# Criteria Assessment Protocols
# Recommended Revisions

I.

Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

II.

Expanded Application of Deep Water and Deep Channel Designated Uses

Presentation to WQGIT 12 February 2010

# Decisions Requested

## Criteria Assessment Protocol Modifications

### I. Pycnocline Method: "Episodic-Only" v. "Episodic + Long-Term Average"

- To modify criteria assessment procedures to apply the Deep Water and Deep Channel designated uses only when a pycnocline is present

### II. Expanded Application of Deep Water and Deep Channel Designated Uses

- To apply the summer Deep Water designated use to the MAGMH and SOUMH segments when a pynocline is determined to be present
- To review application of the Deep Water designated use for additional segments prior to the 2012 listing assessment

# Background

## Open Water designated use

"If the presence of a pycnocline prevents oxygen replenishment, the open-water fish and shellfish designated use extends only as far as the upper boundary of the pycnocline. If a pycnocline exists but other physical circulation patterns (such as the inflow of oxygen-rich oceanic bottom waters) provide oxygen replenishment to the deep waters, the open-water fish and shellfish designated use extends to the bottom water-sediment interface."

## Deep Water designated use

"Tidally influenced waters located between the measured depths of the upper and lower boundaries of the pycnocline, ***where a measured pycnocline is present and presents a barrier to oxygen replenishment from June 1 to September 30***… the deep-water designated use extends from the upper boundary of the pycnocline down to the sediment/water interface at the bottom, where a lower boundary of the pycnocline is not calculated."

## Deep Channel designated use

"Tidally influenced waters at depths greater than the measured lower boundary of the pycnocline in isolated deep channels."

From EPA 903-R-03-002: Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and chlorophyll *a* for the Chesapeake Bay And Its Tidal Tributaries, April 2003

# Background

## Segments With Deep Water & Deep Channel Designated Uses:

From p. 5 of EPA criteria guidance document 903-R-04-006:

Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability: 2004 Addendum (October 2004)

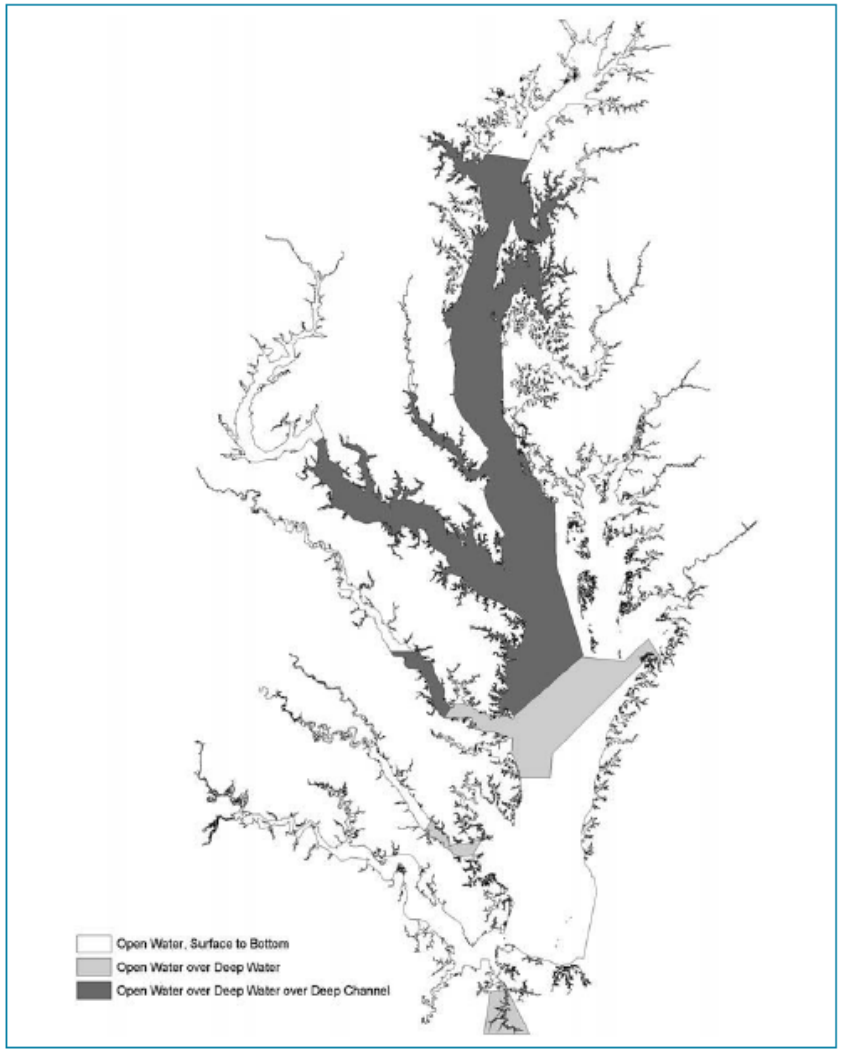



**Figure II-2.** Map illustrating the refined geographic distribution of the open-water fish and shellfish, deep-water seasonal fish and shellfish and deep-channel seasonal refuge designated uses across Chesapeake Bay and its tidal tributaries.

