The “Umbrella Criteria” Assumption

What is it?

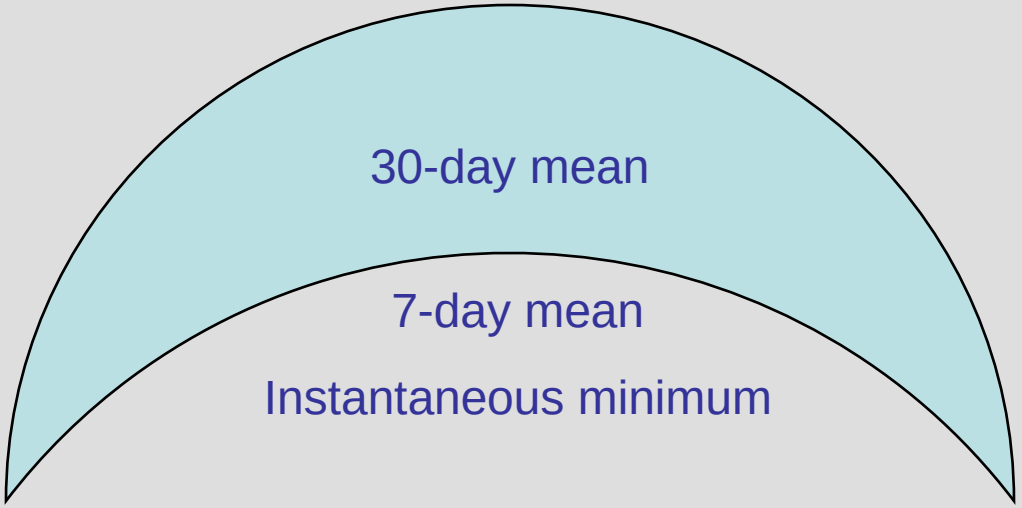
Where did it come from?

The Dissolved Oxygen Criteria

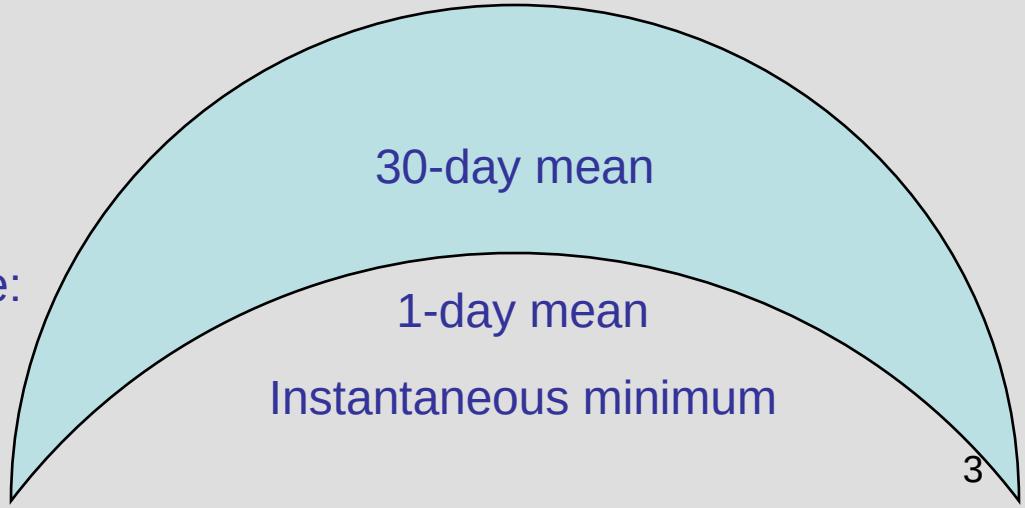
Designated Use	Dissolved oxygen Criteria Concentration/Duration		Temporal Application
Migratory fish spawning and nursery use	7-day mean $\geq$ 6 mg/L tidal habitats with 0-0.5ppt salinity		February 1 – May 31
	Instantaneous minimum $\geq$ 5 mg/L		
	Open water fish & shellfish designated use criteria 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	$\geq$ 5.5 mg/L for salinity = 0-0.5ppt	Year-round
		$\geq$ 5.0 mg/L for salinity > 0.5ppt	
	7-day mean	$\geq$ 4 mg/L	
	Instantaneous min $\geq$ 3.2 mg/L for water temp $\leq$ 29° C		
	Instantaneous min > 4.3 mg/L for water temp > 29° C		
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 $\geq$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 fish & shellfish designated use applies		October 1 – May 31

