South Carolina Surface Water Monitoring: Different Designs for Different Objectives

Presented by David Chestnut

Reporting Requirements

- §305(b) Report
  - Comprehensive statewide summary report on water quality to Congress every two years
- §303(d) List
  - Listing of impaired waters
  - Submitted to EPA every two years

Other Data Needs

- Capability for targeted monitoring for specific needs:
  - Special studies
  - Tracking of implementation of control strategies
  - Respond to emerging issues

Purpose of the Ambient Water Quality Monitoring Program

- The collection and analysis of data needed to make water quality management decisions:
  - Determine water quality status & identify waters not supporting classified uses (§305(b), §303(d), WWQA)
  - Determine long-term trends in concentrations of various constituents at individual sites (WWQA)
  - Collect data for Wasteload Allocation Models
  - Support specific NPDES permit limits
  - Evaluate effectiveness of SCDHEC programs

Basic Designs of Ambient Surface Water Monitoring are:

- Big Picture:
  - Make statements about representative WQ at varying scales (§305(b), WWQA)
- Site Specific
  - Examine long-term trends in concentration of specific WQ parameters
  - Identify waterbodies not meeting classified uses (§303(d))
  - Track specific targeted activities

Main Ambient Monitoring Activities

- Physical & Chemical Monitoring
  - Water Column
  - Sediment
- Biological Community Monitoring
  - Macroinvertebrate
- Fish Tissue Monitoring

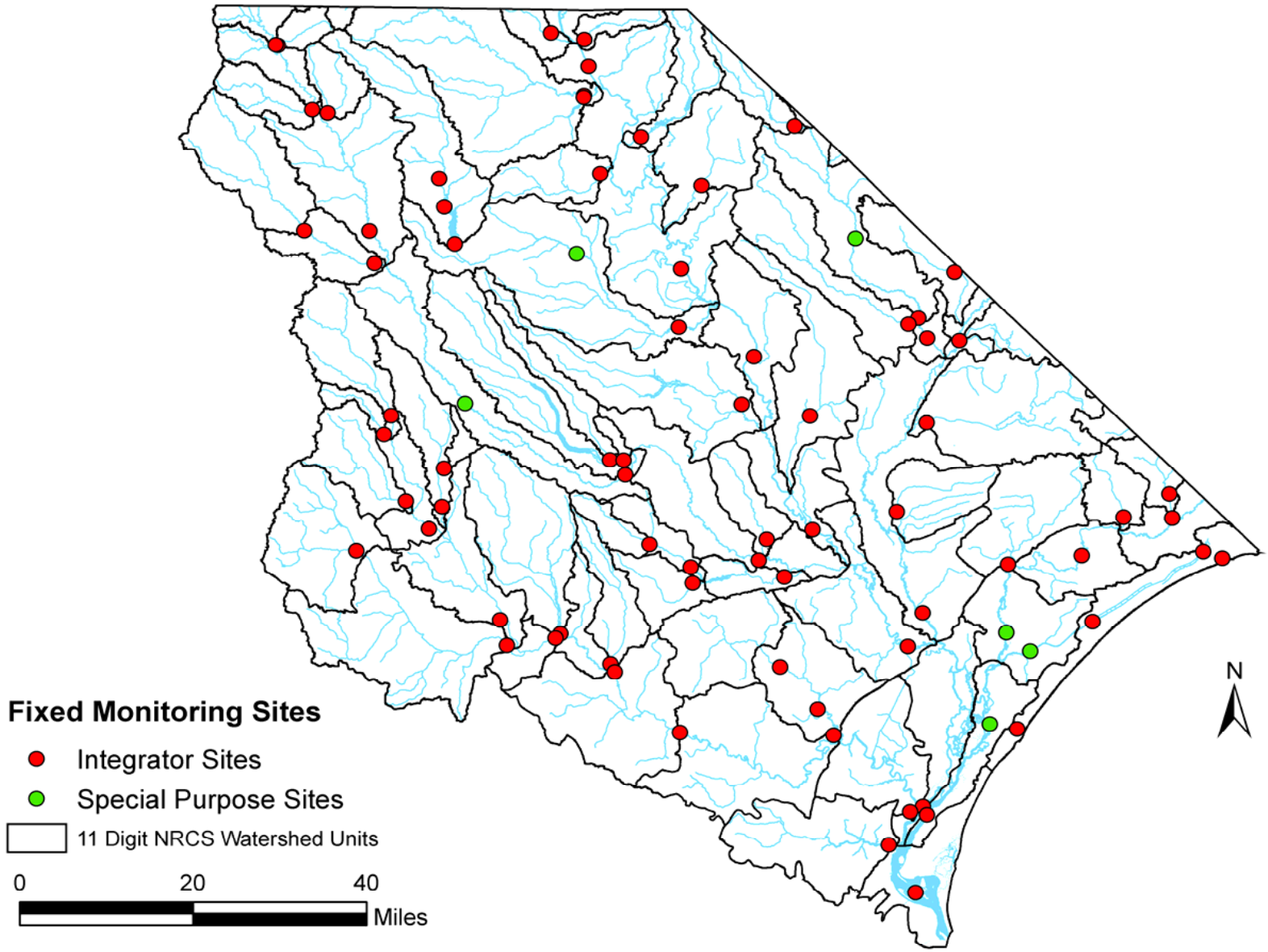
Components of the Ambient Monitoring Network Design

- Fixed Monitoring Network
  - Long-term trends
  - Consistent statewide coverage
- Cyclical Basin Monitoring
  - More spatially dense coverage
  - Watershed focus
- Probability-Based Monitoring
  - Statistical survey of statewide resources
  - Sample new locations

Types of Fixed Statewide Surface Water Chemistry Monitoring Sites

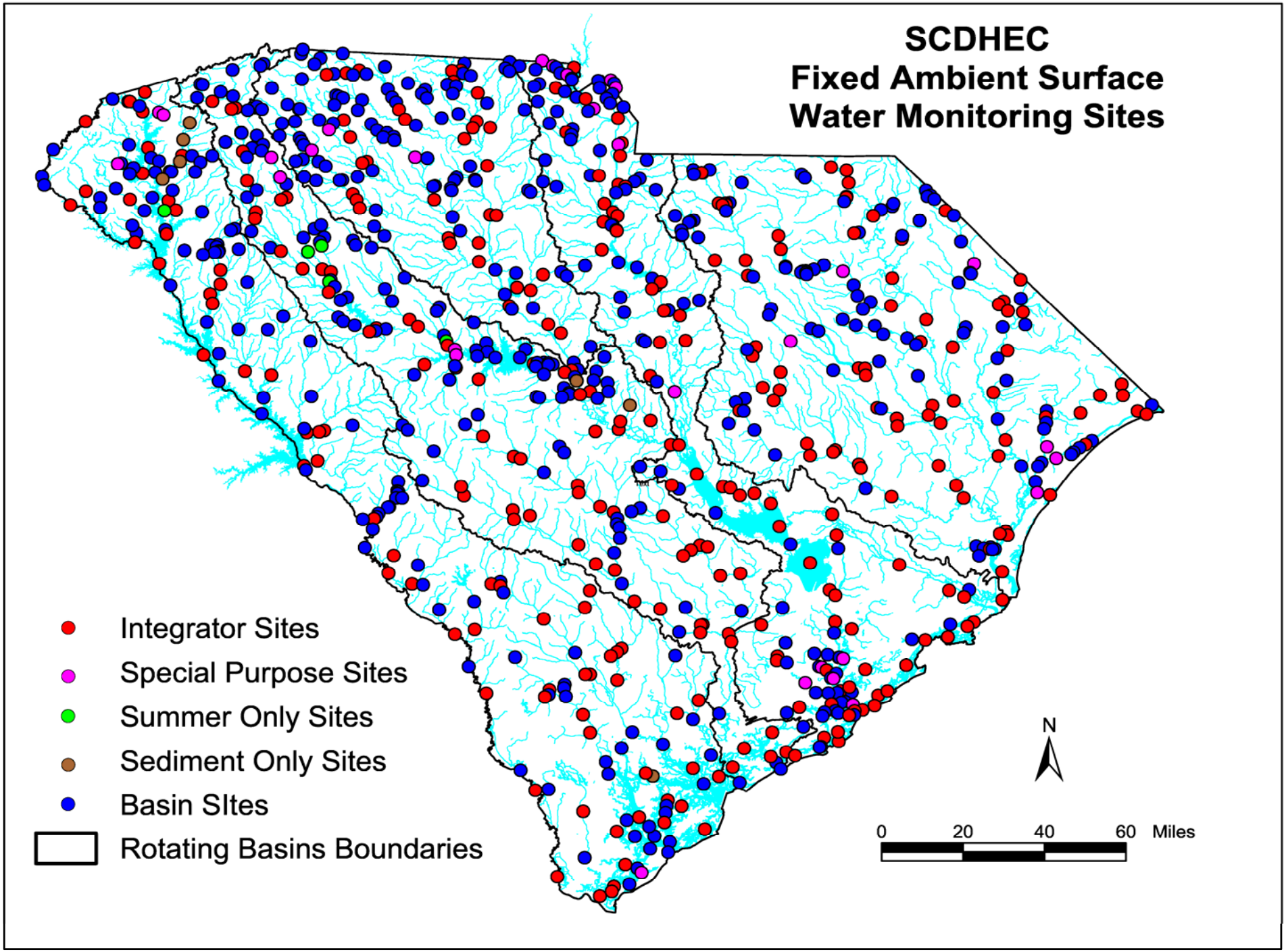
- Integrator & Special Purpose Sites
  - Sampled monthly year-round, every year
  - Target outflow of 11-digit WSU or specific data needs
  - Tend to be larger streams with smaller order streams under-represented
- Special Summer-Only Sites
  - Sampled monthly May-October, every year
  - Target specific data needs

