New Monitoring Technologies Bring New Opportunities for Science-Based Management Decisions in the Coastal Zone

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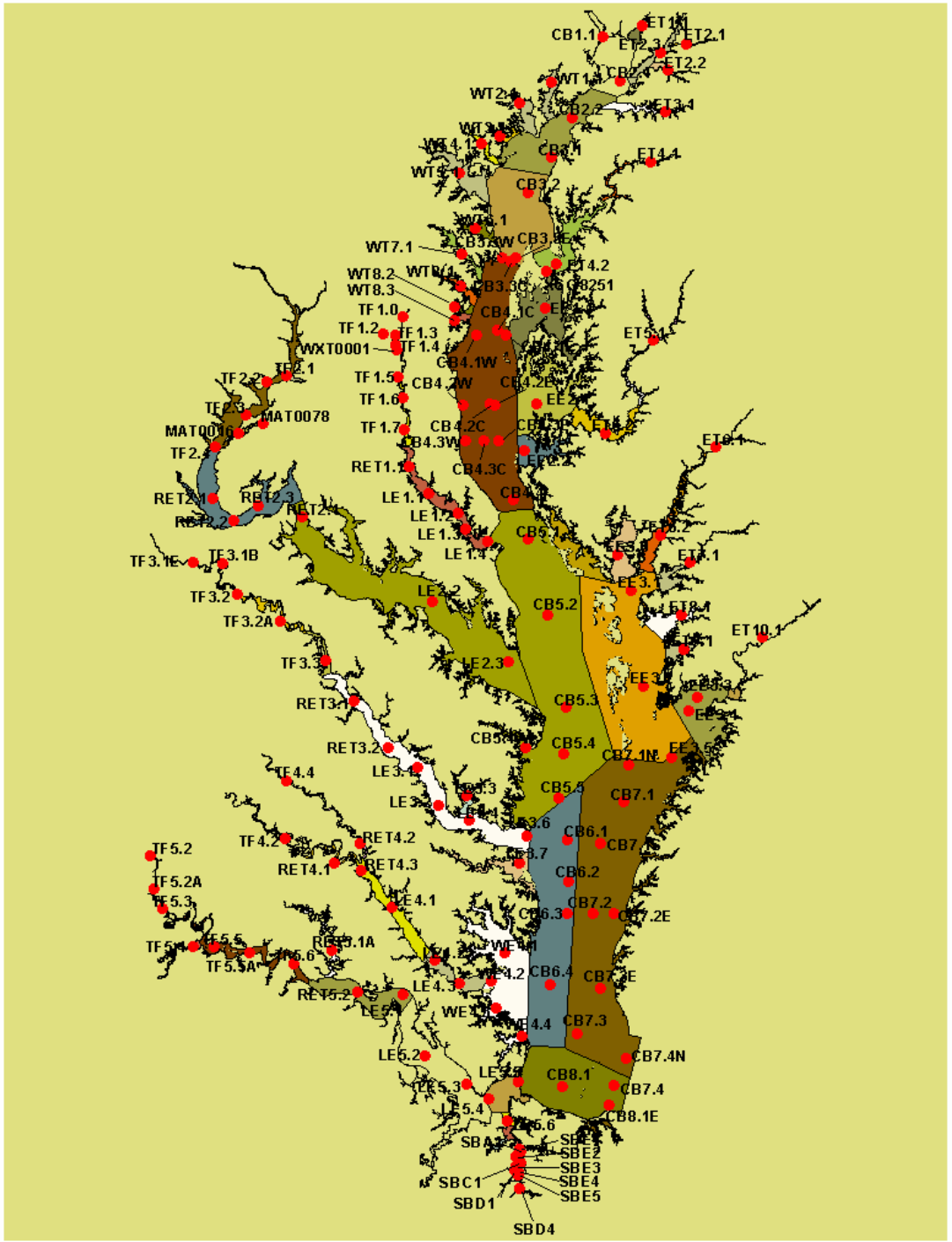
Overview of Presentation

- Brief look at existing Bay monitoring
- Description of new monitoring technologies
- Examples of how new monitoring technologies and analysis techniques offer new support for management decisions
- A look at where we may be going in the future

Current Chesapeake Bay Program Water and Habitat Quality Monitoring:

Stations Sampled 1-2X / month



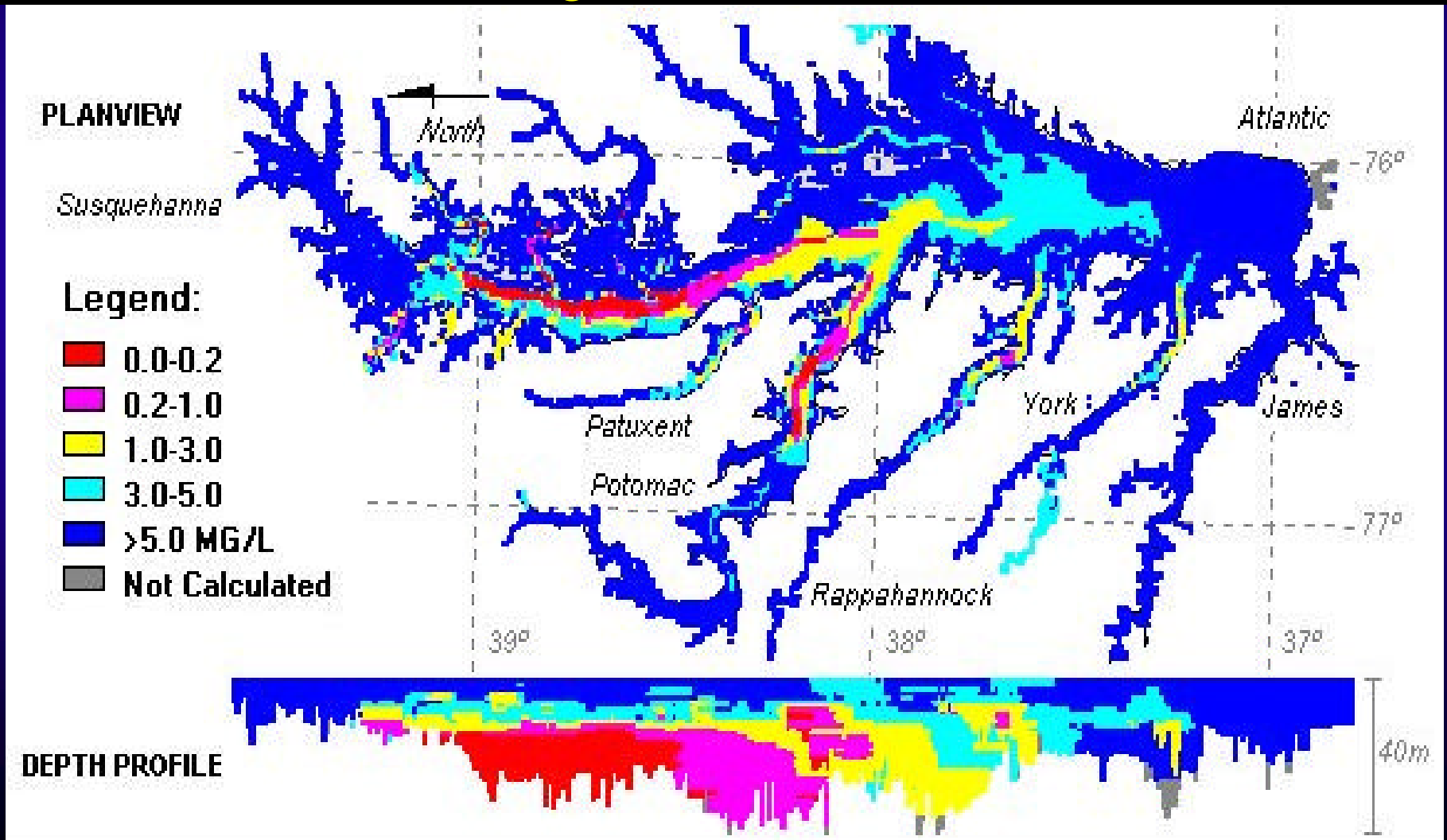
Chesapeake Bay Monitoring:

Conventional Sampling and Sample Processing

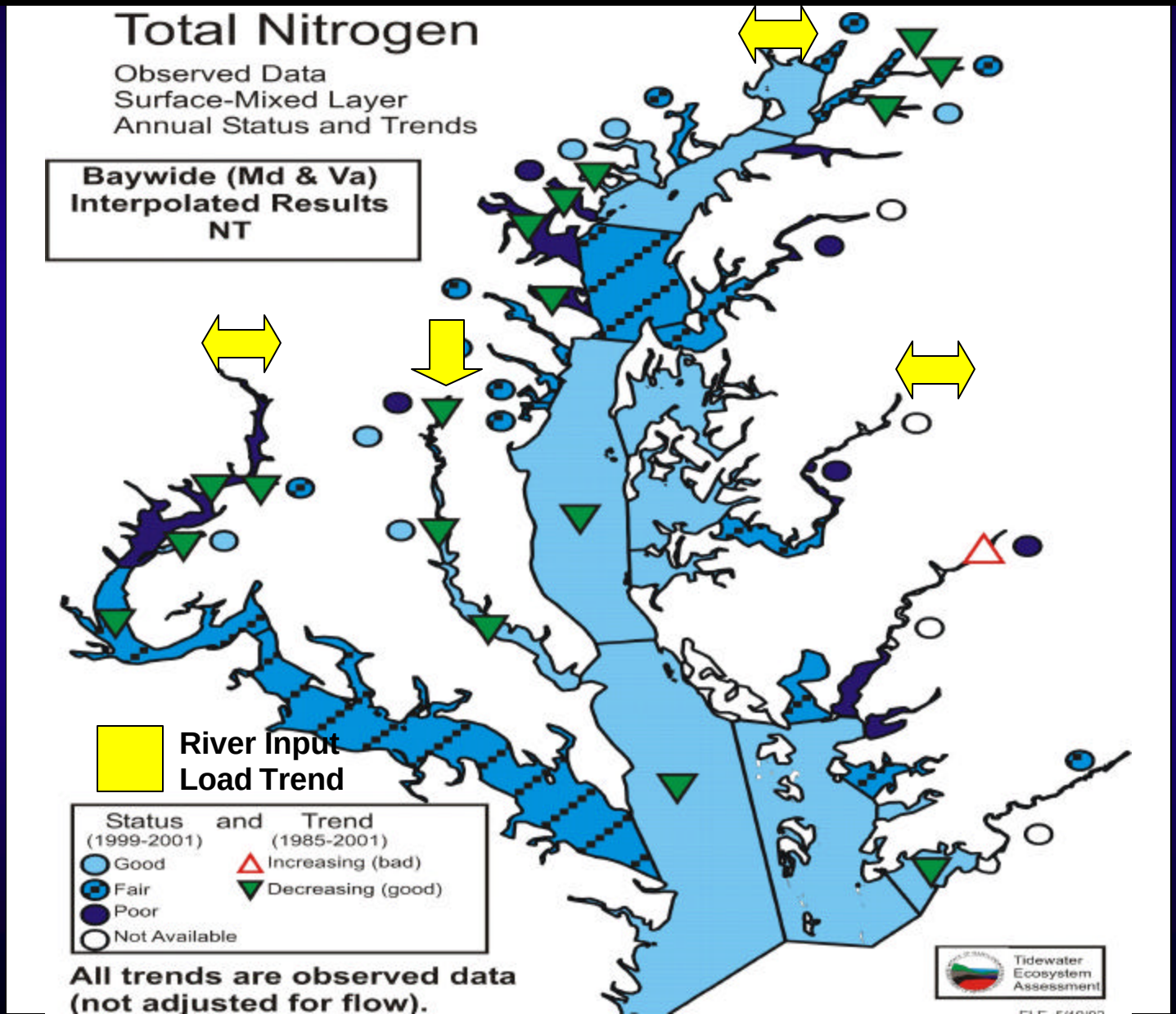
MD DNR's R/V Kerhin

Current Monitoring Program Provides "Big Picture" Characterization

Chesapeake Bay Oxygen Concentrations Interpolated From Monitoring Stations - August, 1997

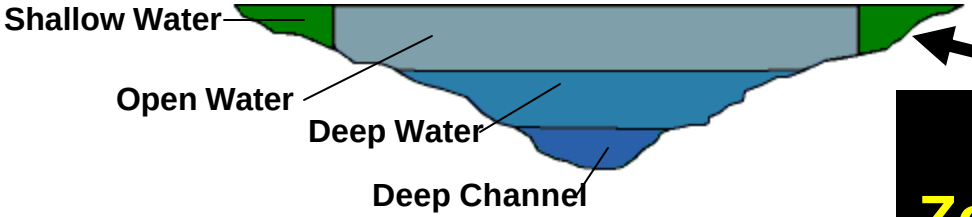


Current Monitoring Program Provides Information on Status and Trends



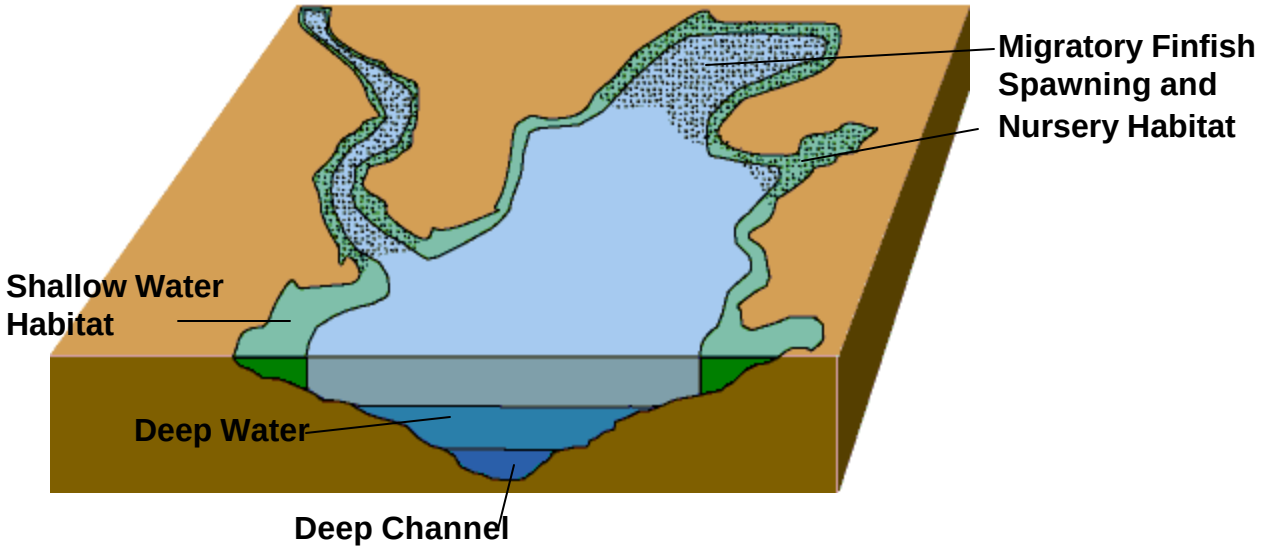
New Restoration Goals for Chesapeake Bay: 5 Designated Uses (below) and 3 Criteria – D. O., Water Clarity, Chlorophyll

A. Cross Section of Chesapeake Bay or Tidal Tributary



Shallow Water Zone Not Currently Monitored

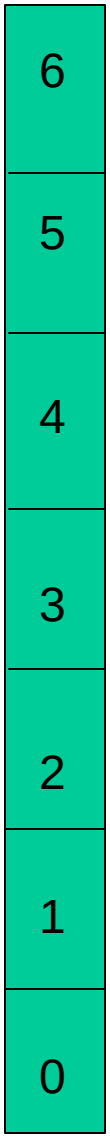
B. Oblique View of the "Chesapeake Bay" and its Tidal Tributaries



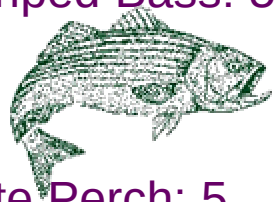
New Dissolved Oxygen Criteria Include Short and Long Term Durations:

Instantaneous
7-day mean
30-day mean

Minimum Amount of Oxygen (mg/L) Needed to Survive by Species



Striped Bass: 5-6



American Shad: 5

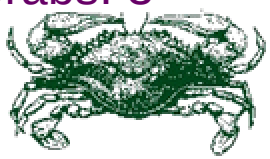
White Perch: 5

Yellow Perch: 5

Hard Clams: 5

Alewife: 3.6

Crabs: 3



Bay Anchovy: 3

Spot: 2

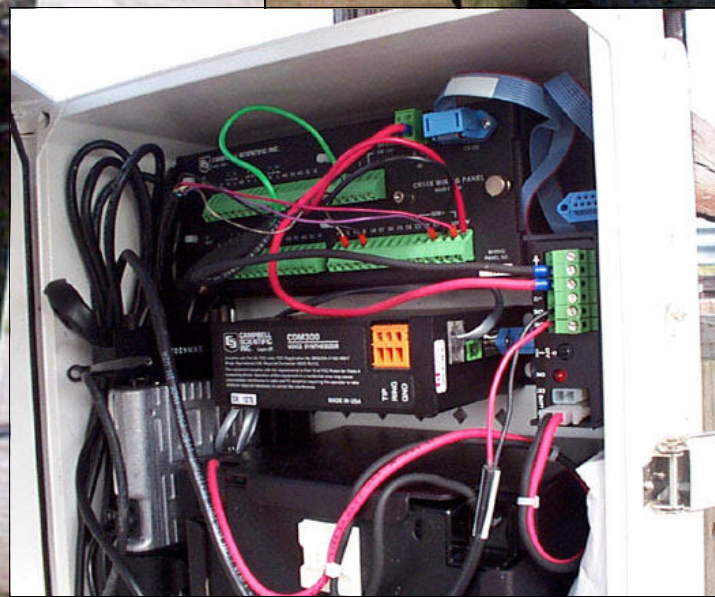
Worms: 1

"New" Technologies to be Discussed

- Continuously recording *in situ* instruments for temporally intensive monitoring
- Spatially-intensive monitoring for water and habitat quality mapping
- Linking to Internet for near real-time availability of data
- Not the "latest and greatest" but practical, implementable and useful for management now

