

# INTEGRATING N-SPECT WITH THE DEVELOPMENT OF A MANAGEMENT PLAN FOR THE KINGSTON LAKE WATERSHED

Tammie Middleton  
GIS/Web Specialist  
&

Dr. Susan Libes  
Director, Waccamaw  
Watershed Academy

GEOTOOLS  
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# Collaborative Demonstration Project

NOAA Coastal  
Services Center

Waccamaw Regional  
Council of Governments

Strom Thurmond Institute,  
SC Water Resources Center

US EPA Region IV  
Wetland Program  
Development Program

CCU's Waccamaw  
Watershed Academy

Pro Bono

# Overview

- KLW Watershed Planning Project
- N-SPECT
- Project Modeling Scenarios
- Modeling Output
- Role of N-SPECT in public outreach for KLW project
- Future work plan





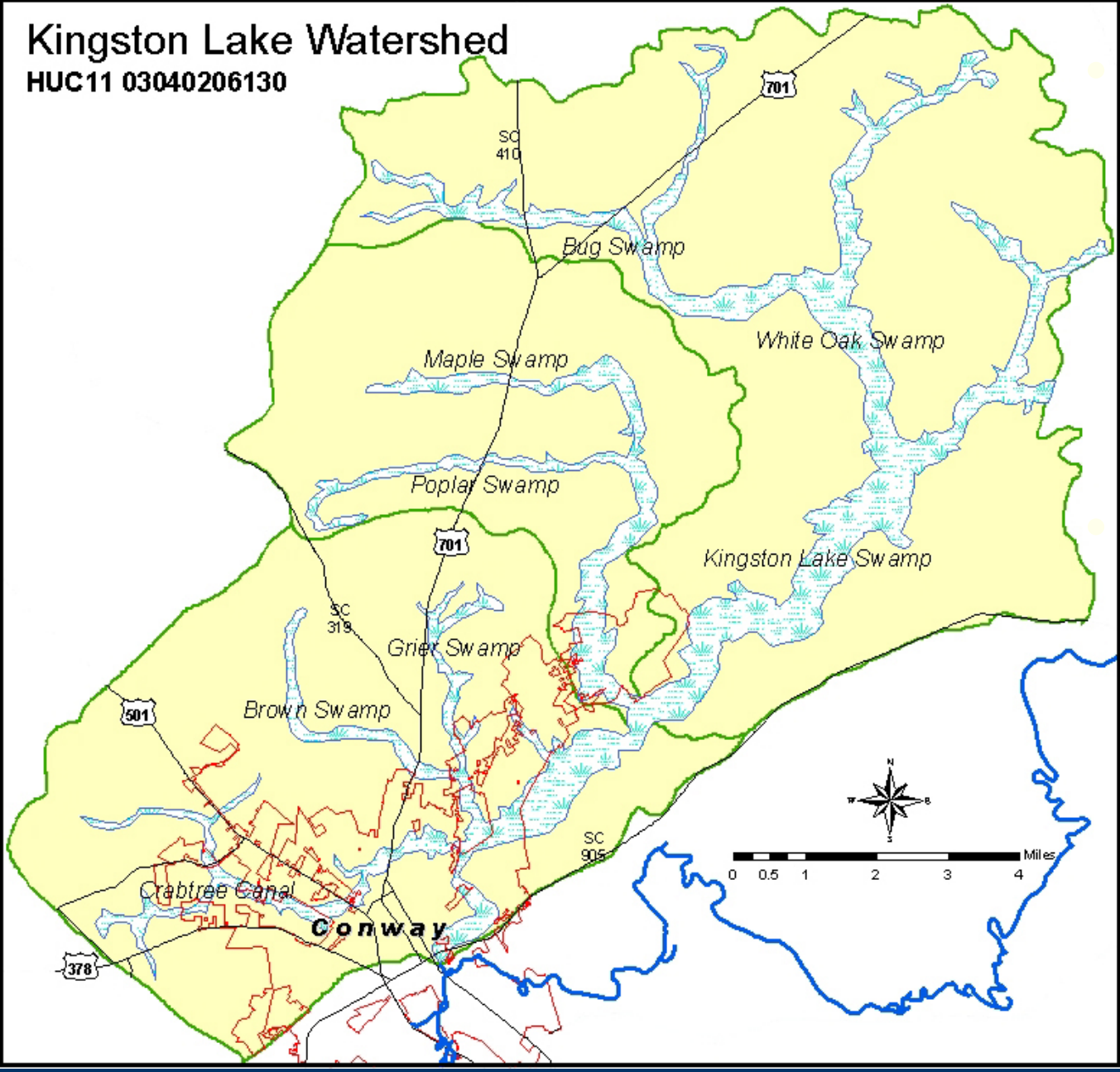
## Waccamaw River

Lake Waccamaw to  
Atlantic Ocean: 140 mi

1,243,000 acres  
drainage

# Kingston Lake Watershed

HUC11 03040206130



## KLW

- 83,446 acres
- 166 stream mi
- 3 subwatersheds
- Two 303(d) listed sites
- Only urban area on River

## KLW Project

- Funded by EPA Region IV
- 06/05 to 03/09
- Watershed management plan development
- Builds on prior WQ research by CCU's WWA



# WACCAMAW WATERSHED ACADEMY

Research and Monitoring	Learning Resources	Educational Services	Communicate	Links
				

Click on an image to get more information

### Mission Statement:

In 2004, Coastal Carolina University established the Waccamaw Watershed Academy (WWA) under the aegis of the Center for Marine and Wetland Studies (CMWS) to meet local needs for expertise in the areas of watershed and wetland science and management. The mission of the academy is to deliver educational, research, and public outreach services to the university and the local region. The latter encompasses the Waccamaw River which lies in Horry and Georgetown counties in South Carolina and Brunswick and Columbus counties in North Carolina.

# Collaborators

City of Conway

Horry County

Waccamaw Regional Council of Governments

Waccamaw Riverkeeper (Winyah Rivers Foundation)

SC Department of Health & Environmental Control – BOW

SC Department of Health & Environmental Control - OCRM

US Fish and Wildlife Service

Winyah Bay Focus Area Task Force

Natural Resources Conservation Service

Center for Watershed Protection

US Environmental Protection Agency

SC Sea Grant Consortium

North Inlet – Winyah Bay National Estuarine Research Reserve

SC Water Resources Institute

Center for Watershed Protection

Earthworks Group



# Why Kingston Lake Watershed and Crabtree Canal?

- Clean up polluted areas & reduce stormwater flooding
  - Two 303(d) listed sites
- Plan for rapid growth
  - Preserve water quality
  - Preserve traditional uses (hunting, fishing, boating)
  - Increase ecotourism
  - Conserve natural areas for wildlife





# Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT)

- Helps coastal managers and local officials predict potential water quality impacts to rivers and streams from nonpoint source pollution and erosion.
- Compares different land-use change scenarios
- Simulates effects of site-specific stormwater BMPs
- Output types
  - Annual accumulated load & concentrations
  - Rain event loads & concentrations
- Pollutants
  - **Nutrients & Sediment**
  - Zinc & Lead



# N-SPECT

- Advantages
  - It's not US EPA's BASINS
  - User Friendly
  - Low data requirement
  - Low computer complexity
- Limitations
  - It's not US EPA's BASINS
  - Not as sophisticated
  - Not necessarily site specific unless you collect a whole lot of data

# NOAA Modelers

- Development team
  - Dr. David L. Eslinger, Jamie Carter, Margaret VanderWilt, Bev Wilson, Ed Dempsey, Andrew Meredith
- Major contributors
  - Hawaii Coastal Zone Management Program
  - NOAA Coastal Services Center (CSC)
  - National Ocean Service Pacific Services Center
  - Hawaiian management community