Pee Dee Basin Showing Integrator Sites Relative to 11 Digit NRCS Watershed Units



Cyclic Basin Sites

- More-or-less fixed, on a 5 year cycle
- Sampled monthly for 1 year when active
- Historical sites – old primaries & secondaries
  - Individual sites were selected for a variety of reasons, e.g. below point source, urban area, background conditions, locations with strong public use or interest, district requests, citizen concerns, other special interests


SCDHEC
Fixed Ambient Surface
Water Monitoring Sites
Integrator Sites
Special Purpose Sites
Summer Only Sites
Sediment Only Sites
Basin SItes
Rotating Basins Boundaries
N
0
20
40
60
Miles

Probability-Based Component

- Probability Sites
  - Sampled monthly for 1 year
- Make comprehensive statements about statewide WQ conditions (§305(b) use support)
  - Unbiased random sample (survey) of water resources
  - Represents entire resource
  - Known confidence of condition estimates
- Sample previously unsampled locations
  - Identify new §303(d) candidates

Resource Types Assessed Using Probability-Based Approach

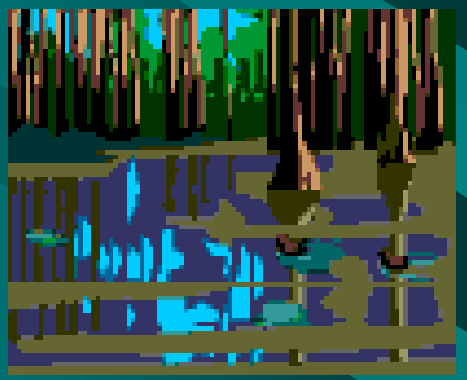
- Streams
- Lakes
- Estuaries

Targeted Categories for Probability-Based Sites

- Streams (30 sites per year)
  - Sampled monthly
  - First order streams
  - Second order streams
  - Third order & greater streams
  - Unequal weights

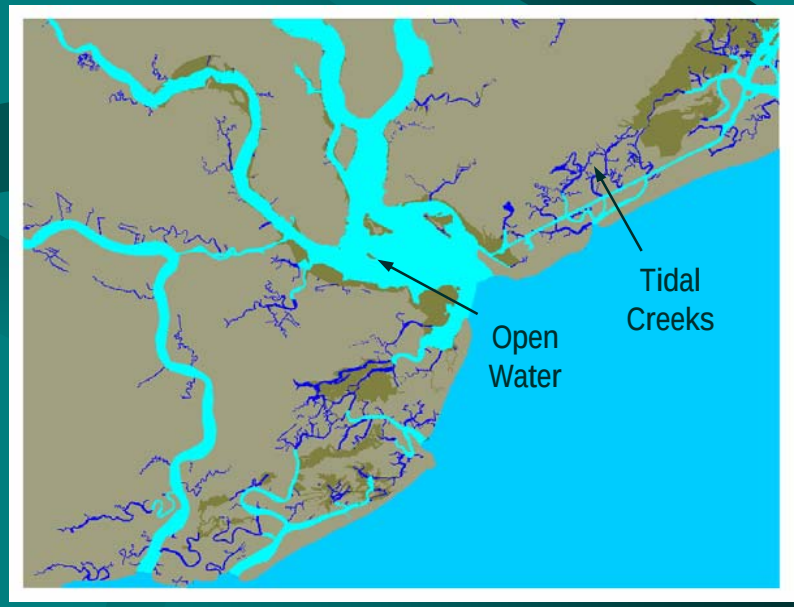
Targeted Categories for Probability-Based Sites

- Significant Lakes with Public Access (30 sites per year)
  - Sampled monthly
  - Major lakes (≥ 850 acres)
  - Minor lakes (40 to 850 acres)
  - Unequal weights

