



# **Chesapeake Bay Instantaneous Minimum Dissolved Oxygen Criteria: History and Background**

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U.S. Environmental Protection  
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**December 2, 2013 Workshop**



# **Blame Batiuk this Instant for Getting Up into this Mess of Minimums!**

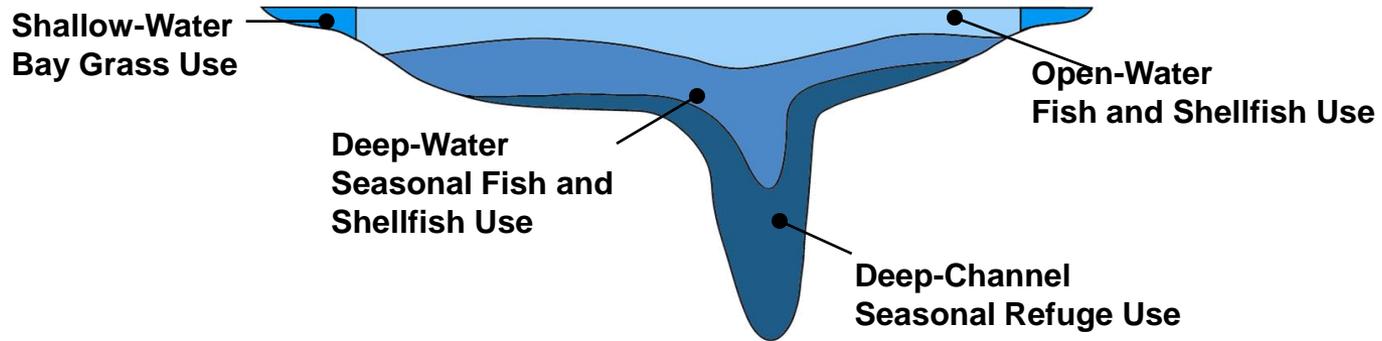
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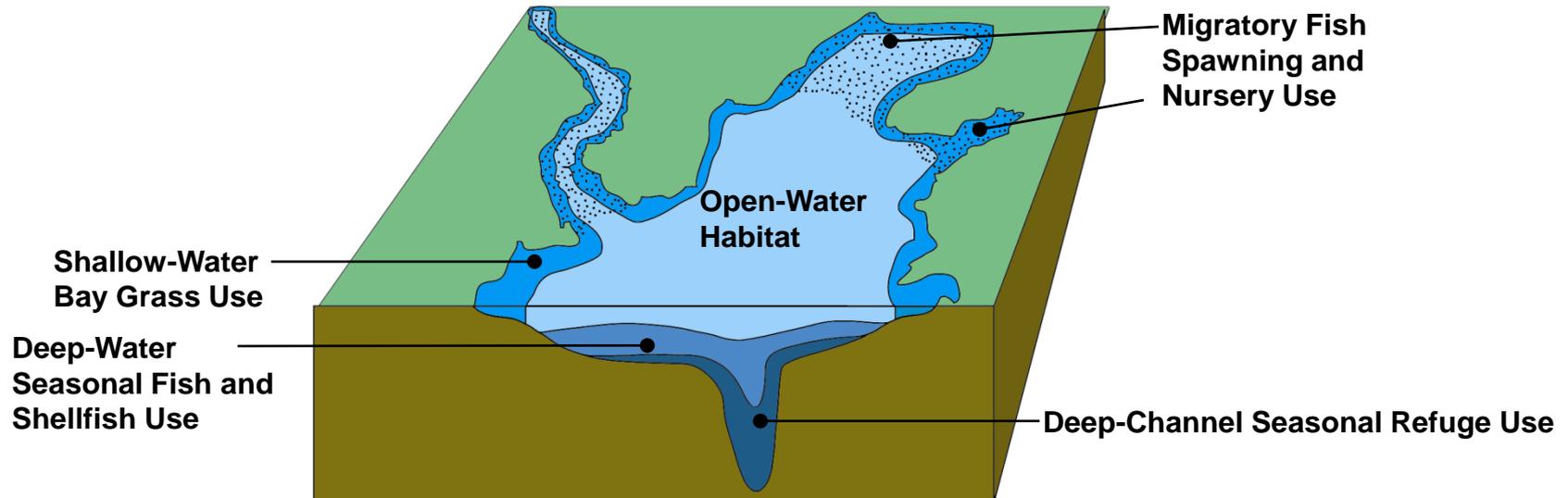
**DISCLAIMER:** This presentation was actually drafted on October 2, 2013 under the mis-impression that Congress was going to pass a budget and well intentioned Feds would be back to work in time for originally scheduled the October 7<sup>th</sup> workshop...Batiuk did not realize he would have a much larger number of days of working at home until the gov reopened....optimistic fool that he is!

