



Chesapeake Bay Program
A Watershed Partnership

Details of DO Criteria

Peter Tango

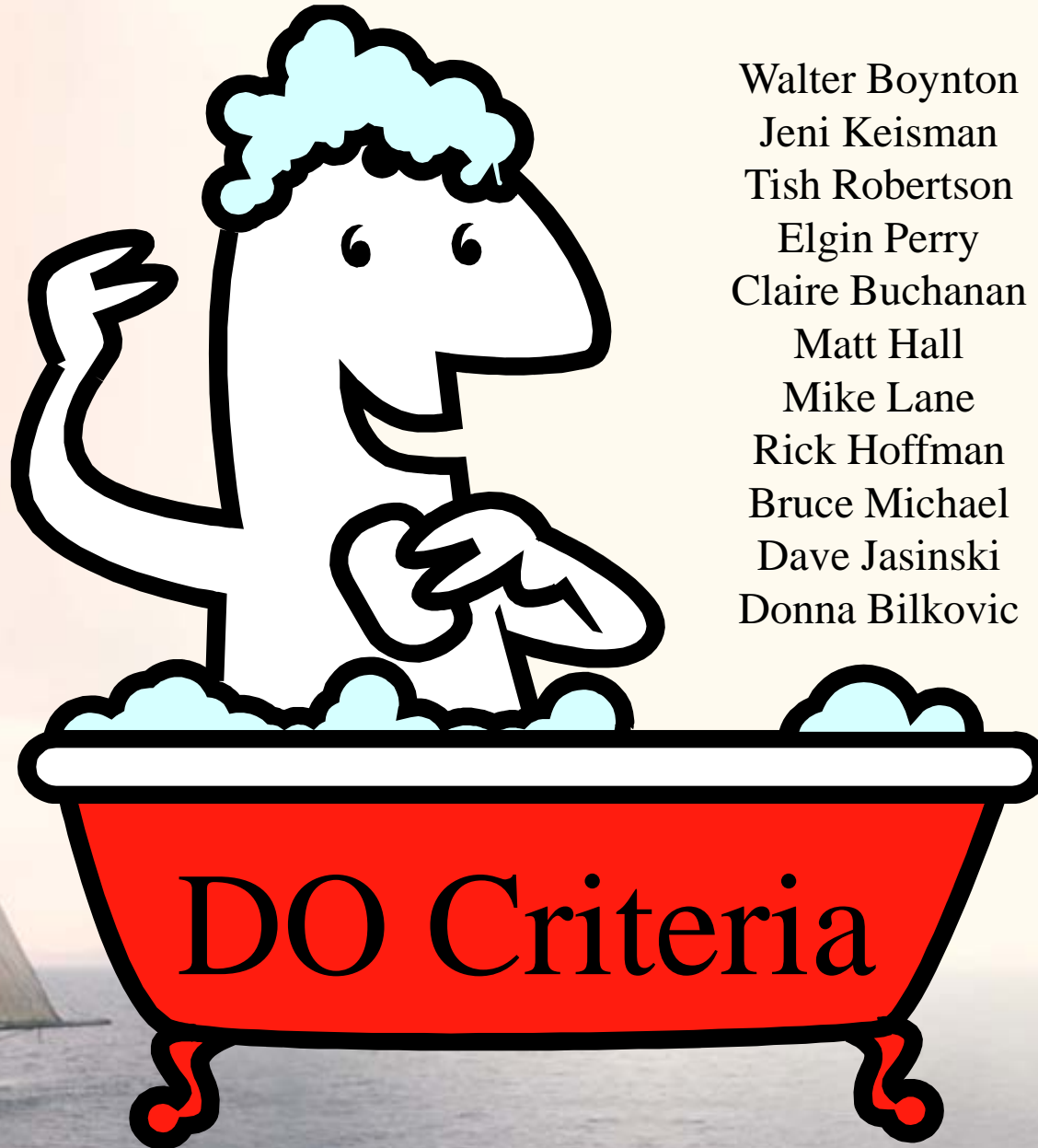
USGS@ EPA Chesapeake Bay Program Office

March 16, 2011

Umbrella Criteria Action Team



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Partners Commitment to Restored Bay Water Quality



“By 2010, correct the nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries...”

What is the water quality of a restored Bay?



What Do We Want to Achieve?



DNR PHOTO BY
ANGEL BOLINGER

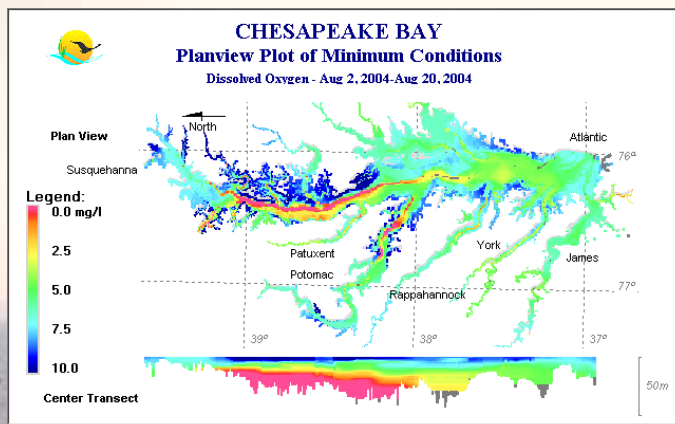


Water quality that supports abundant fish, crabs, oysters and underwater grasses in the Bay and its rivers.

