

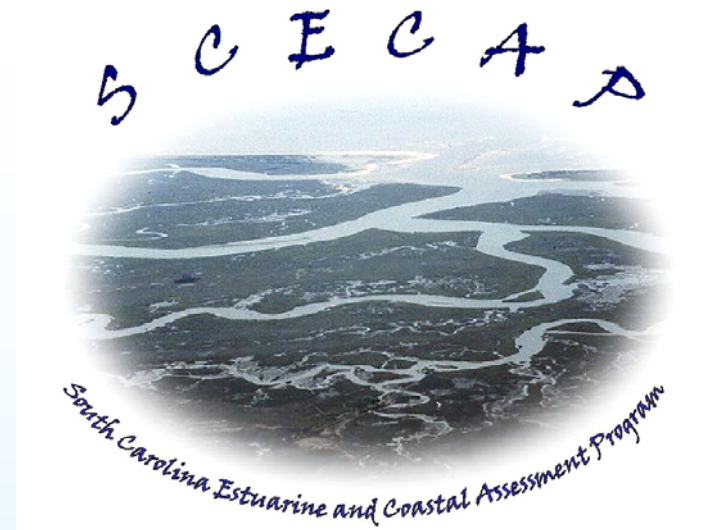
South Carolina's Approach to Probability-Based Monitoring: Trends and Uses

Bob Van Dolah¹, Derk C. Bergquist¹, David E. Chestnut²

**¹Marine Resources Research Institute
South Carolina Department of Natural Resources**

**² Bureau of Water
South Carolina Department of Health and Environmental Control**

The South Carolina Estuarine and Coastal Assessment Program



Objectives:

- *Monitor the overall quality of all South Carolina estuaries*
 - Water Quality
 - Sediment Quality
 - Biological Condition
- *Report findings to the public in understandable formats*
- *Use the data for management / regulatory decisions*



Program Approach / Advantages

- *Uses integrated measures of condition (water, sediment, biota)*
- *Unbiased sampling design*
- *Identifies percentage of impaired habitat with statistical confidence limits*
- *Allows for trends analyses*
- *Spatially extensive station array with many uses*

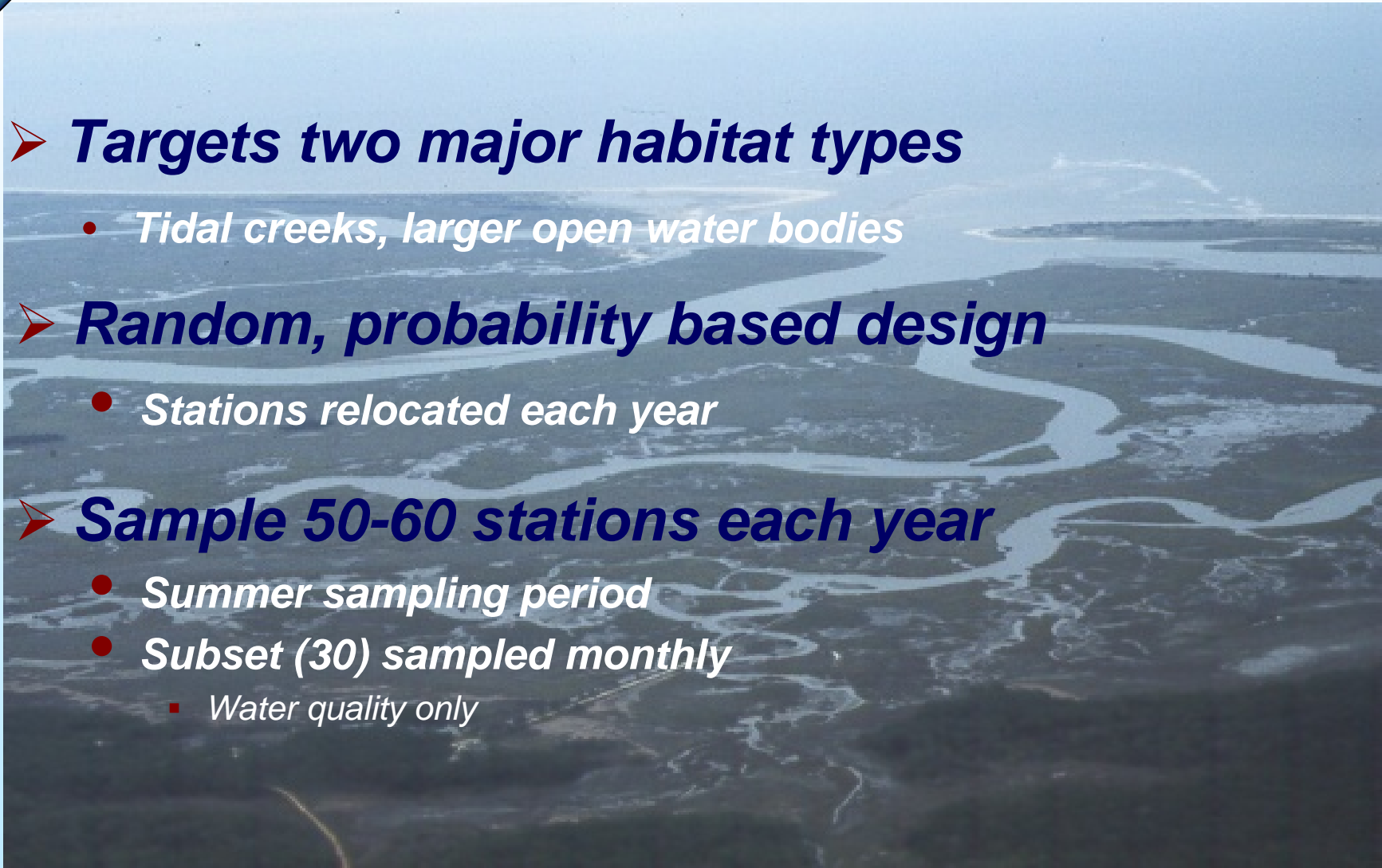
Monitoring Approach

- ***Targets two major habitat types***
 - *Tidal creeks, larger open water bodies*





Monitoring Approach

- 
- **Targets two major habitat types**
 - *Tidal creeks, larger open water bodies*
 - **Random, probability based design**
 - *Stations relocated each year*
 - **Sample 50-60 stations each year**
 - *Summer sampling period*
 - *Subset (30) sampled monthly*
 - *Water quality only*

Sampling Components

Water Quality

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

Sediment Quality

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

Biological Condition

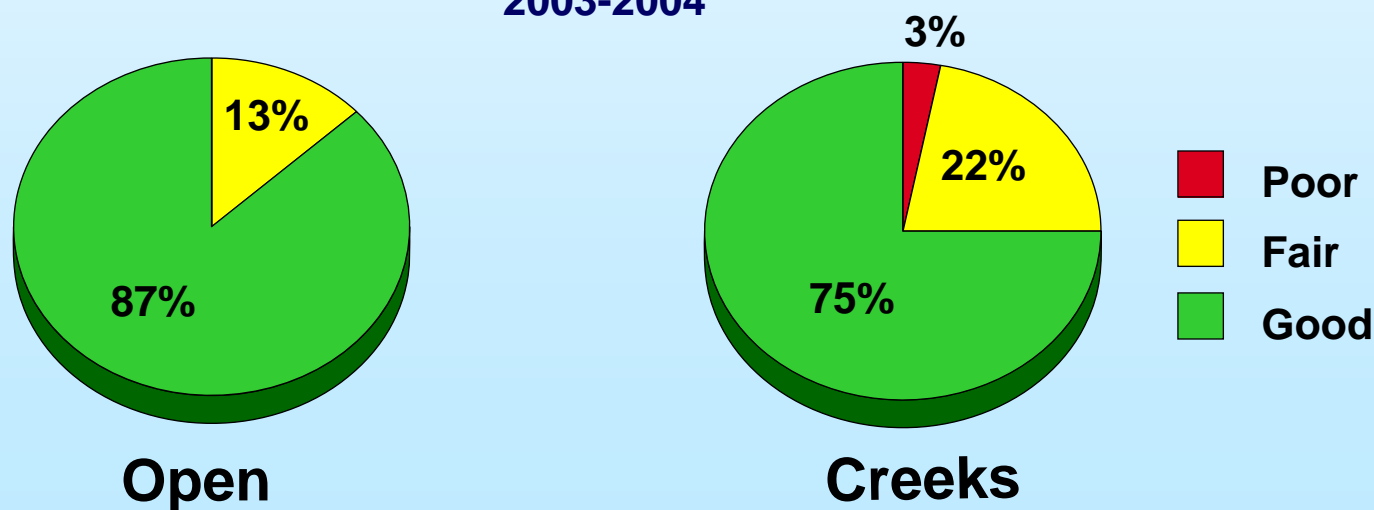
- Benthos
- Phytoplankton composition
- Finfish and crustaceans