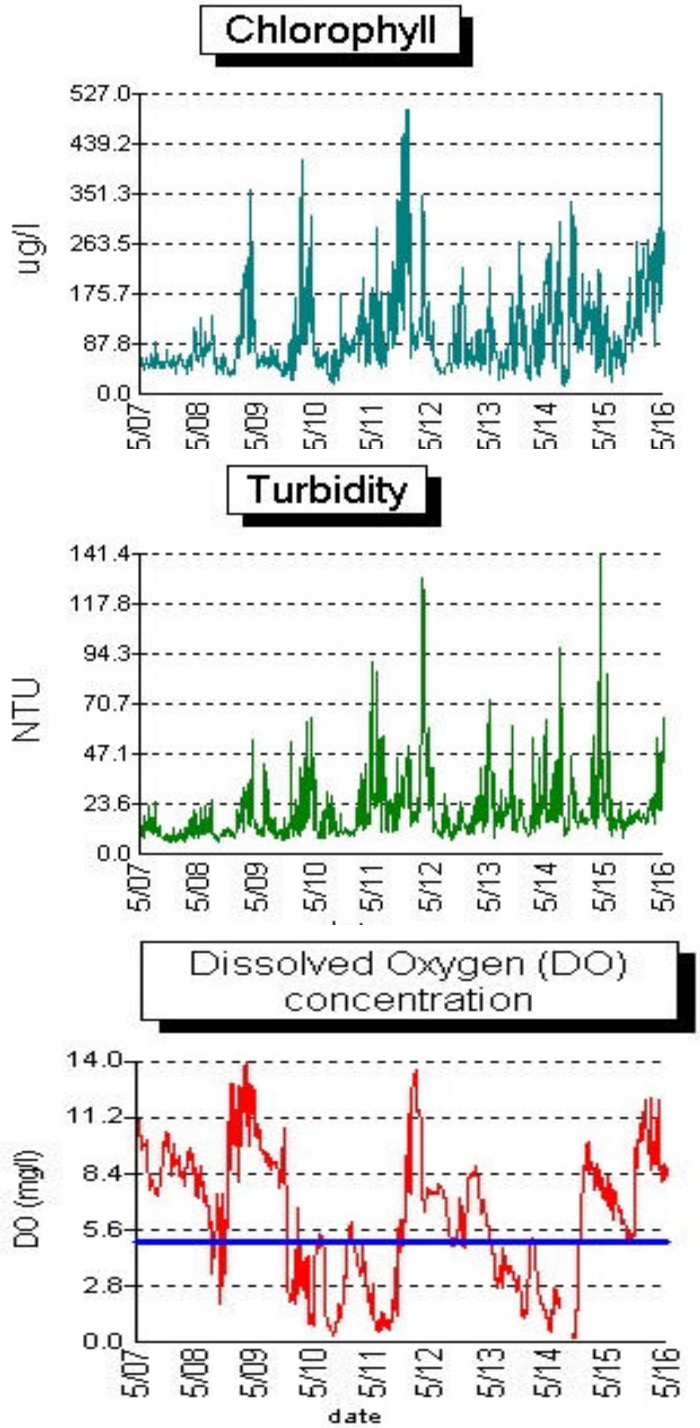
Continuously-Recording Water Quality Meter:

D.O., Salinity, Temp., pH, Chlor-ophyll, Turbidity



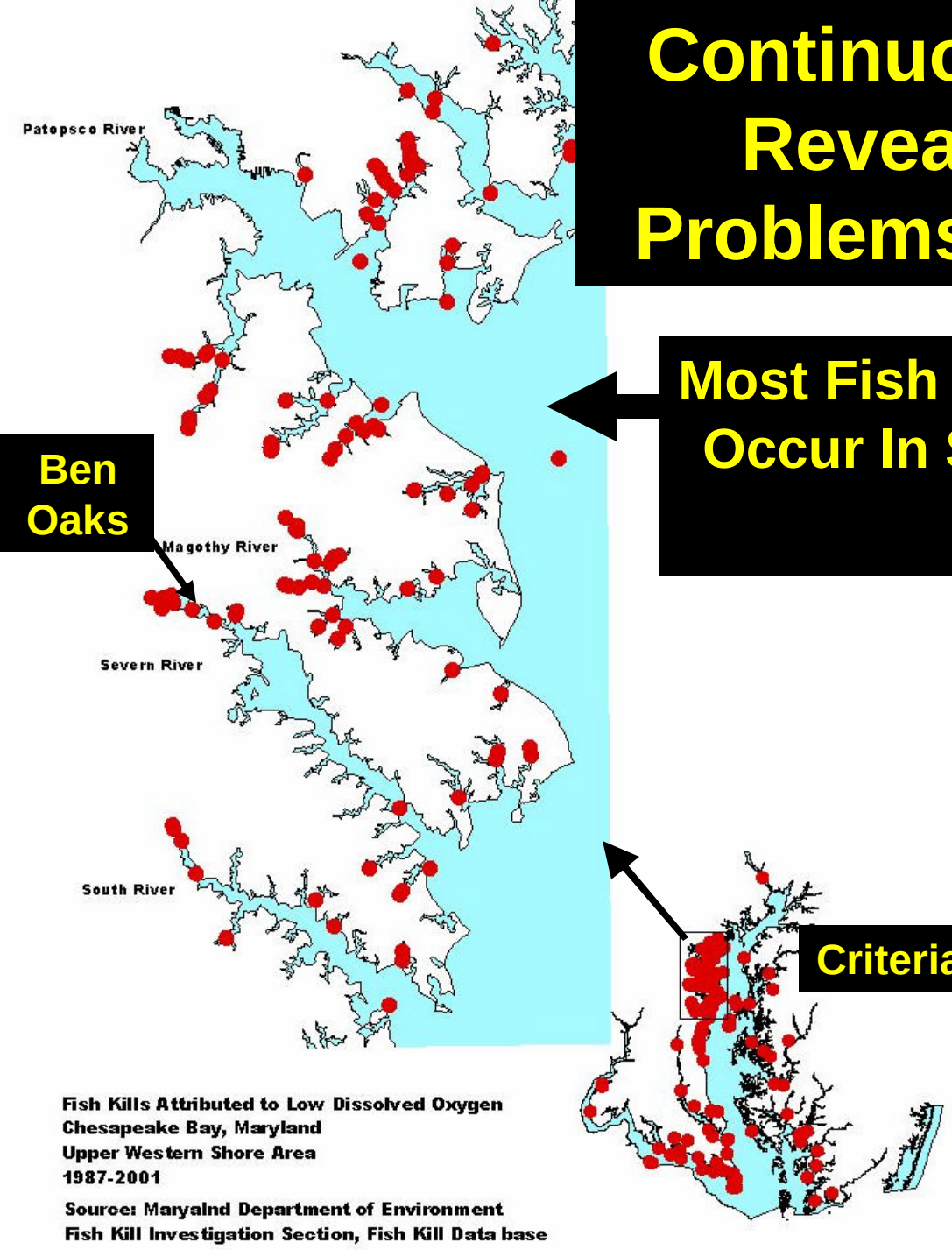
Continuous Monitoring is Revealing Dissolved Oxygen and Turbidity Impacts in Shallow Waters, Driven by Higher Than Expected Algal Blooms

Severn River at Ben Oaks

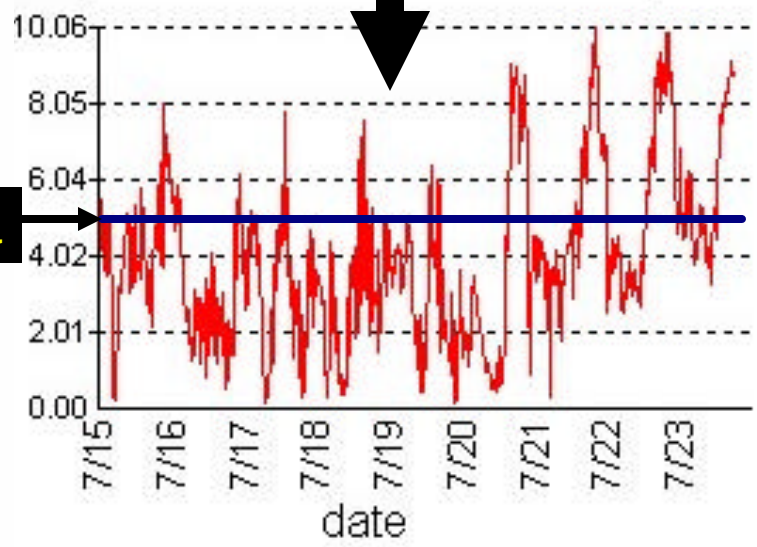


Continuous Monitoring Has Revealed Severe D. O. Problems in Shallow Waters

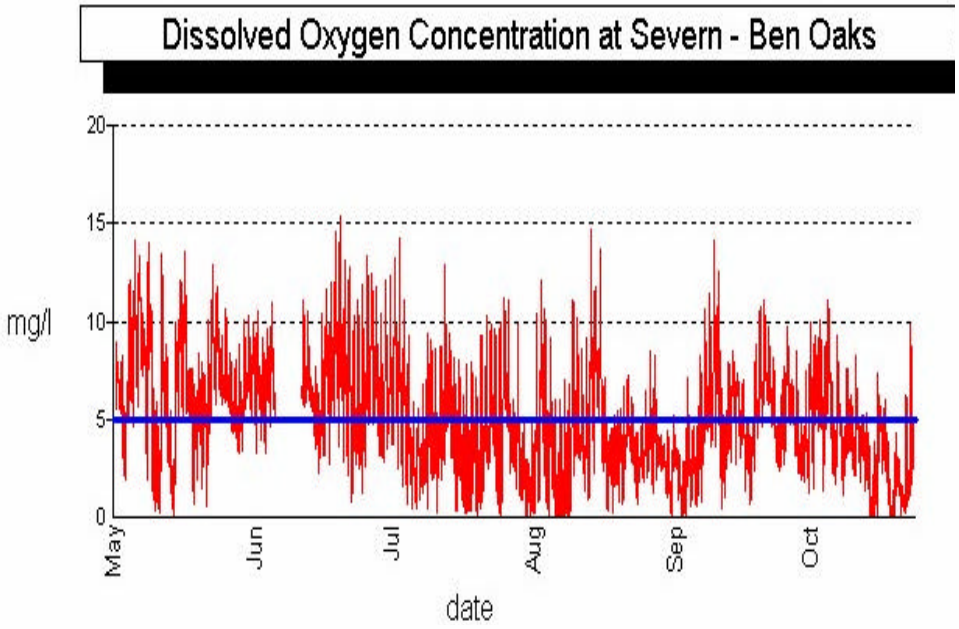
Most Fish Kills Attributed to low D.O. Occur In Shallow-Water Tributaries

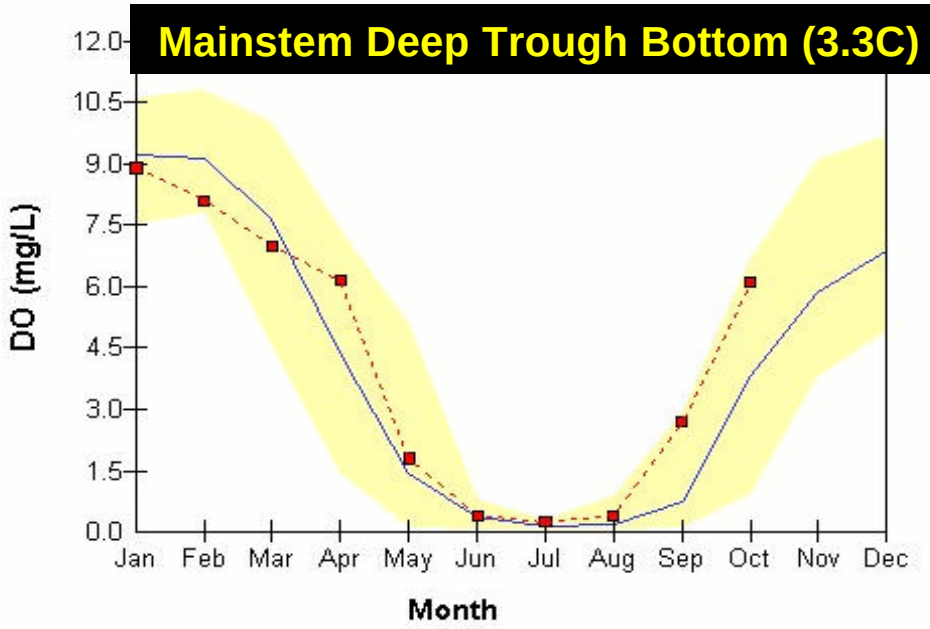


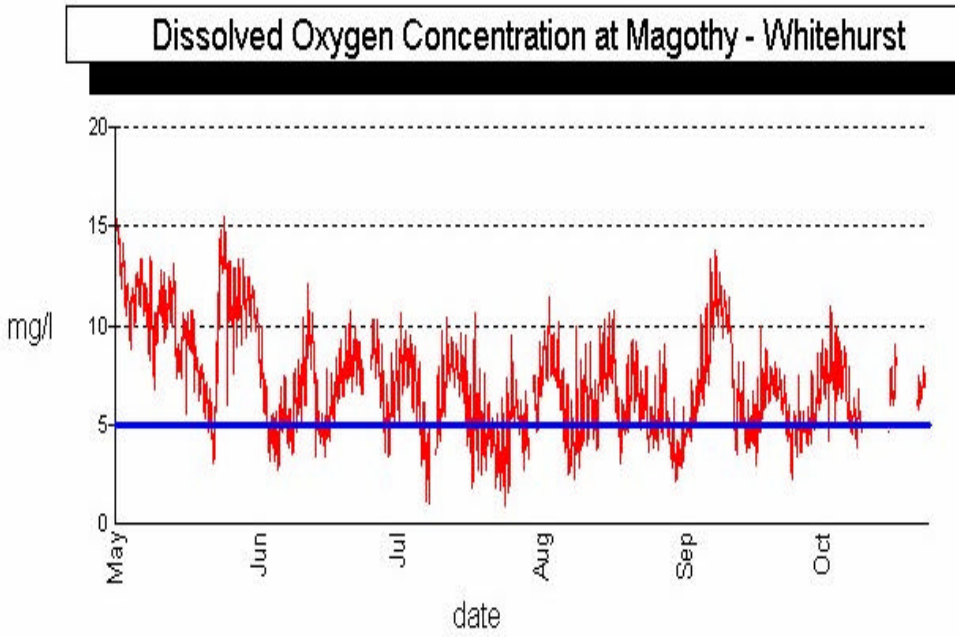
Severe Violations of Criteria in Severn River at Ben Oaks - 2002

