South Carolina Department of Health and Environmental Control

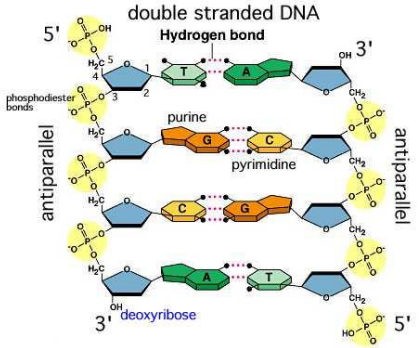
Promoting and Protecting the Health of the Public and the Environment

Numeric Nutrient Criteria Development in SC Estuaries, Rivers & Streams

Dr. Casandra West, Ph.D.

Generally refer to nutrients as TN & TP

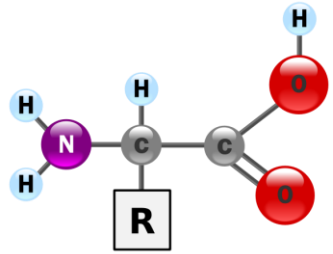
- Nitrogen & Phosphorus Species



academic.brooklyn.cuny.edu

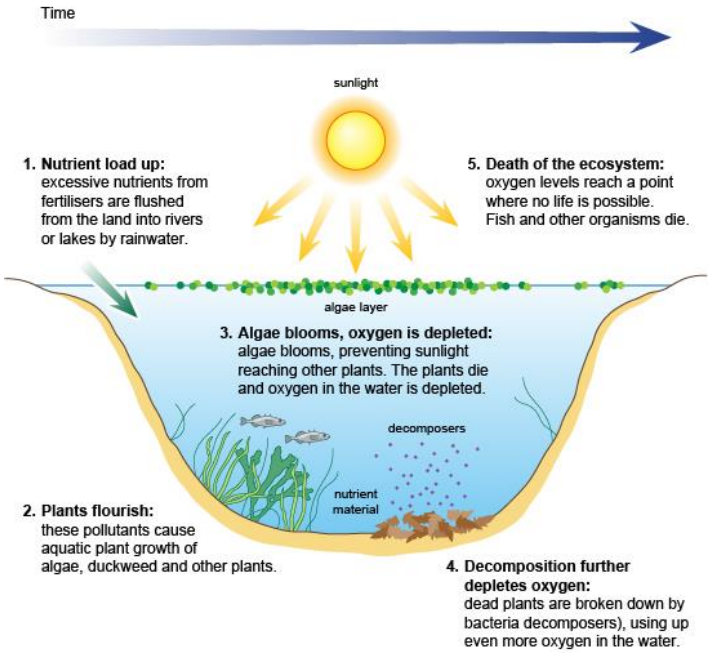
- Essential for the healthy functioning of food webs and ecosystems

- Required for life



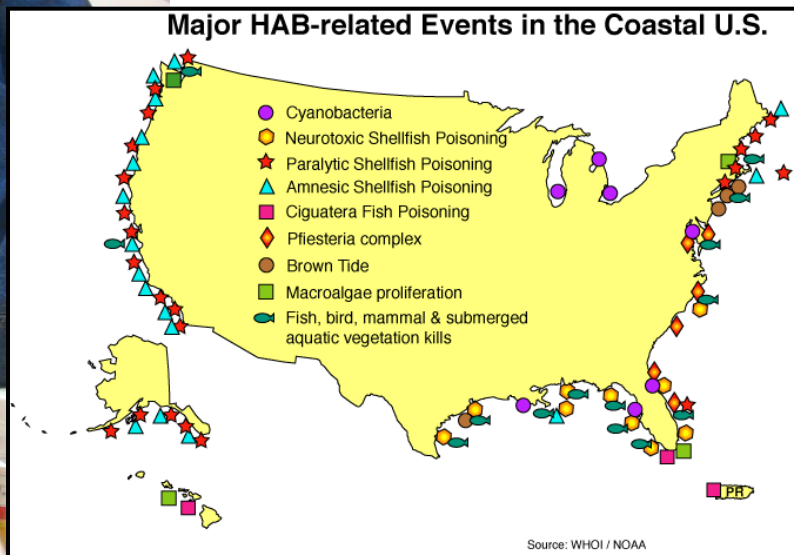
en.wikipedia.org

- Eutrophication: Results when there is an overabundance of nutrients
  - Drives primary production
  - Disrupts the balance of aquatic life

