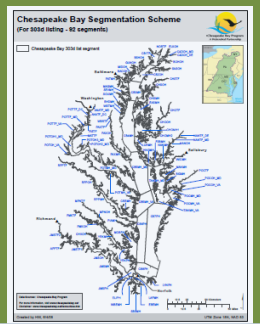
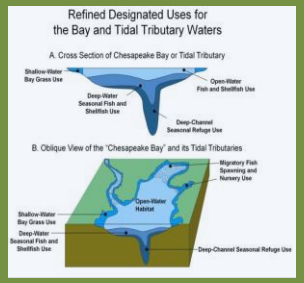
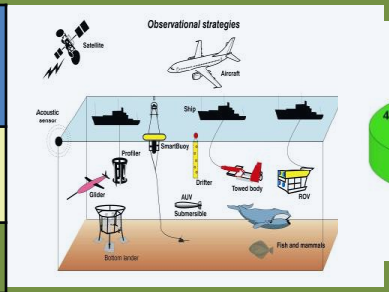
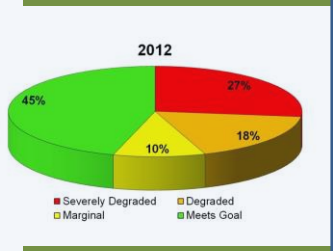
Content Overview of the next Chesapeake Bay Ambient Water Quality Criteria Technical Addendum

Peter Tango
USGS@CBPO
February 12, 2016
STAC Criteria Addendum Review Panel

The Water Quality Standards Framework and The New WQ Criteria Technical Addendum

Standard	Bay segmentation	Designated Uses	Water Quality Criteria	Assessment Protocols	Communicating Status & Change
			**Designated Use** / **Dissolved oxygen Criteria Concentration/ Duration** / **Temporal Application** **Deep channel seasonal refuge use** — **Instantaneous min > 1 mg/L** — **June 1 – September 30** **Open water F & S applies** — **October 1 – May 31**		
D.O.	Chap 3 Volume of WBRTF resolved supporting assessment and listing	Chap 2. Short duration DO Criteria Assessment Subseg options	-	Chap2. DO guidance and Chap 6. Nontraditional partners DO criteria assessment guidance	Chapter7. Multimetric Water Quality Index to track progress in attaining water quality standards
Water Clarity /SAV		Chap 4. SAV goal acreage alignment	-	-	
CHLA		-	-	-	
Aq. Life		-	-	Chap 5 Interim BIBI rule: Category classification for outliers	-

Chapter 2. Assessing Short-duration Dissolved Oxygen Criteria

- Issue

For over ten years there have been gaps in our ability to assess all criteria that define the Chesapeake Bay tidal water dissolved oxygen standards.

Designated Use	Criteria Concentration/Duration	Protection Provided	Temporal Application
Migratory fish spawning and nursery use	7-day mean ≥ 6 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Survival/growth of larval/juvenile tidal-fresh resident fish; protective of threatened/endangered species.	February 1 - May 31
	Instantaneous minimum ≥ 5 mg liter^{-1}	Survival and growth of larval/juvenile migratory fish; protective of threatened/endangered species.	
	Open-water fish and shellfish designated use criteria apply		June 1 - January 31
Shallow-water bay grass use	Open-water fish and shellfish designated use criteria apply		Year-round
Open-water fish and shellfish use	30-day mean ≥ 5.5 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Growth of tidal-fresh juvenile and adult fish; protective of threatened/endangered species.	Year-round
	30-day mean ≥ 5 mg liter^{-1} (tidal habitats with >0.5 ppt salinity)	Growth of larval, juvenile and adult fish and shellfish; protective of threatened/endangered species.	
	7-day mean ≥ 4 mg liter^{-1}	Survival of open-water fish larvae.	
	Instantaneous minimum ≥ 3.2 mg liter^{-1}	Survival of threatened/endangered sturgeon species.[1]	
Deep-water seasonal fish and shellfish use	30-day mean ≥ 3 mg liter^{-1}	Survival and recruitment of bay anchovy eggs and larvae.	June 1 - September 30
	1-day mean ≥ 2.3 mg liter^{-1}	Survival of open-water juvenile and adult fish.	
	Instantaneous minimum ≥ 1.7 mg liter^{-1}	Survival of bay anchovy eggs and larvae.	
	Open-water fish and shellfish designated-use criteria apply		October 1 - May 31
Deep-channel seasonal refuge use	Instantaneous minimum ≥ 1 mg liter^{-1}	Survival of bottom-dwelling worms and clams.	June 1 - September 30
	Open-water fish and shellfish designated use criteria apply		October 1 - May 31

[1] At temperatures considered stressful to shortnose sturgeon (>29°C), dissolved oxygen concentrations above an instantaneous minimum of 4.3 mg liter^{-1} will protect survival of this listed sturgeon species.

Chapter 2. Assessing Short-duration Dissolved Oxygen Criteria

- Issue

  Chapter 2 provides for a set of approaches to fill the assessment gaps.

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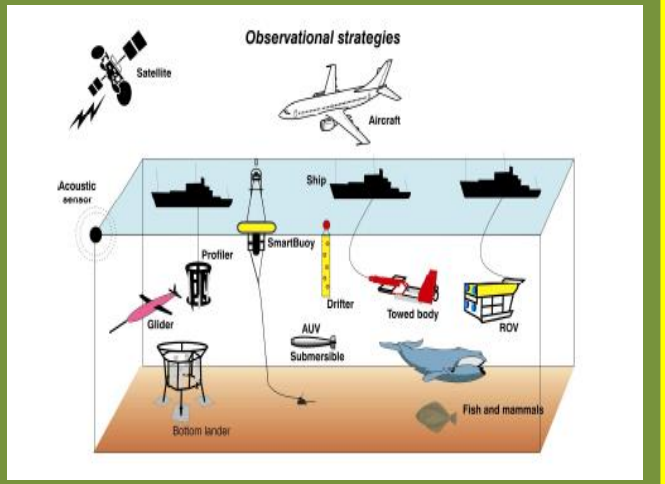
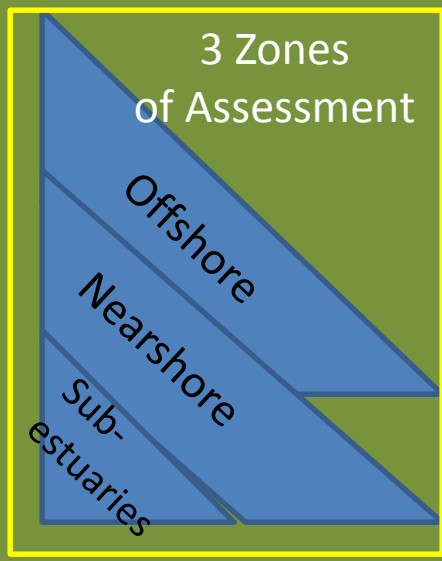
Chapter 2. Assessing Short-Duration DO Criteria in Chesapeake Bay. Options.

- Measure water quality at higher temporal frequency and spatial coverage than provided for by the long-term wq monitoring program.
- Use a Conditional Attainment approach.
- Subsegment (specifically Open Water designated use) and apply zone-specific assessment method.





Assess Status and Tracking Change:
Chesapeake Bay Program Monitoring Networks

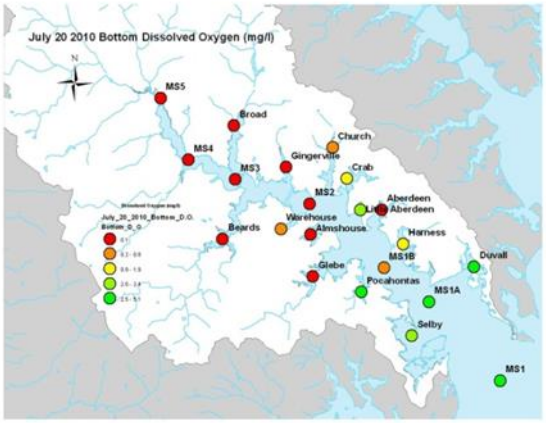
Bay Water Quality Monitoring

Summer 2x month
Other seasons monthly

Shallow Water Habitat

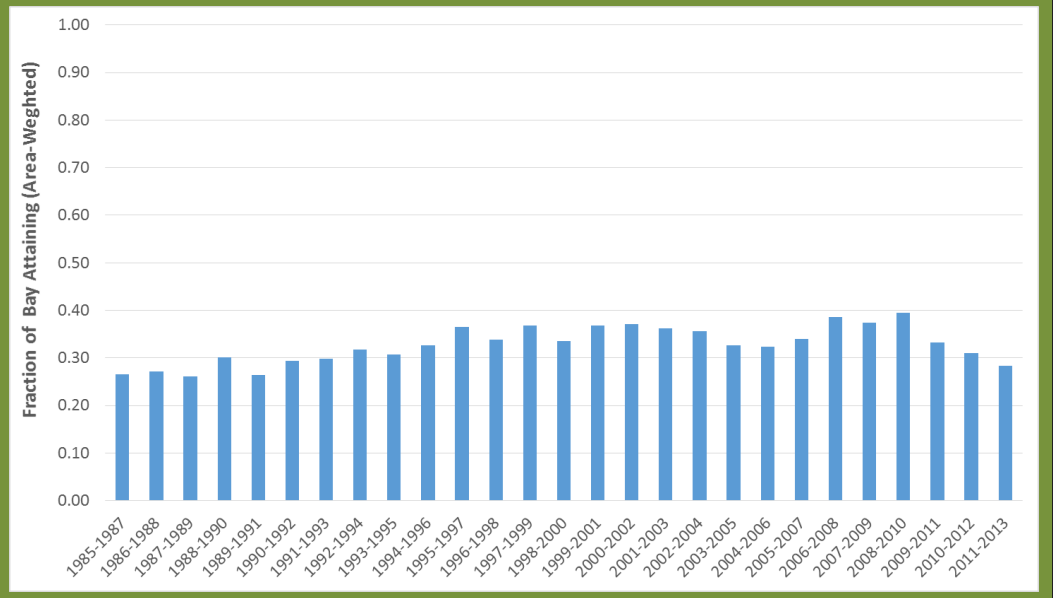
Temporally dense Nearshore data

(Some offshore profiling too)