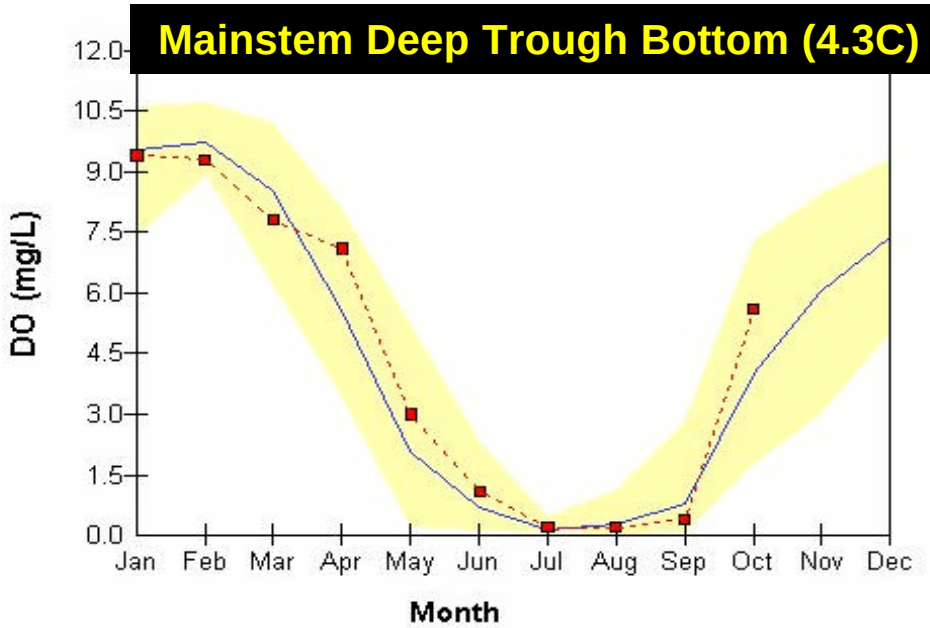


D. O. Dynamics: Shallow-Water Tributaries vs. Deep Channel Mainstem

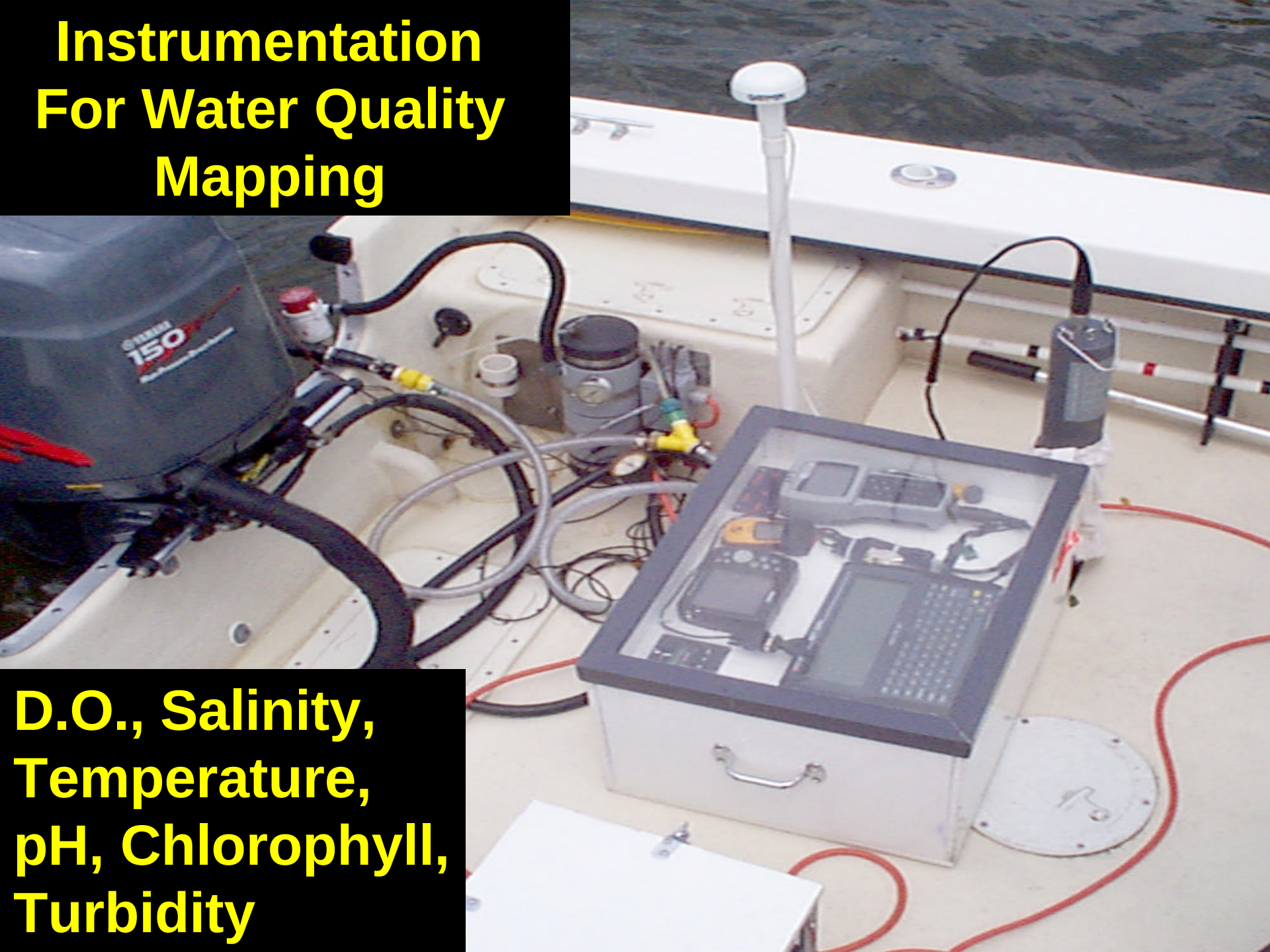






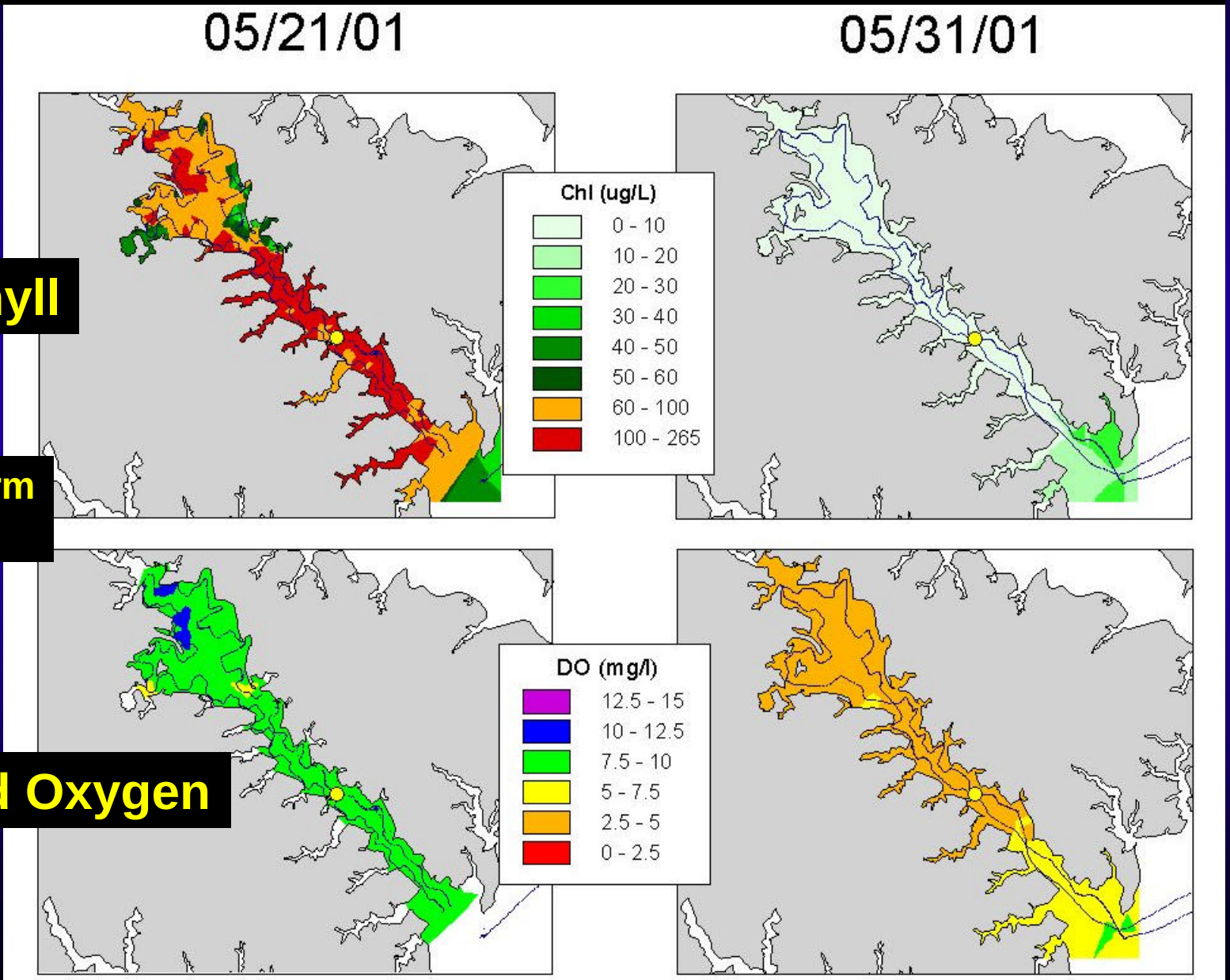


Instrumentation For Water Quality Mapping



D.O., Salinity, Temperature, pH, Chlorophyll, Turbidity

Water Quality Mapping:
Severn River Algal Bloom and Dissolved Oxygen



Chlorophyll

● **Long-Term Station**

Dissolved Oxygen

DNR's "Eyes on the Bay" Web Site Provides Near Real-Time and Long-Term Monitoring Data

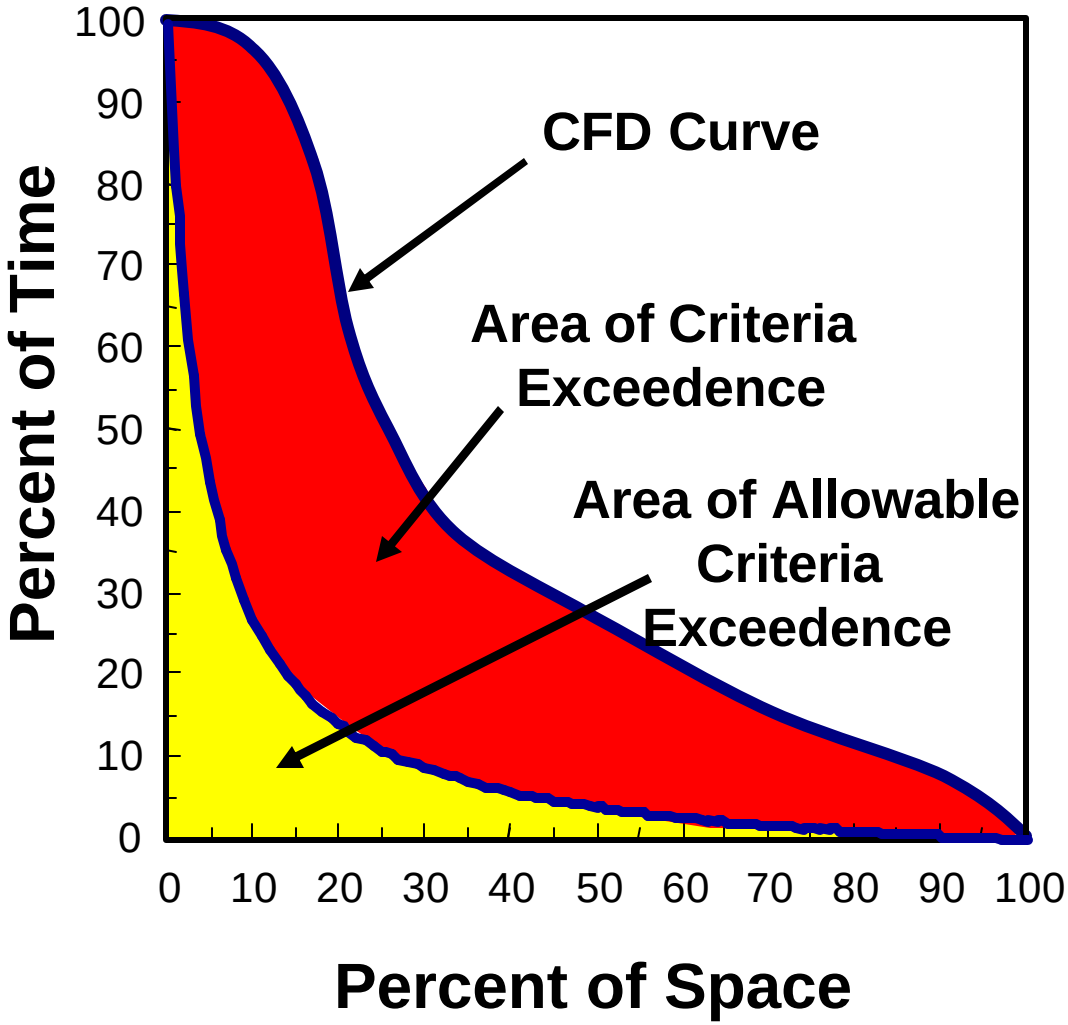
Underlying databases updated automatically via telemetry or on-line entry forms and are linked dynamically to Web interface. Data can be accessed for other purposes; e-mail warnings can be sent.

www.eyesonthebay.net

Examples of How New Monitoring Technologies and Analysis Techniques Offer New Support for Management Decisions

- Assessing new estuarine criteria for nutrient-enrichment based impacts
- Assessing fish habitat, fish kills
- Habitat Restoration

Assessment of New Criteria Will Involve a Time/Space Cumulative Frequency Distribution



Requires spatially and temporally intensive monitoring coupled with new analytical techniques

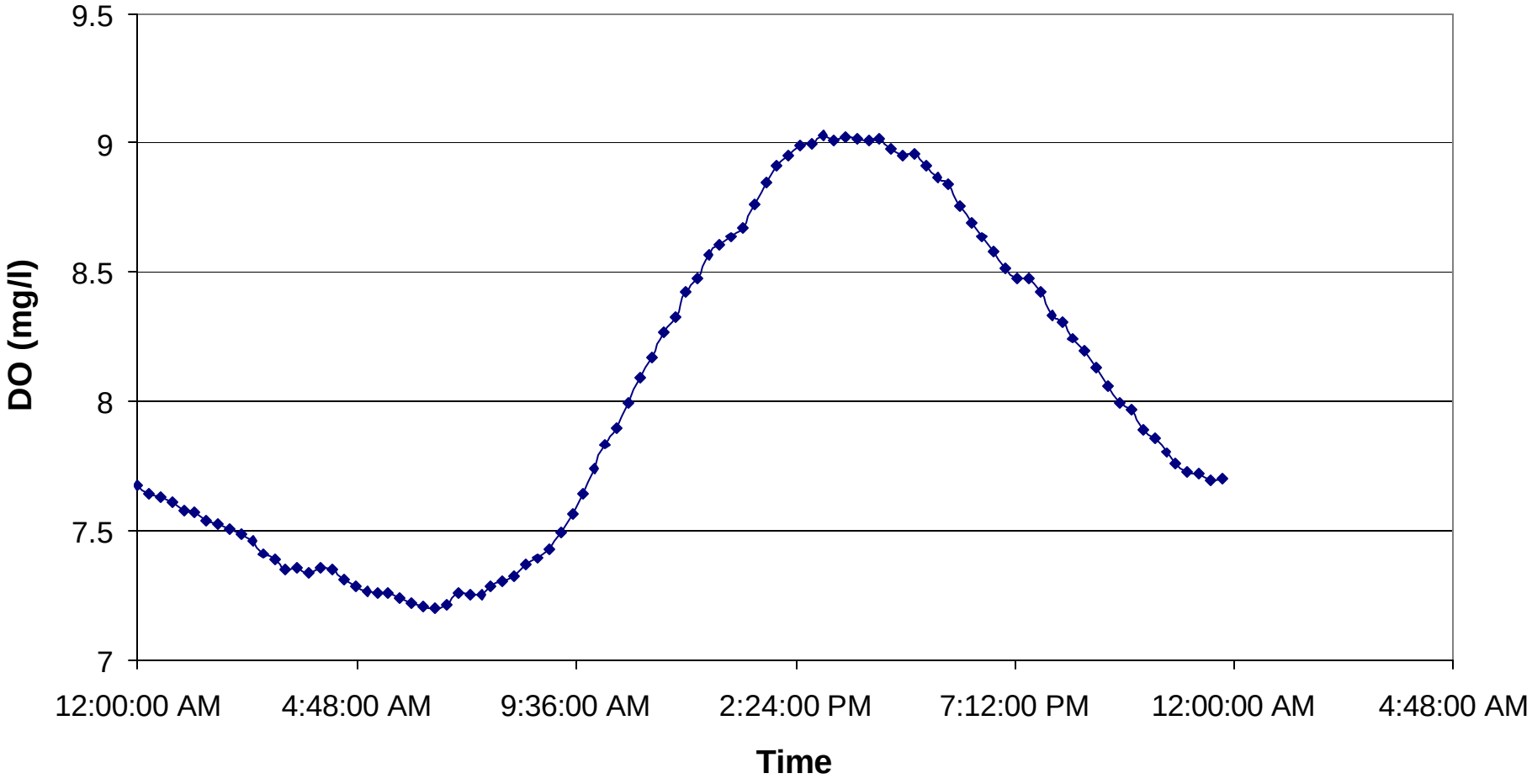
New Technology Monitoring Offers One of Two Choices:

1. Intensive temporal data at one location
2. Intensive spatial data at one point in time

Is there a way of bringing these results together to provide a more comprehensive assessment in space and time?