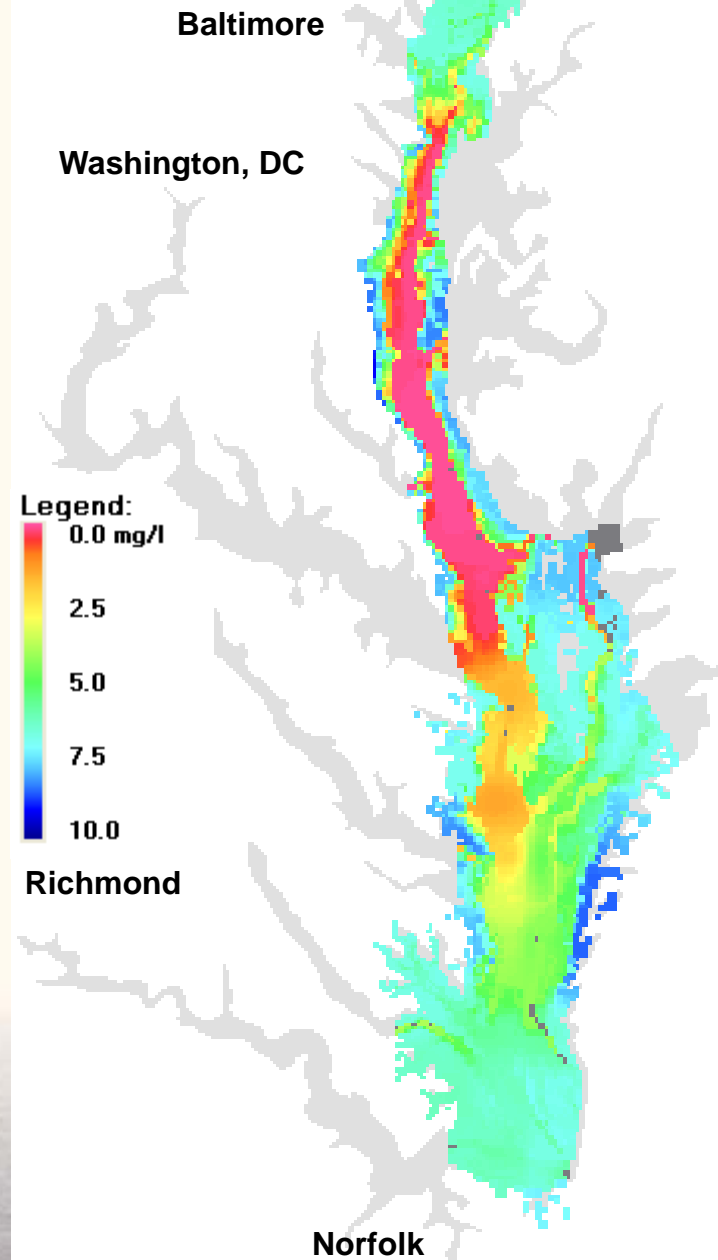


Where are we now?

Extensive low to no dissolved oxygen conditions persist throughout the Chesapeake Bay



June 2005 Bottom
Dissolved Oxygen



Bay Dissolved Oxygen Criteria

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

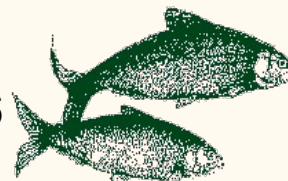


Migratory Fish Spawning & Nursery Areas

6



Striped Bass: 5-6



American Shad: 5

Shallow and Open Water Areas

5



White Perch: 5



Yellow Perch: 5

4



Hard Clams: 5



Alewife: 3.6

Deep Water

3



Crabs: 3



Bay Anchovy: 3

2

Deep Channel

1



Spot: 2



Worms: 1

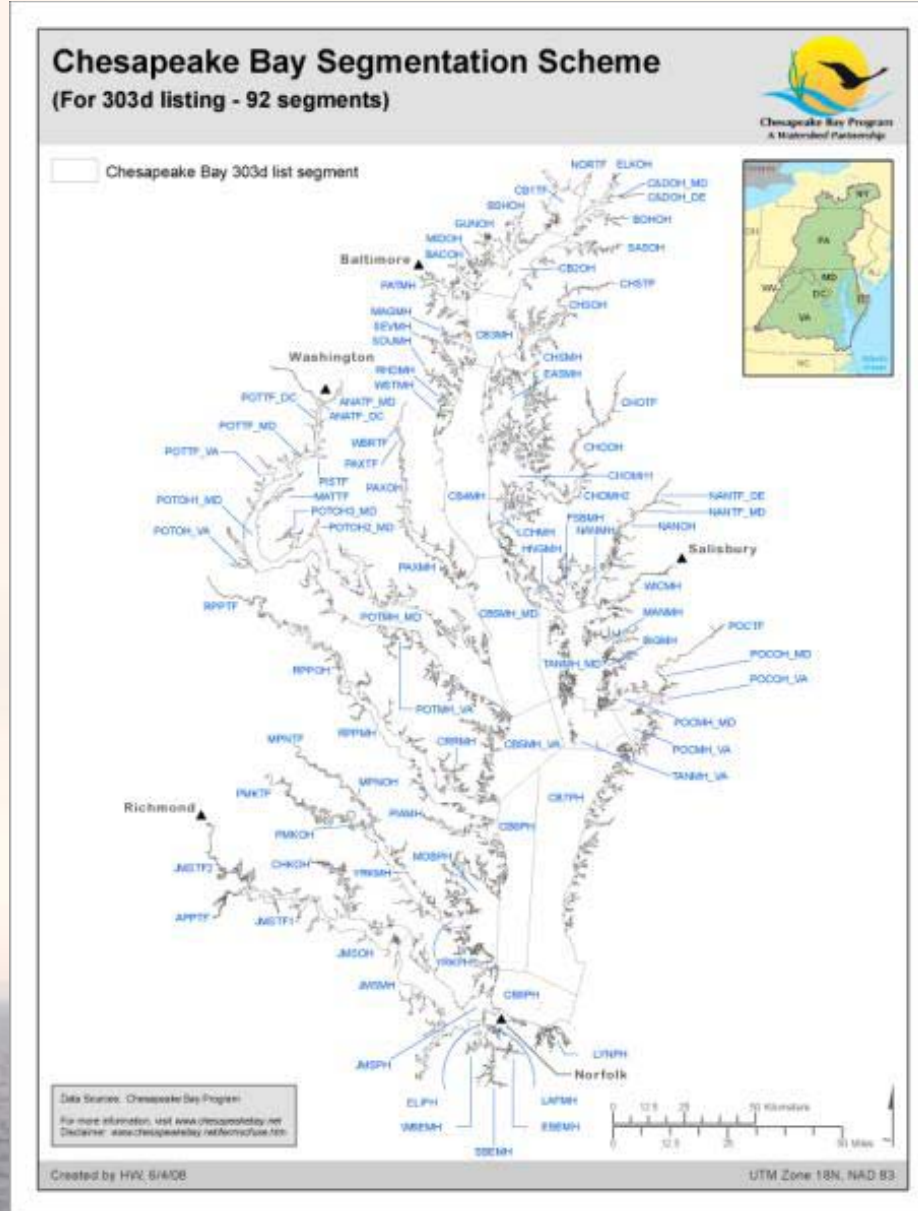
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92 Chesapeake Bay Management Segments



