

US EPA ARCHIVE DOCUMENT

# **Assessing the Quality of Estuarine Habitats in South Carolina Using Integrated Measures of Environmental and Biotic Condition**

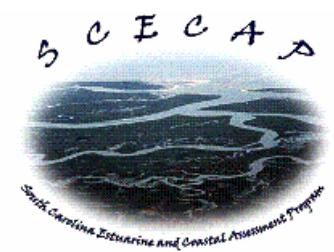
**By**

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South Carolina Department of Health and Environmental Control**

# South Carolina Estuarine and Coastal Assessment Program



**South Carolina Department of Natural Resources**



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



**U.S. Environmental Protection Agency**



**NOAA National Ocean Service**



**U.S. Fish and Wildlife Service**

# SCECAP Program Objectives

- *Monitor quality of all South Carolina estuaries*
  - Water and Sediment Quality
  - Biological Condition
- *Report findings in formats useful and understandable to the public*
- *Integrate with USEPA National Coastal Assessment Program*

# Monitoring Approach

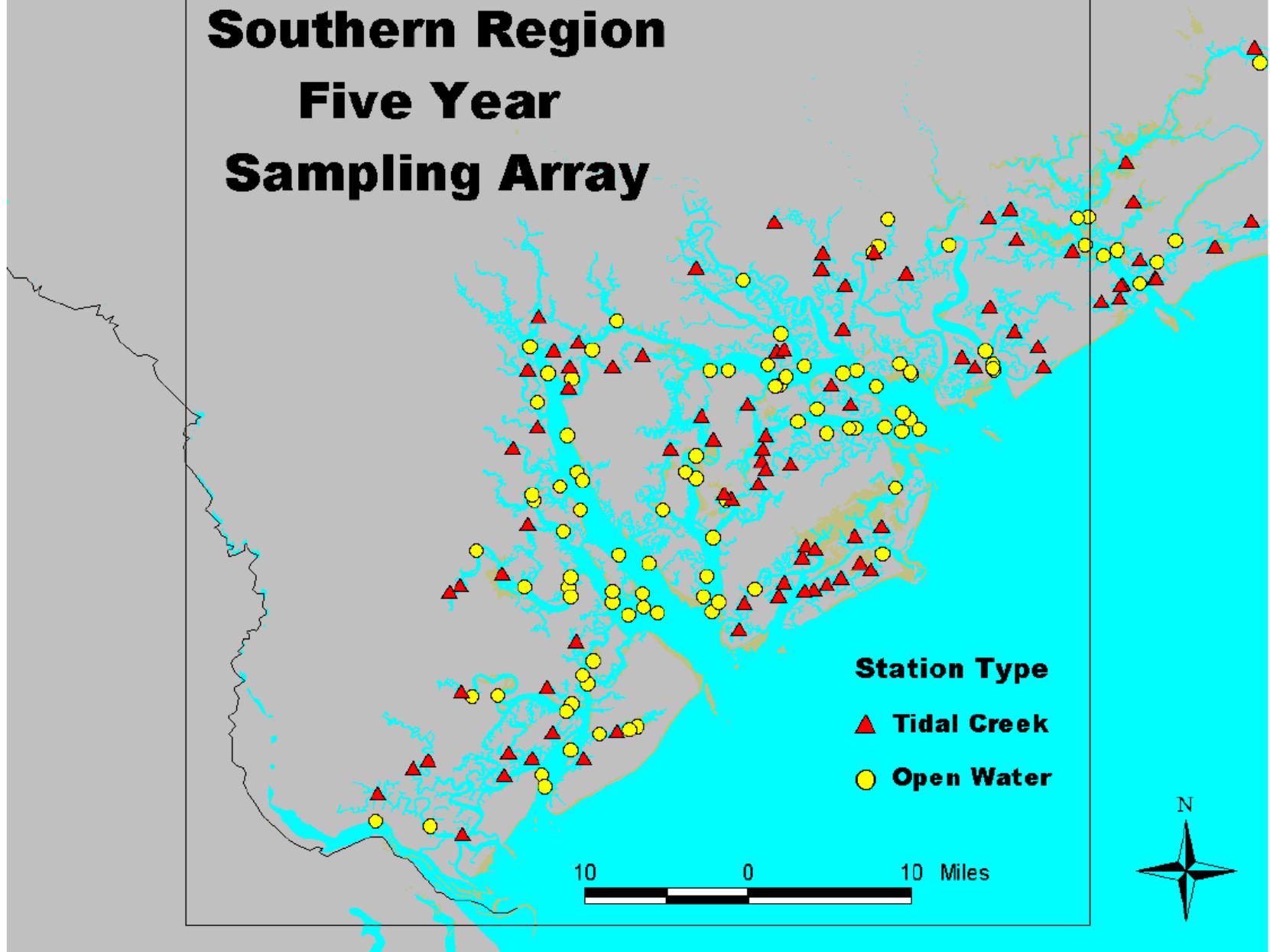
- ***Probability-Based Sampling Design***
- ***Sample 60 stations each year***
  - *Open water, Tidal creeks*
  - *Summer sampling period*
  - *Relocate stations every year*
  - *Subset (30) sampled monthly*
    - *Water quality only*



# **Southern Region**

## **Five Year**

### **Sampling Array**



# **Sampling Components**

## ***Water Quality***

- Continuous monitoring for salinity, DO, pH, temp
- Nutrients (total & dissolved nitrogen, phosphorus)
- BOD, fecal coliform bacteria, metals
- Phytoplankton (Chl-a concentration)

## ***Sediment Quality***

- Contaminants (85 analytes)
- Toxicity (3 assays)