The Umbrella Criteria

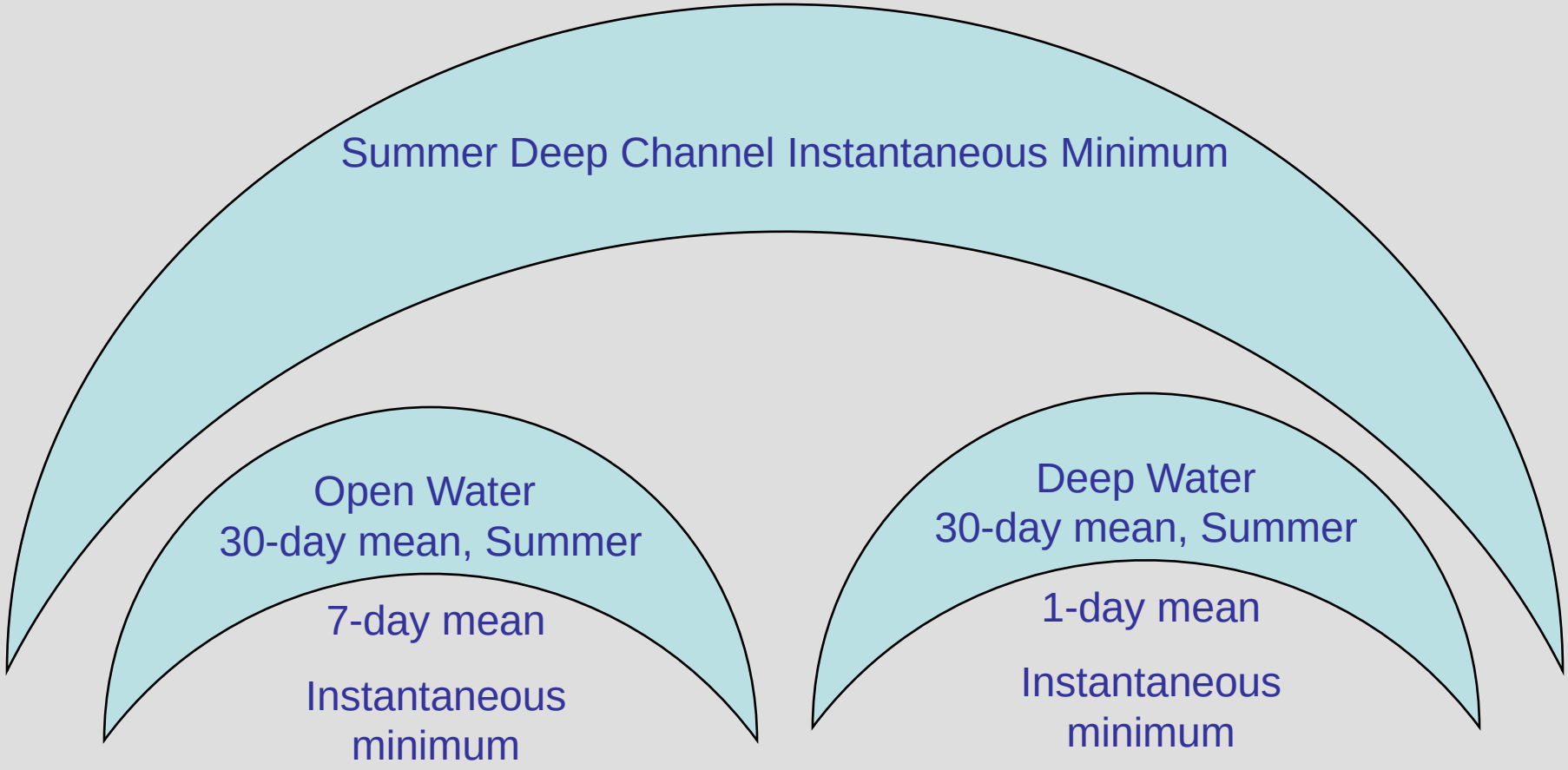
Open Water designated use:



Deep Water (summer) designated use:



The Umbrella Criteria



Key Underlying Assumption

*"…**assuming that the temporal variability of dissolved oxygen in the Bay is reasonably well-characterized in the Bay model,***

the relative protectiveness of different standards evaluated directly from model output

would approximate the relative protectiveness of standards evaluated through monitoring data."

