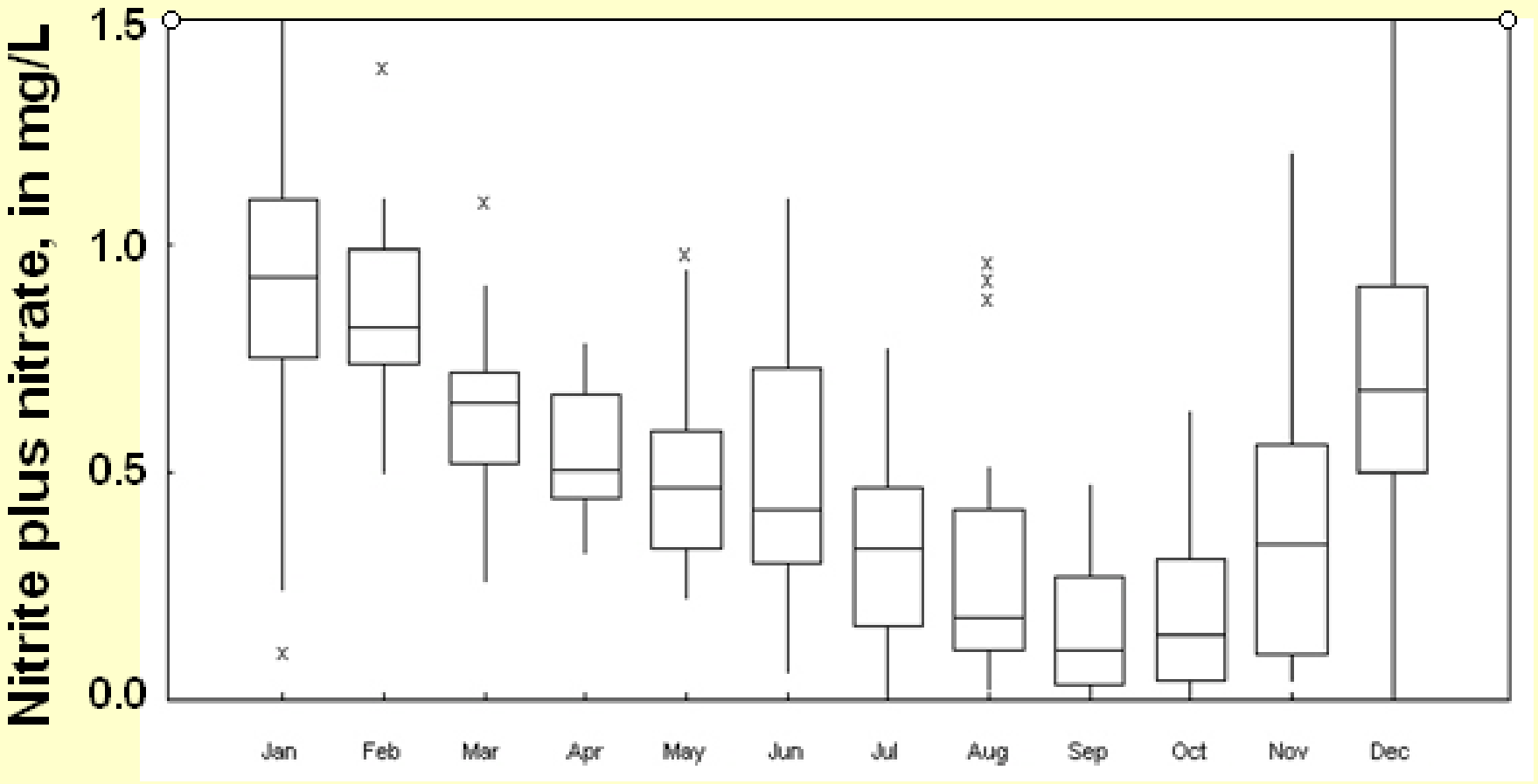
Swift Creek Seasonal Nitrate Patterns



- **Benefits to APNEP: Long-term, consistent data for evaluation of change**

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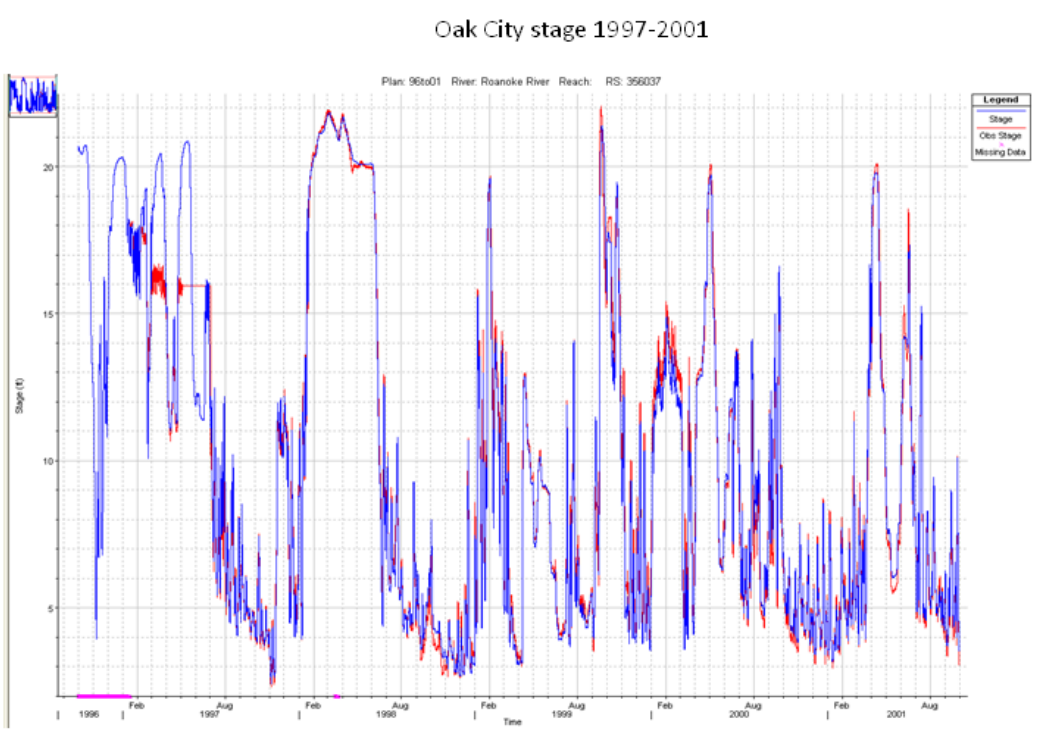
Roanoke River Kerr 216 Study

- 1D and 2D flow and water-quality model
  - Roanoke Rapids to Albemarle Sound
  - Continuous, unsteady
- Simple dissolved-oxygen model
- Benefits to APNEP: High-quality management tool for largest river in APNEP system