Integrated Measures

Water Quality

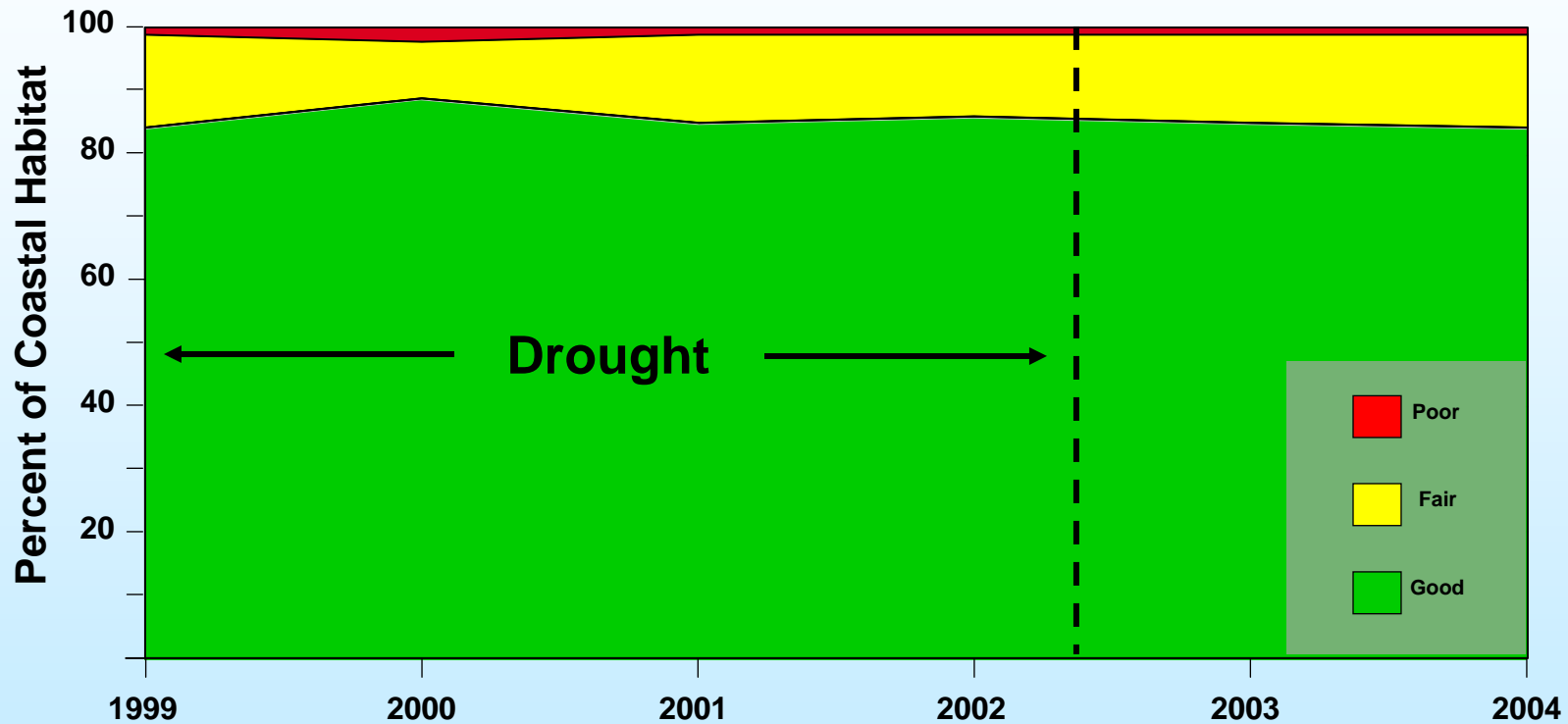
- Six primary measures (DO, pH, fecal coliform bacteria, TN, TP, Chla)
- Each measure scored based on water quality criteria or historical data (thresholds 75th and 90th percentiles)
- Scores averaged for integrated water quality measure

Integrated Water Quality
2003-2004



Trend in Water Quality Condition

Integrated Water Quality Score



Integrated Water Quality Index

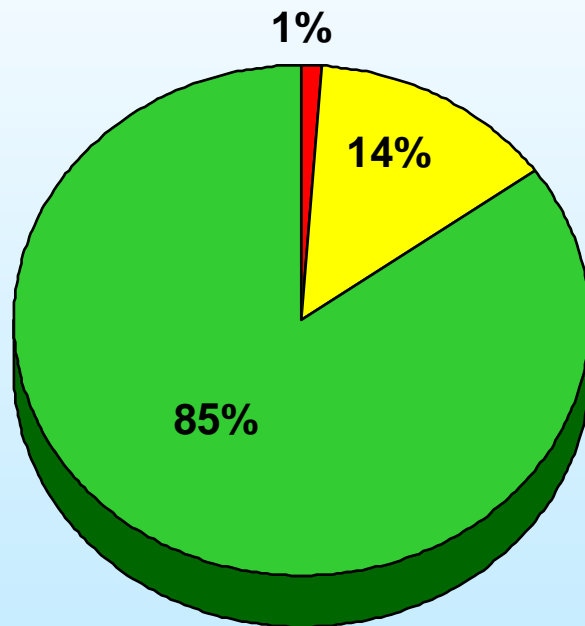
Potential Issues:

- Are summer only vs. year round measures comparable?
- What is the right mix of water quality variables?
 - Number and type
- Right thresholds?

