South Carolina Surface Water Monitoring: Different Designs for Different Objectives

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

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 SCDHEC Reporting Activities

- Watershed Water Quality Assessments (WWQA)
- *Healthy People Living In Healthy Communities*

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:

- <u>Big Picture:</u>
  - Make statements about representative WQ at varying scales (§305(b), WWQA)
- <u>Site Specific</u>
  - 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

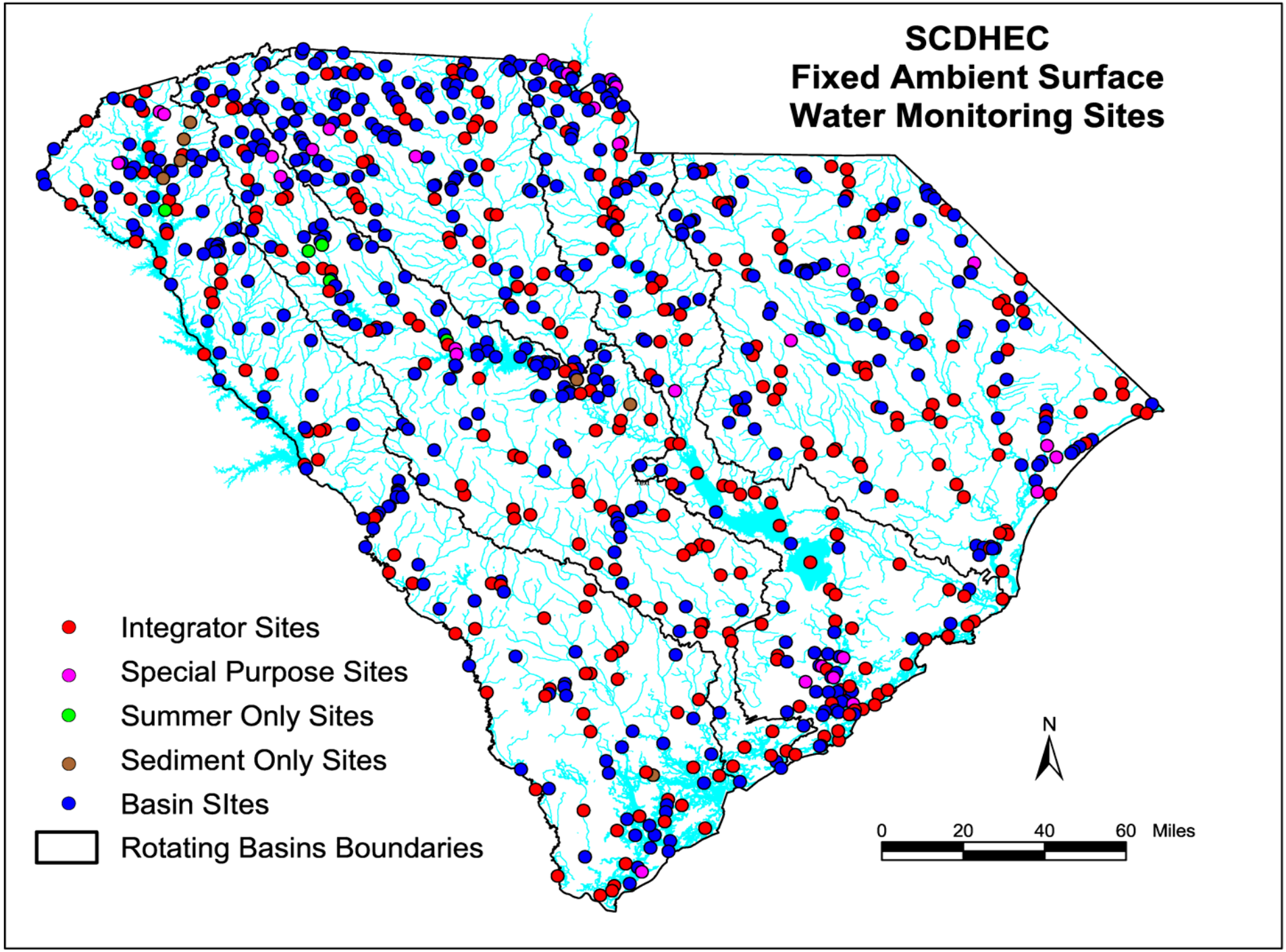
- Fish Tissue Monitoring

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
  - Target outflow of 11-digit WSU or specific data needs
- Special Summer-Only Sites
  - Sampled monthly May-October
  - Target specific data needs
- Basin Sites
  - More-or-less fixed, on a 5 year cycle
  - Sampled monthly for 1 year when active


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)
  - Known confidence of estimates
- Sample previously unsampled locations
  - Identify new §303(d) candidates

Assistance in Development of Probability- Based Monitoring

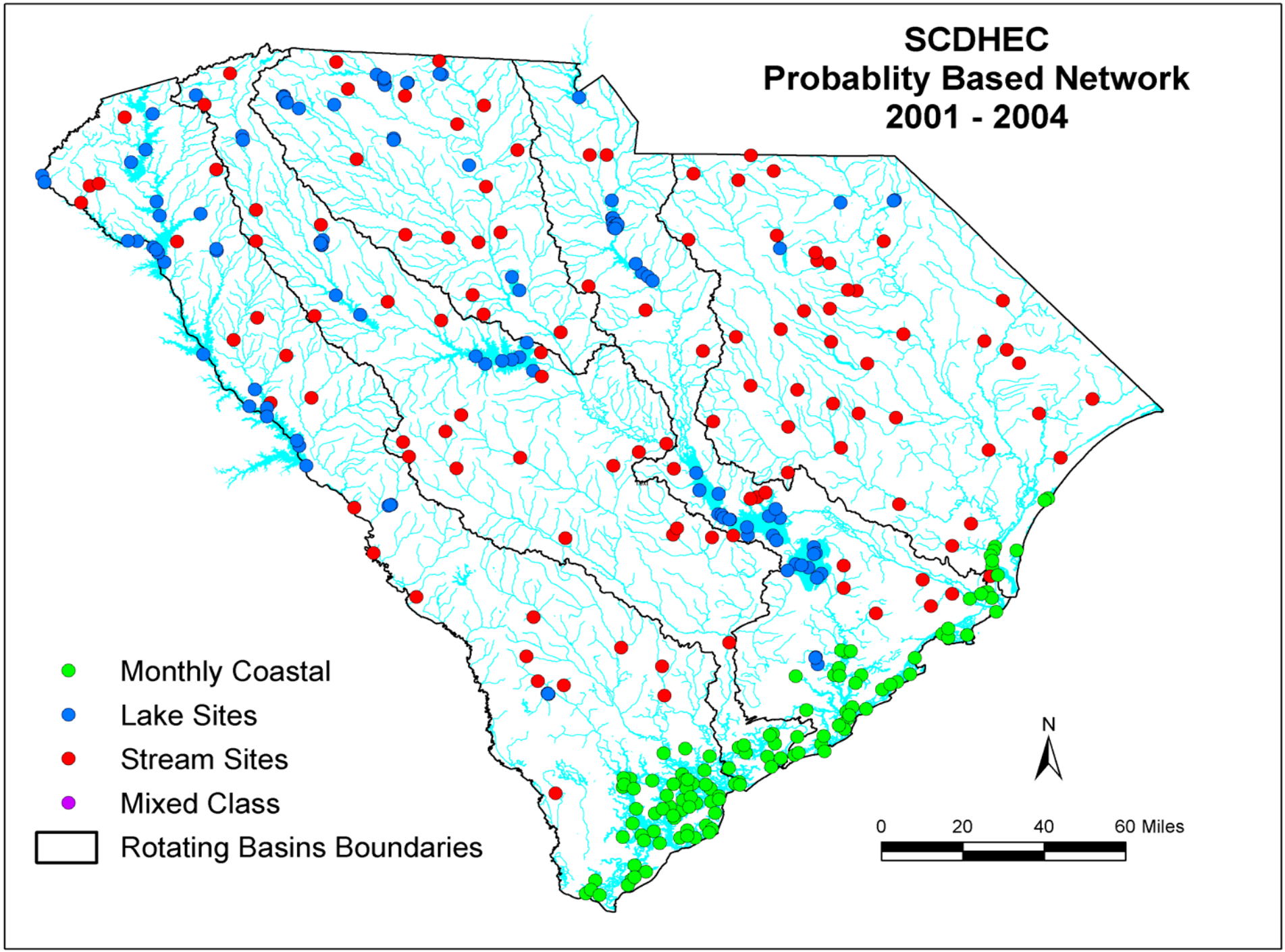
- Ron Raschke – Region IV EPA (retired)
- Kent Thornton – FTN Associates
- EPA ORD National Health & Environmental Effects Research Laboratories
- Tony Olsen – EPA ORD NHEERL Corvallis, OR
- Kevin Summers – EPA ORD NHEERL Gulf Breeze, FL
- Bob Van Dolah – SCDNR MRRI