# Background

## Segments With Existing Deep Water & Deep Channel Designated Uses:

### Deep Water:

**CB3MH**

**CB4MH**

**CB5MH**

**CB6PH** (portion north of UTM Y 4145)

**CB7PH** (portion N/NW of UTM Y = UTM X + 3752745)

**CHSMH**

**EASMH**

**PATMH**

**PAXMH**

**POTMH**

**RPPMH** (portion S of UTM Y = 4185000)

**SBEMH**

**YRKPH**

### Deep Channel:

**CB3MH**

**CB4MH**

**CB5MH**

**CHSMH**

**EASMH**

**PATMH**

**POTMH**

**RPPMH** (portion S of UTM Y = 4185000 & upstream of line where UTM_Y – 1.49(UTM_X) ≥ 3621199.172)

From EPA 903-R-03-002: Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and chlorophyll *a* for the Chesapeake Bay And Its Tidal Tributaries (April 2003) and

EPA 903-R-04-006: Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability: 2004 Addendum (October 2004)

# Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

- A standardized method is used for identifying pycnoclines.

- The method is applied only in those segments that have been classified as containing Deep Water and Deep Channel designated uses (in addition to Open Water)

- In these segments, the pycnocline is used to delineate the boundaries of the Open Water, Deep Water, and Deep Channel designated uses
  - For summer months only: June – September

# Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

To date, an undocumented rule has been used for delineating pycnocline-based designated use boundaries:

- In those segments containing Deep Water and Deep Channel designated uses
  - For a given station, on a given sampling event (assuming vertical profile)
    - when a pycnocline is not identified for the sampling event using the standardized method, the long-term average pycnocline boundary for that station is used

# Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

Recommendation: to allow Deep Water and Deep Channel designated uses to occur “episodically”

- For those segments that have been classified as having deep water and deep channel designated uses
  - When a pycnocline is observed, the Deep Water and Deep Channel designated uses exist and their numeric criteria are applied
  - When no pycnocline is observed, the Open Water designated use applies to the entire water column

# Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

## Effects On TMDL Scenario Assessments: 1996-1998 Open Water Summer

| 1996-1998 Open Waer Summer | Scenario→ | 91 -'00 Base Scenario, 340TN 24.1TP | Target Load Scenario Option 3 198TN 14.8TP | E3 2010 Scenario, 138TN 12.0TP | | 91 -'00 Base Scenario, 340TN 24.1TP | Target Load Scenario Option 3 198TN 14.8TP | E3 2010 Scenario, 138TN 12.0TP |
|---|---|---|---|---|---|---|---|---|
| | | published DW & DC du's | | | | DU's per pycnocline | | |
| CB3MH | MD | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| CB4MH | MD | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| CB5MH | both | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| CB6PH | VA | 0.9% | 0.0% | 0.0% | | 1.1% | 0.0% | 0.0% |
| CB7PH | VA | 4.3% | 0.0% | 0.0% | | 4.4% | 0.0% | 0.0% |
| CHSMH | MD | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| EASMH | MD | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| MD5MH | MD | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| PATMH | MD | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| PAXMH | MD | 4.7% | 0.0% | 0.0% | | 3.9% | 0.0% | 0.0% |
| POMMH | MD | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| POTMH | both | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| POVMH | VA | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| RPPMH | VA | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| SBEMH | VA | 25.0% | 0.0% | 0.0% | | 23.8% | 0.0% | 0.0% |
| VA5MH | VA | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| YRKPH | VA | 6.9% | 0.0% | 0.0% | | 8.1% | 0.0% | 0.0% |

# Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

## Effects On TMDL Scenario Assessments: 1996-1998 Deep Water Summer

| 1996-1998 Deep Waer Summer | Scenario → | 91 -'00 Base Scenario, 340TN 24.1TP | Target Load Scenario Option 3 198TN 14.8TP | E3 2010 Scenario, 138TN 12.0TP | | 91 -'00 Base Scenario, 340TN 24.1TP | Target Load Scenario Option 3 198TN 14.8TP | E3 2010 Scenario, 138TN 12.0TP |
|---|---|---|---|---|---|---|---|---|
| | | published DW & DC du's | | | | DU's per pycnocline | | |
| CB3MH | MD | 1.9% | 0.3% | 0.0% | | 3.4% | 0.9% | 0.5% |
| CB4MH | MD | 19.9% | 8.2% | 4.4% | | 20.0% | 8.2% | 4.5% |
| CB5MH | both | 5.6% | 0.4% | 0.0% | | 5.8% | 0.4% | 0.0% |
| CB6PH | VA | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| CB7PH | VA | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| CHSMH | MD | 0.0% | 0.0% | 0.0% | | 2.2% | 0.2% | 0.4% |
| EASMH | MD | 1.9% | 0.0% | 0.1% | | 8.6% | 1.3% | 1.0% |
| MD5MH | MD | 9.5% | 1.2% | 0.0% | | 9.7% | 1.2% | 0.0% |
| PATMH | MD | 5.5% | 0.0% | 0.0% | | 7.7% | 0.0% | 0.0% |
| PAXMH | MD | 1.8% | 0.0% | 0.0% | | 1.1% | 0.0% | 0.0% |
| POMMH | MD | 6.3% | 0.0% | 0.0% | | 6.7% | 0.0% | 0.0% |
| POTMH | both | 6.2% | 0.0% | 0.0% | | 6.6% | 0.0% | 0.0% |
| POVMH | VA | 0.0% | 0.0% | 0.0% | | 0.0% | 0.0% | 0.0% |
| RPPMH | VA | 7.0% | 0.0% | 0.0% | | 7.3% | 0.0% | 0.0% |
| SBEMH | VA | 0.0% | 0.0% | 0.0% | | 0.0% | NoData | NoData |
| VA5MH | VA | 0.3% | 0.0% | 0.0% | | 0.7% | 0.0% | 0.0% |
| YRKPH | VA | 1.1% | 0.0% | 0.0% | | 2.0% | 0.0% | 0.0% |

# Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

## Effects On TMDL Scenario Assessments: 1996-1998 Deep Channel Summer

| 1996-1998 Deep Channel Summer | Scenario → | 91 -'00 Base Scenario, 340TN 24.1TP | Target Load Scenario Option 3 198TN 14.8TP | E3 2010 Scenario, 138TN 12.0TP | | 91 -'00 Base Scenario, 340TN 24.1TP | Target Load Scenario Option 3 198TN 14.8TP | E3 2010 Scenario, 138TN 12.0TP |
|---|---|---|---|---|---|---|---|---|
| | | published DW & DC du's | | | | DU's per pycnocline | | |
| CB3MH | MD | 6.8% | 0.6% | 0.0% | | 13.3% | 2.9% | 0.0% |
| CB4MH | MD | 52.2% | 4.2% | 0.0% | | 52.6% | 4.1% | 0.0% |
| CB5MH | both | 17.6% | 0.0% | 0.0% | | 18.9% | 0.0% | 0.0% |
| CB6PH | VA | N/A | N/A | N/A | | 0.0% | 0.0% | 0.0% |
| CB7PH | VA | N/A | N/A | N/A | | 0.0% | 0.0% | 0.0% |
| CHSMH | MD | 0.0% | 1.9% | 0.7% | | 5.6% | 8.1% | 4.2% |
| EASMH | MD | 22.4% | 4.7% | 0.1% | | 29.3% | 6.4% | 0.5% |
| MD5MH | MD | 28.5% | 0.0% | 0.0% | | 29.1% | 0.0% | 0.0% |
| PATMH | MD | 16.2% | 0.0% | 0.0% | | 19.8% | 0.0% | 0.0% |
| PAXMH | MD | N/A | N/A | N/A | | 7.6% | 0.0% | 0.0% |
| POMMH | MD | 18.9% | 0.0% | 0.0% | | 21.1% | 0.0% | 0.0% |
| POTMH | both | 18.8% | 0.0% | 0.0% | | 20.9% | 0.0% | 0.0% |
| POVMH | VA | NoData | NoData | NoData | | NoData | NoData | NoData |
| RPPMH | VA | 18.2% | 0.0% | 0.0% | | 22.8% | 0.0% | 0.0% |
| SBEMH | VA | N/A | N/A | N/A | | NoData | NoData | NoData |
| VA5MH | VA | 2.4% | 0.0% | 0.0% | | 2.5% | 0.0% | 0.0% |
| YRKPH | VA | N/A | N/A | N/A | | 0.0% | 0.0% | 0.0% |

# Pycnocline Method: “Episodic-Only” v. “Episodic + Long-Term Average”

## Summary

- It is technically sound to apply Deep Water and Deep Channel designated uses only when evidence of stratification is present
- “This is how we thought you were doing it already”
- Effect on assessment results is small
- Recommendation from CAP workgroup:
  - In any segments that have been determined to contain deep water and deep channel designated uses, to apply those uses only when pycnoclines are found to be present.

**Criteria Assessment Protocols**
**Recommended Revisions**

II.

Expanded Application of Deep Water and Deep Channel Designated Uses

# Expanded Application Of Deep Water & Deep Channel Designated Uses

## Deep Water designated use

Where:

1. the physical exchange of higher oxygenated waters in the upper water-column habitats is much reduced by density stratification, ***and***
2. pycnocline waters are not reoxygenated by riverine or oceanic bottom waters

## Deep Channel designated use

1. The very deep water-column and adjacent bottom surficial sediment habitats located principally in the river channel at the lower reaches of the major rivers and along the spine of the middle mainstem of the bay
2. At depths below which seasonal anoxic to severe hypoxic conditions routinely set in and persist for extended periods of time under current conditions
3. At depths greater than the lower boundary of the pycnocline

From EPA 903-R-03-002: Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and chlorophyll *a* for the Chesapeake Bay And Its Tidal Tributaries, April 2003