Water Quality – Habitats Combined

SCECAP Criteria Summer Only

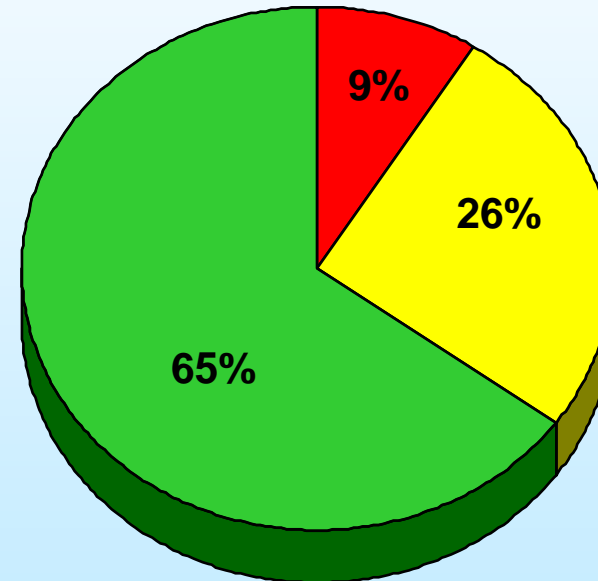
2003-2004



Good

SCECAP Criteria Monthly

2003-2004



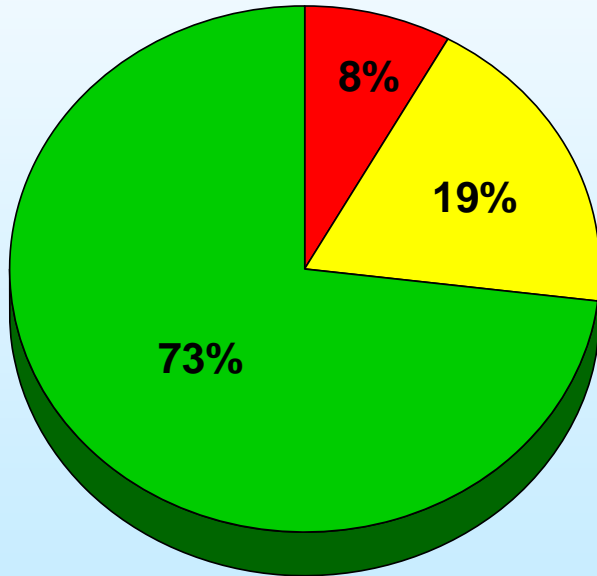
Fair

Poor

Water Quality – Habitats Combined

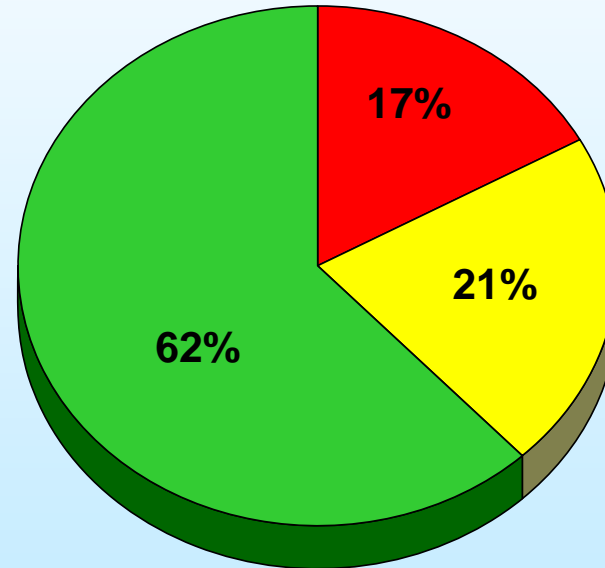
**DO, pH, Fecals
Summer Only**

2003-2004



**DO, pH, Fecals
Monthly – One Year**

2003-2004



 Good

 Fair

 Poor

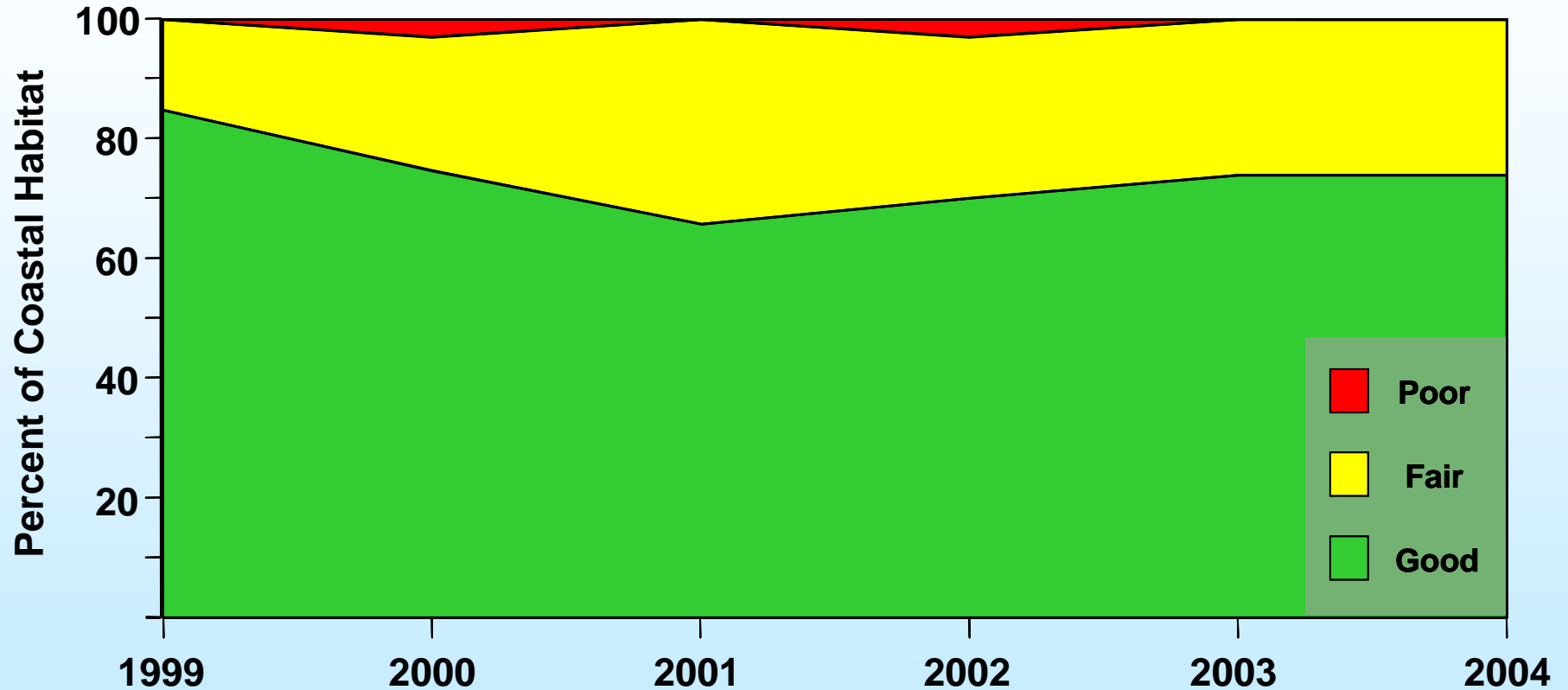
Integrated Measures

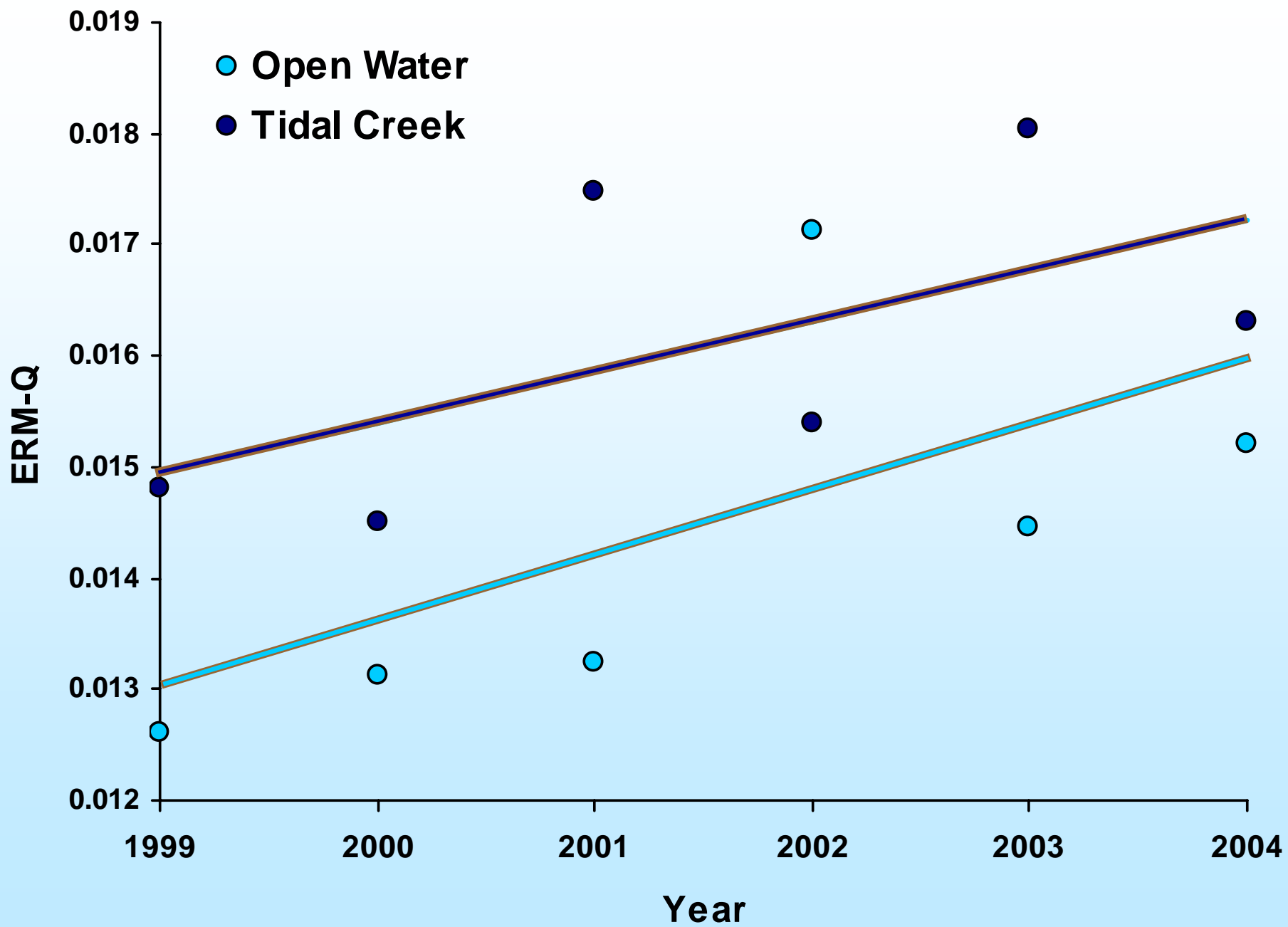
Sediment Quality

- **Contaminant Concentrations**