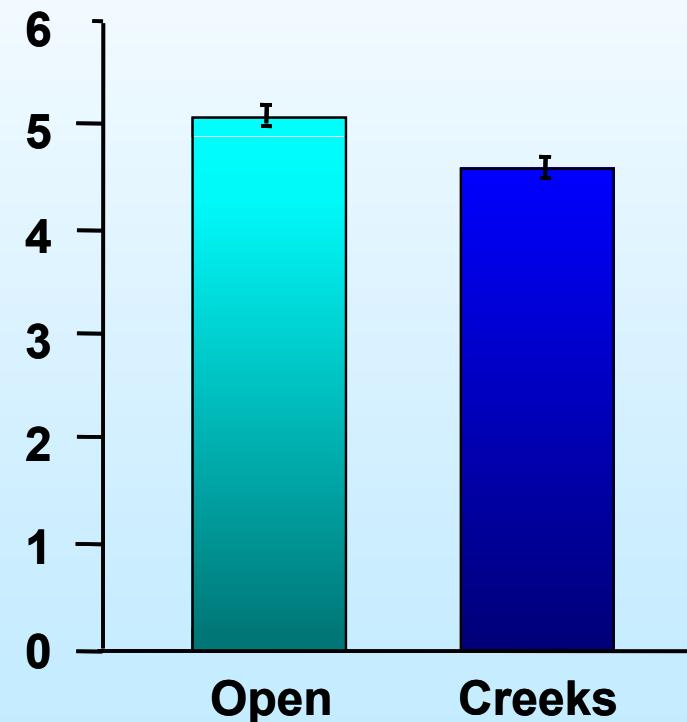
## ***Biological Condition***

- Benthos
- Phytoplankton composition
- Demersal finfish and crustaceans

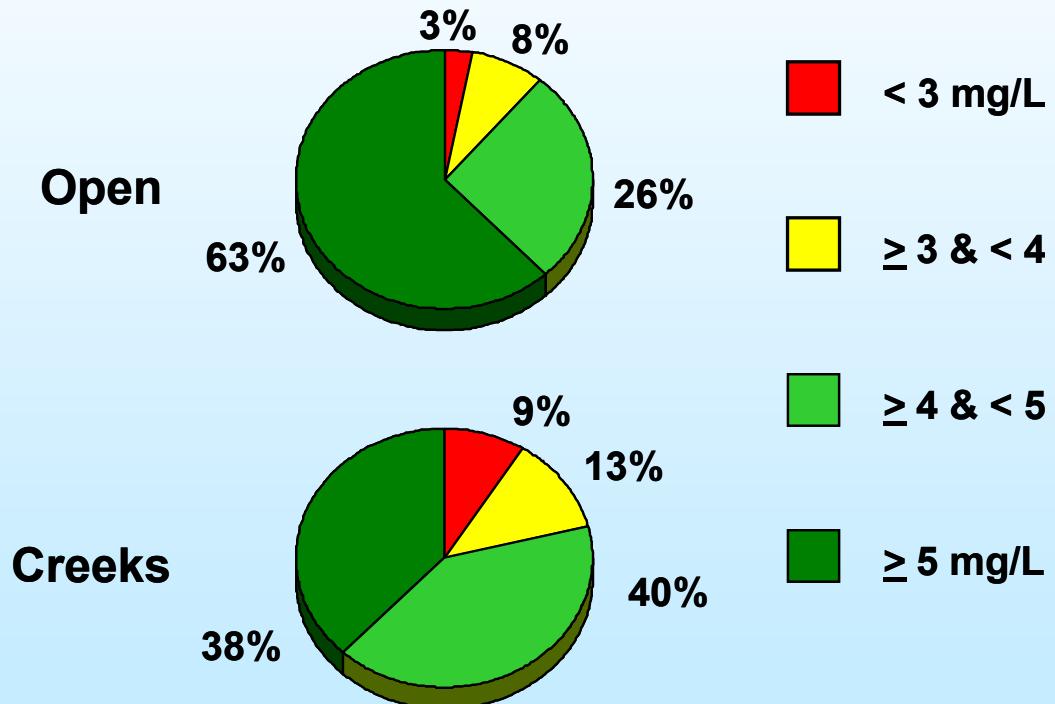
# *Average Dissolved Oxygen*

*2001-2002*

**Average Dissolved Oxygen**



**Percent of Coastal Habitat**



# *Integrated Water Quality Measure*

## **Six Measures** (of 26 total)

- Mean Dissolved Oxygen
- Mean pH
- Fecal Coliform Bacteria
- Total Nitrogen
- Total Phosphorus
- Chlorophyll-a

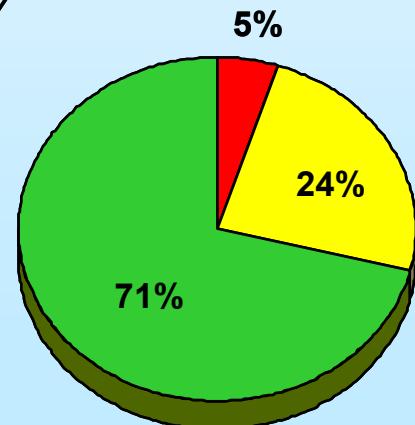
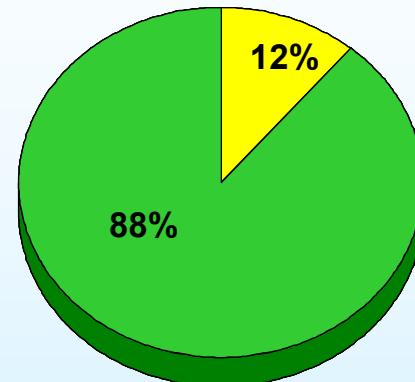
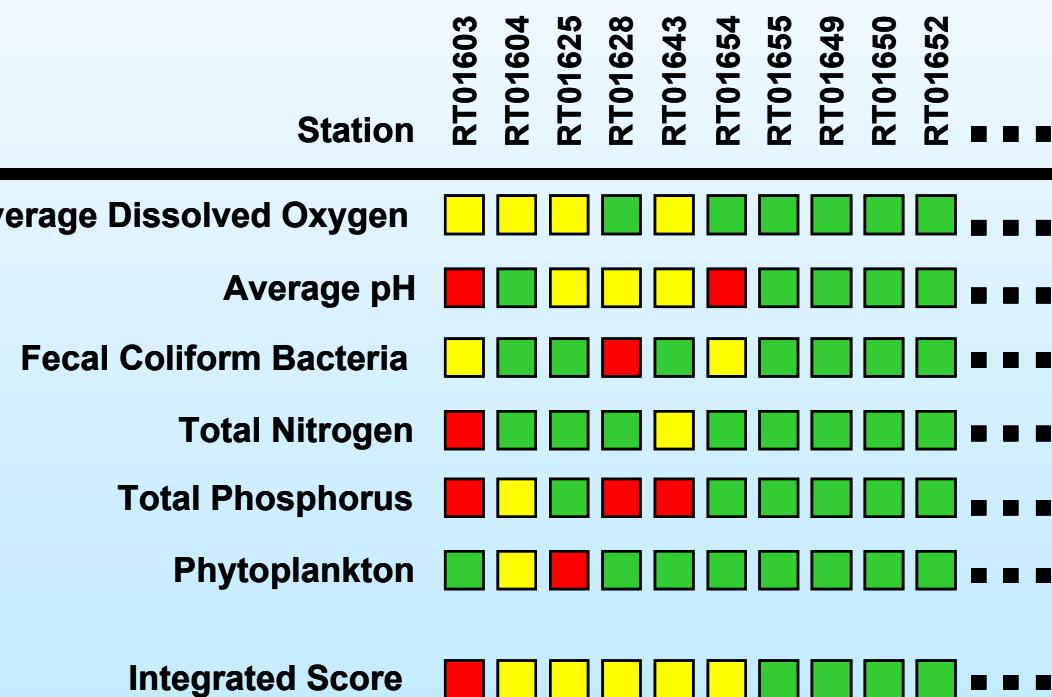
# Integrated Water Quality Scoring Process

## Water Quality Scoring Process

Parameter	Threshold Values	RT01654 Values	Parameter Score	Integrated Score
Mean Dissolved Oxygen (mg/L)	<ul style="list-style-type: none"> <li>≥ 4</li> <li>≥ 3 - &lt; 4</li> <li>&lt; 3.0</li> </ul>	4.9	5	
Mean pH	<ul style="list-style-type: none"> <li>≥ 7.4</li> <li>≥ 7.1 - &lt; 7.4</li> <li>&lt; 7.1</li> </ul>	7.0	1	
Fecal Coliform Bacteria (col/100mL)	<ul style="list-style-type: none"> <li>≤ 43</li> <li>&gt; 43 - ≤ 400</li> <li>&gt; 400</li> </ul>	50	3	$\frac{24}{6} = 4.0$
Total Nitrogen (mg/L)	<ul style="list-style-type: none"> <li>≤ 0.95</li> <li>&gt; 0.95 ≤ 1.29</li> <li>&gt; 1.29</li> </ul>	0.60	5	
Total Phosphorus (mg/L)	<ul style="list-style-type: none"> <li>≤ 0.09</li> <li>&gt; 0.09 ≤ 0.17</li> <li>&gt; 0.17</li> </ul>	0.03	5	
Chlorophylla (µg/L)	<ul style="list-style-type: none"> <li>&lt; 12</li> <li>&gt; 12 &lt; 20</li> <li>&gt; 20</li> </ul>	9.3	5	$\frac{24}{24} = 1.0$