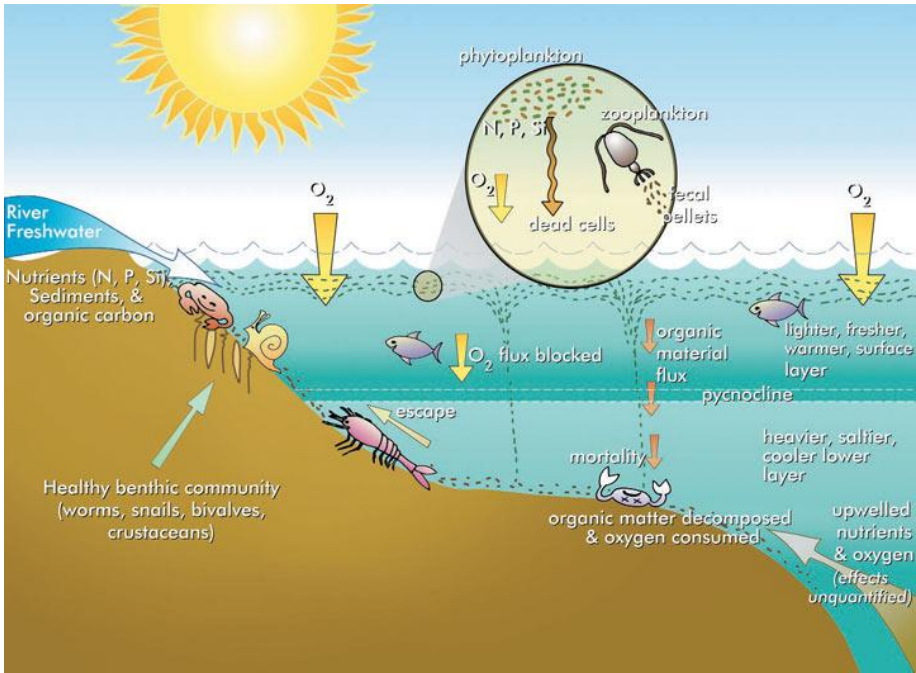


http://www.bbc.co.uk

- Results
- Phytoplankton blooms/HABs



- Results
  - Decreased light availability to submerged aquatic vegetation
  - Low dissolved oxygen levels
  - Fish kills
  - Change in community composition



- Nutrients: on EPA's list of the top 5 causes of impairment
  - Nutrients
  - Pathogens
  - Sediment
  - Oxygen depletion
  - Habitat alterations

- EPA has requested that States develop NNC for all waterbodies
  - TN (causal)
  - TP (causal)
  - Chlorophyll a (response)
  - Turbidity (response)

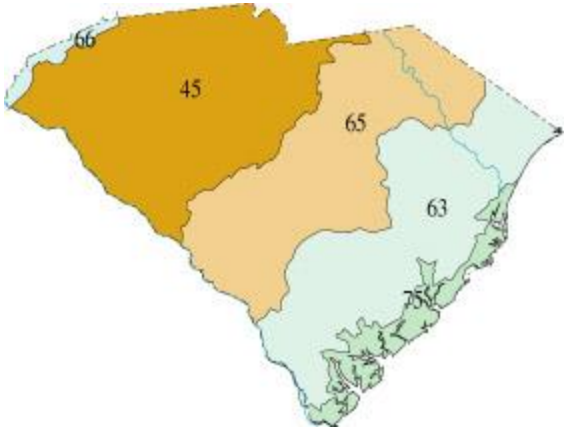
- Why Should SC set statewide numeric nutrient limits?
  - A starting point permitting and enforcement
  - A numeric standard defines the maximum N or P concentration that will allow a water body to meet its designated use
  - Protective of flora and fauna