 - 24 inorganic and organic
 - ERM-Q (Long et al., 1998)
 - Thresholds related to probability of observing degraded benthos (Hyland et al., 1999)
- **Toxicity Assays**
 - 2-3 whole sediment assays

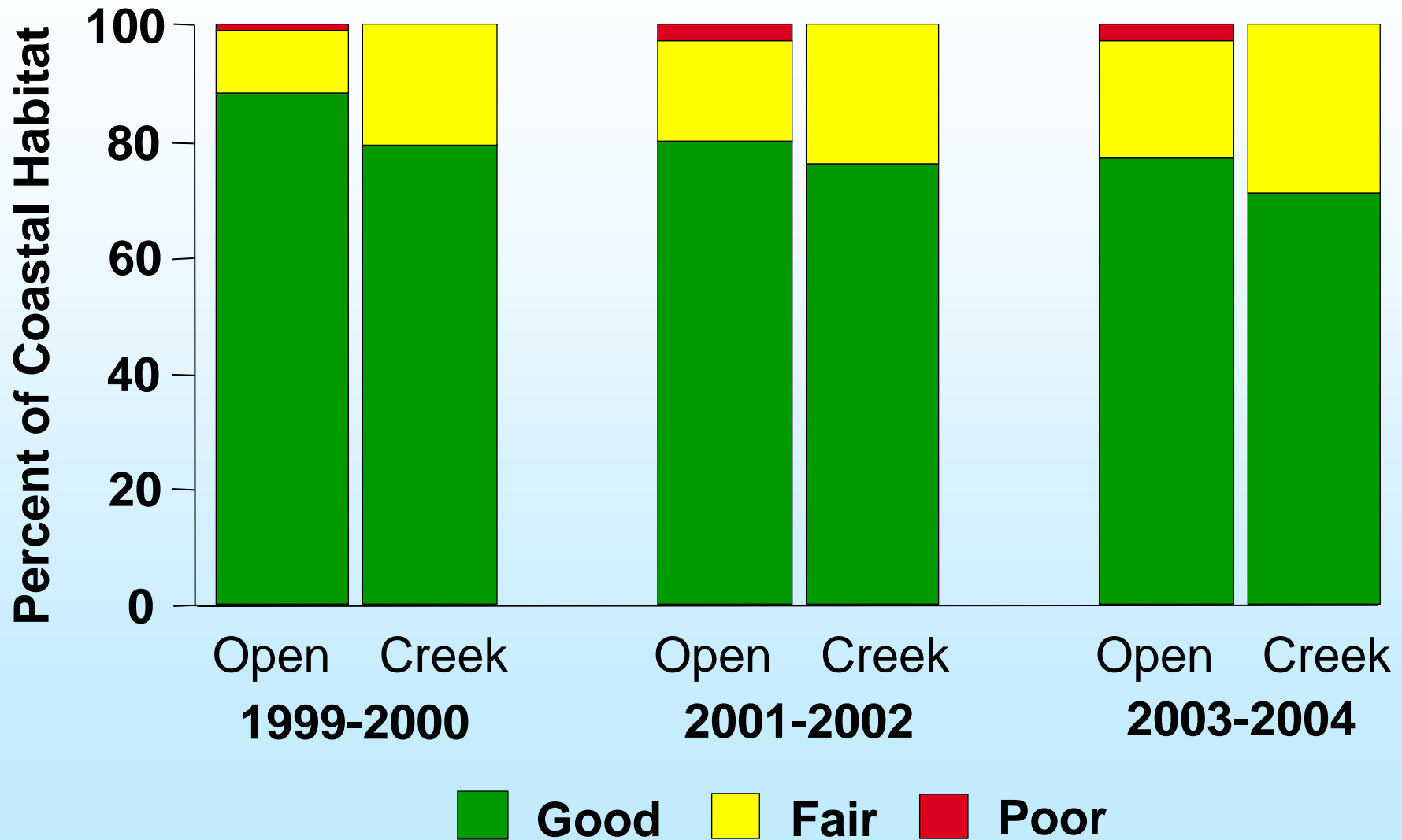
Trend in Sediment Quality Condition

Integrated Sediment Quality Score





Sediment Contamination (ERM-Q)



Integrated Measures

Biological Condition

- Benthic Index of Biotic Integrity (B-IBI) for biological response
 - *Described by Van Dolah et al. (1999) for use in Southeast region*

