Instantaneous Minimum Criteria Workshop: Afternoon Discussions

A joint meeting of the Chesapeake Bay Program's Criteria Assessment Protocol Work Group and the Tidal Monitoring and Analysis Work Group

December 2, 2013

Our charge:

To develop science-based recommendations for consideration by the Chesapeake Bay Program partnership that may include:

1. alternative interpretations of the instantaneous minimum criterion definition,

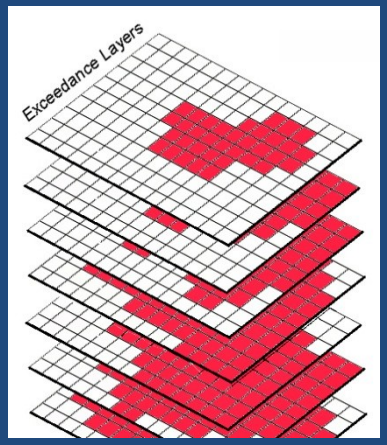
2. alternative short-duration criteria, and

3. coincident options for their procedures supporting their assessment.

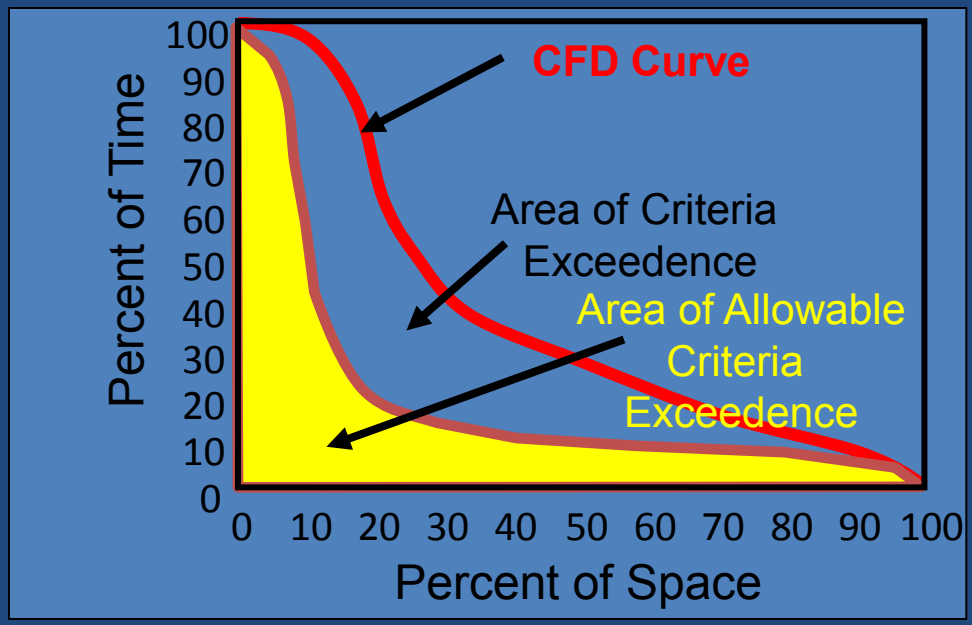
1. Chesapeake Bay has science-based protections of populations and communities of living resources.

Designated Use	Dissolved oxygen criterion concentration	Protection Provided	Temporal Application
Migratory fish spawning and nursery use	≥5 mg/L	Survival and growth of larval/juvenile migratory fish; protective of endangered species	February 1-May 31
	≥3.2 mg/L	Survival of threatened/endangered sturgeon species	June 1-January 31
Open water fish and shellfish use	≥3.2 mg/L	Survival of threatened/endangered sturgeon species	Year-round
Shallow water Bay grass use	≥3.2 mg/L	Survival of threatened/endangered sturgeon species	Year-round
Deep water use	≥1.7 mg/L	Survival of bay anchovy eggs and larvae.	June 1-September 30
	≥3.2 mg/L	Survival of threatened/endangered sturgeon species	October 1-May 31
Deep channel seasonal refuge use	≥1 mg/L	Survival of bottom dwelling worms and clams	June 1-September 30
	≥3.2 mg/L	Survival of threatened/endangered sturgeon species	October 1-May 31