# Expanded Application Of Deep Water & Deep Channel Designated Uses

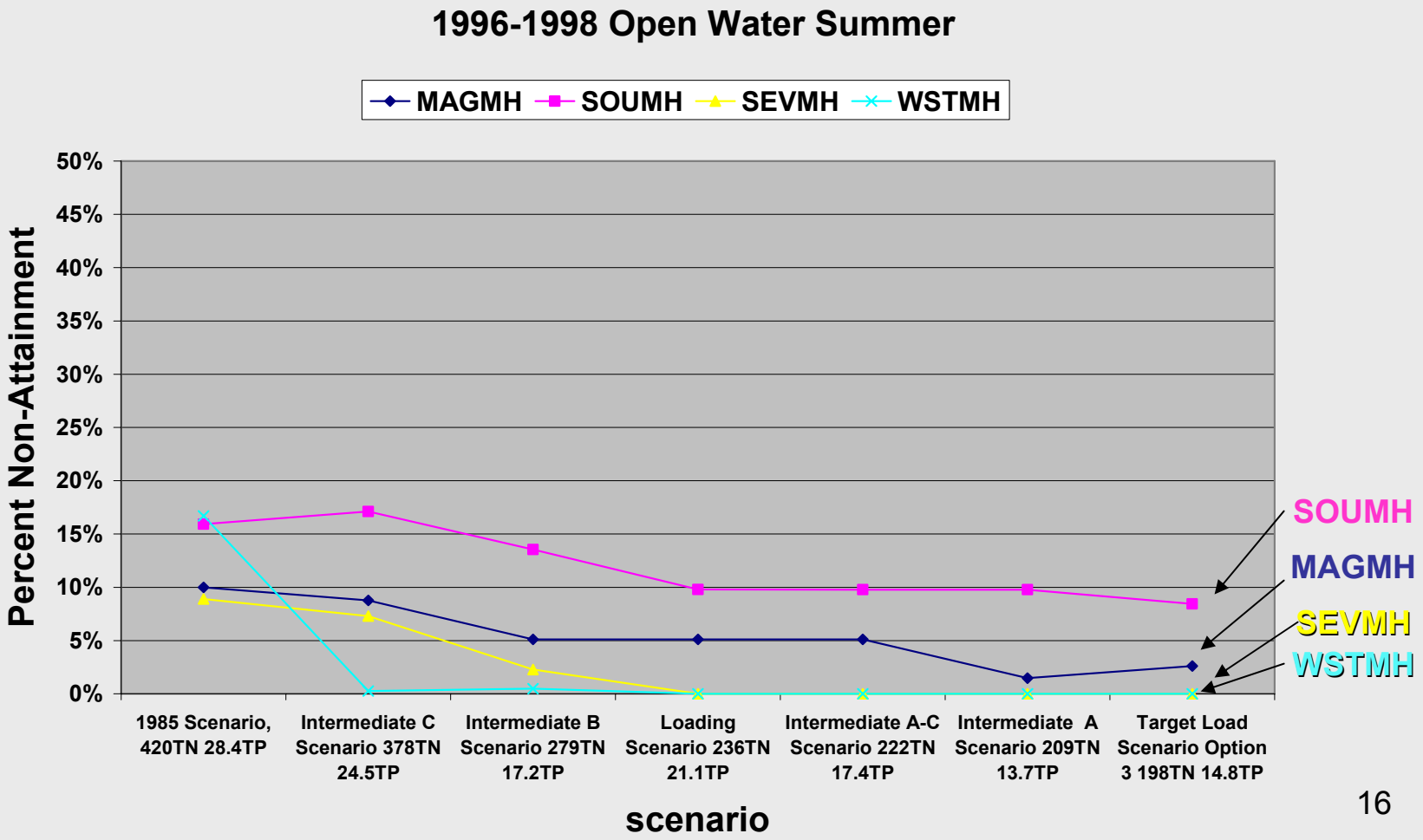
Where:

1. The physical exchange of higher oxygenated waters in the upper water-column habitats is much reduced by density stratification, ***and*** pycnocline waters are not reoxygenated by riverine or oceanic bottom waters…
2. …located principally in the river channel at the lower reaches of the major rivers and along the spine of the middle mainstem of the bay…

From EPA 903-R-03-002: Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and chlorophyll *a* for the Chesapeake Bay And Its Tidal Tributaries, April 2003

# Expanded Application Of Deep Water & Deep Channel Designated Uses

Results of Scenario Assessments indicated that these segments were responding less than many others to load reductions



# Expanded Application Of Deep Water & Deep Channel Designated Uses

1. Where density stratification occurs:
   - 44 segments suggested pycnocline presence
     - **3 in TF**
     - **13 in OH**
     - **24 in MH**
     - **4 in PH**