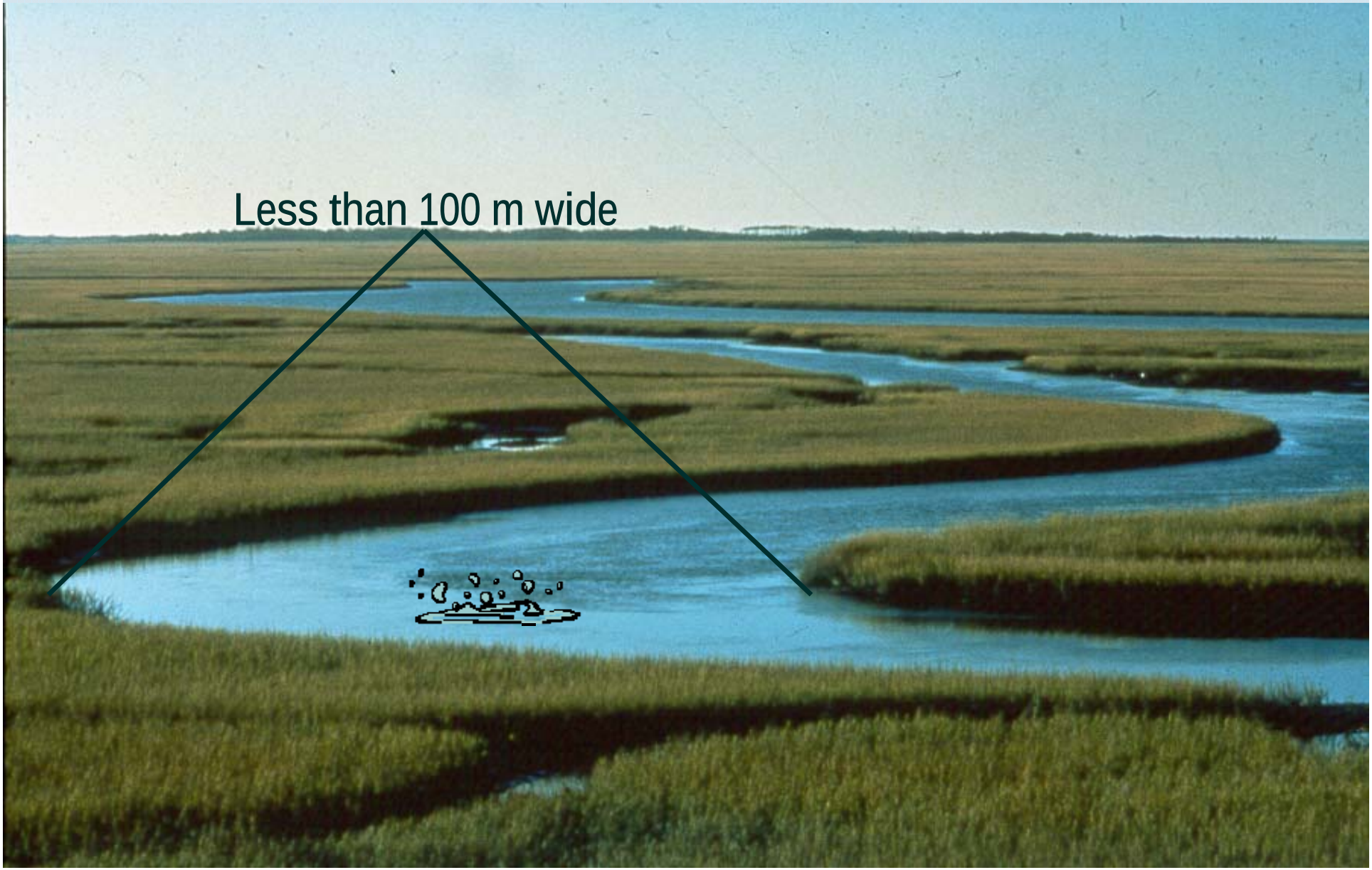


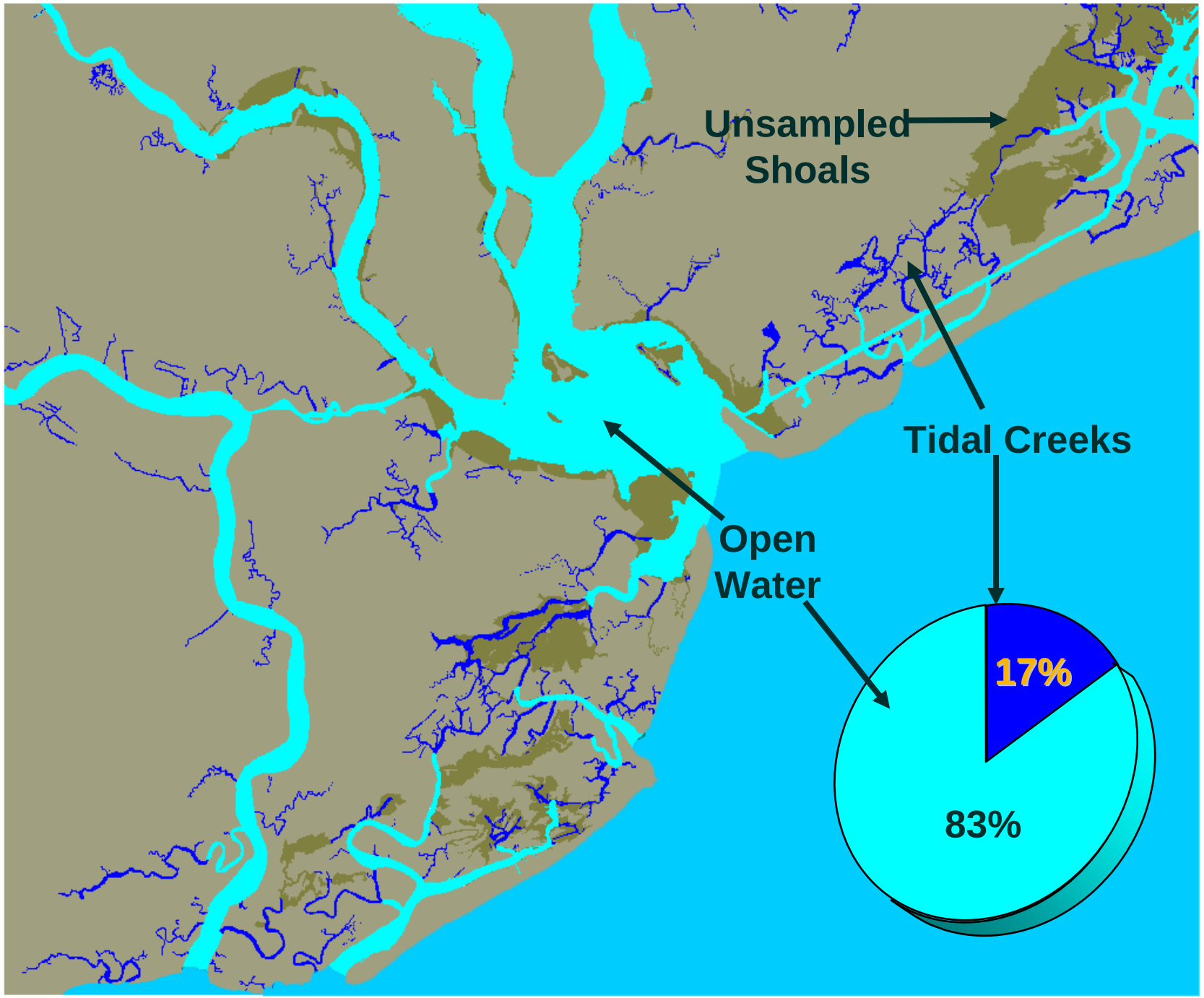
Targeted Categories for Probability-Based Sites

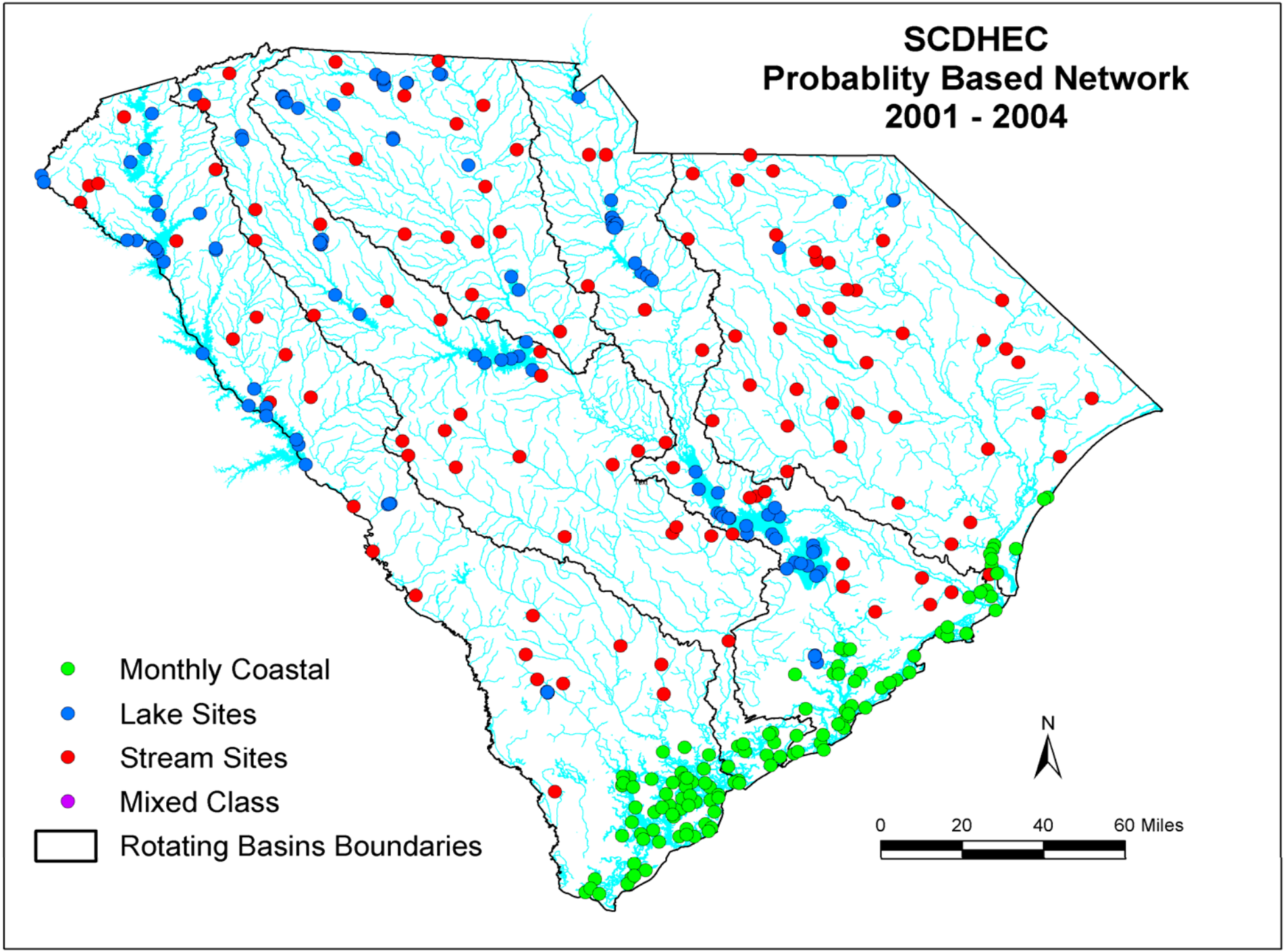
- Estuaries (30 sites per year with cooperators)
  - 30 visited monthly
  - Two distinct strata
  - Open water (> 100 m wide)
  - Creeks (< 100 m wide)