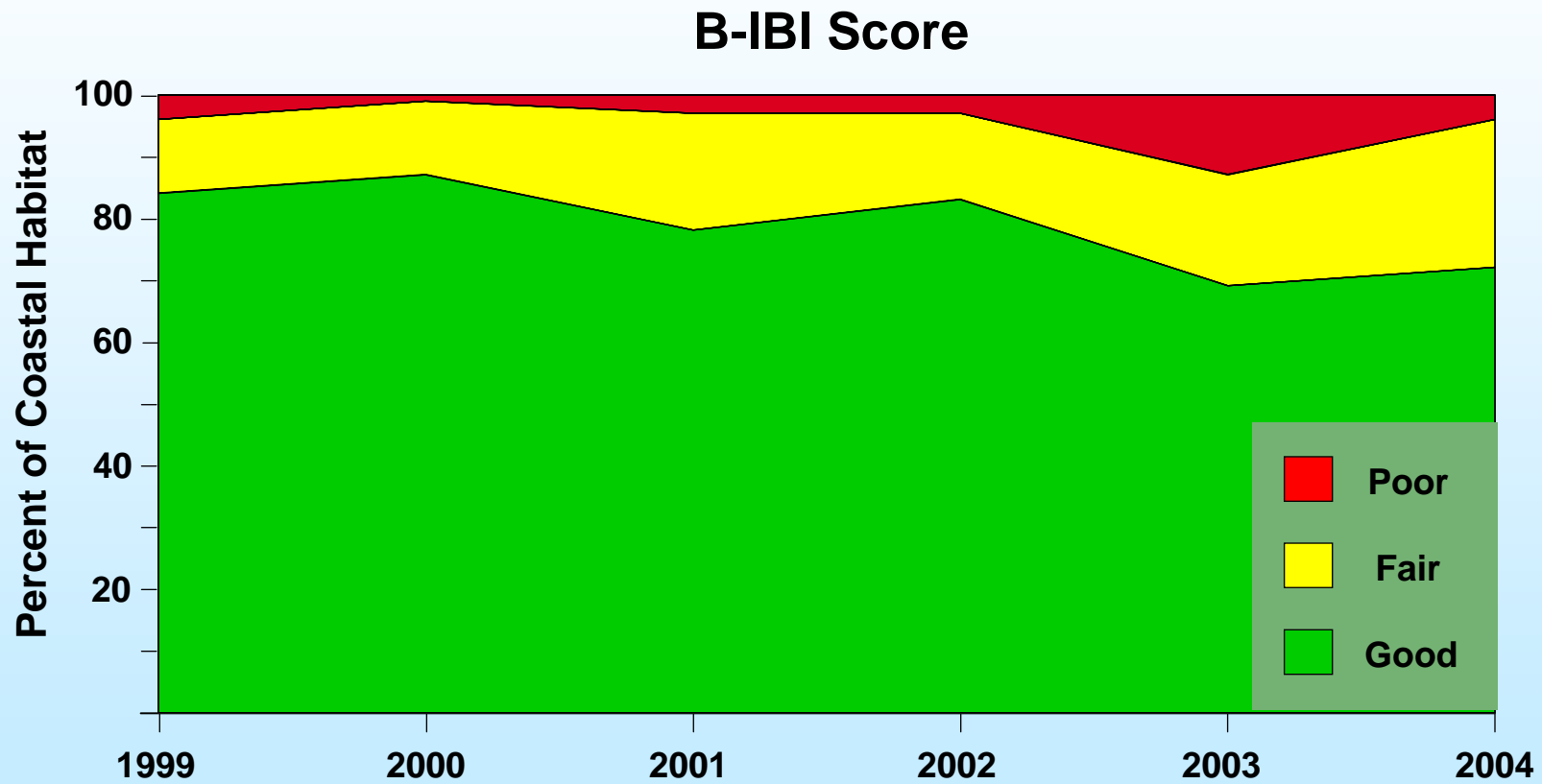


Other Indices of Interest

- Demersal Finfish / Crustacean IBI
- Phytoplankton Composition Index (HABs)