# N-SPECT Data Requirements

**KLW Management Scenario 8w2005**

File Help

Project Information  
 Name: KLW Management Scenario 8w2 Working Directory: C:\NSPECT\workspace

Land Cover  
 Grid: C-CAP Land Cover 1995  
 Grid Units: meters  
 Type: Kingston\_Lake\_CCAP

Soils  
 Soils Definition: Kingston\_Lake  
 Hydrologic Soils Data Set: C:\NSPECT\kingstonlakedata\soils1

Miscellaneous  
 Selected Polygons Only  
 Layer: KLW\_bnd\_Dissolvi  
 Local Effects Only

Precipitation Scenario  
 Name: Kingston\_Lake

Watershed Delineation  
 Name: Kingston Lake

Water Quality Standard  
 Name: Long Term Criteria

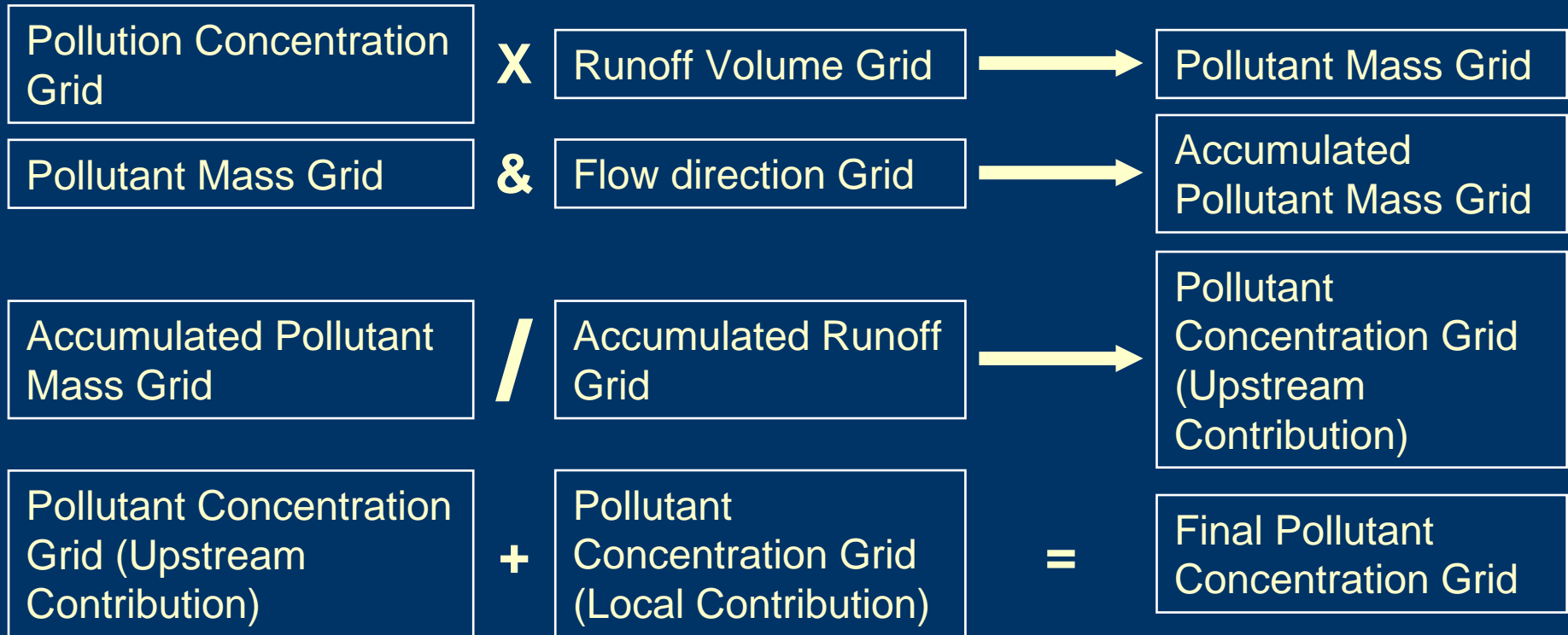
Pollutants | Erosion | Land Uses | Management Scenarios

Apply	Pollutant Name	Coefficient Set	Which Coefficient
<input checked="" type="checkbox"/>	Phosphorus	Kingston_Lake_Phosphorus	Type 1
<input checked="" type="checkbox"/>	Nitrogen	Kingston_Lake_Nitrogen	Type 1
<input type="checkbox"/>	Total Suspended Solids		
<input type="checkbox"/>	Zinc		
<input type="checkbox"/>	Lead		

Run Cancel

- Primary
  - Landcover
  - Soils
  - Precipitation
  - Digital Elevation
  - Water Quality Coefficients
  - Water Quality Standards
- Derivative
  - Watershed Delineation
  - Soil Erosivity Factor


# Annualized Pollutant Load & Concentration



- Doesn't cover first flush issues



# Growth Scenarios

- Historical growth rates projected forward
  - Spatial
  - % areal growth rate : % population growth rate
  - 1:1 (low)
  - 2.5:1 (medium)
  - 3.9:1 (observed for 1992-2001)
- Wetlands Loss rate (8% in 9 yr  1992-2001)
- Only projects development
  - Doesn't differentiate low from high intensity
  - First iteration, used high intensity pollutant coefficient
- Does not include impacts from proposed I-73

CLEMSON  
UNIVERSITY



# Modeling Scenarios for Predicting Impact of Increased Growth on Phosphorus, Nitrogen & Sediment Loads & Concentrations

Time Steps:  
2005, 2010, 2015,  
2020, 2025, 2030

Historical wetland  
Development rate

No wetland  
development

**Worst case**

**Best case**

Growth ratios  
(1:1, 2.5:1, 3.9:1)

Growth ratios  
(1:1, 2.5:1, 3.9:1)