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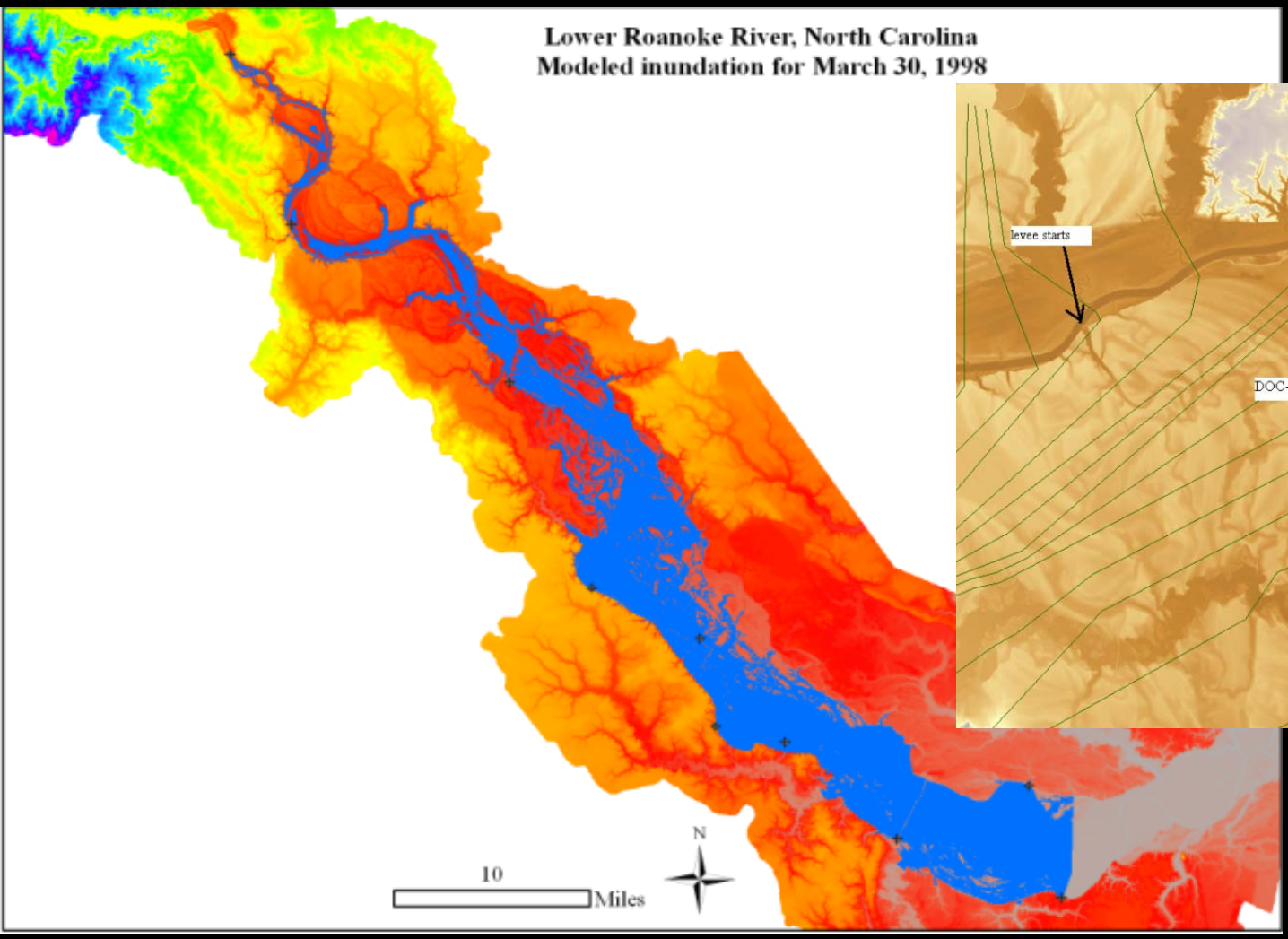
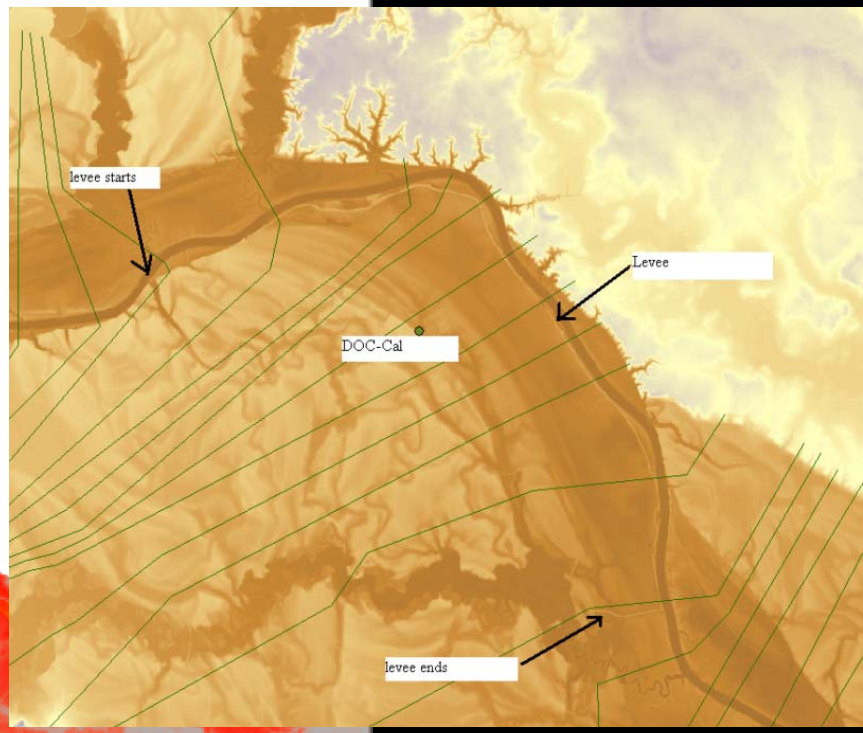
Roanoke River Floodplain Inundation





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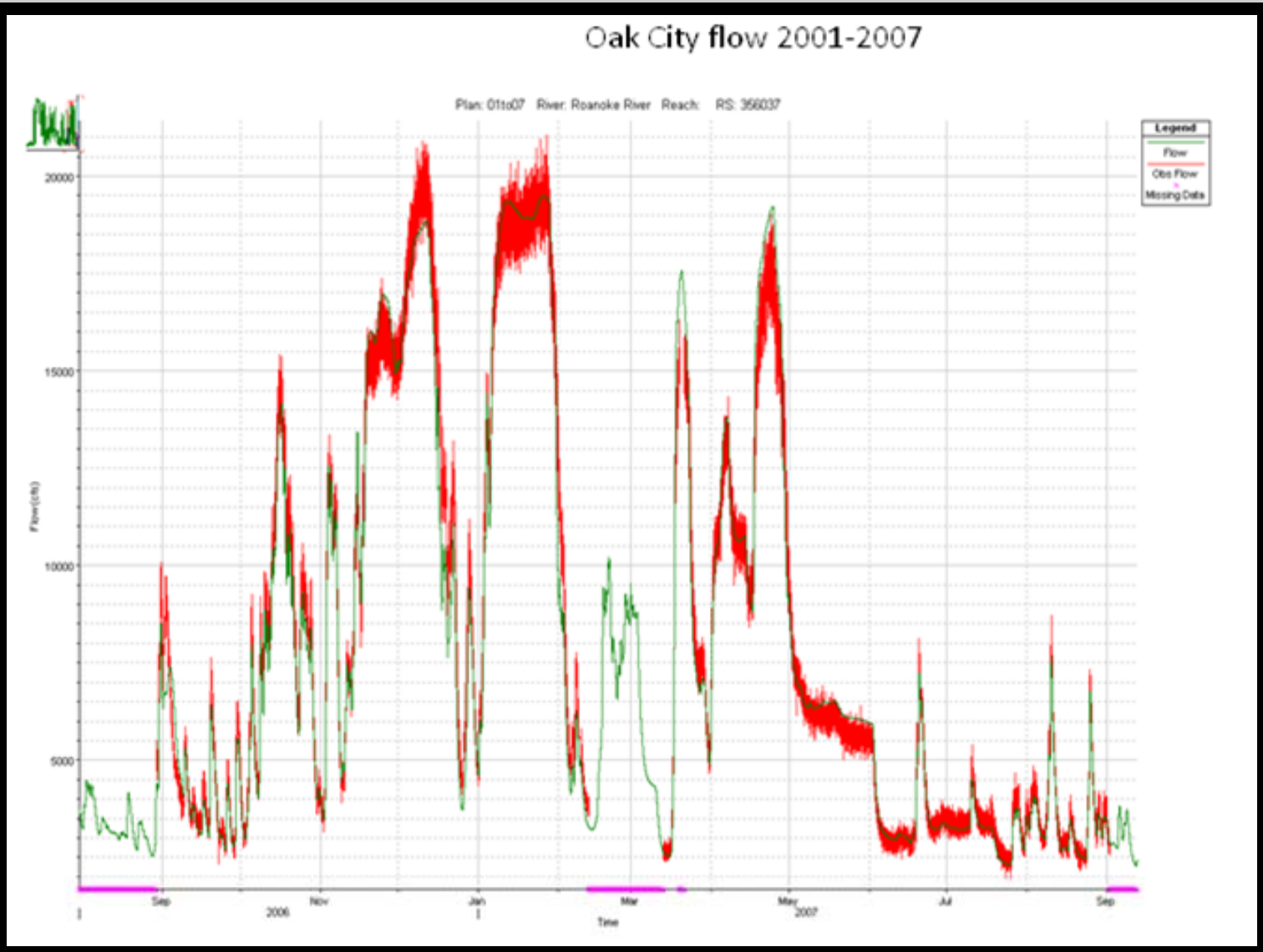
Roanoke River Flow Simulations