Time of Day Averaged Continuous Monitoring DO

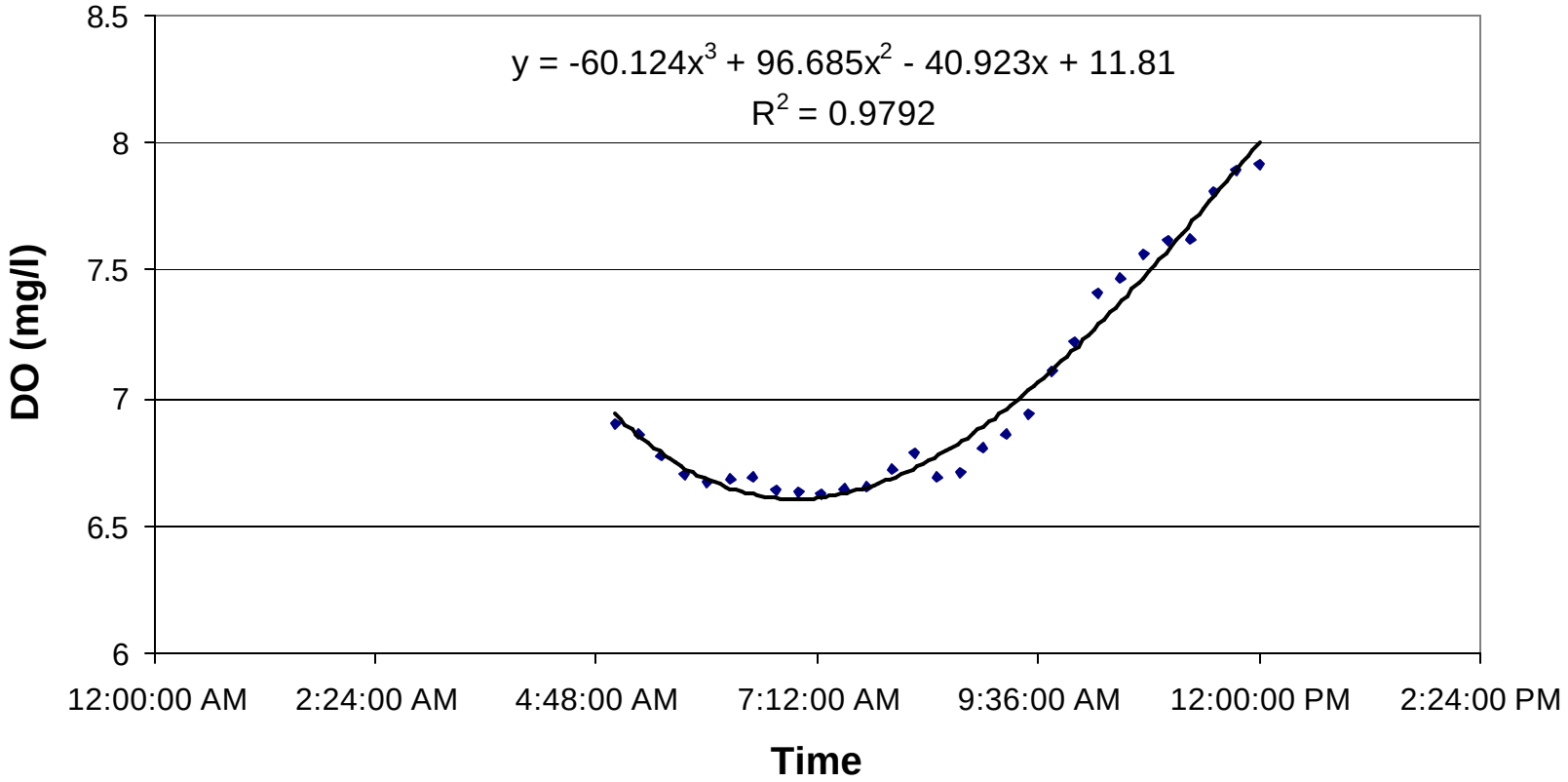
Magothy R., April 15 - October 31, 2001



Correcting DO Data for Time of Day to "Normalize" Water Quality Mapping

- Average 15-minute intervals of Continuous Monitoring DO data from a 2-week period surrounding a water quality mapping cruise (8/22/01).
- Fit 3rd-order polynomial regression of averaged continuous monitoring DO data from 5am to 1-hr after water quality mapping cruise.
- Use regression equation to obtain time-based correction factor for water quality mapping and adjust to daily minimum (0600).

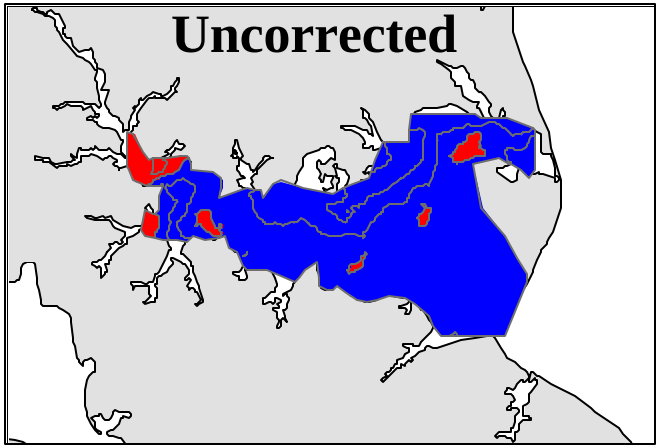
Mapping Data - (Predicted ($T_{collected}$) - Predicted T_{0600})

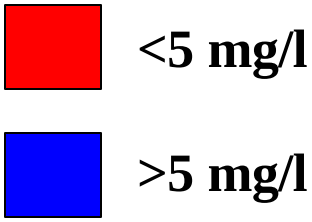


Examples of Regressions for DO vs. Time of Day -
Magothy River

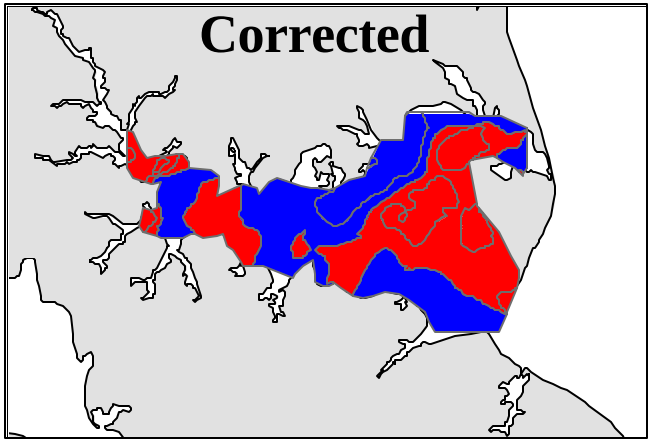
Cruise	Dates	R^2	Equation
2	*5/3/2001*	0.9807	y = -33.613x3 + 44.866x2 - 15.793x + 12.544
4	*5/31/2001*	0.957	y = -23.481x3 + 32.623x2 - 11.492x + 8.7653
6	*6/27/2001*	0.9799	y = -11.697x3 + 28.238x2 - 12.421x + 7.923
8	*7/25/2001*	0.975	y = -35.351x3 + 94.068x2 - 47.12x + 12.363
10	*8/22/2001*	0.9945	y = -72.002x3 + 128.02x2 - 56.354x + 12.6
12	*9/18/2001*	0.9792	y = -60.124x3 + 96.685x2 - 40.923x + 11.81
14	*10/18/2001*	0.9566	y = -20.048x3 + 31.757x2 - 12.961x + 9.9

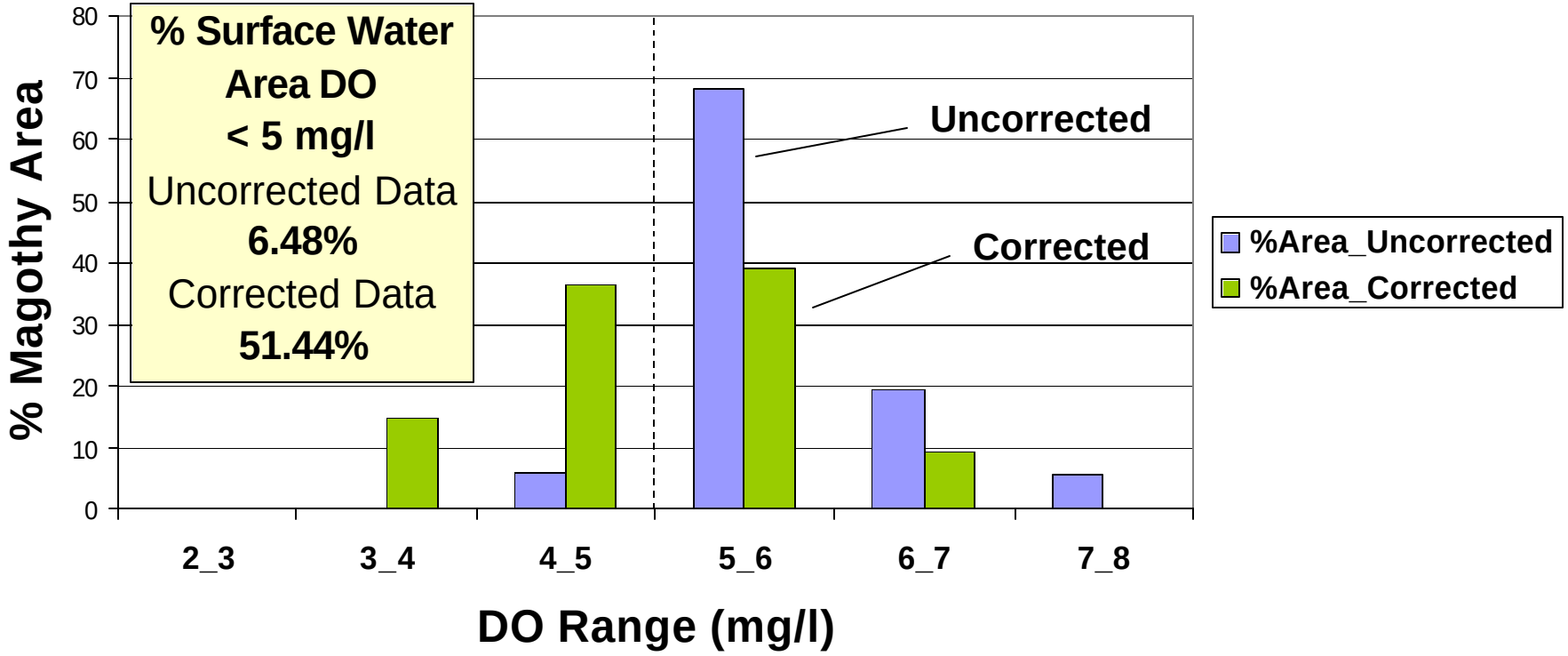
Dissolved Oxygen Corrected to Daily Minimum



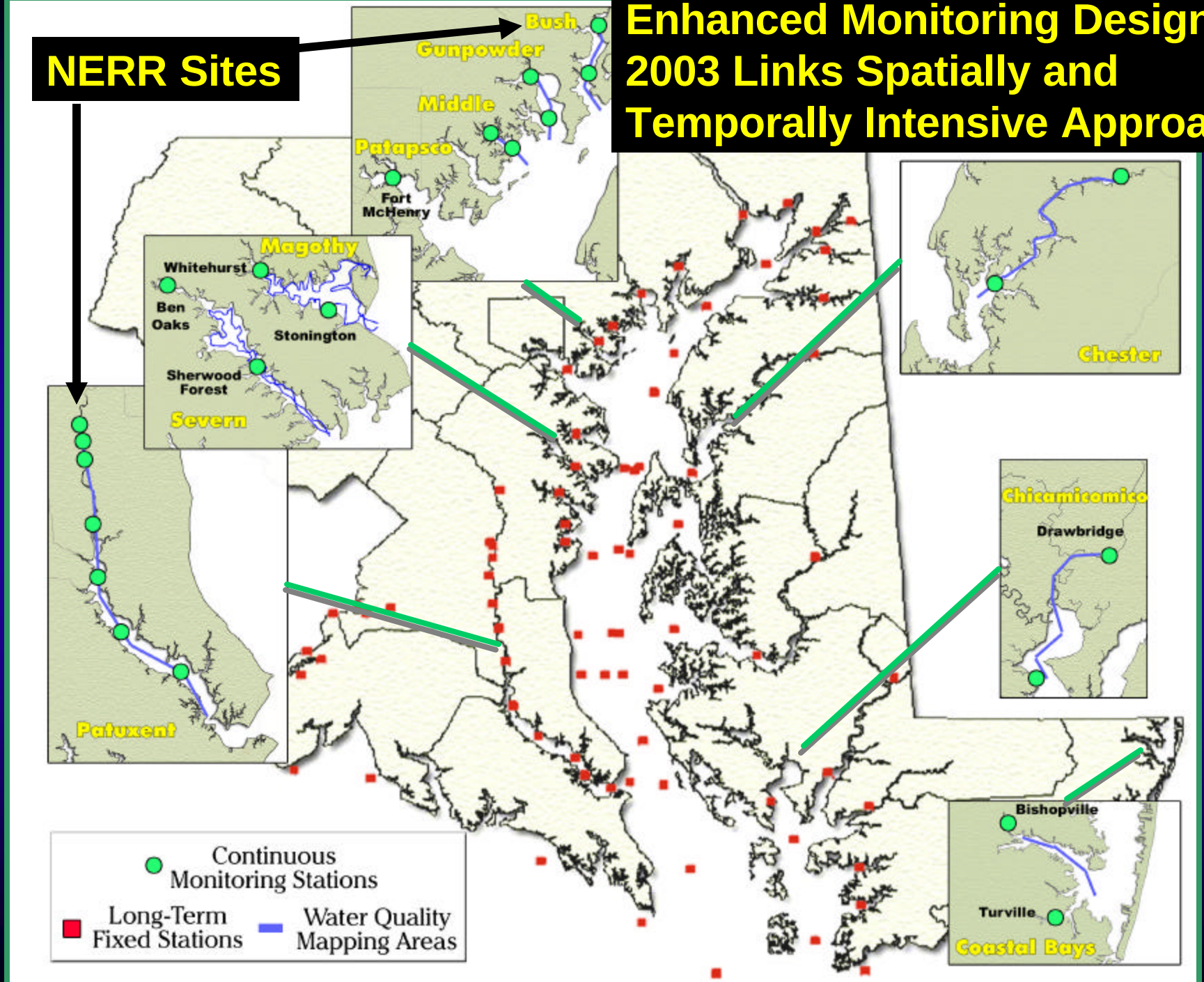


08/22/01 Magothy River

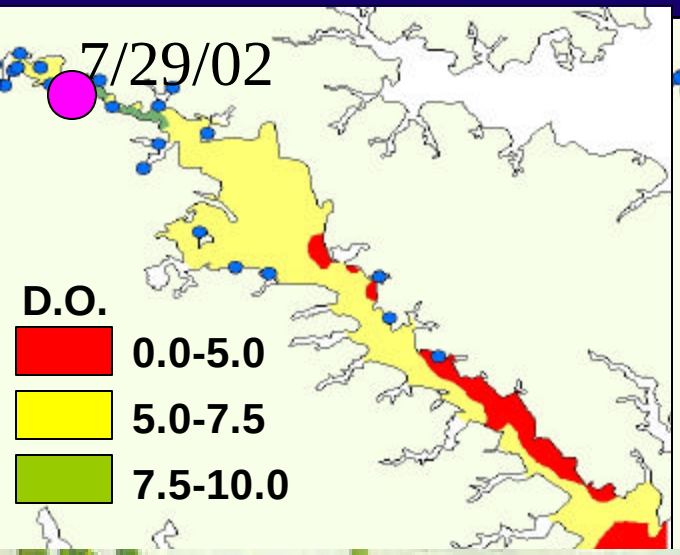


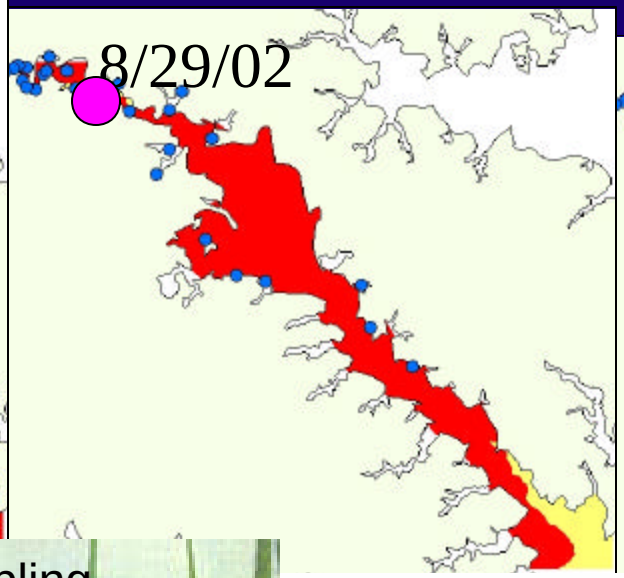


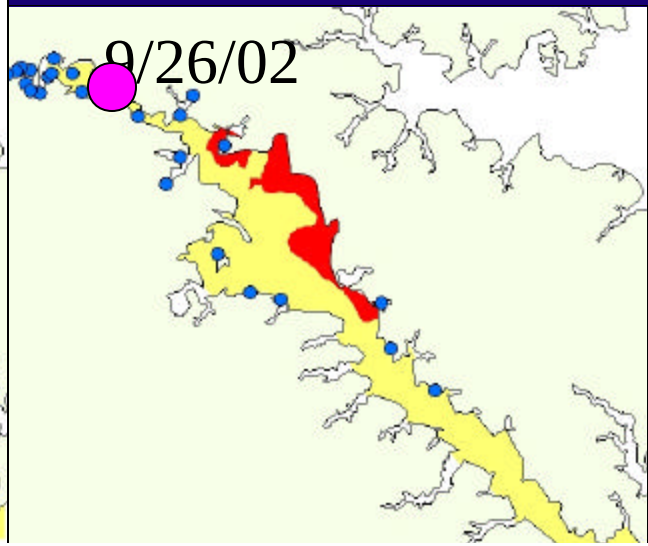
Enhanced Monitoring Design for 2003 Links Spatially and Temporally Intensive Approaches