Annual  
Accumulated  
Load

Annual Mean  
Concentration

Annual  
Accumulated  
Load

Annual Mean  
Concentration

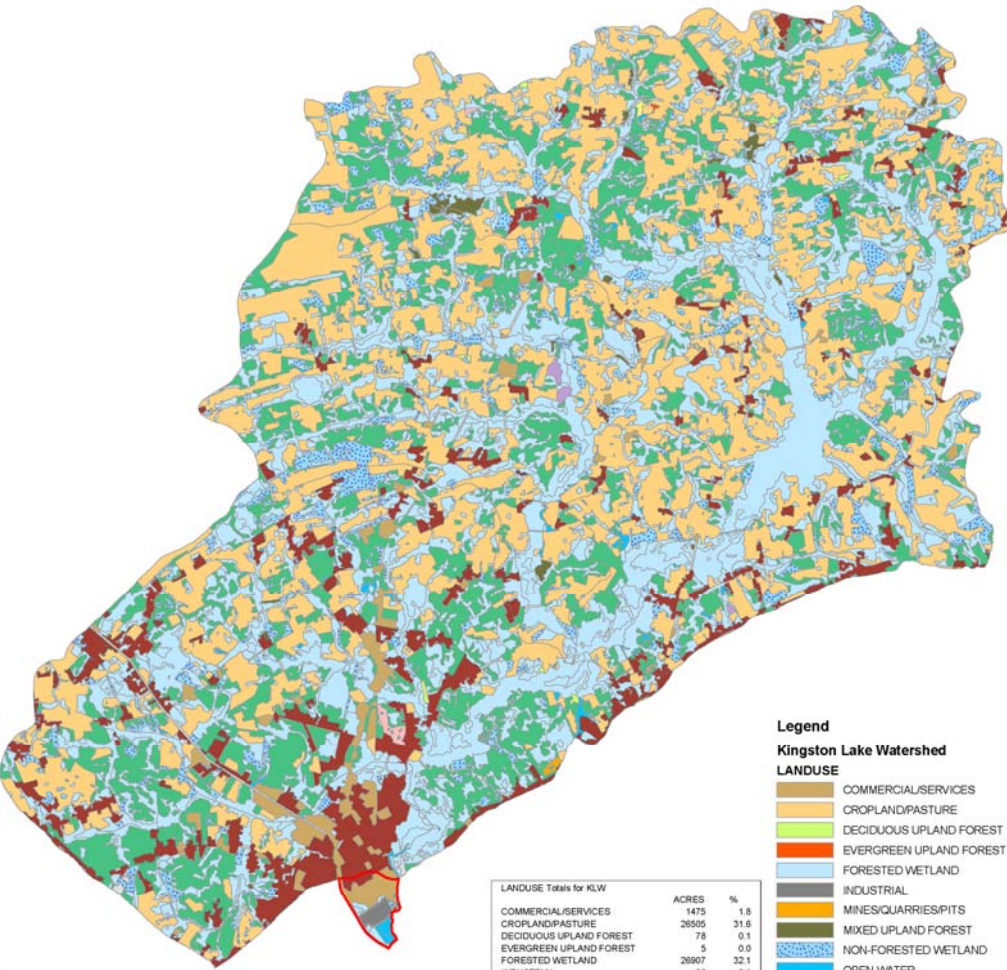
### C-CAP Land Cover 1990

- High Intensity Developed
- Low Intensity Developed
- Cultivated Land
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Scrub/Shrub
- Palustrine Forested Wetland
- Palustrine Scrub/Shrub Wetland
- Palustrine Emergent Wetland
- Estuarine Emergent Wetland
- Unconsolidated Shore
- Bare Land
- Water



# Kingston Lake Watershed Landuse

HUC11-03040206-130



LANDUSE Totals for KLW	ACRES	%
COMMERCIAL/SERVICES	1475	1.8
CROPLAND/PASTURE	26505	31.6
DECIDUOUS UPLAND FOREST	78	0.1
EVERGREEN UPLAND FOREST	5	0.0
FORESTED WETLAND	28907	32.1
INDUSTRIAL	80	0.1
MINES/QUARRIES/PITS	23	0.0
MIXED UPLAND FOREST	319	0.4
NON-FORESTED WETLAND	4463	5.3
OPEN WATER	654	0.8
ORCHARD/GROVE/VINEYARD	70	0.1
OTHER URBAN	73	0.1
RESIDENTIAL	6062	7.2
SANDY AREA	16	0.0
TRANSPORTATION/UTILITIES	349	0.4
UPLAND PLANTED PINE	16776	20.0
<b>TOTALS</b>	<b>83882</b>	<b>100</b>

scale 1:120,000

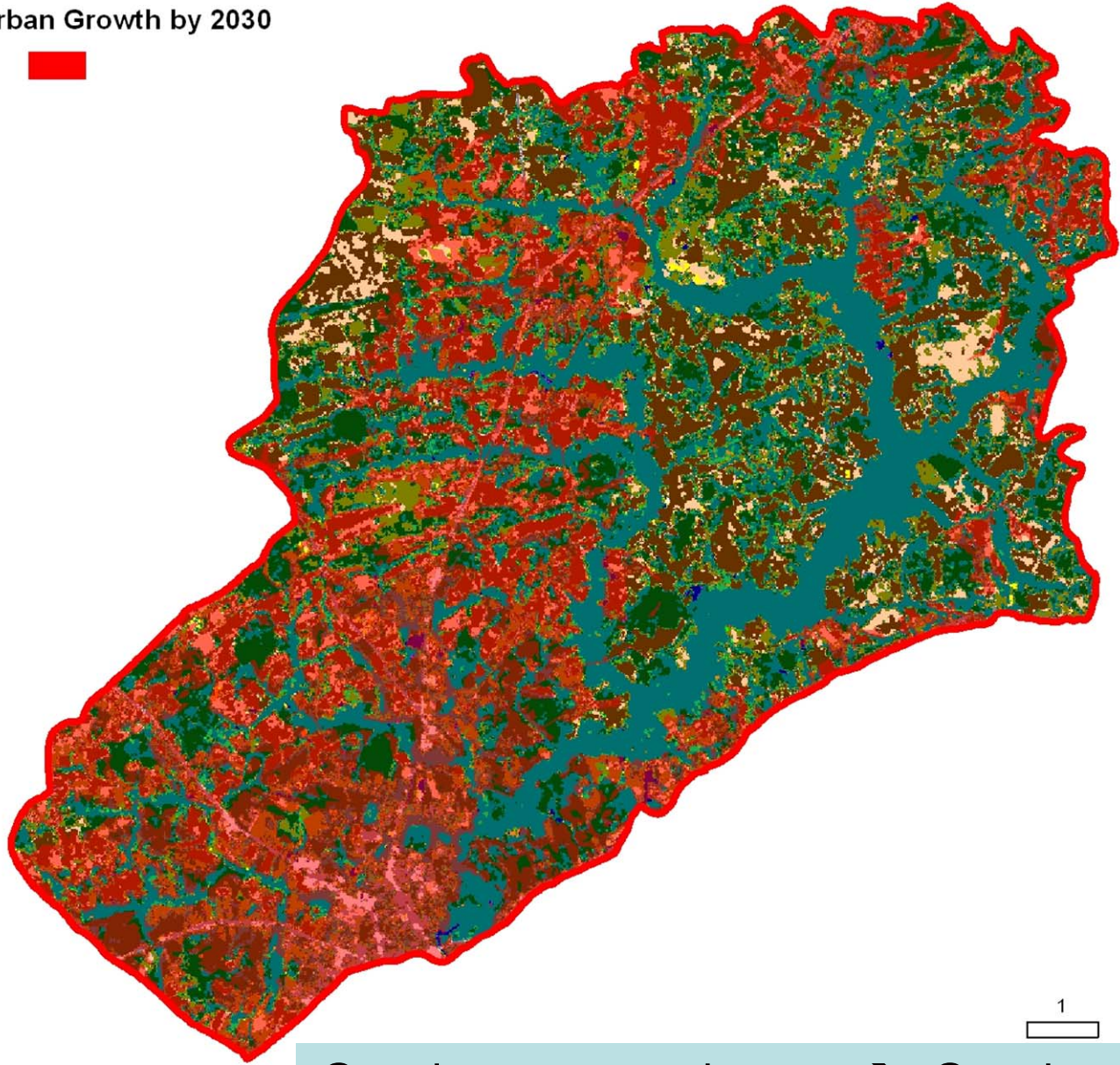
source: 94NM maps (2002)

LANDUSE	%
COMMERCIAL/SERVICES	1.76
CROPLAND/PASTURE	31.60
DECIDUOUS UPLAND FOREST	0.09
EVERGREEN UPLAND FOREST	0.01
FORESTED WETLAND	32.08
INDUSTRIAL	0.10
MINES/QUARRIES/PITS	0.03
MIXED UPLAND FOREST	0.38
NON-FORESTED WETLAND	5.32
OPEN WATER	0.82
ORCHARD/GROVE/VINEYARD	0.08
OTHER URBAN	0.09
RESIDENTIAL	7.23
SANDY AREA	0.02
TRANSPORTATION/UTILITIES	0.42
UPLAND PLANTED PINE	20.00