Habitat Designation Criteria

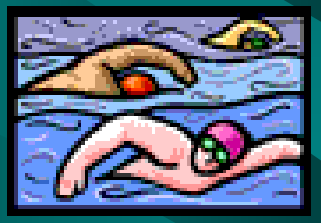



Unsampled
Shoals
Tidal Creeks
Open
Water
17%
83%


SCDHEC
Probablity Based Network
2001 - 2004
Monthly Coastal
Lake Sites
Stream Sites
Mixed Class
Rotating Basins Boundaries
N
0
20
40
60 Miles

Primary Uses to be Assessed with Probability Data

- Statewide
  - Aquatic Life Use Support
  - Recreational Use Support



Use of Generated Data

- §303(d)
  - Integrator Sites
  - Special Purpose Sites
  - Summer Only Sites
  - Basin Sites
  - Probability Sites
  - Other QA'd data
- §305(b)
  - Probability Sites

In order to do that, sufficient data must be collected at each Probability Site to apply SCDHEC's Assessment Methodology

- This is a different approach than that employed by most other states with Probability-Based designs

Annual Ambient Surface Water Chemistry Monitoring Numbers

313 Integrators (statewide)

31 Special Purpose (statewide)

5 Summer Only (statewide)

8 Sediment Only (statewide)

83-104 Basin Sites (depending on target basins)

90 Probability Sites (statewide)

Don’t Put All of Your Eggs in One Basket!

You Need to Have a Little of Everything

- Probability based for big picture statements
- Fixed sites to examine long-term trends in individual parameters
- Capability for targeted monitoring for specific needs:
  - Emerging issues/special studies
  - Tracking of implementation of control strategies

Benefits of Entire Package

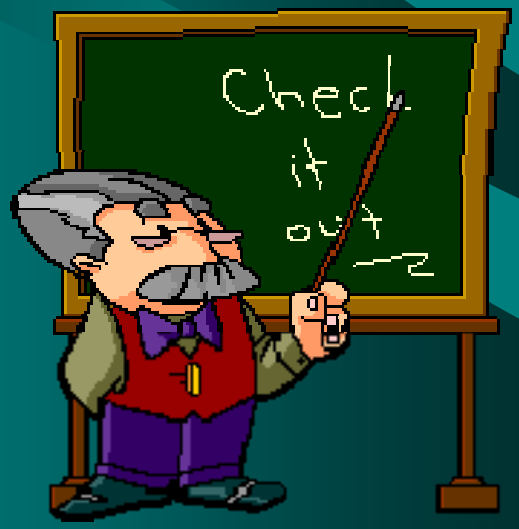
- Consistent & comparable data statewide
- Known confidence in §305(b) statements
- Sample previously unsampled locations
- Identify new §303(d) candidates

So what do the results show?

Site-Based §303(d) List

vs.

Statewide Probability-Based §305(b) Results



§303(d) List

- 2006 list approved by Region IV EPA
- Basis for TMDLs, projects, etc.
- Directly impacts permit limits
- Based on assessment results at individual monitoring sites
  - Number of sites not meeting standards
  - Number of parameters not meeting standards at an individual site