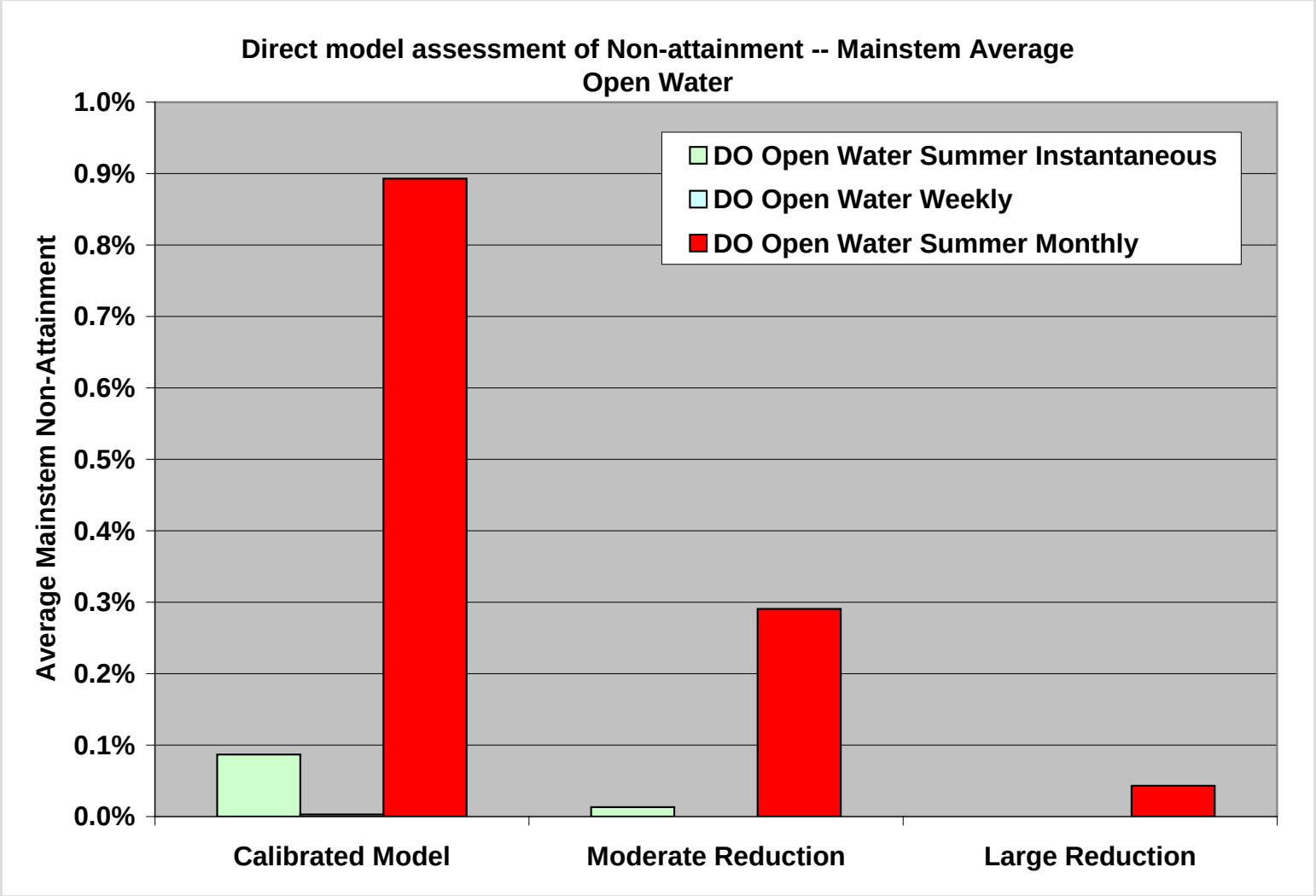
-- G. Shenk, R. Batiuk. 2010. *Evaluation of the Most Protective Bay Dissolved Oxygen Criteria.* Appendix D in USEPA (U.S. Environmental Protection Agency) *Chesapeake Bay Total Maximum Daily Load.* EPA-R03-OW-2010-0736. U.S. Environmental Protection Agency, Region 3, Philadelphia, PA.