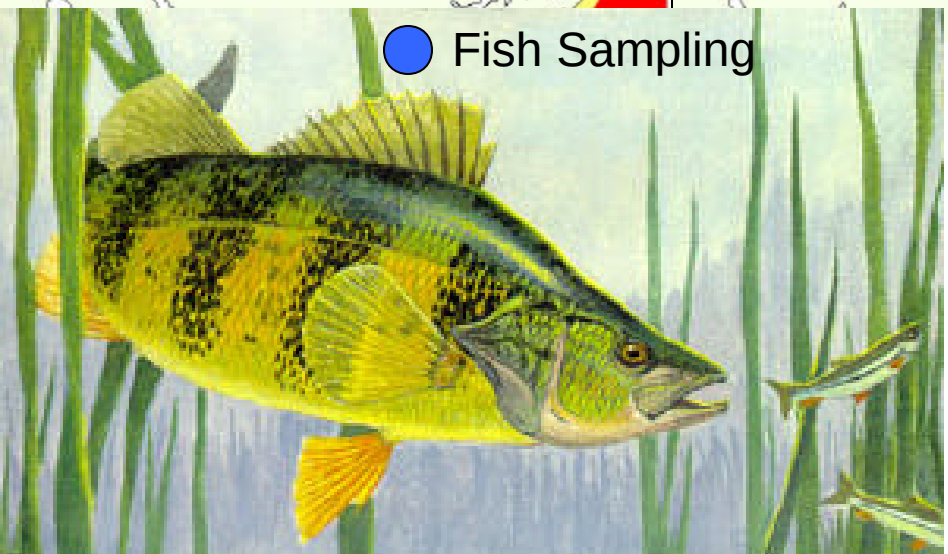


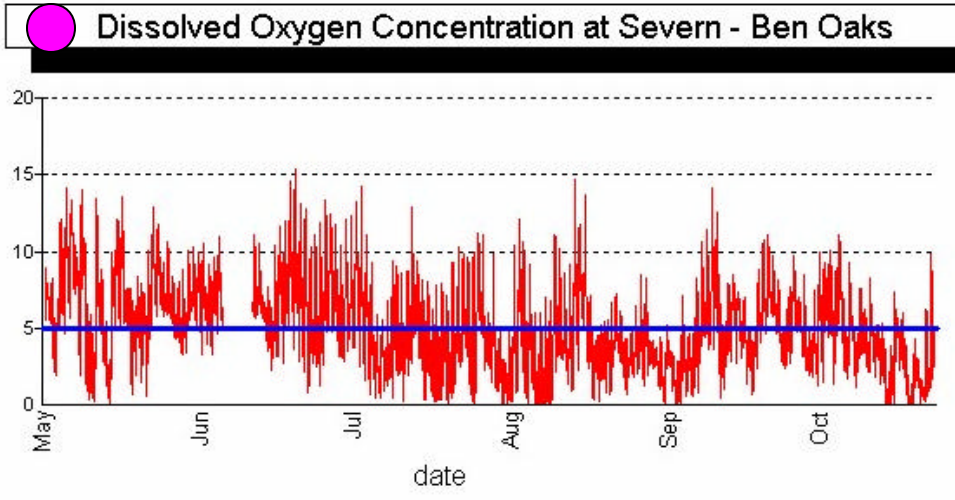
Using New Technologies for Assessing Fish Habitat: Yellow Perch in Western Shore Subestuaries of Chesapeake Bay





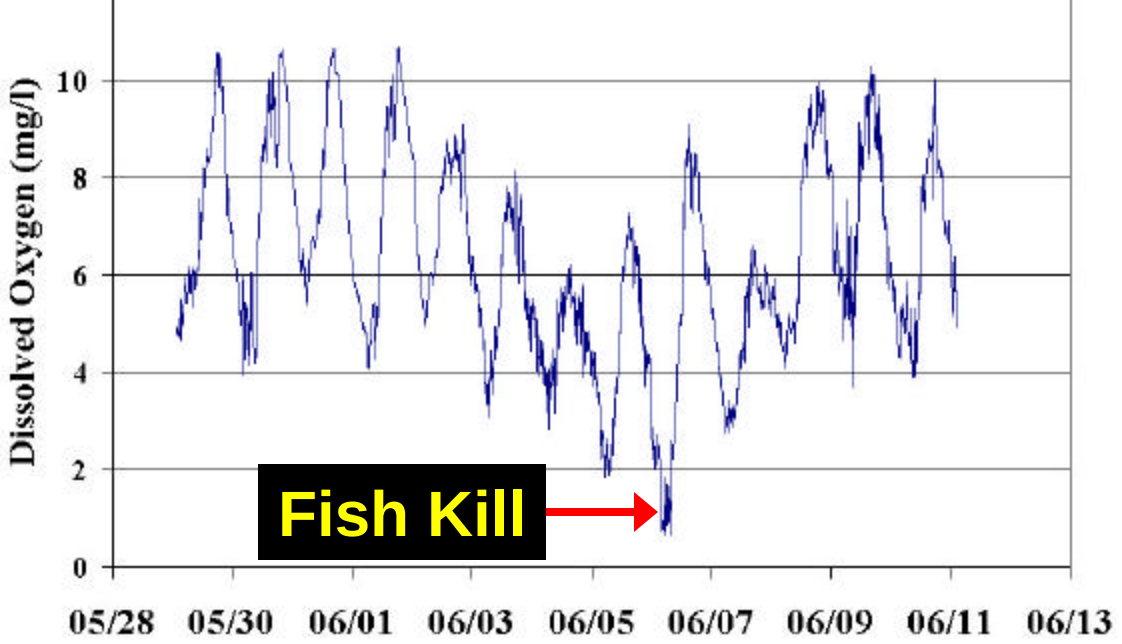


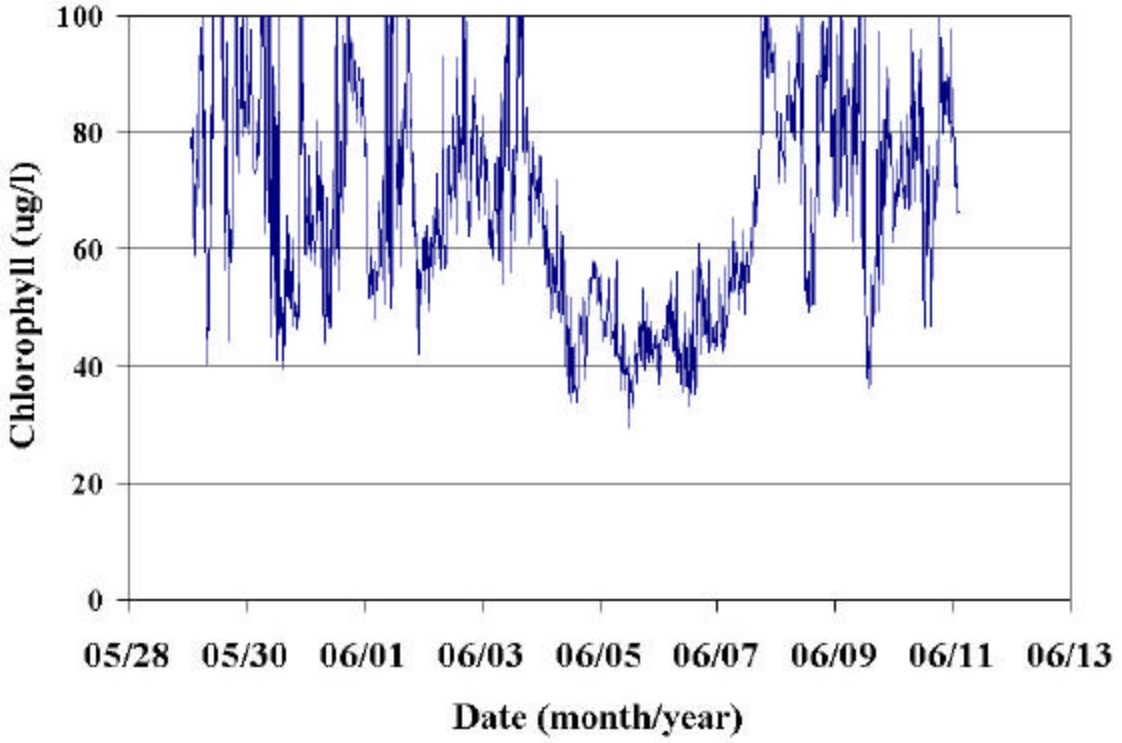




Continuous Monitor Diagnoses Coastal Bays Fish Kill June 6-7, 2002

15,000 Menhaden Reported Dead

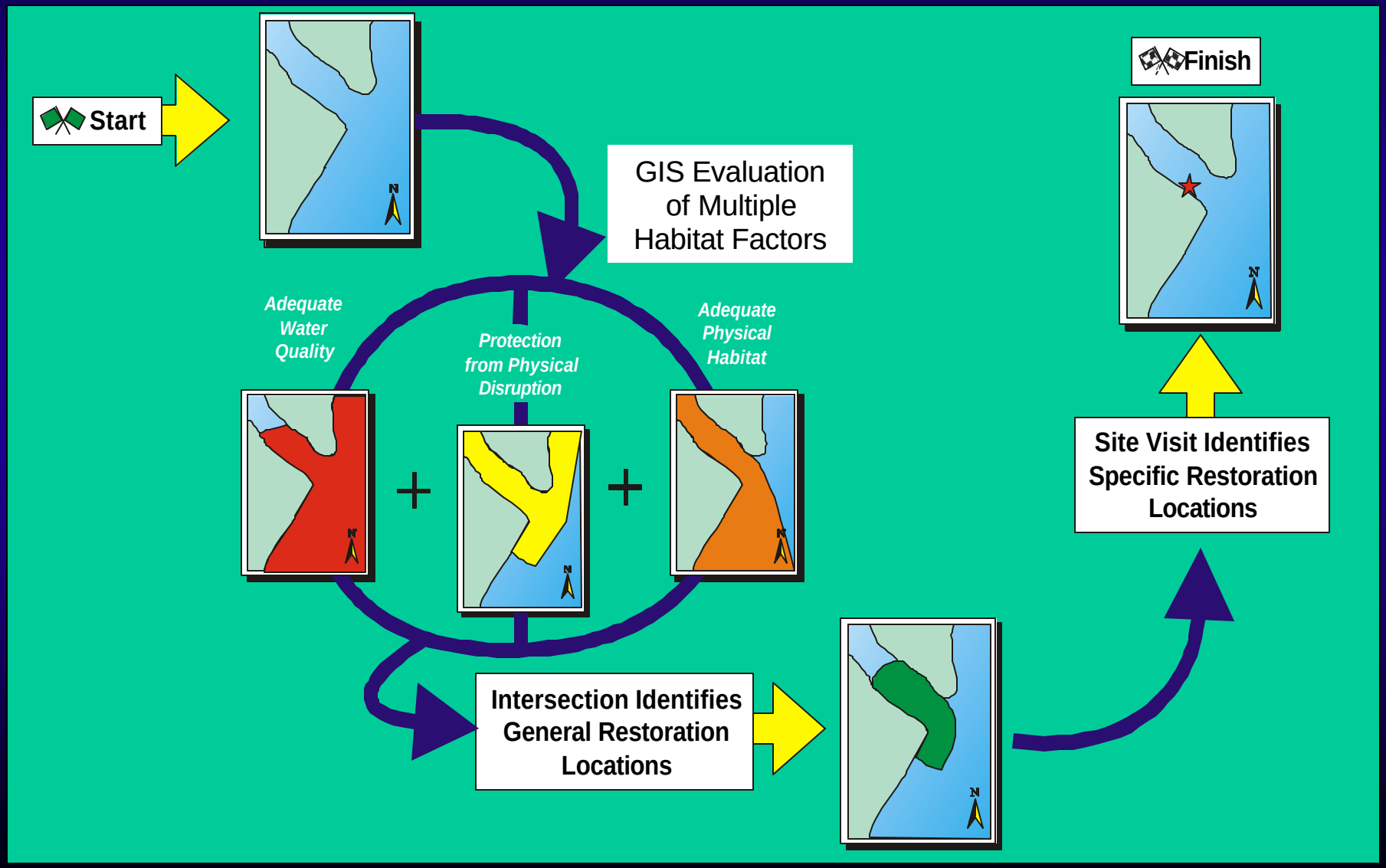




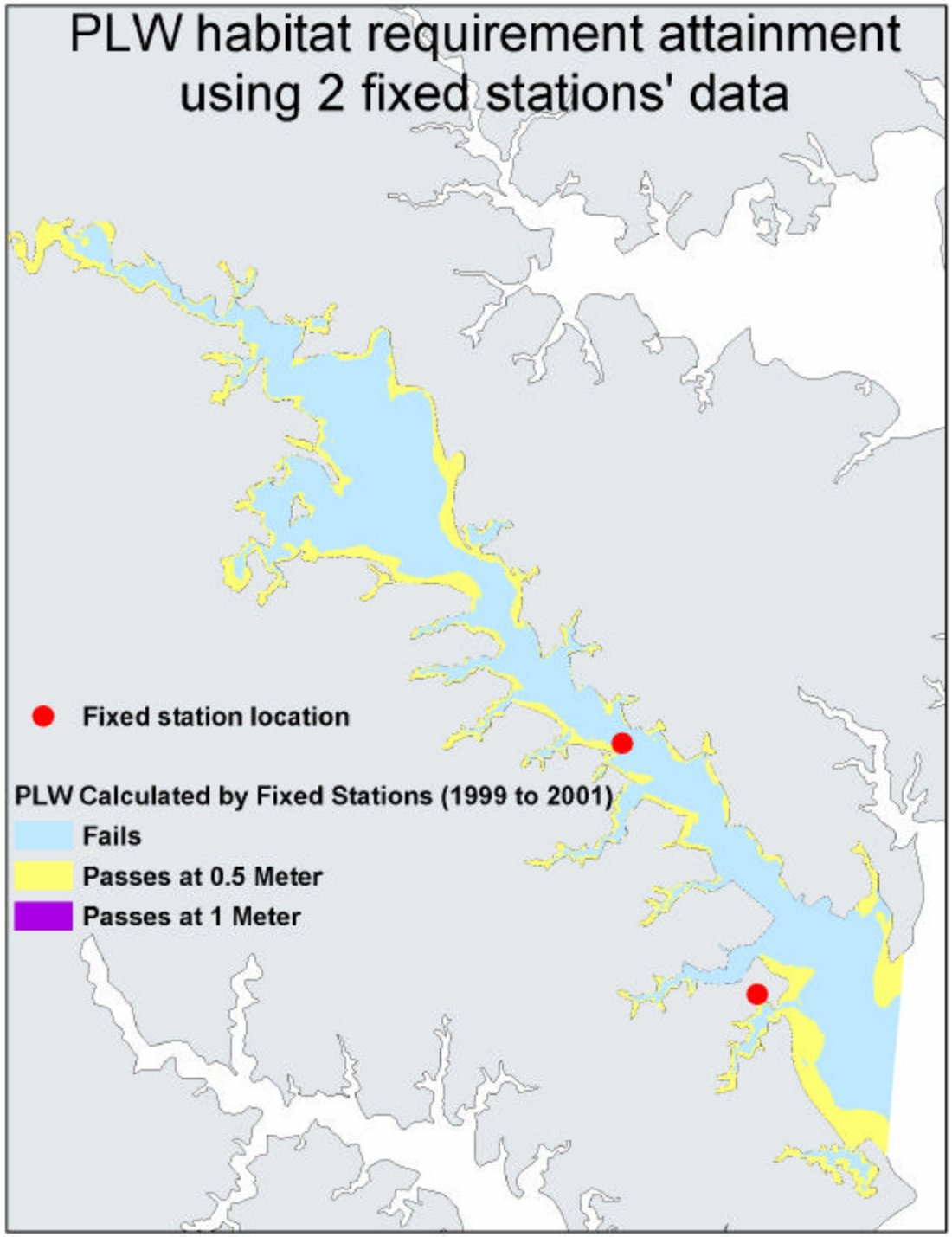
New Bay Goals Call for Restoration of Submerged Aquatic Vegetation - How Do We Find Suitable Sites?