http://www.btnep.org/BTNEP

SC already has some numeric limits in place

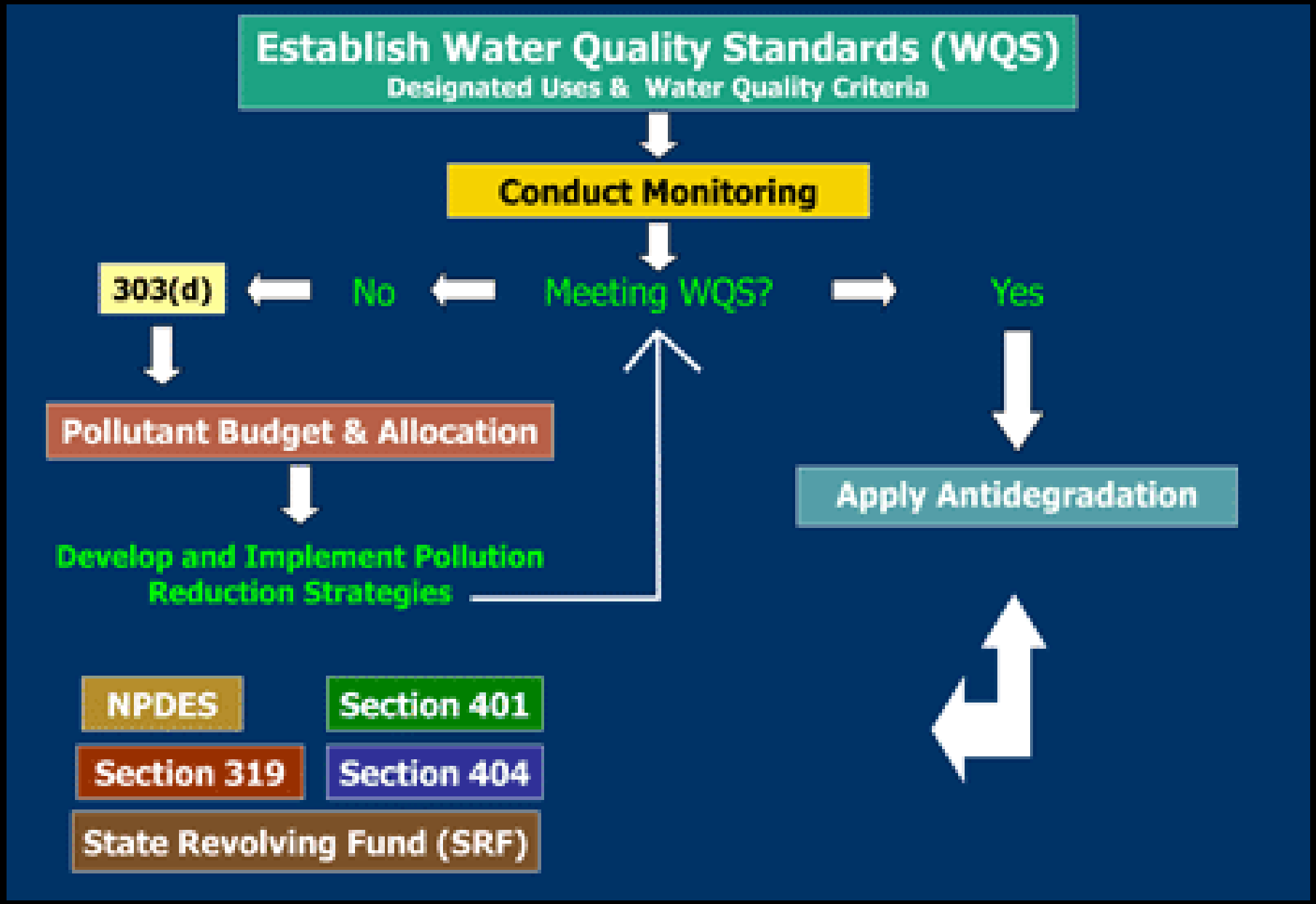
Lakes over 40 acres