Umbrella Criteria Assumption

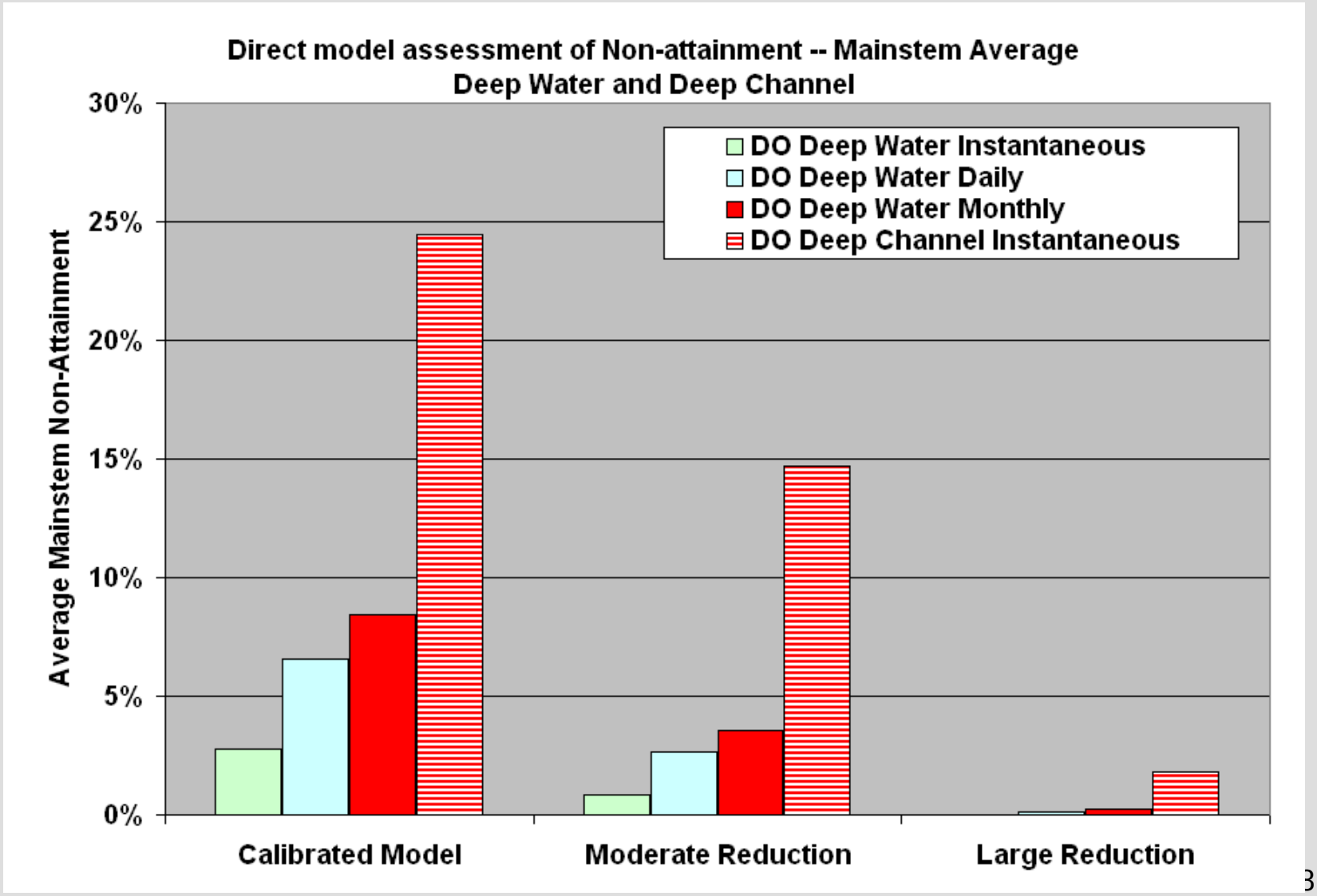
Approach

- Methodology employed for model output assessments:
  - Calculate running-time-weighted averages at cell level
    - Instantaneous criterion: evaluate on each hour
    - 1-day mean: average for each 24-hr period
    - 7-day mean: begins on Day 1 of each month; evaluate first 4 weeks of month and ignore trailing days
    - 30-day mean: begins on Day 1 of each month; ignore trailing day
    - Designated use (du) of each cell is assigned at each time increment based on the pycnocline boundaries of that time increment
  - Calculate violation rates at segment-du level

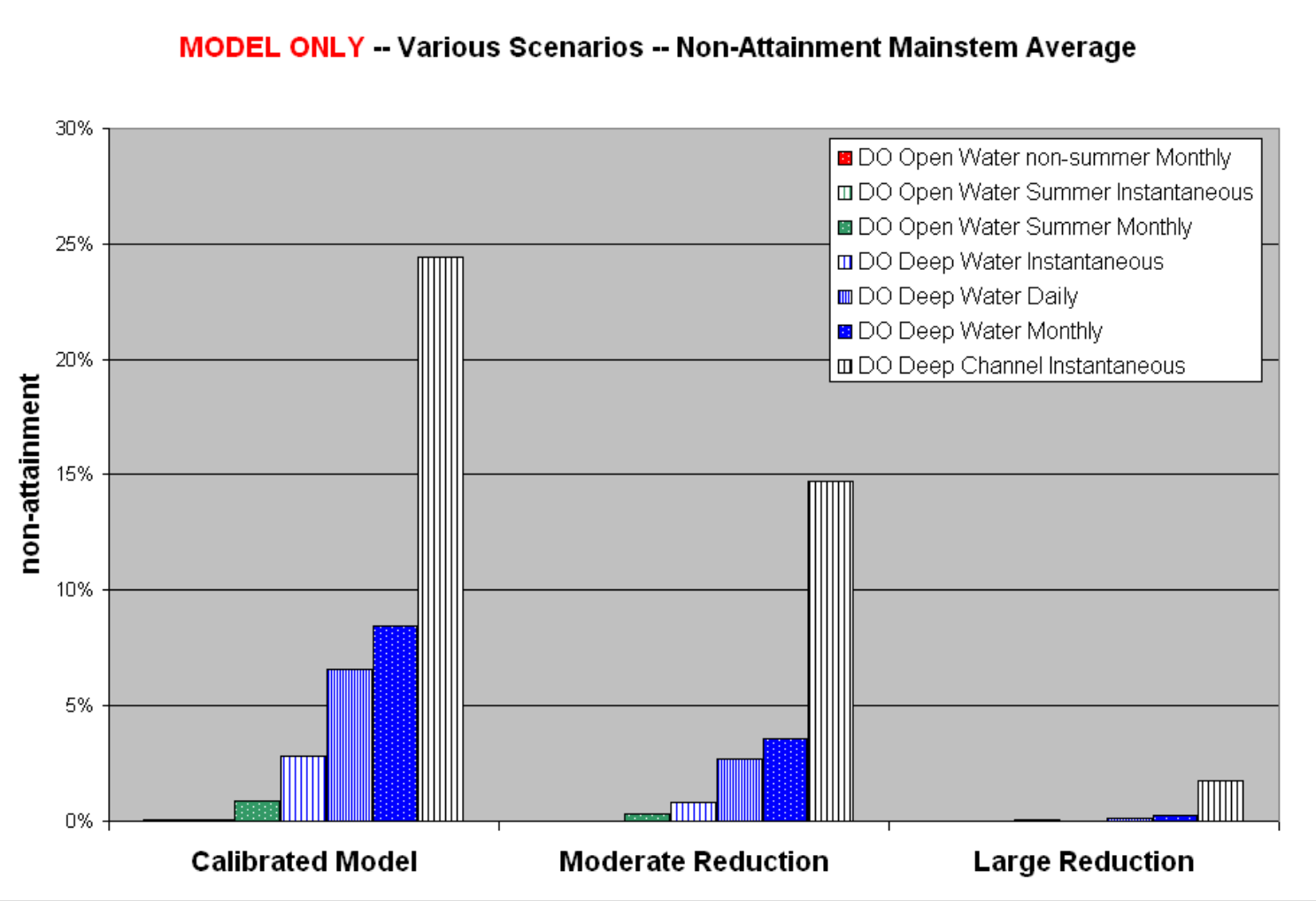
Estuarine Model Evaluation: Open Water



Estuarine Model Evaluation: Deep Water/Deep Channel



Estuarine Model Evaluation: Deep Channel Summer v. All Other (Summer)



Question

Does the estuarine Water Quality Sediment Transport Model (WQSTM) capture the range of short-term variability that has been observed in recent high-frequency data collections?