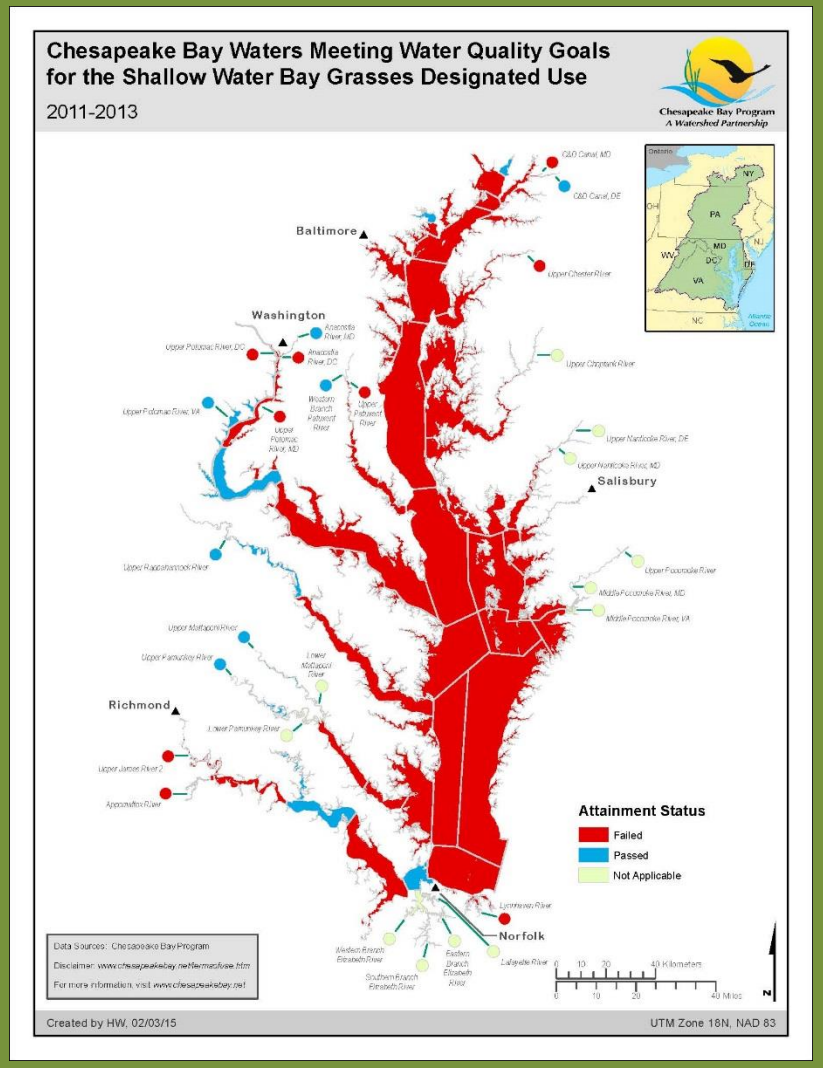

July 20 2010 Bottom Dissolved Oxygen (mg/l)
N
MS5
Broad
Church
MS4
Gingerville
MS3
Crab
MS2
Aberdeen
Aberdeen
Warehouse
Beards
Almshouse
Harness
MS1B
Duvall
Glebe
Pocahontas
MS1A
Selby
MS1

Water Quality Criteria Attainment (Ehrich example)

Area-Weighted Fraction of Bay In Attainment for Each 3-year Period

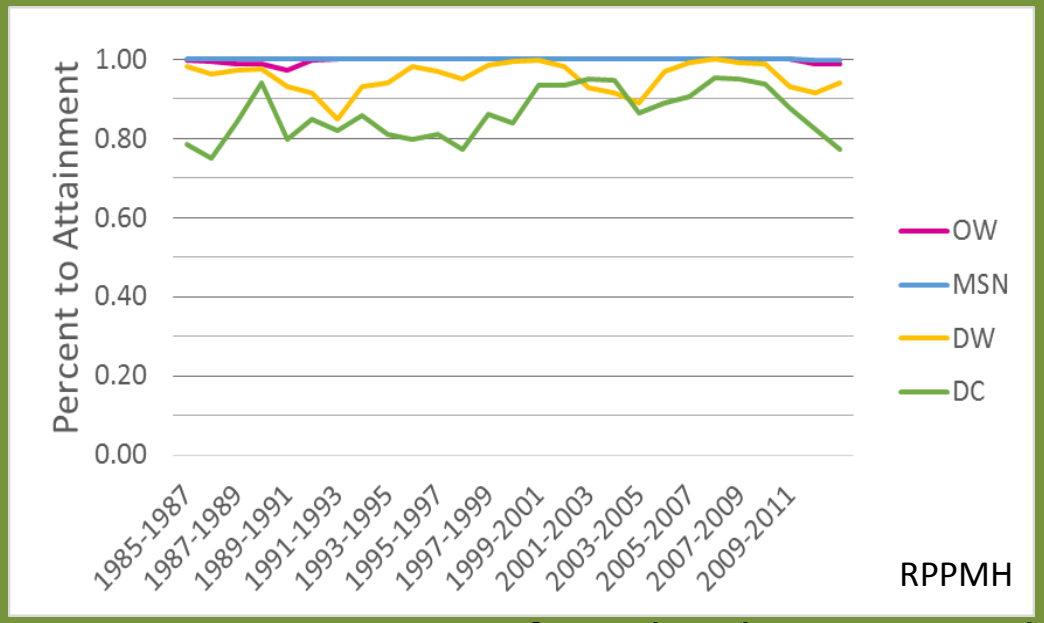


Single 3-year Period Pass/Fail for Shallow Water Segments



How can we describe what is occurring with DO DUs by Segment?

One Segment Dissolved Oxygen DUs (DC, DW, OW, MSN):



- Not many segments found to have a trend
- Most values were above 75%

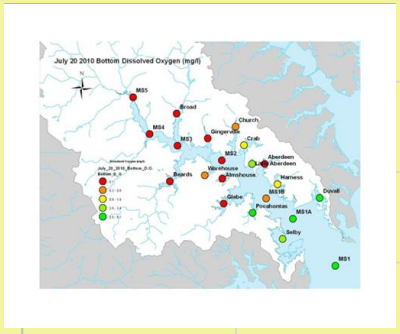
DO DESIGNATED USES

- DC: Deep-channel seasonal refuge use (worms and clams)
- DW: Deep-water seasonal fish and shellfish use
- OW: Open water fish and shellfish use
- MSN: Migratory fish, spawning and nursery use

100% is the <u>minimum</u> needed for sustaining the habitat to meet standards.

M. Ehrich

Aerial Average DO CBP only (Y-axis) paired with CBP + South River (x-axis). 3 years, monthly averages



Monthly Mean DO
CBP only 1 site

1:1 line

Unpublished Data – do NOT CITE OR DISTRIBUTE

Average Concentration CBP OW Average Concentration CBP OW

0 1 2 3 4 5 6 7 8 9

0 2 4 6 8 10 12

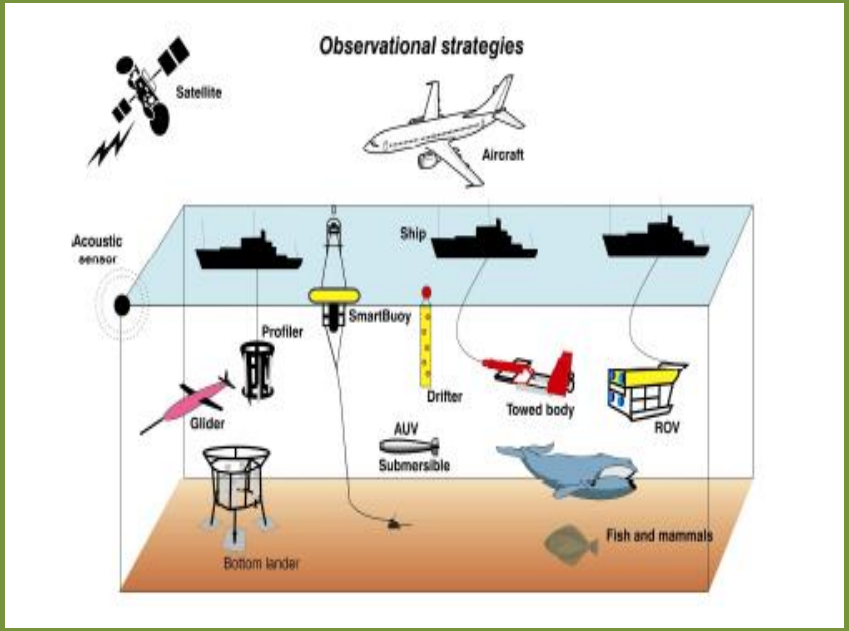
Monthly Mean DO
CBP + 20 stations South River

Tango, Mallonee, Tian – CERF 2015

Chapter 2. Assessing Short-Duration DO Criteria in Chesapeake Bay. Options.

- Option 1: Measure water quality at higher temporal frequency and spatial coverage than provided for by the long-term wq monitoring program.

- Greater resolution offers an improved representation of the conditions. Results may change the attainment status.



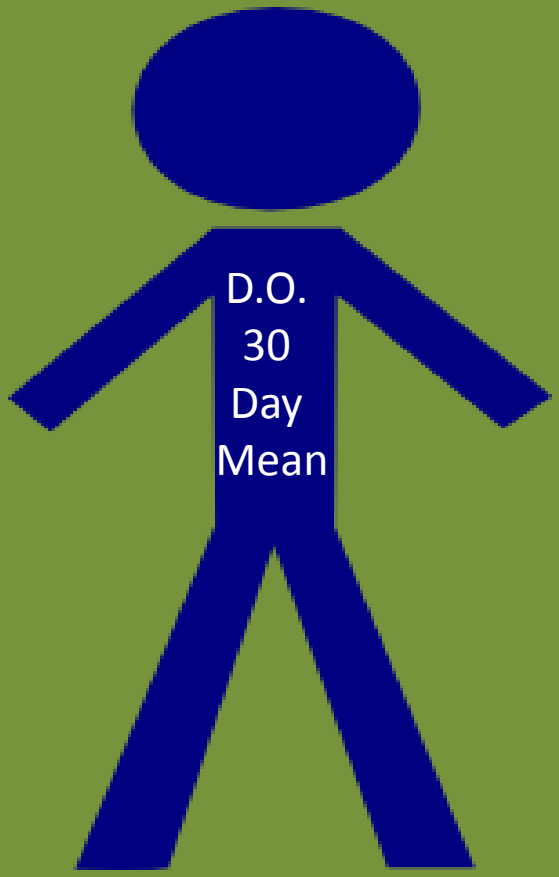
Option 2. Conditional Attainment:

Compute one statistic for one time scale (e.g. 30-day mean DO) to inform conditions at another time scale.