# *Integrated Water Quality Scores*

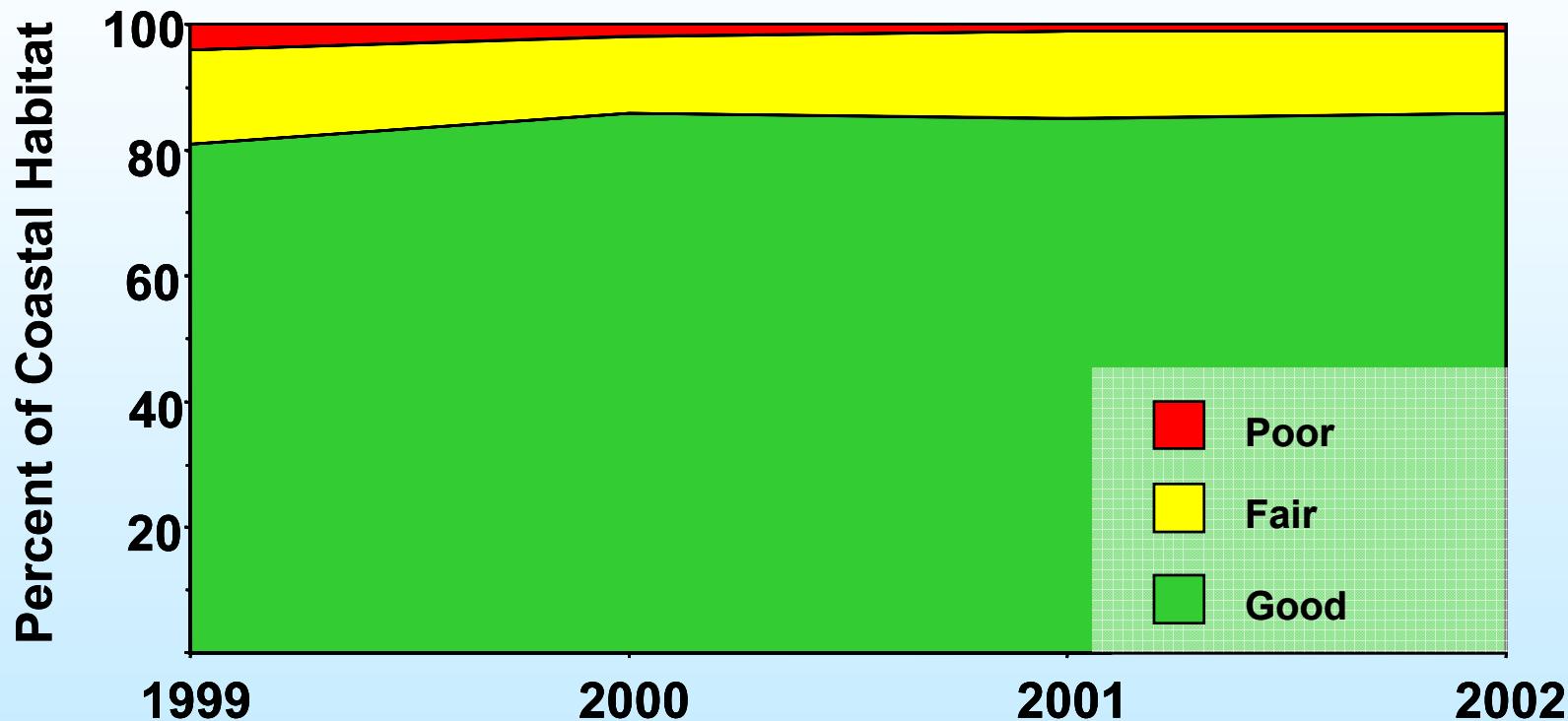
**2001 - 2002**



Open

Creeks

# Integrated Water Quality Score



# *Integrated Sediment Quality Measure*

## Two Measures

- **Contaminants** (24 of 85 measured)
- **Toxicity** (3 bioassays)

# Contaminant Measures

**ERM = Effects Range Median** (Long et al. 1998)

**ERM-Q = Effects Range Median - Quotient**

<b>ERM-Q =</b>	<b>Low Risk</b>	<b>&lt; 0.02</b>
	<b>Moderate Risk</b>	<b>0.02 – 0.058</b>
	<b>High Risk</b>	<b>&gt; 0.058</b>

Hyland *et al.* 1999. Predicting stress in benthic communities of southeastern U.S. estuaries in relation to chemical contamination of sediments. Environmental Toxicology and Chemistry 18: 2557-2564

**Calculated as:**

$$\sum \left( \frac{\text{Actual Conc}}{\text{As ERM}} + \frac{\text{Actual Conc}}{\text{Pb ERM}} + \dots + \frac{\text{Actual Conc}}{\text{PCB ERM}} + \dots + \frac{\text{Actual Conc}}{\text{Pest ERM}} + \dots + \frac{\text{Actual Conc}}{\text{PAH ERM}} \right)$$

**24 Analytes**

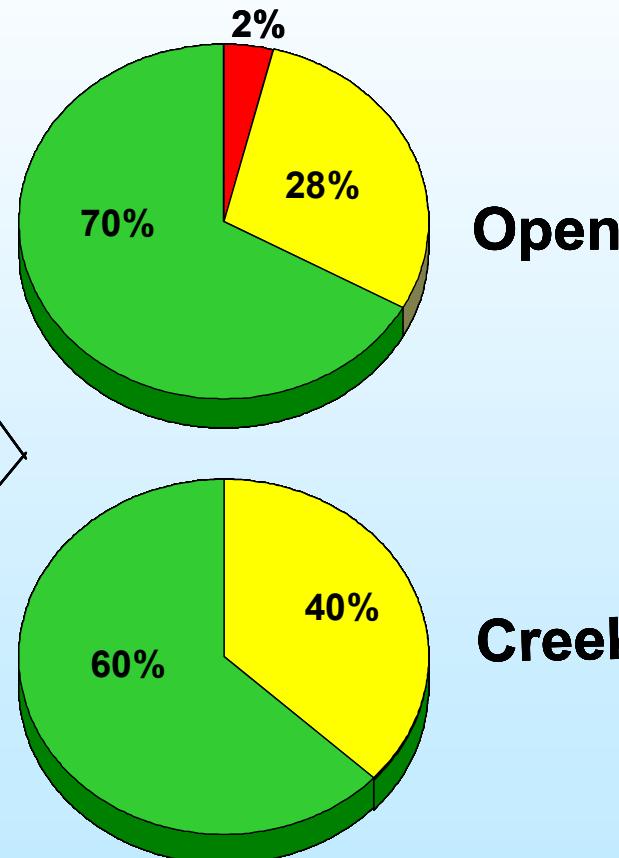
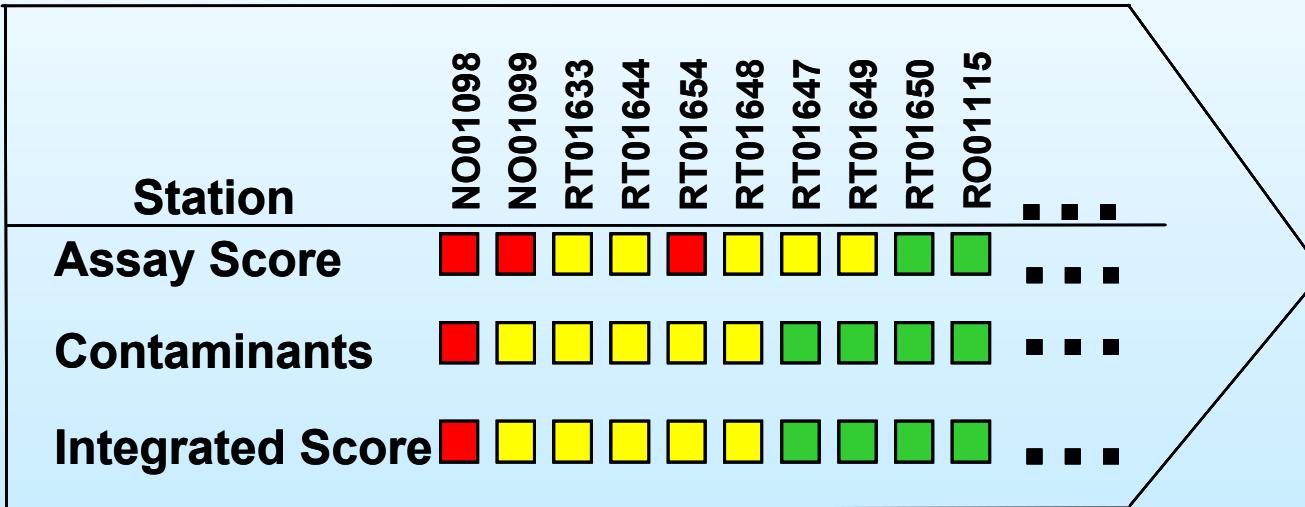
# Integrated Sediment Quality Scoring Process