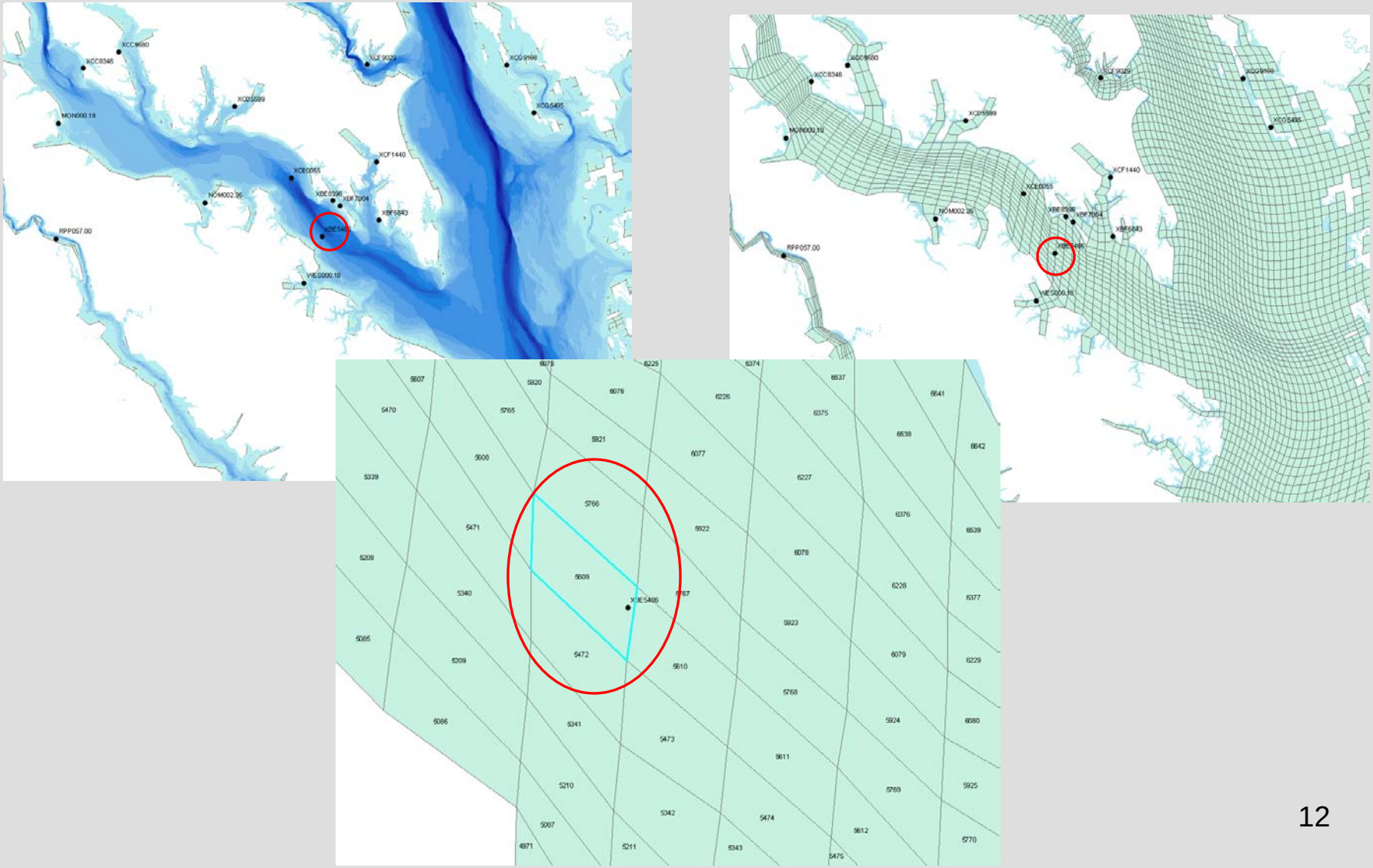
Premise

A WQSTM that fails to simulate the extent of short-term variability in DO concentrations will provide a flawed estimate of the protective nature of the 30-day mean criterion relative to the 7-day mean, the 1-day mean, and/or the instantaneous minimum criteria.