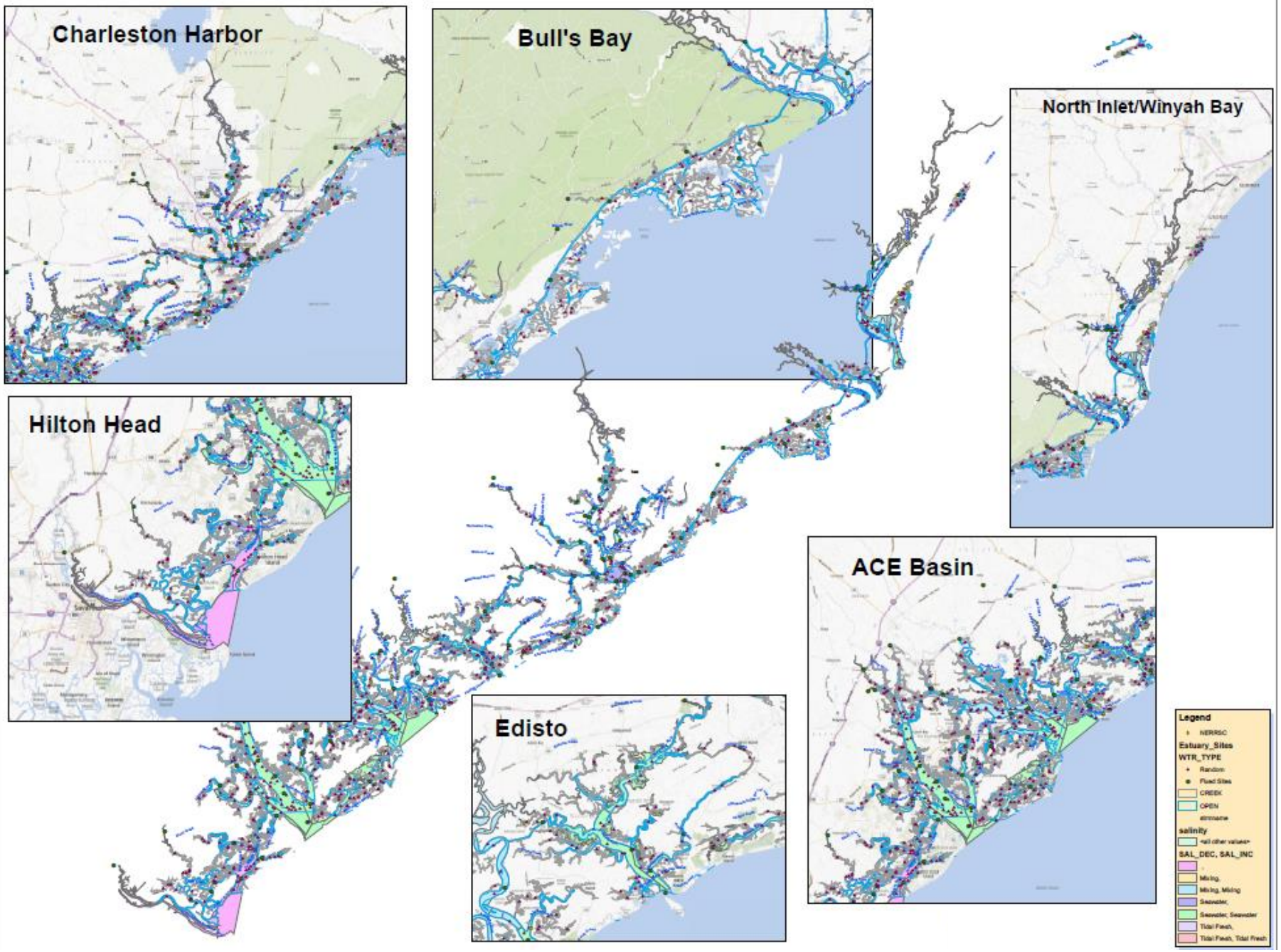
Shall not exceed

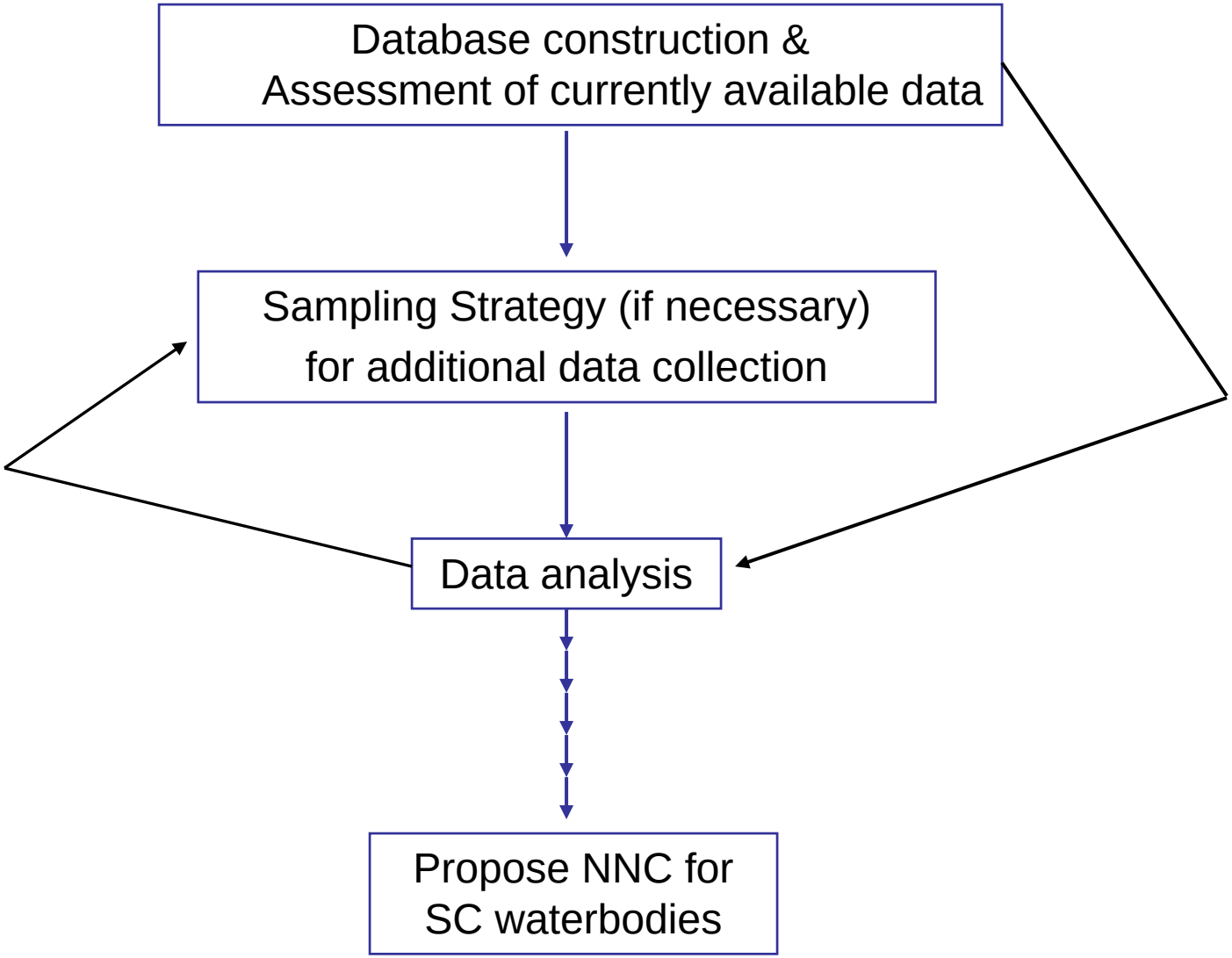


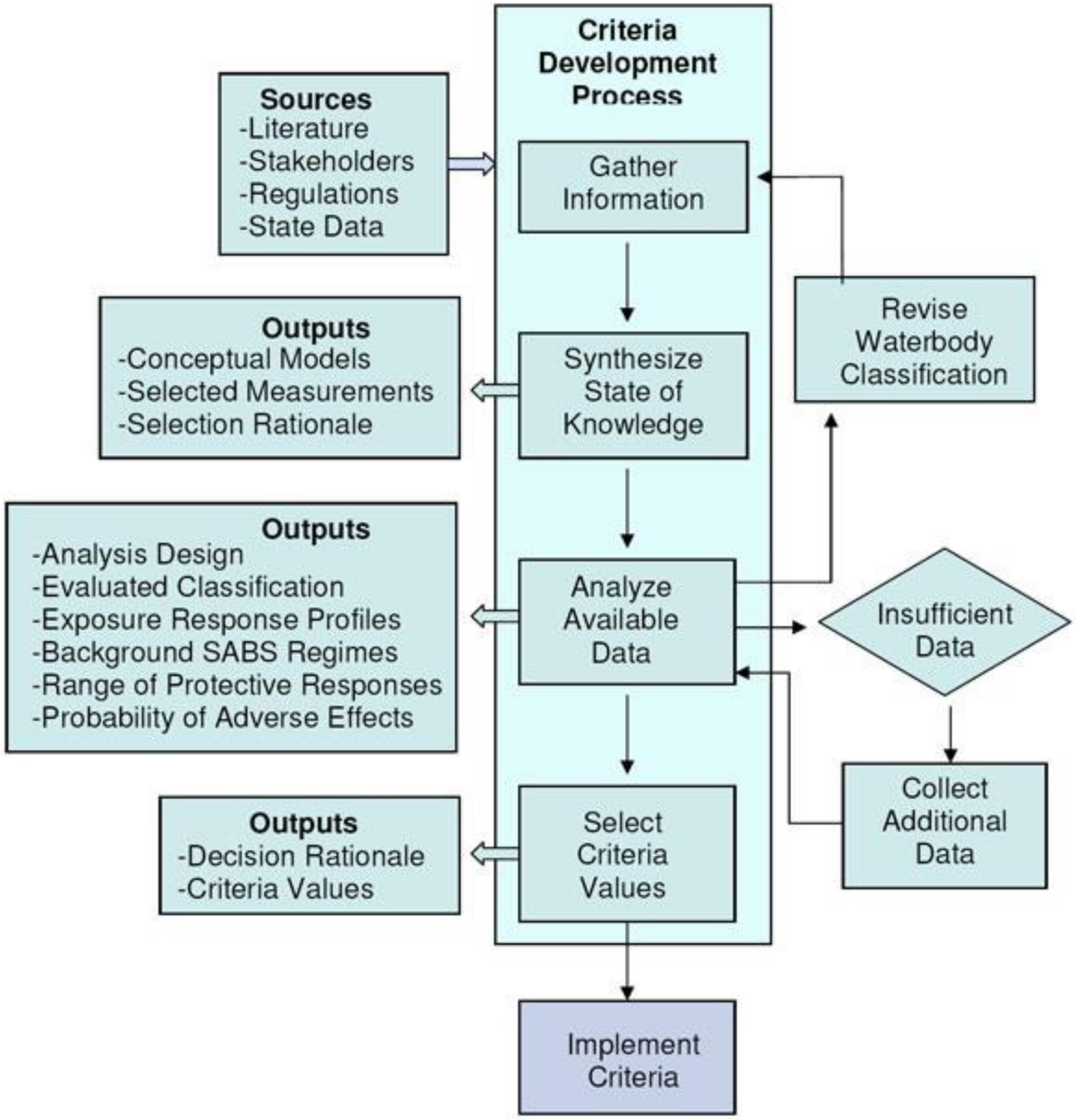
45. Piedmont
63. Middle Atlantic Coastal Plain
65. Southeastern Plains
66. Blue Ridge
75. Southern Coastal Plain