Parameter	Threshold Values	RT01654 Values	Parameter Score	Integrated Score
Contaminant ERM-Q Score	< 0.020 ≥ 0.020 – 0.058 ≥ 0.058	0.046	3	$\frac{4}{2} = 2$
No. of Bioassays Showing Significant Toxicity	0 1 ≥ 2	2	1	$\frac{4}{4} = 1$

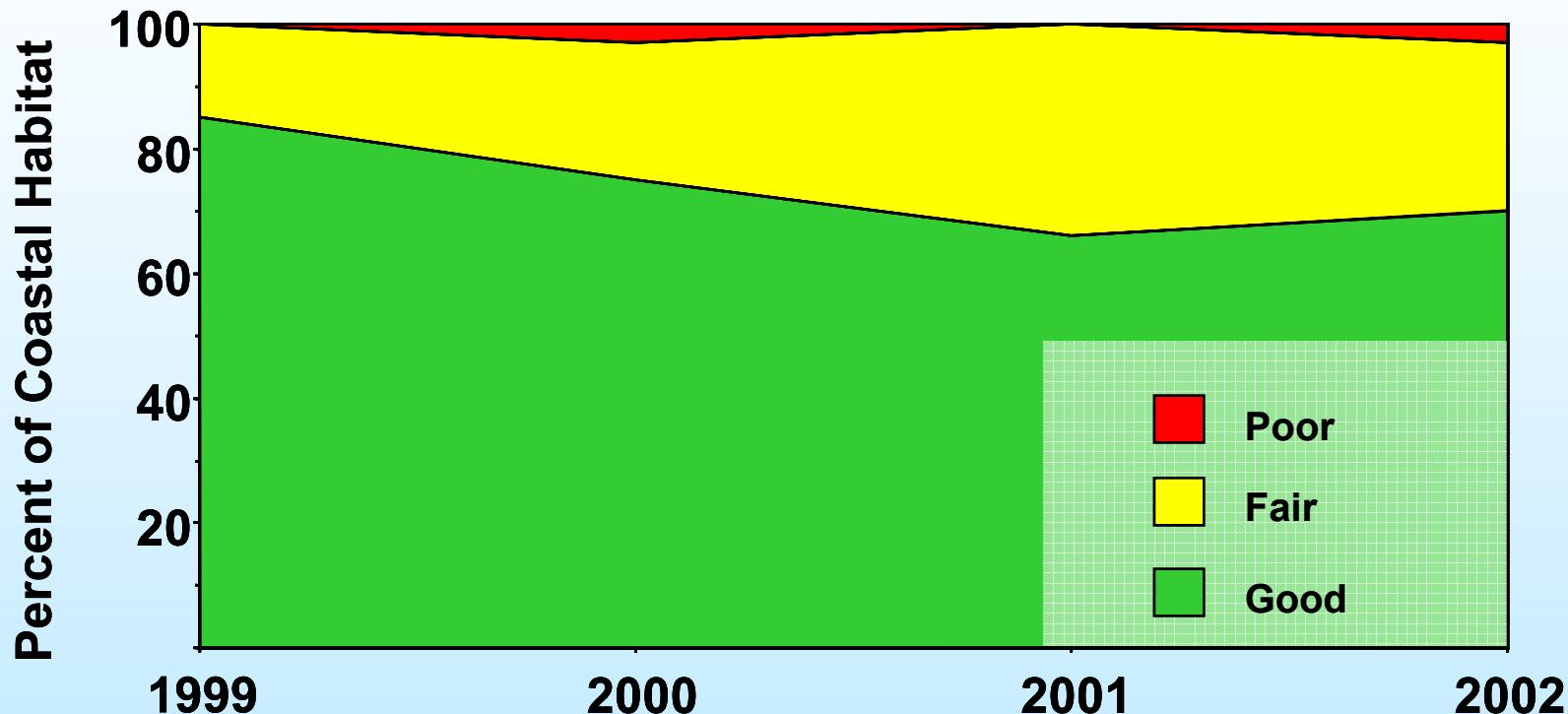


# *Integrated Sediment Quality Scores*

*2001- 2002*



# Integrated Sediment Quality Score



# Biotic Condition Measures

- *Phytoplankton Communities*
- *Benthic Communities*
- *Fish and Crustacean Communities*

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- *Benthic Communities*
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# Carolinian Benthic Index of Biotic Integrity