2. But pycnocline must prevent reoxygenation

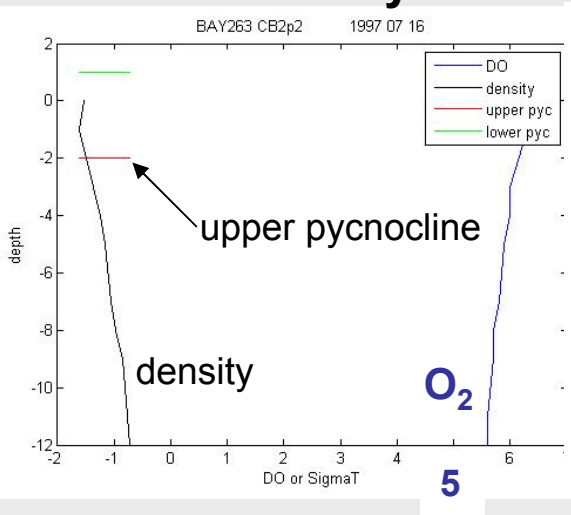
| MH & PH Segments | Nr. Upper Pycs (~40) | Nr. Lower Pycs (~60-70) |
|---|---|---|
| BIGMH | 4 | 0 |
| CHOMH1 | 39 | 47 |
| CHOMH2 | 39 | 20 |
| CRRMH | 6 | 0 |
| EBEMH | 1 | 0 |
| FSBMH | 4 | 0 |
| JMSMH | 38 | 11 |
| LCHMH | 30 | 36 |
| MAGMH | 16 | 0 |
| MANMH | 12 | 0 |
| NANMH | 15 | 0 |
| PIAMH | 16 | 7 |
| POCMH | 13 | 6 |
| SEVMH | 32 | 14 |
| SOUMH | 27 | 19 |
| TANMH | 37 | 50 |
| WBEMH | 3 | 0 |
| WICMH | 17 | 3 |
| WSTMH | 2 | 0 |
| YRKMH | 33 | 8 |
| CB8PH | 40 | 68 |

| OH & TF Segments | Nr. Upper Pycs (~40) | Nr. Lower Pycs (~60-70) |
|---|---|---|
| CB1TF | 24 | 2 |
| CB2OH | 32 | 45 |
| CHOOH | 38 | 20 |
| CHOTF | 1 | 0 |
| CHSOH | 28 | 12 |
| CHSTF | 2 | 0 |
| ELKOH | 2 | 0 |
| JMSOH | 19 | 2 |
| PO1OH | 40 | 33 |
| MPNOH | 6 | 0 |
| NANOH | 15 | 0 |
| PAXOH | 31 | 1 |
| PMKOH | 1 | 0 |
| POTOH | 40 | 33 |
| SASOH | 1 | 1 |

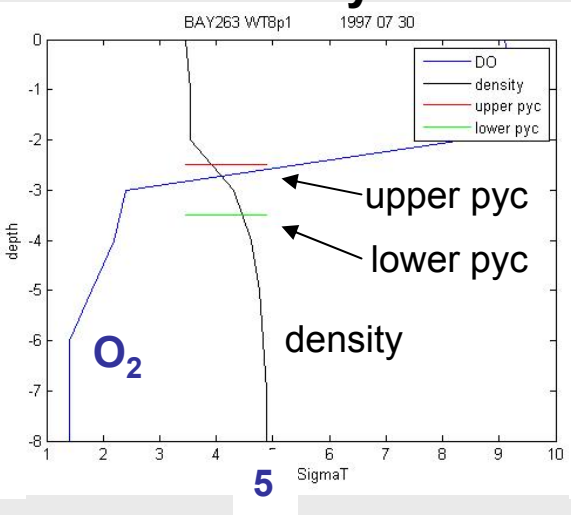
# Expanded Application Of Deep Water & Deep Channel Designated Uses

- Where presence of a pycnocline does/does not prevent reoxygenation

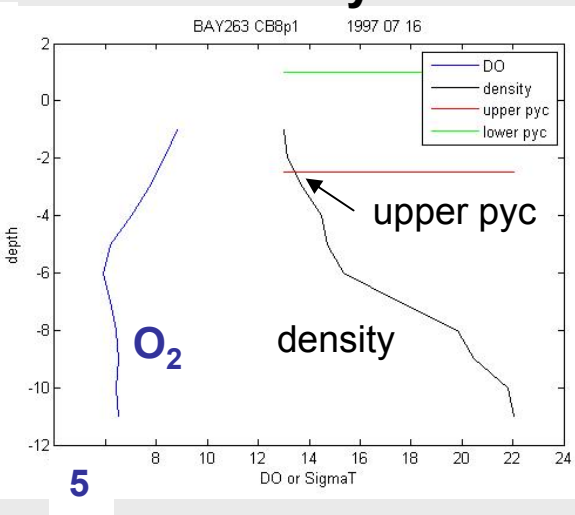
**CB2OH July 1997**




**SOUMH July 1997**




**CB8PH July 1997**




- We do/don't see evidence of criteria violation

| (1996-1998)<br><br>Segment | Historical monitoring data | Draft Target Load Scenario<br>198TN, 14.8 TP<br>DO Open Water Summer Monthly |
|---|---|---|
| CB2OH | 0.02% | 0.0% |
| CB8PH | 0.0% | 0.0% |
| SOUMH | 17.1% | 11.0% |

# Expanded Application Of Deep Water & Deep Channel Designated Uses

Plan:

1. Phase I: Pre-TMDL
    - Limited the “pre-TMDL” review to MH & PH segments with high probability of both stratification & persistent oxygen violations
        - Consistent with current published guidance for designated use boundaries (e.g. “lower reaches of rivers and mainstem of bay”)
        - Time constraint

2. Phase II: Post-TMDL
    - Review additional segments for potential application of DW and DC designated uses prior to 2012 listing assessment

# Expanded Application Of Deep Water & Deep Channel Designated Uses

Plan:

- Use time period 1991-2000

- Depth profiles of change in density and oxygen concentrations provide both evidence of stratification and prevention of re-oxygenation

- Criteria assessments provide evidence of criteria violation and lack of response to load reductions
  - Lack of response suggests physical constraint to re-oxygenation

# Expanded Application Of Deep Water & Deep Channel Designated Uses

## Phase I: Pre-TMDL

- We identified persistent violations for each scenario (Base, Target, E3).