Resource Types Assessed Using Probability-Based Approach

- Streams

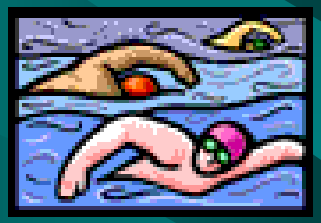
- Lakes

- Estuaries


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



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

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

Core Parameters - All Physical & Chemical Sites

<u>Monthly</u>

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

<u>Quarterly</u>

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

<u>Annually</u>

Hardness*

*Freshwater sites only

Core Parameters - Waterbody-Type Specific

<u>Monthly</u>

- Salinity
- Conductivity

} Saltwater sites only

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

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

Expected Benefits of Whole Package

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

Use of Generated Data

- §305(b)
  - Probability Sites
  - Initially a comparison of old approach, all data all sites, with probability results
- §303(d)
  - Integrator Sites
  - Special Purpose Sites
  - Summer Only Sites
  - Basin Sites
  - Probability Sites
  - Other QA'd data

Use of Generated Data

- Watershed Water Quality Assessments
  - All available data for basin
  - Assess use support
  - Assess long-term trends
  - Track corrective actions

So what do the results show?

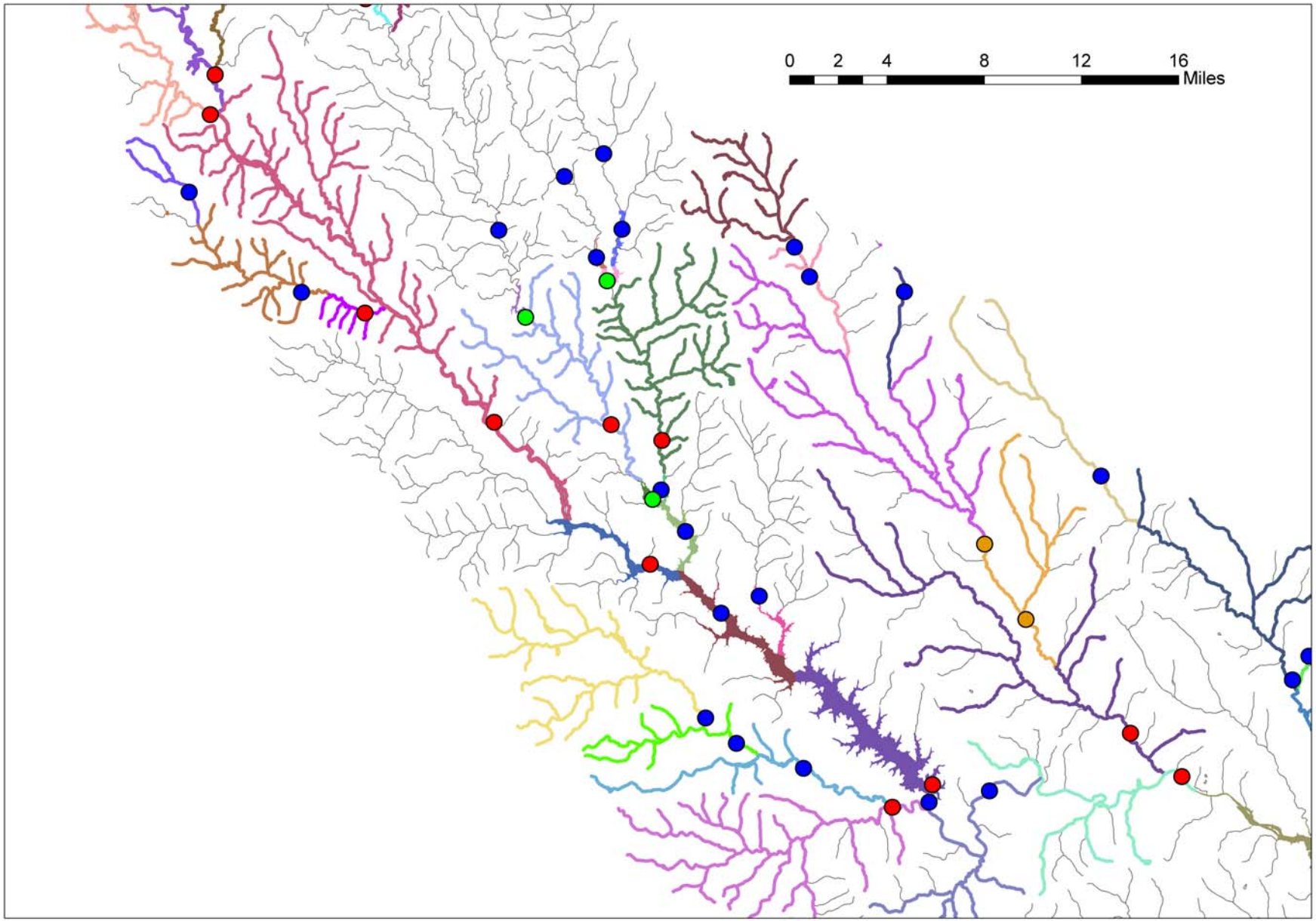
Traditional 5 -Year §305(b) Assessment

vs.

