



# Waters of the State

**Forty Years of Surface Water Monitoring and Assessment by SCDHEC**

**James B Glover, Ph.D.**

**South Carolina Department of Health and Environmental Control**

*Promoting and Protecting the Health of the Public and the Environment*



**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*

## Surface Water Monitoring and Assessment

Why?

Where?

When?



# Why?



**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*

## **Rivers on Fire** **Cuyahoga River, Ohio circa 1950's and 1960's**



Credits:

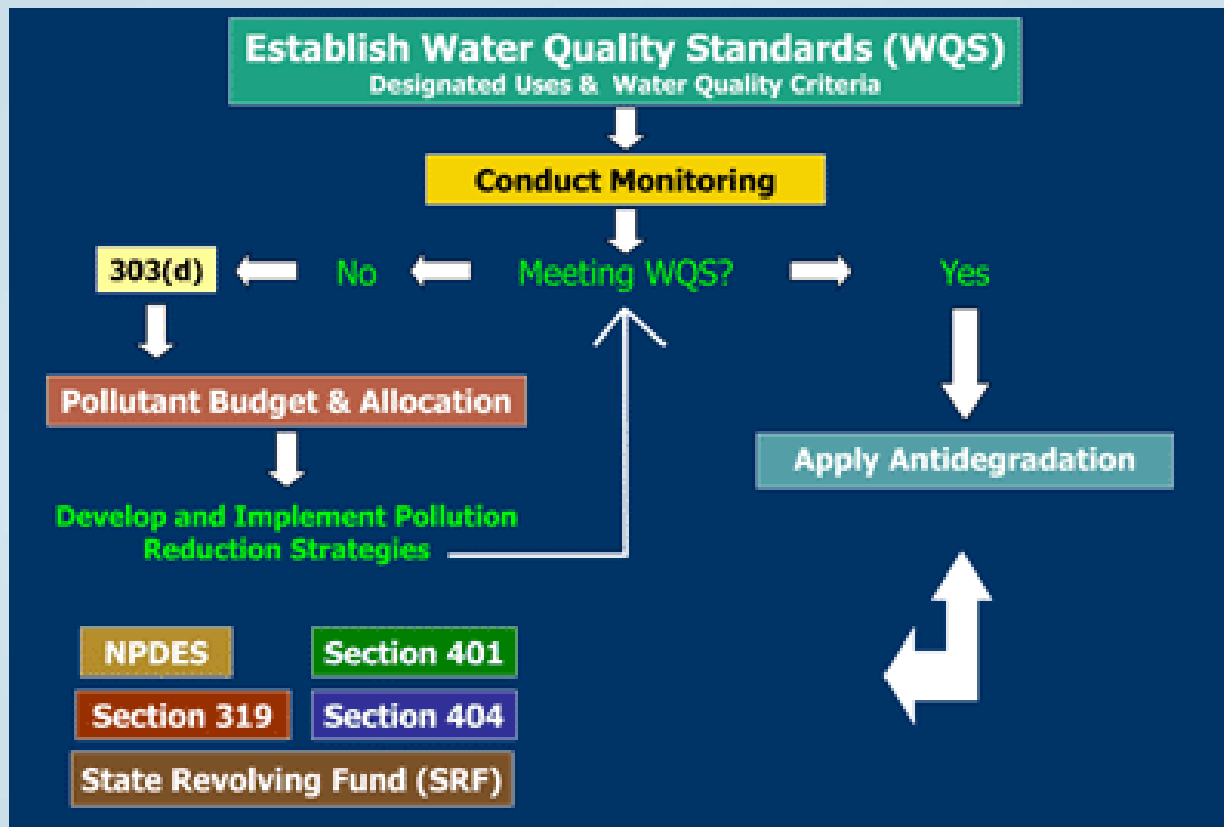
<http://www.ohiohistorycentral.org/entry.php?rec=1642>

# Why?

CWA § 101 [33 USC 1251]. Congressional Declaration of Goals and Policy. a) Restoration and maintenance of chemical, physical and biological integrity of Nation's waters



**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*



Monitoring and assessment provides the feedback loop to evaluate the effectiveness of environmental management programs. Without appropriate standards and a robust monitoring program the goals of the CWA, and the mission of SCDHEC, can not be achieved.

# Where? Point Sources

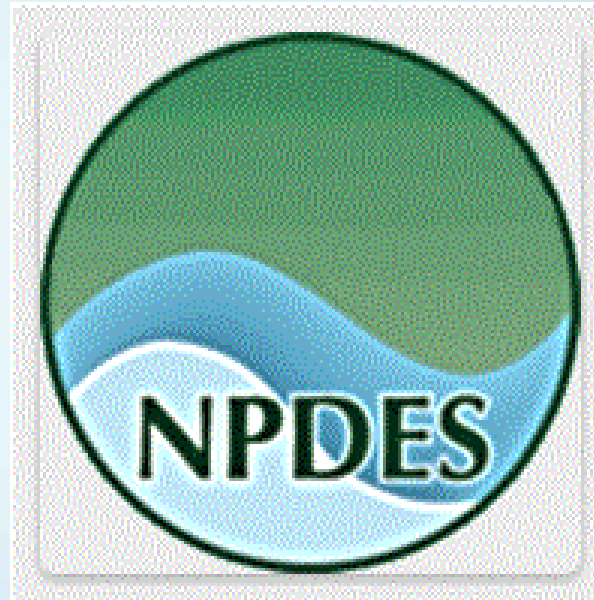


**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*

**Human activities, in part, that have or could alter the chemical, physical, and biological integrity of the waters of the State**

## **Point Source Discharge**

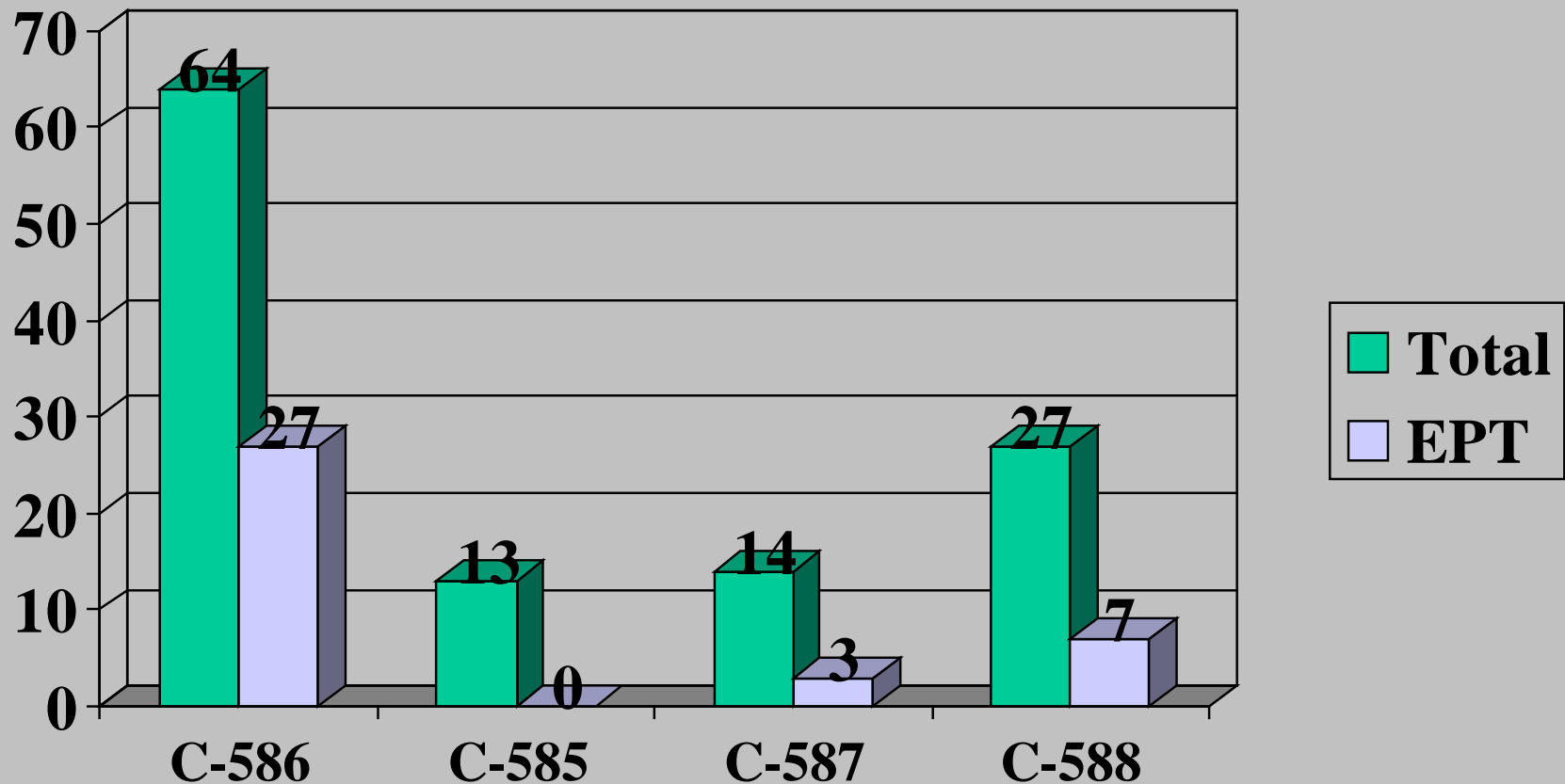
The NPDES permitting process has been extremely effective at restoring our Nations waters from what they were in the 1950's and 60's. But to continue to evaluate their effectiveness monitoring must occur.