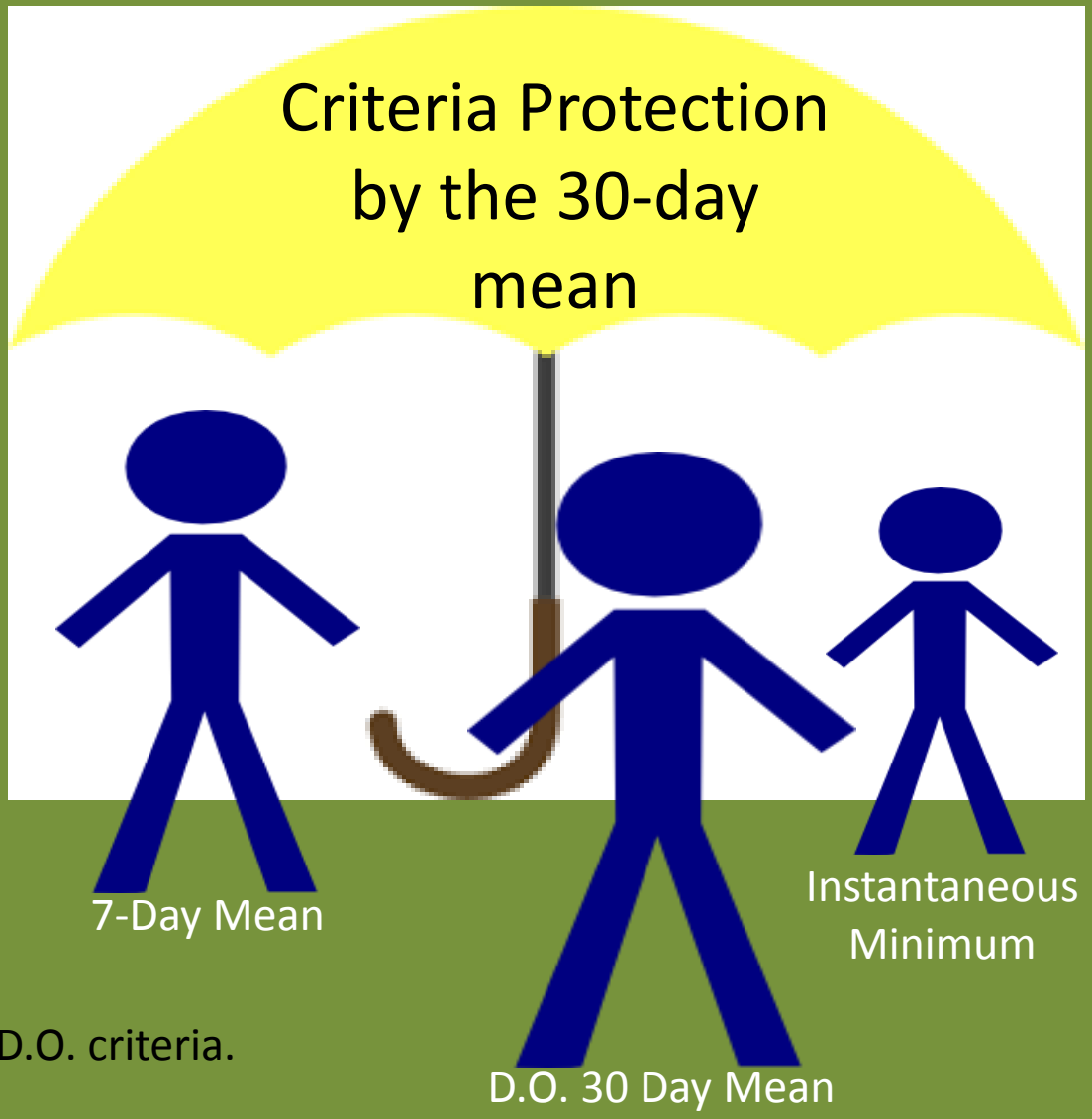
History:

- Jordan et al. 1996 – A seasonal mean DO could provide a good measure of meeting other DO thresholds.
- U.S. EPA 2003 – Recommends estimating “probable attainment” to address short duration criteria.
- U.S. EPA 2004 – Demonstrates levels of protection of one criterion for other, short duration criteria.
- U.S. EPA 2010 – Modeled “Umbrella Criterion” application.
- CBP-STAC 2012 – Umbrella Criterion report, options.
- 2015 – New Tech addendum report. Renaming the approach “Conditional Attainment”.

Foundations of the Umbrella Protection principle where the work to protect one species offers protection for other species


D.O.
30
Day
Mean

D.O. 30 Day Mean

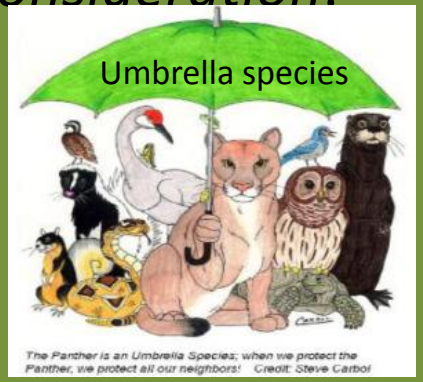


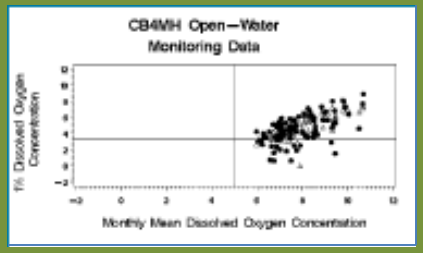
Same principle but applied to our D.O. criteria.

Can we extend the use of existing monitoring data for more efficient, cost effective water quality monitoring?

*Enter the **Umbrella Criterion** consideration.*

- Existing concept: The Umbrella Criterion Concept parallels Conservation Biology's use of Umbrella species (Wilcox 1984).
  - Some scientists have found that the umbrella effect provides a simpler way to manage ecological communities.





U.S. EPA 2004 CB4MH test
Of mutual criteria protection

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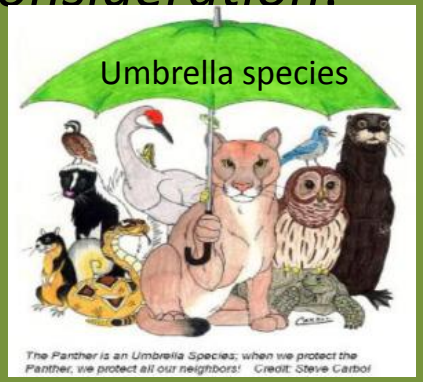
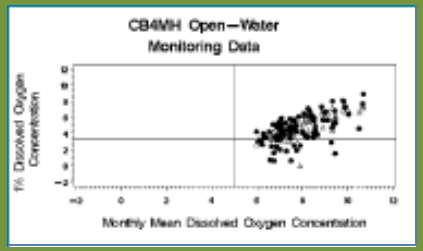
- U.S. EPA (2004) was the first assessment of Umbrella Criterion principles
- U.S. EPA CBPO Shenk and Batiuk (2010) evaluated Bay model output for Umbrella protection of measurements made by the existing water quality monitoring program to protect short duration criteria.



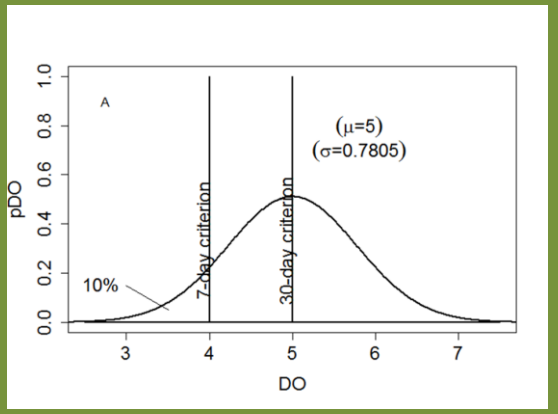


U.S. EPA 2004 CB4MH test
Of mutual criteria protection

Chapter 2. **II. Assessing Dissolved Oxygen Criteria Attainment: Short-Duration Criteria Attainment Assessments**

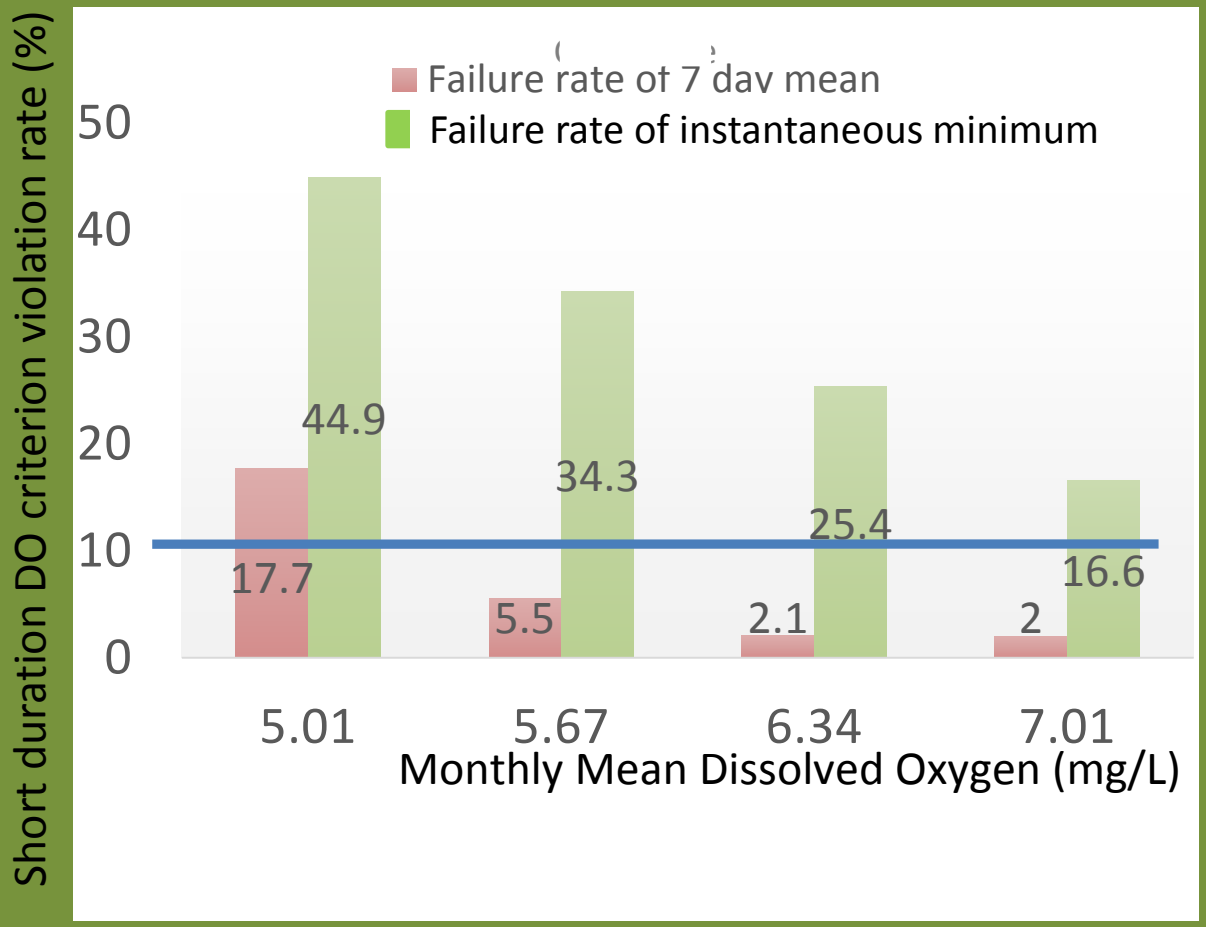
- "~~Umbrella Criteria~~"

- "Conditional Attainment"
  - This is the updated label for "Umbrella Criterion" and all the associated work that went into providing a potential basis for making assessments from one scale of measurement, including uncertainty associated with sampling frequency. .