- Segments with both stratification and persistent violations were put on "Phase I" list (n=10 segments) for pre-TMDL review:

  - MAGMH+ Magothy River
  - SOUMH+ South River

  - EBEMH* Elizabeth River
  - WBEMH* Elizabeth River
  - CRRMH* Rappahannock River
  - FSBMH* Fishing Bay
  - WICMH* Wicomico River
  - SEVMH* Severn River
  - WSTMH* West River
  - YRKMH* York River

**+** segments where stratification appears to limit oxygen replenishment

***** Segments where stratification does ***not*** appear to limit oxygen replenishment

# Expanded Application Of Deep Water & Deep Channel Designated Uses

## Phase I: Pre-TMDL

- Segments where presence of a pycnocline appeared to prevent re-oxygenation (i.e. deep waters do not respond sufficiently to reduced load scenarios) represented highest priority for review and were assigned to Phase I.
  - SOUMH (South River)
  - MAGMH (Magothy River)

- Segments showing only “Base” scenario violations (*) were assigned to Phase II
  - In these segments, improved conditions for load reduction scenarios suggest that stratification does not prevent re-oxygenation of deep waters.
    - EBEMH (Elizabeth R.)
    - WBEMH (Elizabeth R.)
    - CRRMH (Rappahannock R.)
    - FSBMH (Fishing Bay)
    - WICMH (Wicomoco R.)
    - SEVMH (Severn R.)
    - WSTMH (West R.)
    - YRKMH (York R.)

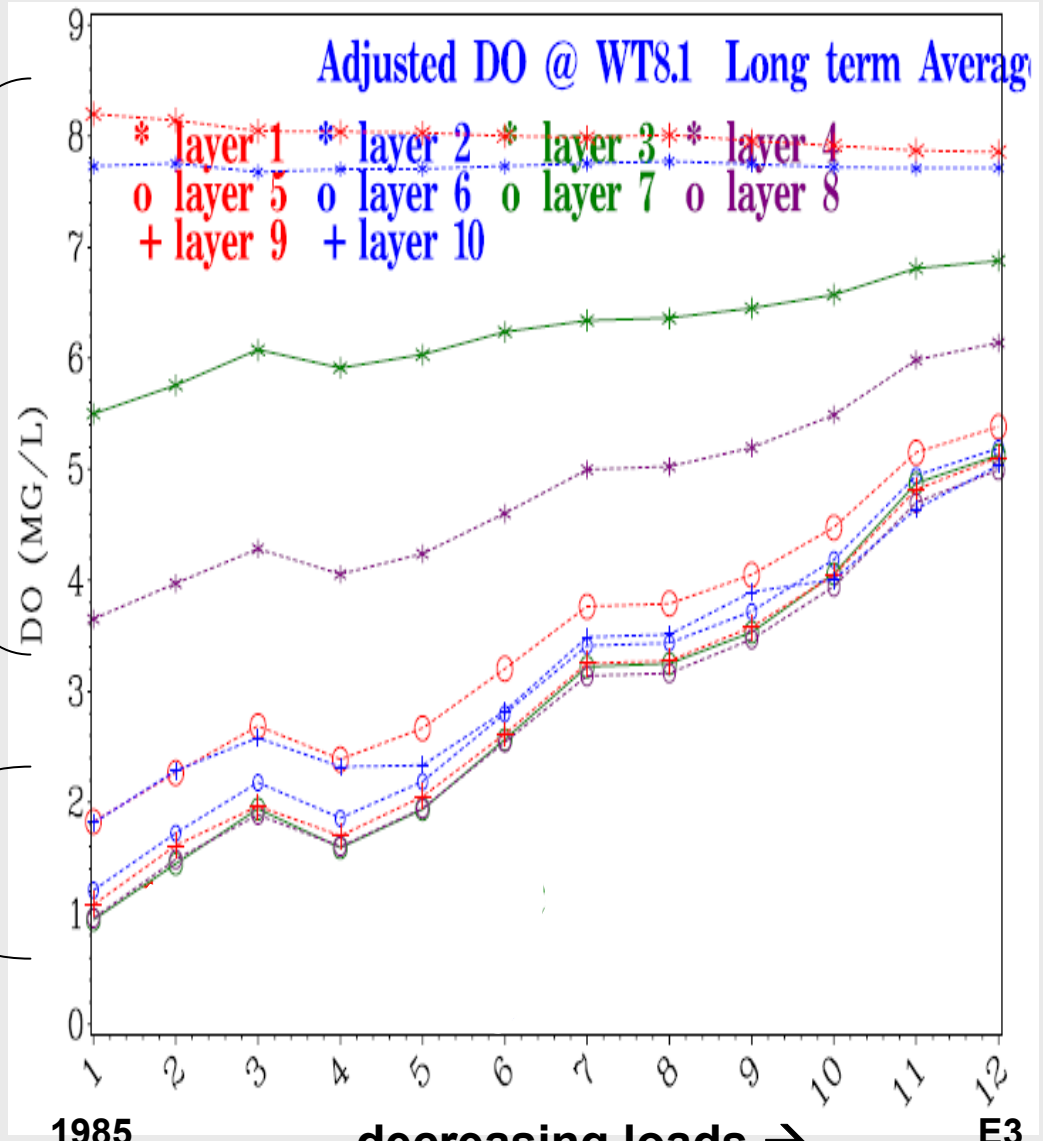
# Expanded Application Of Deep Water & Deep Channel Designated Uses