*"All models are wrong. Some models are useful." George Box, statistician*

## Where and When to sample? Catastrophic Events

### Macroinvertebrate Community Impact Assessment following a chemical release into Red Bank Creek, Feb. 2000.



# Where and When? Spills



**South Carolina Department of Health and Environmental Control**

*Promoting and Protecting the Health of the Public and the Environment*

## Colonial Oil Pipeline Oil Spill of 1996

June 26, 1996

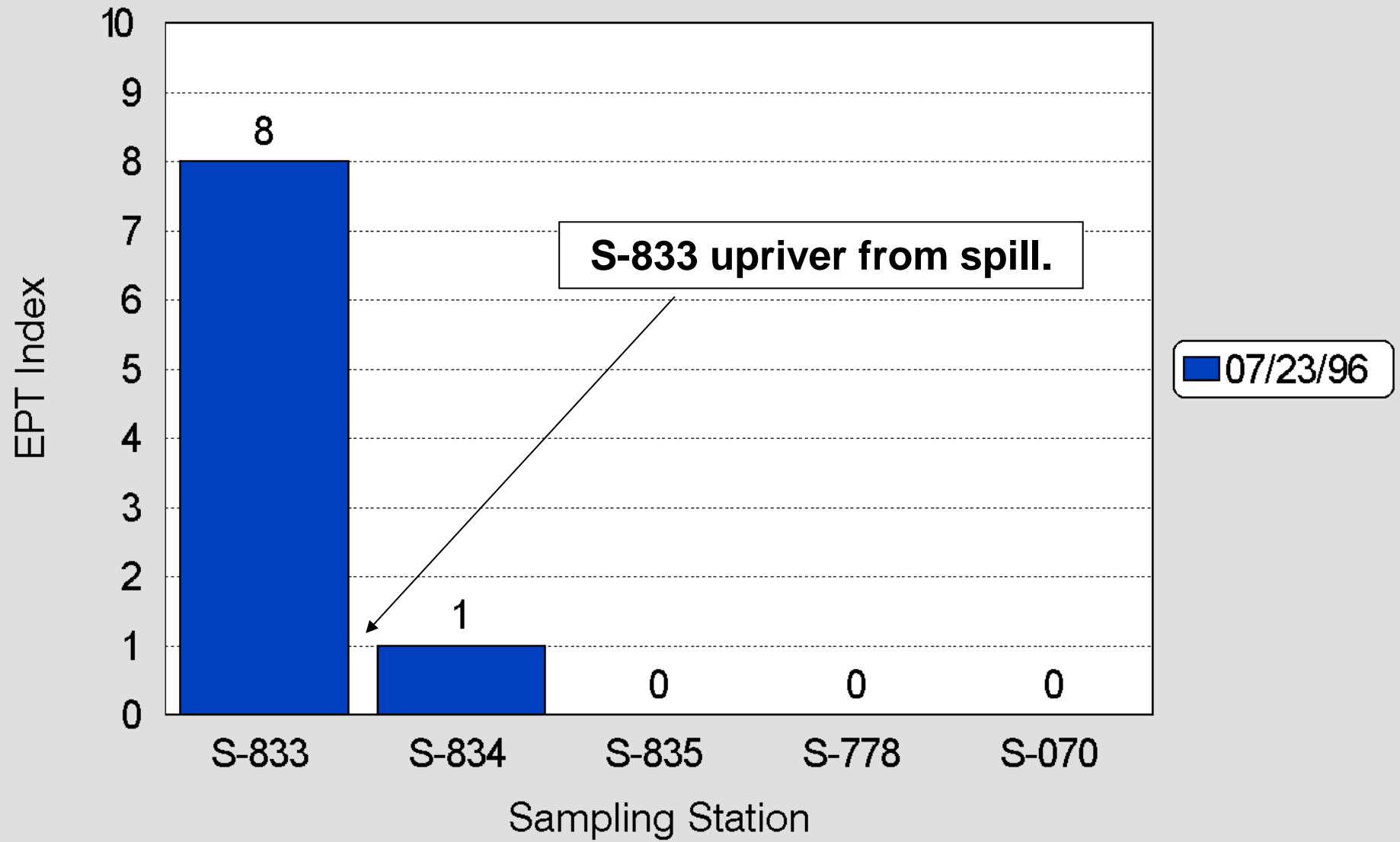
Rupture Released 22,800 barrels  
(957,600 gallons) of Diesel Fuel  
Oil #2