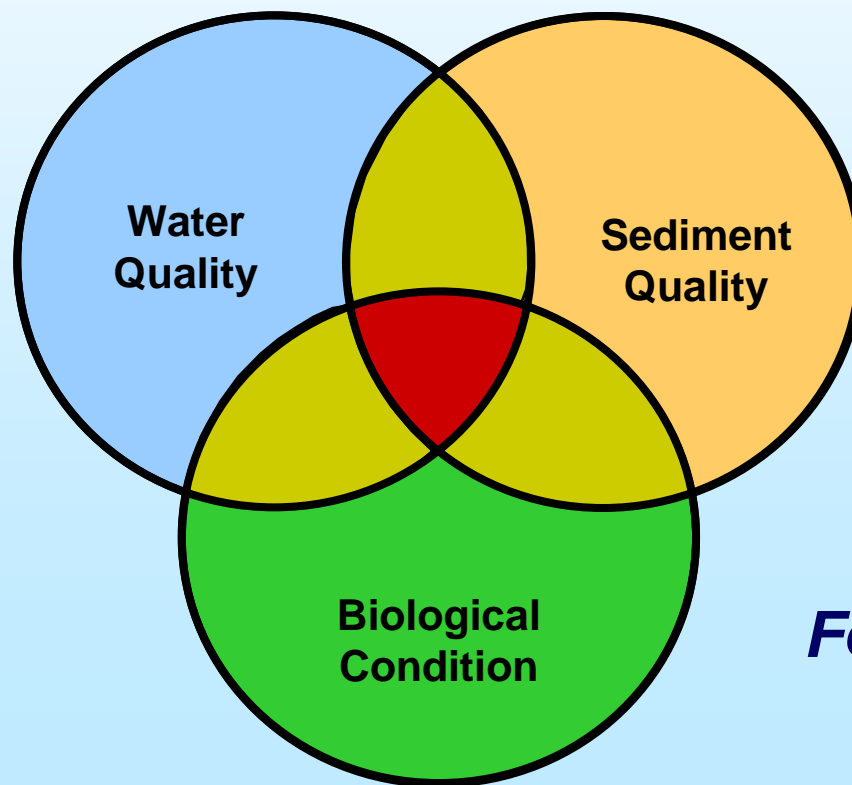
Trend in Benthic Condition Measure



Integrated Measures

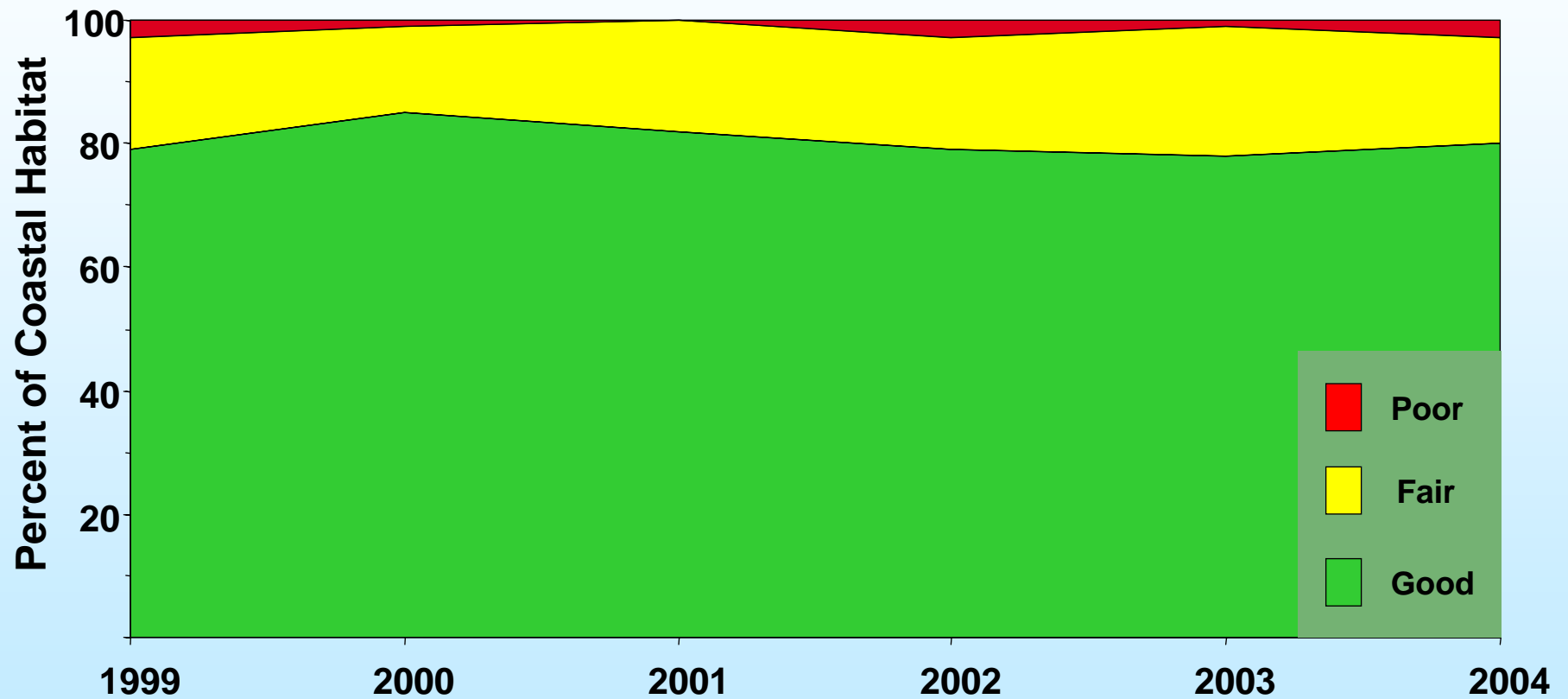
Overall habitat quality

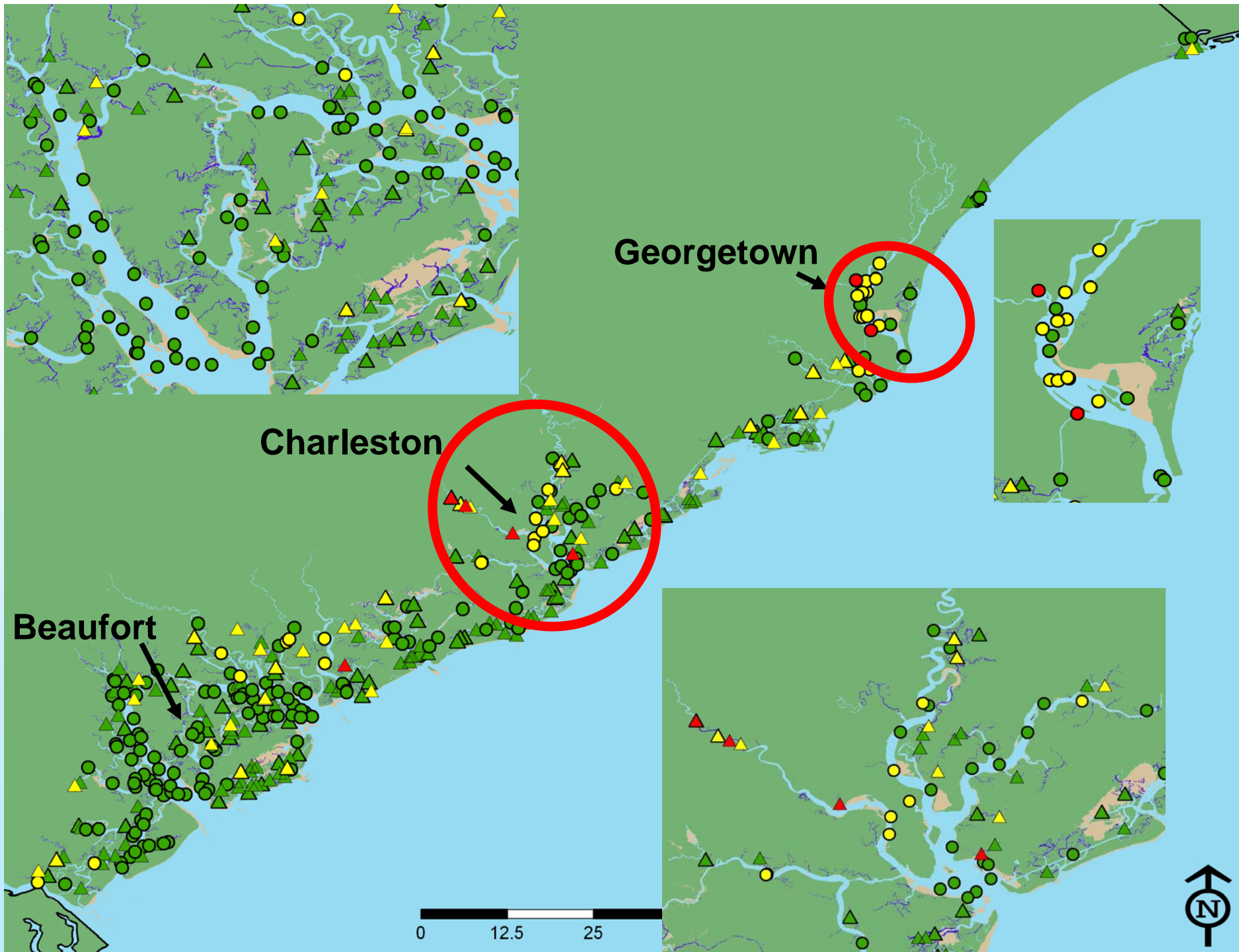
- Averaged scores of each subcomponent into an integrated score for overall habitat quality
- Each component weighted equally



*For more information: Google
South Carolina SCECAP*

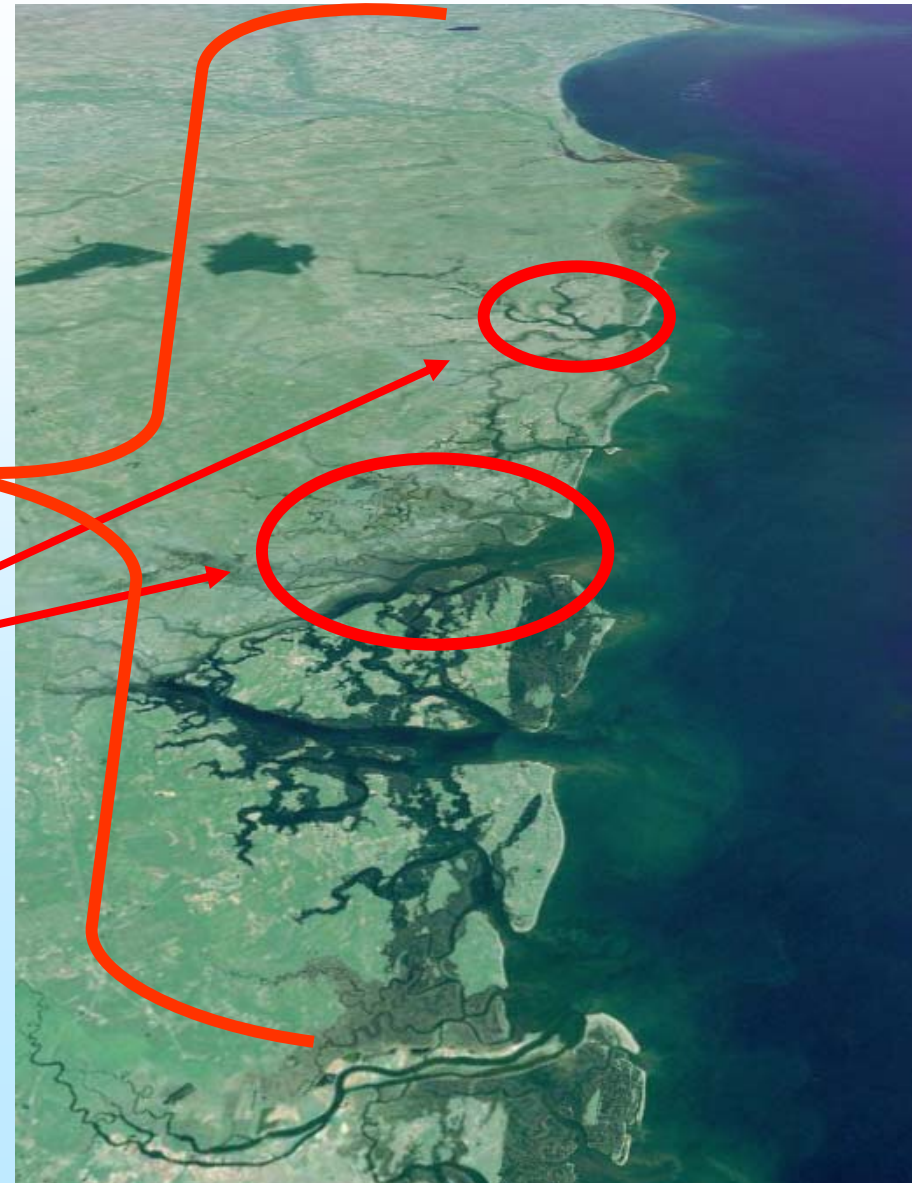
Temporal Change in Overall Habitat Quality Score





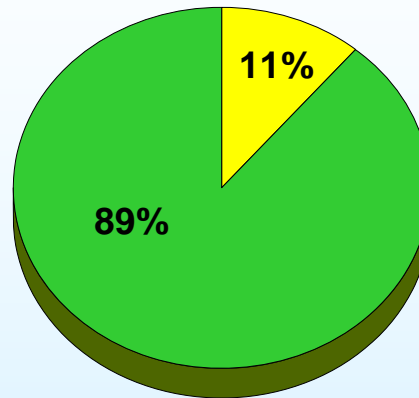
Approach Useful at Several Levels

- **State Wide Assessment**
 - Approach used for 305(b), 303(d) reporting
 - Better than index sites
 - Unbiased random sample
 - Represents entire resource
 - Known confidence of estimates
- **Specific watersheds**