Maximum Urban Growth by 2030



Growing crops and trees → Growing houses

# Pollutant Coefficients by Land Use Type

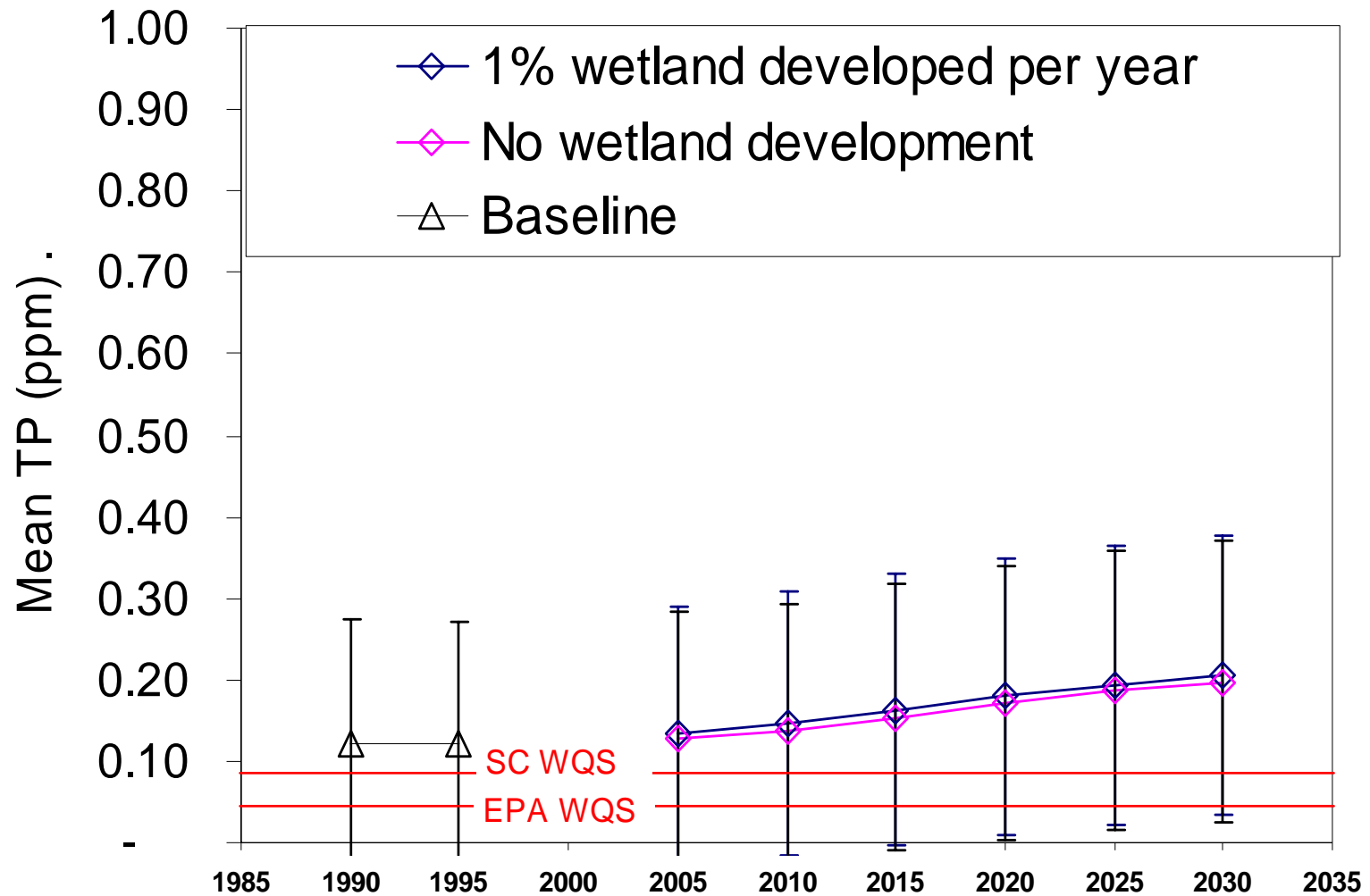
Landcover Type	Nitrogen Coefficient	Phosphorus Coefficient
High Intensity Developed	1.7	0.47
Low Intensity Developed	2.68	0.18
Cultivated Land	2.48	0.42
Grassland	1.25	0.48
Deciduous Forest	1.25	0.05
Evergreen Forest	1.25	0.05
Mixed Forest	1.25	0.05
Scrub/Shrub	1.1	0.05
Palustrine Forested Wetland	1.1	0.2
Palustrine Scrub/Shrub Wetland	1.1	0.2
Palustrine Emergent Wetland	1.1	0.2
Bare Land	0	0
Water	0	0

Not site specific (yet)

Source: N-SPECT Technical Guide, Appendix B

# Phosphorus Benchmarks

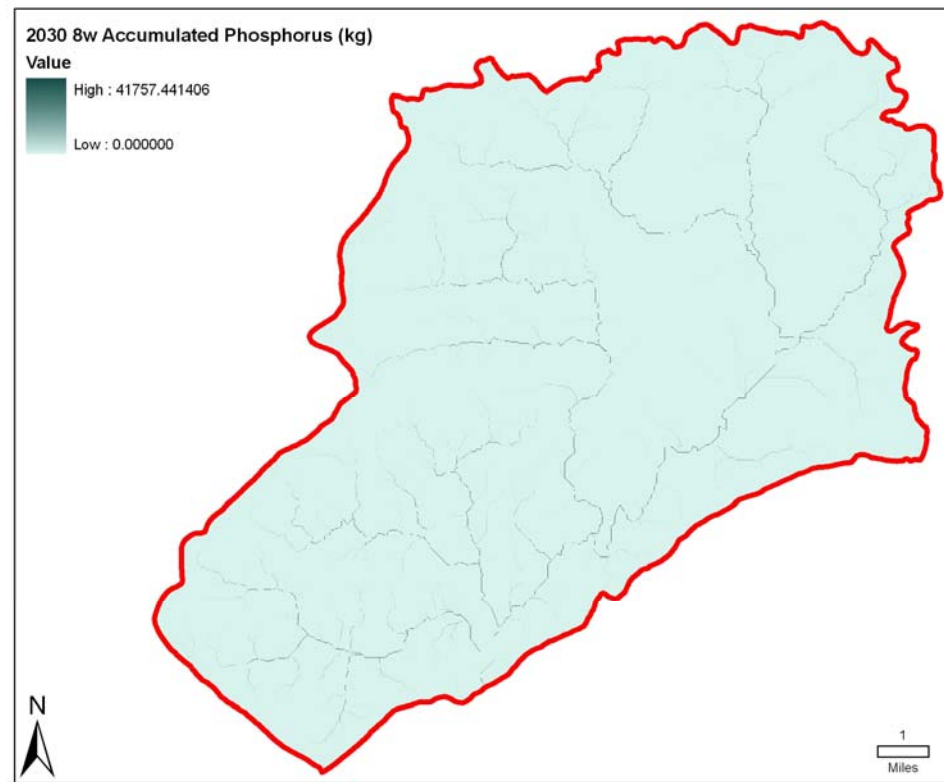
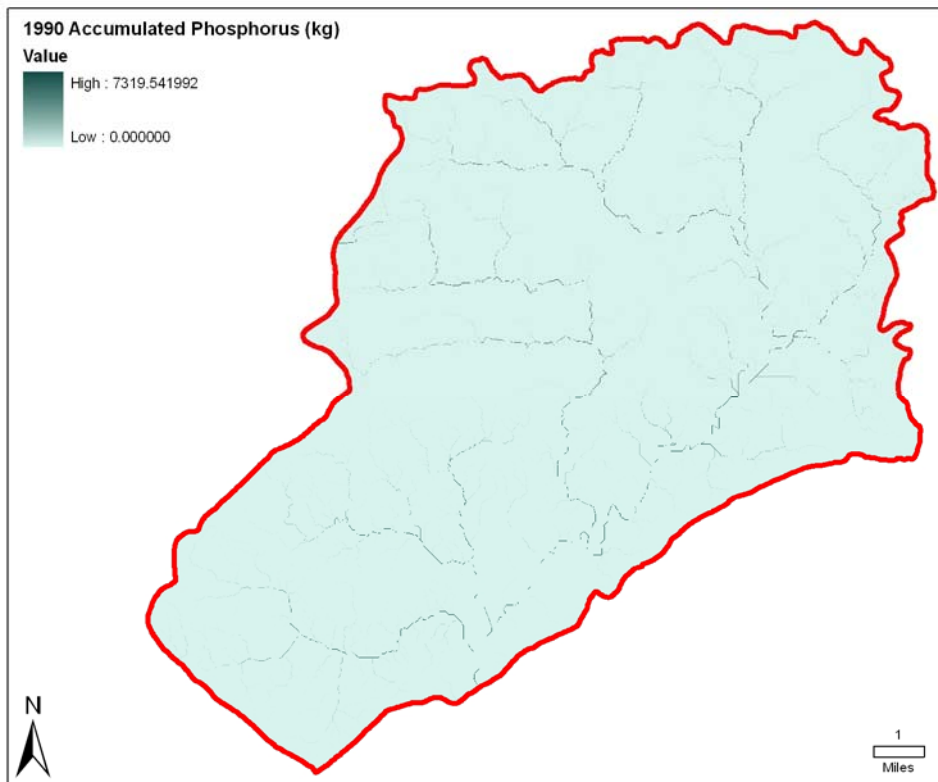
- Water Quality Standards
  - SC State Standards
    - 0.09 ppm P as TP
  - EPA Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion XIV, Level III Ecoregion 63 (2000)
    - 0.05 ppm P as TP
- Observational Data
  - Storet from Crabtree and Kingston Lake as TP
    - 2003: Crabtree Mean  $0.04 \pm 0.01$  ppm P as TP
    - 2003: Kingston Lake  $0.03 \pm 0.01$  ppm P as TP
    - 2005: Kingston Lake  $0.05 \pm 0.02$  ppm P as TP
  - US EPA 319 Project (1999-2001) in KLW
    - Median dry weather:  $0.01 \pm 0.02$  ppm P-phosphate
    - Median wet weather:  $0.28 \pm 0.09$  ppm P-phosphate