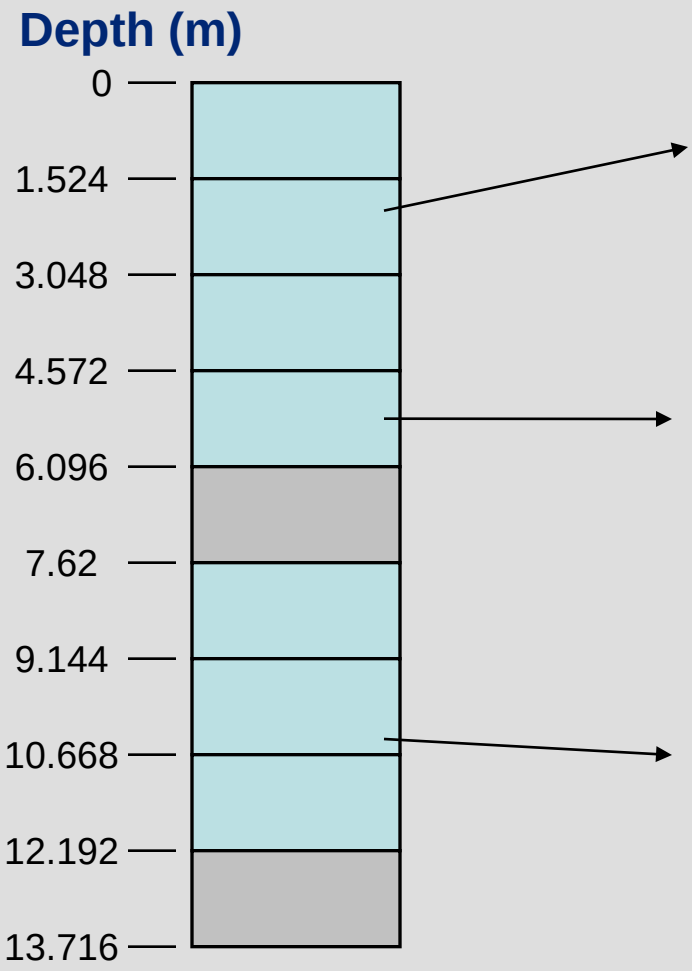
Profiler v. Model: Methods

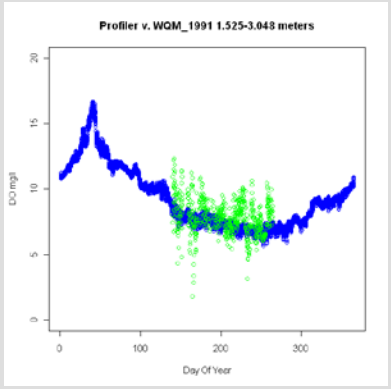
1. Matched location of Potomac Profiler with a stack of cells from the WQSTM
2. Binned profiler observations by depth into groups matching vertical cells at that location of the WQSTM
3. WQSTM: data from 1991-2000; Profiler: May-November 2009
4. Compared empirical frequency distribution (EDF) of observations from summer 2009 with WQSTM simulations for the same date range of each year, 1991-2000.
5. Graphed time series of profiler data against a sample single-year of data (1991) from the WQSTM