Ecoregion	Blue Ridge	Piedmont & SE Plains	Mid. Atlantic Coastal Plains
Chlorophyll a	10 µg/L	40 µg/L	40 µg/L
TP	0.02 mg/L	0.06 mg/L	0.09 mg/L
TN	0.35 mg/L	1.5 mg/L	1.5 mg/L


Establish Water Quality Standards (WQS)
Designated Uses & Water Quality Criteria
Conduct Monitoring
Meeting WQS?
No
Yes
303(d)
Pollutant Budget & Allocation
Develop and Implement Pollution Reduction Strategies
Apply Antidegradation
NPDES
Section 401
Section 319
Section 404
State Revolving Fund (SRF)


Charleston Harbor
Bull's Bay
North Inlet/Winyah Bay
Hilton Head
ACE Basin
Edisto
Legend
NERRSC
Estuary_Sites
WTR_TYPE
Random
Fixed Sites
CREEK
OPEN
salinity
SAL_DEC, SAL_INC
Mixing,
Mixing, Mixing
Seawater,
Seawater, Seawater
Tidal Fresh,
Tidal Fresh, Tidal Fresh


Database construction &
Assessment of currently available data
Sampling Strategy (if necessary)
for additional data collection
Data analysis
Propose NNC for
SC waterbodies


Criteria Development Process
Sources
-Literature
-Stakeholders
-Regulations
-State Data
Gather Information
Outputs
-Conceptual Models
-Selected Measurements
-Selection Rationale
Synthesize State of Knowledge
Revise Waterbody Classification
Outputs
-Analysis Design
-Evaluated Classification
-Exposure Response Profiles
-Background SABS Regimes
-Range of Protective Responses
-Probability of Adverse Effects
Analyze Available Data
Insufficient Data
Collect Additional Data
Outputs
-Decision Rationale
-Criteria Values
Select Criteria Values
Implement Criteria

