York and Rappahannock River Profiler Data Evaluation

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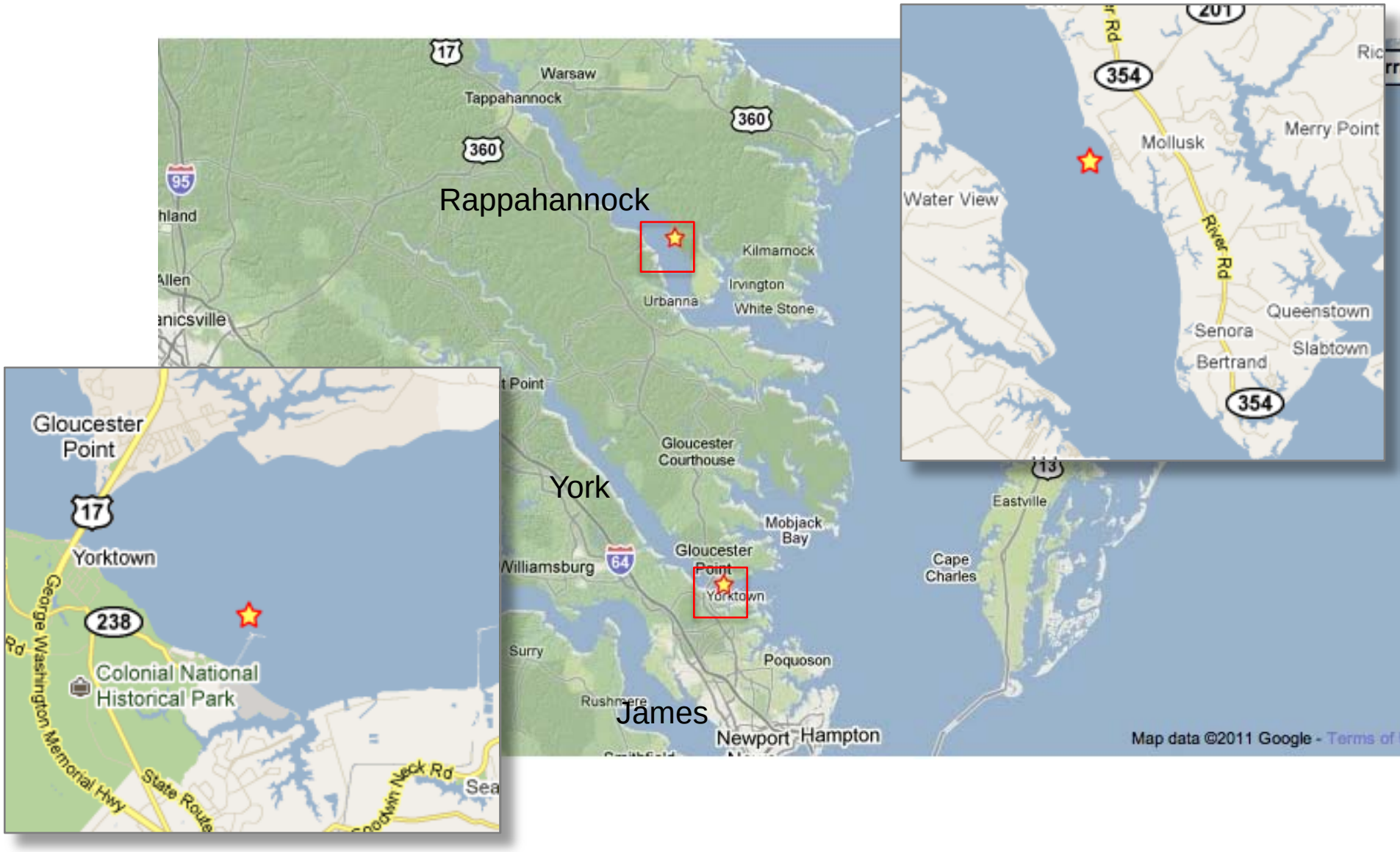
Profiler station locations



Data Details – York River

- There were a total of 61,248 observations during 2007-2009 used in the analysis
- Data cover summer months (June 1 – Sept 30) for 3 years 2007-2009
- All values below **8 meters** were dropped since these values occurred infrequently.
- There were cases for which data were not collected at exactly one meter intervals. This occurred with pretty high frequency. This problem was fixed by substituting the mean of the values at the depth above and the depth below the missing interval.
- Other problematic observations were substituted with an appropriate mean value. Typically this amounted to the substitution of one days worth of data with the mean hourly values of the previous and the next day.