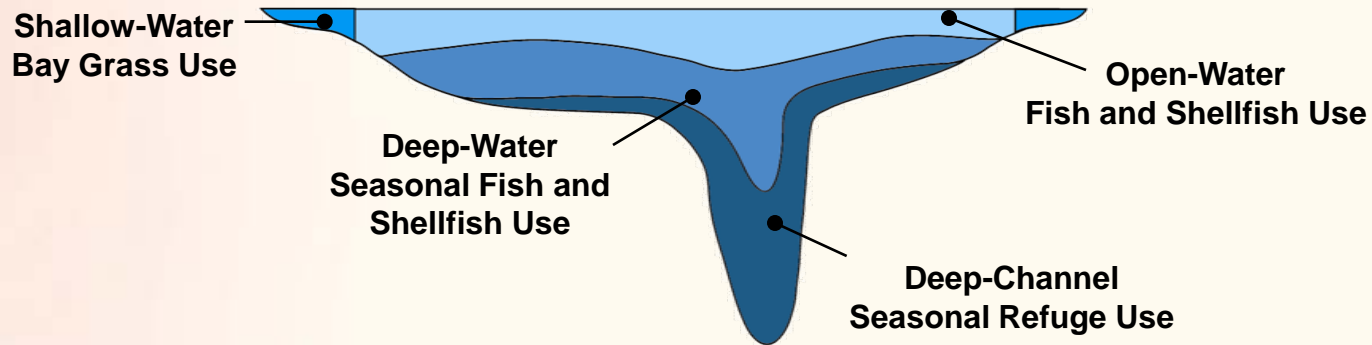
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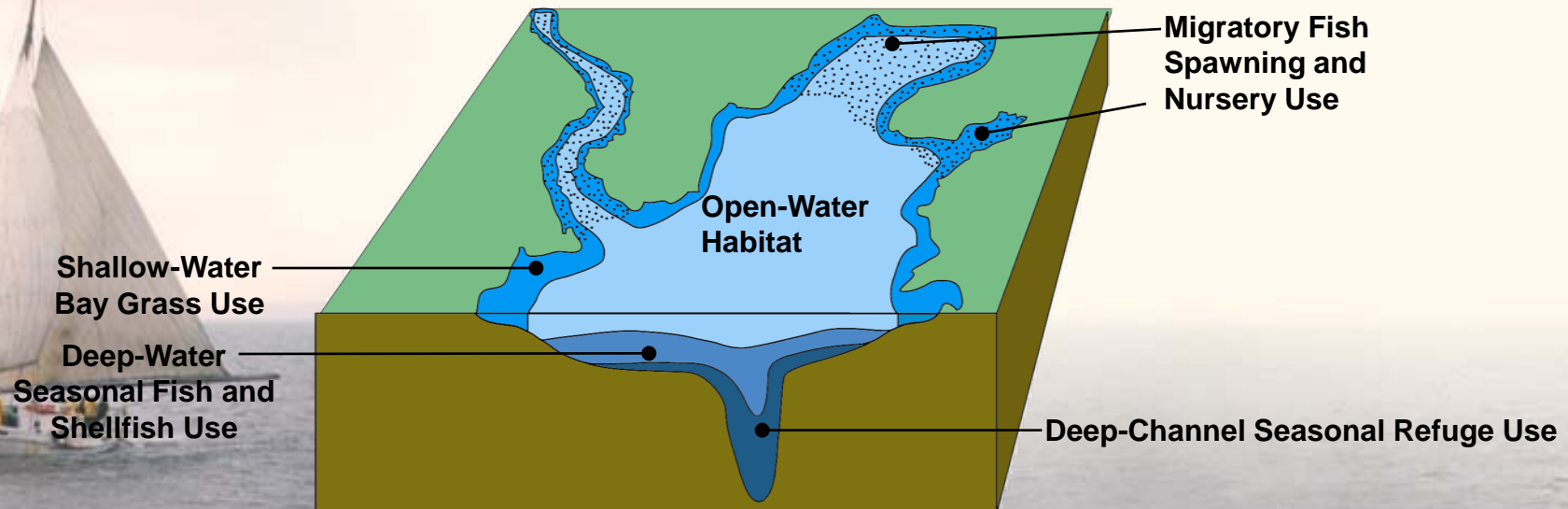
Spatial criteria considerations: Refined Designated Uses for the Bay and Tidal Tributary Waters



A. Cross Section of Chesapeake Bay or Tidal Tributary



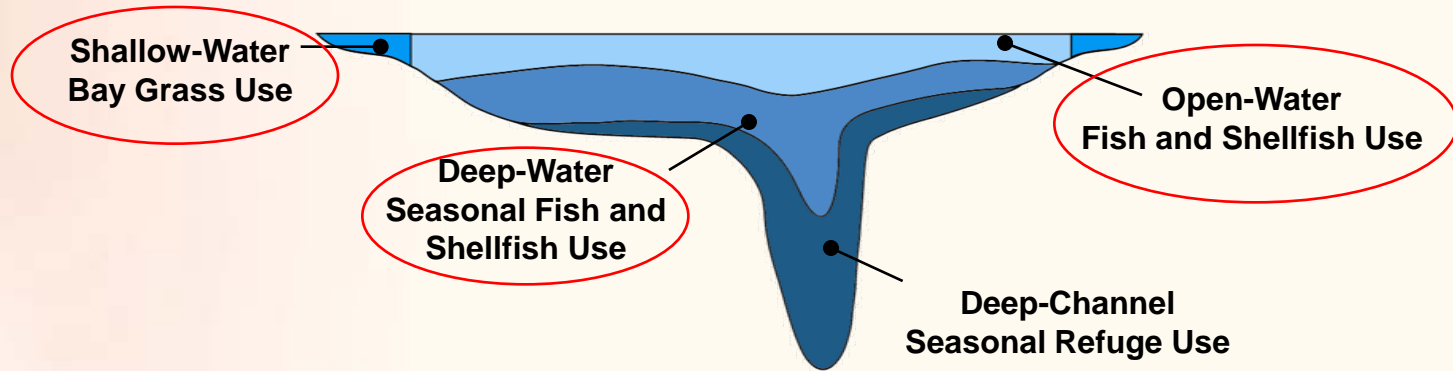
B. Oblique View of the “Chesapeake Bay” and its Tidal Tributaries