Probability-Based Stream Results

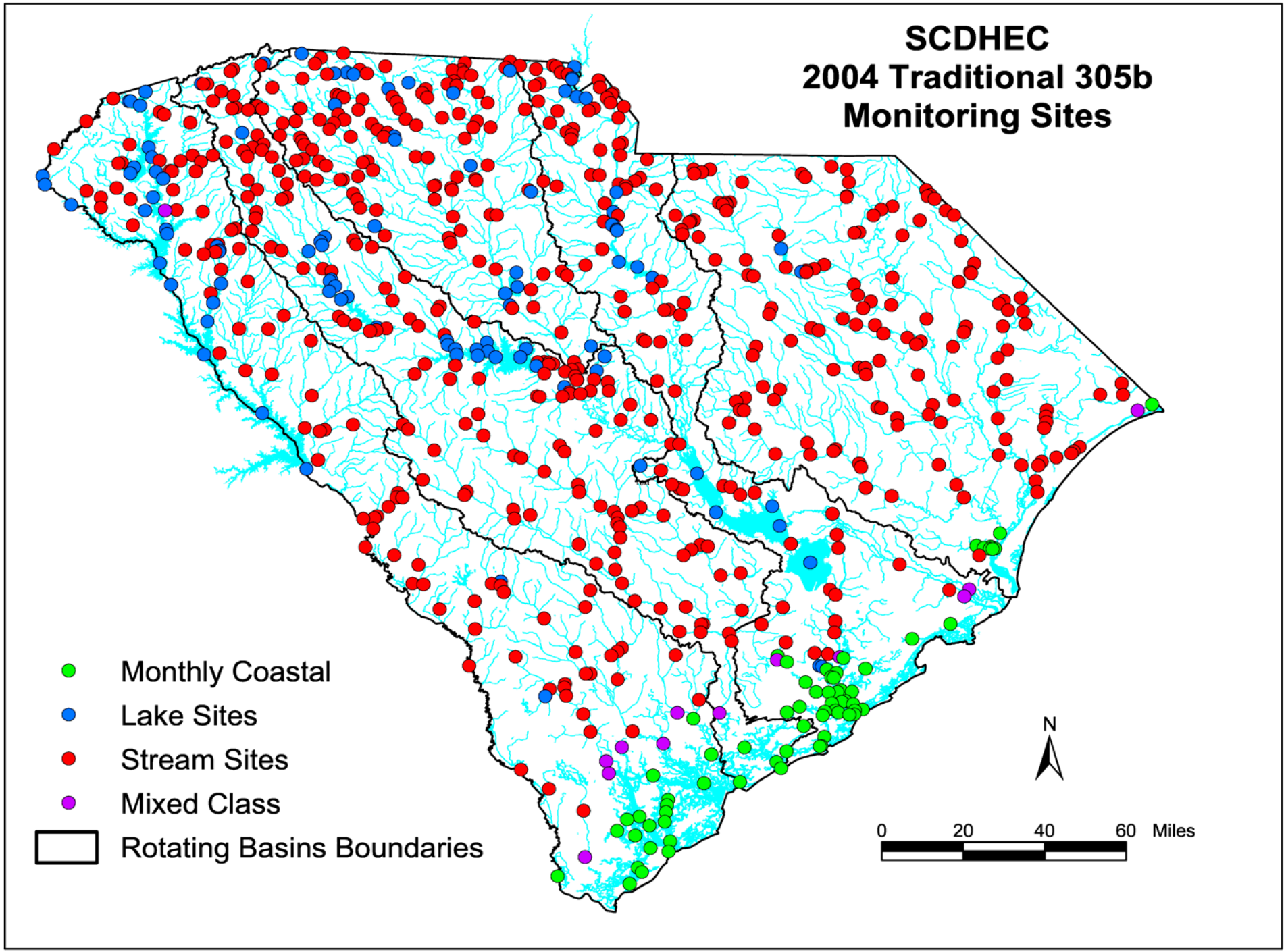
Traditional 5 -Year §305(b) Assessment

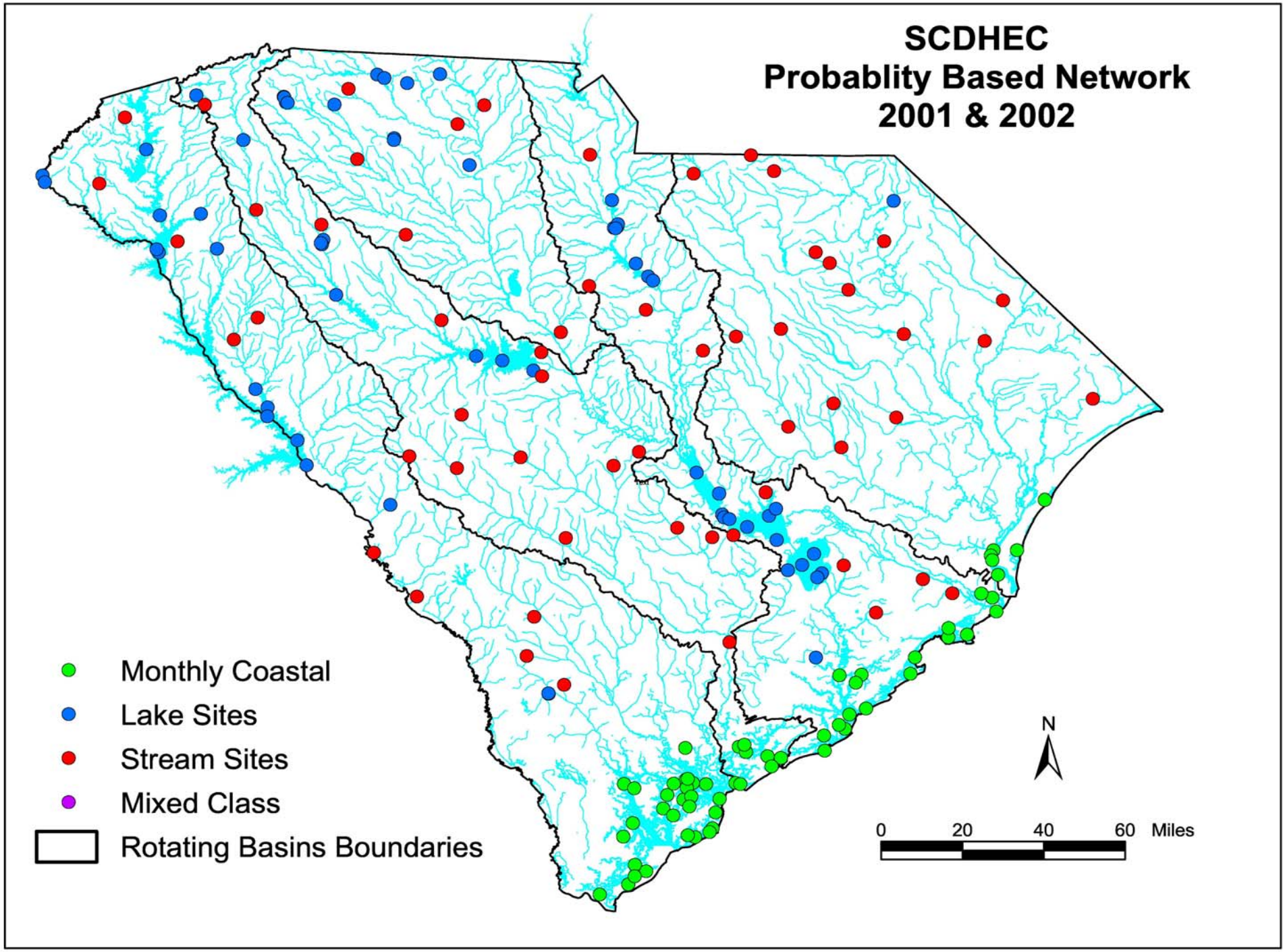
- Individual fixed sites selected for a variety of reasons, e.g. below point source, urban area, background conditions, citizen concerns, other special interests
- Individual sites (points) are sampled
- Segments or polygonal areas are assigned to be represented by the water quality at the sampled point
  - Based on professional judgment; general landuse, stream size, local knowledge, etc.
  - Determines size represented by individual point

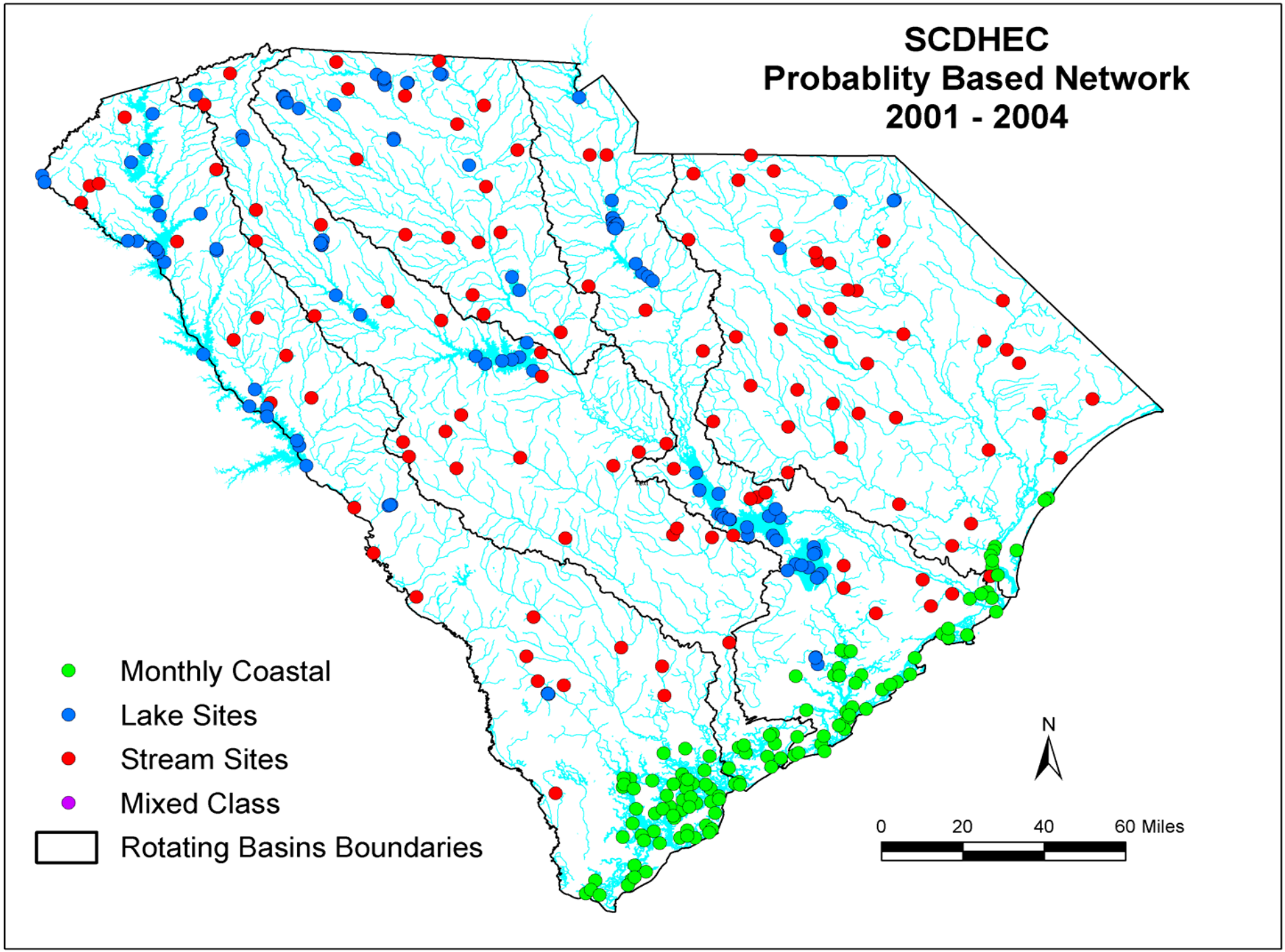

0
2
4
8
12
16
Miles

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


SCDHEC
2004 Traditional 305b
Monitoring Sites
Monthly Coastal
Lake Sites
Stream Sites
Mixed Class
Rotating Basins Boundaries
N
0
20
40
60
Miles