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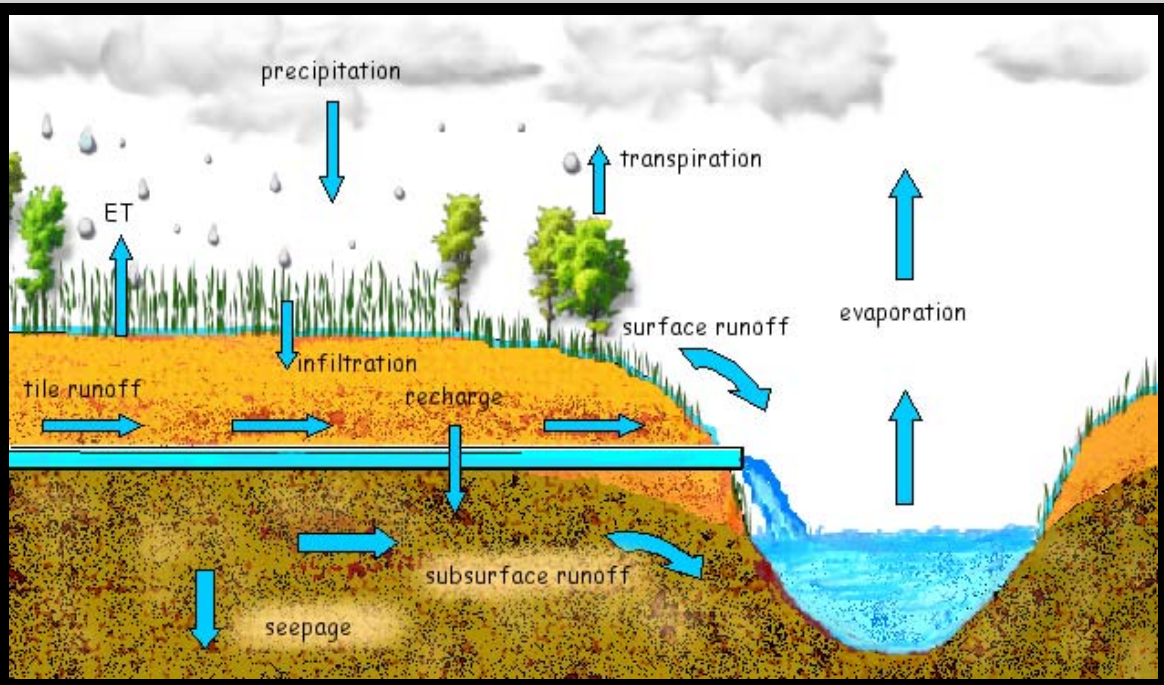
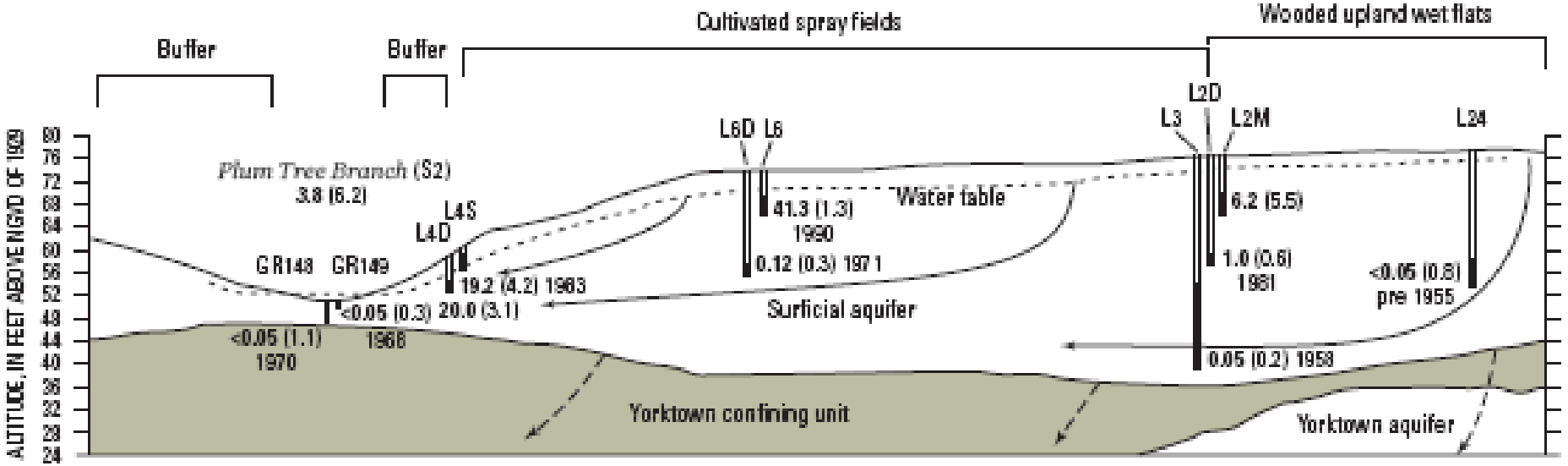
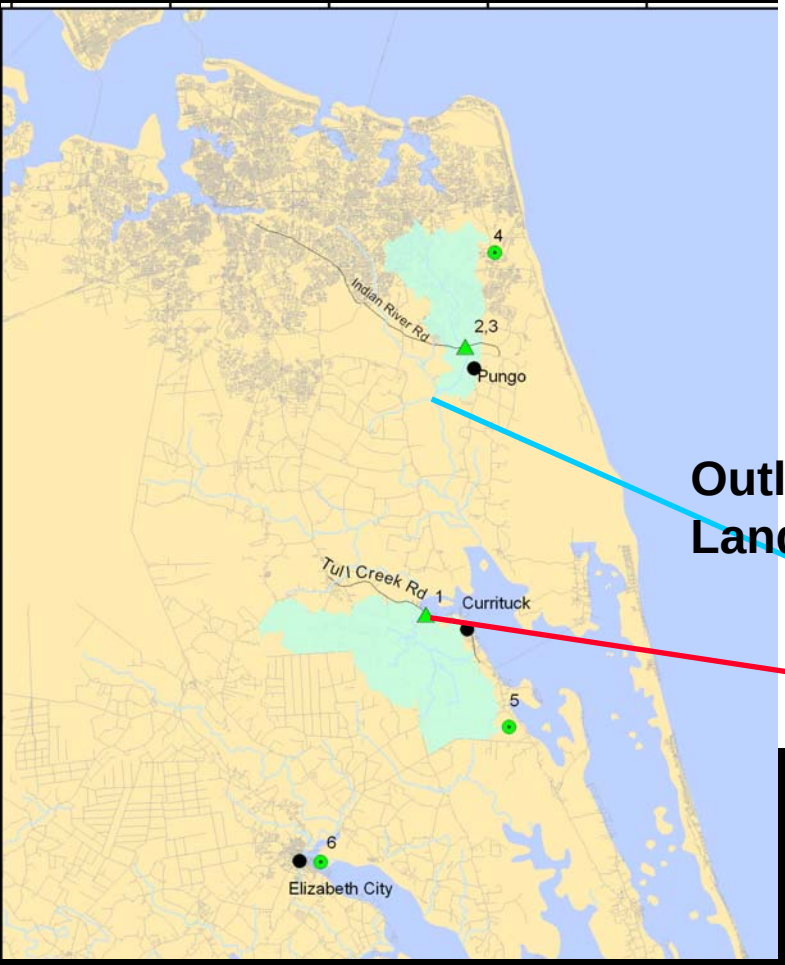
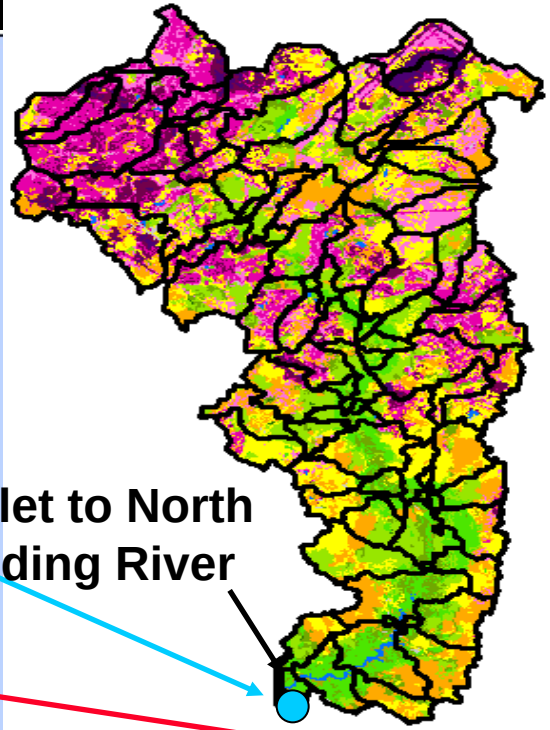
Agricultural Watershed Modeling





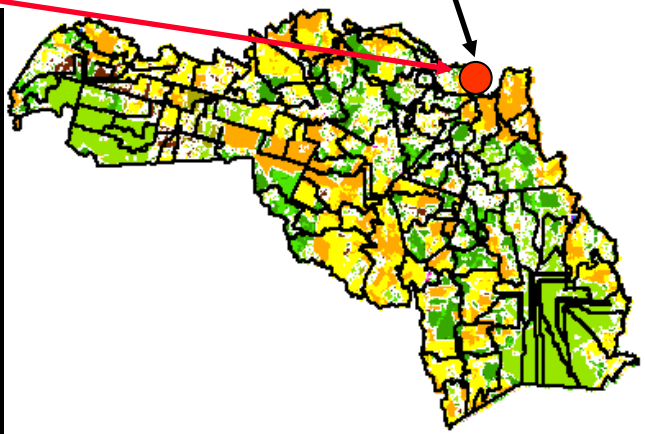
Currituck Sound Watershed Models





Outlet to North Landing River

Outlet to Tull Bay



Watershed models to support Currituck Sound management models by estimating loads for different scenarios.