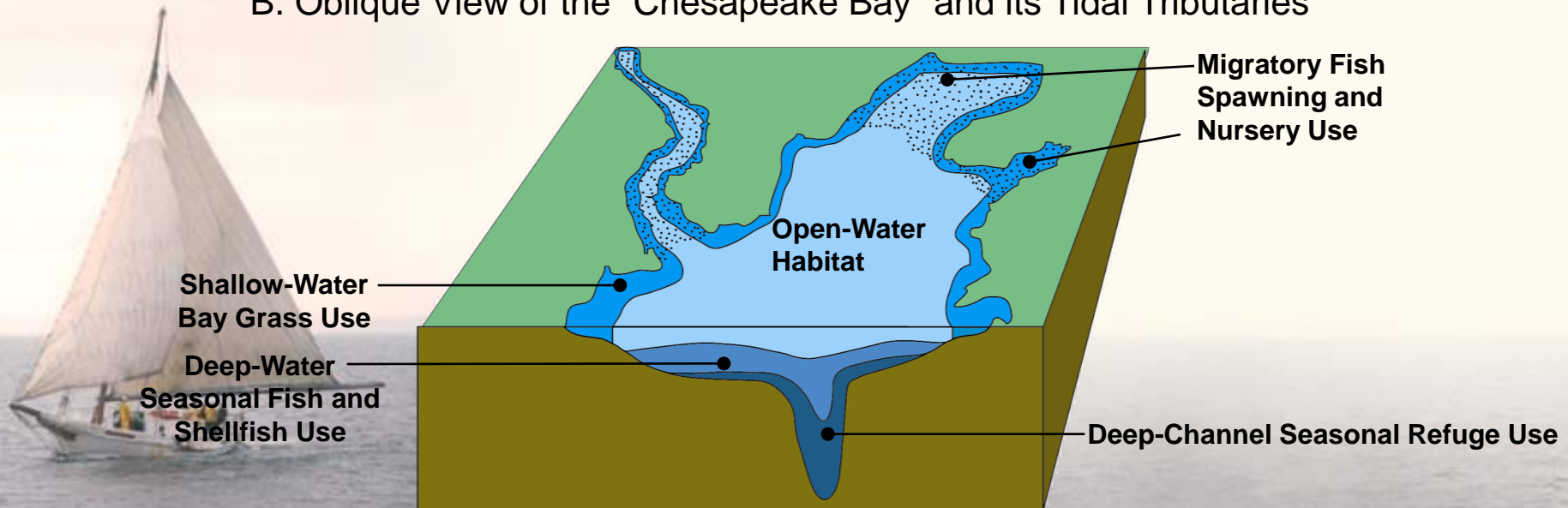
Spatial criteria considerations: Refined Designated Uses for the Bay and Tidal Tributary Waters



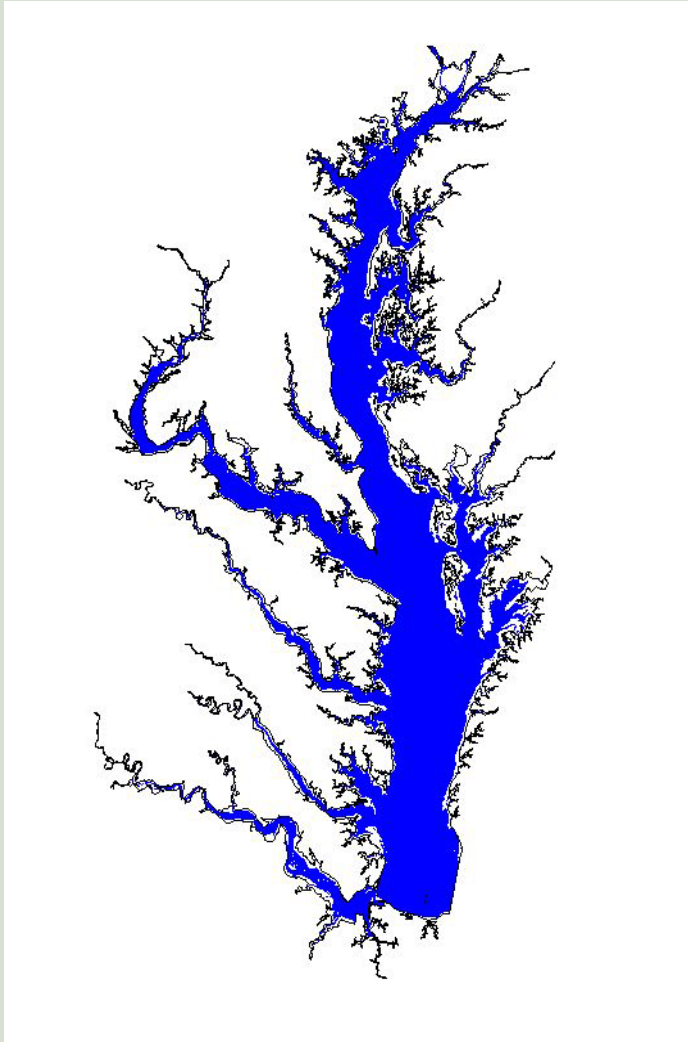
A. Cross Section of Chesapeake Bay or Tidal Tributary




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



Temporal Criteria Considerations: Seasonal Application Due to Stratification



 **Open-Water Habitat October - May**

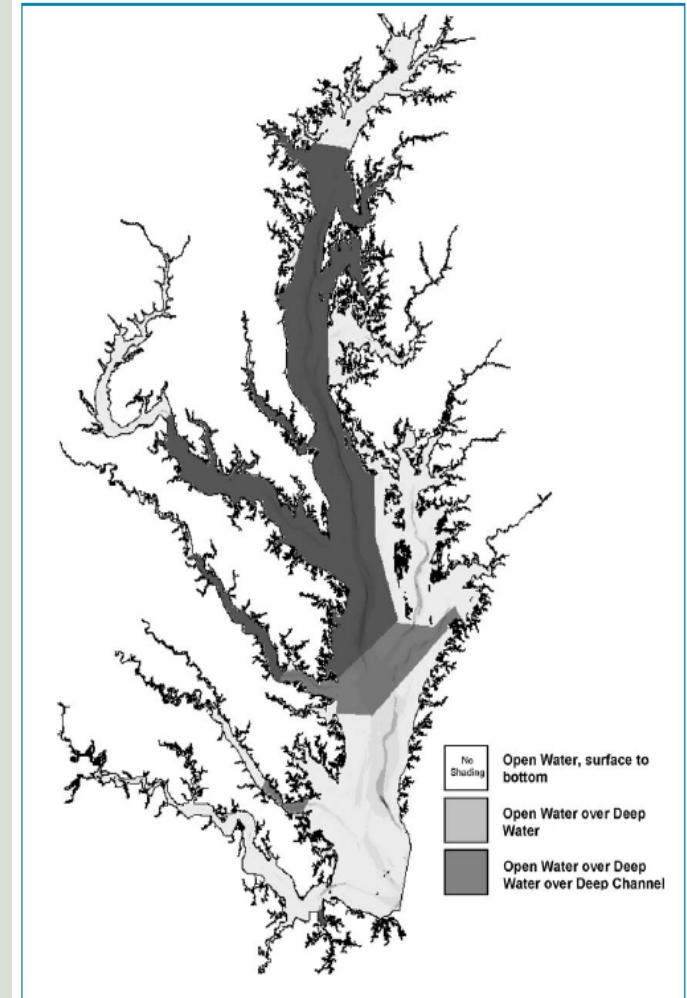


Figure IV-23. Map showing the dissolved oxygen designated uses of the Chesapeake Bay and its tidal tributaries.