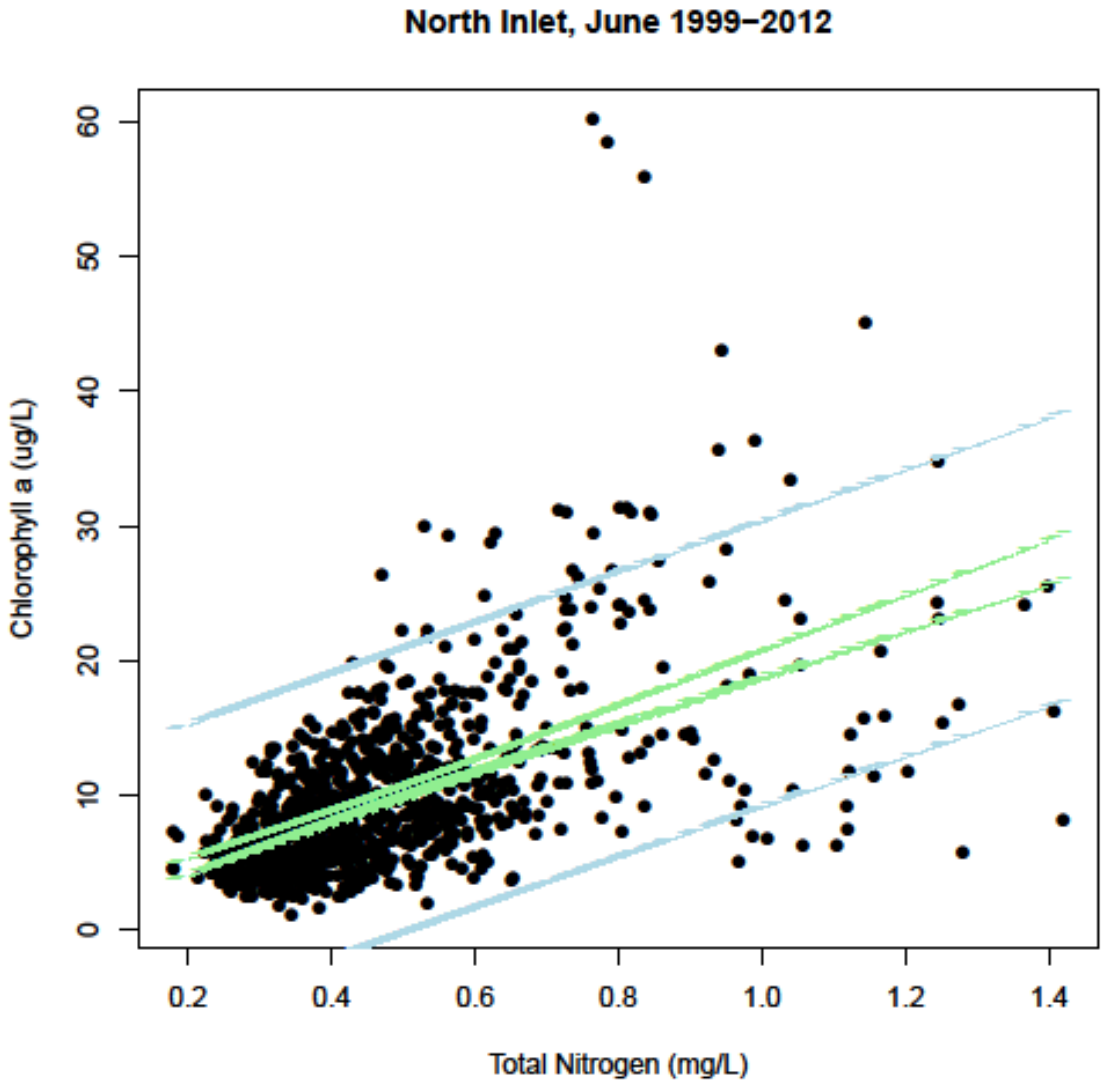
- Goals of Criteria Development

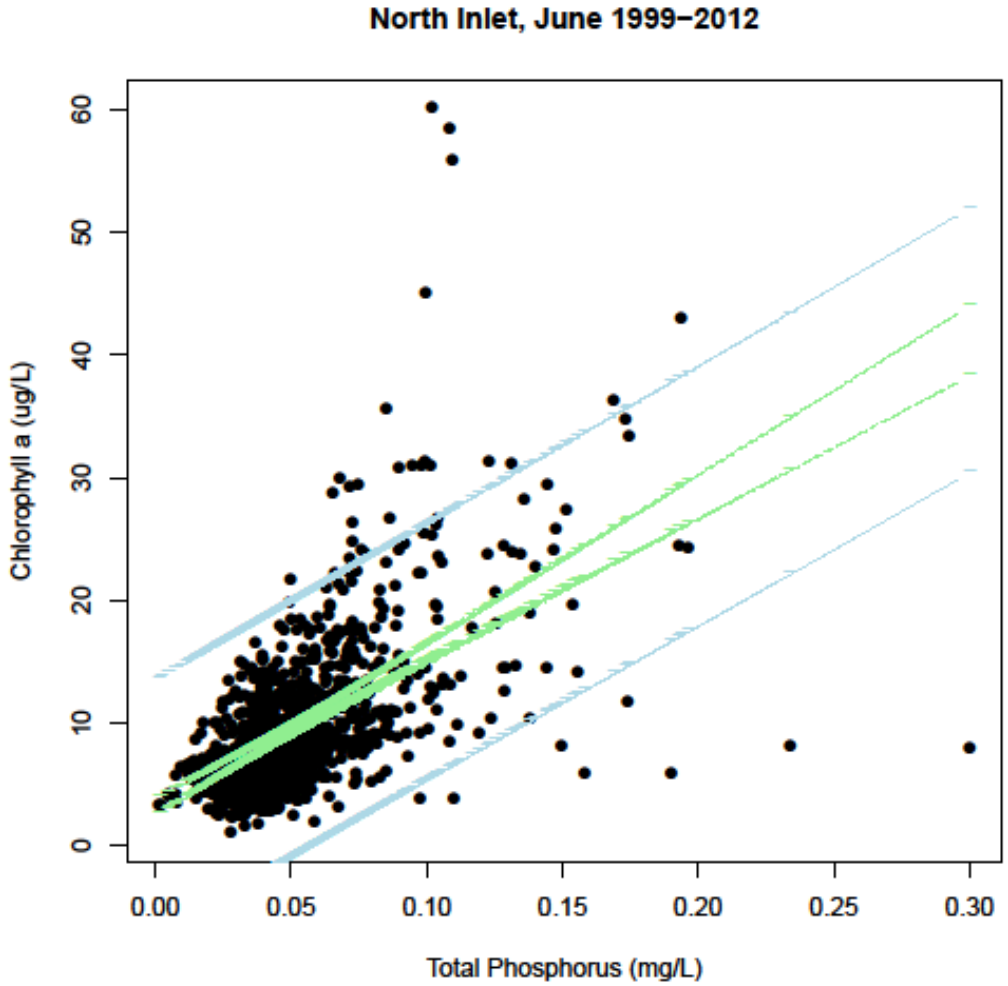
  -Supportive of designated uses and aquatic life

  -Scientifically defensible

  -Realistic/attainable standards

  -Support from local citizens, stakeholders & academic community


North Inlet, June 1999–2012
Chlorophyll a (ug/L)
0
10
20
30
40
50
60
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Total Nitrogen (mg/L)


North Inlet, June 1999–2012
Chlorophyll a (ug/L)
0
10
20
30
40
50
60
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Total Phosphorus (mg/L)

- Several approaches recommended by EPA
  - Reference condition approach
  - Data distribution approach
  - Predictive/mechanistic modeling approach
  - And many more . . . . . .