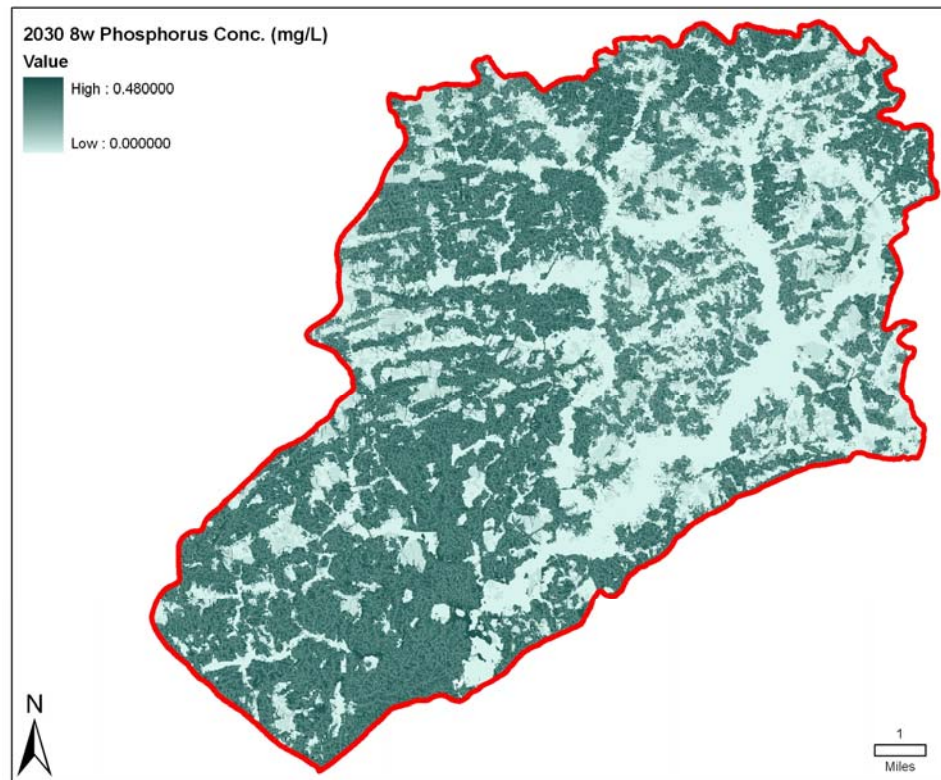
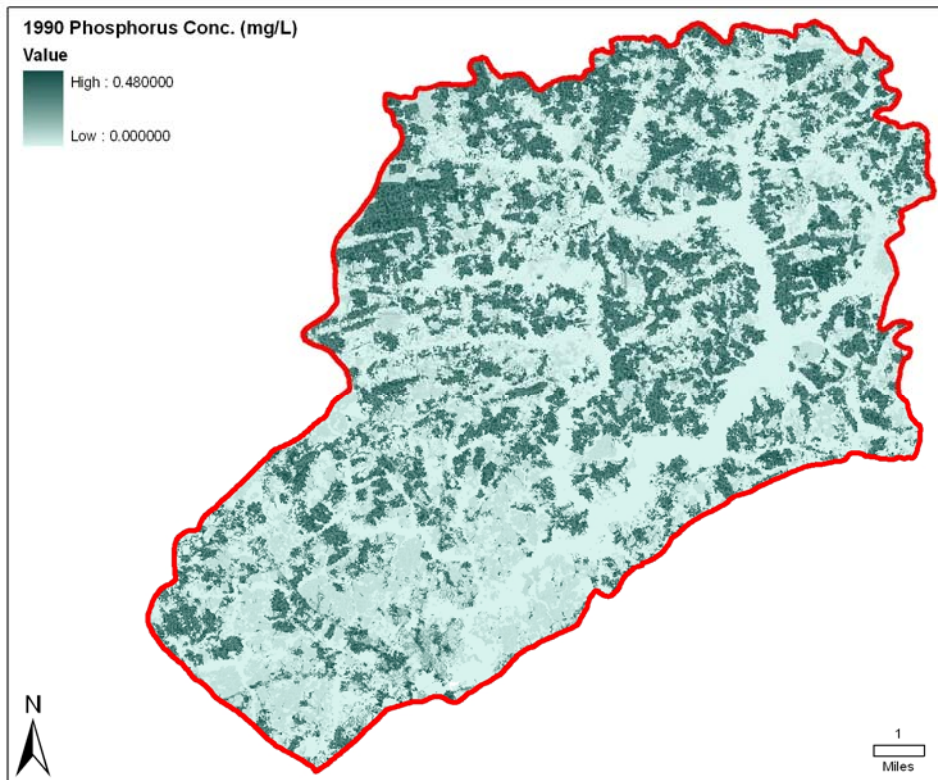
- Model scenarios exceed both State and EPA WQS
- 67% increase from baseline to 2030 (61% nw)
- Large standard deviation due to watershed accumulating effect