**Open-Water/Deep-Water/Deep Channel uses
June - September**

Temporal Considerations

Examples: Duration and Magnitude

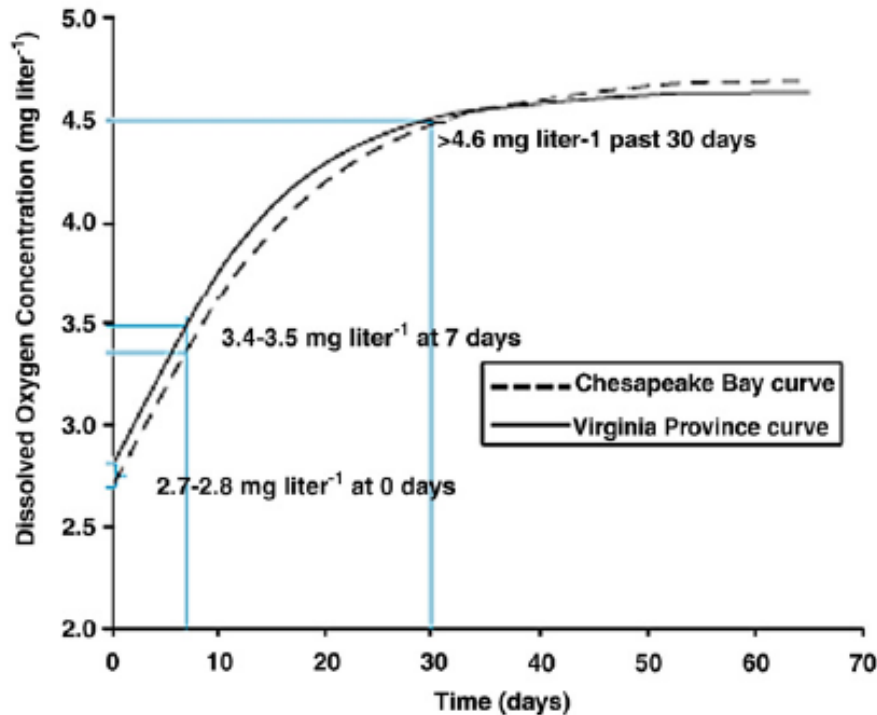


Fig. 3. Comparison of the Virginia Province-wide and Chesapeake Bay-specific larval recruitment effects curves (U.S. EPA, 2000, 2003a). Each line indicates concentrations reducing larval recruitment by 5% of the total population. Plots were generated using the larval recruitment model described in the Virginia Province document (U.S. EPA, 2000). The model is a discrete time, density-independent model that expresses the cumulative impact of low DO as a proportion of the potential annual recruitment of a species. The model accounts for both the magnitude and duration of a hypoxic event.

Table 2
Dissolved oxygen effects data used in the derivation of the migratory fish spawning and nursery designated use dissolved oxygen criteria to ensure protection against adverse effects on survival, growth and larval recruitment.

Criteria components	Concentration (mg L ⁻¹)	Duration	Source
Protection against growth effects	>4.8	-	U.S. EPA (2000)
Protection against larval recruitment effects	>4.6	30 to 40 days	U.S. EPA (2000)
	>3.4-3.8	7 days	U.S. EPA (2000)
Protection of early life stages for resident tidal freshwater species	>2.7-2.8	Instantaneous minimum	U.S. EPA (2000)
	>6	7-day mean	U.S. EPA (1986)
	>5	1-dawn min.	U.S. EPA (1986)
Protection against effects on threatened/endangered species (shortnose sturgeon)	>5	30 days	Secor and Niklitschek (2001, 2002); Niklitschek (2001); Secor and Gunderson (1998); Jenkins et al. (1993);
	>3.5	6 h	Campbell and Goodman (2004)
	>3.2 ^a	2 h	Campbell and Goodman (2004)
	>4.3 ^b	2 h	Campbell and Goodman (2004)
Additional published findings			
Growth effects on striped bass	<3 to 4	-	Brandt et al. (1998); Chittenden (1971b); Bradford et al. (1968); O'Malley and Boone (1972);
Protect eggs hatching	>5	-	Marcy and Jacobson (1976); Harrell and Bayless (1981); Jones et al. (1988)
Survival/growth of larvae, juveniles	>5	-	Tagatz (1961); Bogdanov et al. (1967); Krouse (1968); Bowker et al. (1969); Chittenden (1969, 1971a,b, 1973);
			Meltrin et al. (1974); Rogers et al. (1980); Miller et al. (1982); Coustan (1985); Jones et al. (1988)
Intermediate striped bass survival	>3	72 h	Krouse (1968)
Full survival	>5	72 h	Krouse (1968)
Preferred concentrations	>6	-	Hawkins (1979); Christie et al. (1981); Rothschild (1990)

^a Protective of shortnose sturgeon at non-stressful temperatures.
^b Protective of shortnose sturgeon at stressful temperatures (>29 °C).

Open water

Protection juv/adult survival (USEPA2000)
>2.3 mg/L 24h

Protection for resident tidal freshwater spp.
(USEPA 1986):

>5.5 mg/L

30 days

>4 mg/L

7 days

>3 mg/L

instantaneous min

Designated Use	Dissolved oxygen Criteria Concentration/Duration		Temporal Application
Migratory fish spawning and nursery use	7-day mean ≥ 6 mg/L tidal habitats with 0-0.5ppt salinity		February 1 – May 31
	Instantaneous min ≥ 5 mg/L		
	Open water fish & shellfish designated use criteria apply		June 1 – January 31
Shallow water Bay grass use	Open water fish & shellfish designated use criteria apply		Year-round
Open water fish and shellfish use	30-day mean	≥ 5.5 mg/L Salinity: (0-0.5ppt)	Year-round
		≥ 5 mg/L Salinity: >0.5ppt	
	7-day mean	≥ 4 mg/L	
	Instantaneous min ≥ 3.2 mg/L		
Deep-water seasonal fish and shellfish use	30 day mean > 3mg/L		June 1 – September 30
	1-day mean >2.3 mg/L		
	Instantaneous min ≥ 1.7 mg/L		
	Open water Fish and shellfish designated use criteria apply		October 1-May 31
Deep channel seasonal refuge use	Instantaneous min > 1 mg/L		June 1 – September 30
	Open water F & S applies		October 1 – May 31