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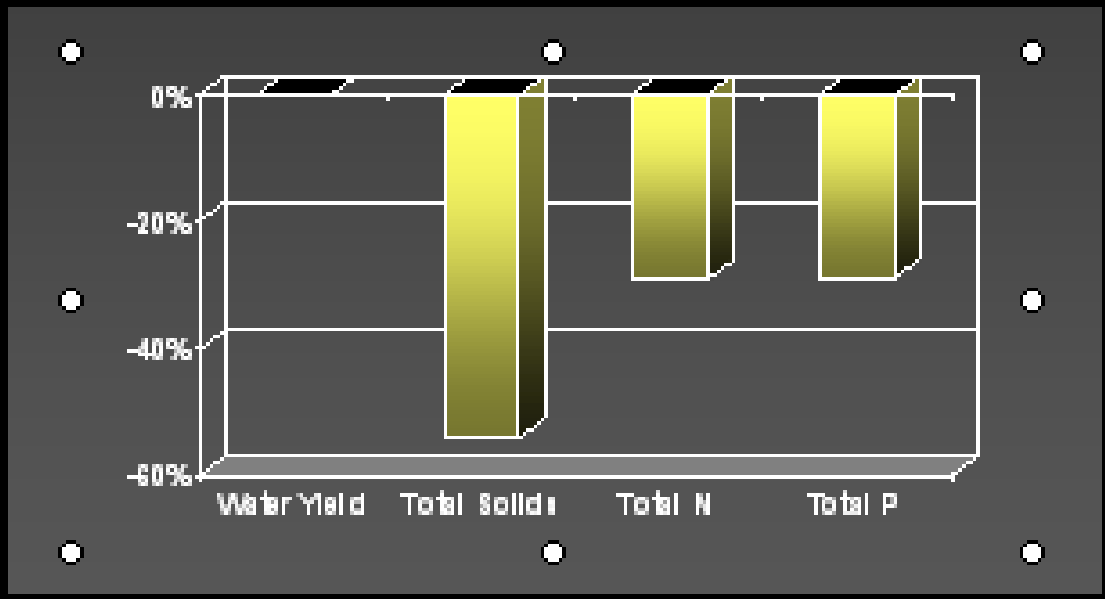
Applications

Yield estimates for 2006-07

Parameter	Tull Creek	West Neck Creek	Percent Difference*
Water Yield (mm)	1005	570	-43%
Total Solids (metric tons/km2)	44	13	-70%
Total N (kg//km2)	1201	1406	17%
Total P (kg//km2)	185	126	-32%

A sediment BMP for agricultural lands lowered sediment and nutrient yield by 29 and 54 percent, respectively, from existing values.



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SPARROW Modeling

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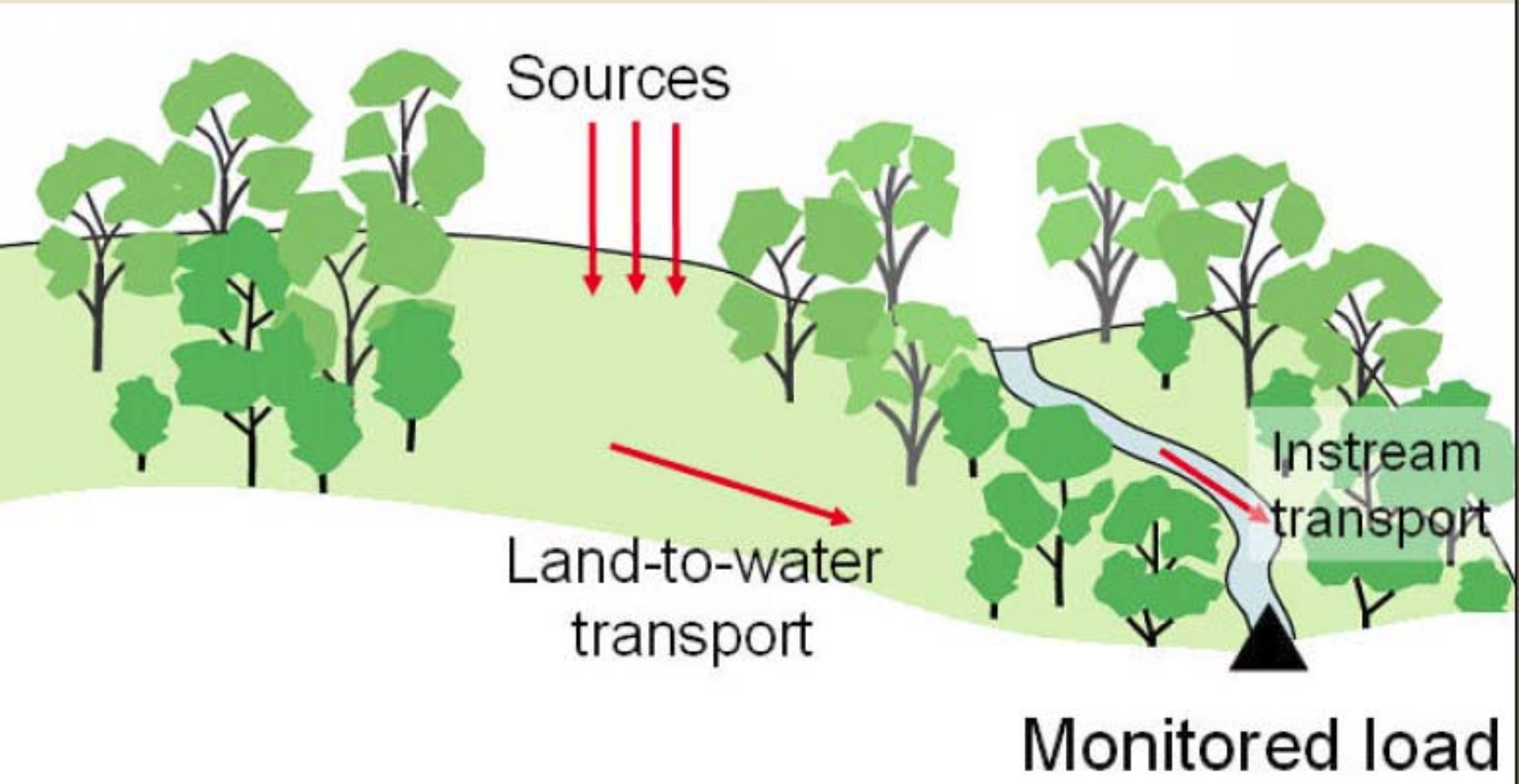
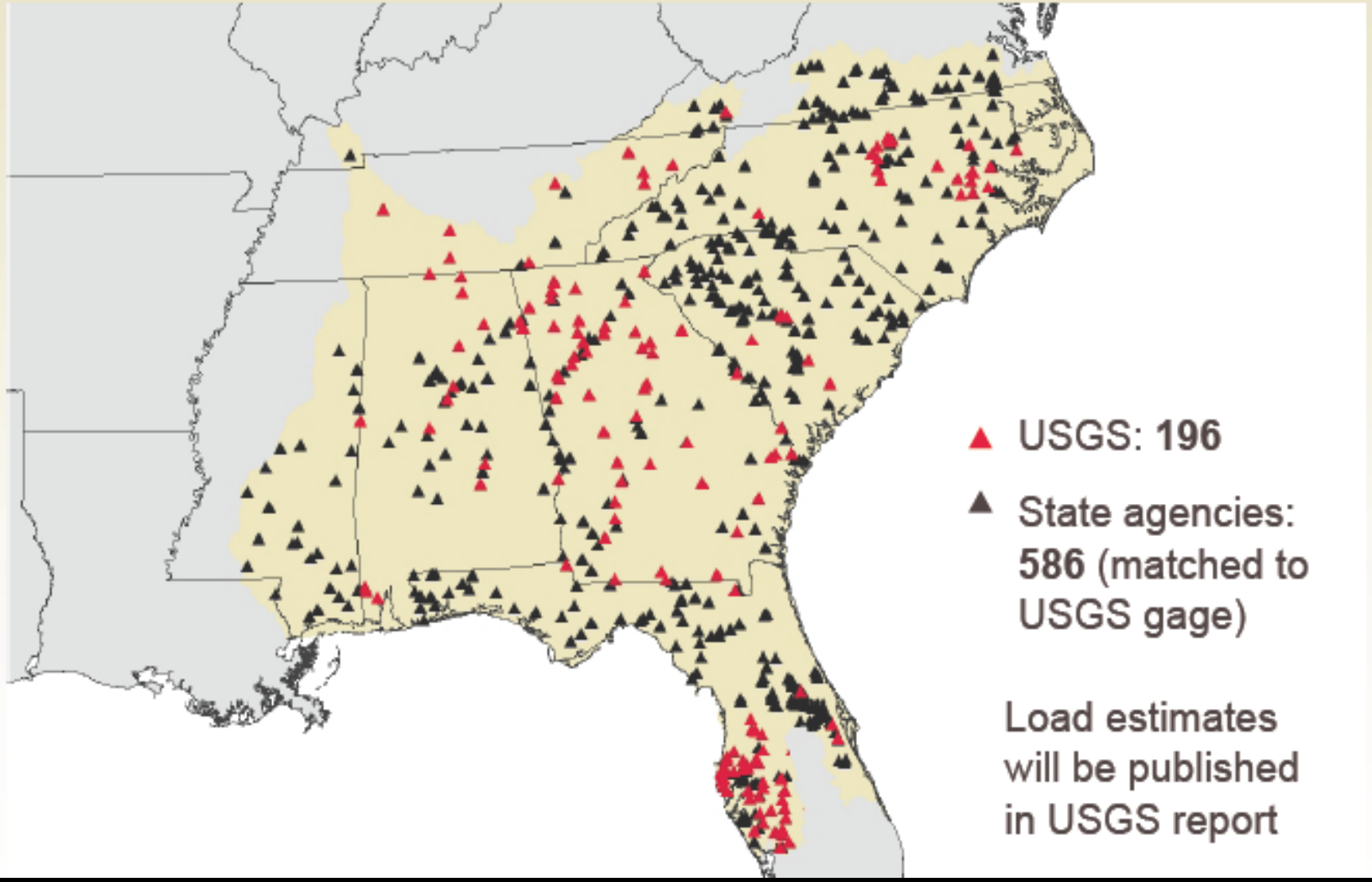
SPARROW* Model Concept