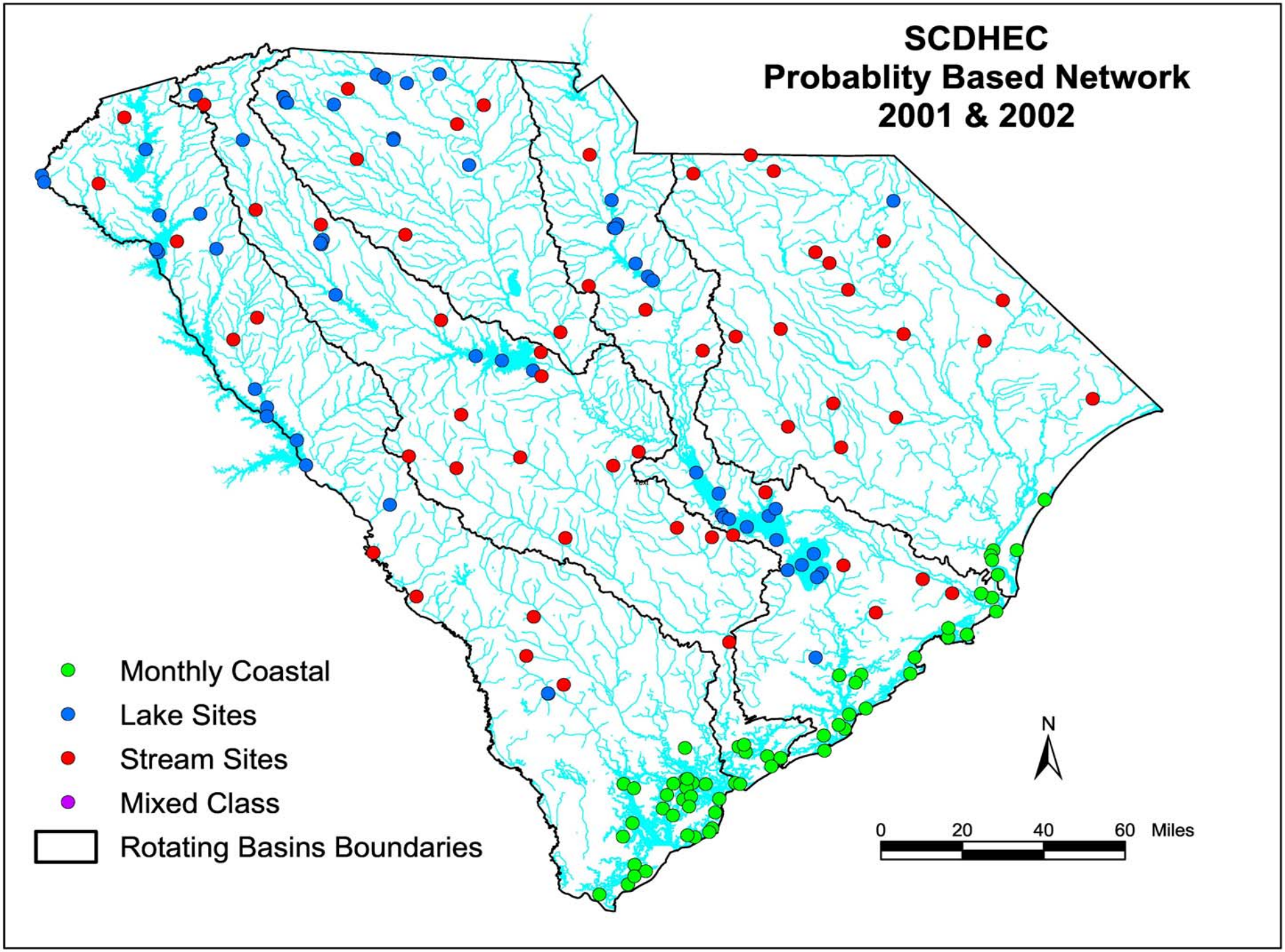
2006 §303(d) List

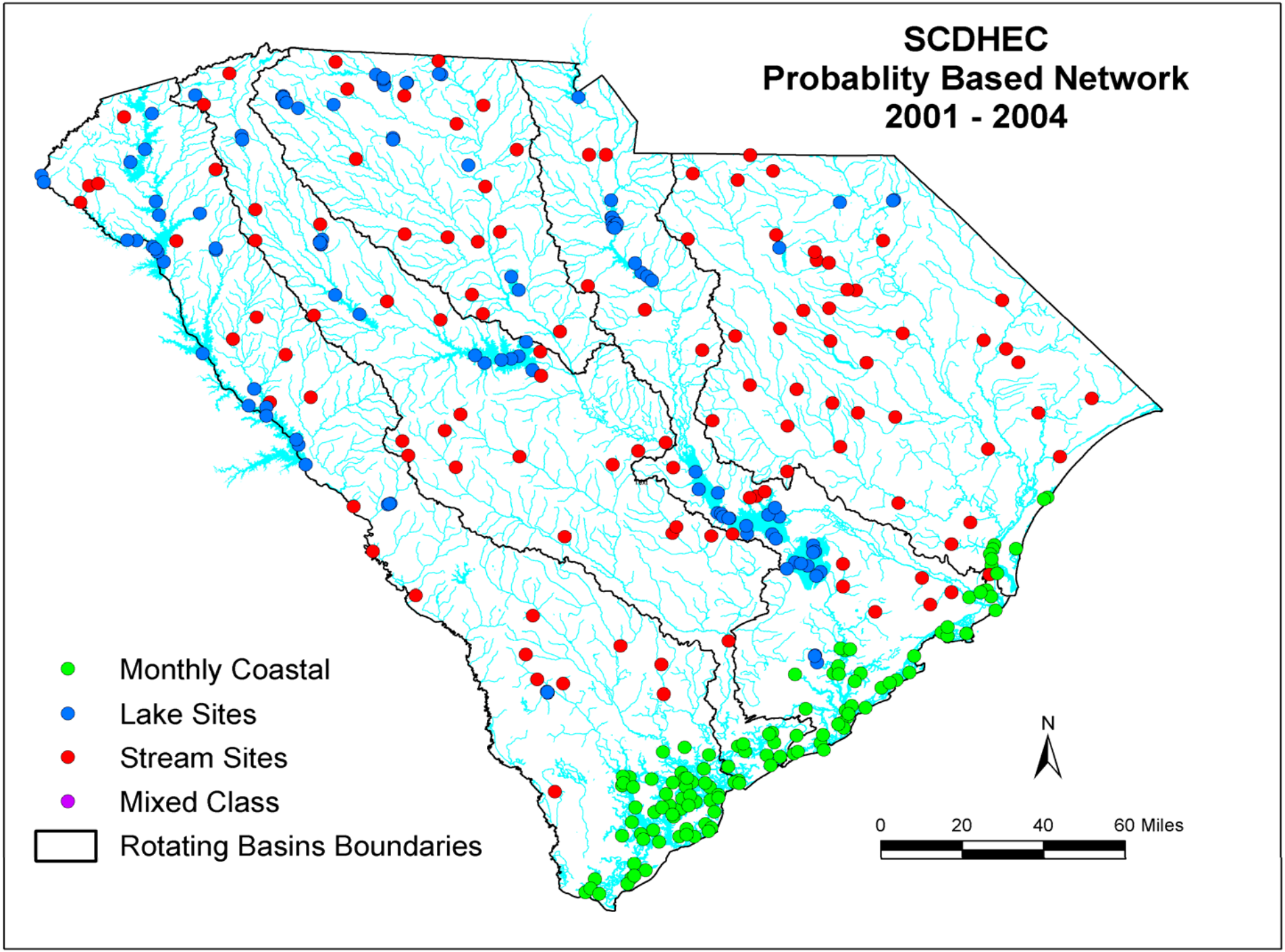
	All Sites	Random Sites
Sites Assessed	1405	329
Sites Listed	585	119
Total # Impairments	757	163
Fecal Coliform	21%*	28%
Low DO	17%	11%
Impaired Bio. Comm.	19%	12%
pH	10%	4%
Copper	12%	9%
Zinc	2%	4%
Turbidity	7%	15%
Other impairment	11%	15%

- Of Random Sites Listed
  - 28 Lake Sites
  - 65 Stream Sites
  - 28 Estuary Sites

% =
# Sites Impaired for Parameter
÷ Total # Impairments

So what do the statewide probability-based results show?

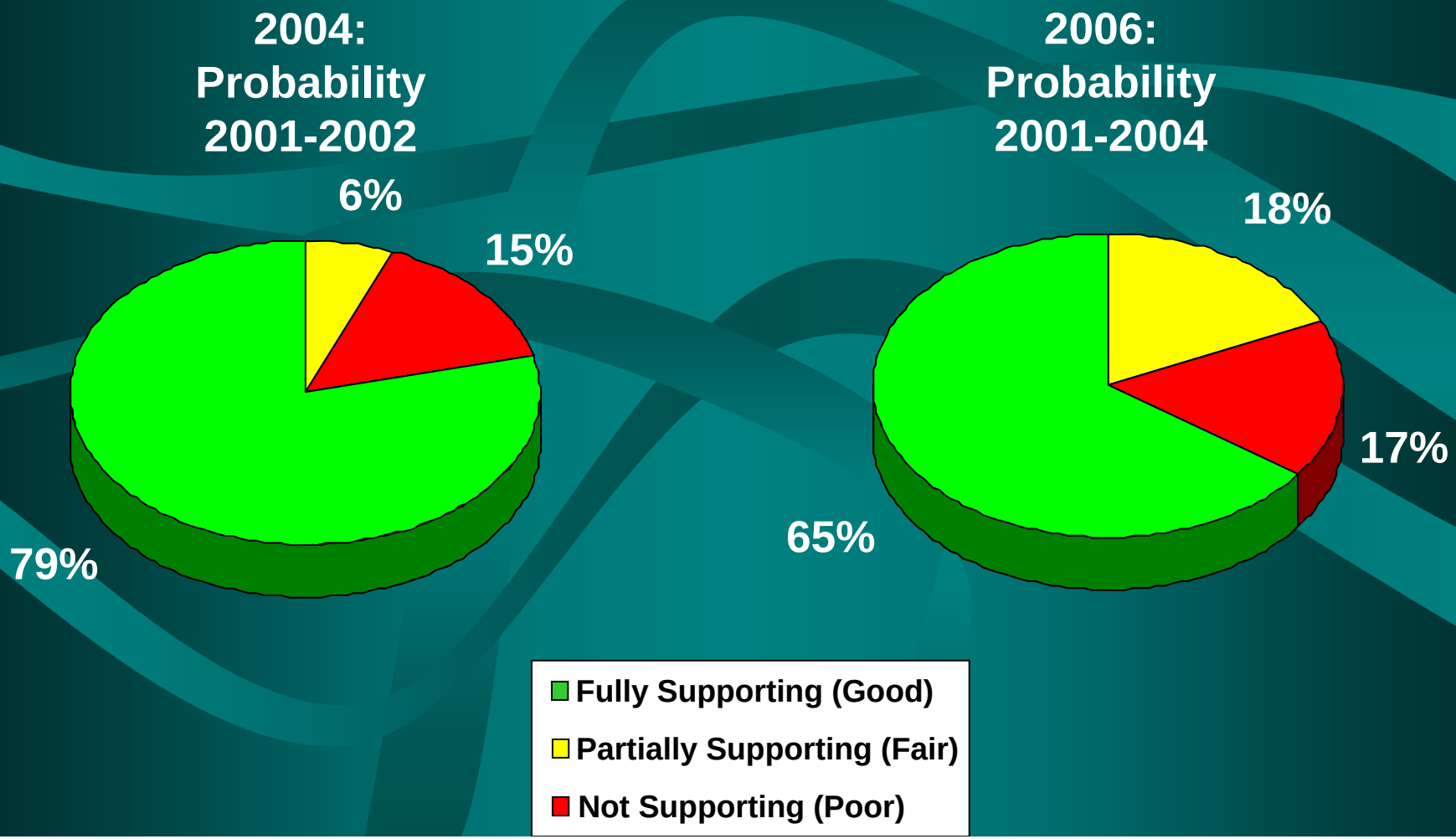

SCDHEC
Probablity Based Network
2001 & 2002
Monthly Coastal
Lake Sites
Stream Sites
Mixed Class
Rotating Basins Boundaries
N
0
20
40
60
Miles