Phase I: Pre-TMDL

layers 1 thru 4

layers 5 thru 8

**Compression of DO concentrations at depth in SOUMH suggests constraint on re-oxygenation**

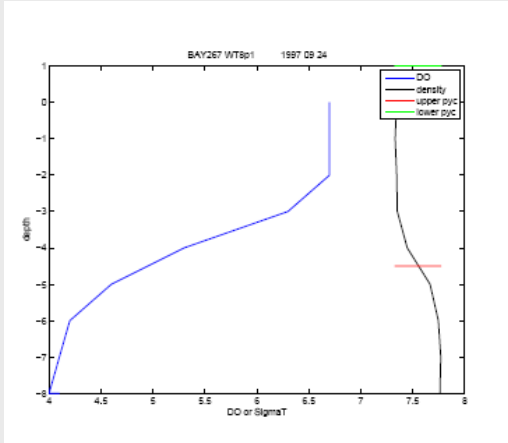


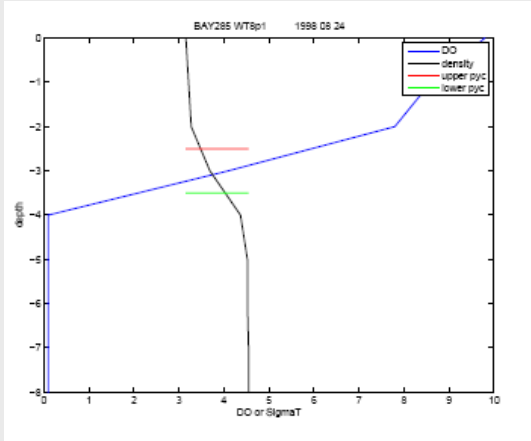
# Expanded Application Of Deep Water & Deep Channel Designated Uses

## MAGMH & SOUMH: results

### SOUMH

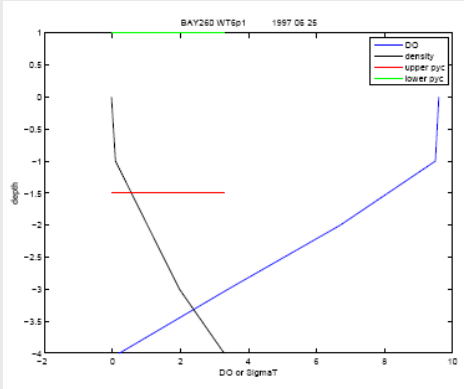
- 39 of 43 depth profiles (91%) had upper pycnocline
- 19 of 43 depth profiles (44%) had lower pycnocline

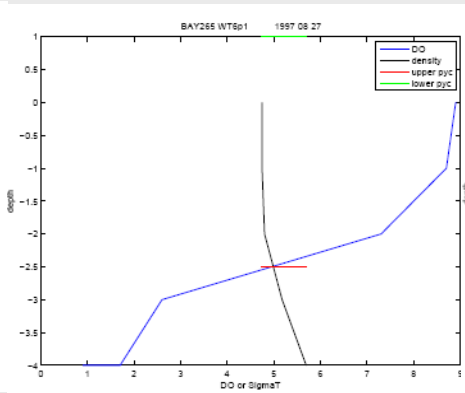


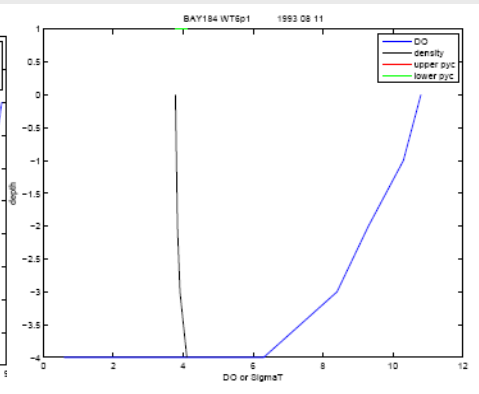




### MAGMH:

- 16 of 40 depth profiles (40%) had upper pycnocline
- 0 of 40 depth profiles (0%) had lower pycnocline