*SPAtially Referenced Regression On Watershed Attributes

Estimates of mean annual nutrient load at 782 sites for 2002

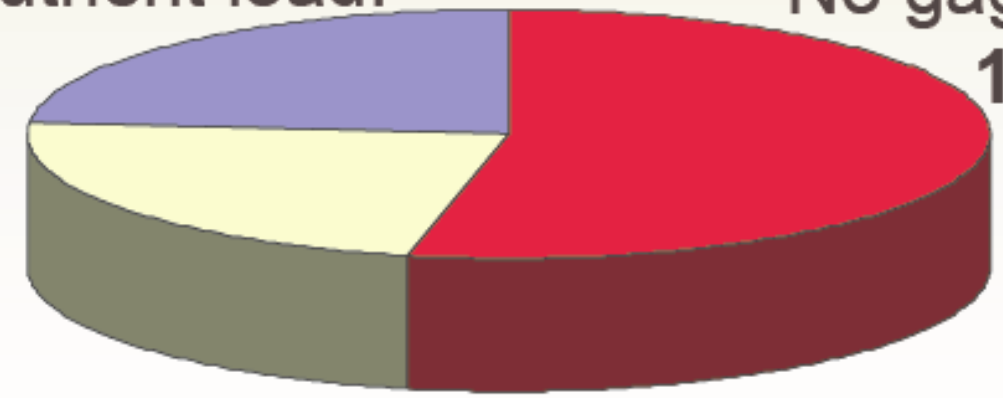


"Shakedown" of monitoring data for load estimation

- Nutrient data retrieved for 21,500 stream sites
- Retain sites (3,400) with ≥ 20 samples, sampling frequency ≥ 4X / year, not in reservoir/lake
- Of the 3,400 sites:

Estimate nutrient load: **782** sites

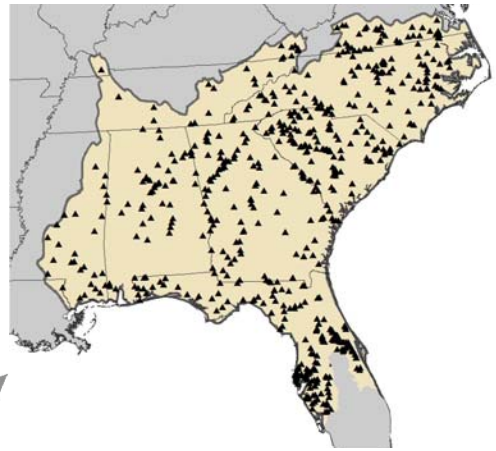
No gage nearby: **1824** sites



Insufficient streamflow record: **794** sites

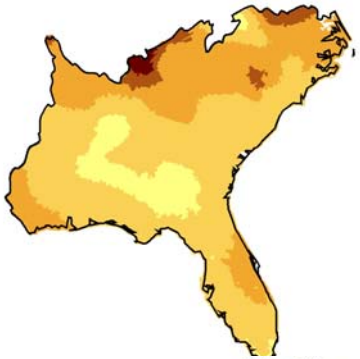
SPARROW Model Framework

Monitoring Data
804 Sites

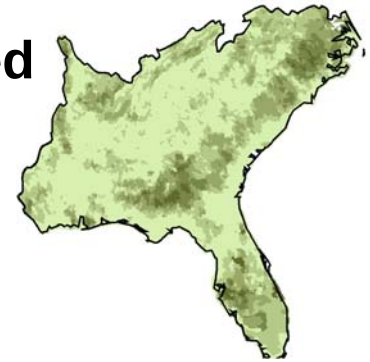


Spatial Data Layers

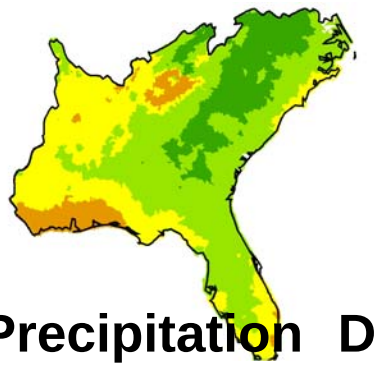
Atmospheric deposition



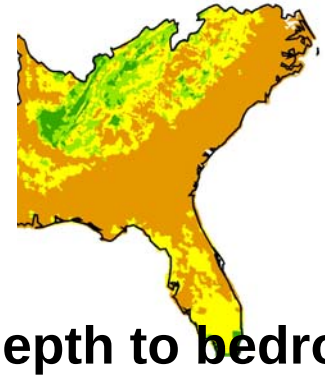
Fertilizer applied to farmland; animal waste; point sources