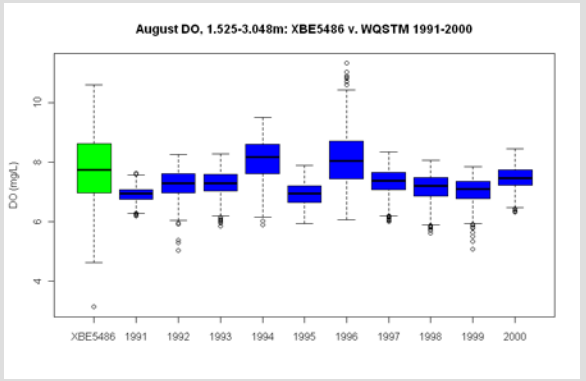
Potomac River Profiler and WQSTM grid

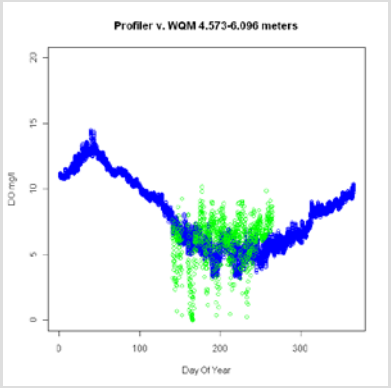


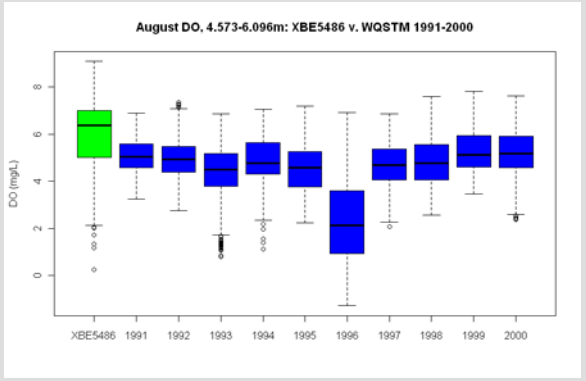
Comparisons with Depth

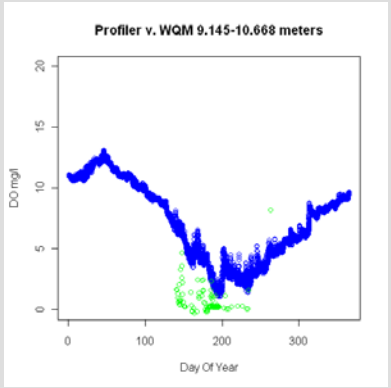


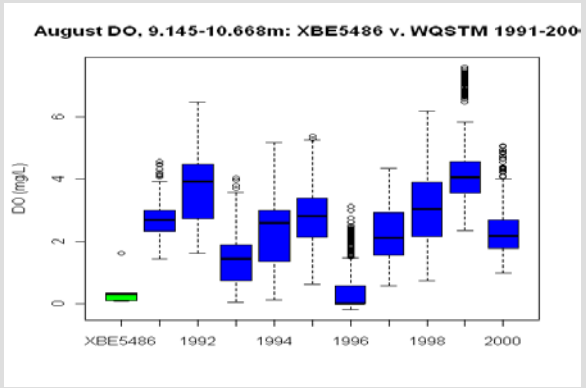




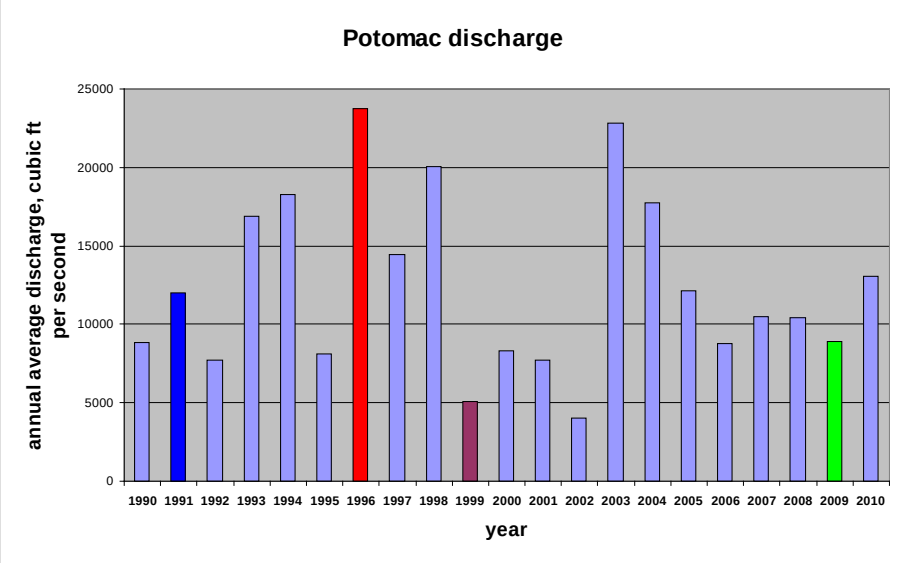


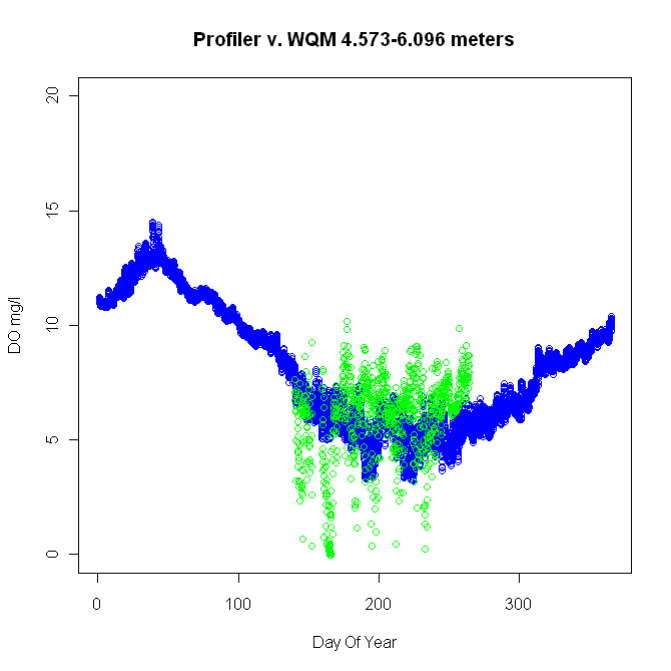


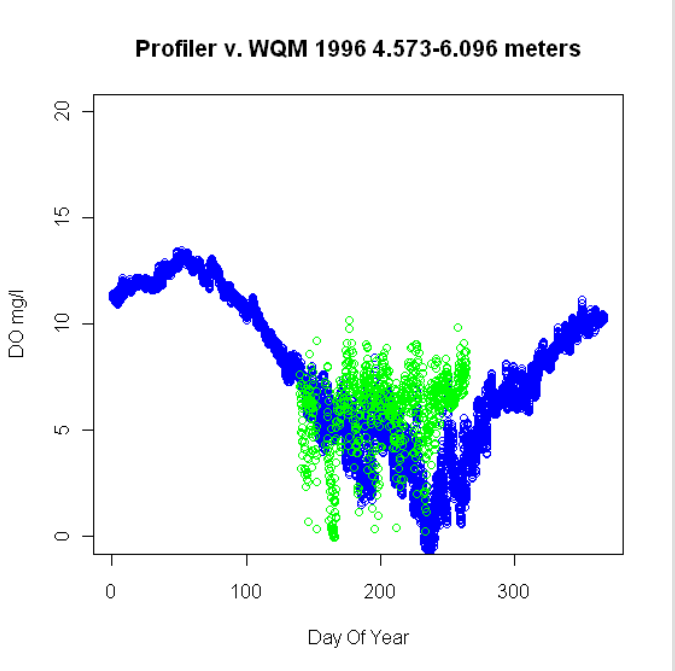




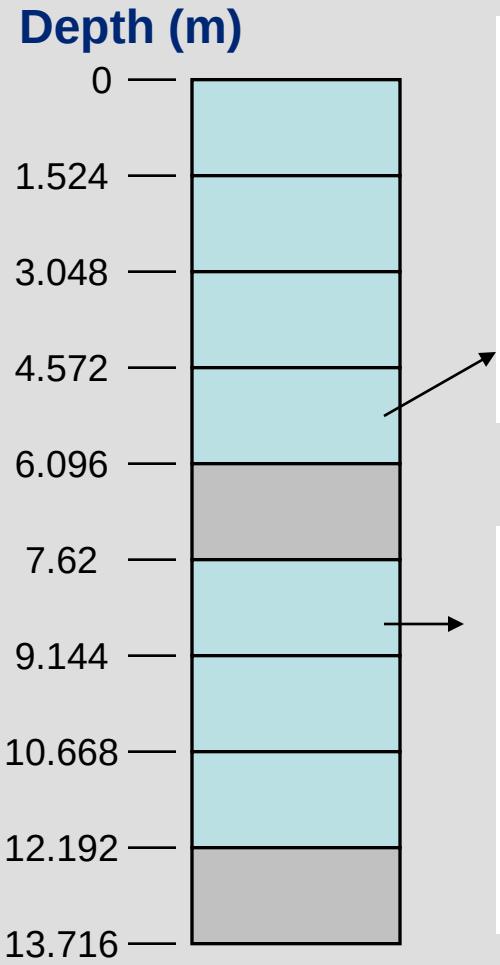
Model Variability: Year Matters

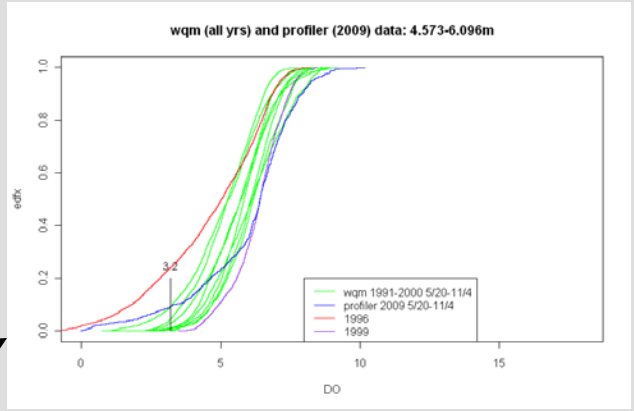


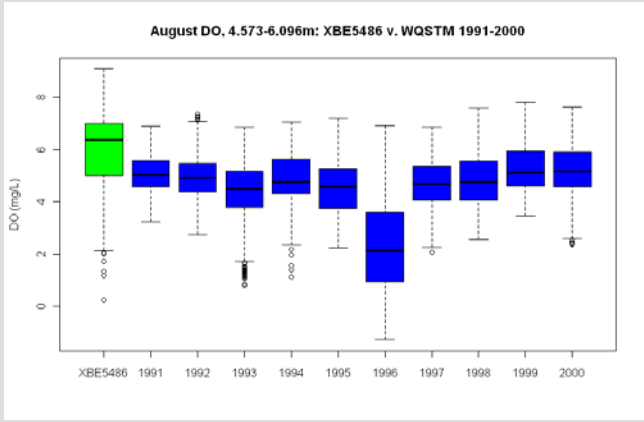


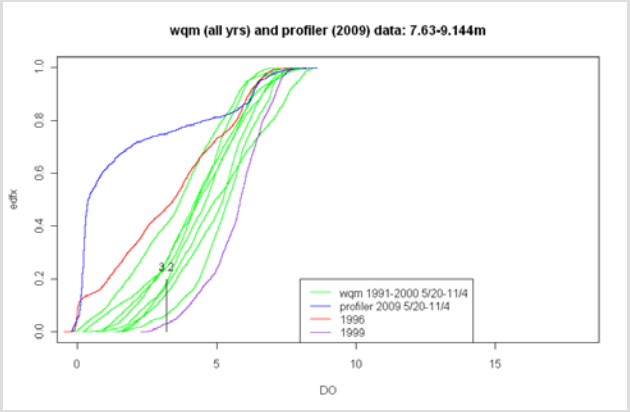


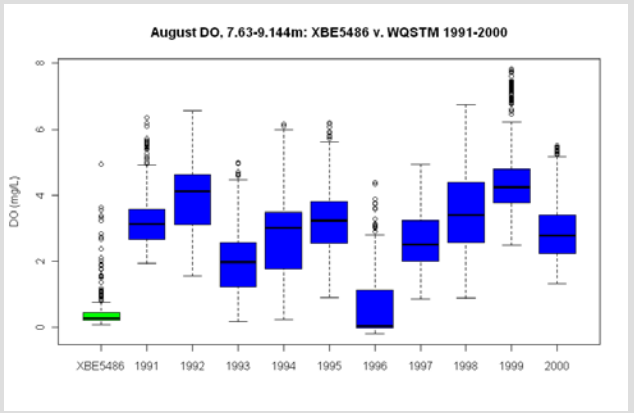
Profiler v. Model Comparisons











Profiler v. Model: Preliminary Conclusions

1. Across a range of years and hydrological conditions, the model approximates the variability seen in a single, average-ish year of observed data for the mid-channel of the POTMH segment
2. Within individual years, the model's approximation of variability may not be sufficient to draw conclusions regarding relative protectiveness of criteria
3. Still need to look at nearshore data; shallow water is likely to be less well-characterized than mid-channel data
4. Stronger conclusions may be drawn when data are binned into designated uses