SCDHEC
Probablity Based Network
2001 - 2004
Monthly Coastal
Lake Sites
Stream Sites
Mixed Class
Rotating Basins Boundaries
N
0
20
40
60 Miles

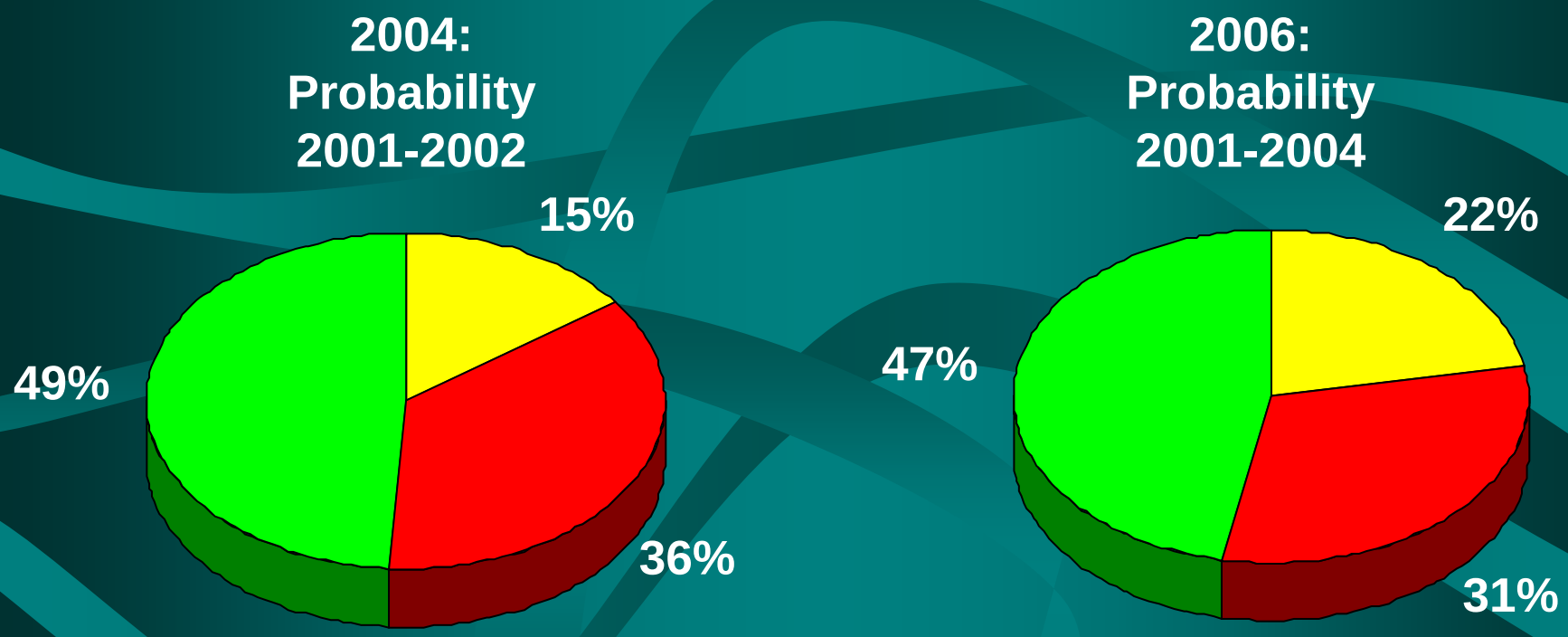
Rivers & Streams

- Probability-Based Approach
  - Estimated 20,954 miles in stream design frame
  - 2004: 58 water quality monitoring sites 2001-02
  - 2006: 118 water quality monitoring sites 2001-04
    - 65 sites on §303(d)
  - Representing all stream miles

Rivers & Streams Aquatic Life Use Support (ALUS)



Rivers & Streams Recreational Use Support



Percent of Rivers & Streams Impaired by Specific Causes

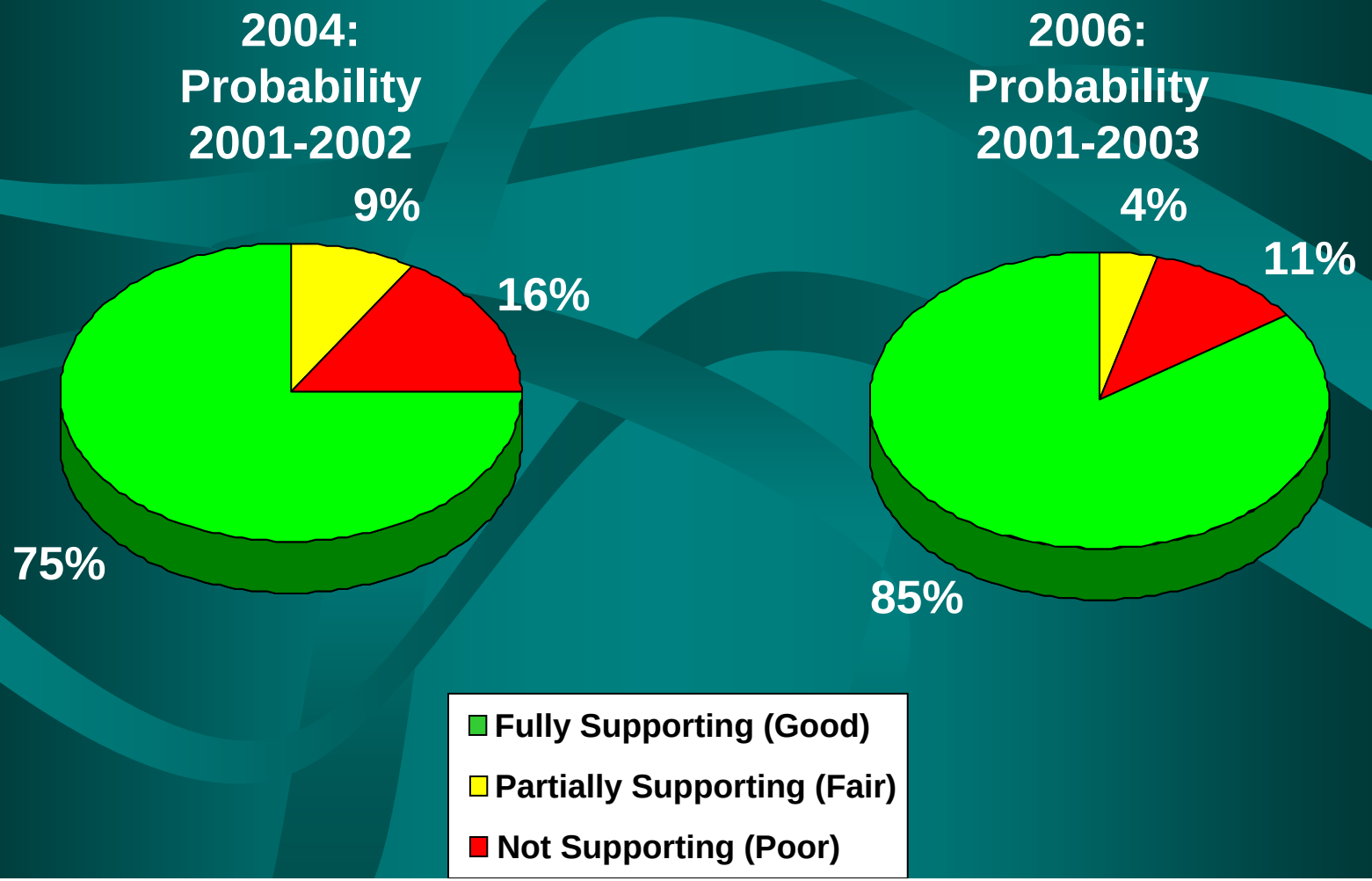
Indicator	2001-2004 Probability Estimated %	2001-2004 Lower 95% CL	2001-2004 Upper 95% CL
Percent of Rivers and Streams Miles Impaired by Various Cause Categories			
Macroinvertebrate Community *	22.6%	13.7%	31.5%
Turbidity	1.9%	0.3%	3.5%
Dissolved Oxygen	8.3%	3.7%	13.0%
pH	3.9%	0.1%	7.6%
Chromium	0.5%	0.0%	1.4%
Copper	6.6%	1.8%	11.3%
Nickel	0.5%	0.0%	1.4%
Zinc	3.9%	1.0%	6.8%
Fecal Coliform Bacteria	53.2%	43.8%	62.6%