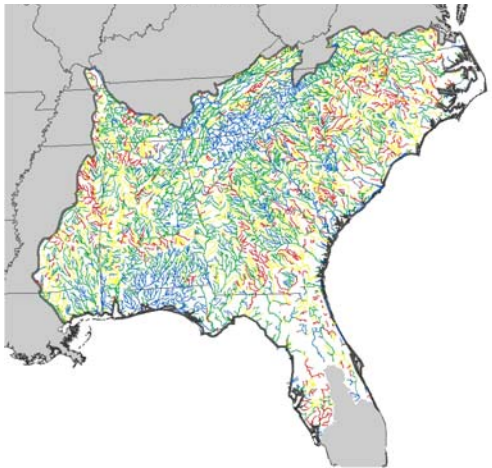
Precipitation



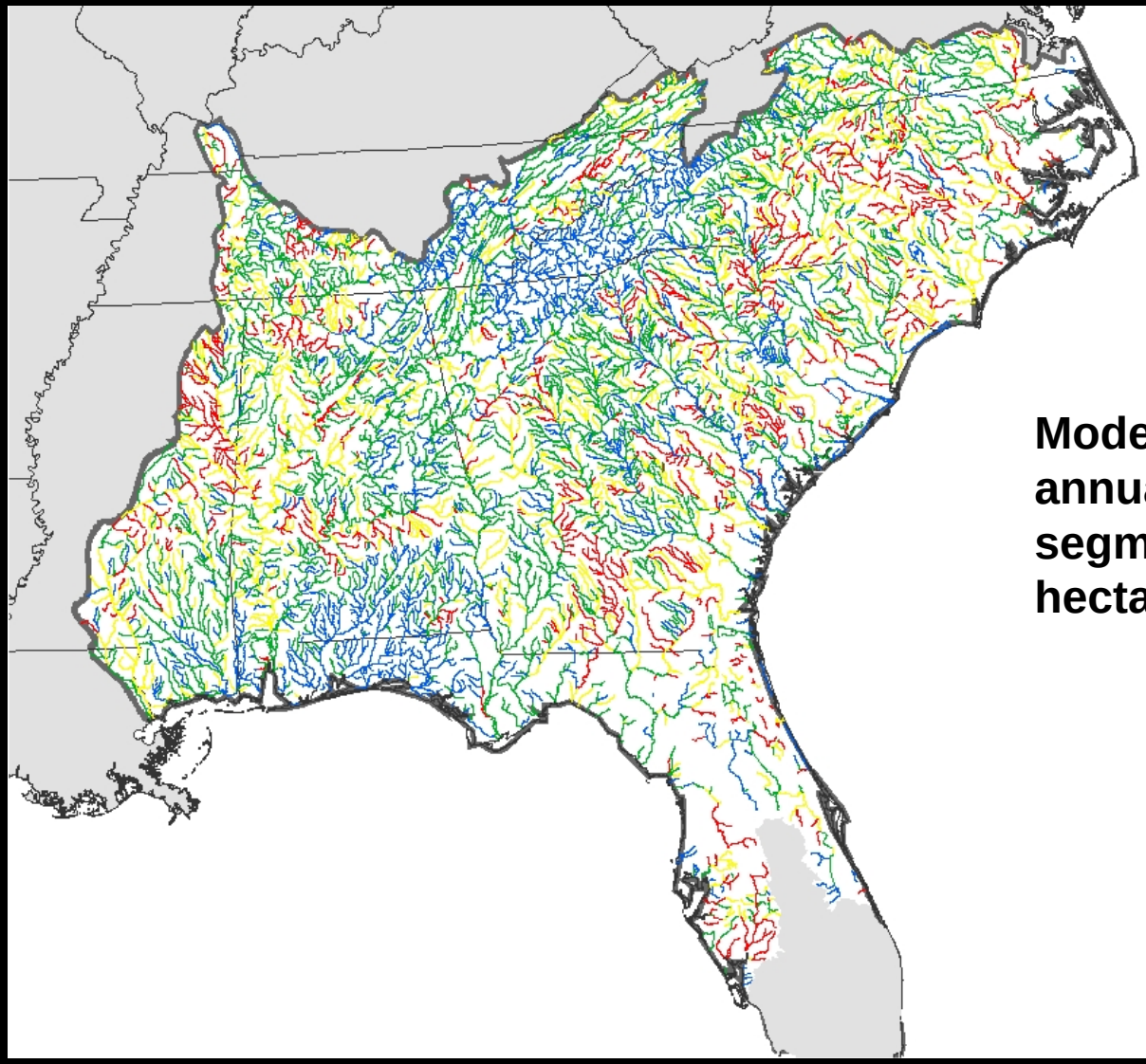
Depth to bedrock; impervious area



Model Predictions
8,092 Stream Reaches



Supporting Resource Management Decisions



Model-estimated mean annual load for RF1 reach segment, in kilograms per hectare

- < 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- > 1.5

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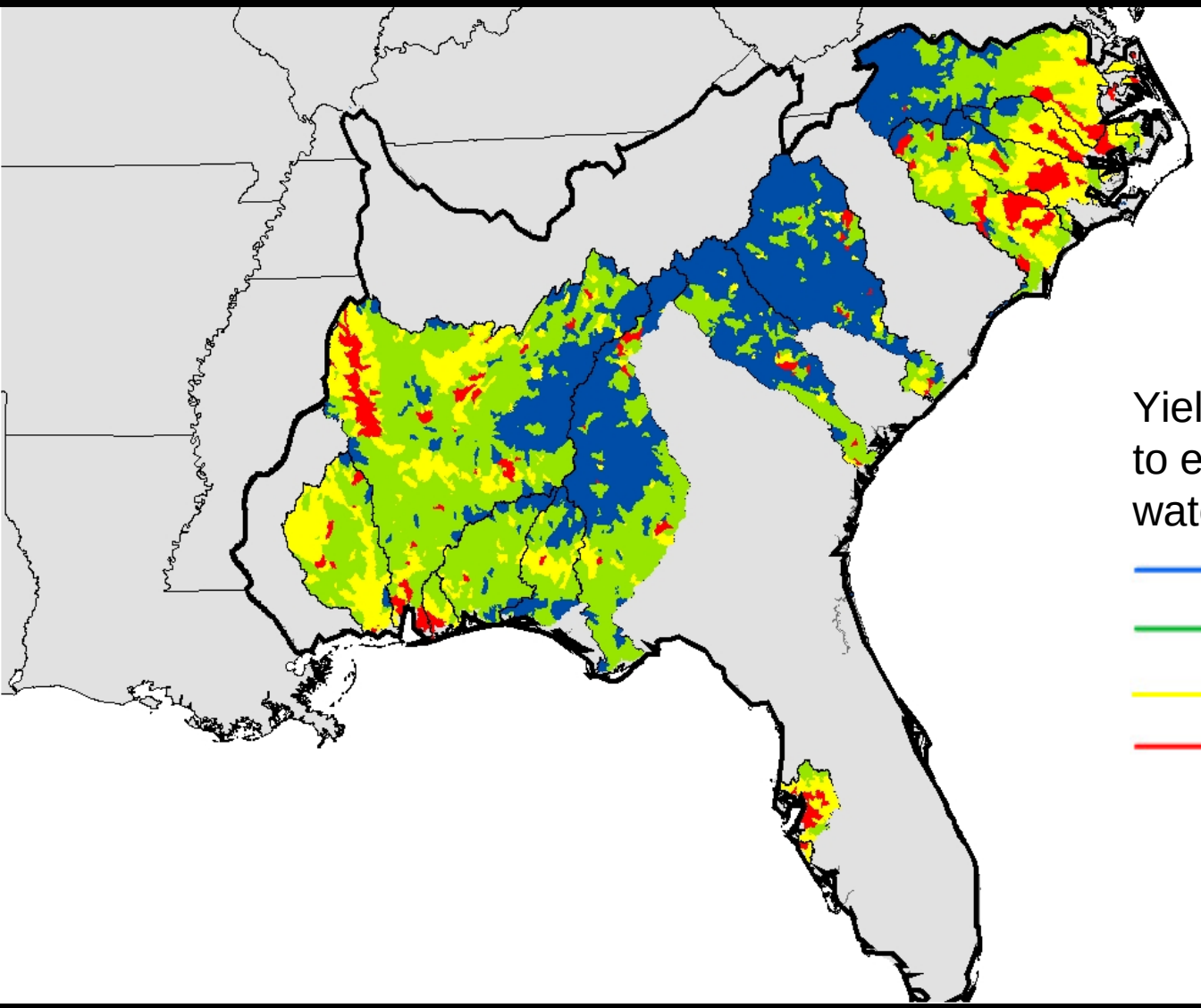
Coastal Areas Sensitive to Nitrogen Input



Yield (2002) delivered to estuary from watershed, kg/yr/ha

- < 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- > 1.5

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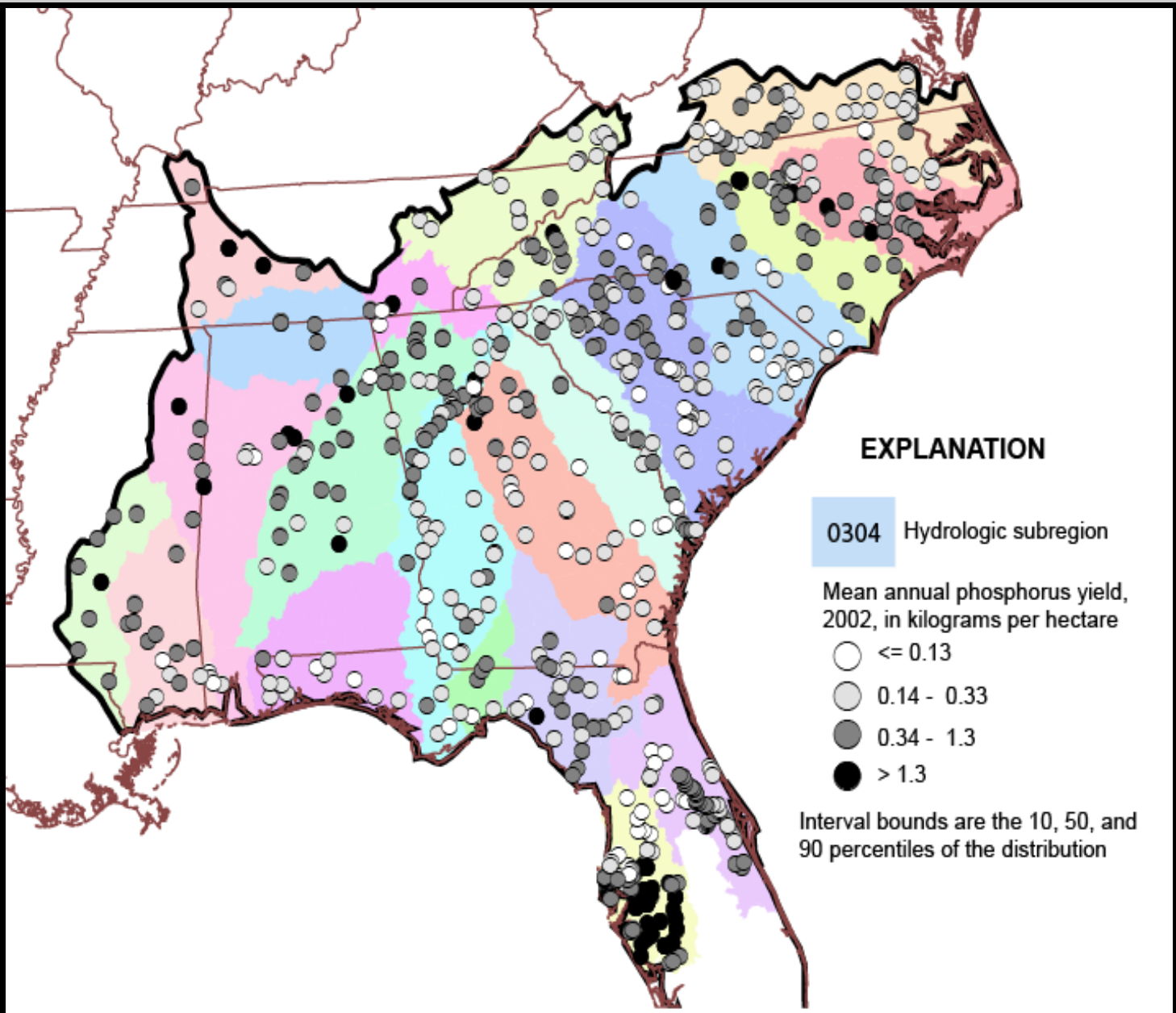
Preliminary Phosphorus Results



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Benefits to APNEP

- **Improved understanding of**
  - **Importance of sources and loss mechanisms**
  - **Key source areas**
- **Framework for models using more detailed digital hydrography**
- **Identification of data gaps**