Note: At temperatures above 29°C, DO conc's above an instantaneous minimum of 4.3 mg/L will protect survival of shortnose sturgeon

Spatial and temporal water quality criteria assessment through Cumulative Frequency Diagram evaluation

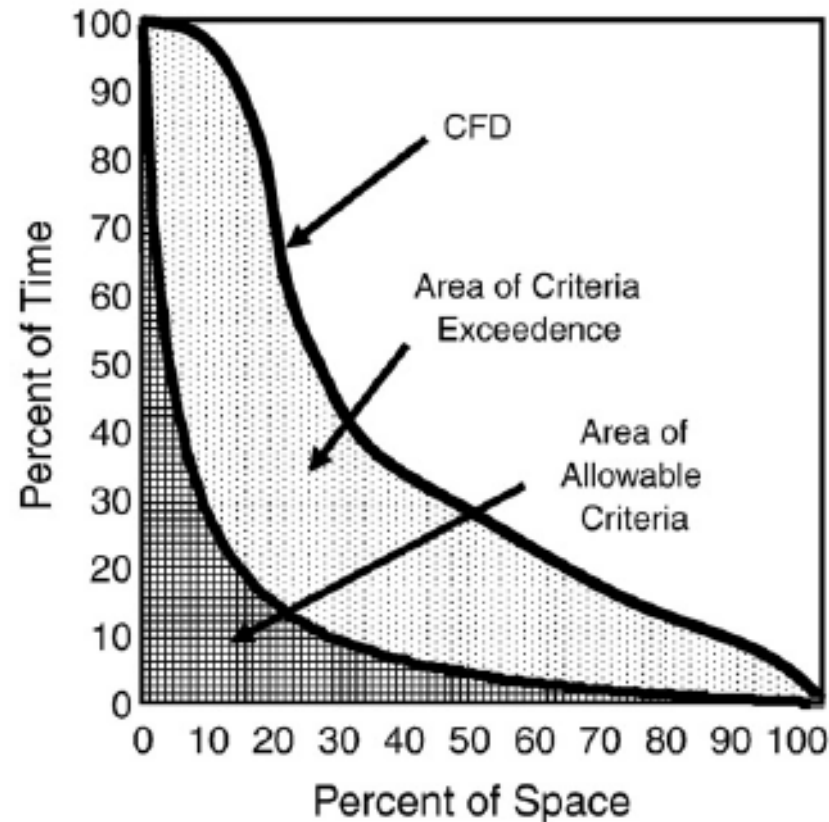


Fig. 1. Cumulative Frequency Diagram (CFD) for attainment assessment of exceedences of water quality criteria. Area of allowable criteria exceedence is determined by a reference curve representing a pristine or healthy condition (U.S. EPA, 2003a).



Discussions



- **DAY 1**

- I. Protectiveness of the Umbrella Criteria

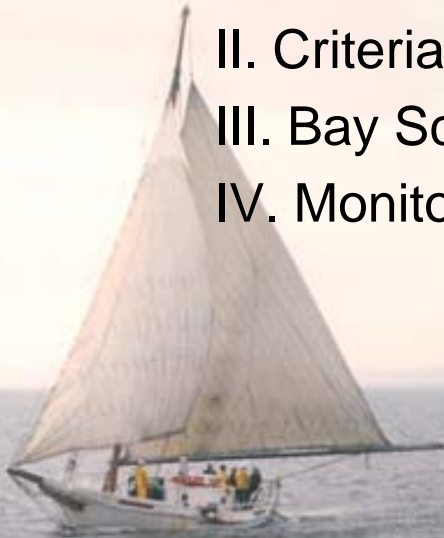
- Jeni will further describe the background on Umbrella Criteria assumption

- **DAY 2**

- II. Criteria Assessment Methodology

- III. Bay Science

- IV. Monitoring



II. Criteria Assessment Methodology for Evaluating Dissolved Oxygen Criteria Attainment



- **EPA recognizes the existing data limitations supporting assessment of *7-day mean*, *1-day mean* and *instantaneous minimum criteria* for all segments and the resource intensive nature of collection of dissolved oxygen data at these time scales**



II. Criteria Assessment Methodology for Evaluating Dissolved Oxygen Criteria Attainment

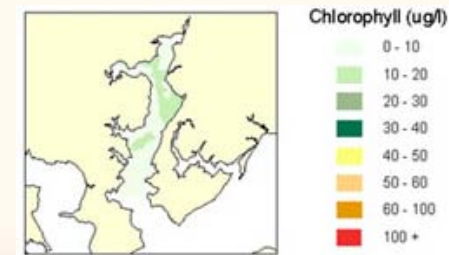


- EPA recognizes the existing data limitations supporting assessment of *7-day mean*, *1-day mean* and *instantaneous minimum criteria* for all segments and the resource intensive nature of collection of dissolved oxygen data at these time scales



ConMon

- Short deployment buoy data sets
- Pilot shallow water monitoring sites established around 2000
- CBPO initiated its Shallow Water Monitoring Program in 2004



DATAFLOW

RIPENING DATA SETS!



II. Criteria Assessment Methodology for Evaluating Dissolved Oxygen Criteria Attainment



- **USEPA 2003: “Determining full attainment of the dissolved oxygen criteria, given multiple criteria were adopted for protection of an individual designated use, must involve attainment assessment of each individual criterion”**

Review community work on Spectral Analysis/Spectral Casting and considerations for details of its application with criteria assessments.

$$y = x + \sum_{j=1}^J [a_j \cos(2\pi jT) + b_j \sin(2\pi jT)]$$



III. Bay Science



- **“Water quality dynamics of shallow water habitats in Chesapeake Bay and its tidal tributaries have been poorly characterized” (USEPA 2003).**
- **“The surface layer and much of the nearshore shallow water habitat have been considered to not be subjected to low dissolved oxygen with several caveats...” (Batiuk et al. 2009)**



III. Bay Science



USEPA 2007 July text on the Shallow water designated use: *Acknowledging science needs*

- “Shallow water monitoring will characterize dissolved oxygen conditions in shallow water habitats more fully.”



III. Science



USEPA (2007)

“Neither the need, nor the requirement exists for a separate assessment of dissolved oxygen criteria attainment strictly within shallow waters.