* - Misleading because not every site had a macroinvertebrate assessment. The total resource size represented by macroinvertebrate results is 5,667 miles

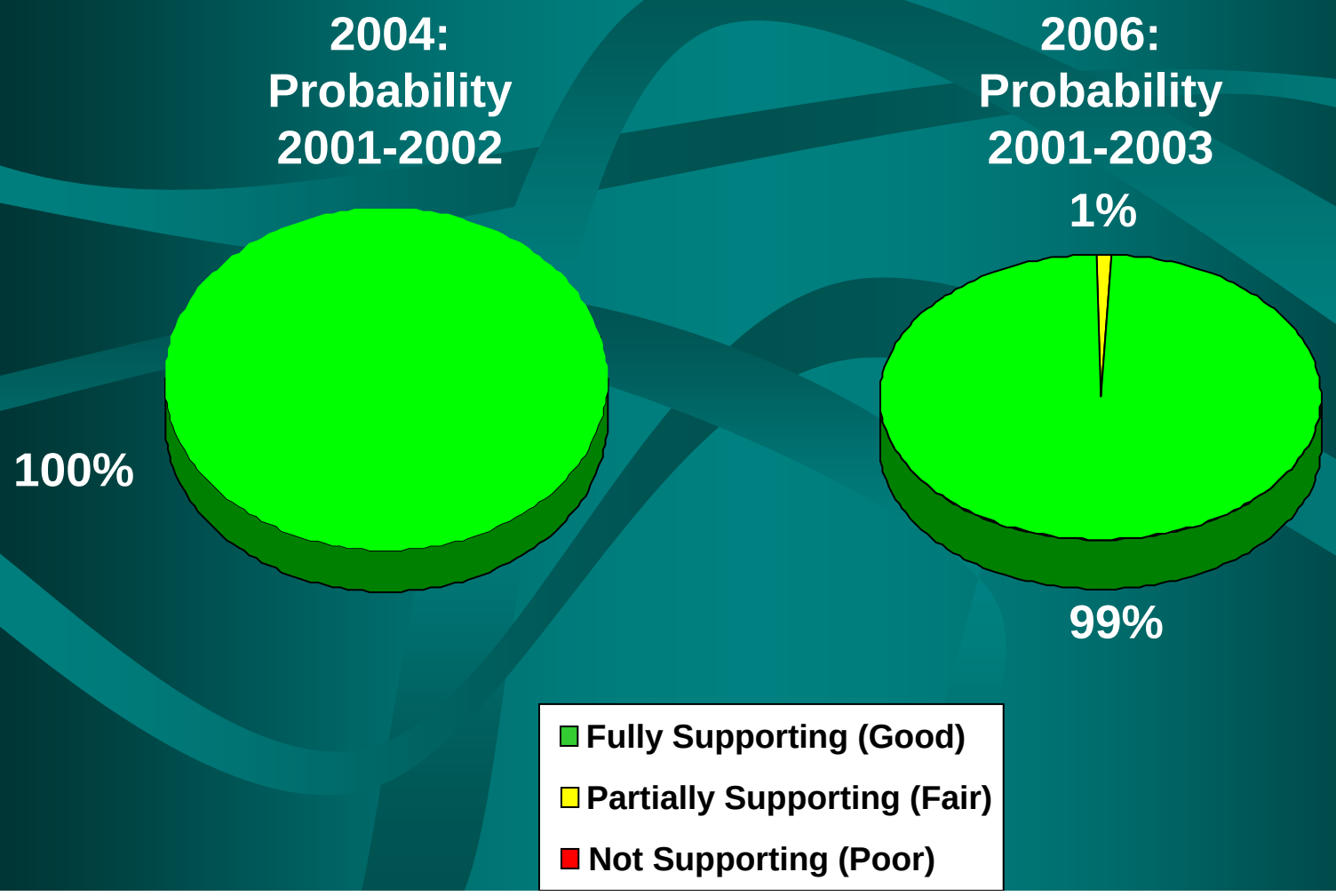
Lakes & Reservoirs

- Probability-Based Approach
  - Estimated 308,765 acres of lake/reservoir in design frame
  - 2004: 61 water quality monitoring sites 2001-02
  - 2006: 91 water quality monitoring sites 2001-03
    - 28 sites on §303(d)
  - Representing all lake acres

Lakes & Reservoirs Aquatic Life Use Support (ALUS)



Lakes & Reservoirs Recreational Use Support



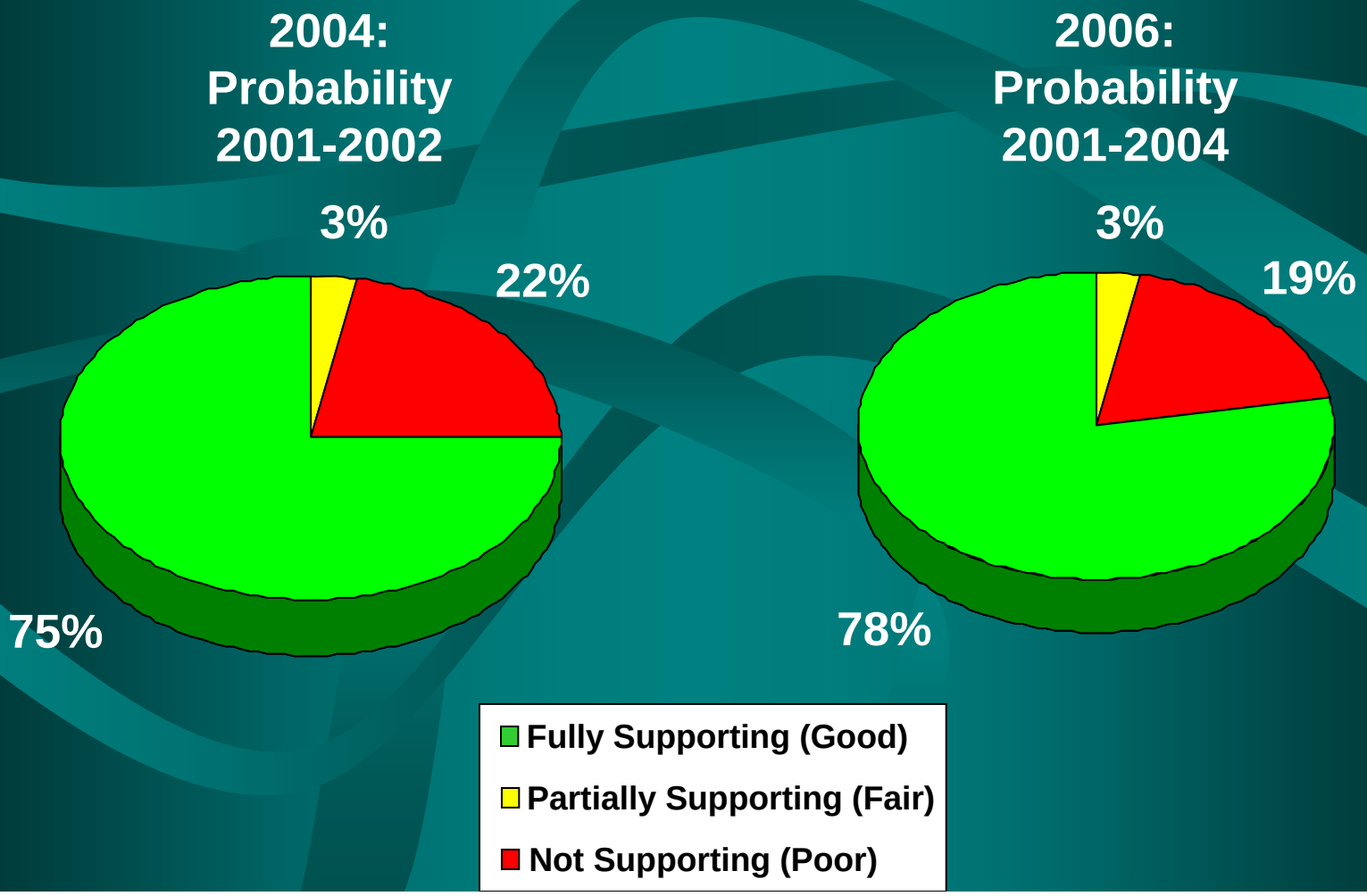
Percent of Lakes & Reservoirs Impaired by Specific Causes