# 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

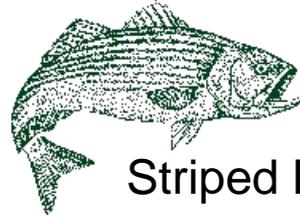


# Bay Dissolved Oxygen Criteria

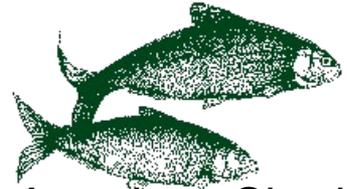
Minimum Amount of Oxygen (mg/L)  
Needed to Survive by Species

Migratory Fish Spawning  
& Nursery Areas

6



Striped Bass: 5-6



American Shad: 5

Shallow and Open Water  
Areas

5



White Perch: 5

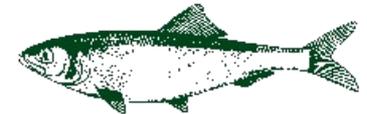


Yellow Perch: 5

4



Hard Clams: 5



Alewife: 3.6

Deep Water

3



Crabs: 3



Bay Anchovy: 3

2

Deep Channel

1



Spot: 2



Worms: 1

0

# Provide Full Protection

- Adult survival
- Juvenile survival
- Egg and larvae survival
- Larval recruitment
- Growth
- Behavioral effects
- Endangered species protection

# 1992 DO Restoration Goal

- Narrative DO restoration goal supported by target dissolved oxygen concentrations

Target Dissolved Oxygen Concentrations	Time and Location
Dissolved oxygen $\geq 1$ mg/L	<b>All times, everywhere</b>
$1.0$ mg/L $\geq$ dissolved oxygen $\leq 3$ mg/L	For no more than 12 hours, interval between excursions at least 48 hours, everywhere
Monthly mean dissolved oxygen $\geq 5$ mg/L	<b>All times</b> , throughout above pycnocline waters
Dissolved oxygen $\geq 5$ mg/L	<b>All times</b> , throughout above pycnocline waters in spawning reaches, spawning rives, and nursery areas

**Blame Steve  
Jordan, Marcia  
Olson, Kent  
Mountford and  
Cynthia  
Stenger!!**

# Chesapeake Bay Instantaneous Minimum Dissolved Oxygen Criteria

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

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# Migratory Spawning and Nursery

- Larval recruitment
  - Above 2.7 mg/L at all times
- Early life stages for resident tidal fresh species
  - **Instantaneous minimum** of 5 mg/L from EPA's 1986 freshwater criteria document
- Endangered species
  - 3.2 mg/L instantaneous minimum based on mortality occurring within 2-4 hours of exposure

# EPA 1986 Freshwater DO Criteria

- Introduced the instantaneous minimum criterion

Duration	Early Life Stage	Other Life Stage
30-day mean	NA	5.5
7-day mean	6	NA
7-day mean minimum	NA	4
1-day minimum*	5	3

\*All minima should be considered as **instantaneous concentrations** to be achieved at all times.

Source: U.S. EPA 1986

# Open-Water

- Larval recruitment
  - Above 2.7 mg/L at all times
- Warm water resident tidal fresh species
  - **Instantaneous minimum** of 3 mg/L from EPA's 1986 freshwater criteria document
- Endangered species
  - 3.2 mg/L instantaneous minimum based on mortality occurring within **2-4 hours of exposure**

# Deep-Water

- Larval recruitment
  - Above 1.7 mg/L **at all times** based on bay anchovy egg/larval recruitment

# Deep-Channel

- Protection against lethality some adverse behavioral effects on infaunal and epifaunal benthic species
  - Instantaneous minimum of 1 mg/L based on effects observed at **exposures lasting several hours**

# Instantaneous Minimum vs. Daily Mean

From comprehensive review of the effects of hypoxia on coastal fishes and fisheries, Breitburg (2002) was quoted in the 2003 Bay criteria document (page 33):

“Oxygen concentration below those that result in the standardly calculated 50% mortality in 24 to 96 h exposure test can lead to mortality in minutes to a few hours. For example, in the case of naked gobies, exposure to dissolved oxygen concentrations of 0.25 mg/L leads to death in a matter of minutes.”

“The effects of exposure duration and temperature are thus very important to consider in setting water quality standards for dissolved oxygen concentration, highlighting the need to set absolute minima, instead of time-averaged minima, and the need to consider geographic variation in maximum water temperatures.”

Double

blame

Denise

Breitburg!

# Bay Criteria Addendum History

- 2004 Addendum:
  - Evaluated attainment of 30-day mean compared with instantaneous min, 7-day mean
- 2007 Addendum:
  - Application of biological reference curve to instantaneous minimum criteria
- 2010 Addendum:
  - Application of default reference curve based on re-evaluation of benthic biological reference curve applied to deep-channel habitats

# Recommendations

- Don't mess with Texas...or the dissolved oxygen criteria
  - Three decade record of recommending instantaneous minimum criteria based on available scientific data and finding
  - No new findings to change criteria or clarify duration/averaging periods in any meaningful way

# Recommendations

- Focus on refining the assessment procedures fully respectful of tidal monitoring network constraints
  - Future network likely to provide similar or less data, not more
  - Think Apollo 13: use data, tools we have in hand
  - It's been a decade since publication of the 2003 Bay criteria—let's reach closure and move on

In the end,  
it's still really  
Batiuk's fault!

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