Fuel traveled 22 miles downstream

Fish kill estimated at 35000



# EPT Index for benthic macroinvertebrate samples collected from Reedy River during July 1996





# Where and When? Changes in Landuse

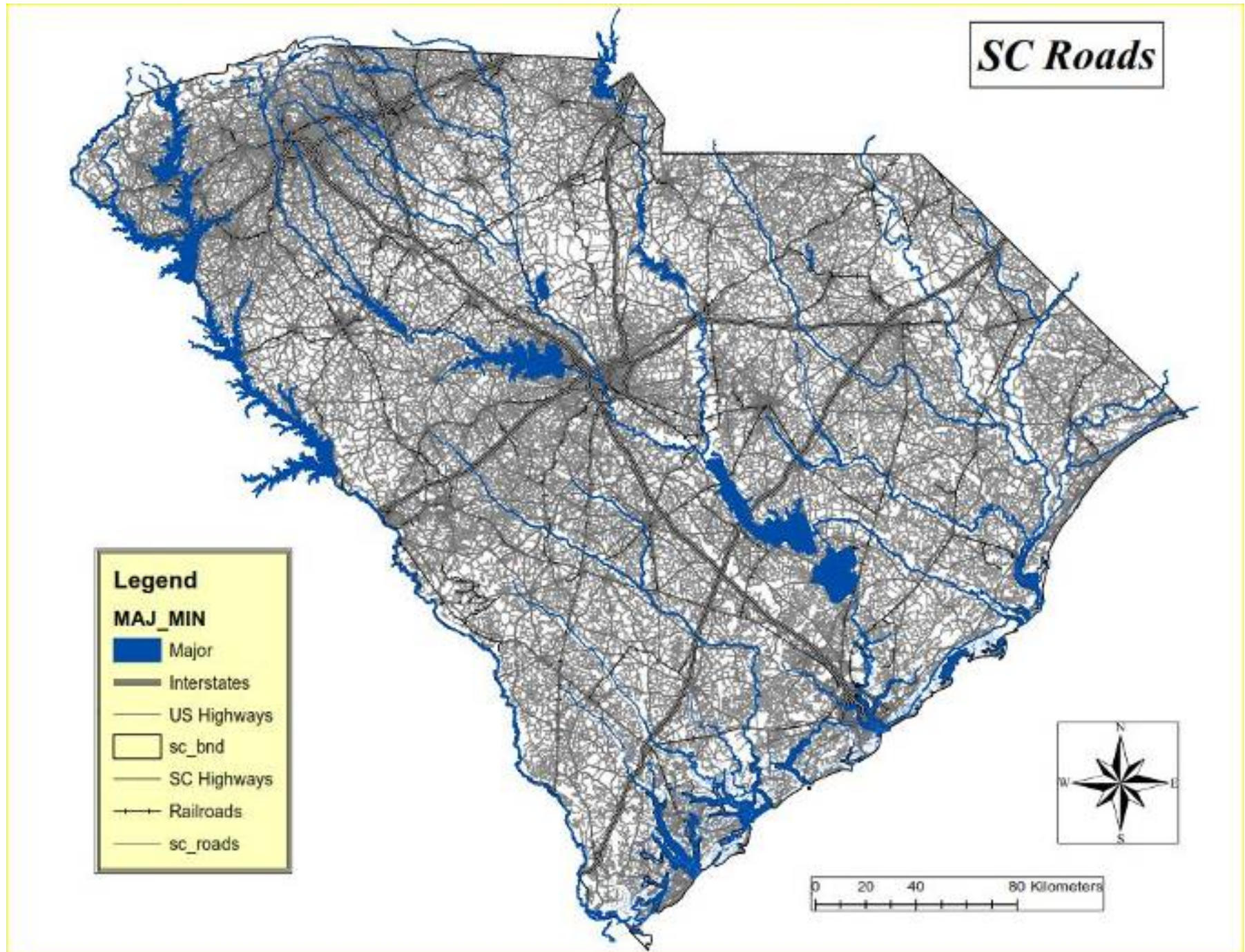


**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*

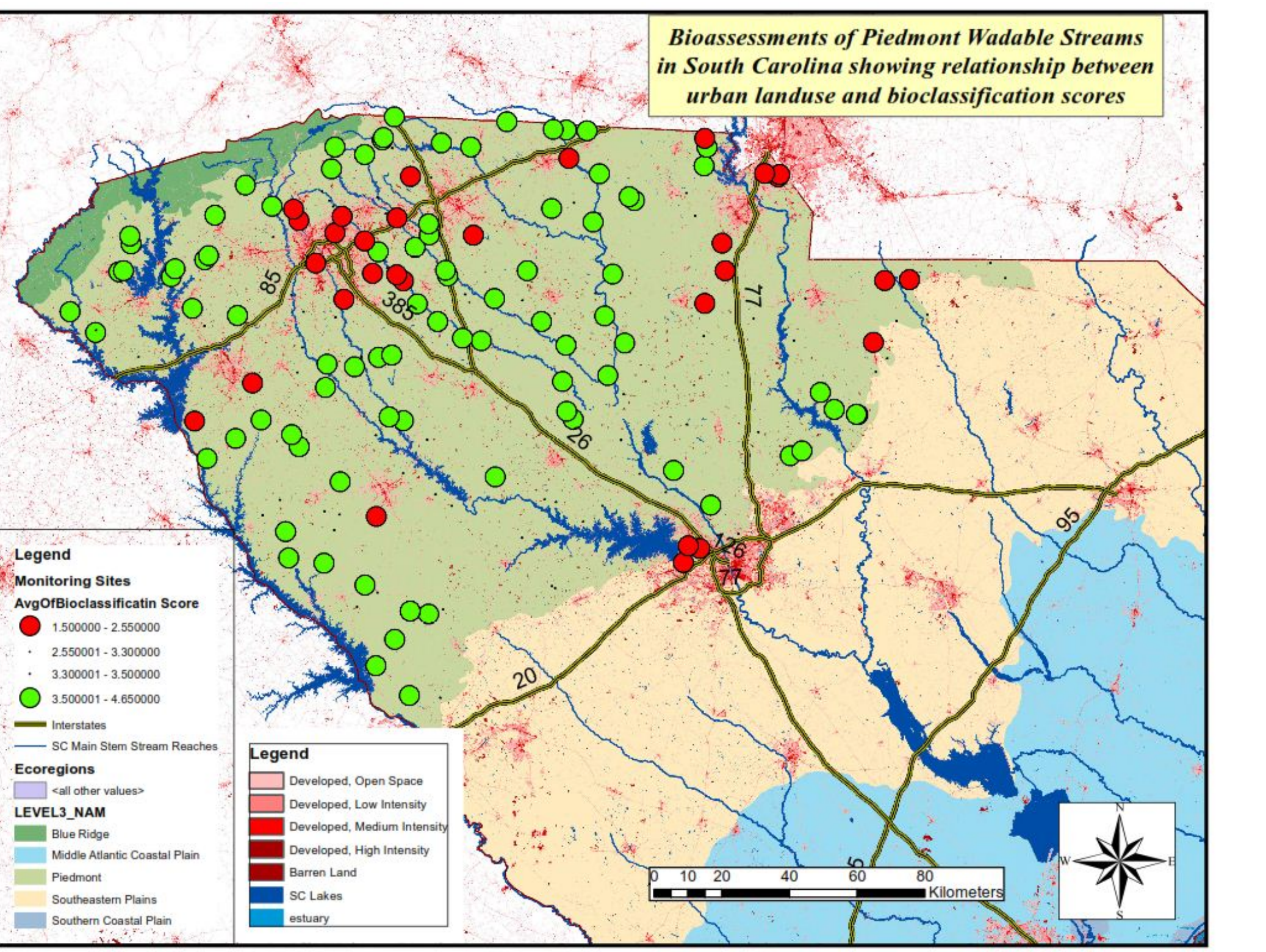
~~BMP~~



Landuse Changes cont.



*Bioassessments of Piedmont Wadable Streams in South Carolina showing relationship between urban landuse and bioclassification scores*



**Legend**

**Monitoring Sites**

**AvgOfBioclassificatin Score**

- 1.500000 - 2.550000
- 2.550001 - 3.300000
- 3.300001 - 3.500000
- 3.500001 - 4.650000

— Interstates

— SC Main Stem Stream Reaches

**Ecoregions**

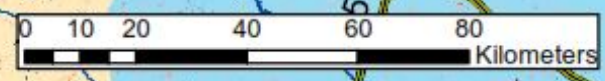
- <all other values>

**LEVEL3\_NAM**

- Blue Ridge
- Middle Atlantic Coastal Plain
- Piedmont
- Southeastern Plains
- Southern Coastal Plain

**Legend**

- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- SC Lakes
- estuary



Urban landuse practices has led to significant water quality degradation.