Indicator	2001-2003 Probability Estimated %	2001-2003 Lower 95% CL	2001-2003 Upper 95% CL
Percent of Lake and Reservoir Acres Impaired by Various Cause Categories			
Turbidity	0.2%	0.1%	0.4%
Dissolved Oxygen	0.2%	0.0%	0.3%
pH	10.7%	3.9%	17.5%
Total Phosphorus	6.8%	1.6%	12.0%
Total Nitrogen	0.1%	0.0%	0.2%
Chlorophyll-*a*	2.3%	0.0%	5.8%
Copper	0.1%	0.0%	0.2%
Zinc	0.1%	0.0%	0.2%
Fecal Coliform Bacteria	0.1%	0.0%	0.2%

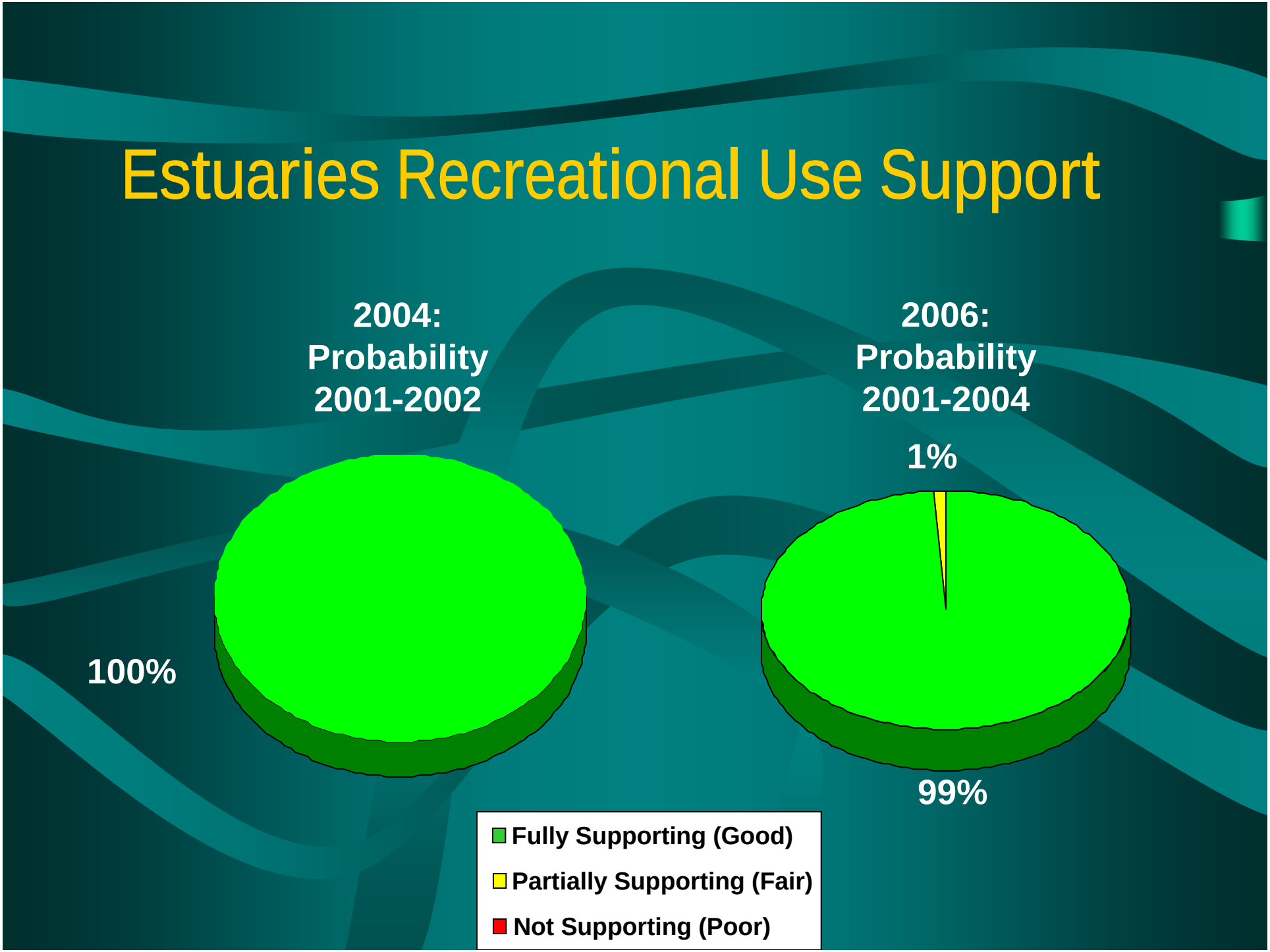
Estuaries

- Probability-Based Approach
  - 277 square miles in the estuarine sampling design frame
  - 2004: 60 water quality monitoring sites 2001-02
  - 2006: 120 water quality monitoring sites 2001-04
    - 28 sites on §303(d)
  - Representing all estuary square miles

Estuaries Aquatic Life Use Support (ALUS)



Estuaries Recreational Use Support



Percent of Estuaries Impaired by Specific Causes

Indicator	2001-2004 Probability Estimated %	2001-2004 Lower 95% CL	2001-2004 Upper 95% CL
Percent of Estuary Square Miles Impaired by Various Cause Categories			
Turbidity	11.2%	6.0%	16.4%
Dissolved Oxygen	7.6%	2.9%	12.3%
pH	0.0%	0.0%	0.0%
Ammonia	1.4%	0.0%	3.8%
Copper	5.2%	0.9%	9.6%
Nickel	0.0%	0.0%	0.0%
Zinc	0.2%	0.0%	0.6%
Fecal Coliform Bacteria	0.2%	0.0%	0.6%

That's All Folks!

Any Questions?

Discussion?

Visit our Web Site!
www.scdhec.net/water/

- Laws and regulations
- Reports and publications
- Fish Consumption Advisories
- Watershed maps
- Program contacts
- Outreach information

Indicators

Core Parameters - All Physical & Chemical Sites

Monthly

Air & Water Temp

Dissolved Oxygen

pH

BOD_5

Fecal Coliform Bacteria

Turbidity

Total Phosphorus

Kjeldahl Nitrogen

Nitrate

Ammonia

Alkalinity

Core Parameters - All Physical & Chemical Sites

Quarterly

Total Organic Carbon
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Zinc

Annually

Hardness*

*Freshwater sites only

Core Parameters - Waterbody-Type Specific

Monthly

- Salinity
- Conductivity

} Saltwater sites only

- Chlorophyll a (May-Oct. all lakes and select estuarine)
- Transparency (Secchi depth, all lakes)

Sediment Sampling

Annually

- Probability-based sites
  - All 30 streams and 30 lakes sampled and analyzed by SCDHEC
  - All estuarine sites collected by SCDNR and analyzed by NOAA – NOS
- 86 Fixed-location sites
- Select basin sites each year