Photo Courtesy of VIMS

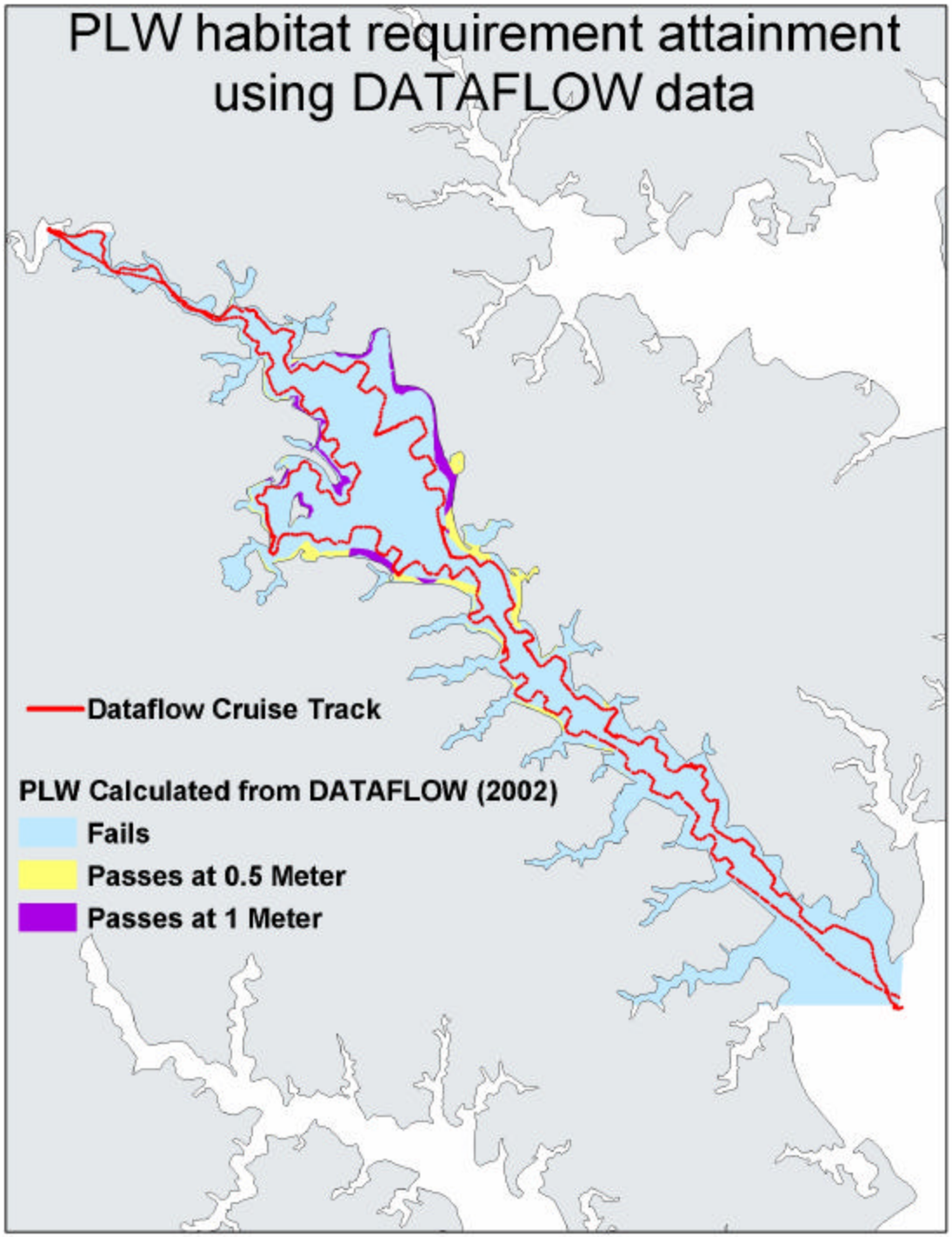
DNR's SAV Restoration Targeting System: New MonitoringTechnologies Greatly Improve Spatial Resolution



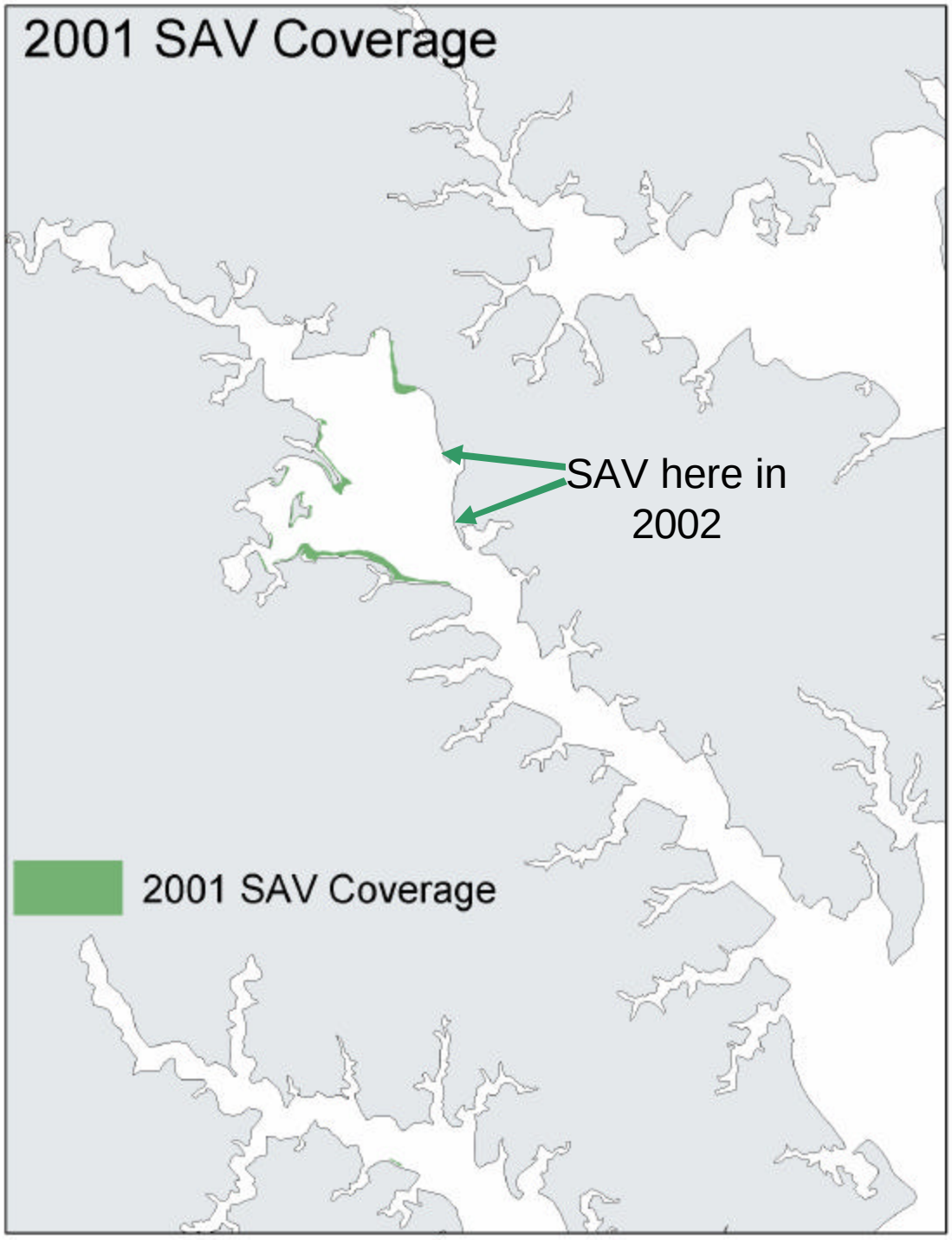
Assessment of SAV Habitat in Severn River Using Existing Monitoring Program



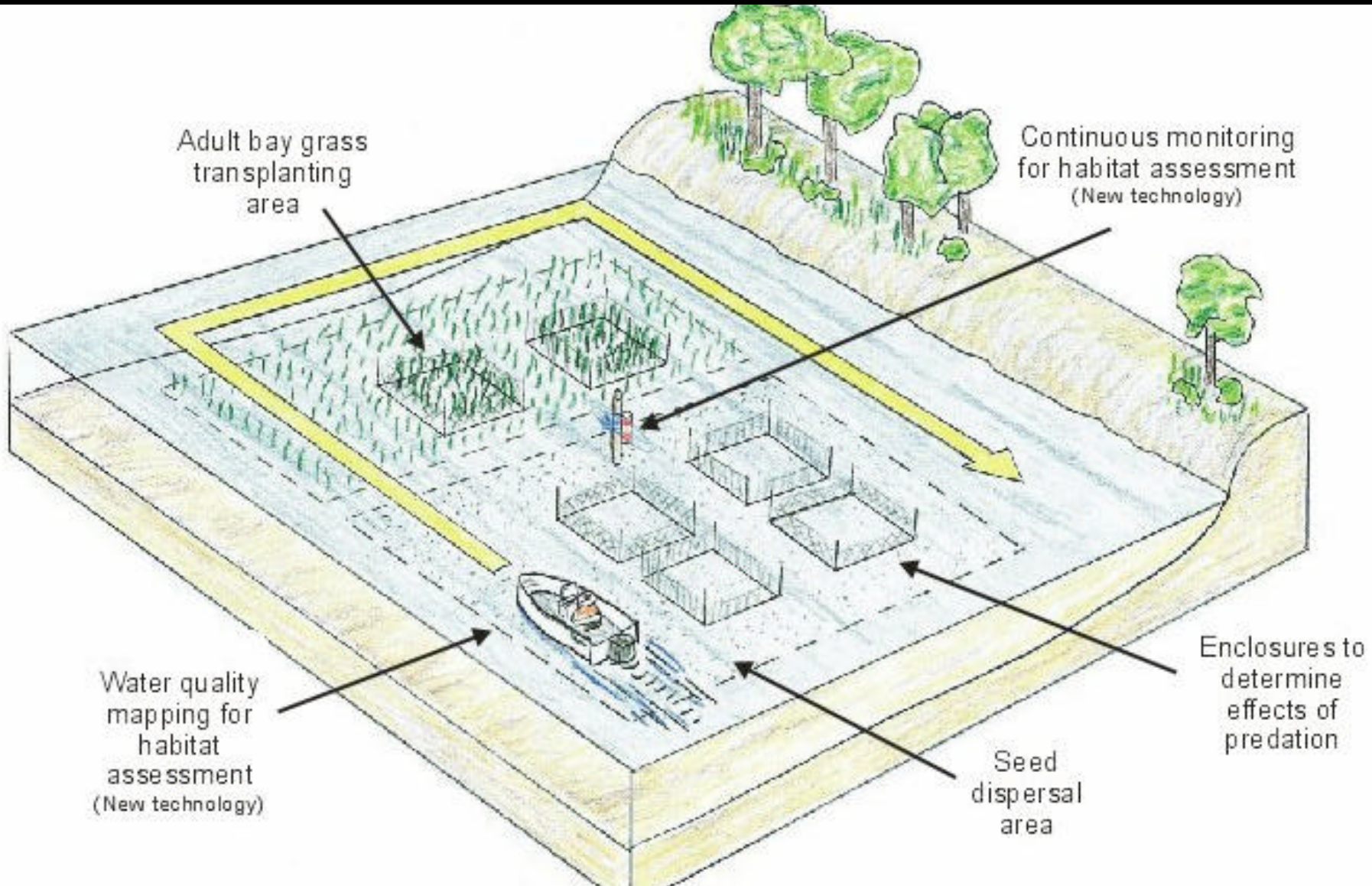
Assessment of SAV Habitat in Severn River Using Water Quality Mapping



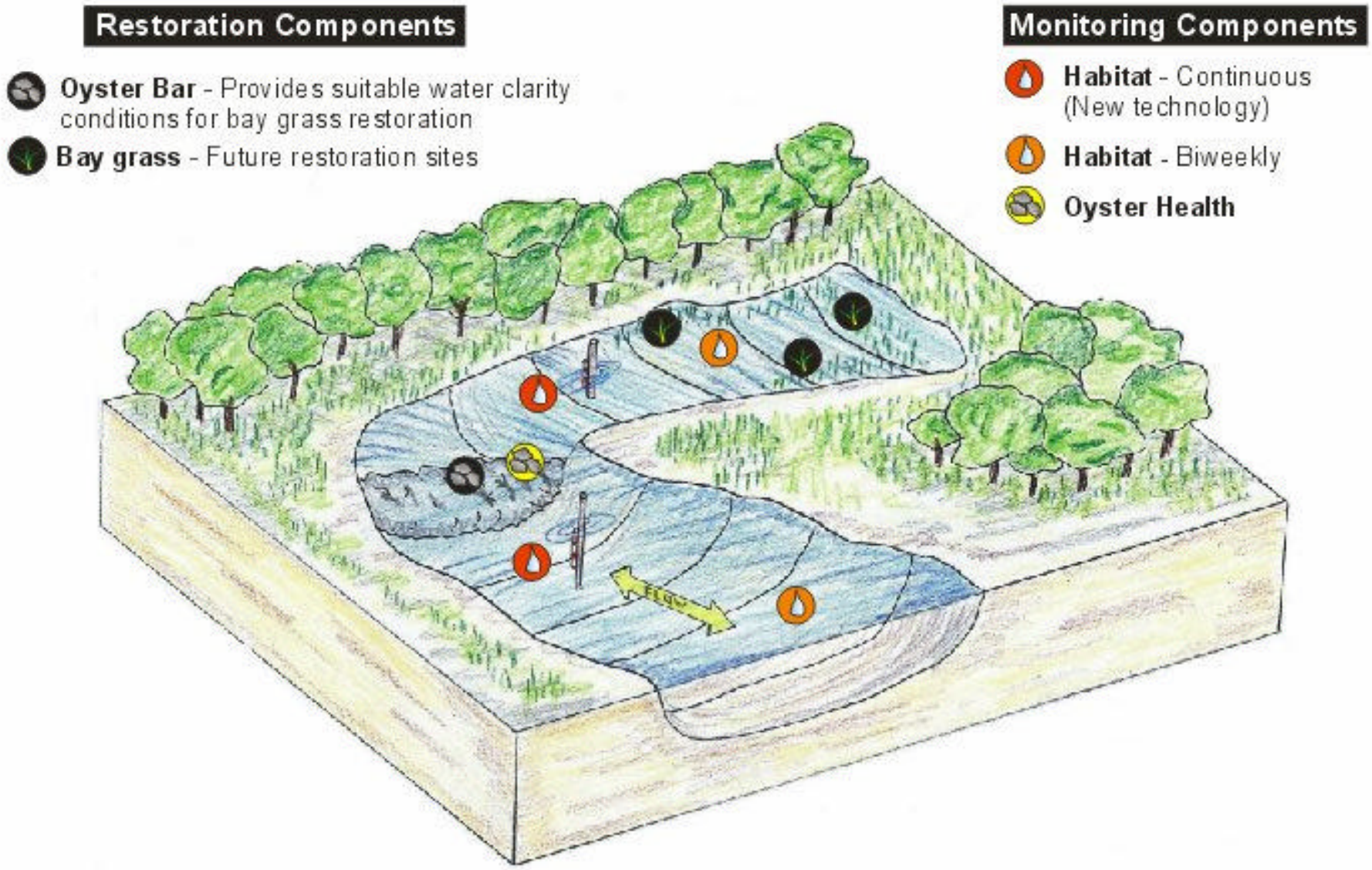
Actual Distribution of SAV in Severn River Closely Matches Habitat Assessment from Water Quality Mapping



New Monitoring Technologies Will Be Used To Select and Monitor Large-Scale SAV Restoration Sites in the Patuxent Estuary in 2003



New Monitoring Technologies Being Used To Evaluate Effects of Oyster Filtration and Suitability of Site for SAV Restoration – Harness Cr., South R.