- **Characterization of Shallow water and offshore water DO dynamics: How, where, when are they different/the same?**
- **DO event duration, frequency issues**
- **SAV and DO**



IV. Monitoring for Dissolved Oxygen Criteria Attainment

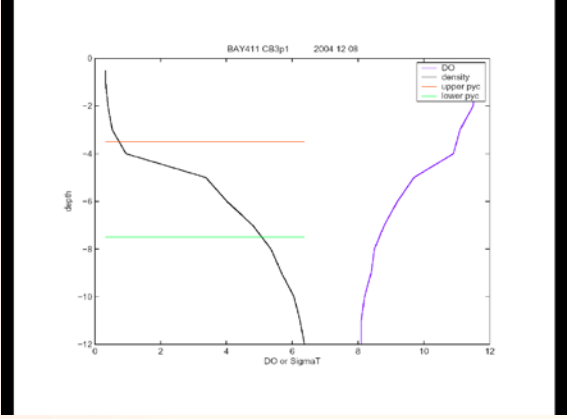


“Monitoring for dissolved oxygen criteria attainment should address all four frequencies of dissolved oxygen criteria: 30-day mean, 7-day mean, 1-day mean and instantaneous minimum.”

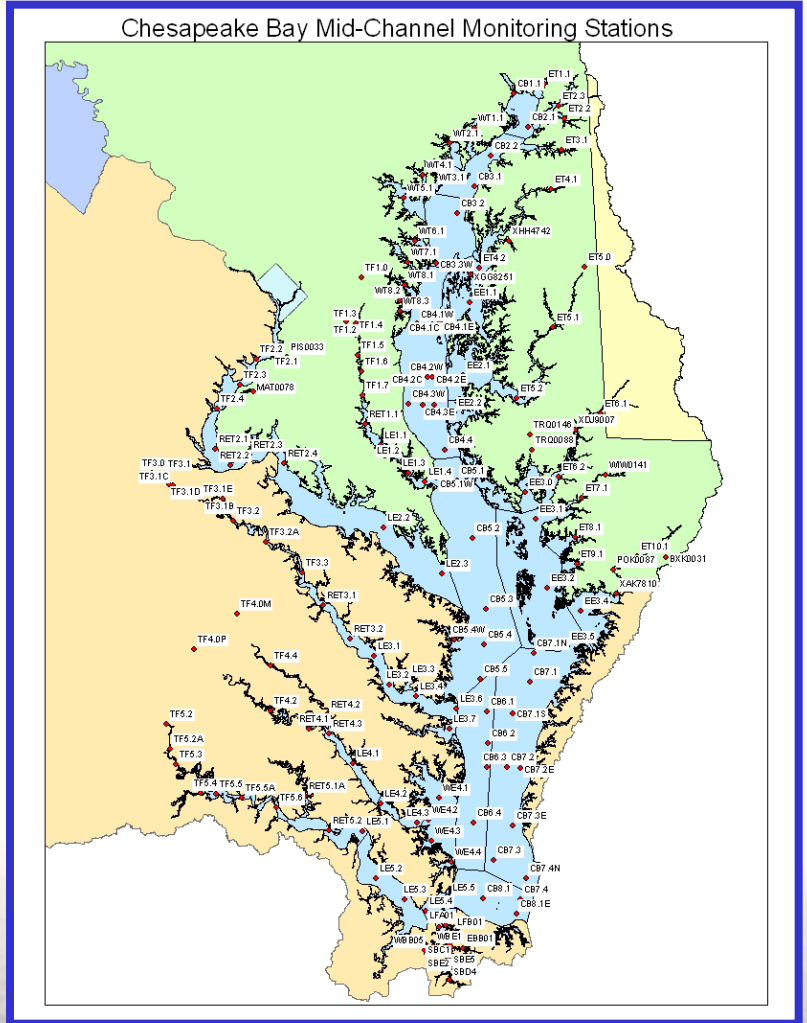
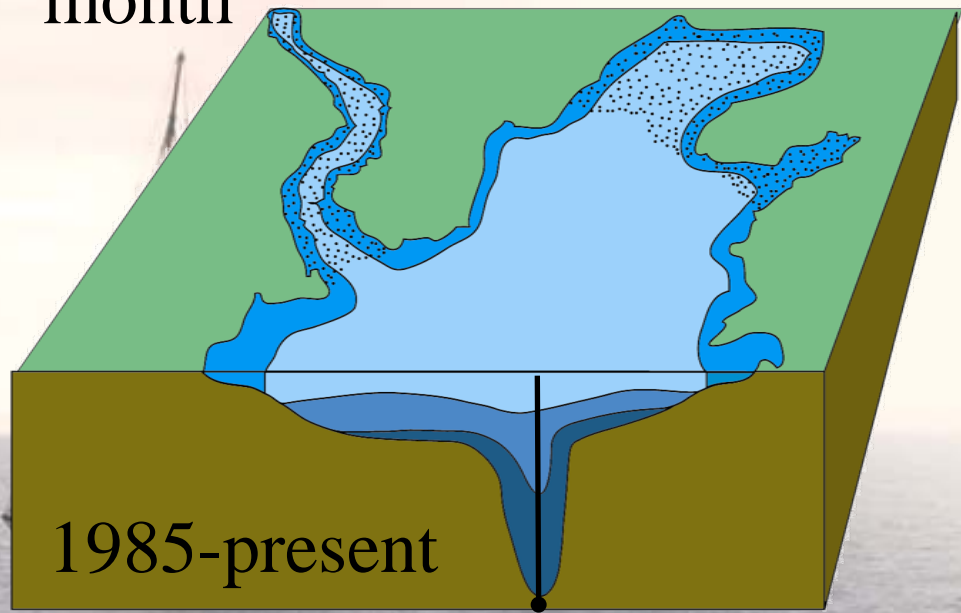
U.S. EPA 2003. Page 179



IV. Monitoring data serving criteria assessment: “Measurable criteria”



1-2x/
month



What, if any, are the data needs to improve our assessments and reduce our uncertainties?