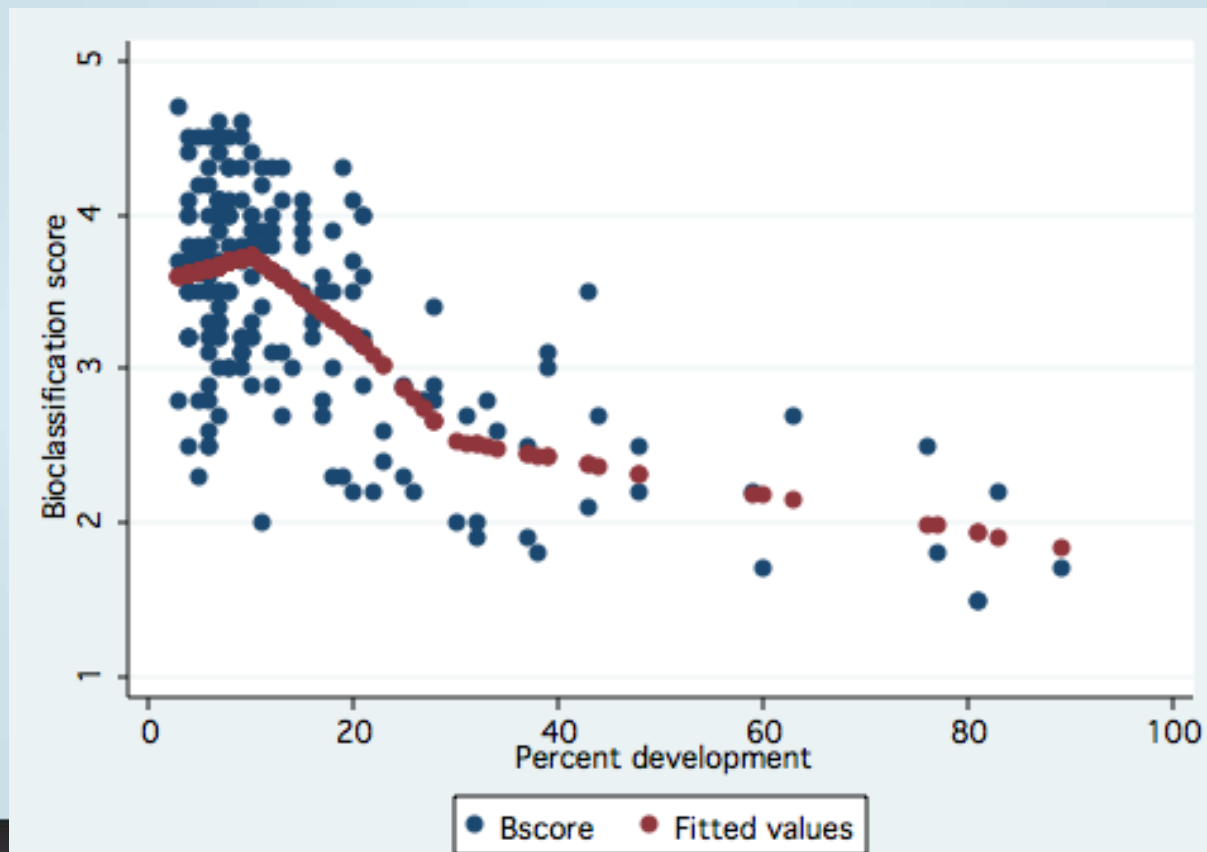


**South Carolina Department of Health and Environmental Control**

*Promoting and Protecting the Health of the Public and the Environment*

### Relationship of % Developed land use to SC Bioclassification Score

Spline Regression; knots equal 10%, 20%, 30%

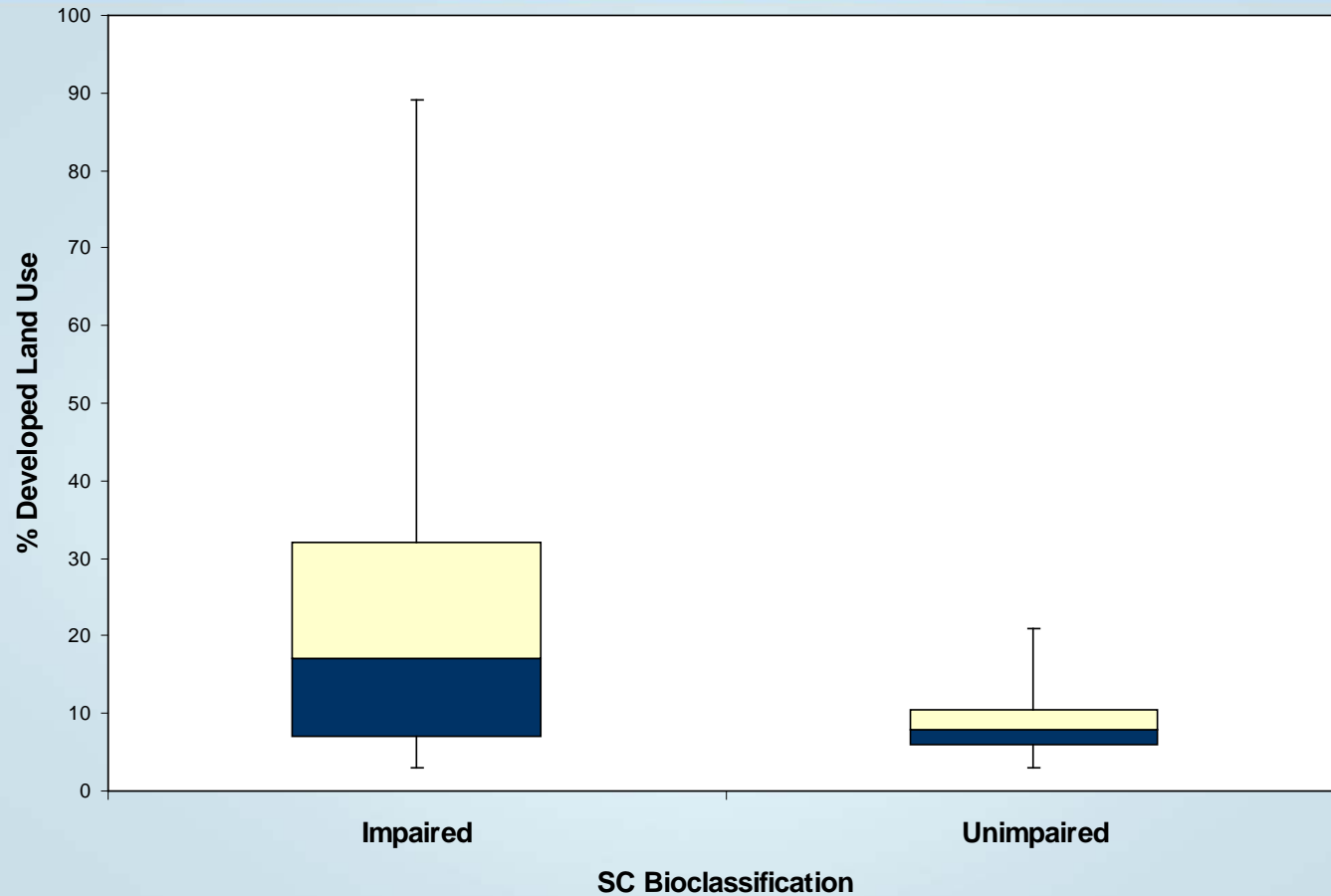


From Glover et al. 2008. The effects of watershed landuse on aquatic biota in South Carolina. *Proceedings of the 2000 South Carolina Water Resources Conference*, held October 14-15, 2010, Charleston SC.

Box Plots comparing condition categories with  
% developed watershed land use.



**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*



# Hydrologic Modification



**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*

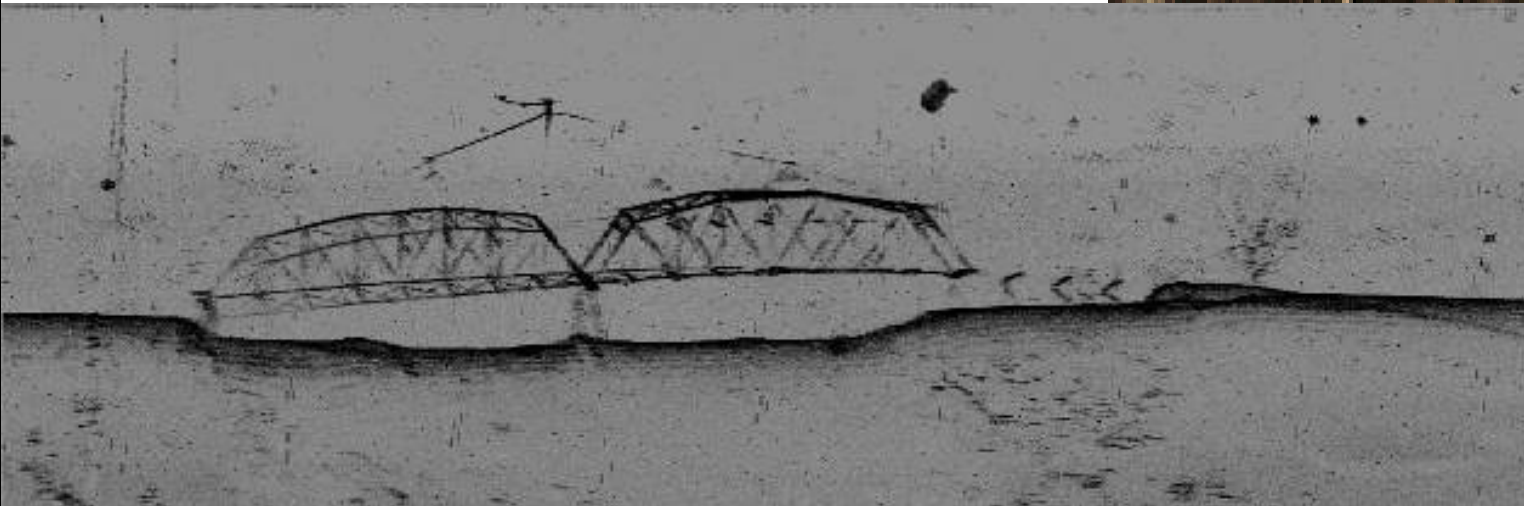
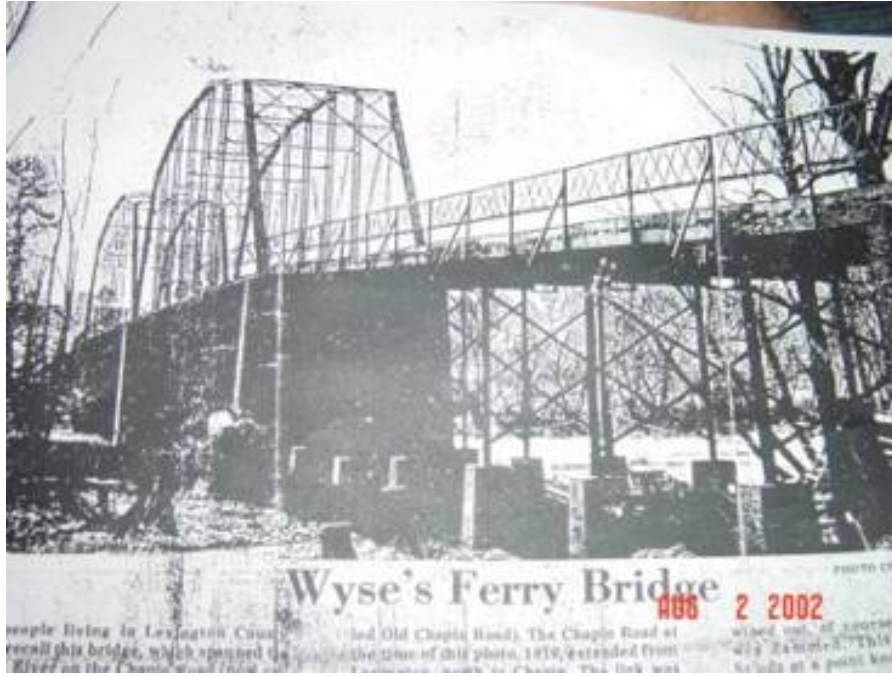


Los Angeles River circa 1900 and now



# SC has Regulated Rivers But Few Lakes

Saluda River 1919; Saluda River Valley 1928; Sonar image of bridge 160 feet below Lake Murray 2005