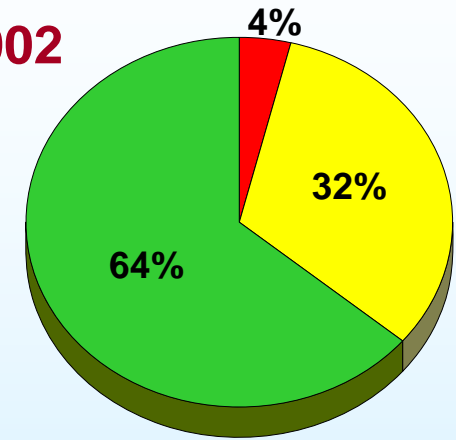


ACE Basin Condition (99-02)

*Overall Quality
ACE*

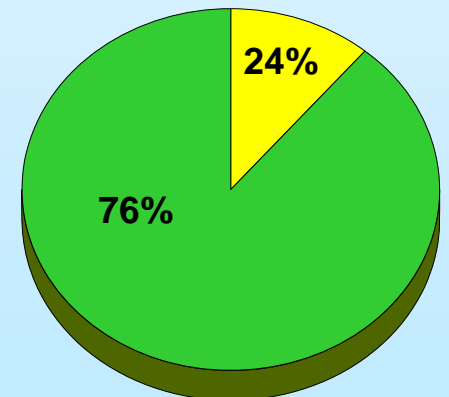
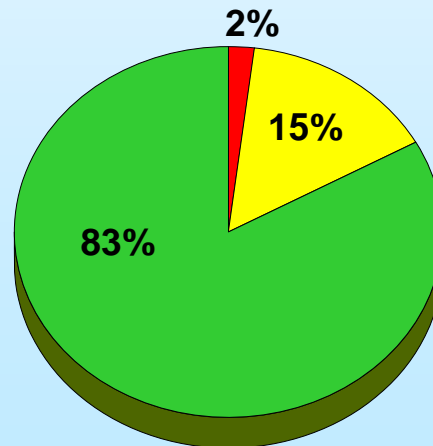