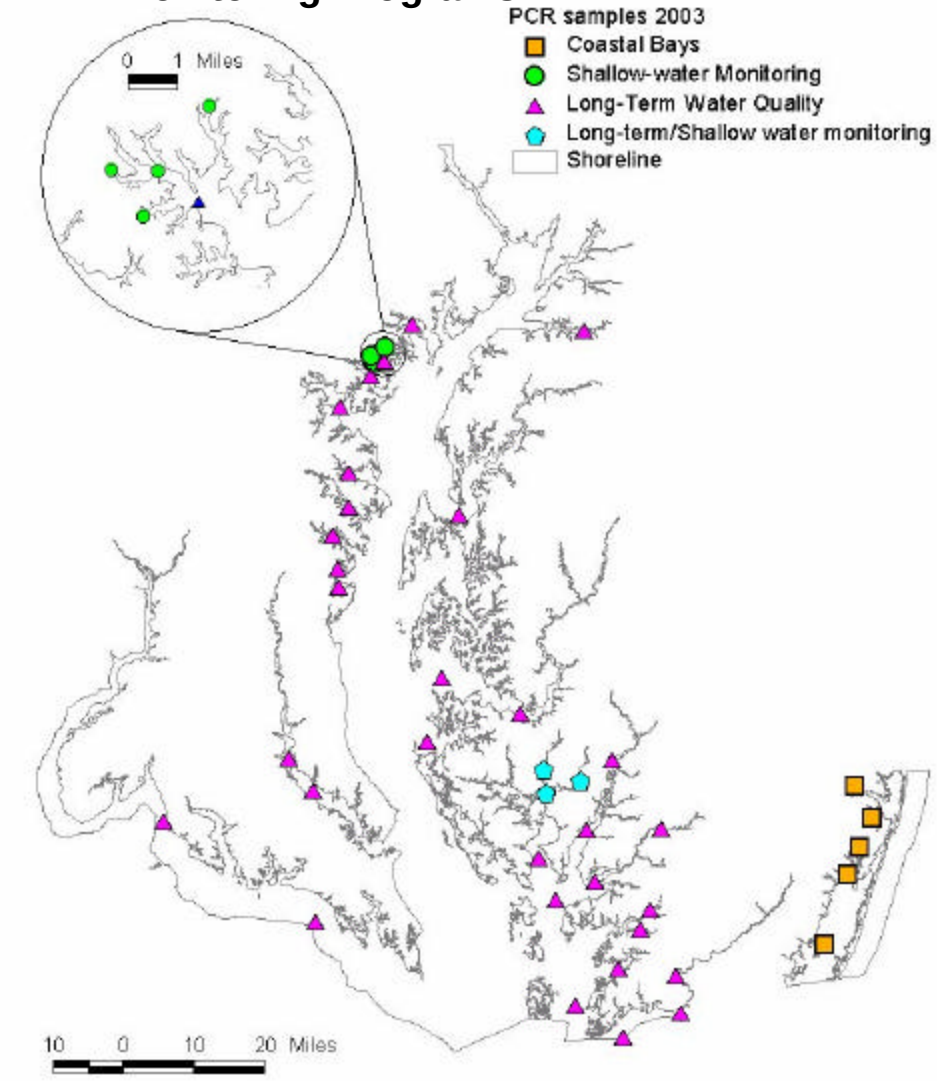


A Look At Where We May Be Going In The Future

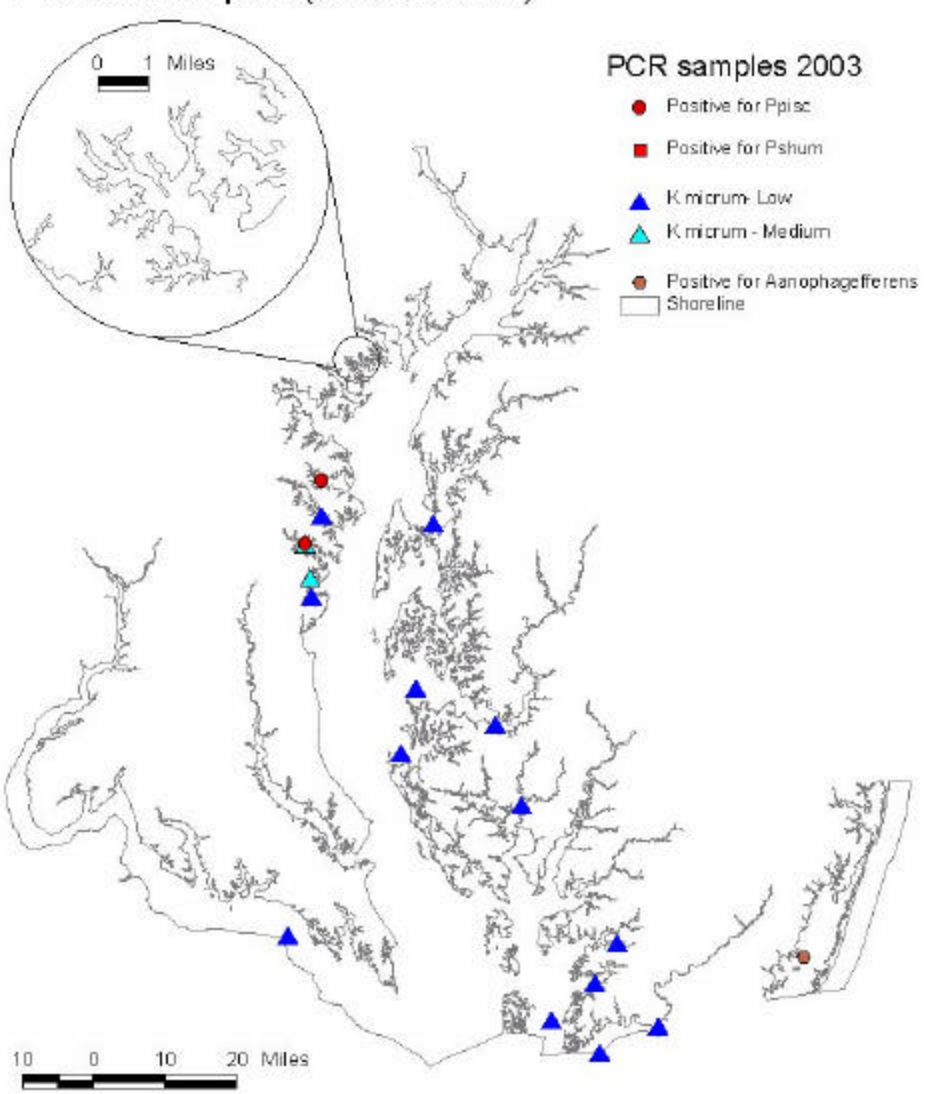
- Utilizing genetic probes for HABs, pathogens, other organisms
- Autonomous underwater vehicles (AUVs)
- Satellite imagery in near real-time
- Expanding use of a range of models, including assimilation of real-time data

Utilizing Genetic Probes For HAB Detection: Becoming Practical For Routine Use

PCR Sampling Sites Integrated Into Routine DNR Monitoring Programs



2003 Water sample PCR results
Positive samples (as of 5/15/03)

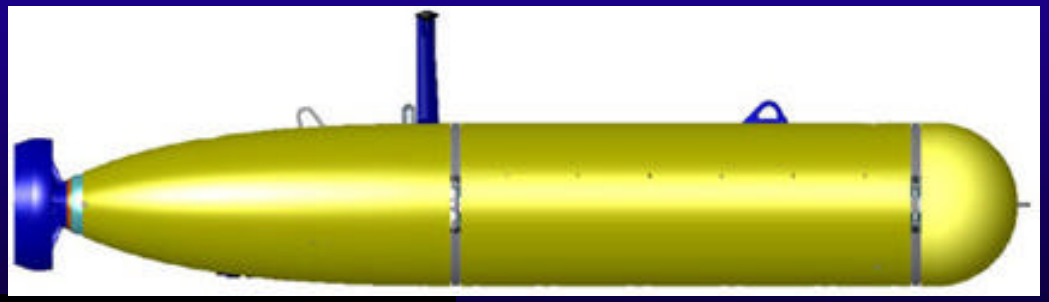


In Situ Sample Processor for HAB Detection Utilizing Sandwich Hybridization

Techniques Such as These May Become Practical for Wider Deployment in Near Future

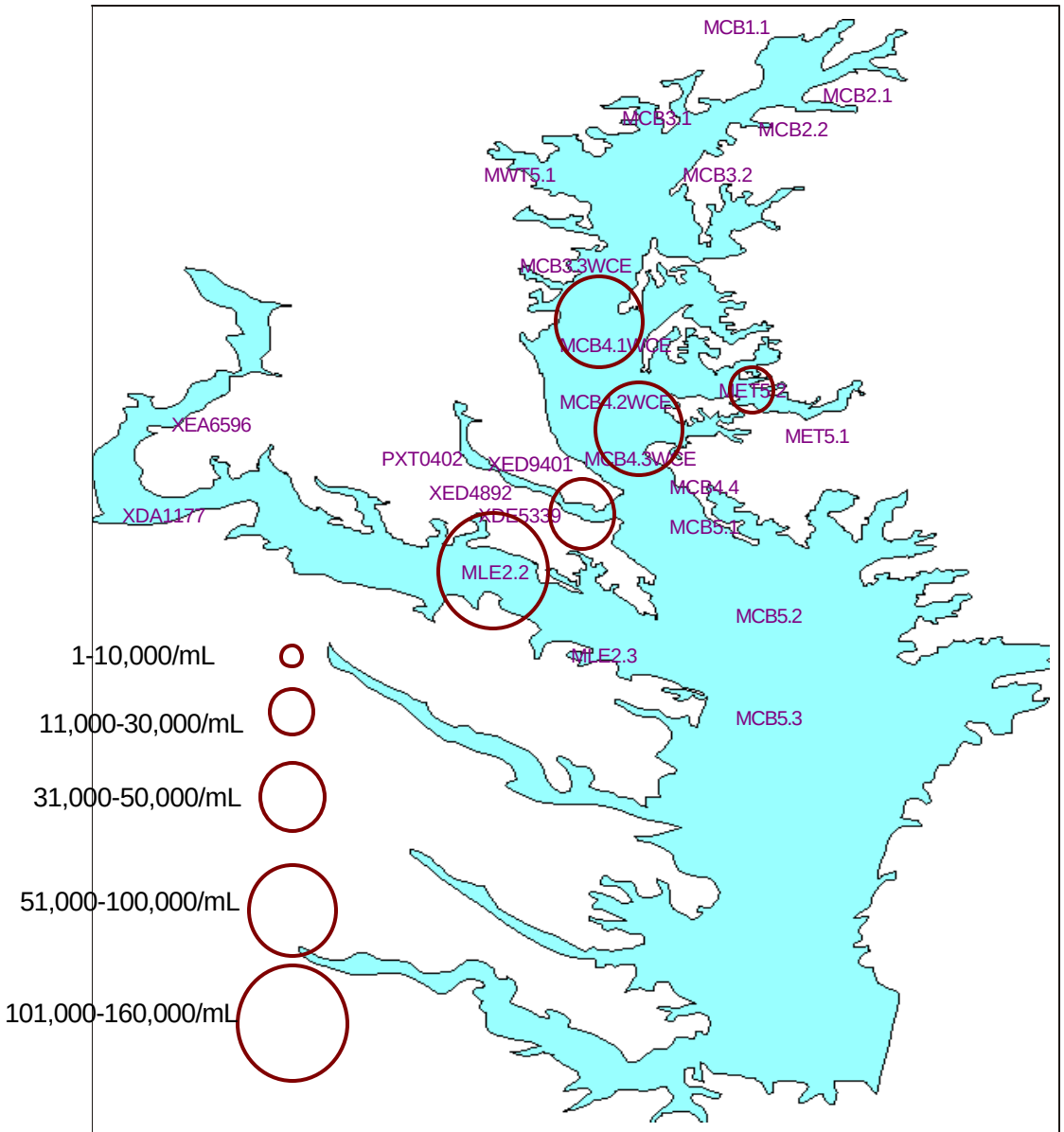
C. Scholin

Autonomous Underwater Vehicles AUVs



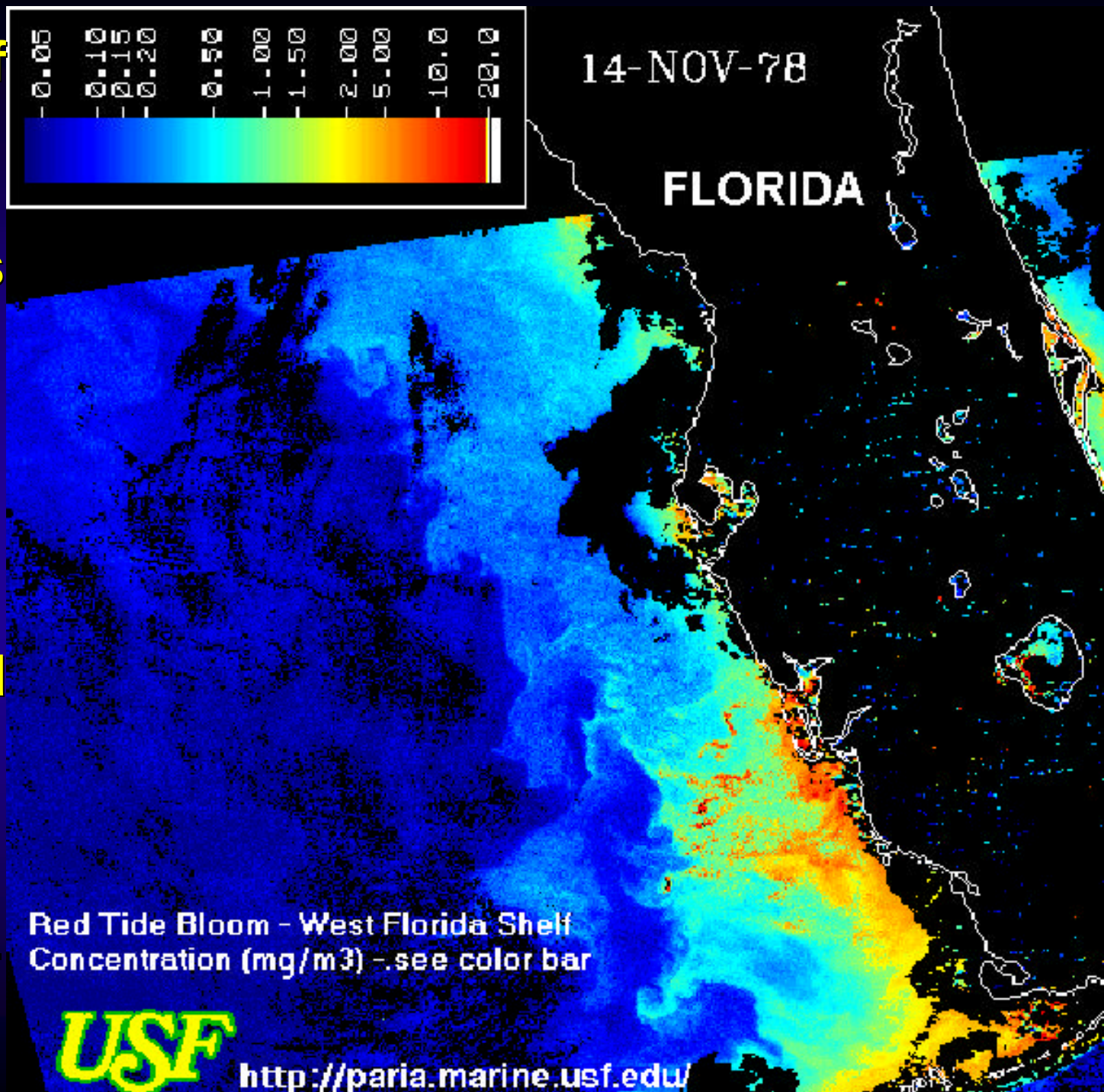
Photos From Web Sites:
MIT Sea Grant AUV Lab
Bluefin

Prorocentrum minimum Bloom, May 2000: The View With Conventional Ship-board Monitoring