Data Details – Rappahannock River

- Dates of record: 16 June – 5 October 2009 (*28162 raw data records; 21888 QAQC data records*)
- Data were collected hourly and once per depth. **Depths ranged from 0 to 13 m.**
- All values below **11 meters** were dropped since these values occurred infrequently.
- There were cases (~1500) for which data were not collected at exactly one meter intervals. This problem was fixed by substituting the mean of the values at the depth above and the depth below the missing interval.
- Other problematic observations (e.g. shortened profiles) were substituted with an appropriate mean value. Typically this amounted to the substitution of several depths within a given hour of a day (1819 records interpolated in this manner).

Analyses

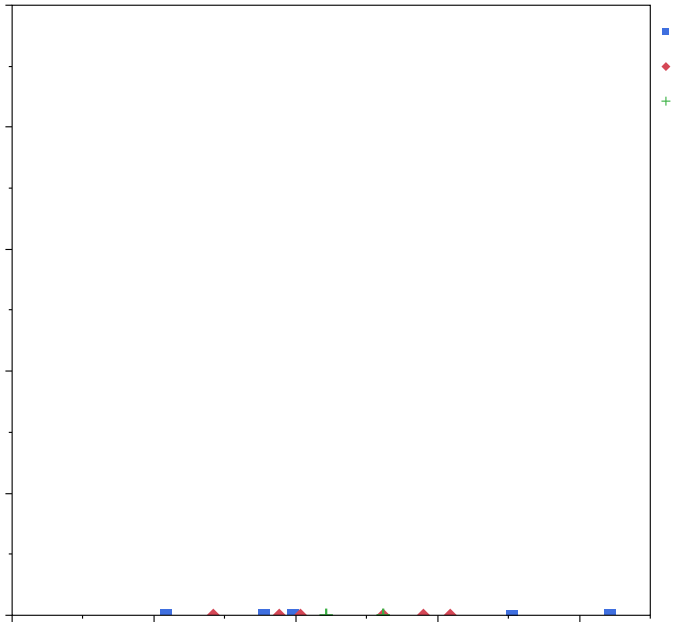
- Pycnocline determined and DU assigned
- Moving 7-day averages (rolling means) were calculated and 1-day and 30-day means were calculated.
- The percentage of instantaneous measures that failed the DO criteria was calculated separately for Deep Channel (≤ 1.0 mg/l), Deep Water (≤ 1.7 mg/L) and Open Water (≤ 3.2 mg/L).
- Assessment of protectiveness of 30 day mean of the 7 and 1 day criteria
- Regression analyses to determine protectiveness of 7 and 1 day means of the instantaneous criteria.

York River Results

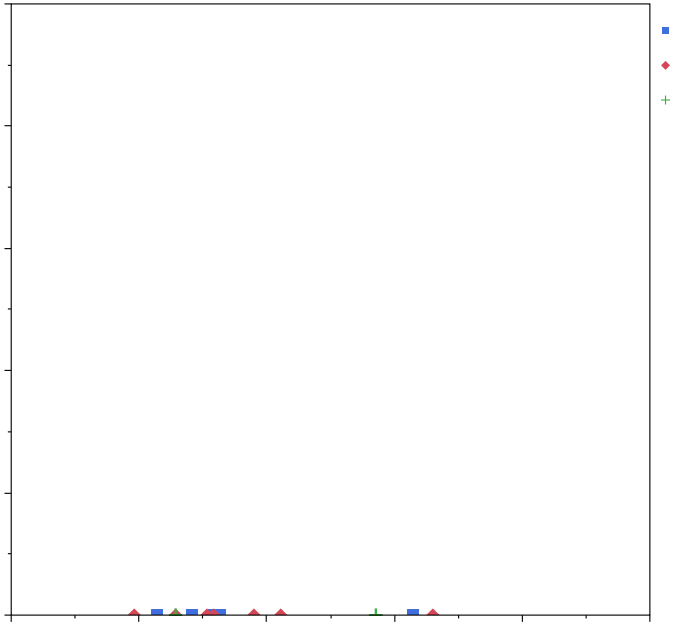
- The location (and presence) of the pycnocline is highly variable on a daily basis with a reduced presence of a pycnocline in the fall (September).
- Overall, Deep water accounted for 20% of the readings (n=12,379), Open water = 80% (48,869). No consistent trend in the depth of occurrence of the pycnocline
- For Open Water, there were 7 instantaneous violations in 2007, 36 in 2008 and 10 in 2009. For Deep Water, there were only instantaneous violations in 2008 (all but one in June) numbering 15.