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
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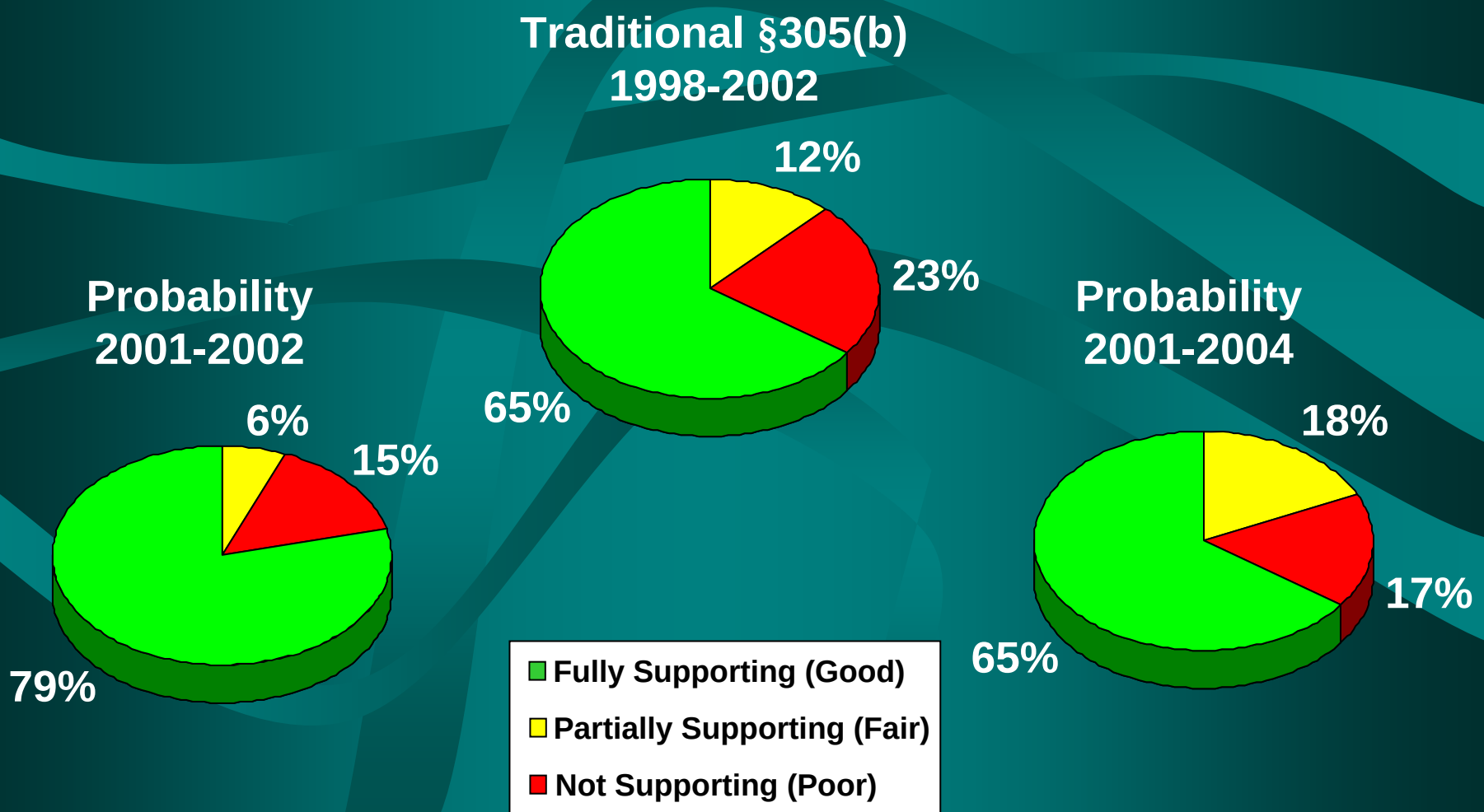
Monthly Coastal
Lake Sites
Stream Sites
Mixed Class
Rotating Basins Boundaries
N
0
20
40
60 Miles

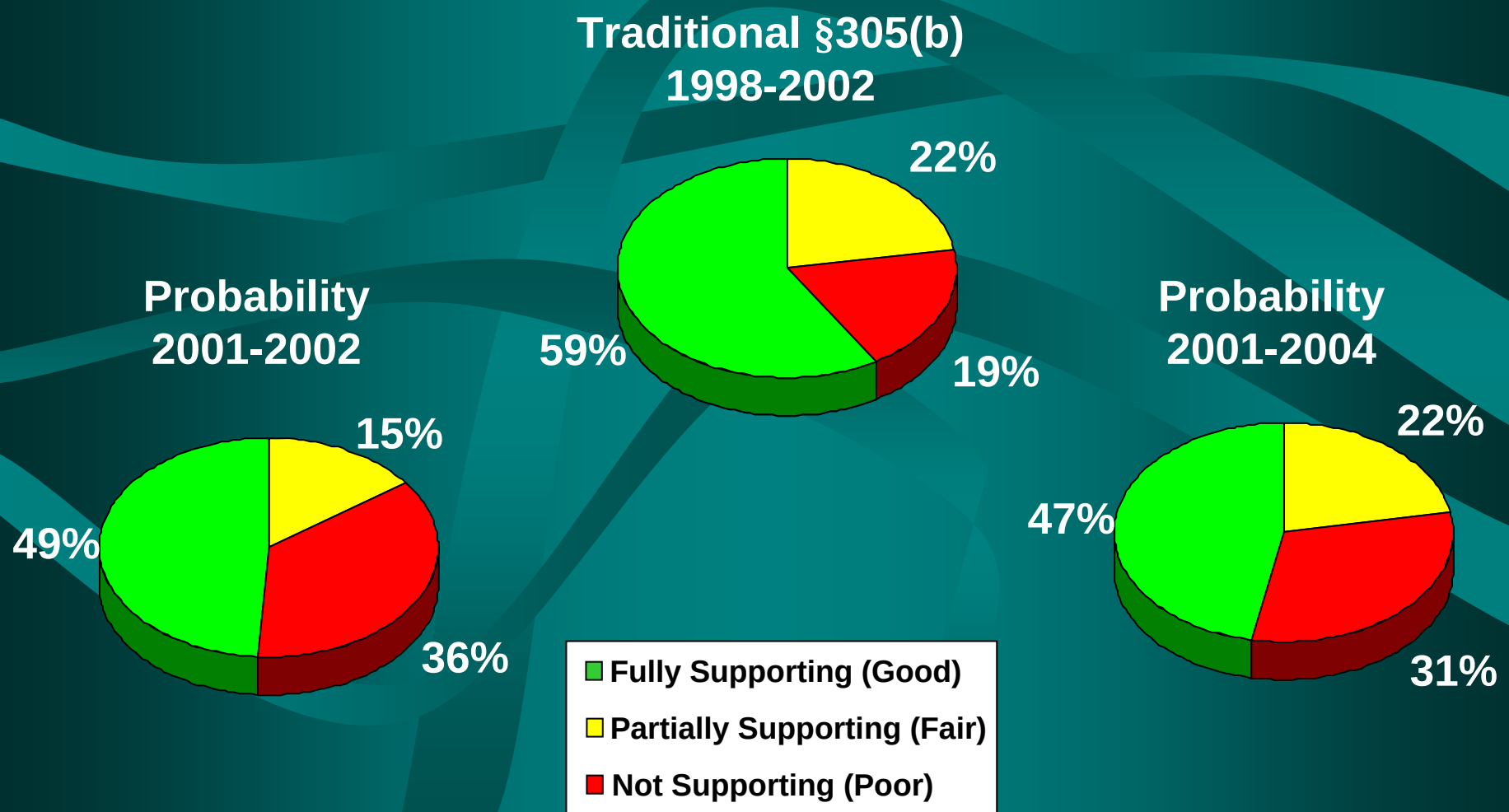
Rivers & Streams

- Traditional §305(b) Approach
  - NHD 29,794 Total Miles
  - 630 water quality monitoring sites
  - Representing 15,312 miles assessed
- Probability-Based Approach
  - Estimated 20,954 miles in stream design frame
  - 58 water quality monitoring sites 2001-02
  - 118 water quality monitoring sites 2001-04
  - Representing all miles

Rivers & Streams Aquatic Life Use Support (ALUS)