# Phosphorus Accumulated Load

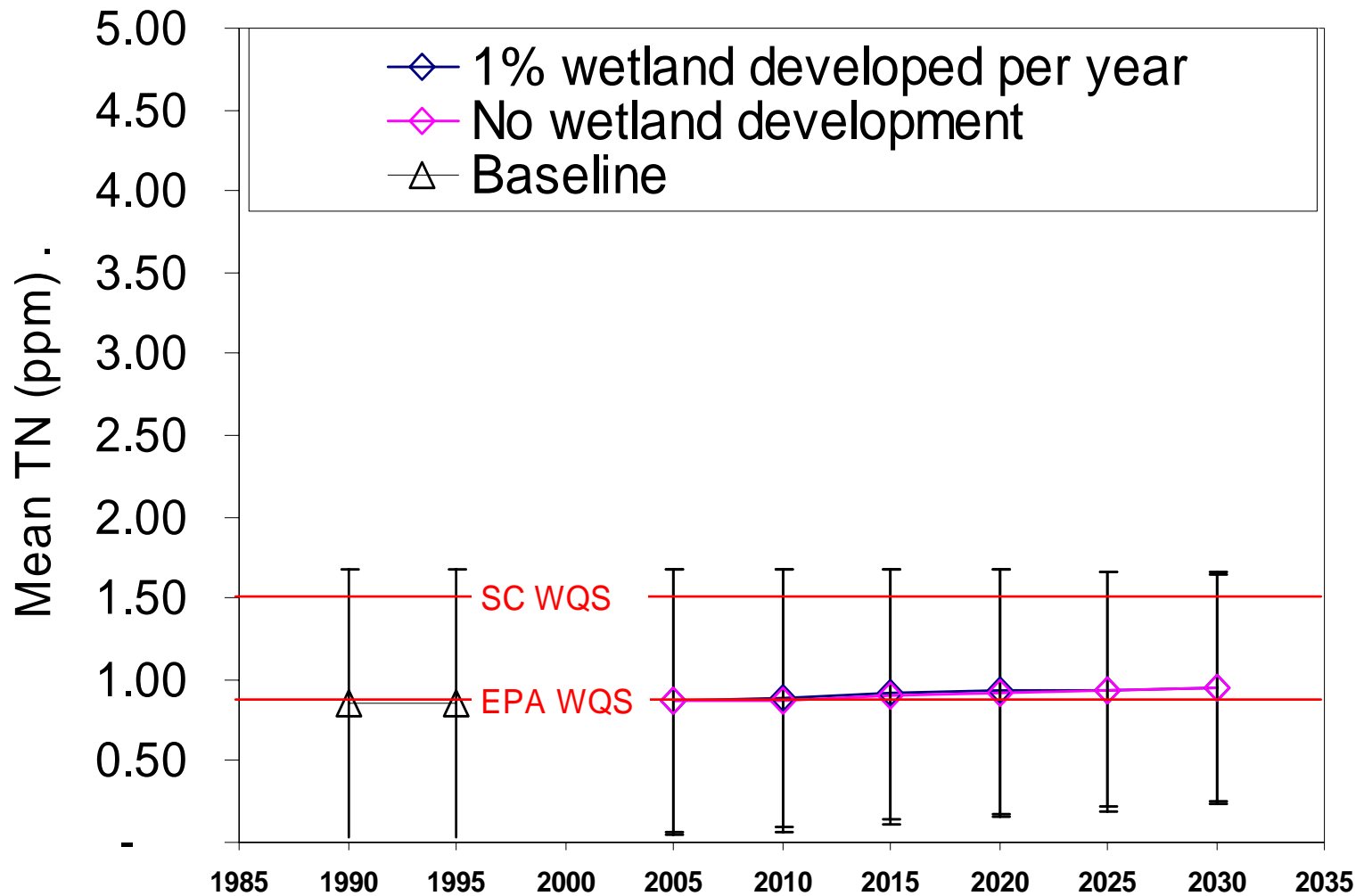


# Phosphorus Concentrations



# Nitrogen Benchmarks

- Water Quality Standards
  - SC State Standards
    - 1.5 ppm N as TN
  - EPA Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion XIV, Level III Ecoregion 63 (2000)
    - 0.87 ppm N as TN
- Observational Data
  - Storet from Crabtree and Kingston Lake as TN
    - 2003: Crabtree  $1.486\text{ppm} \pm 0.0933$  as TN
    - 2003: Kingston Lake  $1.6343\text{ppm} \pm 0.5299$  as TN
    - 2005: Kingston Lake  $1.2783\text{ppm} \pm 0.2551$  as TN
  - US EPA 319 Project (1999-2001) in KLVW
    - Median dry weather (urban):  $0.81 \pm 0.40$  ppm TDIN
    - Mean wet weather peak (2001):  $0.37 \pm 0.25$  ppm TDIN



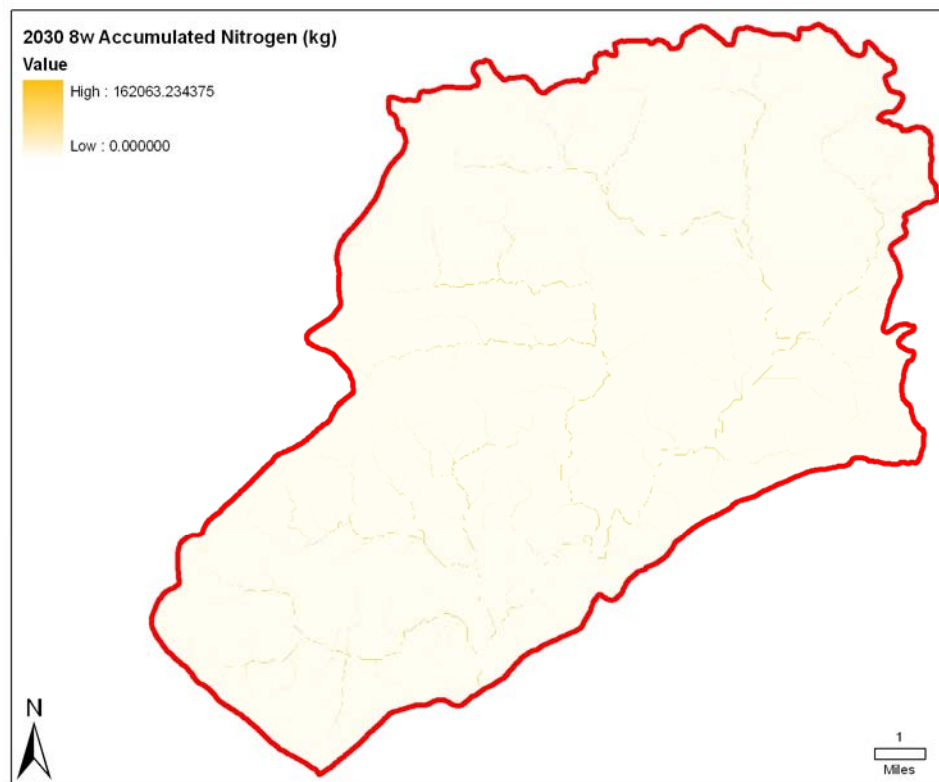
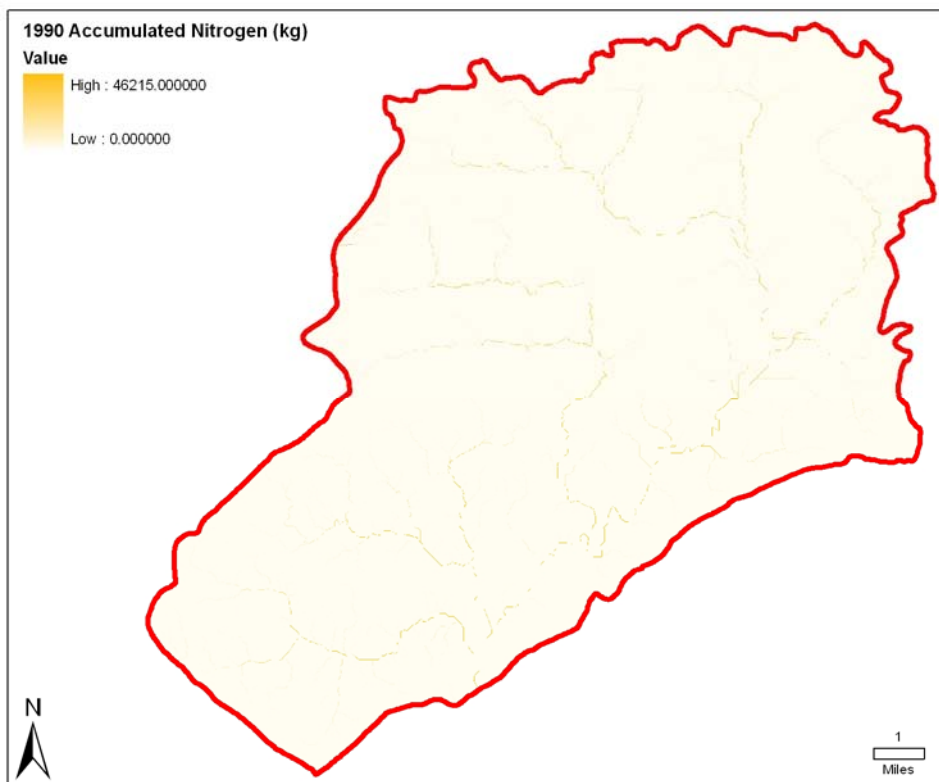
Within State WQS, Exceeds EPA WQS by 2015