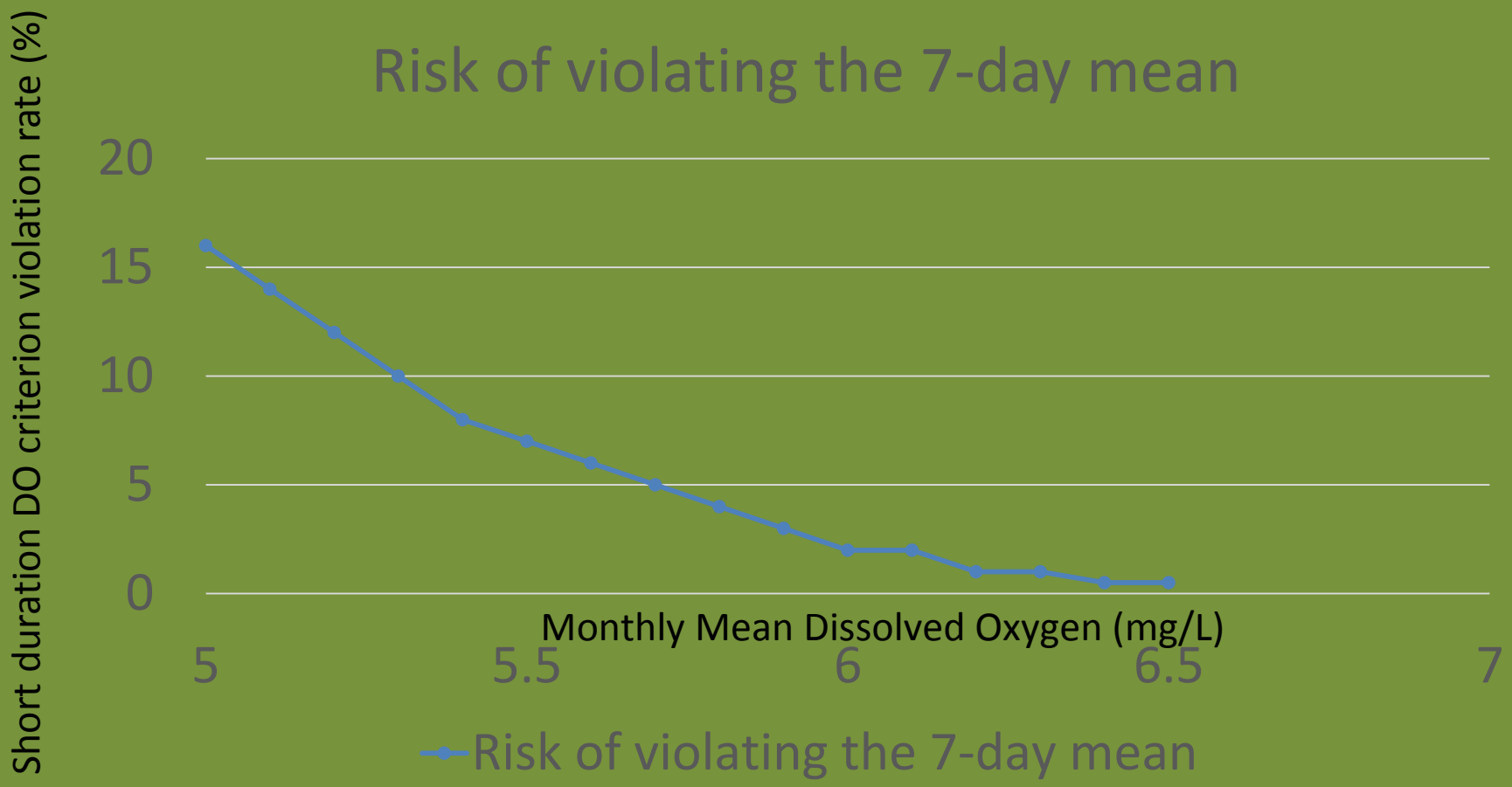
E. Perry. Statistics Consultant

As the monthly mean dissolved oxygen concentration increases, the associated violation rate for short-duration criteria declines.



- Suggestion: Instead of basing protection for short-duration criteria only on the pass-fail assessment, use the information on monthly means to understand the level of risk of violating short-duration criteria.

Simulation analysis based on subsampling continuous DO monitoring data filled in the gaps on risk for nonattainment based on 30-day means.



Conditional Attainment Option

- An Umbrella Protection Effect exists for protecting multiple criteria using a single scale of measurement.
  1. *The size of the Umbrella Effect varies depend on the density of measurements used to assess the criterion. (Sampling effort counts).*
  2. Levels of protection provided by a monthly mean dissolved oxygen value are different depending on what criteria you choose to protect. (7-day mean vs. 1 day mean vs. Instantaneous minimum)

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

Criteria Assessment Coverage

U.S. EPA 2003
U.S. EPA 2004
and more…

Umbrella Criterion – Summer Season assumption

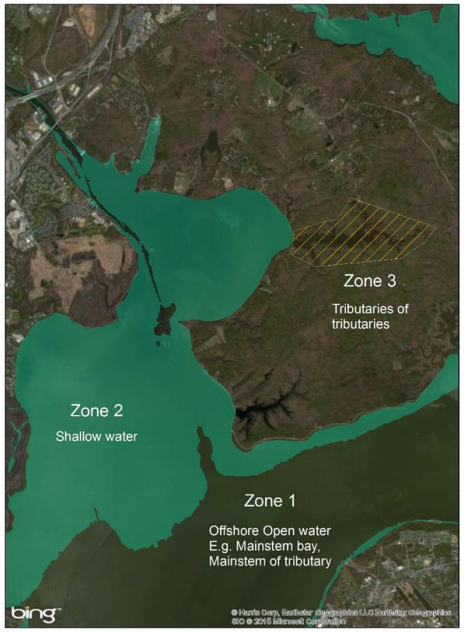
Conditional Attainment or measure it.

TMDL basis: Meet summer and protect other seasons.

Chapter 2. **II. Assessing Dissolved Oxygen Criteria Attainment: Short-Duration Criteria Attainment Assessments**

Three Zone framework: choosing to sub-segment

- Links to the Open Water designated use work, the latest work by Boynton et al on D.O. behavior in shallow water, and existing EPA-supported basis for sub-segmenting habitats already used by Virginia in other assessments.



Graphic by H. Weinberg..CBPO

USEPA (2003)

- Insufficient information was available regarding differences in dissolved oxygen dynamics between offshore and shallow, nearshore habitat to support separating the two habitats into their own designated use assessments. (U.S. EPA 2003)

Recent Bay research

This section provides a recommendation for sub-segmenting and applying habitat-specific monitoring protocols options.

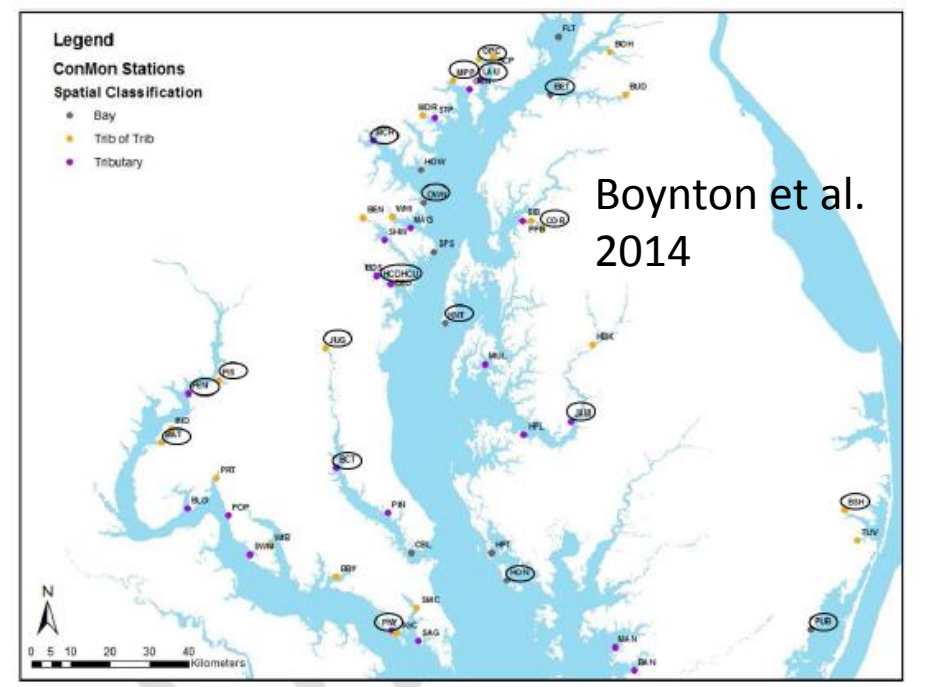


Figure 2-1. Locations of 57 ConMon stations used in the non-attainment analysis and their spatial classifications. The 23 locations circled are the subset of stations that were also analyzed using 1 hour average temporal scheme.

- Boynton et al. 2014 found failure rates differing by nearshore habitat location in 3 ‘zones’

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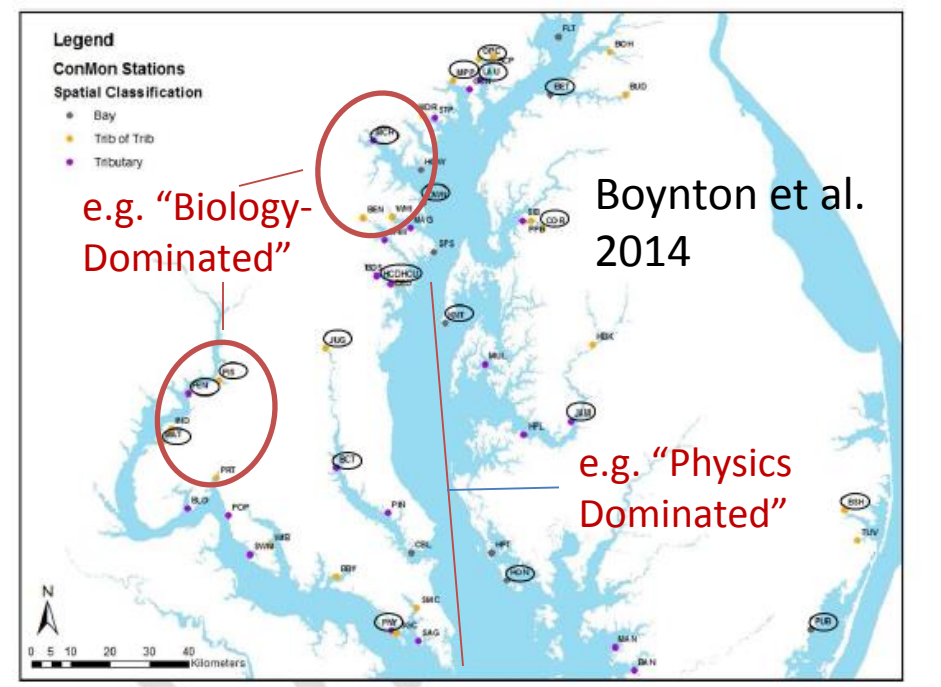

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- Boynton et al. 2014 found failure rates differing by nearshore habitat location in 3 'zones'

More from Boynton et al. 2014 on 3 zones of D.O. conditions

Frequencies of violations increase from Bay to tribs of tribs.

Distribution of % failures grows from Bay to tribs of tribs.