Rivers & Streams Recreational Use Support



Percent of Rivers & Streams Impaired by Specific Causes

Indicator	1998-2002 §305(b) % of Assessed	2001-2004 Probability Estimated %	2001-2004 Lower 95% CL	2001-2004 Upper 95% CL
Percent of Rivers and Streams Impaired by Various Cause Categories				
Macroinvertebrate Community *	4.0%	22.6%	13.7%	31.5%
Turbidity	0.9%	1.9%	0.3%	3.5%
Dissolved Oxygen	18.6%	8.3%	3.7%	13.0%
pH	7.2%	3.9%	0.1%	7.6%
Chromium	0.5%	0.5%	0.0%	1.4%
Copper	7.0%	6.6%	1.8%	11.3%
Nickel	0.0%	0.5%	0.0%	1.4%
Zinc	1.3%	3.9%	1.0%	6.8%
Fecal Coliform Bacteria	40.7%	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

Difference in Recreational Use & Fecal Coliform Impairment Numbers

- In the past the tendency was to establish fixed sites on stream locations with strong public use or interest
- Under the traditional §305(b) approach, larger streams represent a lot of the total miles assessed compared to smaller order streams
- The smaller order streams not "represented" are just assumed to be "not assessed“

Difference in Recreational Use & Fecal Coliform Impairment Numbers

- All the traditional percentages are based on the total stream miles assessed
- So the small streams are under-represented in the total miles assessed
- Under the probability-based assessment they are now 100% represented, as are all other stream sizes

Rivers & Streams

Indicator	Category	1998-2002 §305(b) % of Assessed	2001-2004 Probability Estimated %	2001-2004 Lower 95% CL	2001-2004 Upper 95% CL
Aquatic Life Use	Fully Supporting	65.3%	65.1%	55.4%	74.8%
	Partially Supporting	12.1%	18.2%	9.9%	26.5%
	Not Supporting	22.5%	16.7%	10.0%	23.3%
Recreational Use	Fully Supporting	59.3%	46.8%	37.4%	56.2%
	Partially Supporting	21.5%	21.9%	13.8%	29.9%
	Not Supporting	19.2%	31.3%	22.3%	40.4%
Support of All Assessed Uses	Fully Supporting All	41.8%	33.3%	24.8%	41.7%
	Impaired for One or More	58.2%	66.7%	58.3%	75.2%

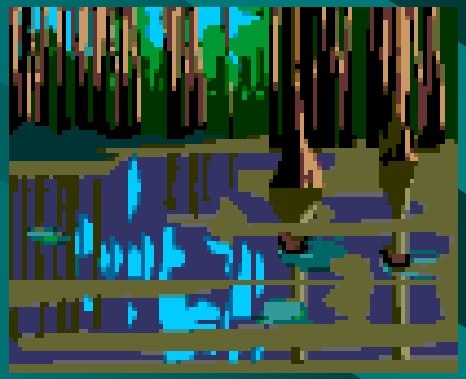
That’s All Folks!

Any Questions?

Discussion?

Targeted Categories for Probability-Based Sites

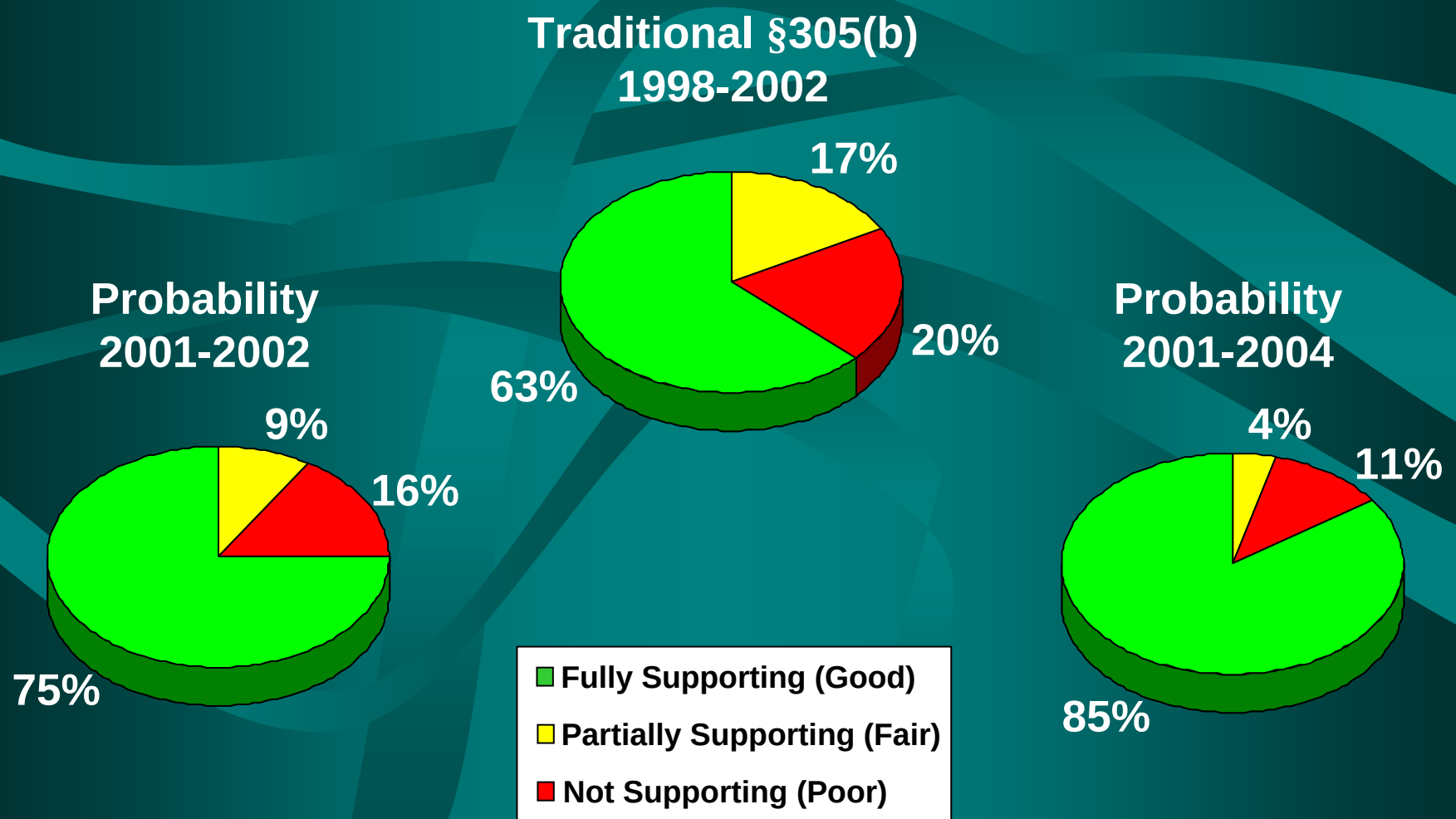
- Significant Lakes with Public Access (30 sites per year)
  - Sampled monthly
  - Major lakes (≥ 850 acres)
  - Minor lakes (40 to 850 acres)
  - Unequal weights