# Expanded Application Of Deep Water & Deep Channel Designated Uses

## Phase I: Pre-TMDL

The Criteria Assessment Protocol (CAP) Workgroup reviewed evidence of:

- Stratification
- Evidence of lack of expected response to load reductions

**Recommendation from the CAP Workgroup:**

- **When a pycnocline is present, apply the Deep Water designated use to MAGMH and SOUMH**

# Expanded Application Of Deep Water & Deep Channel Designated Uses

## Implications: Historical Loading Scenario

**Entire water column is Open Water:**

Open Water

(criterion ≥5.0 mg/L)

OW volume not attaining:

5%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**Water column is divided into OW & DW:**

**Hypoxic volume occurs in deep water, below pycnocline**

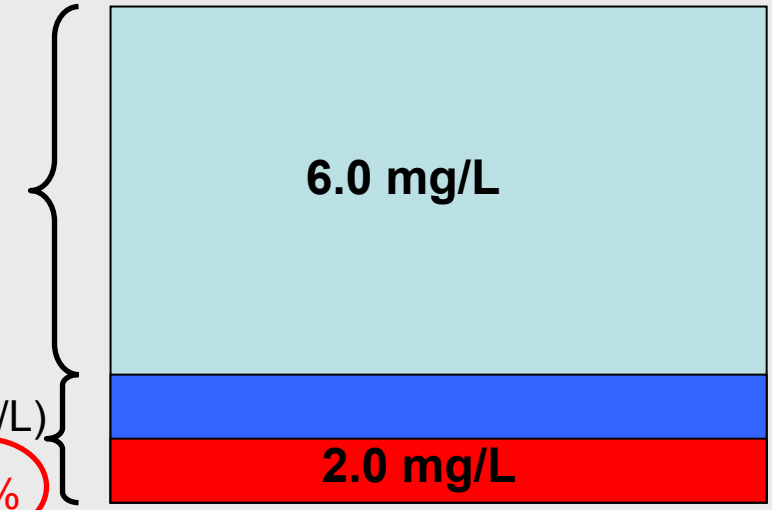
Open Water

OW volume not attaining:

0%

Deep Water (criterion ≥3.0 mg/L)

DW volume not attaining: 50%



# Expanded Application Of Deep Water & Deep Channel Designated Uses

## Implications: Reduced Loading Scenario

**Entire water column is Open Water:**

Open Water (criterion ≥5.0 mg/L)

volume not attaining:

5%


---

**Water column is divided into OW & DW:**

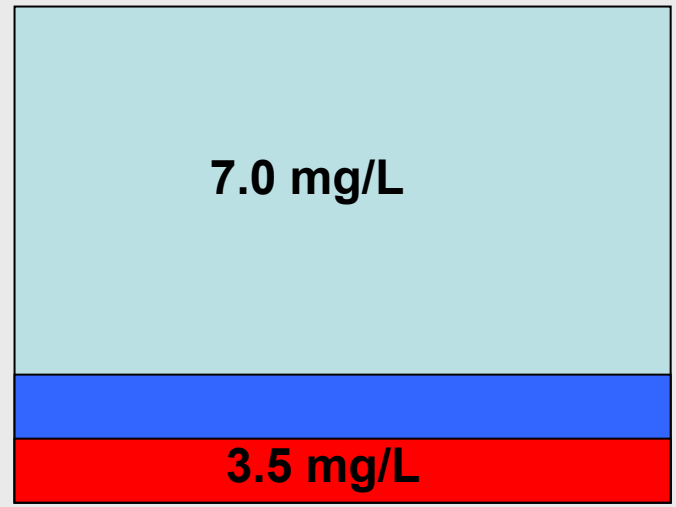
**Hypoxic volume occurs in deep water, below pycnocline**

OW volume not attaining:

0%

Deep Water (criterion ≥ 3.0 mg/L)

volume not attaining: 0%



# Expanded Application Of Deep Water & Deep Channel Designated Uses

## Implications: Criteria Assessment Results For Draft Target Load Scenario

| Segment | Open Water Only<br>Target Load Scenario Option 3 198TN 14.8TP<br>'96-'98<br>DO Open Water Summer Monthly |
|---|---|
| MAGMH | 2.6% |
| SOUMH | 8.4% |

| Segment | Open Water + Deep Water<br>Target Load Scenario Option 3 198TN 14.8TP<br>'96-'98<br>DO Open Water Summer Monthly | Target Load Scenario Option 3 198TN 14.8TP<br>'96-'98<br>DO Deep Water |
|---|---|---|
| MAGMH | 0.0% | 0.0% |
| SOUMH | 0.0% | ~2.0% |

# Decisions Requested

## Criteria Assessment Protocol Modifications

### I. Pycnocline Method: "Episodic-Only" v. "Episodic + Long-Term Average"

- To modify criteria assessment procedures to apply the Deep Water and Deep Channel designated uses only when a pycnocline is present

### II. Expanded Application of Deep Water and Deep Channel Designated Uses

- To apply the summer Deep Water designated use to the MAGMH and SOUMH segments when a pynocline is determined to be present
- To review application of the Deep Water designated use for additional segments prior to the 2012 listing assessment