York River Results

30 day mean in relation to 7-day mean violations (Open Water)



30 day mean in relation to 1-day mean violations (Deep Water)

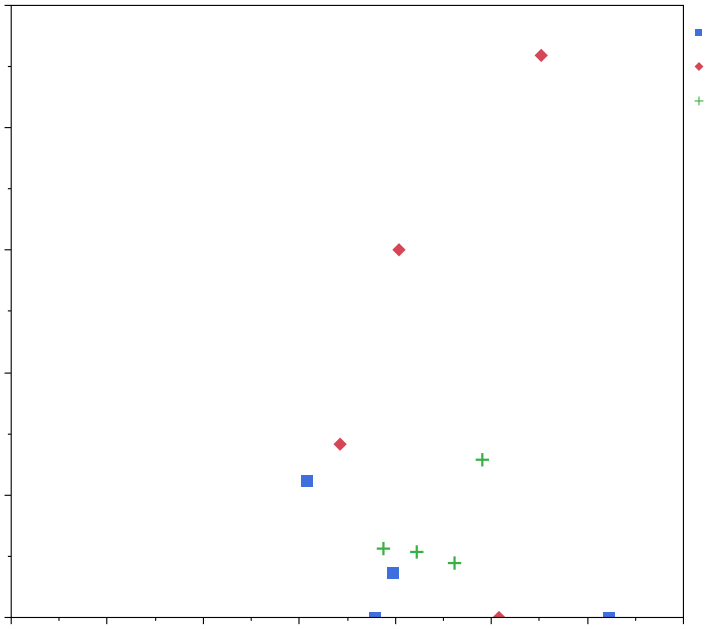


- There were no Open water 7-day mean violations in a given 30-day period observed in 2007-2009.
- There were no Deep water 1-day mean violations in a given 30-day period observed in 2007-2009
- Calculating monthly mean from continuous monitoring data gets us very close to “true” mean

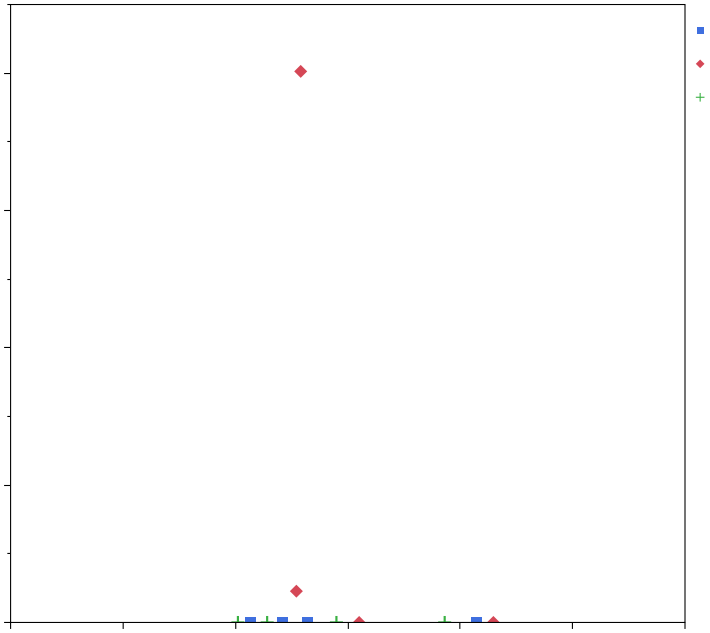
	OW	DW
30d	5.0	3.0
7d	4.0	
1d		2.3
Instant	3.2	1.7

York River Results

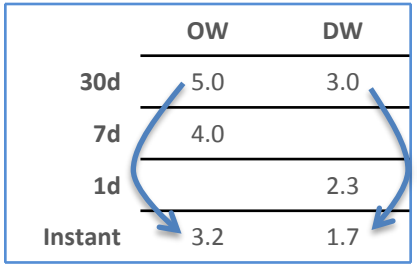
30 day mean in relation to instantaneous violations (Open Water)



30 day mean in relation to instantaneous violations (Deep Water)

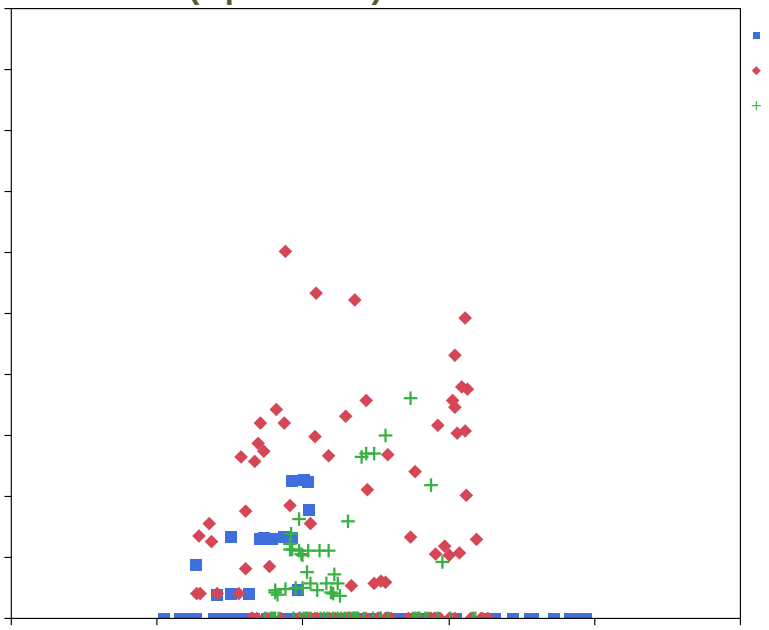


- **Open Water DO instantaneous violations in a given 30-day timeframe were observed in every month and were <0.5%**
- **Deep Water DO instantaneous violations in a given 30-day timeframe were observed in 2008 (June and July) and were <0.5%.**