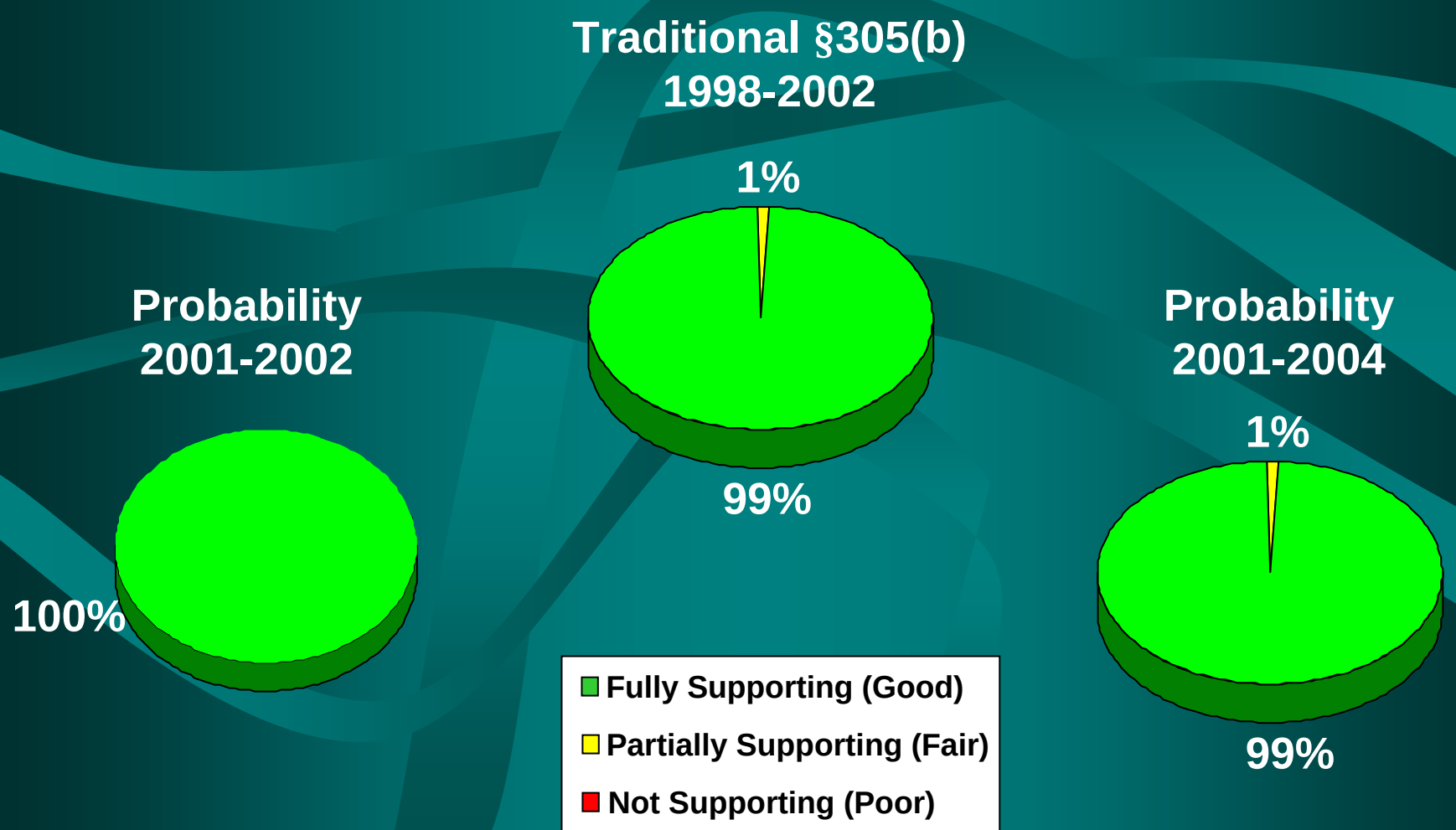
Lakes & Reservoirs

- Traditional §305(b) Approach
  - NHD 407,505 Total Acres
  - 107 water quality monitoring sites
  - Representing 227,275 acres assessed
- Probability-Based Approach
  - Estimated 308,765 acres of lake/reservoir in design frame
  - 61 water quality monitoring sites 2001-2002
  - 91 water quality monitoring sites 2001-2003
  - Representing all acres

Lakes & Reservoirs Aquatic Life Use Support (ALUS)



Lakes & Reservoirs Recreational Use Support



Lakes & Reservoirs

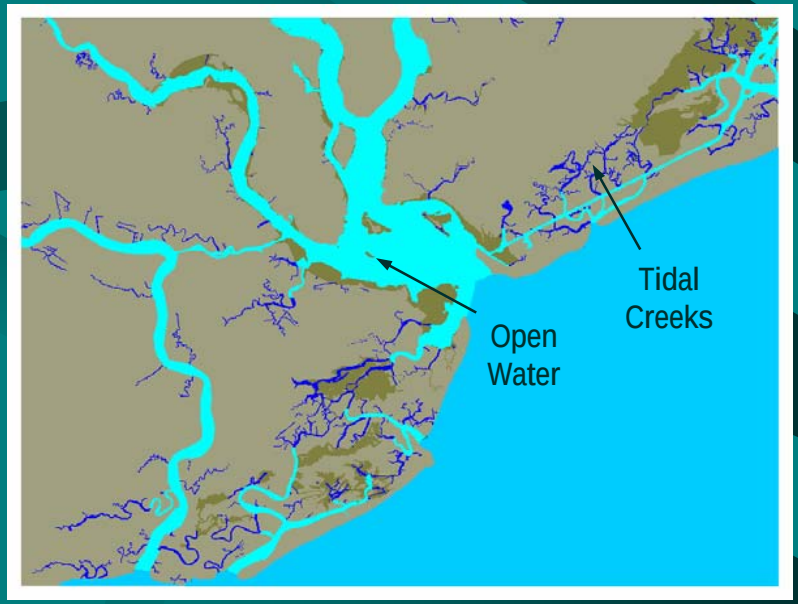
Indicator	Category	1998-2002 §305(b) % of Assessed	2001-2003 Probability Estimated %	2001-2003 Lower 95% CL	2001-2003 Upper 95% CL
Aquatic Life Use	Fully Supporting	62.9%	84.5%	76.3%	92.6%
	Partially Supporting	17.0%	4.4%	0.0%	9.1%
	Not Supporting	20.2%	11.2%	4.4%	18.0%
Recreational Use	Fully Supporting	99.4%	99.9%	99.8%	100.0%
	Partially Supporting	0.6%	0.1%	0.0%	0.2%
	Not Supporting	0.0%	0.0%	0.0%	0.0%
Support of All Assessed Uses	Fully Supporting All	62.8%	84.3%	76.2%	92.5%
	Impaired for One or More	37.2%	15.7%	7.5%	23.8%

Percent of Lakes & Reservoirs Impaired by Specific Causes

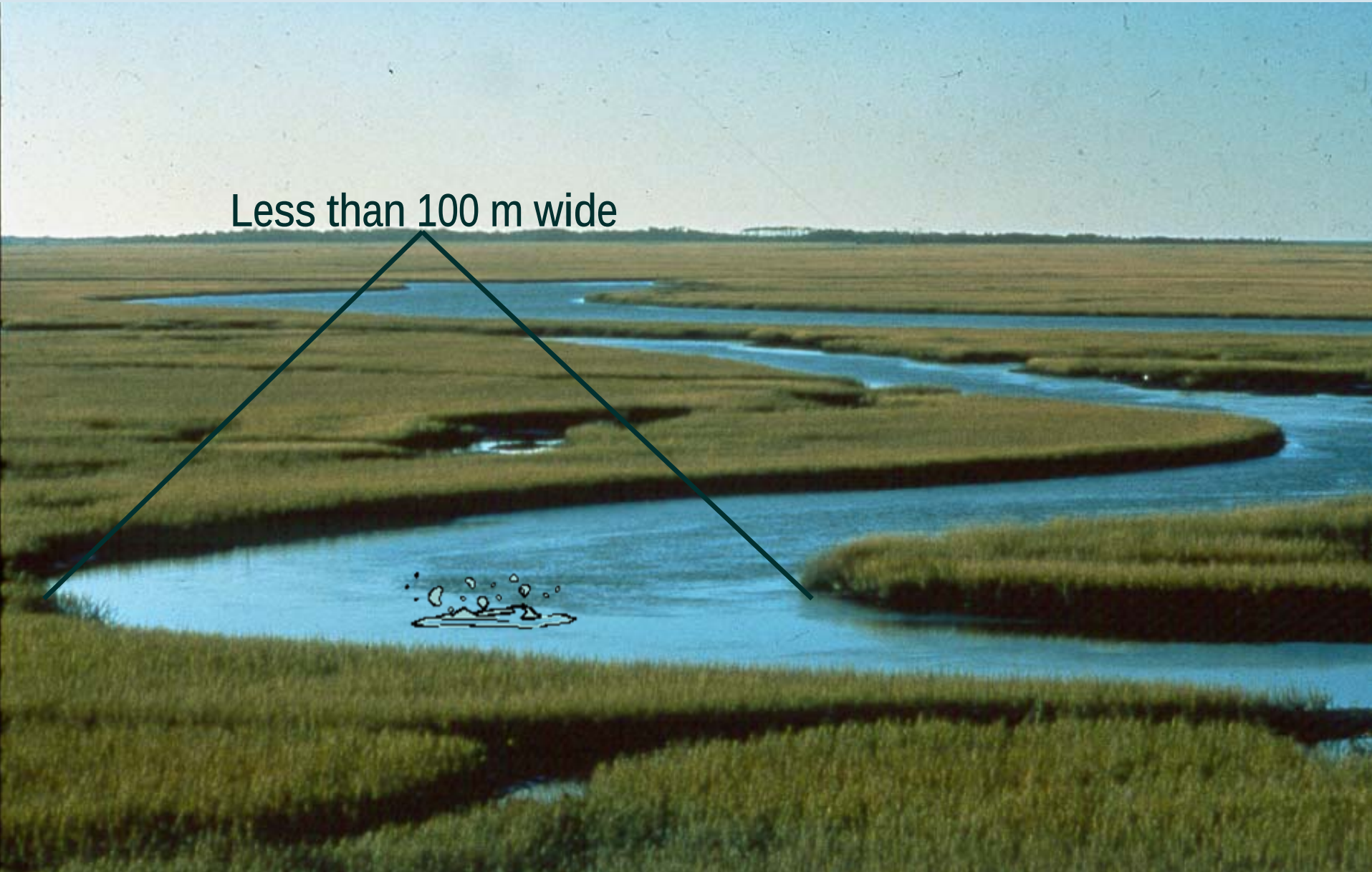
Indicator	1998-2002 §305(b) % of	2001-2003 Probability Estimated %	2001-2003 Lower 95% CL	2001-2003 Upper 95% CL
Percent of Lakes and Reservoirs Impaired by Various Cause Categories				
Turbidity	0.2%	0.2%	0.1%	0.4%
Dissolved Oxygen	5.3%	0.2%	0.0%	0.3%
pH	24.1%	10.7%	3.9%	17.5%
Total Phosphorus	13.7%	6.8%	1.6%	12.0%
Total Nitrogen	0.2%	0.1%	0.0%	0.2%
Chlorophyll-*a*	0.4%	2.3%	0.0%	5.8%
Copper	5.6%	0.1%	0.0%	0.2%
Zinc	0.0%	0.1%	0.0%	0.2%
Fecal Coliform Bacteria	0.5%	0.1%	0.0%	0.2%