## Benthic Metrics Used

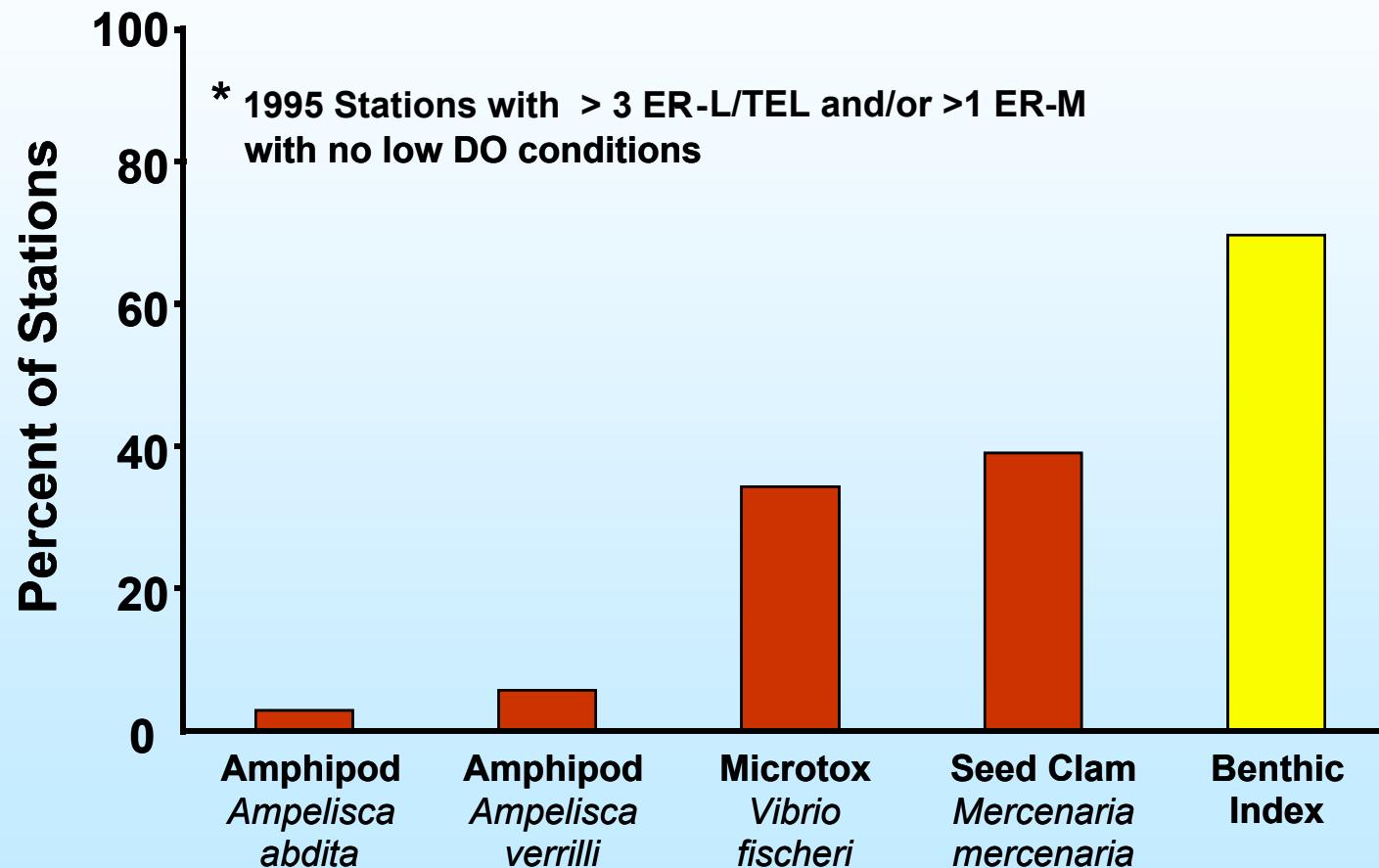
- Total Abundance
- Number of Species (richness)
- 100 – % Abundance of Two Most Dominant Taxa
- % Abundance of Pollution Sensitive Taxa

Van Dolah *et al.* 1999. A benthic index of biological integrity for assessing habitat quality in estuaries of the southeastern USA. Mar. Environ. Res. 48: 269-283

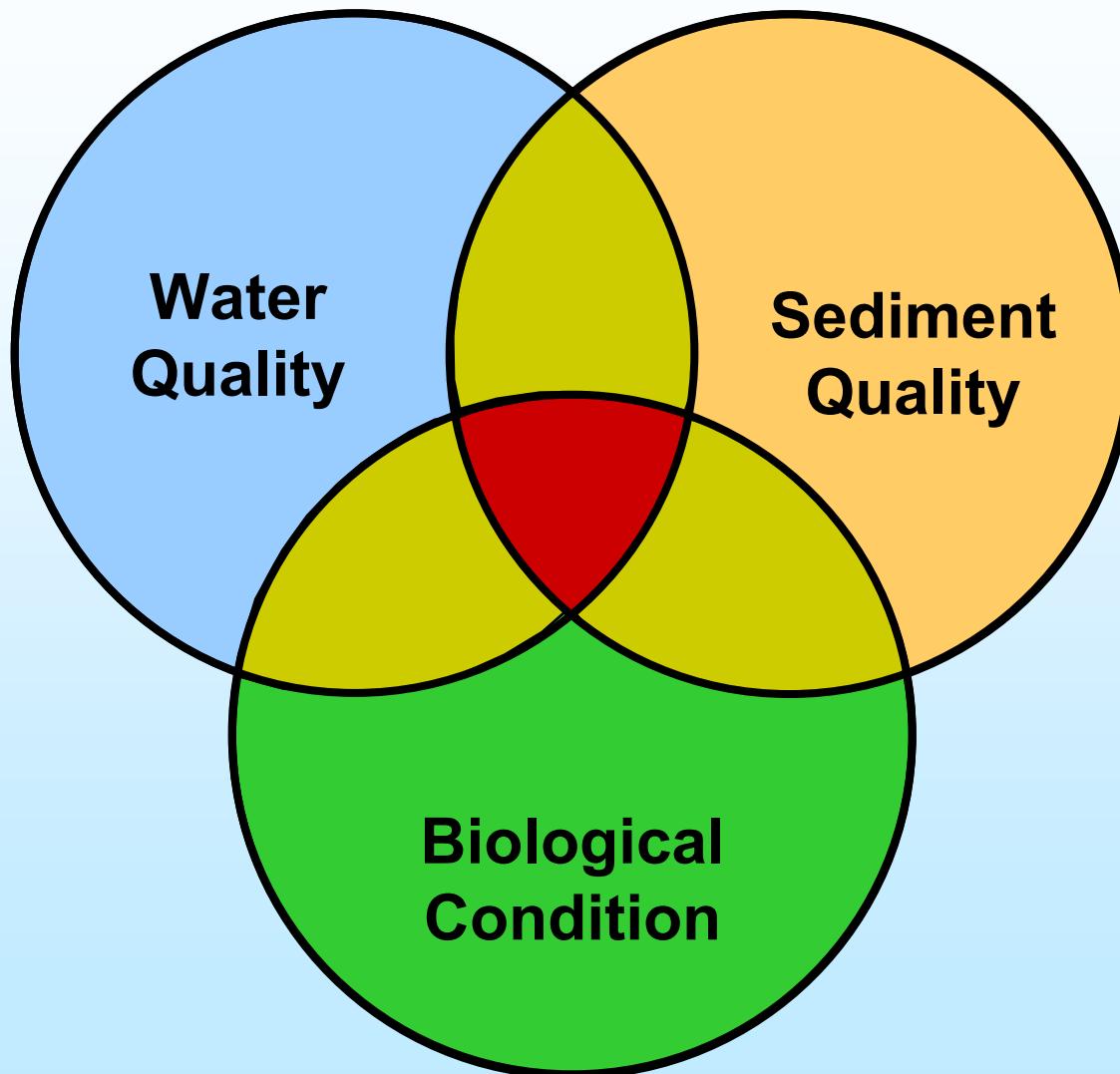
## Classification Accuracy

- 75% correct classification 1995 validation data set (96 sites)
  - 83% overall (171 sites)
- 75% correct classification new data set 1996 – 2002 (316 sites)
  - 71% degraded benthos when ERM-Q is high
  - 87% healthy benthos when ERM-Q is low