# Hydrologic Alteration

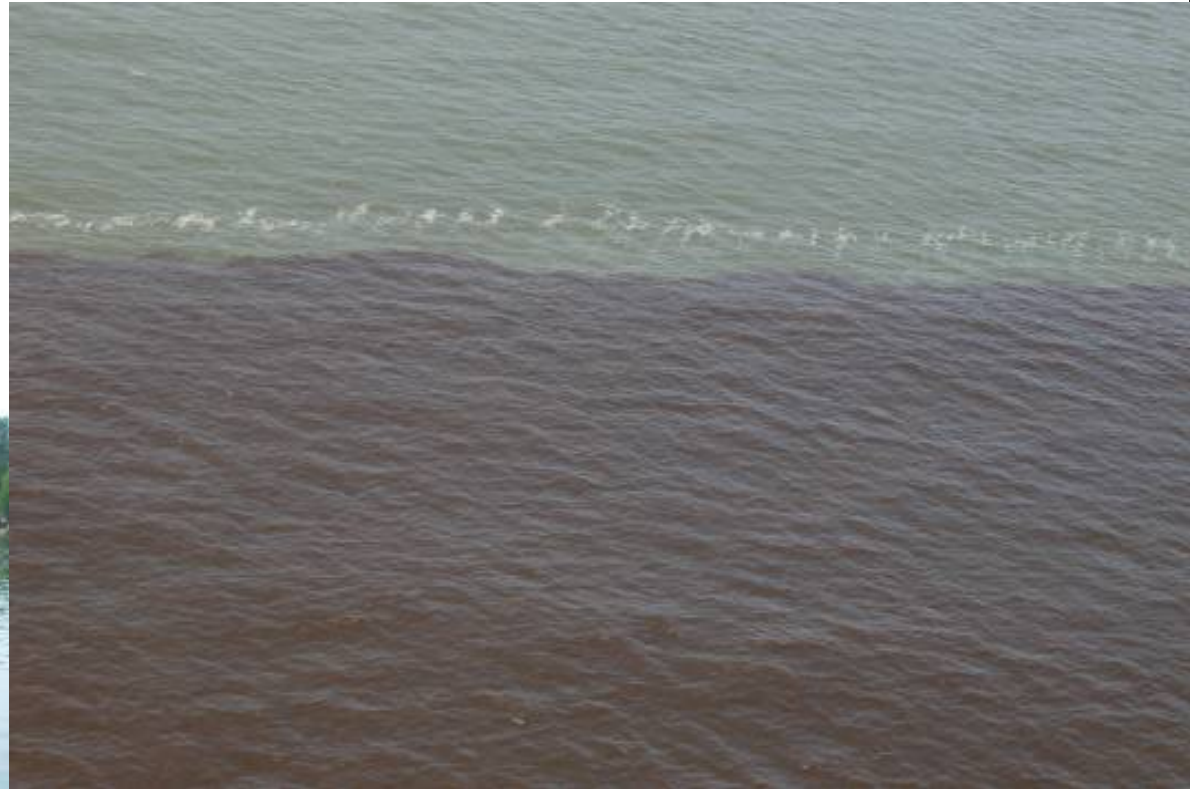


South Carolina  
Circa 1775



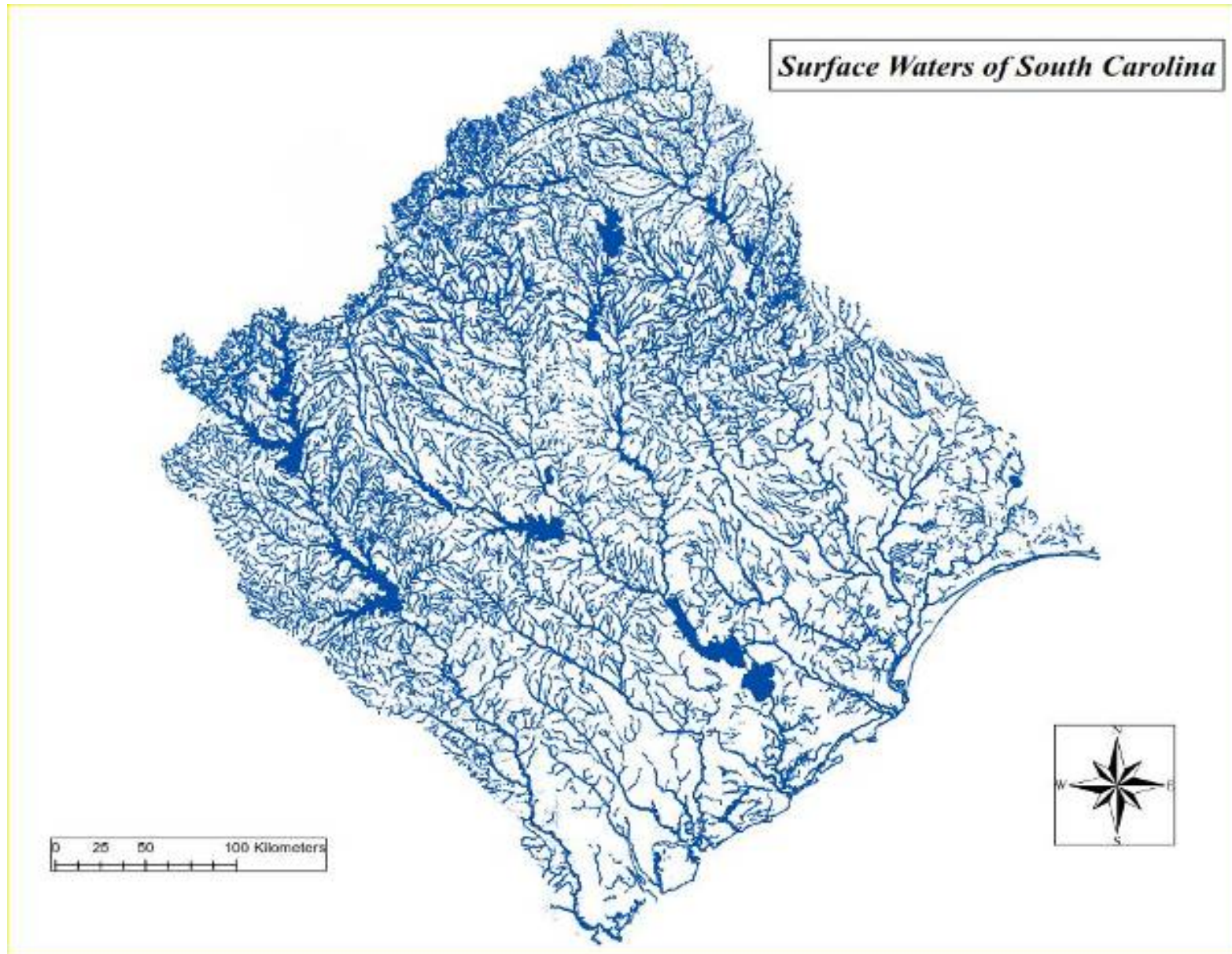
# Nutrient Over Enrichment

- **Can cause toxic and harmful algal blooms effecting the environment and human health**



**Numeric Nutrient Criteria currently a hot topic Nationally**

A river is a continuum and to human water users and sub-aquatic organisms these are the waters of the state



*We may conclude then that in every respect the valley rules the stream.* H.B.N. Hynes 1975

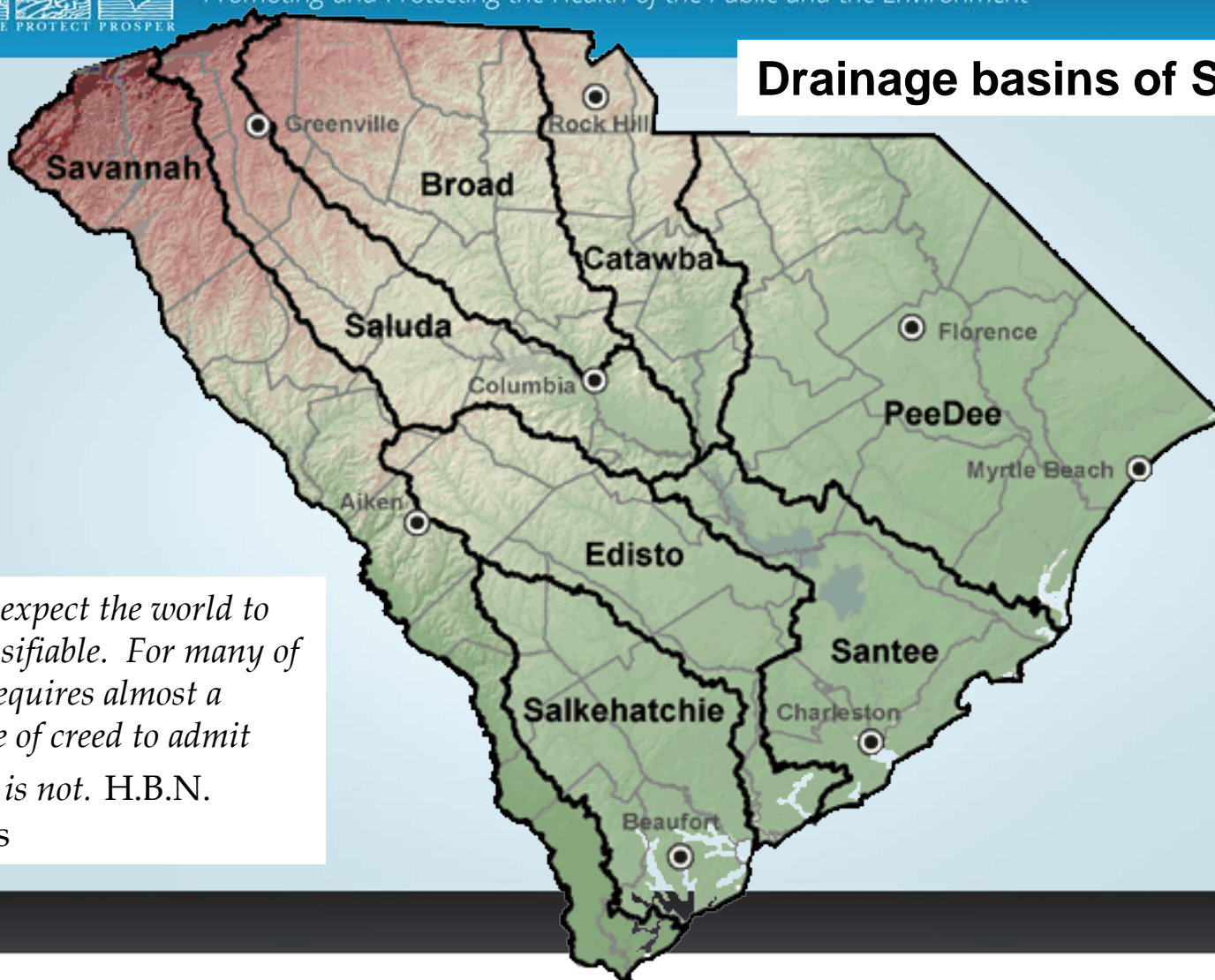
To monitor, assess, report on, and ultimately manage there is a great need to transform the infinite into the discrete