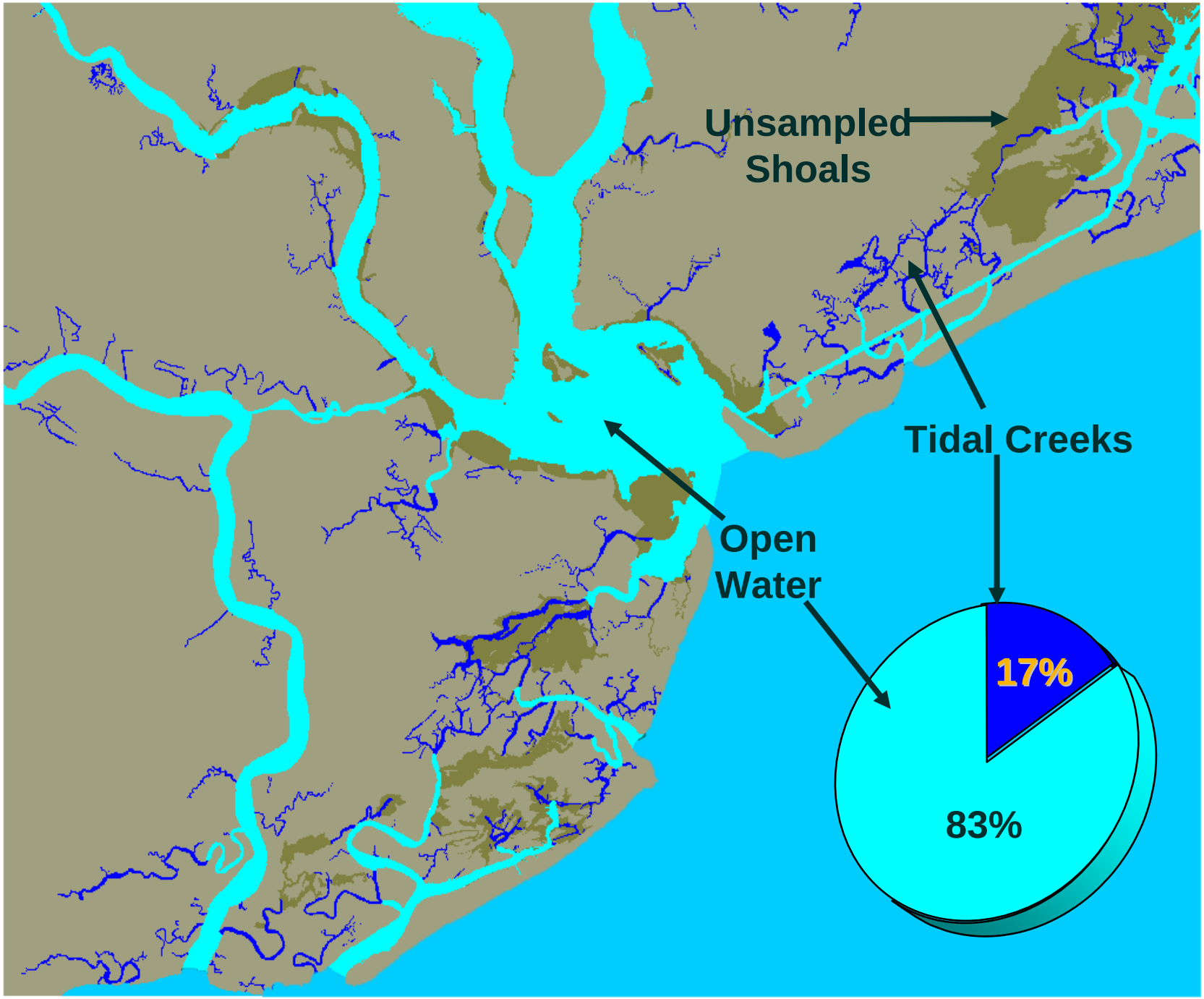
Targeted Categories for Probability-Based Sites