# Comparison of Bioassays vs. Benthic Index



# *Overall Index of Habitat Quality*



# *Overall Habitat Scoring Process*

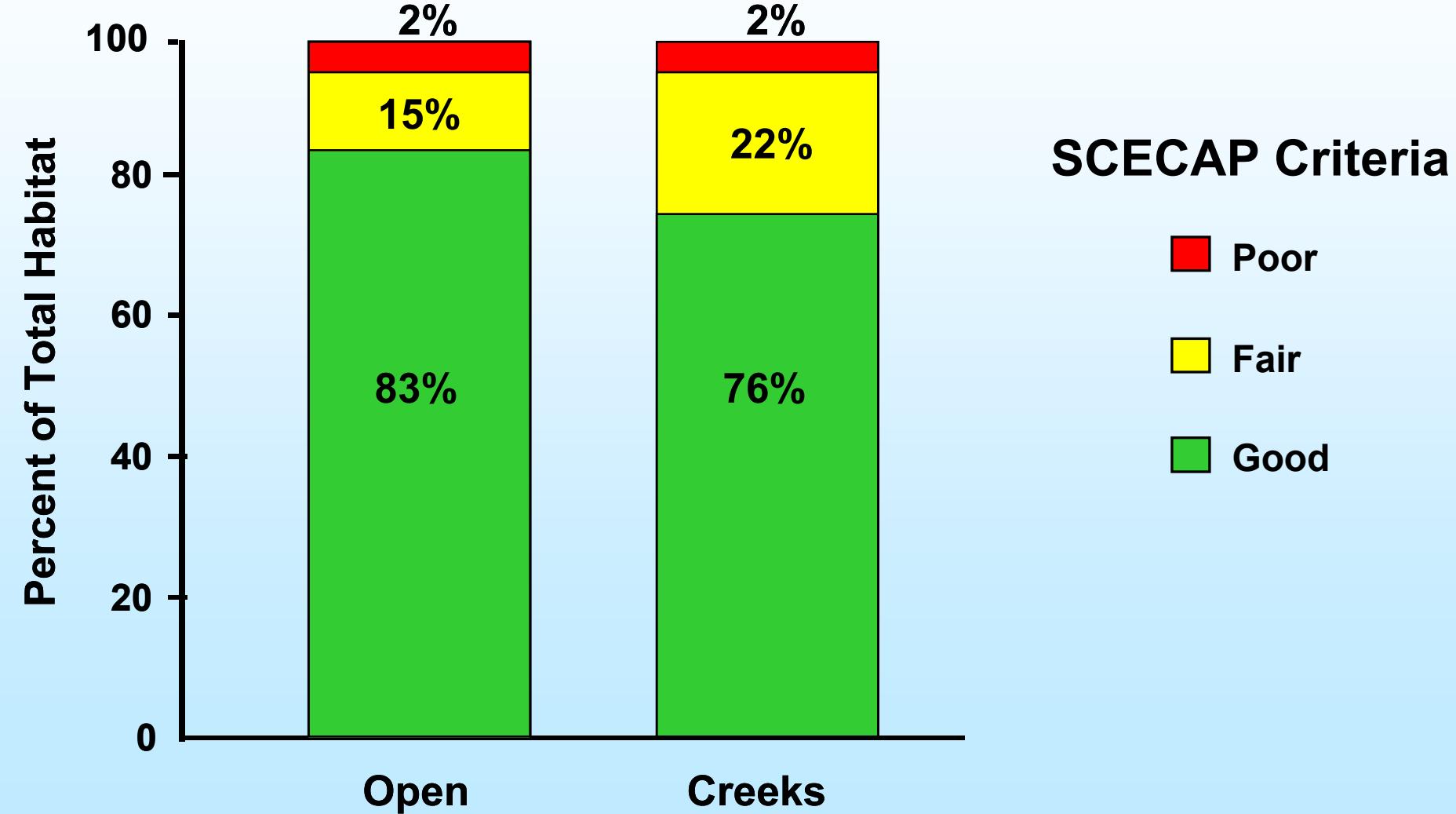
Water Quality Score	Sediment Quality Score	Benthic Index Score		Adjusted Score	Range of Possible Adjusted Scores When Averaged
> 4	$\geq 4$	$\geq 3$	Good	5	4.3 - 5.0
> 3 - $\leq 4$	2 - 3	2 - 2.5	Fair	3	3.0 - 3.7
$\leq 3$	1	$\leq 1.5$	Poor	1	1.0 - 2.3

## Station RT01654 Example

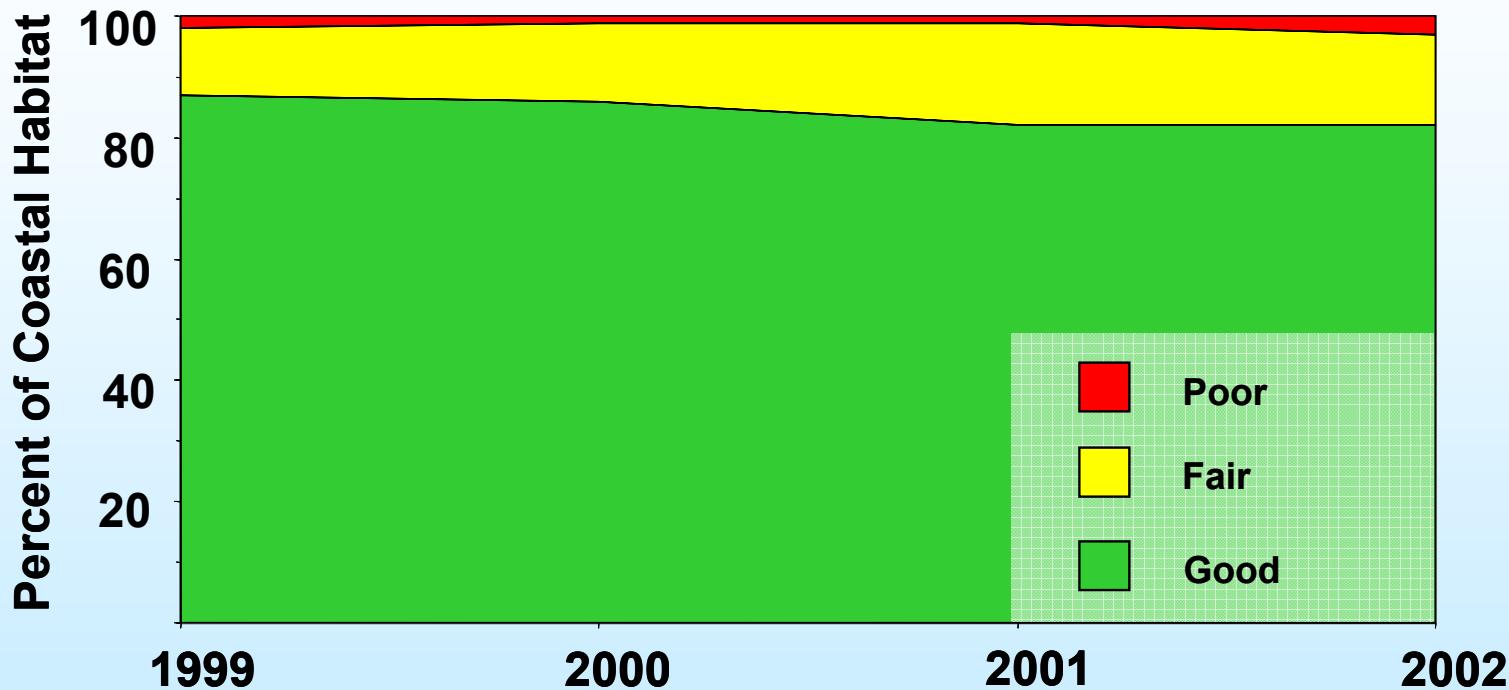
4	2	1.5		Actual Score
3	3	1	$7.0 / 3 =$	Adjusted Score