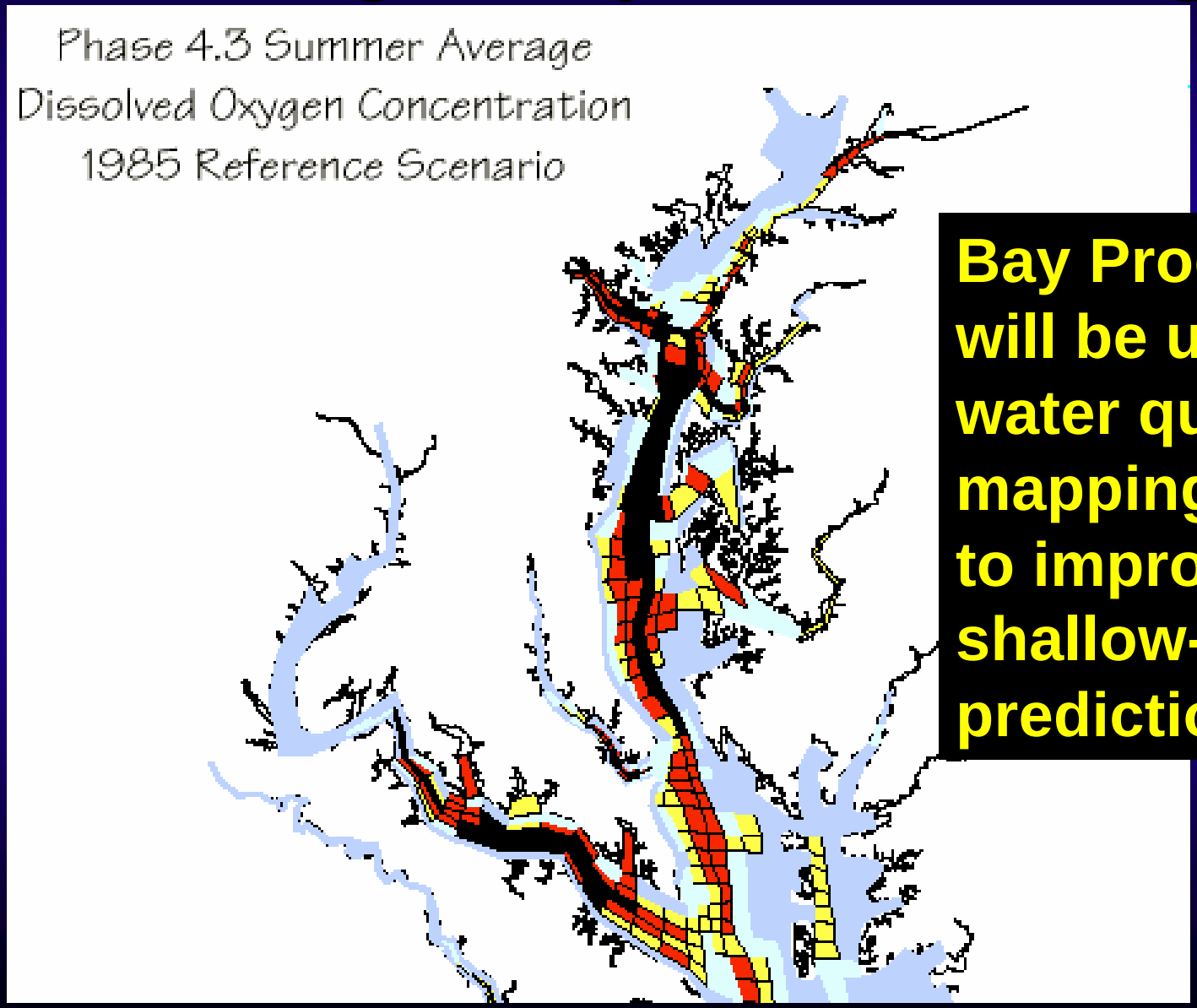


Detection of Spatial Extent of HAB Events Using Satellite Imagery

Need to find ways to obtain this information in near real-time



Using Spatially and Temporally Intensive Monitoring to Improve Modeling Results

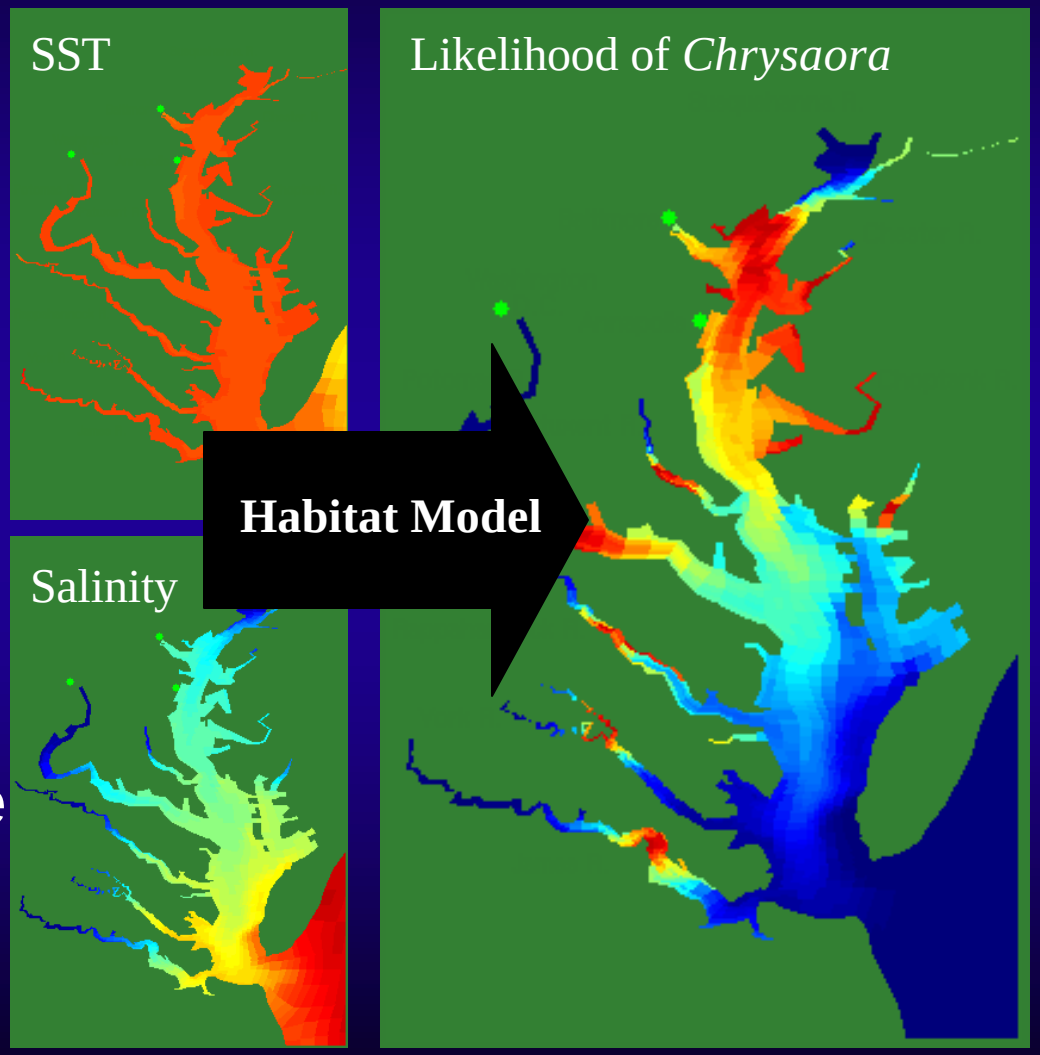


Bay Program will be using water quality mapping data to improve shallow-water predictions

Nowcasting Procedure: Sea Nettles

C. W. Brown, R. R. Hood, T. Gross, Z. Li, M.-B. Decker, J. Purcell, H. Wang

1. Estimate current surface salinity and temperature fields
2. Georeference salinity and SST fields
3. Apply habitat model
4. Generate image illustrating the probable distribution of *Chrysaora*

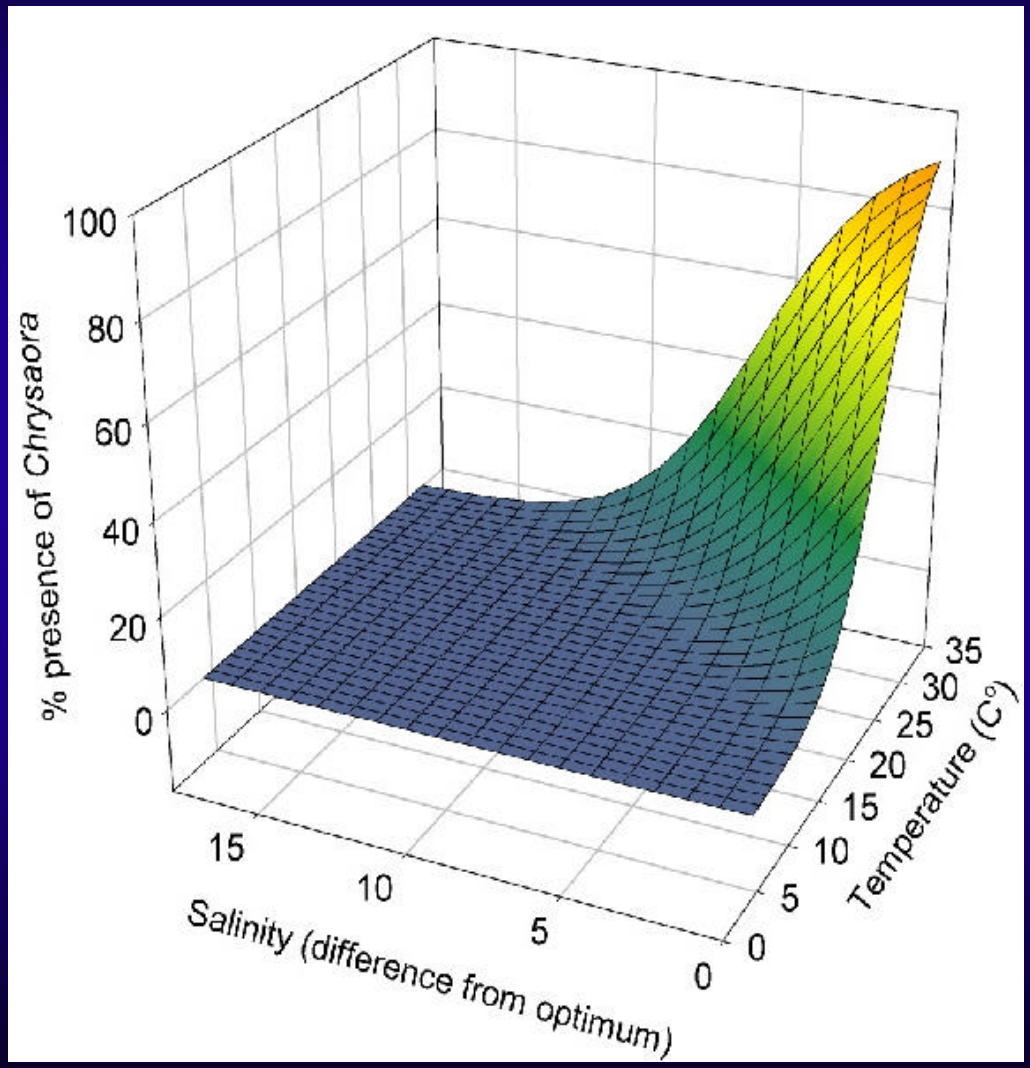


Probability of Encountering Sea Nettles

- Combination of salinity and SST is a good predictor of *Chrysaora* presence
- If SST $\leq$ 34°C:
  - $p = e^{logit} / (e^{logit} + 1)$,

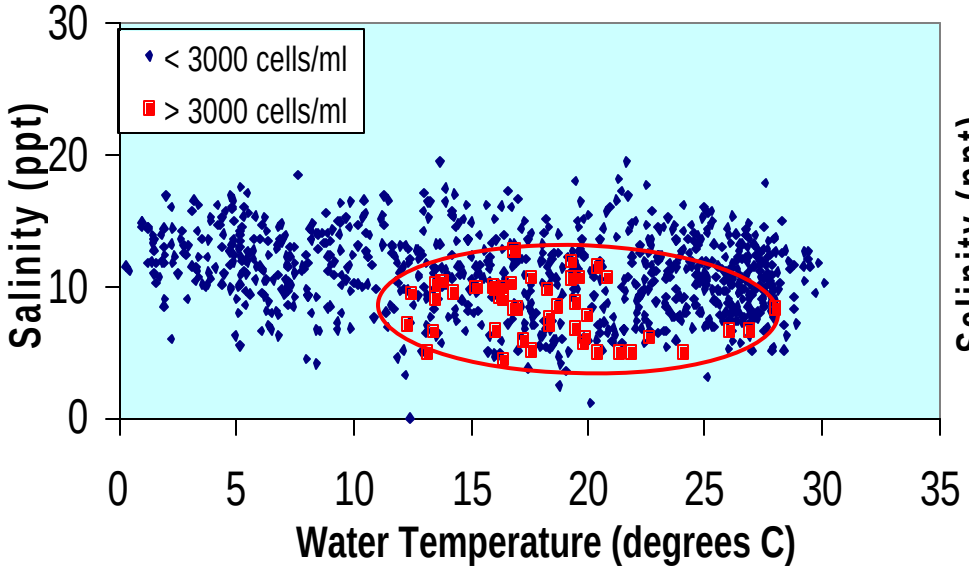
    where,

    logit = -6.995 + (0.30*SST) - (0.469* |SAL - 13.5|)
  - Pearson c^2: $p < 0.001$

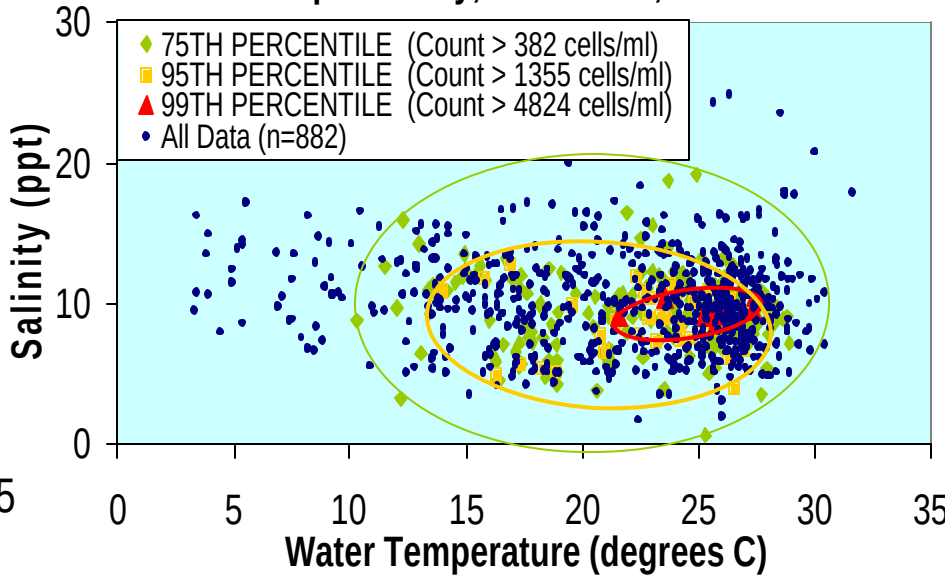


Habitat Preference Models for Phytoplankton Species Can be Used to Adapt Nowcast or Other Models to HABs

Prorocentrum minimum **habitat highlighting conditions favoring blooms > 3000 cells/ml based on salinity and water temperature, n=902.**



Karlodinium micrum **habitat highlighting conditions favoring blooms based on salinity and temperature. Chesapeake Bay, MD. N=882, 1985-2001.**

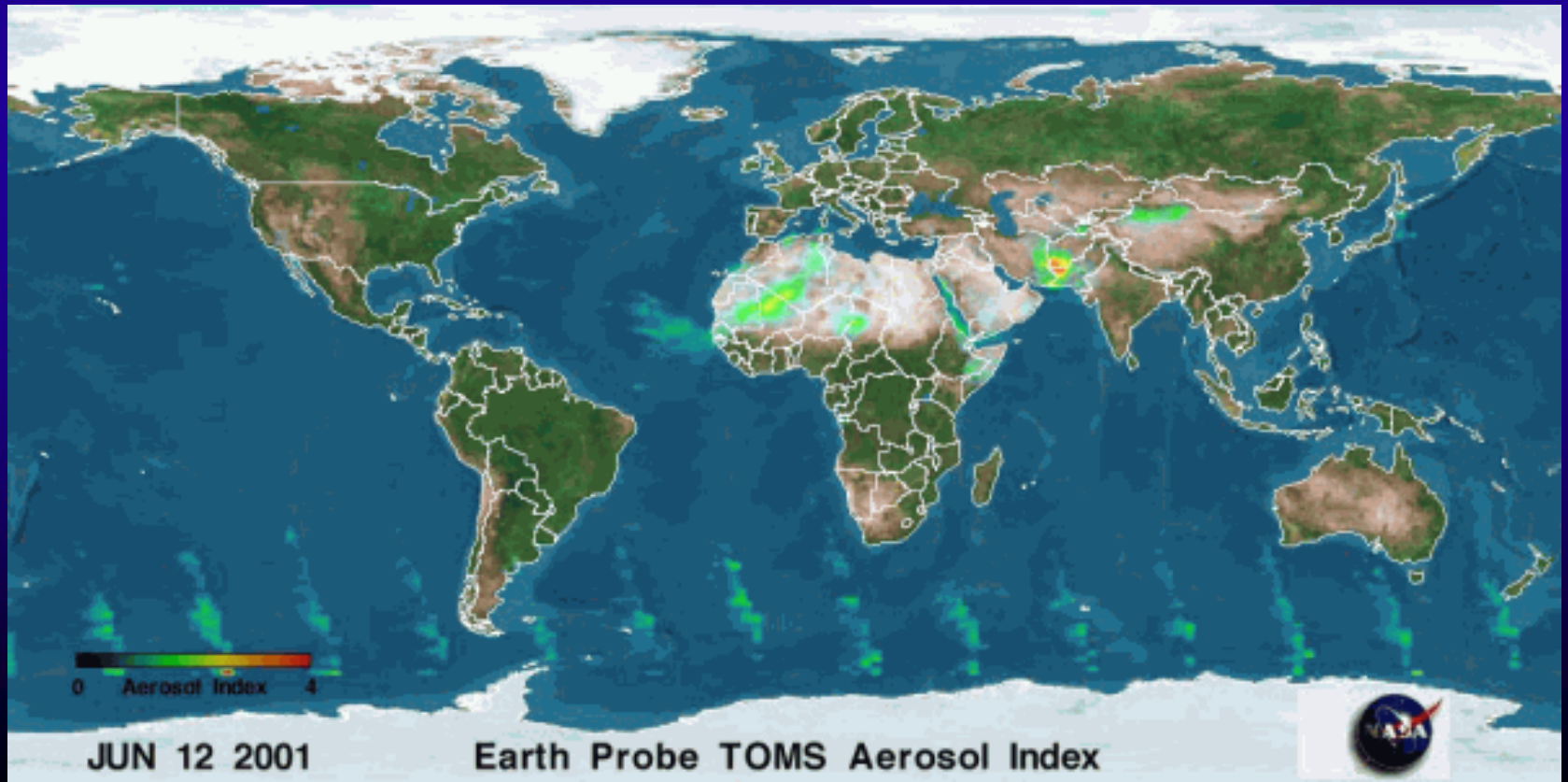


Can We Connect Atmospheric Monitoring & Forecasting, Near Real Time Satellite Data, and *in situ* Sensors to Improve Coastal Zone Predictions?

Saharan Dust Link to Florida Red Tides

Fe in dust>*Trichodesmium*>*K. brevis*

Lenes et al. *L & O* 46:1261–1277



Summary: New Monitoring Technologies Bring New Opportunities for Science-Based Management Decisions in the Coastal Zone

- New monitoring technologies have documented previously unrecognized water quality impairments in critical shallow-water habitats and increased understanding of processes
- New monitoring technologies provide temporally and spatially intensive monitoring needed to address new criteria and standards
- Temporally and spatially intensive monitoring tools can provide more thorough assessment of fish habitat

Summary: New Monitoring Technologies Bring New Opportunities for Science-Based Management Decisions in the Coastal Zone

- Real-time data acquisition can be used for:
  - HAB detection and impacts
  - fish kill diagnoses
  - evaluation of unusual events
  - data assimilation modeling
  - educational purposes
- New monitoring technologies provide critical data for coastal restoration site selection and evaluation

Summary: New Monitoring Technologies Bring New Opportunities for Science-Based Management Decisions in the Coastal Zone

- Genetic probes ready for routine use; expect rapid progress in field-based detection
- Spatially and temporally intensive data coupled with real-time availability could greatly improve predictive modeling skill
- Finding the right match between management need and new technologies will drive broader application