2. Water Quality Criteria Assessment Procedures



"Monitoring" (Synthetic) Data



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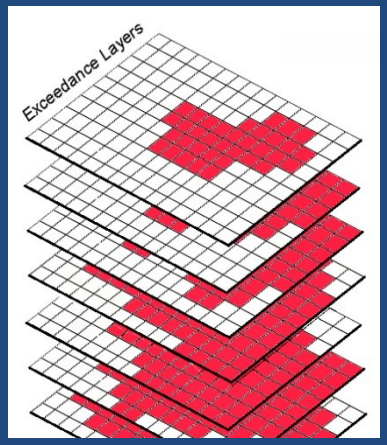

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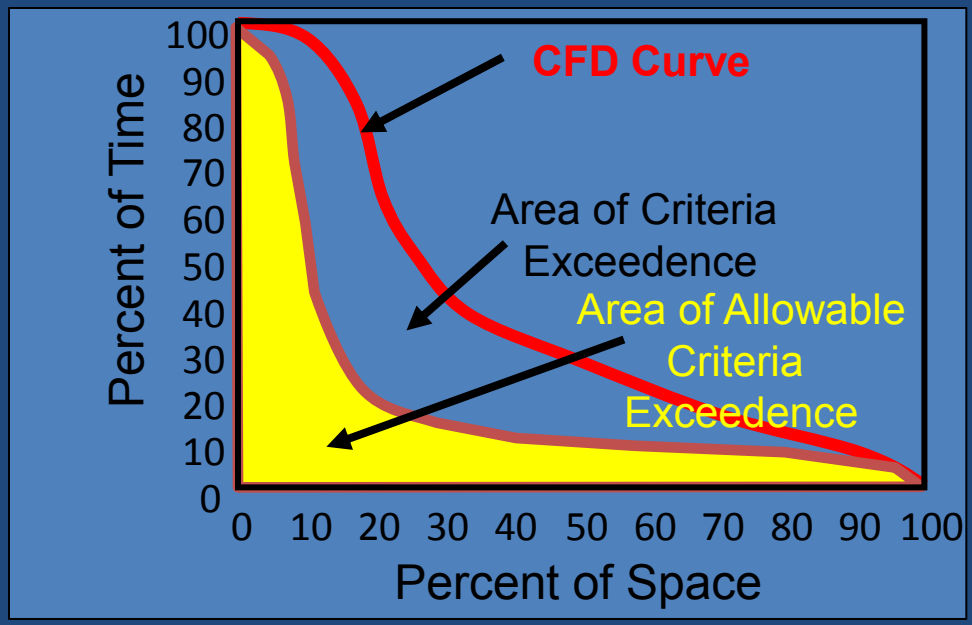
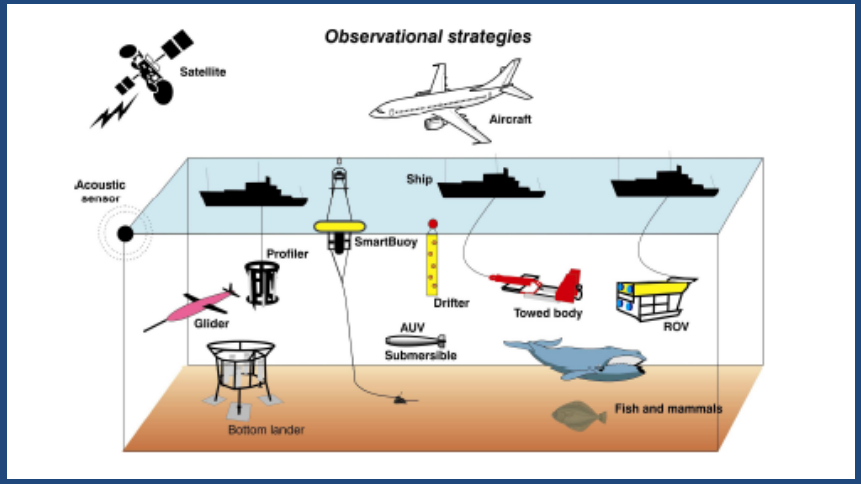


Allowable exceedances are captured.

Two Choices for Assessing Short Duration Criteria in Chesapeake Bay

1. Measure water quality at high temporal frequency.
   (E.g. Virginia example)



2. Use the Umbrella Criterion Approach defining the acceptable risk of nonattainment for unmeasured criteria*

* Open water designated use

What else is out there in the universe of minimum criteria?