12 % increase over time (10.5% nw)

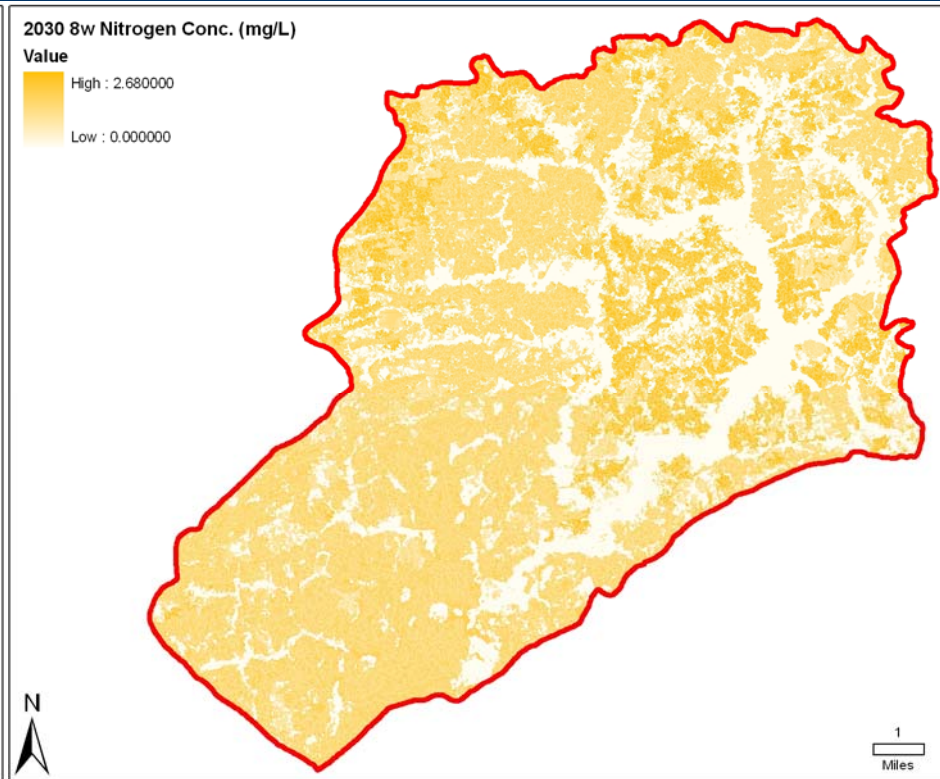
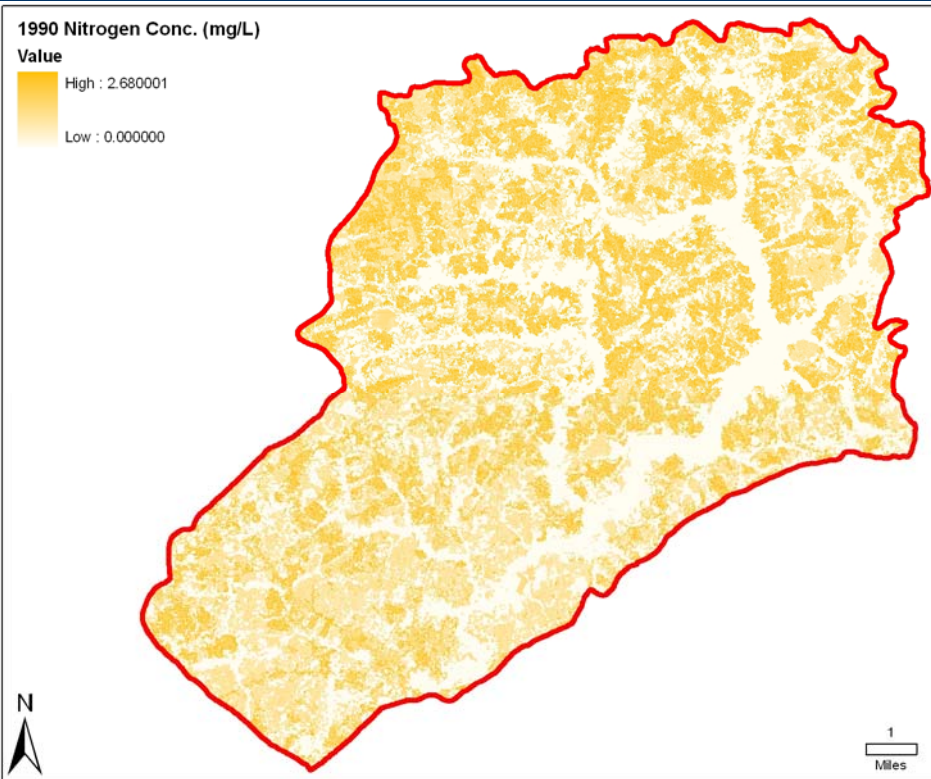
Large standard deviation due to the accumulating effect across the watershed