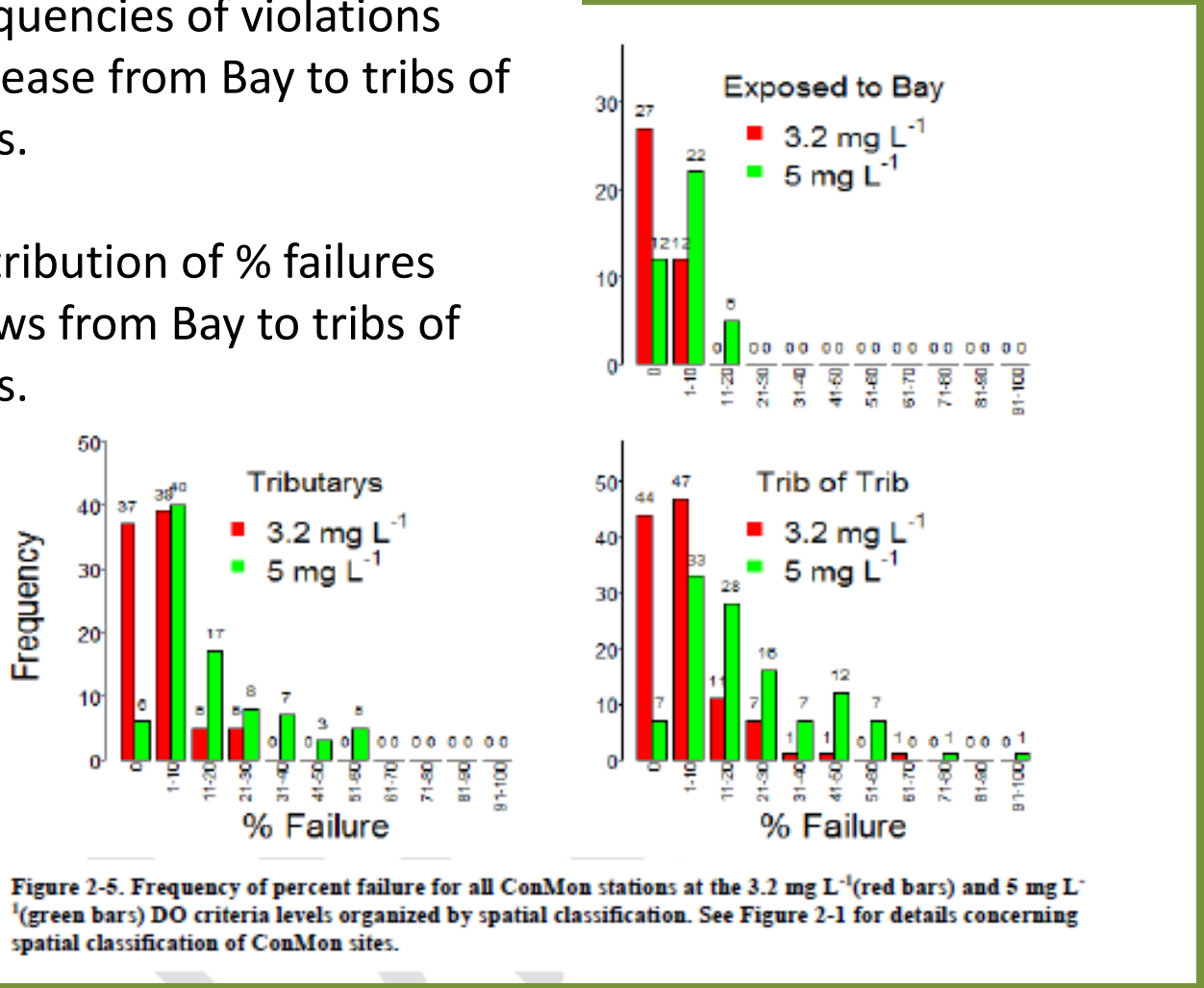
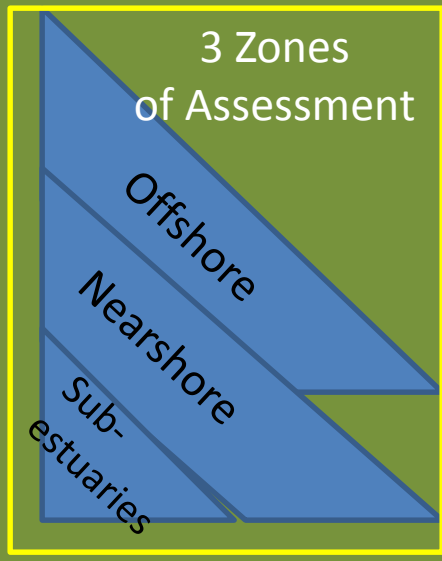


Figure 2-5. Frequency of percent failure for all ConMon stations at the 3.2 mg L^{-1} (red bars) and 5 mg L^{-1} (green bars) DO criteria levels organized by spatial classification. See Figure 2-1 for details concerning spatial classification of ConMon sites.

Also, Caffrey (2004) shows habitat adjacent to monitoring sites can explain general patterns of DO dynamics across sites.

Subsegmenting and Assessing Open Water.



3 Zones:

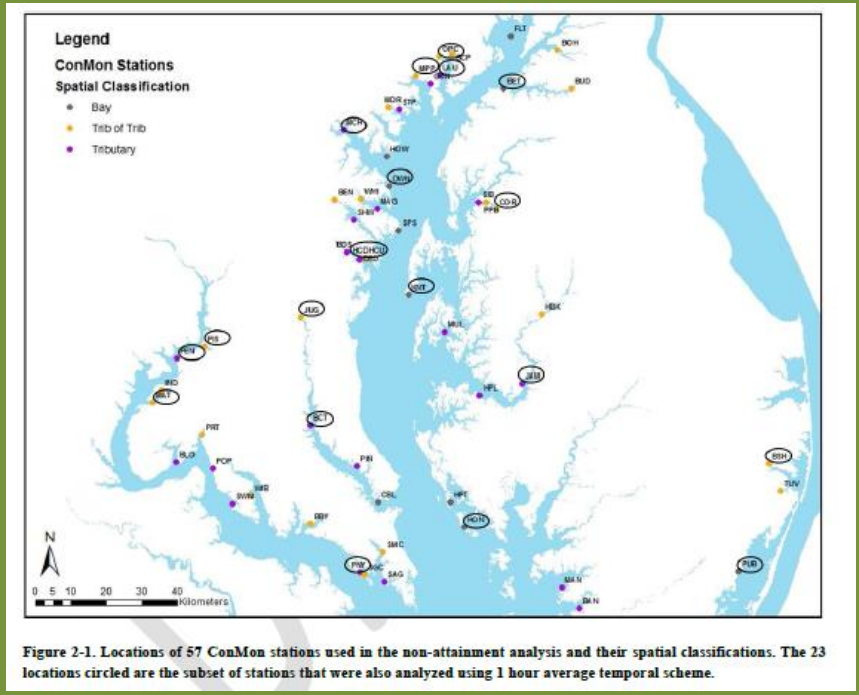
- Supporting Instantaneous minimum assessments.
- U.S. EPA 2003x 305b guidance: 3 zone approach to assessing estuarine habitats
- VADEQ applies approach to non-Bay criteria tidal water assessments citing U.S. EPA 2003x.
- Boynton et al. (2014) illustrates habitat differences in DO behavior for 3 zones.

Recommendation to Support States in Partial Delisting Options Promoting Status and Incremental Progress Reporting

- **1. Offshore**: Subject to Open Water Criterion Assessment (e.g. Umbrella Criterion approach)

- **2. Nearshore of mainchannel Bay or primary tributary**:
  - Zoned on a case by case basis.
  - Coordinated between the jurisdiction and EPA
  - Use 3 Full Seasons of one or more Con Mon data sets in the segment.
  - Apply strict nonattainment rule: compensating for spatial resolution

- **3. Subestuary: Tribs of tribs, small waters**.
  - 3 years of synoptic sampling, 10+ samples per year, 10% rule of assessment applied to meet IM standard.
  - (We should probably discuss time of day as a factor in data collection rules here).



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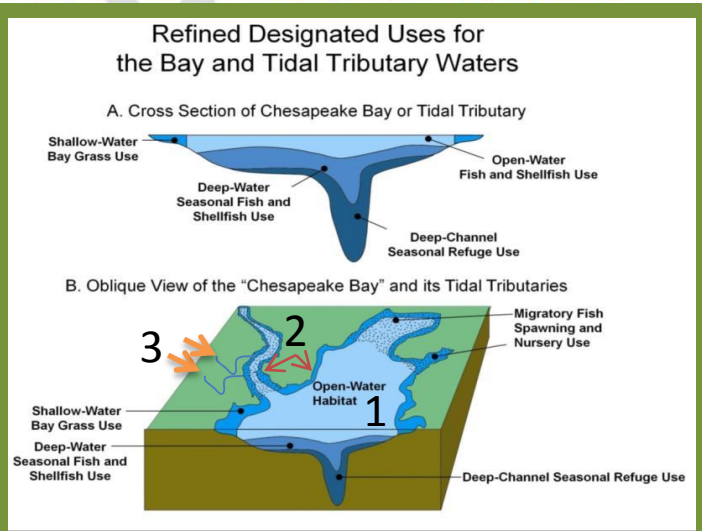
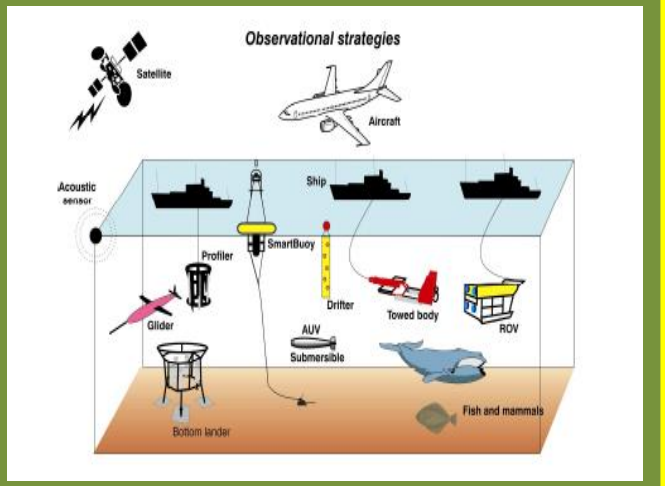


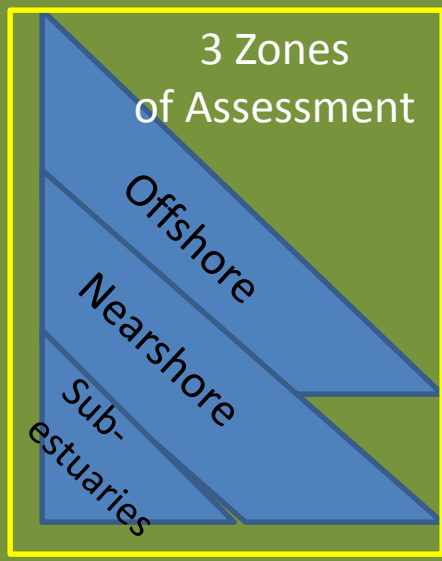
Summary

- Where States wish to work with EPA and subsegment a segment for assessment purposes:
  - Data analyses illustrate a gradient of habitat behaviors.
  - Recommendations supporting assessment relate to available assessment protocols.

Chapter 2. Assessing Short-Duration DO Criteria in Chesapeake Bay. Options.

- Measure water quality at high temporal frequency.
- Use a Conditional Attainment approach.
- Subsegment Open Water and apply zone-specific method.