Some Minimum Criteria Interpretations

- ***Daily minimums*** are popular among the states.
  - U.S. EPA 2000. *Criterion Minimum Concentrations* (CMCs) are defined as daily concentrations below which any exposure for a 24-hr period would result in unacceptable acute effects (mortality) to sensitive species.
  - Further, potentially used because of relationships with mean conditions if we understand the relationship to DO variability.
    - Variation on a theme II: Proposed "daily mean with daily minimum, assessed every 15 minutes, no more than 10% violations in 24 hours." (FL)
    - Variation on a theme :"Daily minimum allowable deviation" from the criterion. (MA)

Some Minimum Criteria Interpretations

- ***Instantaneous minimum = daily average*.**
  - FL 2011 draft criteria document states, for assessment purposes, "An instantaneous minimum taken during daylight hours can substitute for a daily average."
    - If Chesapeake Bay adopted this rationale as a definition, daily water quality profiles at each site in the monitoring network could be used to assess IM *and* 1-day mean criteria.

Some Minimum Criteria Interpretations

- ***<u>Instantaneous minimum = 1-hour average</u>***
  - EPA states that a 1-hr average translates to 'instantaneous minimum'.
    - 1 hour averaging requires some form of high frequency measuring.

VIMS WQ Profiler

Water-loving graduate student?

Some Minimum Criteria Interpretations

- ***Cumulative exposure – Rhode Island***.
  - Because larval recruitment occurs over the whole season, the low DO exposure effects are cumulative. Exposures are evaluated on a daily basis to determine the total seasonal exposure.

  - When instantaneous DO values fall below 4.8 mg/l, the waters shall not be:

    - 1. Less than 2.9 mg/l for more than 24 consecutive hours during the recruitment season; nor
    - 2. Less than 1.4 mg/l for more than 1 hour more than twice during the recruitment season; nor
    - 3. Shall they exceed the cumulative DO exposure presented in Table 3.A.

I interpret this to essentially be the Ches Bay approach with additional temporal resolution

Directions to get us through the afternoon.

- Discussion regarding Instantaneous minimum criteria in Chesapeake Bay.
  - Recommend same criteria, different, and why.
- Consider the available monitoring network that supports the criteria attainment assessments.
  - Funding stresses on sustaining the existing program can affect monitoring capacity.
- Recap where we are in discussions at 2:30pm.
- If we derive more than one recommendation, we will have a vote at 2:45pm to register strength of support for a recommendation.
- Recommendation(s) will be presented to the CBP Water Quality Goal Implementation Team for approval and incorporated into the next Chesapeake Bay Ambient Water Quality Criteria addendum in 2014.

The aquatic life based approach utilized for the Virginia Province (EPA 2000) identifies three important DO concentration levels.

U.S. EPA 2000 Virginia Province publication:
1. The Criterion Continuous Concentration (CCC) which is defined as the **mean daily DO** above which continue exposure is not expected to result in unacceptable chronic effects to sensitive biological communities.
2. The Criterion Minimum Concentration (CMC) which is defined as a daily DO concentration below which any exposure for a 24-hour period would results unacceptable acute effects (mortality) to sensitive organisms.
3. The FRC, which is a function that defines the maximum allowable exposure duration at DO concentrations between the CMC and CCC necessary to prevent unacceptable reductions in seasonal larval recruitment for sensitive species.

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Example of # 2 and #3.

Proposal for an instantaneous minimum criterion as summer daily minimum: 1 hour average. (CMC)

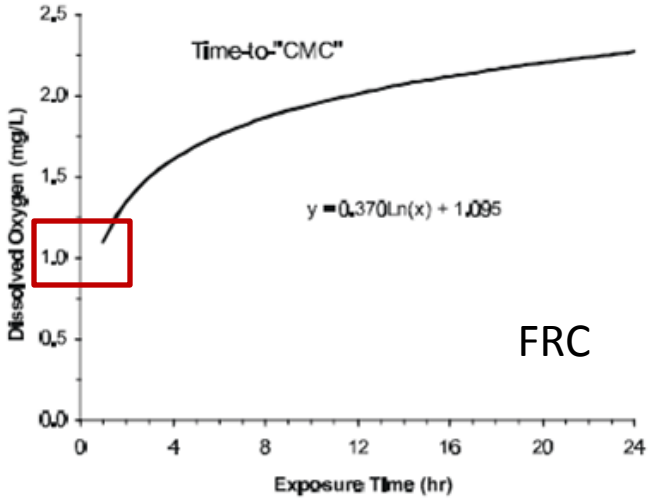

Figure 10. Criterion for juvenile saltwater animals exposed to low DO for 24 hr or less. The line represents the same protective limit as the CMC for juveniles for continuous exposure. The line is a logarithmic expression with a slope and intercept calculated from the regressions in Figure 9 at the DO concentration of 2.3 mg/L (the CMC).