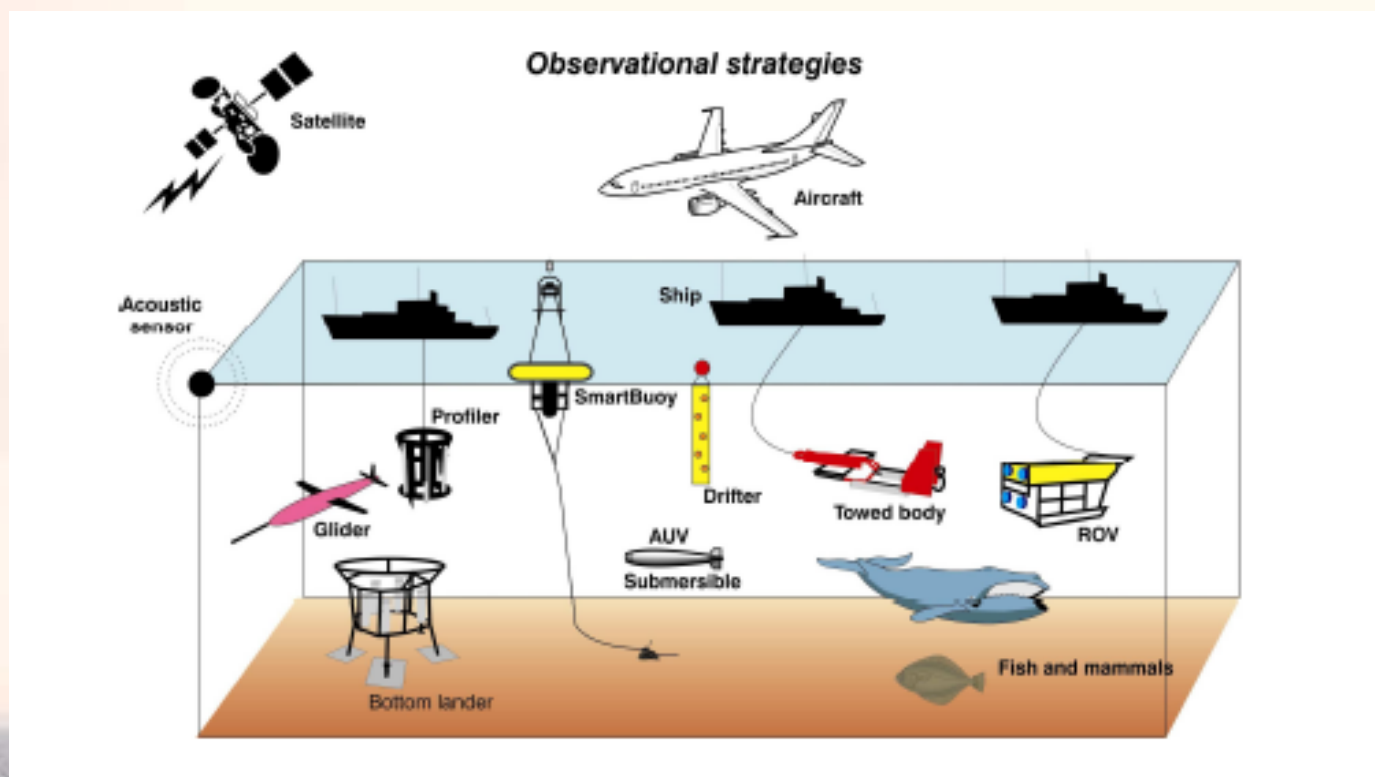


Figure from Kroger et al. 2009

Can we target assessments?

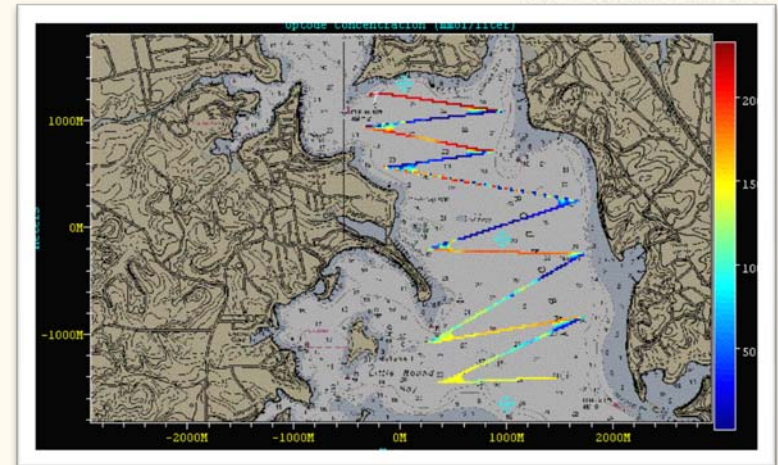


Developing a High Resolution Marine Ecological Observing System using AUVs

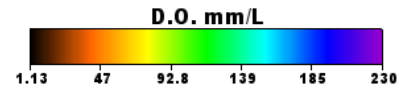
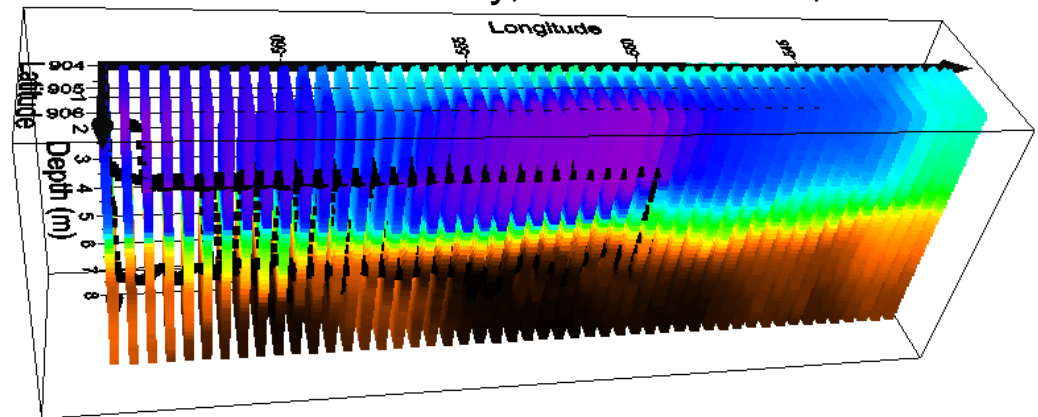
Andrew C. Muller, USNA



- Scientific Question: **How does the timing and strength of stratification effect the development, growth, and decay of anoxia in small tidal tributaries.**
- Approach: **Fly the REMUS AUV with CTD, ADCP and DO in Round Bay on a weekly to biweekly basis throughout the year.**



Round Bay, Severn River, MD.



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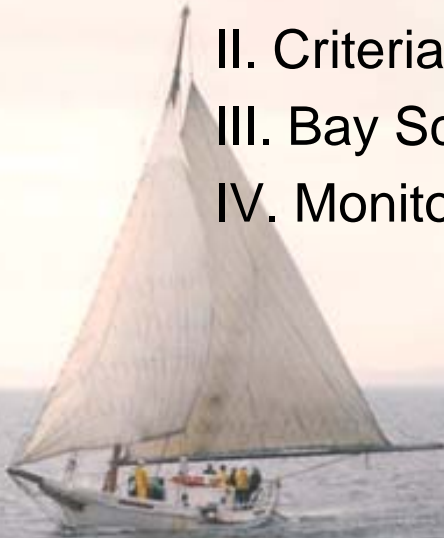
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Thank you and enjoy!