**South Carolina Department of Health and Environmental Control**

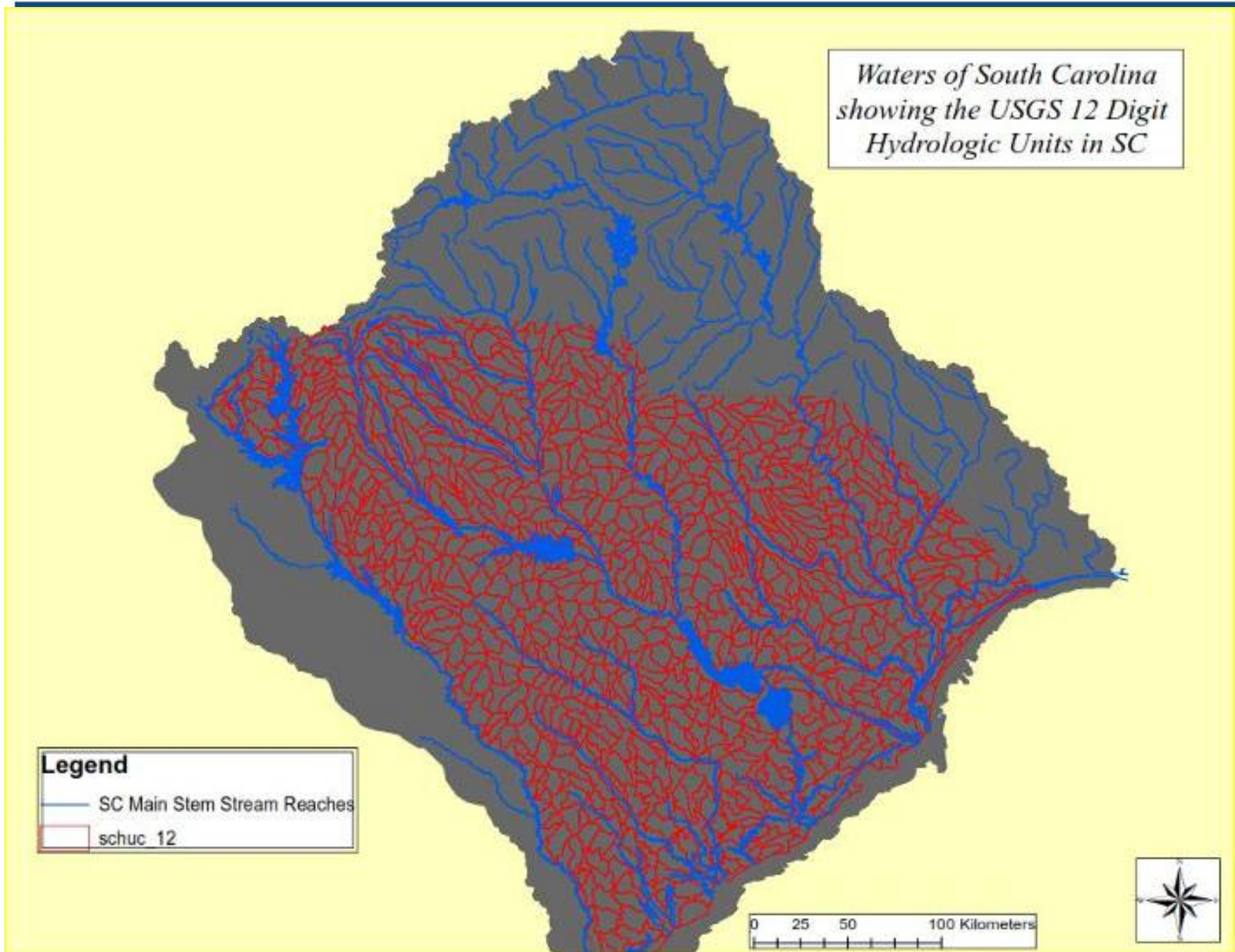
*Promoting and Protecting the Health of the Public and the Environment*

## Drainage basins of SC

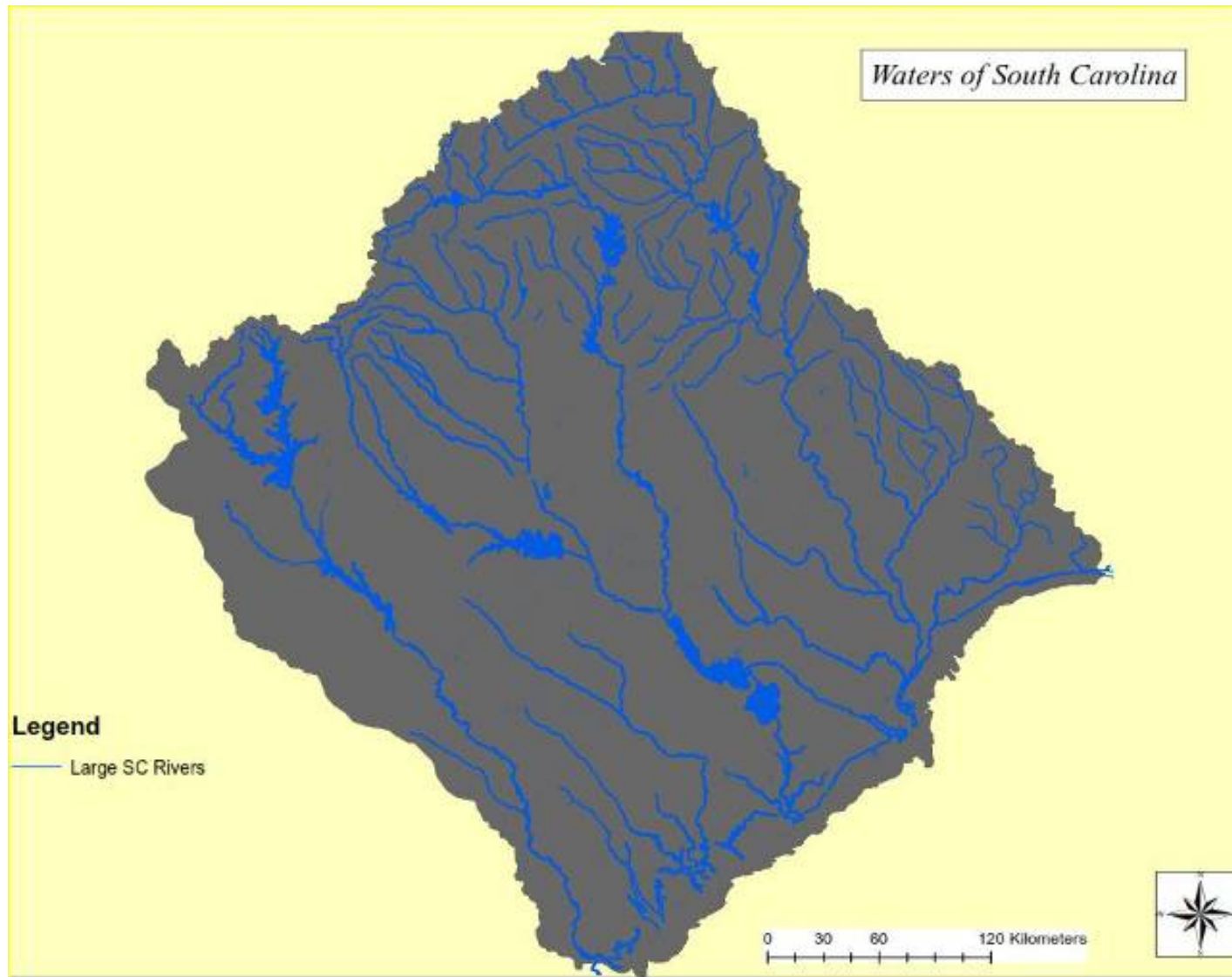


*....we expect the world to be classifiable. For many of us it requires almost a change of creed to admit that it is not. H.B.N. Hynes*

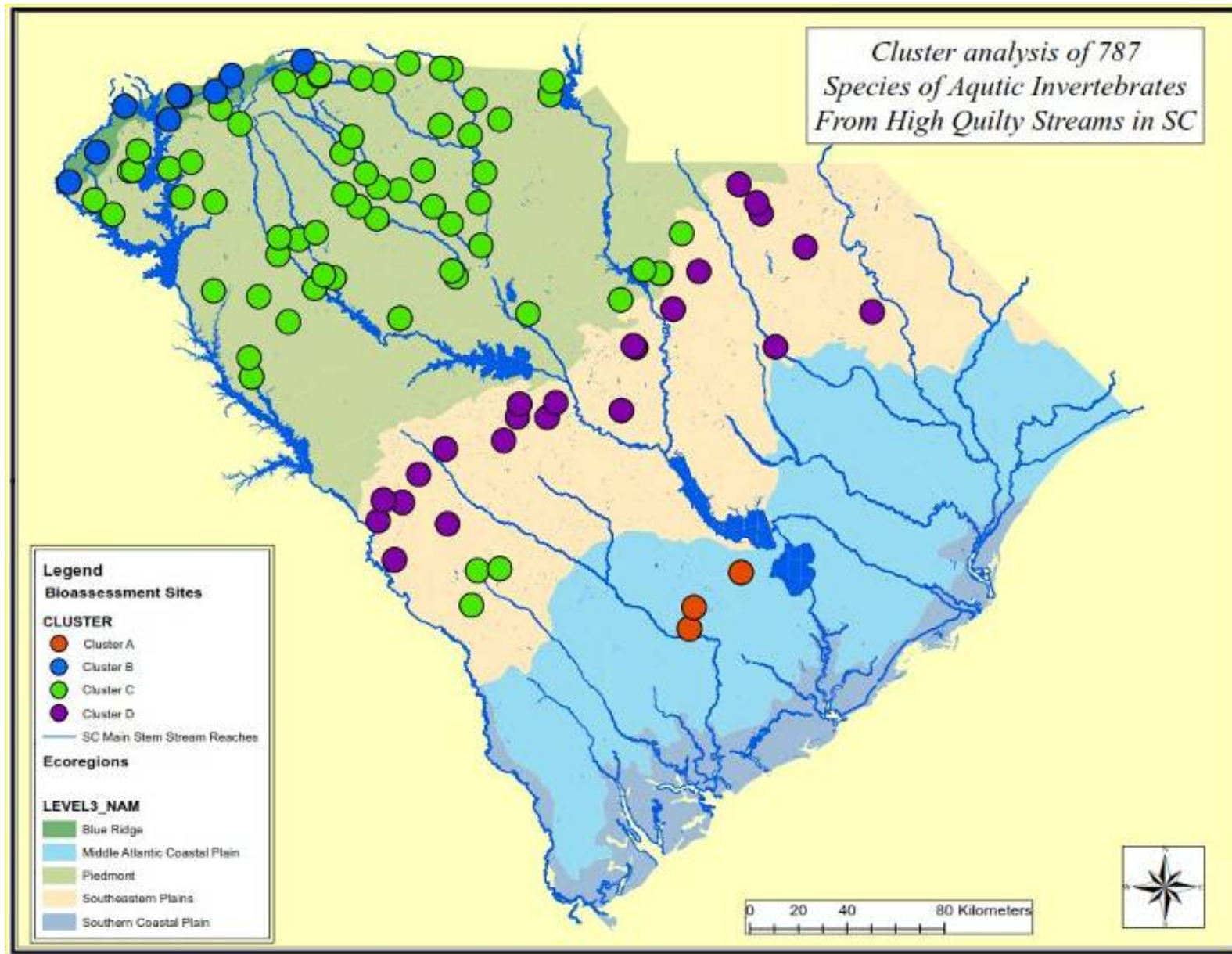
# The hydrologic unit was devised by the USGS in an attempt to classify drainage areas