Tools

- WERF (Water Environment Research Foundation), recently developed a nutrient modeling toolbox
- BASINS: open source GIS, integrates environmental data, analysis tools and modeling systems
- WASP (Water Quality Analysis Simulation Program): allows users to predict waterbody responses to pollutants
- SWAT (Soil and Water Assessment Tool): for rivers

One option, **ANN (Artificial Neural Networks)**

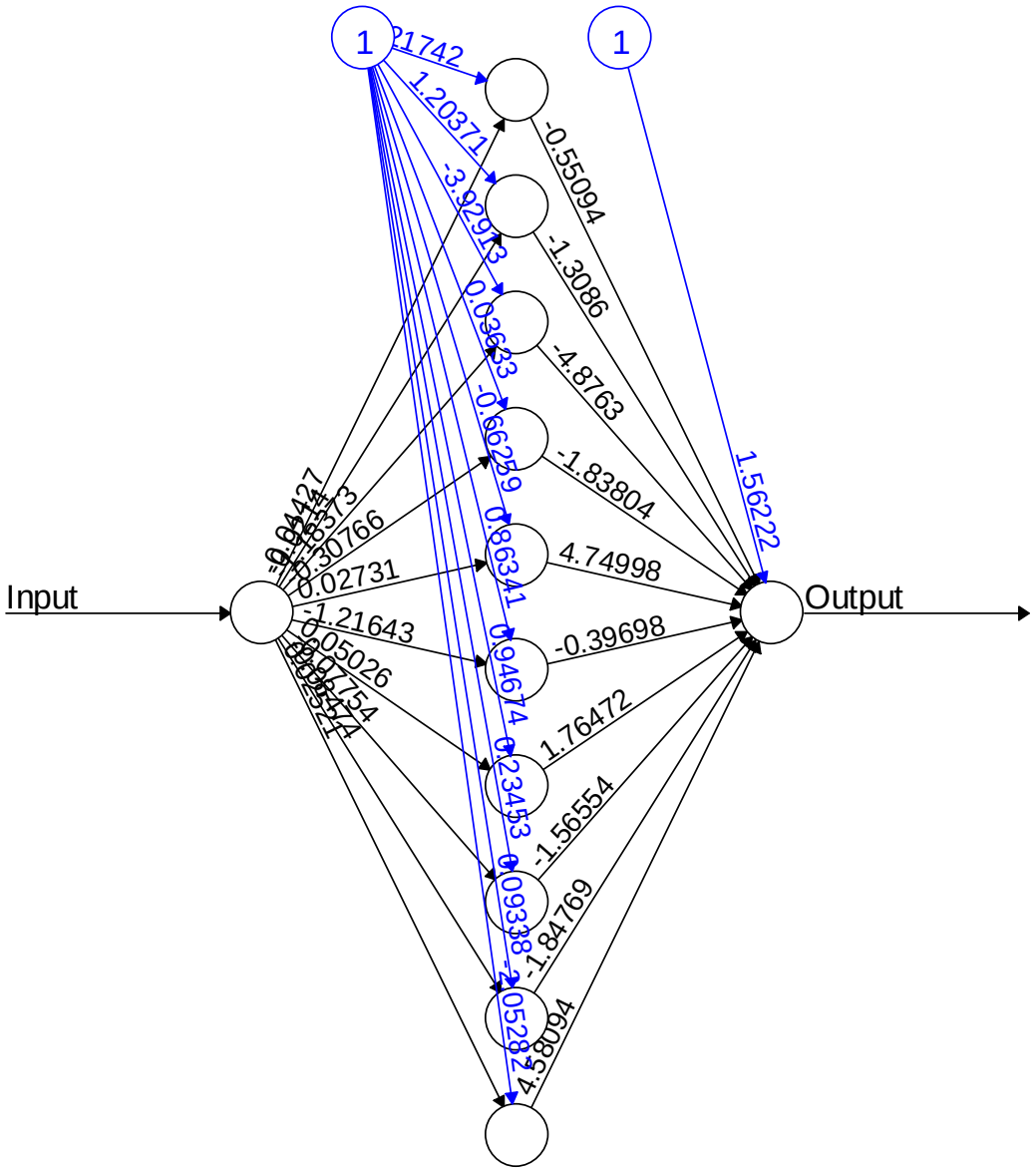
-“learns": using “training” data

-error back propagation algorithms

-predicts relationships between variables using input data

-Used in FL and NJ

-Can model a large number of parameters



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