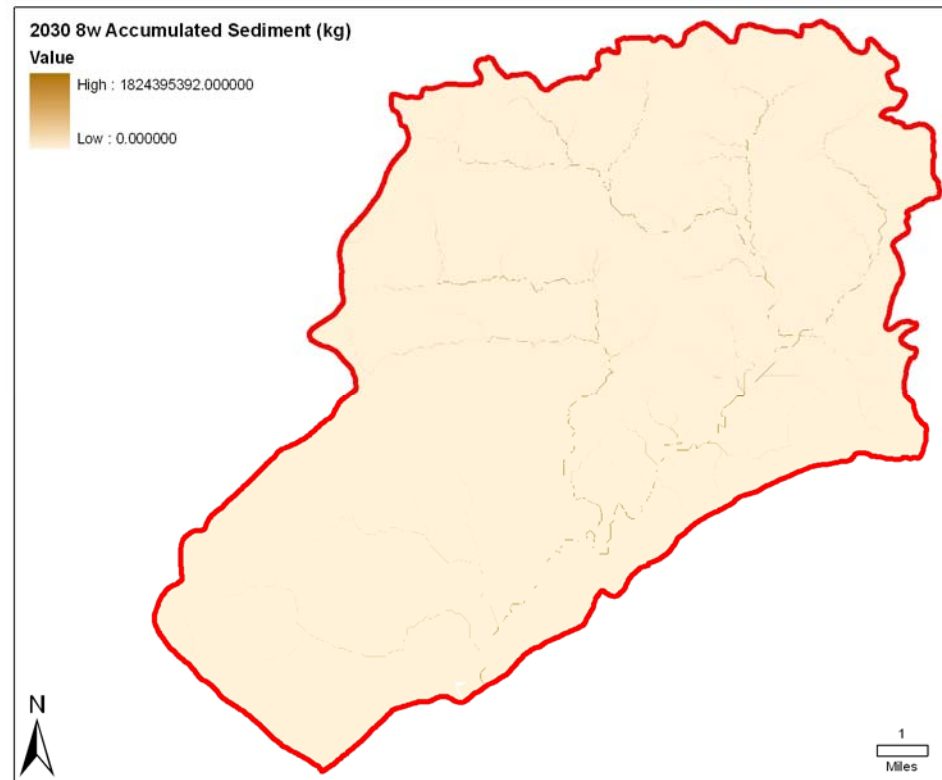
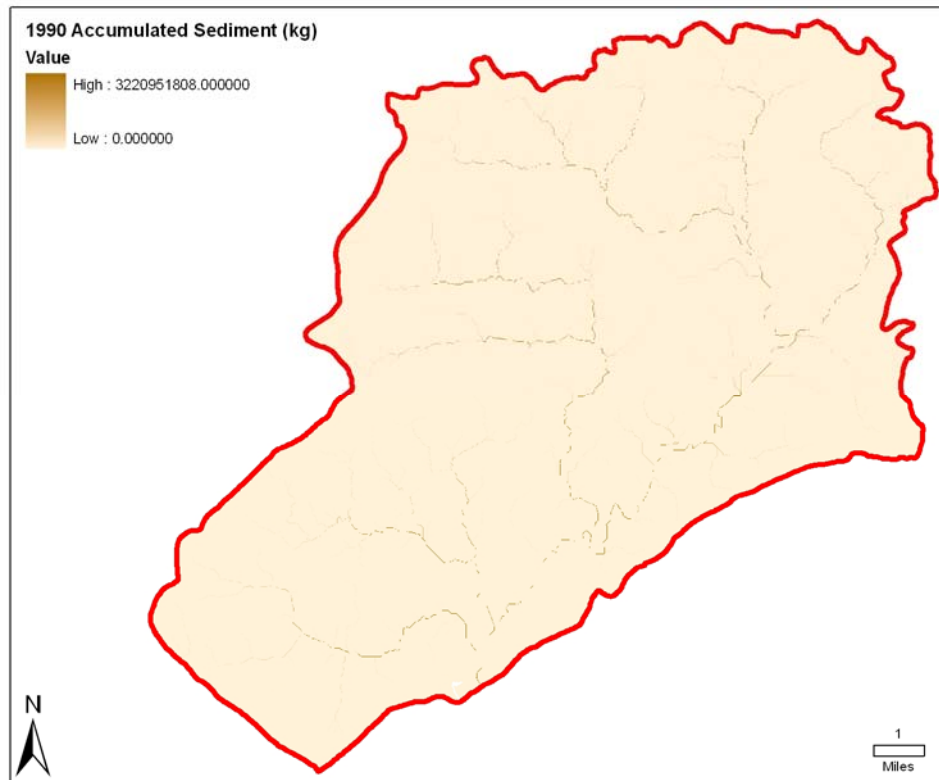
# Nitrogen Accumulated Load



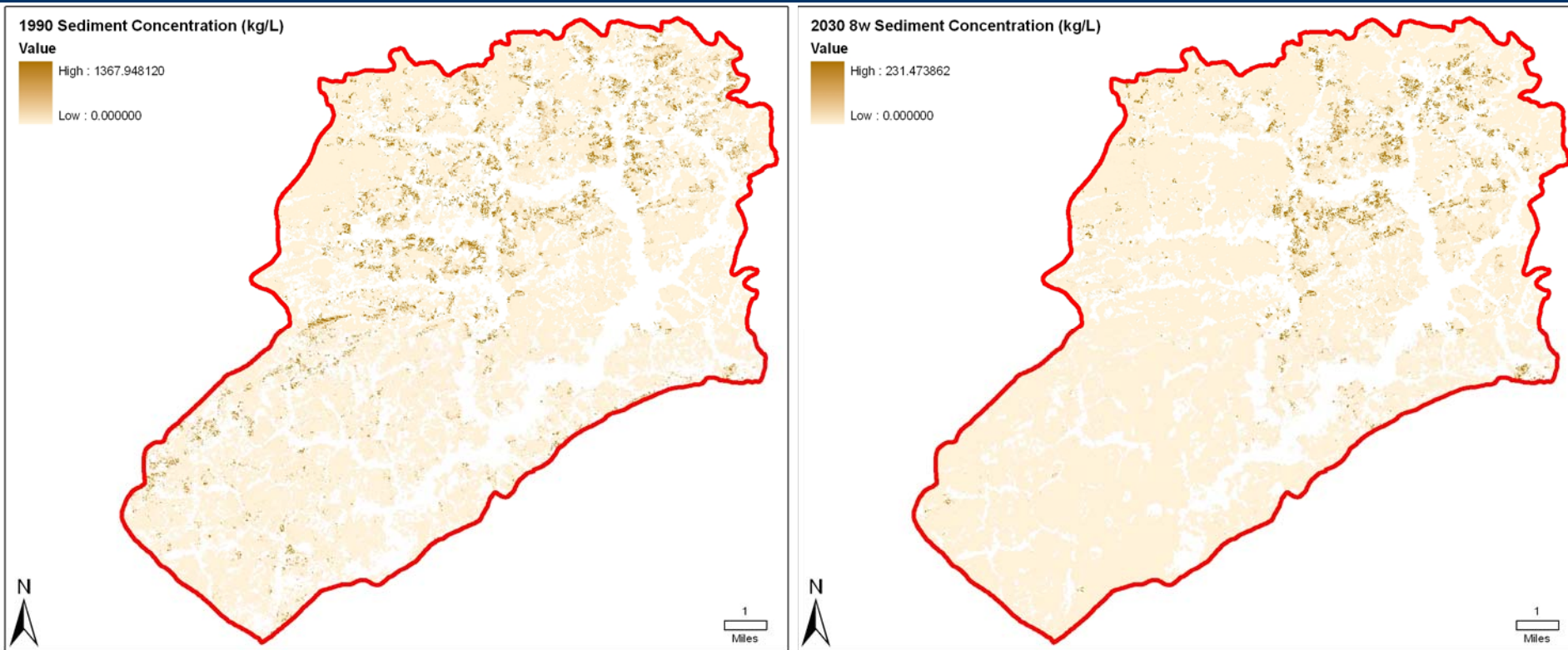
# Nitrogen Concentrations



# Sediment Accumulated Load



# Sediment Concentrations

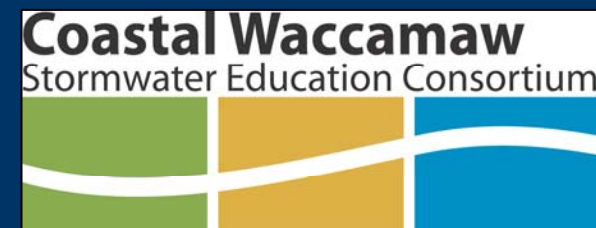


- Sediment concentration initially increases 7% (1990 to 1995), then decreases by 69% (65% nw)
- As more land is developed less sediment is available to be mobilized
- No longer growing crops & trees instead growing houses



# Outreach Plan

- Conceptual tool for community-based land-use planning
- Educational tool for the new NPDES Phase II Program requirements for SMS4's (Conway and Horry County)
  - Coastal Waccamaw Stormwater Education Consortium
  - Nonpoint source education for municipal officials style presentations



# Future Directions

- Create site-specific pollutant coefficients using water quality data from US EPA 319 Project (1991-2001)
- Partition development into low and high intensity
- Create rain event scenarios with site-specific data
- Create stormwater BMP scenarios
  - Assign special pollutant coefficient and soil curve number to a particular polygon
- Develop datalayer animations
- Develop strategy for using continuous monitoring data from USGS gauging stations established in 2006 & 2007



# Acknowledgements

- NOAA Coastal Services Center
- Waccamaw Regional Council of Government
- Environmental Protection Agency
- Clemson University, Strom Thurmond Institute, South Carolina Water Resources Center