Chapter 3. Resolving Missing Segment Volumes to Support CWA 303d Listing Assessments

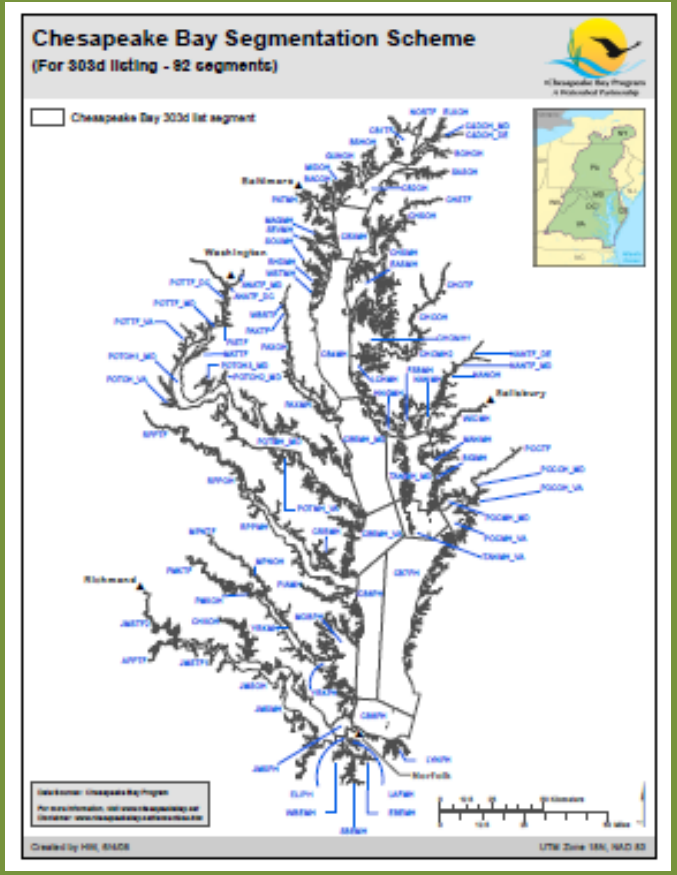
- Issue:

There remain a small number of Chesapeake Bay management segments that have long term water quality monitoring stations but do not have volume measurements.

- Western Branch (PAX) Tidal Fresh
- Patuxent TF segments, and
- Anacostia-TF MD

A segment without a volume measure cannot be assessed for water quality standards

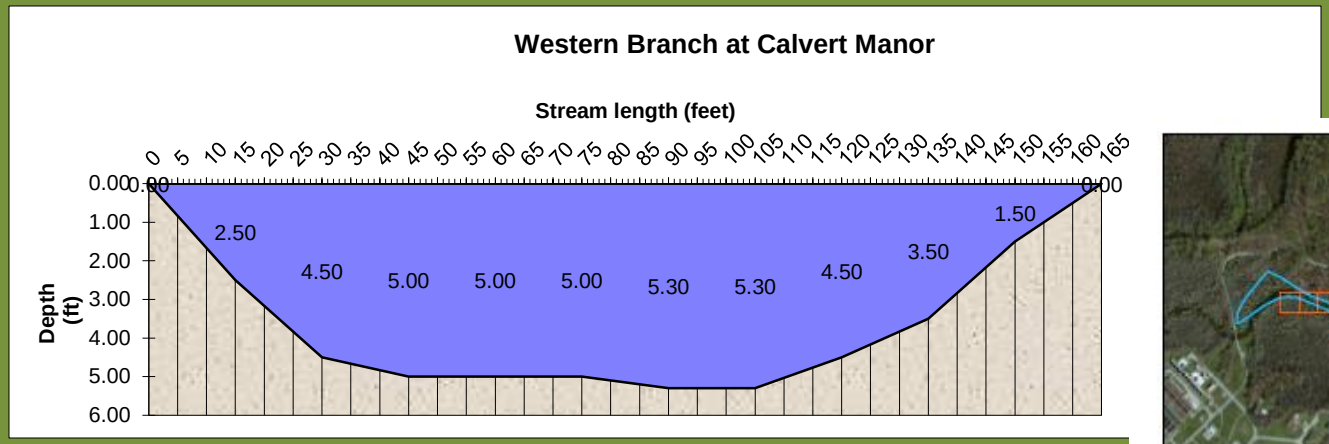
WBRTF management segment has not been represented in model evaluations of the TMDL due to a lack of bathymetry information



Chapter Goal

- Provide volume measures for 3 Chesapeake Bay segments with missing volumes to support their assessment and reporting of water quality standards attainment.

Chapter 3. Accounting for Missing Segment Volumes.

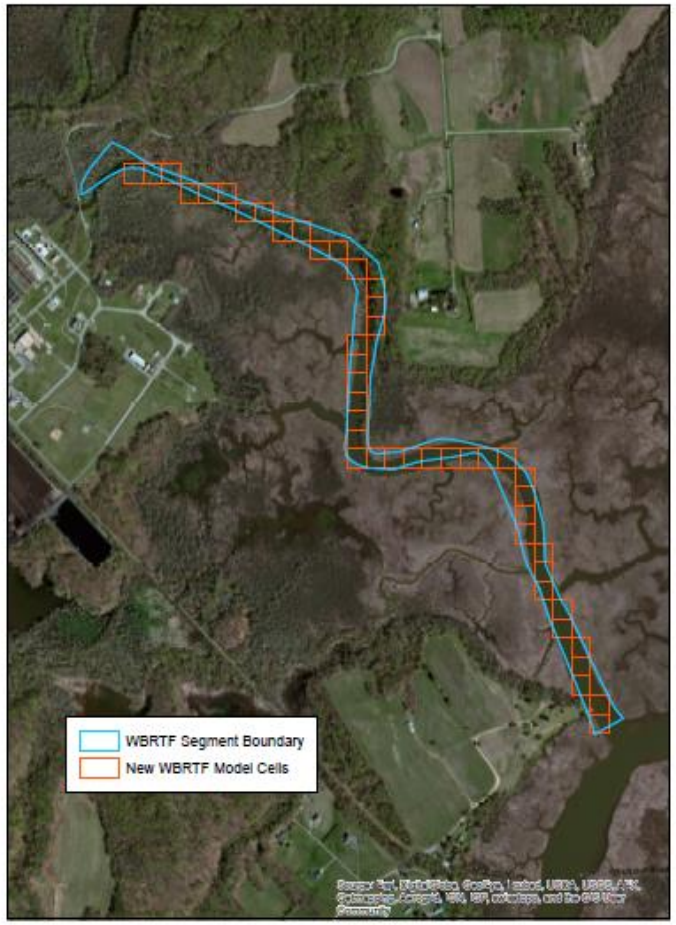


SUMMARY:

3 additional segments can now be assessed for impairment

- Western Branch (PAX) Tidal Fresh
  - Volume estimation was developed by CBPO in cooperation with MDE to support WQ Stds assessment of segment WBPRTF.

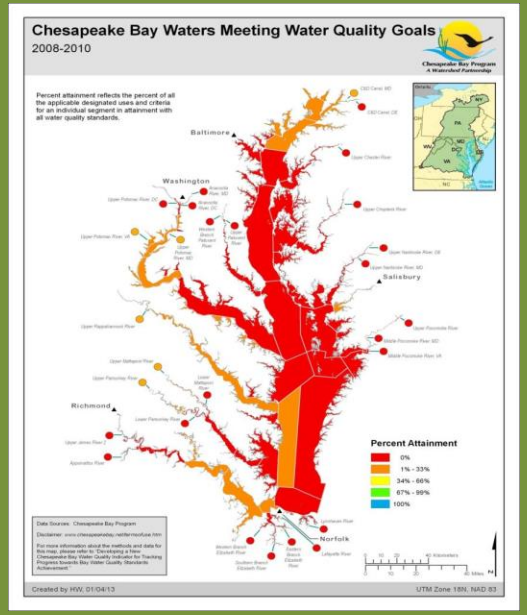
- Anacostia-TF MD and Patuxent TF segments
  - Agreement to use the Bay Model segment volumes as the best available estimates of their volumes for impairment assessments.

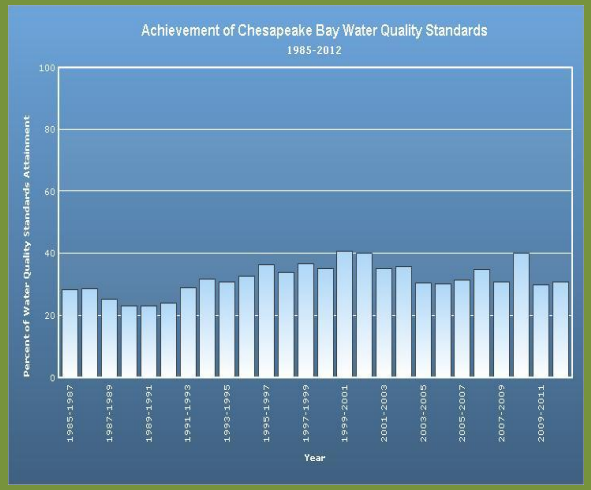


Chapter 4. Multimetric Water Quality Standards Indicator for Supporting Progress Tracking in Bay Restoration

Issue:

- Provide a composite status measure of water quality standards attainment results for DO, water clarity/SAV and chlorophyll a.
- Communicate progress to the public, managers and decision-makers.



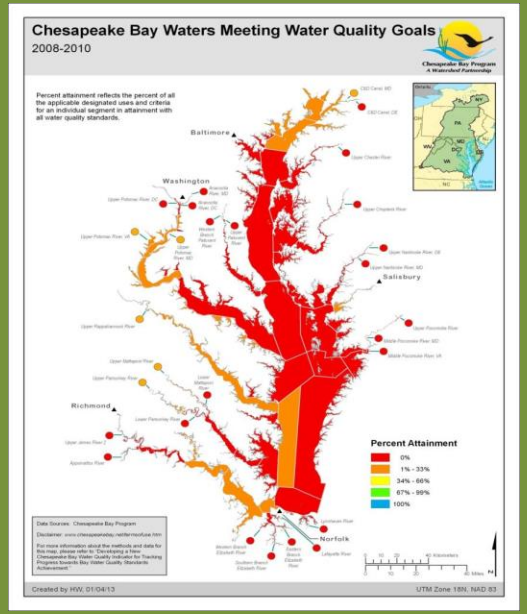


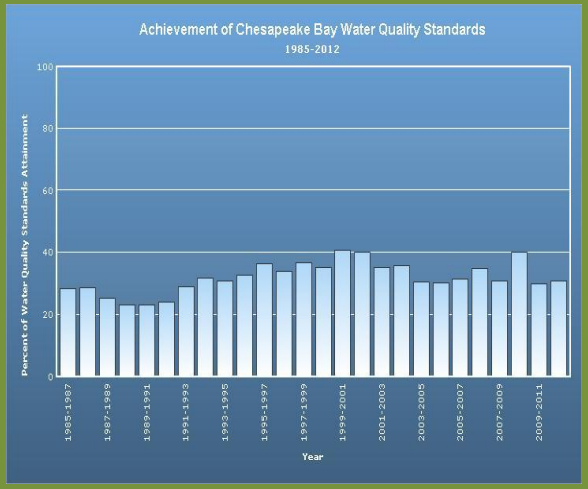
Chapter Goal

- Document the method used to communicate a single measure of the combined water quality standards attainment results for Chesapeake Bay tidal waters.

Chapter 4. Multimetric Water Quality Standards Indicator for Supporting Progress Tracking in Bay Restoration

- Indicator created at CBPO
- It documents the use of DO + Water Clarity/SAV + CHLA standards attainment assessments in a multimetric assessment of progress. (Liza H, Lea R)
- * Approved by WQGIT (and Management Board I think) in 2013.