If a watershed is defined as the drainage area of a landscape above a point on a stream or river then the number of watersheds are infinite.



To the river continuum concept and the watershed concept Omernick (1988) layered the ecoregion concept



# Types of Surface Water Monitoring

**Aquatic Biomonitoring (Bioassessments)** broadly defined are studies that use biological methods to assess water quality.

1. Bioassessys- or toxicity tests
2. Community Assessments
3. Biological indicator organisms or surrogates
4. Tissue Assessments

**Chemical and Physical** parameters (pH, nutrients, temperature)

**Physical morphology-** (landuse, habitat condition, hydrologic modification, hydrology, geomorphology)

# Types of Bioindicators

Many bioindicators serve as permanent sentinels of water quality. Effluent and water column monitoring are rarely continuous and results represent a point in time. The health of biological communities integrate past events regardless of effluent and water column sample frequency.

Most water chemistry standards are extrapolated from laboratory tests and rarely integrate sufficient information to capture the complex variation between waterbody types. However, bioassessments serve as a direct measure of aquatic life condition.



Fish Communities



Wetland Amphibians



Fish Tissue



Microcrustaceans for bioassessys



Phytoplankton and Chl. a



Benthic Algal Communities



Wetland Plants



Fecal Coliform



Wildlife Tissue



Macroinvertebrate





*So my thesis is that biological monitoring will always, or at least for the foreseeable future, have a research element to it, and that it will continue to require the employment of rather high-grade personnel. One cannot leave a technician to do it because biological monitoring needs constant evaluation, just as medical practice does.*

*H.B.N. Hynes (1917-2009) author of The Biology of Polluted Waters (1960)*



SCDHEC ABS staff and Dr. John Nelson, curator of the AC Moore Herbarium USC, at a freshwater wetland, 2011



Richard Renfrow with fish to be tested for tissue contaminants SCDHEC ABS circa 1977



SCDHEC ABS staff taking a soil sample in a coastal wetland, 2011



Richard Renfrow conducting a stream bioassessment in 2006



Richard Renfrow and Harry Gaymon conducting bioassessments in the 1970's

In my opinion the second most important thing an environmental regulator can do is to learn as much as they can about the resource they are charged with protecting. The most important thing they can do is to get away from their desk and get outside.

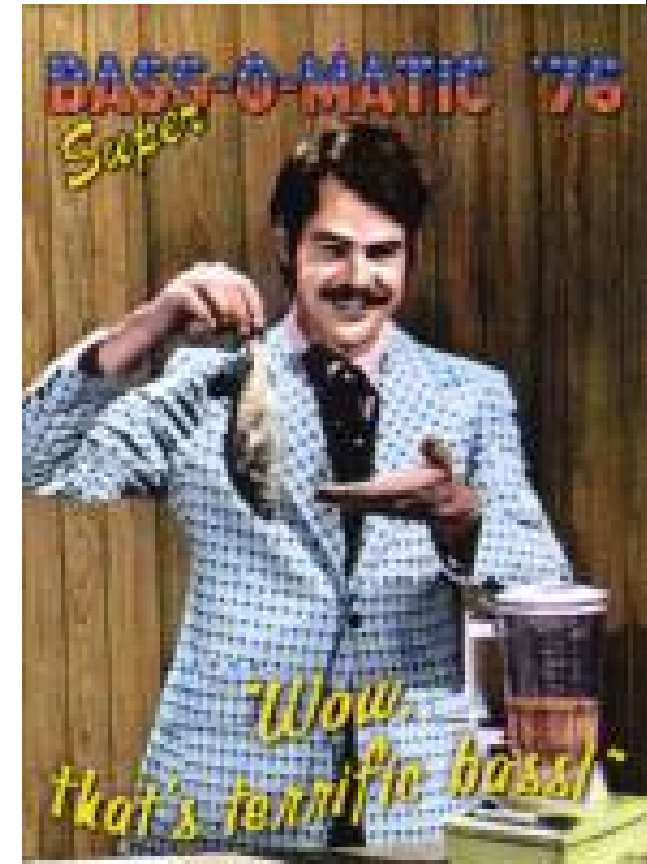
SCDHEC  
*We promote and protect the health of the public and the environment*



# Tissue Program: SCDHEC Advisory Program Began in 1976



# Fish Tissue Program



# SCDHEC Advisory



50,00 Printed Annually;

- all OBGYN facilities
- all known mid-wives
- all WIC departments
- Sporting good stores and state offices

Signs placed at 300  
public boat landings



Atlantic Intracoastal Waterway

NT

NO PARKING

PARD

STOP

STOP

UNLAWFUL TO OBSTRUCT RAMP OR DOCK ACCESS AREA

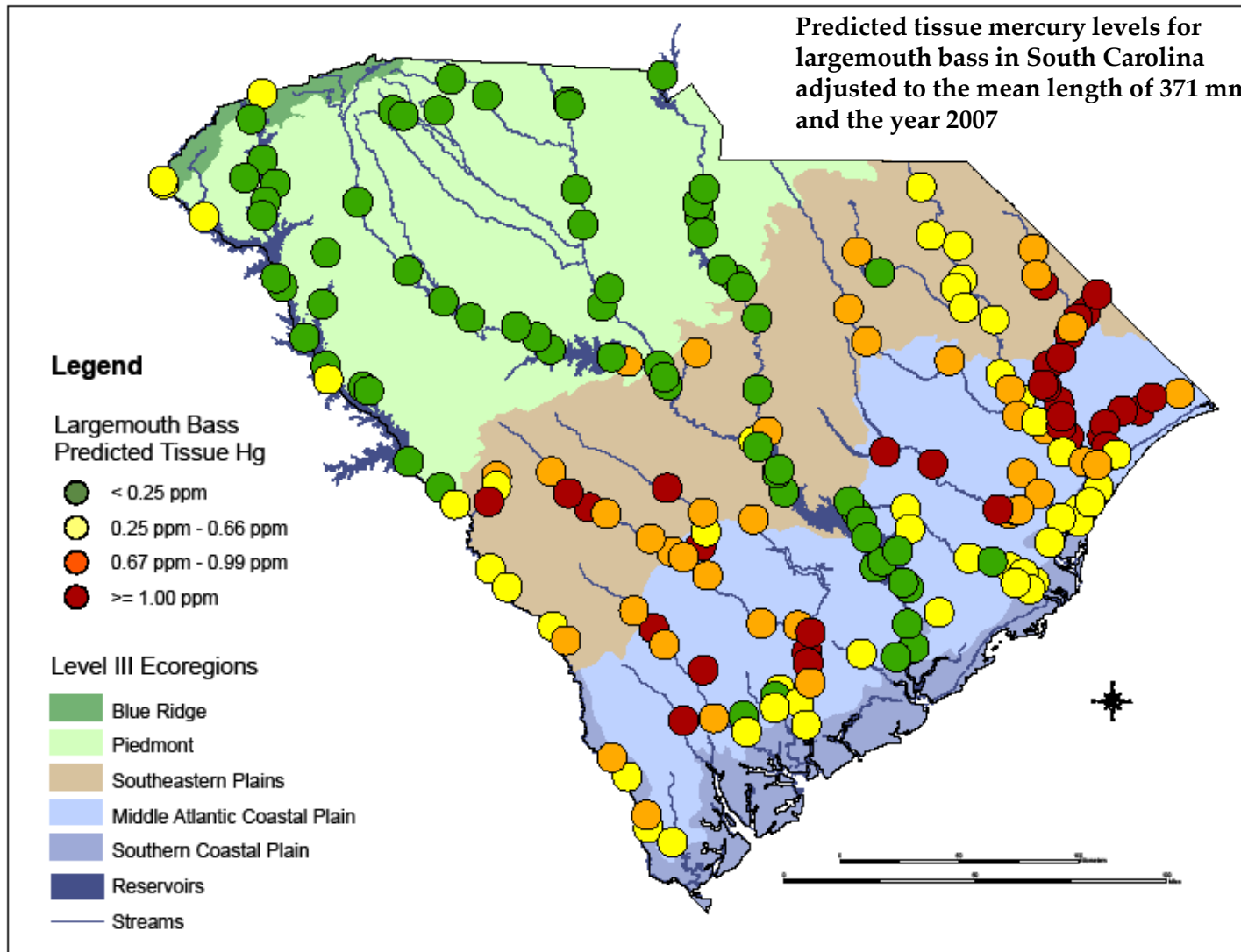
UNLAWFUL TO OBSTRUCT RAMP OR DOCK ACCESS AREA  
TOWING ENFORCED  
FINES UP TO \$100

NO PARKING

NO PARKING



*“It does not occur to most Americans that a good map raises more questions than it answers - that the question of why things are located where they are raises important intellectual issues, with immediate serious implications” Peirce Lewis, 1985*



ISSN 0963-9292, Volume 19, Number 4



Fish are cool but I have spent most of my career studying bait.