Sampling of minimum criteria

Agency/Institution	Water Column Measures		
	1 Day Minimum[1]	7-Day Mean Minimum[2]	30-Day Mean Minimum
Oregon	9.0 mg/L[3]	11.0 mg/L	
Idaho	6.0 mg/L[4]		
Alaska	7.0 mg/L		
Washington	9.5 mg/L		
British Columbia	9.0 mg/L		11.0 mg/L
Makah Tribe	9.5 mg/L	11.0 mg/L	
Port Gamble S'Klallam Tribe	9.0 mg/L	11.0 mg/L	
Confederated Tribes of the Umatilla Indian Reservation	9.0 mg/L	11.0 mg/L	
Lummi Nation	9.0 (11.0) mg/L		
Confederated Tribes of the Warm Springs Indian Reservation	9.0 (11.0) mg/L		
Confederated Tribes of the Colville Indian Reservation	8.0 mg/L[5]	9.5 mg/L[5]	

Other minimum criteria thoughts

- Massachusetts: Daily minimum allowable deviation from the criterion.

- Florida: one proposal is daily mean with daily minimum, assessed every 15 minutes, no more than 10% violations in 24 hours.

- Florida 2: Proposed draft: Temperature dependent freshwater criteria example:
  - The % DO saturation shall not be less than 42%, or
  - The DO concentration shall not be less than the value produced by the following equation:

  DO=(-0.00003*T^3)+(0.0031*T^2)-0.1653*T+6.1003

- California: San Francisco Bay: 3 month median of 80% saturation

FL Marine: Draft 2011 proposed options for statewide DO criteria. Part 1

- Daily (24 hr period) average DO concentrations shall never be below 2.9 mg/L (An instantaneous DO measurement taken during daylight hours can substitute for daily average)

FL Marine: Draft 2011 proposed options for statewide DO criteria. Part 1 and 2

- Daily (24 hr period) average DO concentrations shall never be below 2.9 mg/L (An instantaneous DO measurement taken during daylight hours can substitute for daily average)

AND

- 7 and 30-day average DO concentrations shall not be below 3.7 and 4.3 mg/L respectively. (Minimum data sufficiency requirements must be stated, requiring multiple sampling trips or Sonde deployment).

- Missouri: daily DO minimum and mean, summer season criteria measured with Continuous Monitoring, ≥ 2 ConMon sites per segment, 3 yr assessment.

- Rhode Island: Cumulative Low Dissolved Oxygen exposure as measured by Continuous monitoring or correlated parameter to ConMon DO results.

Waters with a DO concentration above an instantaneous value of 4.8 mg/l shall be considered protective of Aquatic Life Uses. When instantaneous DO values fall below 4.8 mg/l, the waters shall not be:

1. Less than 2.9 mg/l for more than 24 consecutive hours during the recruitment season; nor
2. Less than 1.4 mg/l for more than 1 hour more than twice during the recruitment season; nor
3. Shall they exceed the cumulative DO exposure presented in Table 3.A.

The cumulative seasonal low DO effects are evaluated by totaling the fractions of the observed (or projected) exposure duration (in days) divided by the allowable number of days for each DO concentration. The sum of the decimal fractions shall not exceed 1.0.

- For waters **below the seasonal pycnocline, Aquatic Life Uses are considered to be protected if** conditions do not fail to meet protective thresholds, as described below, more than once every three years.
- DO criteria presented here shall be protective of the most sensitive life stage –survival effects on larvae which affects larval recruitment – for both persistent and cyclic conditions. This criteria evaluates effects of exposure to low DO over time on larval recruitment. Because larval recruitment occurs over the whole season, the low DO exposure effects are cumulative. Exposures are evaluated on a daily basis to determine the total seasonal exposure.