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



Habitat Designation Criteria

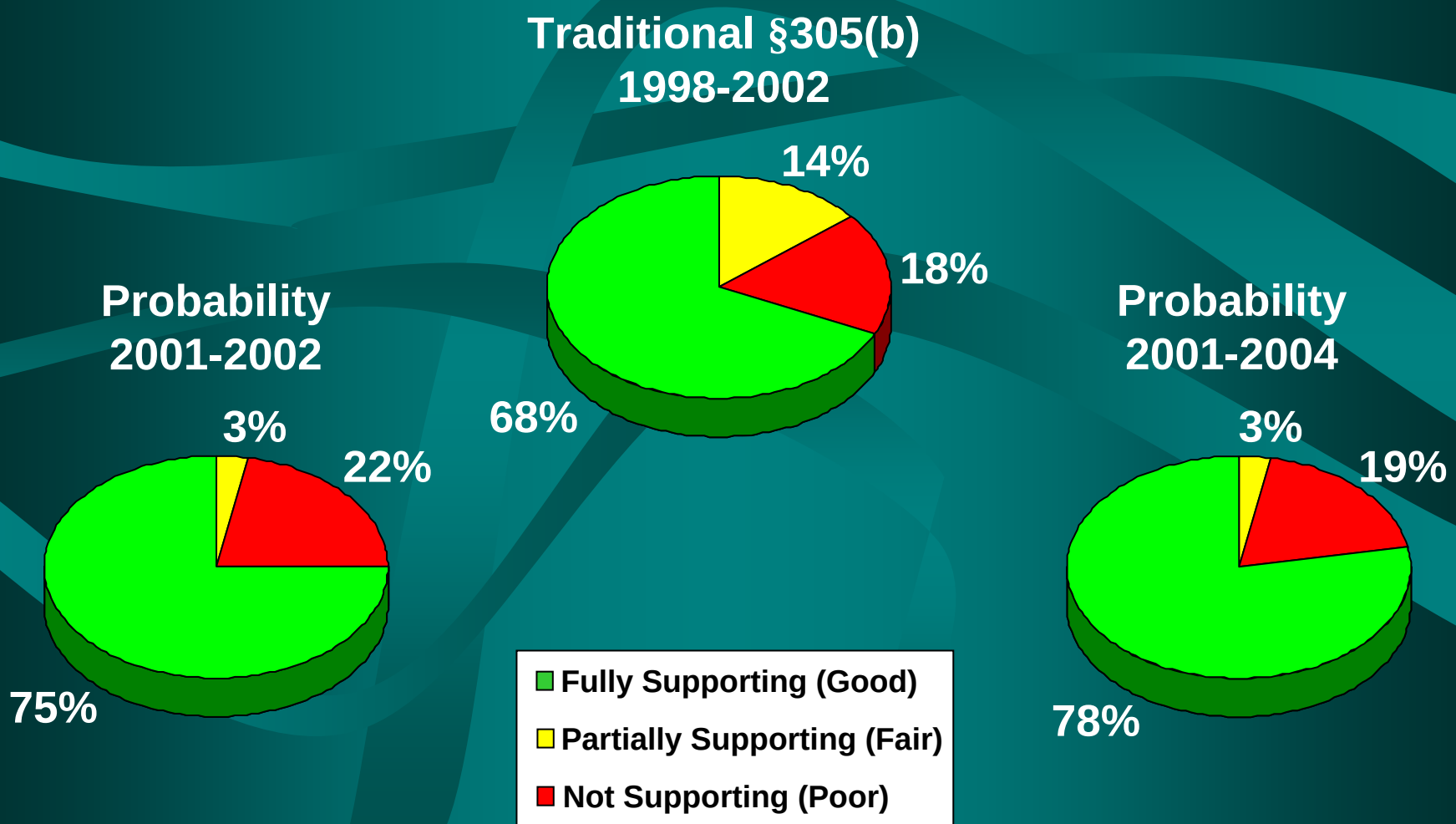



Unsampled Shoals
Tidal Creeks
Open Water
17%
83%

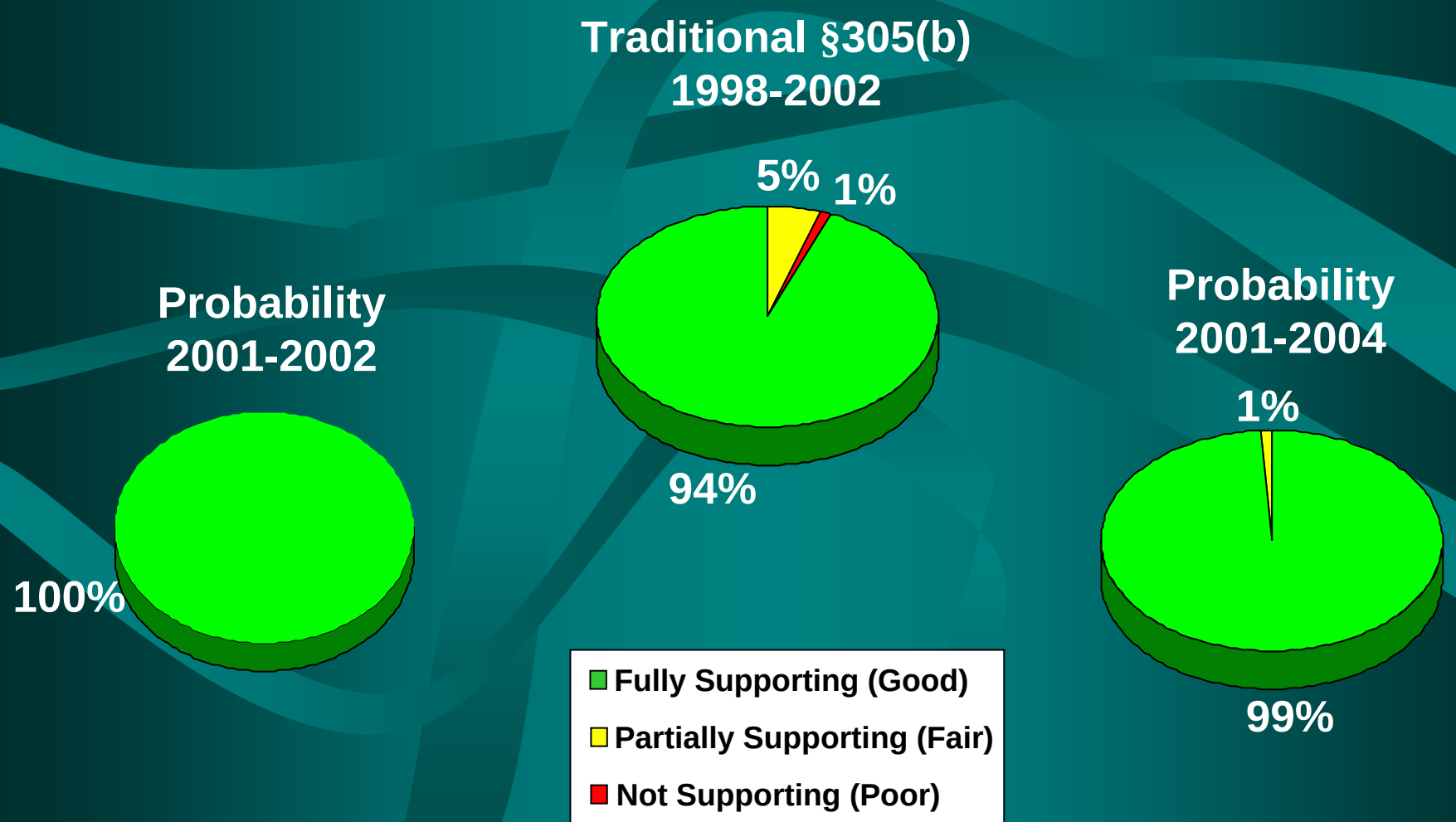
Estuaries

- Traditional §305(b) Approach
  - 401 Total Square Miles
  - 79 water quality monitoring sites
  - Representing 221 square miles assessed
- Probability-Based Approach
  - 277 square miles in the estuarine sampling design frame
  - 60 water quality monitoring sites 2001-02
  - 120 water quality monitoring sites 2001-04
  - Representing all square miles

Estuaries Aquatic Life Use Support (ALUS)



Estuaries Recreational Use Support



Estuaries

Indicator	Category	1998-2002 §305(b) % of Assessed	2001-2004 Probability Estimated %	2001-2004 Lower 95% CL	2001-2004 Upper 95% CL
Aquatic Life Use	Fully Supporting	68.0%	77.6%	70.0%	85.3%
	Partially Supporting	14.4%	2.9%	0.0%	6.2%
	Not Supporting	17.6%	19.5%	12.0%	27.0%
Recreational Use	Fully Supporting	94.1%	99.8%	99.4%	100.0%
	Partially Supporting	4.5%	0.0%	0.0%	0.0%
	Not Supporting	1.4%	0.2%	0.0%	0.6%
Support of All Assessed Uses	Fully Supporting All	65.2%	77.6%	70.0%	85.3%
	Impaired for One or More	34.8%	22.4%	14.7%	30.0%

Percent of Estuaries Impaired by Specific Causes

Indicator	1998-2002 §305(b) % of Assessed	2001-2004 Probability Estimated %	2001-2004 Lower 95% CL	2001-2004 Upper
Percent of Estuaries Impaired by Various Cause Categories				
Turbidity	8.0%	11.2%	6.0%	16.4%
Dissolved Oxygen	17.6%	7.6%	2.9%	12.3%
pH	4.8%	0.0%	0.0%	0.0%
Ammonia	0.0%	1.4%	0.0%	3.8%
Copper	3.9%	5.2%	0.9%	9.6%
Nickel	0.3%	0.0%	0.0%	0.0%
Zinc	1.7%	0.2%	0.0%	0.6%
Fecal Coliform Bacteria	5.9%	0.2%	0.0%	0.6%

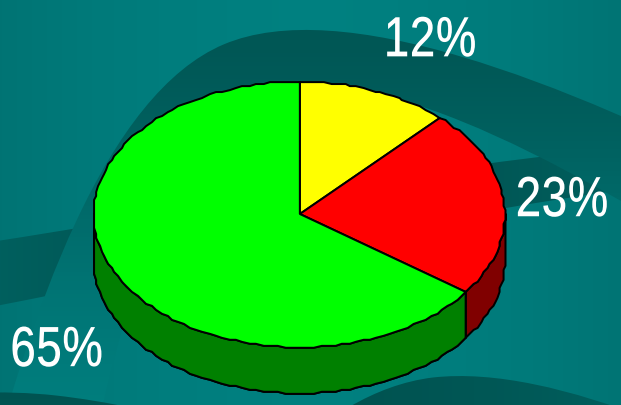
Estuarine Biological Condition

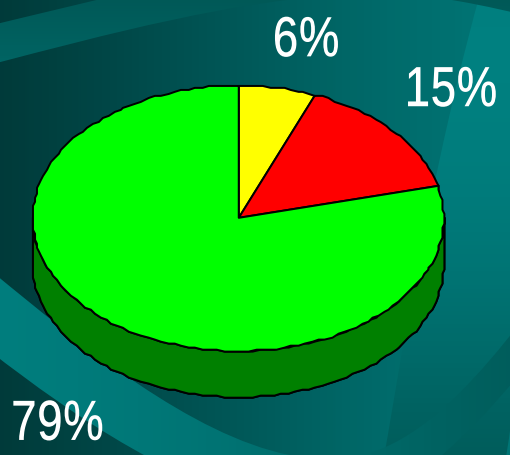
Indicator	Category	2001-2004 Probability Estimated %	2001-2004 Lower 95% CL	2001-2004 Upper 95% CL
Index of Biotic Integrity	Good	76.9%	68.8%	85.0%
	Fair	14.8%	8.0%	21.6%
	Poor	7.9%	2.5%	13.2%

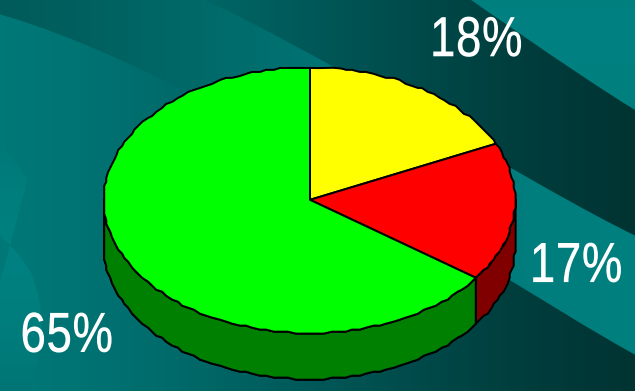
IBI* - SCECAP Benthic IBI. For fun only, not used in §305(b) Assessment

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

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


12%
23%
65%


6%
15%
79%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