Chapter 4. Multimetric Water Quality Standards Indicator for Supporting Progress Tracking in Bay Restoration

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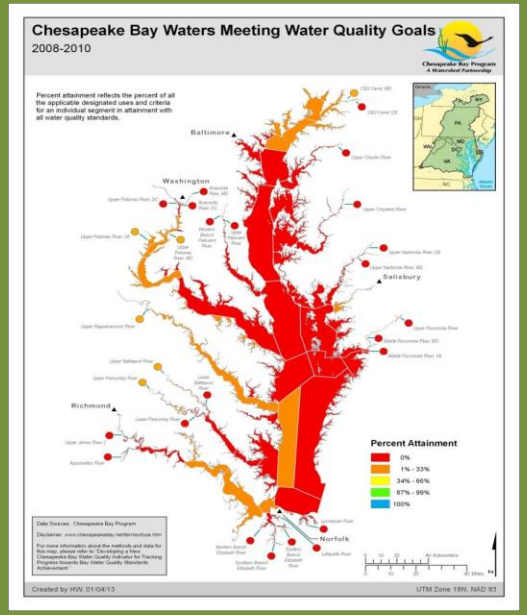
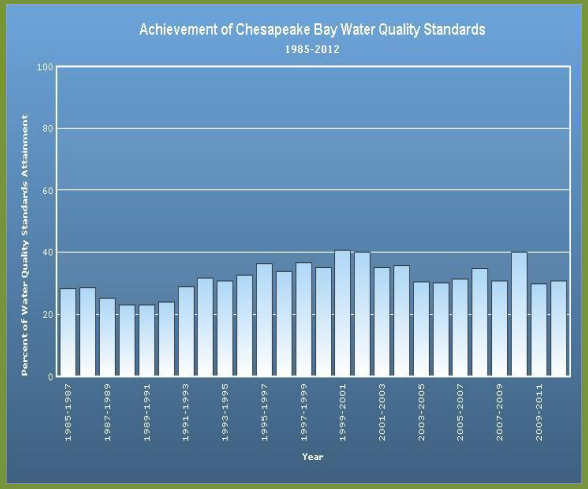
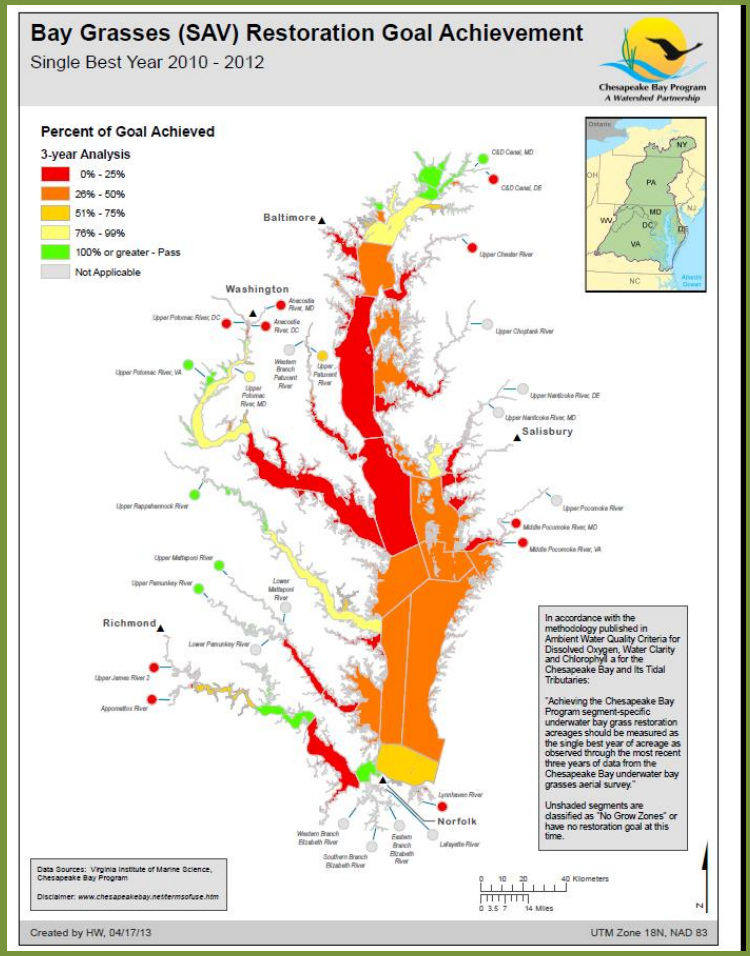




Chapter 5. Alignment of the Chesapeake Bay SAV Restoration Goals.

Issue:

- Chesapeake Bay Program staff identified a difference between the 2003 SAV goal target (185,000 acres) adopted by Chesapeake Bay Program partnership and the existing SAV target acreage goal based on the sum of State/DC adopted Chesapeake Bay water quality standards (192,000 acres) used in the TMDL.



Chapter Goal

- Alignment of the outdated 185,000 acre Chesapeake Bay SAV restoration goal with the TMDL that is based on State water quality standards (192,000 acres).

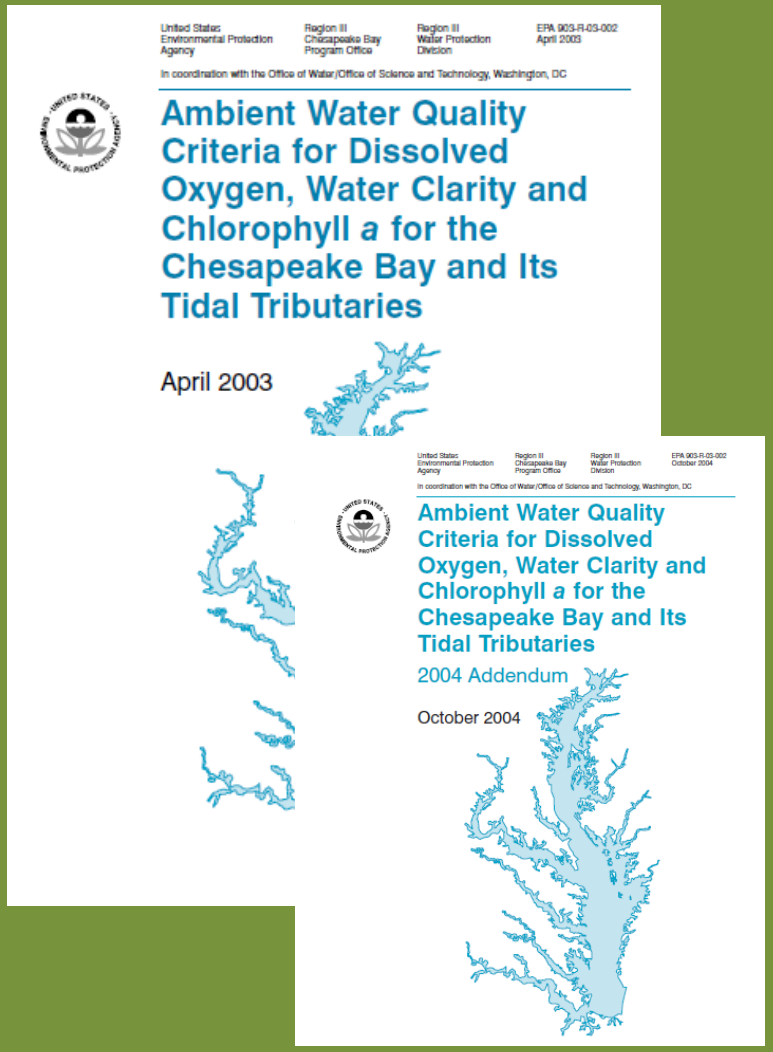
Quick Background History

- In 1993 the Chesapeake Executive Council formally adopted the Tier I SAV restoration target as the Chesapeake Bay Program's first quantitative living resource restoration goal (Chesapeake Executive Council 1993).

  - Refinements were made to the Tier I restoration goal as a result of a reevaluation of the historical SAV aerial survey digital data sets. The revised Tier I goal total was 113,720 acres.

Publication of the 185,000 acre goal

- The basis, derivation, revision and adoption of the 185,000 acre bay-wide submerged aquatic vegetation (SAV) acreage goal and associated assessment protocols is established in 2003 and 2004.
  - Documentation: U.S Environmental Protection Agency Region III's April 2003 publication of *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and its Tidal Tributaries (Regional Criteria Guidance)* and accompanying volumes of technical support documentation, e.g. U.S. EPA 2004.



2004: New information supported establishment of the water quality standards

- U.S. EPA 2004 (Oct) highlighted that:
  - *'Since the 2003 publication of both the Regional Criteria Guidance and the Technical Support Document, new information has become available to the watershed jurisdictions and EPA in support of state adoption of SAV restoration goal…acreages.*
  - *This new information will also help the four jurisdictions with Chesapeake Bay tidal waters to adopt consistent, specific procedures for determining attainment of the shallow-water bay grass designated uses into their regulations.*

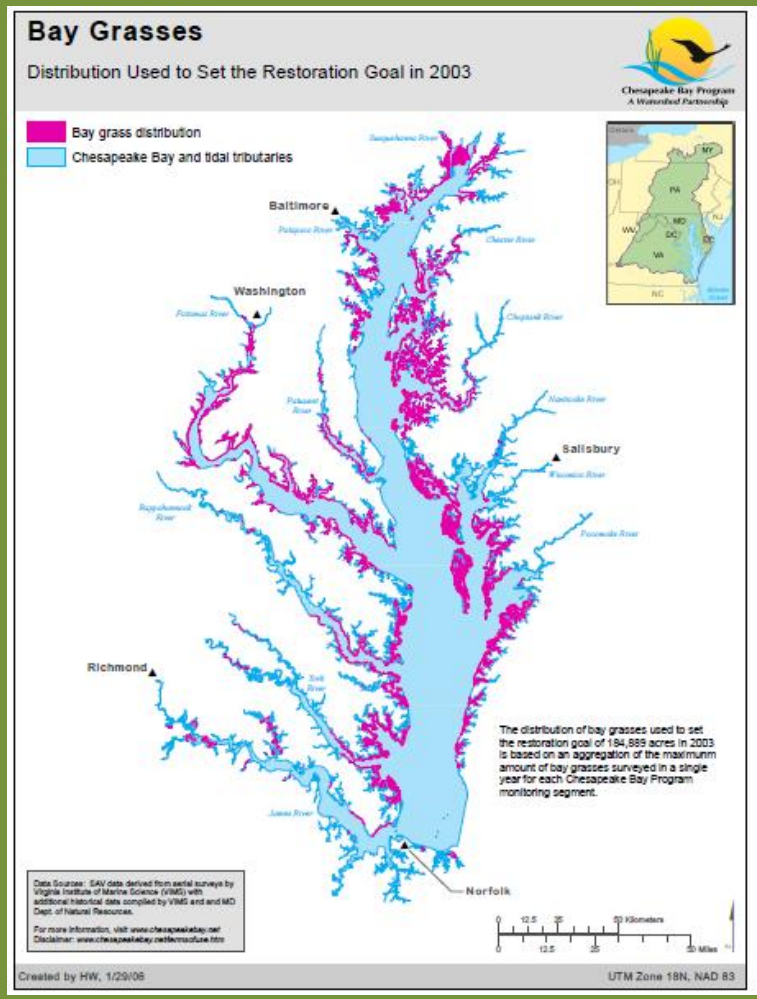
Segment acreage revisions: Single Best Year (SBY) measures were reassessed because…

- SAV was clipped to the GIS-based shoreline (not actual shore).
- No bathymetry on “land”, so SAV on “land” was not counted.