Roanoke R. floodplain

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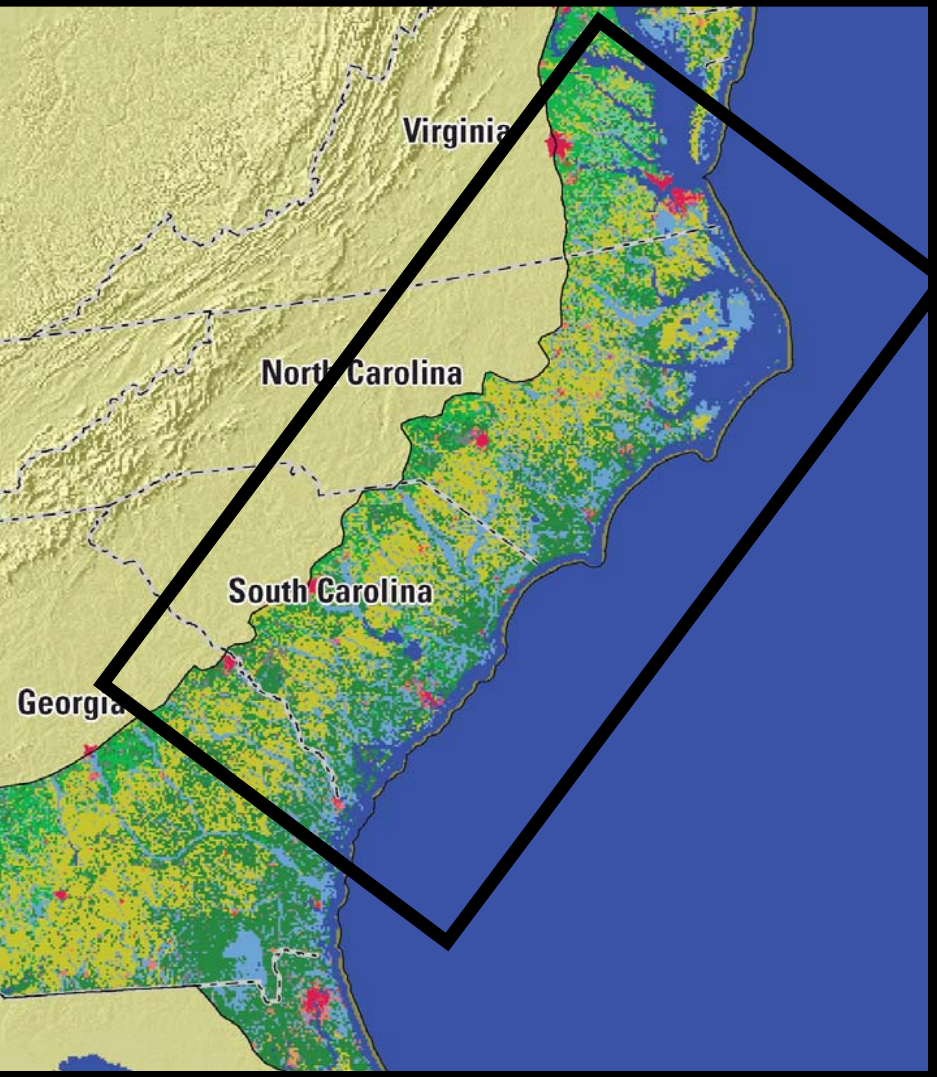
Ground-Water Modeling



- Understand ACP flow paths and recharge.
- Evaluate ground-water and surface-water interactions.
- Provide a scientifically based management tool for optimizing ground-water use.
- Determine susceptibility of shallow aquifers to contamination, saltwater intrusion, and induced leakage from overpumpage of deeper, confined aquifer.

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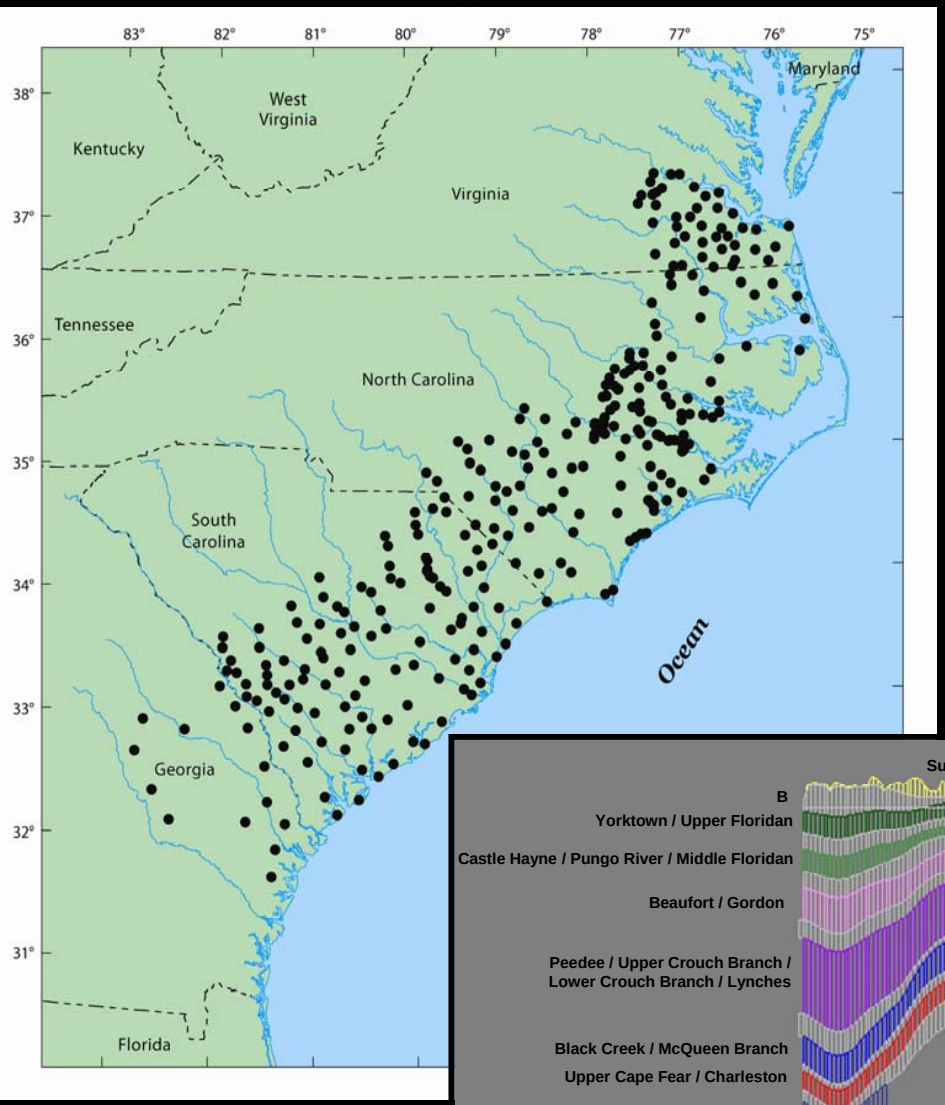
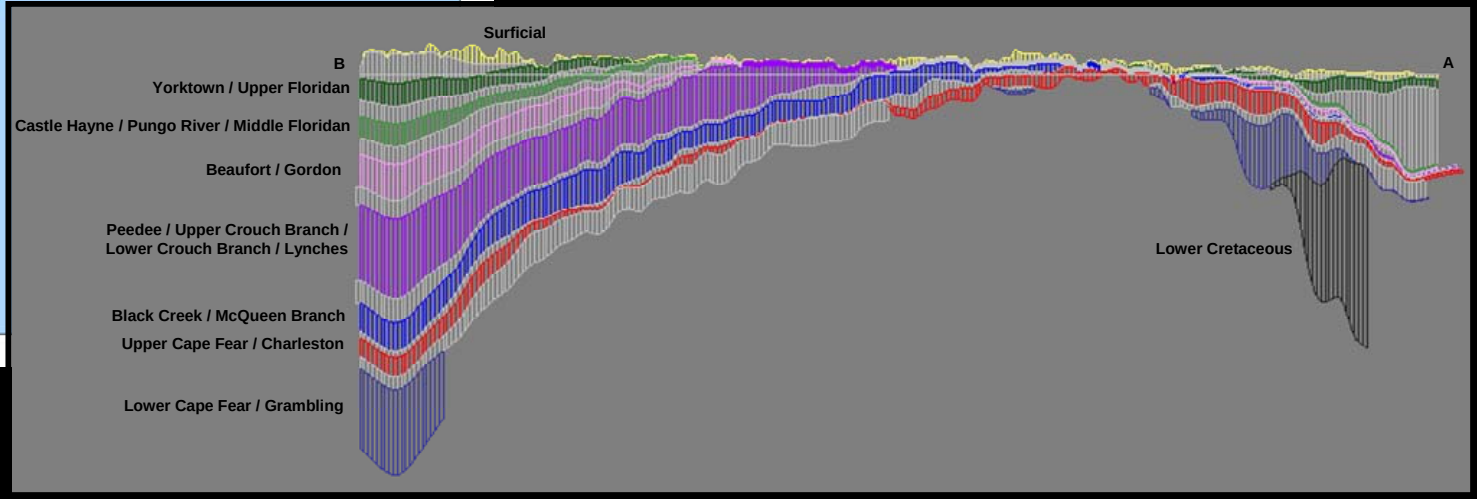
Ground-Water Modeling



- Over 600 boreholes with hydrostratigraphy to basement
- 9 aquifers, 7 confining units.
- 2-mile x 2-mile grid