# *Integrated Habitat Quality Score*

**2001 - 2002**



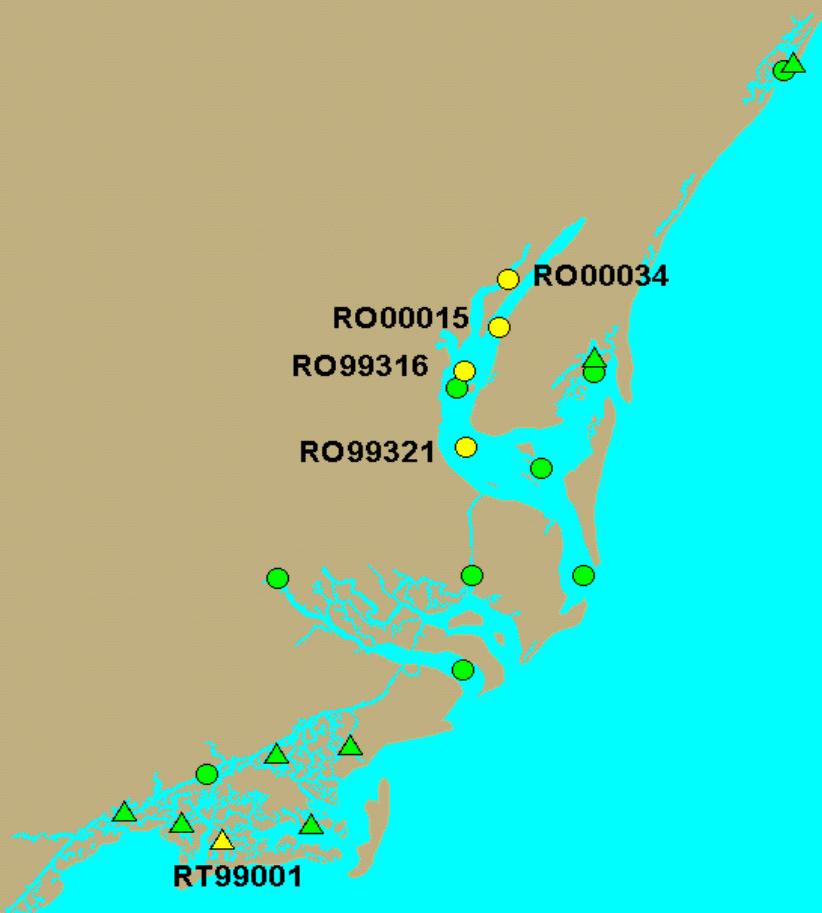
# Overall Habitat Quality Score



# Northern Region

1999-2000

## Overall Integrated Scores



### Station Type

#### Open Water

- Degraded (Red)
- Marginal (Yellow)
- Good (Green)

#### Tidal Creek

- Degraded (Red Triangle)
- Marginal (Yellow Triangle)
- Good (Green Triangle)