New data became available after the 185,000 acre goal was set.

- For the addendum (after goal set), VIMS data for 2001 and 2002 used in setting state regulations:
  - **"2002 Chesapeake Bay SAV Abundance and New Baywide Restoration Goal** *Published: September 22, 2003:* In 2002, SAV coverage reached a record 89,658 acres - more than twice the level first recorded in 1978."

    http://www.chesapeakebay.net/publications/title/2002_chesapeake_bay_sav_abundance_and_new_baywide_restoration_goal



New analyses + new data = improved science for developing water quailty standards acreages

- As recommended by EPA, the original Chesapeake Bay underwater grasses goal acreages by segment and the expanded restoration acreages were used. With few exceptions around the Bay, the water quality standards segment goals for SAV acres are equal to or greater than the segment acreage goals supporting the 185,000 acres.

192,000 acre goal evolved from the foundations of the 185,000 acre goal

Goal acreage basis for developing the Segment-specific Water Quality Standards	U.S. EPA 2008 Segment Count TMDL basis: 92 Management Segments
Segments where Water Quality Standards acres are **GREATER THAN OR EQUAL TO** the original 2003 CBP 185K goal acreages	85 (92.4%)
Segments where acreages were **lower** than the 185K CBP goals basis	7 (7.6%)

Summary

- In adopting segment-specific water clarity standards the Chesapeake Bay Program partners more accurately reflected segment SAV goal acreages from the aerial surveys.

- The 192,000 acre goal is better aligned with the method used in the annual aerial survey of SAV to assess the status of Bay grasses and track change towards attaining water clarity/SAV goals.

Chapter 6. Chesapeake Bay Aquatic Life Use assessments are used to inform water quality standards Assessments

Benthic community condition is assessed using a benthic index of biotic integrity (B-IBI), which evaluates the ecological condition of a sample by comparing values of key benthic community attributes to reference values expected under nondegraded conditions in similar habitat types. The program consists of:

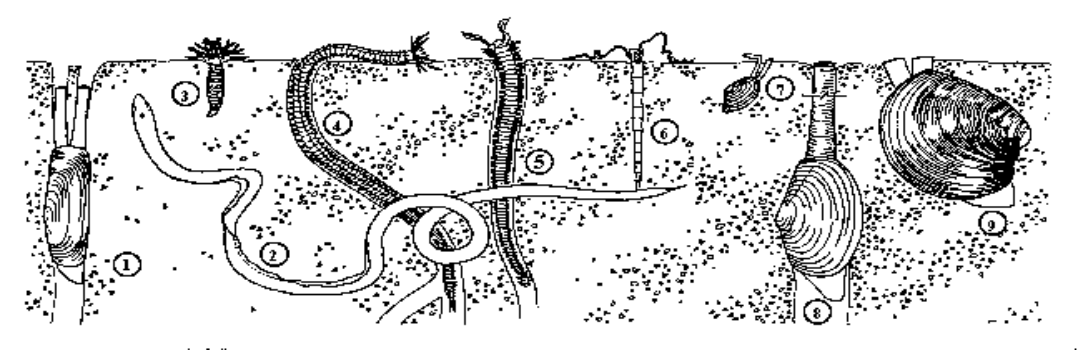
- a fixed-site monitoring effort directed at identifying temporal trends, and
- a probability-based sampling effort intended to assess the areal extent of degraded benthic community condition..

Reference values are the benthic community restoration goals for the Chesapeake Bay.

Chapter 6. Chesapeake Bay Benthic IBI
Interim Assessment Rules in lieu of a complete BIBI recalibration

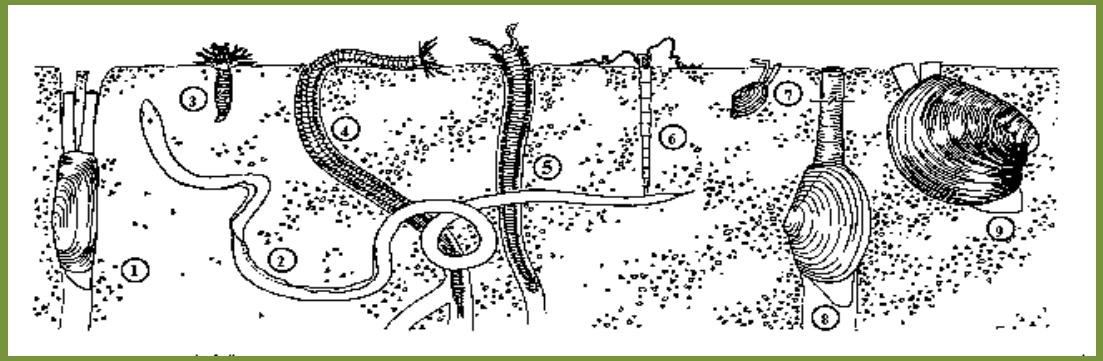
ISSUE:

- There are 4 Chesapeake Bay segments where BIBI results make little sense under existing decision rules (i.e., scores are poor, however, the segments are declared as meeting measures of attaining water quality standards).



Chapter 6. Chesapeake Bay Benthic IBI
Interim Assessment Rules in lieu of a complete BIBI recalibration

- An interim recommendation for classification of “insufficient information” is being applied.



Chapter 5. Recommendation: Interim Rules for Using BIBI to support Aquatic Life Use Assessments

For segments where "Impaired = No" identify those segments that have a breadth of confidence limits (Upper confidence Limit - Lower confidence Limit ≥ 0.5) of .5 or greater. Of that subset of segments, those that have a Mean BIBI <2.7 would be classified as Category 3 (insufficient information) until more conclusive information is available.

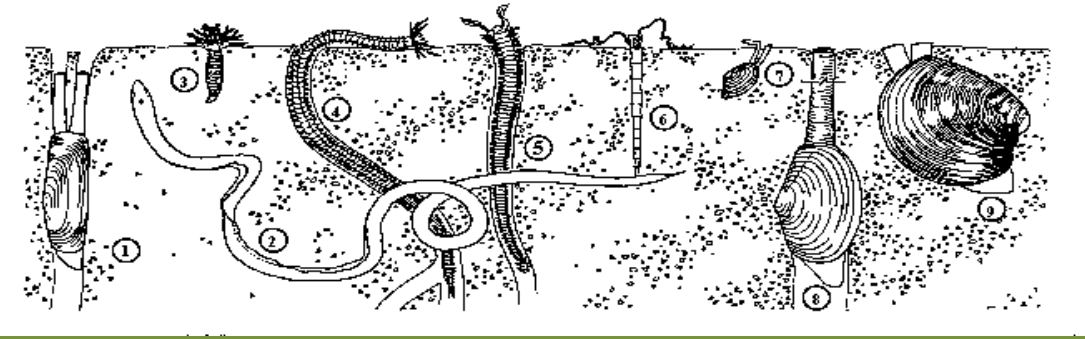
**WQGIT supported 2013*

Classification Category for Water Quality Status	Description
Category 1	All designated uses are supported, no use is threatened.
Category 2	Available data and/or information indicate that some, but not all, designated uses are supported.
Category 3	There is insufficient available data and/or information to make a use support determination.
• Category 3a	• VA: no data are available within the data window of the current assessment to determine if any designated use is attained and the water was not previously listed as impaired.
• Category 3b	• VA: some data exist but are insufficient to determine support of designated uses. Such waters will be prioritized for follow up monitoring, as needed.
• Category 3c	• VA: data collected by a citizen monitoring or another organization indicating water quality problems may exist but the methodology and/or data quality has not been approved for a determination of support of designated use(s). These waters are considered as having insufficient data with observed effects. Such waters will be prioritized by DEQ for follow up monitoring.
• Category 3d	• VA: data collected by a citizen monitoring or other organization indicating designated use(s) are being attained but the methodology and/or data quality has not been approved for such a determination.
Category 4	Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.
• Category 4a	• A State developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination.
• Category 4b	• Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period of time.
• Category 4c	• The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.
Category 5	Available data and/or information indicate that at least one designated use is not being supported or is threatened, and ***a TMDL is needed***.

Chapter 6. Chesapeake Bay Benthic IBI
Interim Assessment Rules in lieu of a complete BIBI recalibration

Summary

- An interim recommendation for classification of "insufficient information" is being applied.

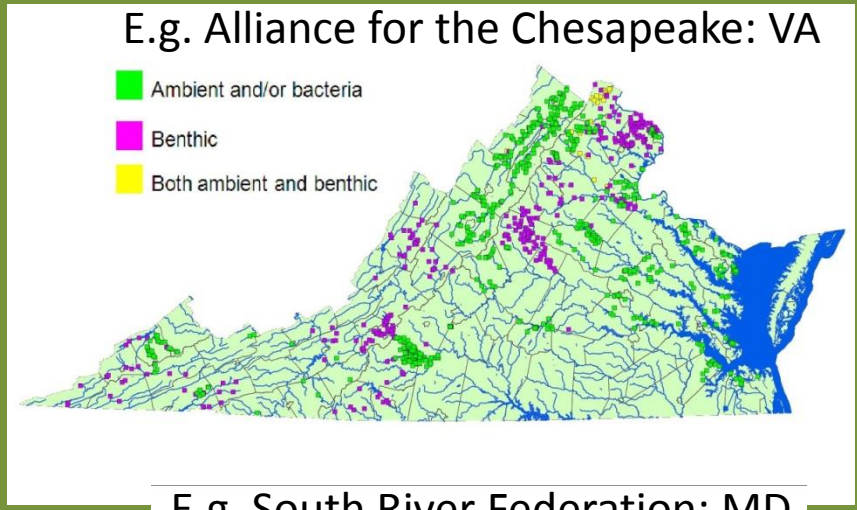


*Work has been supported by EPA to help alleviate this interim classification issue by updating the reference community assessment with 10 more years of data and recalibrating the IBI.

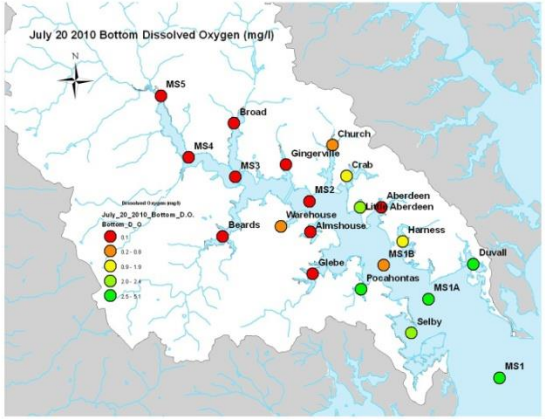
Chapter 7. Nontraditional Partner DO data collection and handling protocol

- Guidance is provided for nontraditional partners to follow EPA protocol for inclusion of their data in regulatory DO assessments.

E.g. Alliance for the Chesapeake: VA



E.g. South River Federation: MD



Chapter Goal

- Document the EPA approved requirements for regulatory quality data to be collected, approved and included in Chesapeake Bay dissolved oxygen water quality standards attainment assessments.


Köszönettel
Gracias
Teşekkürler
THANK YOU
Vielen Dank
תודה
Grazie
Merci
Díky