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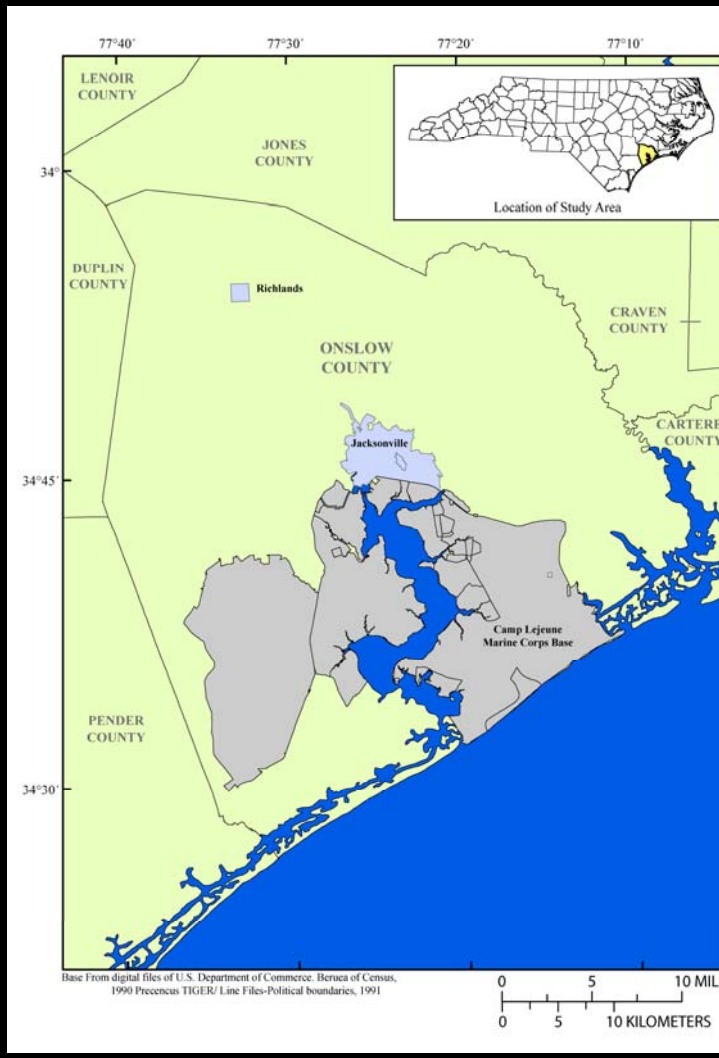
Benefits to APNEP

- Ability to refine mesh for local problems.
- Improved water resources planning in response to
  - Population growth and change
  - Sea-level rise (saltwater intrusion)
- GW-SW interaction.



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Monitoring and Field Experiments

- Continuous, real-time estuarine water-quality monitoring.
- Statewide streamflow, rainfall, ground-water, and water-quality networks.
- Personal care products, endocrine disruptors, & antibiotics.
  - Raw and finished water
  - Animal feeding operation
  - Wastewater effluent discharge
- Effects of urbanization on stream ecology.
- Nitrogen and pathogen transport along flow paths from field to stream.
- Hydrology and Atlantic White Cedar survival.

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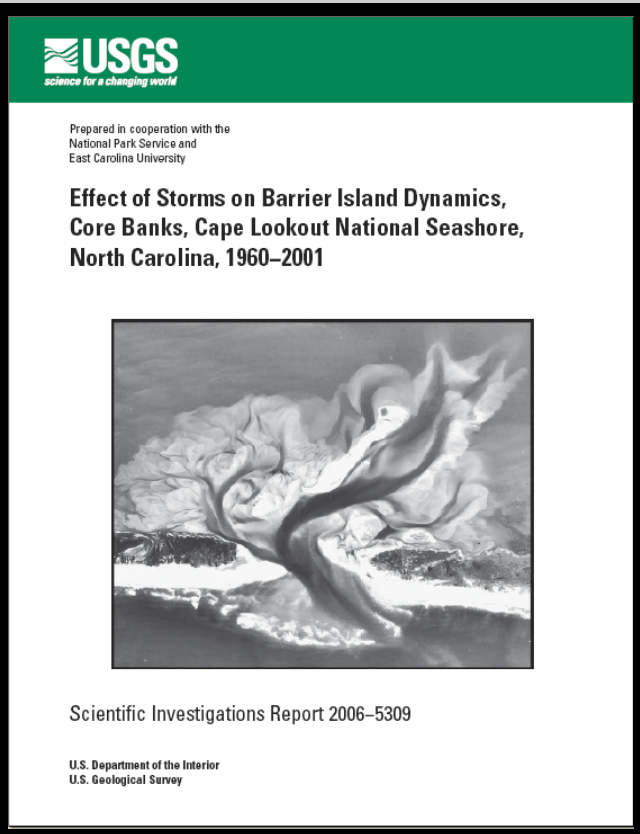
National Capabilities

- Geography
  - EROS Data Center
    - LANDSAT
    - LiDAR
    - NHD
  - Eastern Geography Science Center
    - Environmental consequences of landscape change
- Geology
  - Coastal and Marine Geology Center
  - Coastal Hazards
  - Shoreline Erosion
  - Sea-level change
  - Submarine GW discharge
- Biology
  - National Wetlands Research Ctr.
  - Contaminant Biology
  - Fisheries
  - Invasive Species
  - Status and Trends



- Water
  - NWIS and Water Watch
  - Nutrient processes in ag streams
  - Urbanization and stream ecosystems
  - Mercury transport

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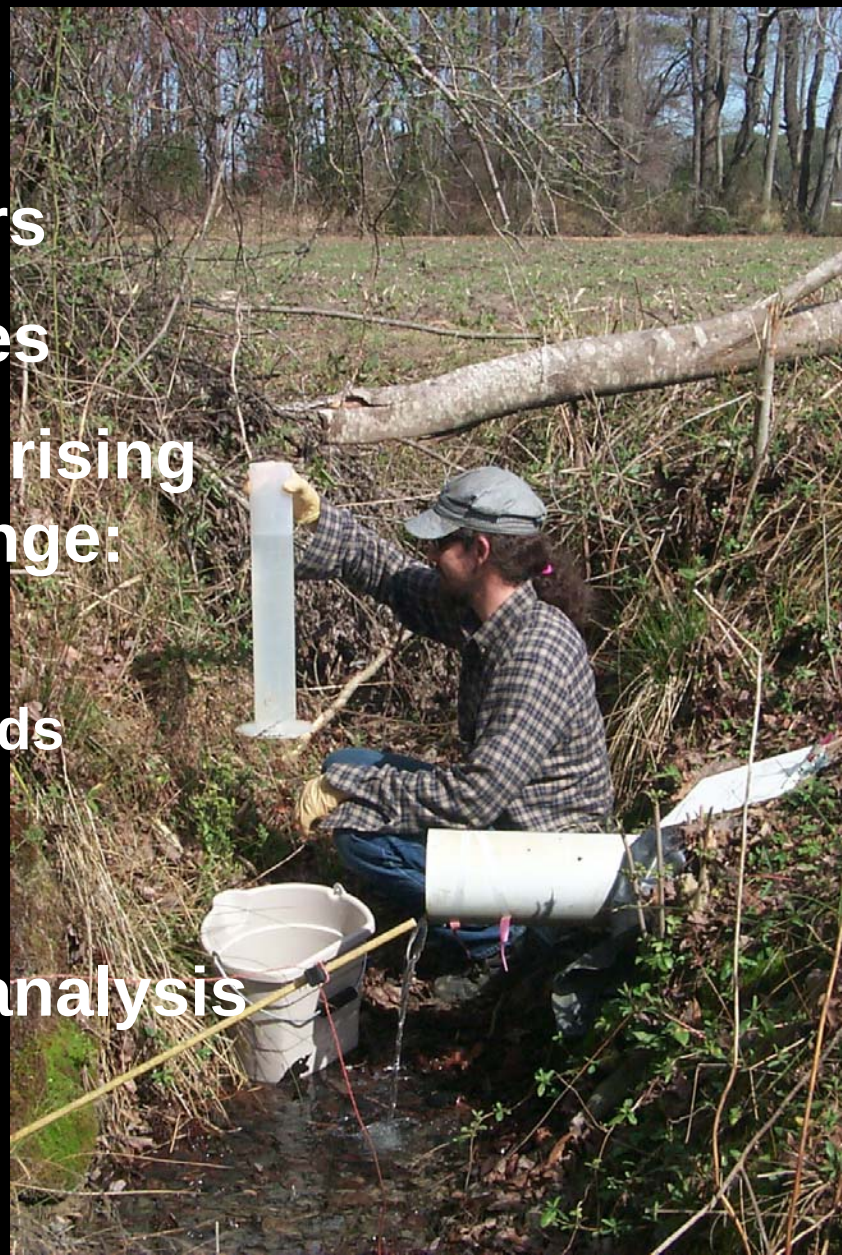
Research and Information Needs

- Fluxes of freshwater and contaminants to coastal waters
- Sustainability of water supplies
- Managing for climate change, rising sea level, and population change:
  - Invasive species
  - Changes in jurisdictional wetlands
  - Marsh retreat
  - Hazards and resiliency
- Land-cover change data and analysis



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For More Information

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http://nc.water.usgs.gov/index.html
http://water.usgs.gov/
http://www.usgs.gov/

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