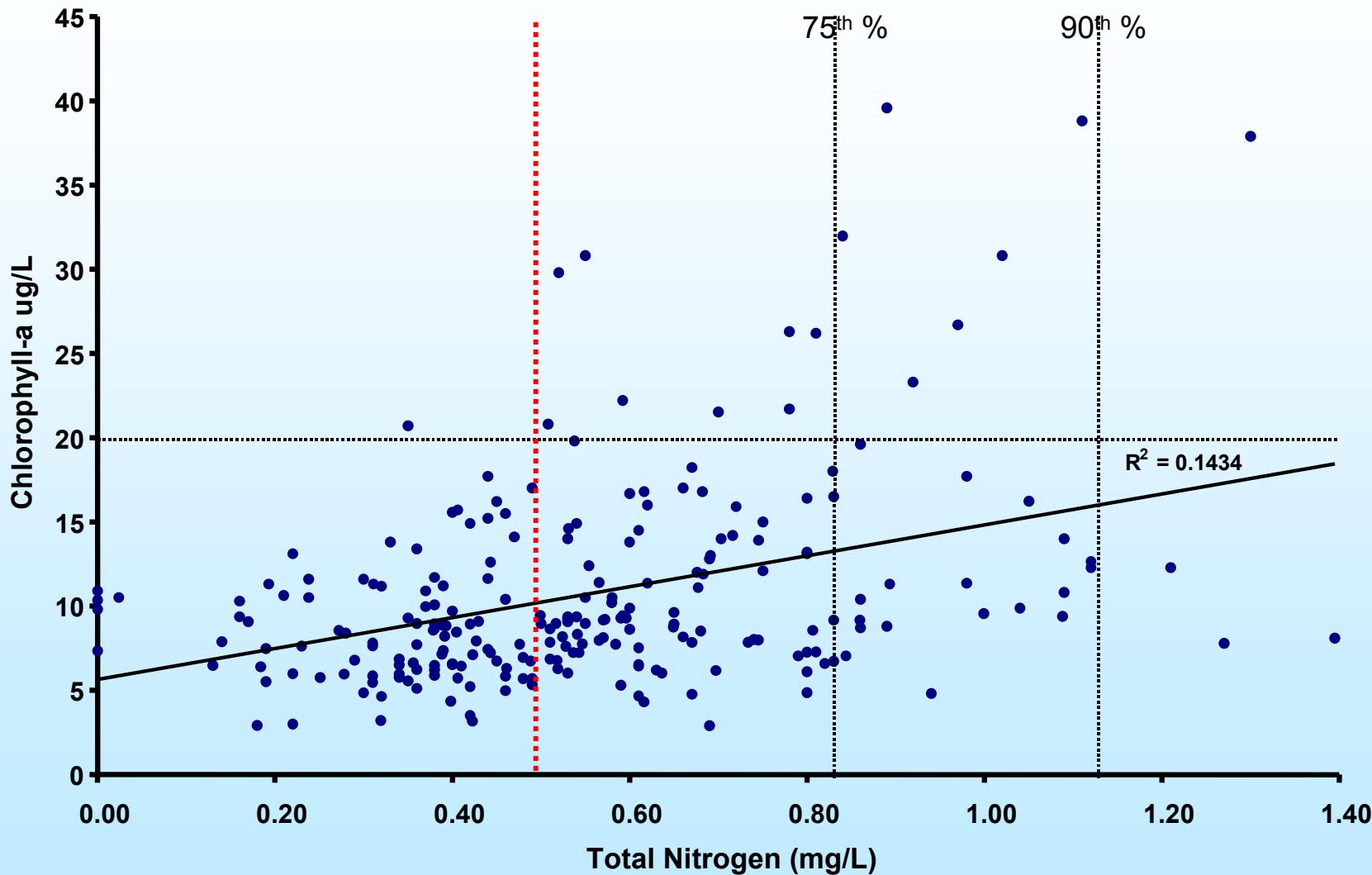


# Areas for improvement

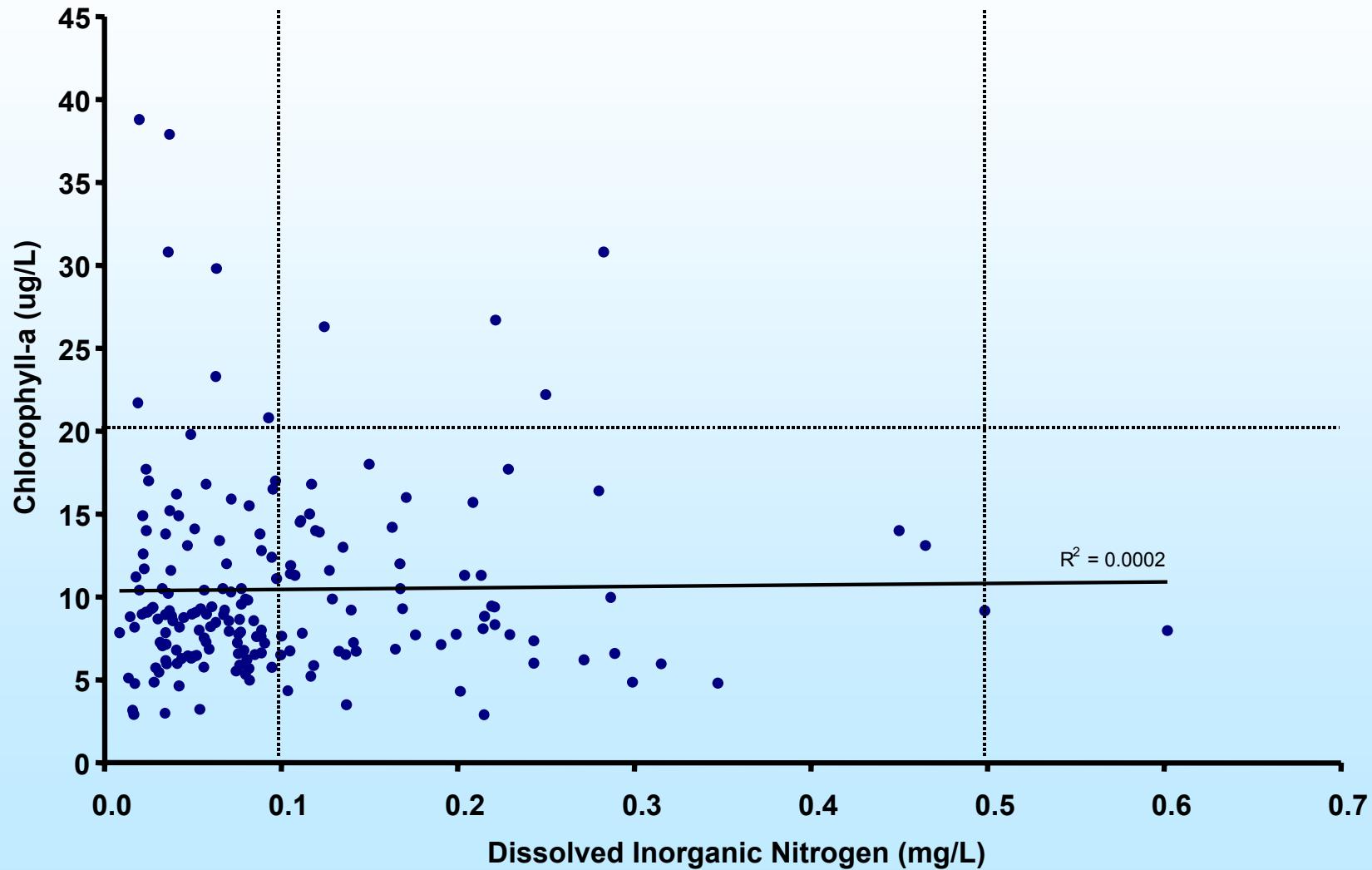
➤ ***Refine threshold values for some parameters based on program data***

- *Different thresholds may be needed for creeks vs open water*
- *Further evaluate numerical threshold criteria for marginal, poor conditions*

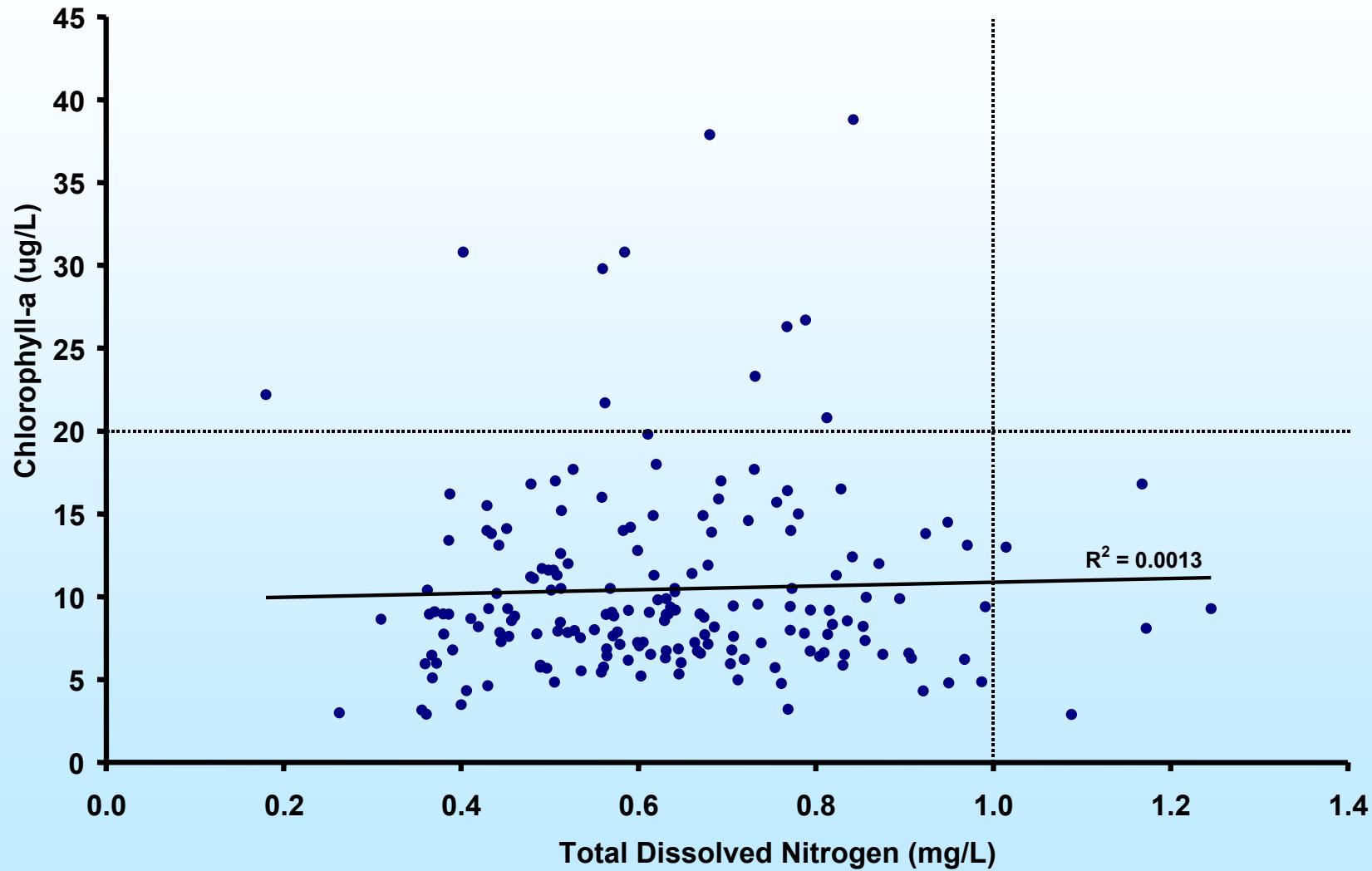
# Total Nitrogen vs. Chlorophyll-a



# Dissolved Inorganic Nitrogen vs. Chlorophyll-a



# Total Dissolved Nitrogen vs. Chlorophyll-a



# Areas for improvement

- ***Refine threshold values for some parameters based on program data***
  - *Different thresholds may be needed for creeks vs open water*
  - *Further evaluate numerical threshold criteria for marginal, poor conditions*
- ***Add or subtract additional water quality measures***
  - *More parameters can make overall score less sensitive to identifying serious problems in one or a few parameters*
  - *Fewer parameters may miss important variables*
- ***Add other biological measures***
  - *Fish and phytoplankton composition measures*

# Summary

- *Improved approach for assessing the state's coastal condition than previously done by either agency*
- *Integrated measures for water quality, sediment quality for easier interpretation by the public and managers*
- *Combined water, sediment, and biotic condition measures into an overall index of estuarine habitat quality*