*Ceraclea new species*  
Glover and Morse 20??

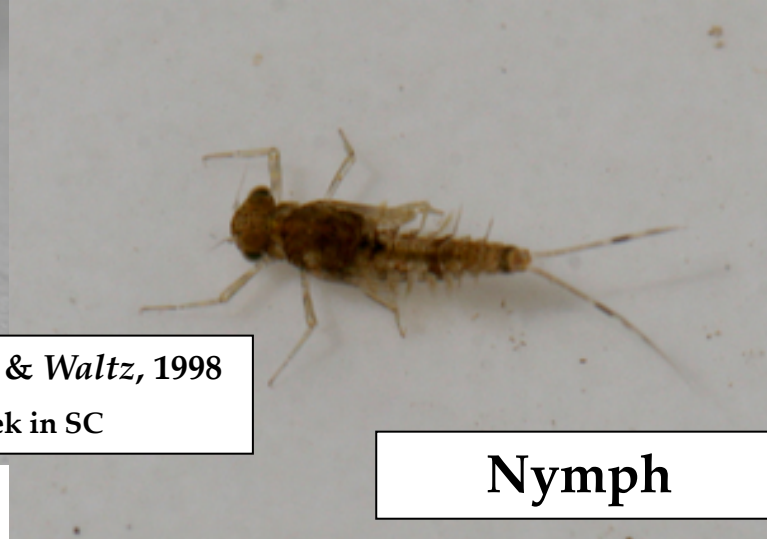


Adult Female

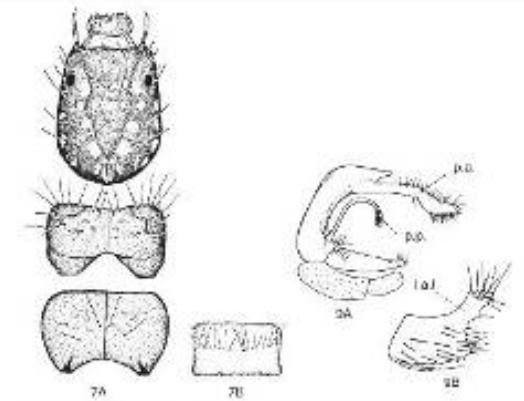
*Nectopsche waccamawens*  
Glover and Floyd 2004



*Plauditus gloveri* McCafferty & Waltz, 1998  
Discovered in Kings Creek in SC



Nymph



It is probable that in the near future many industries will be required to maintain a continuous environmental quality assessment program to demonstrate what biological impact the materials they produce... have upon ecological systems.

John Cairns (1973)



# Role of the Volunteer Monitor



**South Carolina Department of Health and Environmental Control**  
*Promoting and Protecting the Health of the Public and the Environment*



Ms Glover's students were the overall winner of the 2000-2001 Champions of the Environment Award; Top- Students posing for the award featured on WIS; Upper right- 3 students at awards ceremony; Right- SC Governor Jim Hodges preparing to present the award.

## MACROINVERTEBRATE BIOLOGICAL ASSESSMENTS OF STREAMS IN SOUTH CAROLINA BY HIGH SCHOOL MINORITY STUDENTS

Canada, D.K.<sup>1</sup>, R.D. Maree<sup>1</sup>, S.E. Ayers<sup>1</sup>, S.A. Blake<sup>1</sup>, M.R. Borders<sup>1</sup>, W.R. Borders<sup>1</sup>, D.M. Daniels-Hester<sup>1</sup>, C.L. Glover<sup>1</sup>, D.R. House<sup>1</sup>, D.B. Mackey<sup>1</sup>, K.M. Scott<sup>1</sup>, A.N. Ulmer<sup>1</sup>, L.B. Glover<sup>1</sup>, and J.B. Glover<sup>2</sup>. <sup>1</sup>Heathwood Hall Episcopal School, Columbia SC, <sup>2</sup>The South Carolina Department of Health and Environmental Control, Columbia SC

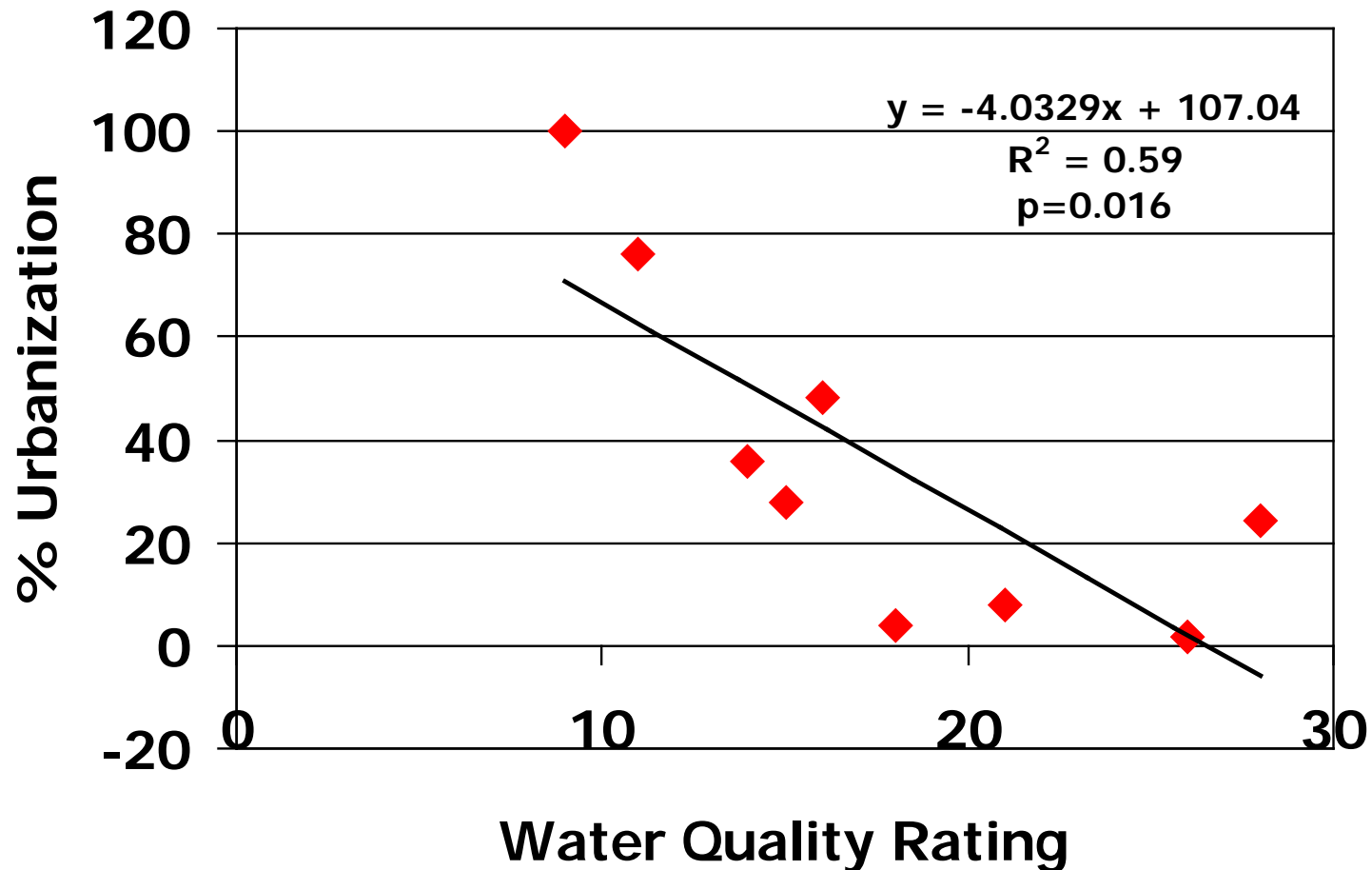


Figure 1. The Heathwood Hall Episcopal School Water Quality Monitoring Group.



Figure 3. W.R. Borders, D.M. Daniels-Hester, A.N. Ulmer, C.L. Glover, K.M. Scott, and S.A. Blake looking at the macroinvertebrates that they found using a kick net

# Linear Regression of % Urbanization vs. Water Quality Rating



Senior High School Project: An offshoot of the Heathwood Hall volunteer monitoring project



**South Carolina Department of Health and Environmental Control**

*Promoting and Protecting the Health of the Public and the Environment*

# CONTACT US

[www.scdhec.gov](http://www.scdhec.gov)

(803) 898-DHEC (3432)



**Follow us on Twitter.**

@scdhec



**Like us on Facebook.**

[www.fb.com/scdhec](http://www.fb.com/scdhec)



**Check us out on YouTube.**

[www.youtube.com/scdhec](http://www.youtube.com/scdhec)