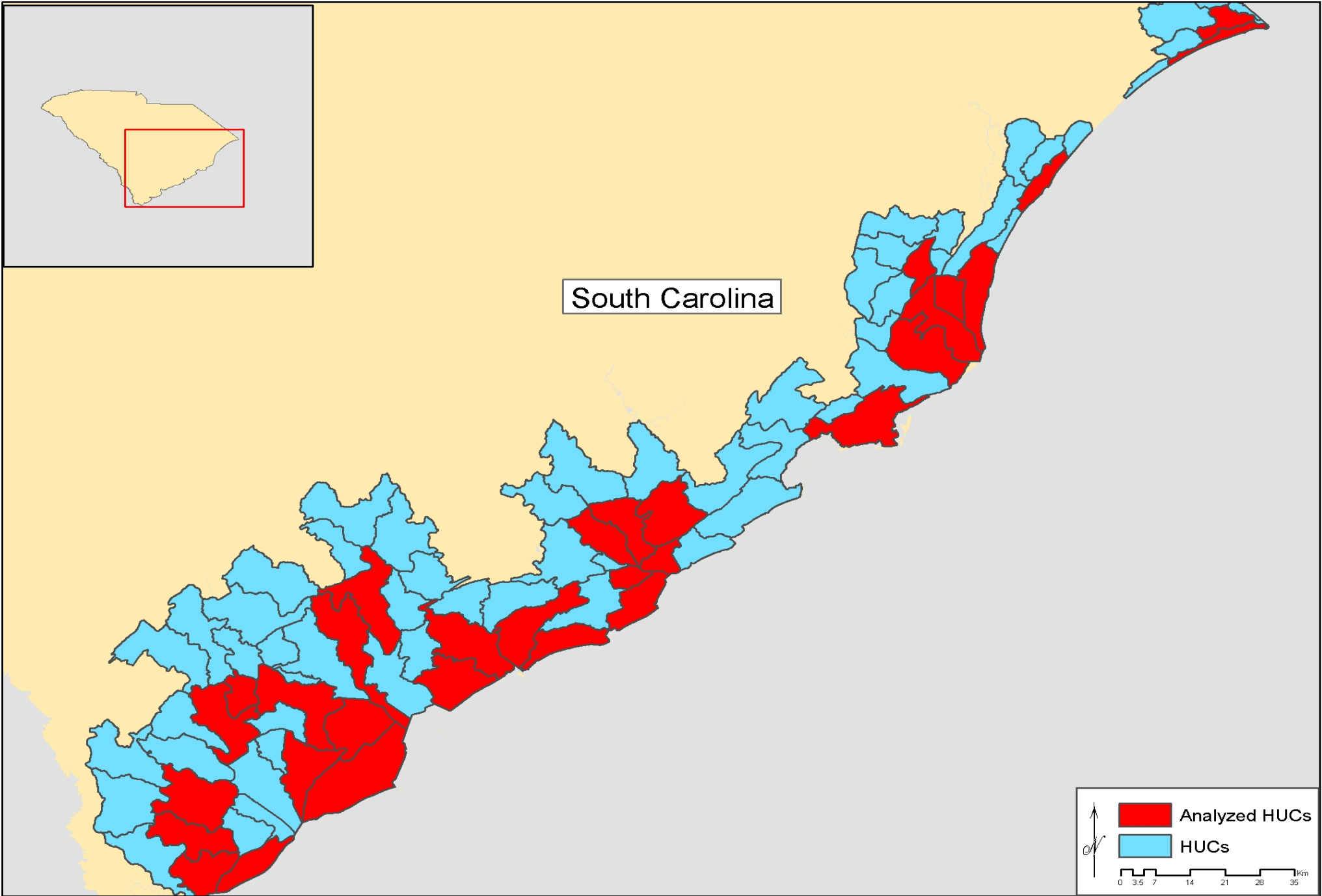
Open



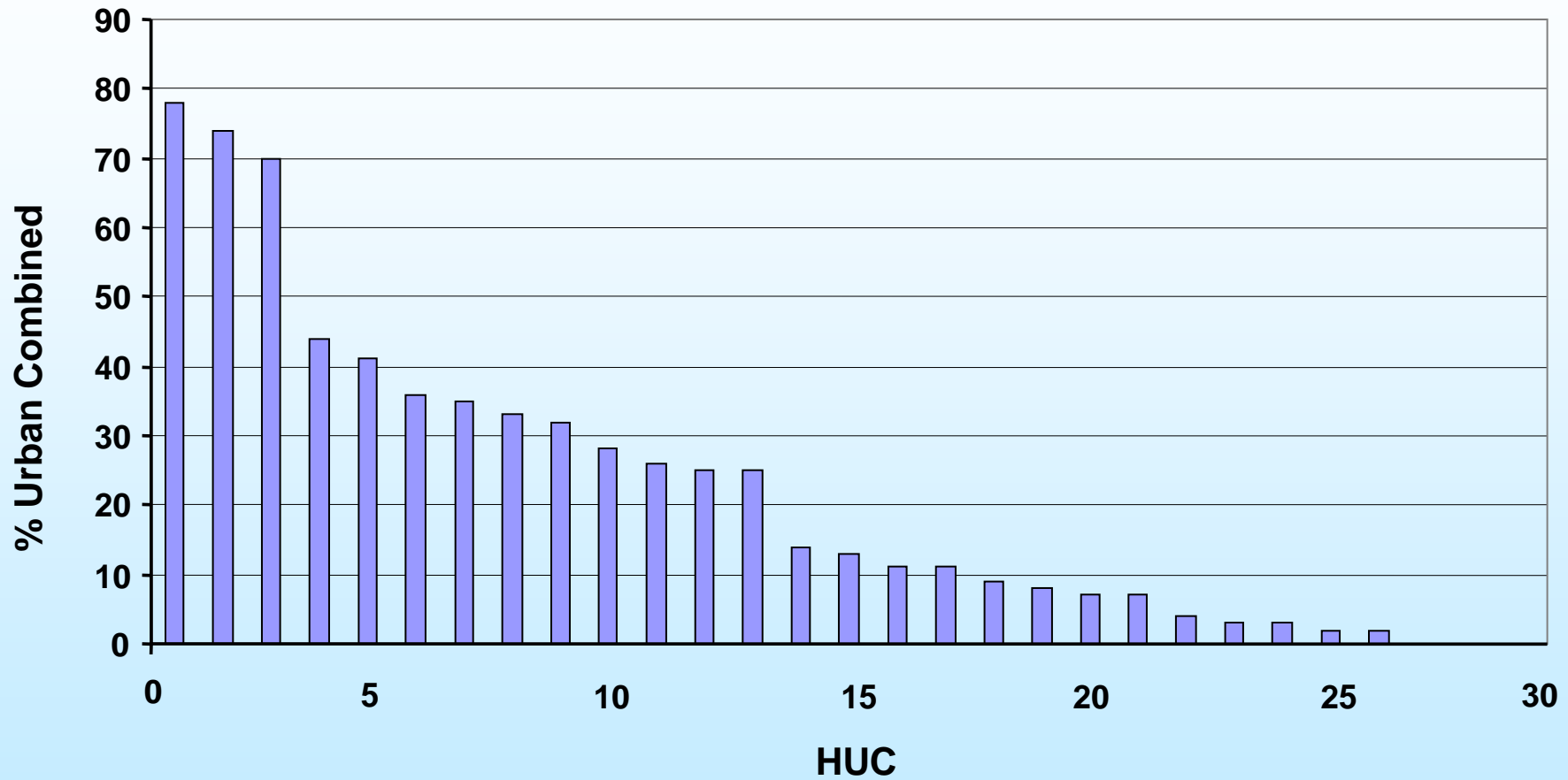
Creeks

*Overall Quality
Entire State*





Percent Urban Cover for Analyzed HUCs




Approx. 600 Stations with Water and/or Sediment Quality Data

Land Cover vs. Estuarine Sediment Quality

Pearson Correlation Analysis Results

| Land Cover Category | Sediment Contaminants | | | | | Water |
|-----------------------------------|-----------------------|------|------|--------|--------|--------|
| | ERM-Q | PAHs | PCBs | Pest.* | Metals | Fecals |
| Scrub shrub & forested wetlands | + | - | - | - | + | - |
| Bare land** | - | - | - | - | - | - |
| Grassland & pasture & scrub shrub | - | - | - | - | - | - |
| Deciduous & mixed forest** | - | - | - | - | - | - |
| Evergreen forest | - | - | - | - | - | - |
| Cutlivated land | - | - | - | - | - | - |
| Urban low density | + | + | + | + | + | + |
| Urban high density | + | + | + | + | + | + |
| Urban combined | + | + | + | + | + | + |
| Percent impervious surface | + | + | + | + | + | + |

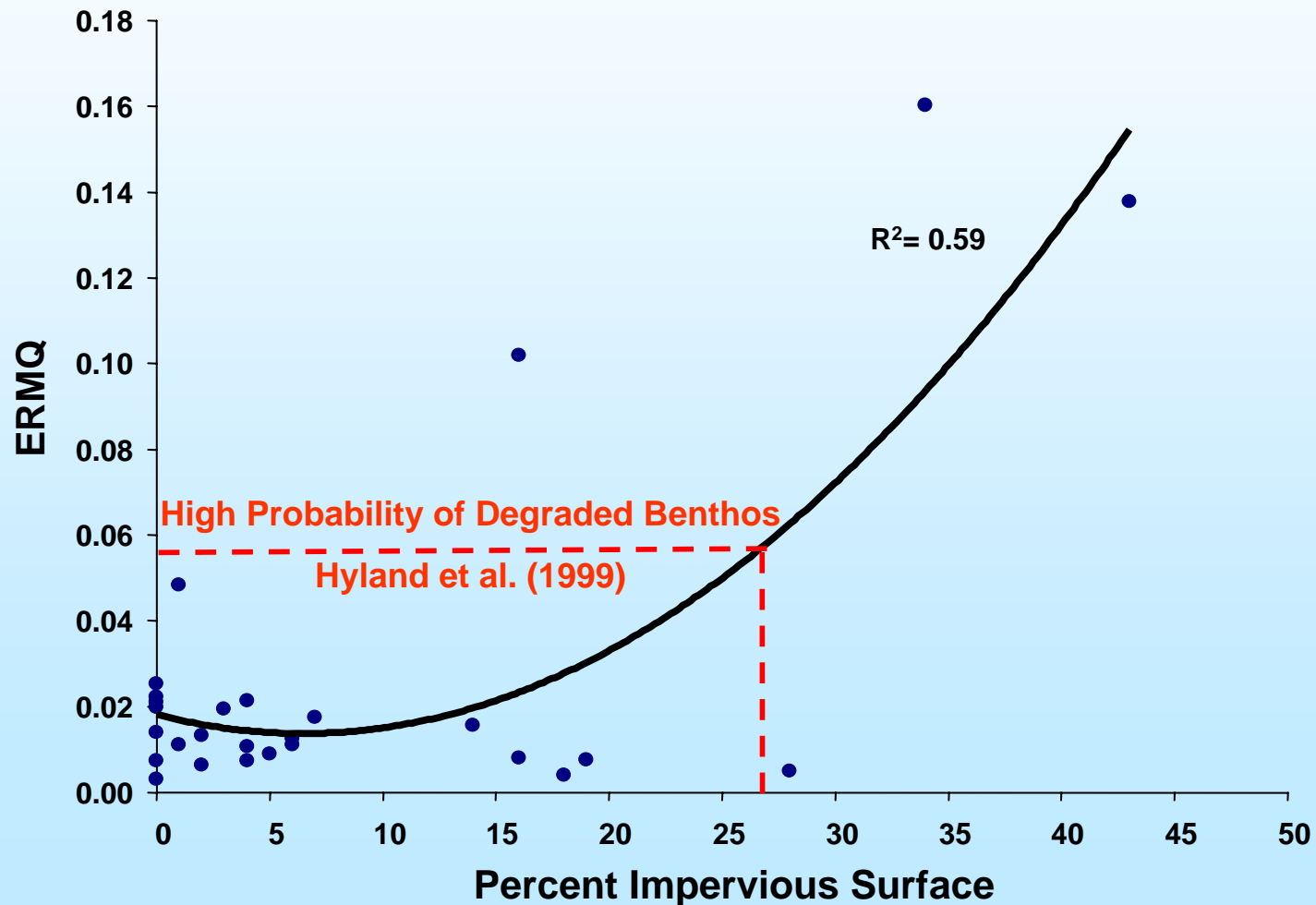
**Spearman rank correlation

 P < 0.05

 P < 0.10

Land Cover vs. Estuarine Quality

ERMQ versus Percent Impervious Surface



Other Agency Uses

➤ **DNR**

- *Special basin assessments requested by towns, agencies*
- *Fishery monitoring data (spot, croaker, weakfish)*

➤ **DHEC - OCRM**

- *Assessment of effects of docks in tidal creeks*

➤ **NOAA**

- *Oceans and Human Health Initiative*
- *Dolphin Health Assessment*

➤ **Academic Scientists**

Summary

- ***SCECAP approach is useful to SCDNR and SCDHEC***
 - *Provides unbiased assessment of state's estuarine environmental quality and biotic condition*
 - *Incorporates integrated measures of ecosystem condition*
 - *Unique to most other state monitoring programs*
 - *Useful for evaluating change over time – state wide*
 - *Allows for watershed or county assessments once enough stations*
 - *Robust database useful for basic research in understanding relationships between environmental and biotic condition*

Summary

➤ ***State of the Coast - Based on SCECAP***

- *Majority of state's coastal habitat is in good condition*
 - *Water quality index may be refined*
- *Tidal creek habitats tend to be more stressed than larger water bodies*
- *Some evidence of increasing degradation state-wide*
 - *(contaminants, benthos)*
- *Evidence of increased incidence of impaired habitat among sites in developed vs. less developed watersheds*