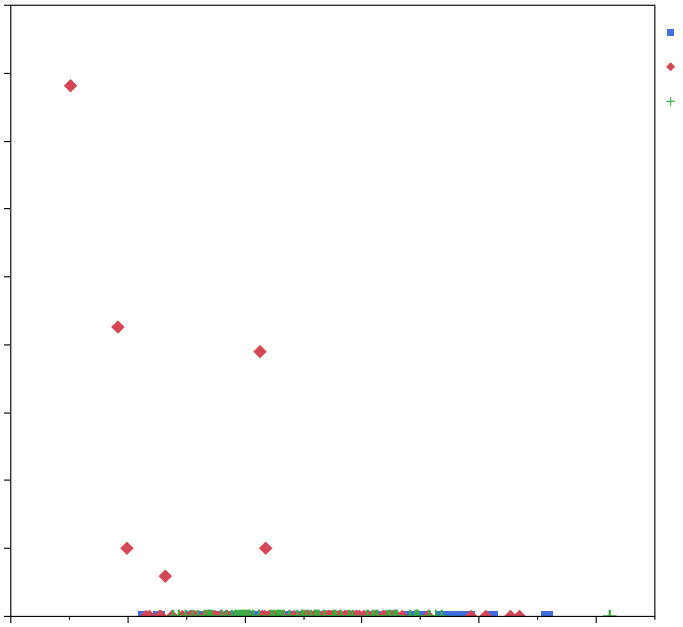


York River Results

7-day mean in relation to instantaneous violations (Open Water)



1-day mean in relation to instantaneous violations (Deep Water)

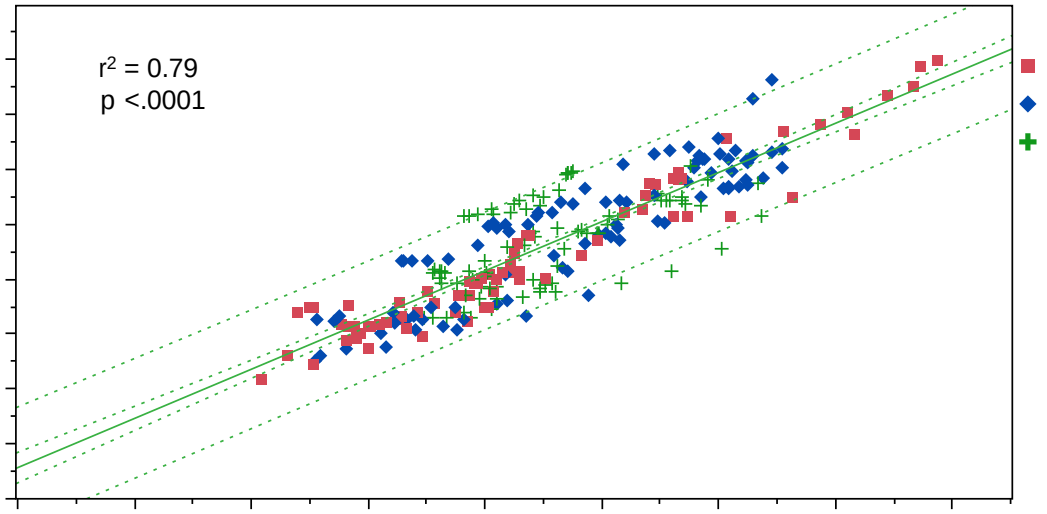


- **Open Water DO instantaneous violations in a given 7-day period are <1.2% for all years. 7 day mean appears protective of Instantaneous Min OW**
- **Deep Water DO instantaneous violations in a given 1-day period are <8% for all years. 1 day mean appears protective of Instantaneous Min DW**

	OW	DW
30d	5.0	3.0
7d	4.0	
1d		2.3
Instant	3.2	1.7

York River Results

10th percentile of instantaneous observations in relation to 7-day mean (Open Water)



Plot explanation

Each dot is the 10th percentile value of each seven day grouping plotted against the seven day mean. 95% confidence intervals are for the fitted line and the predicted observations.

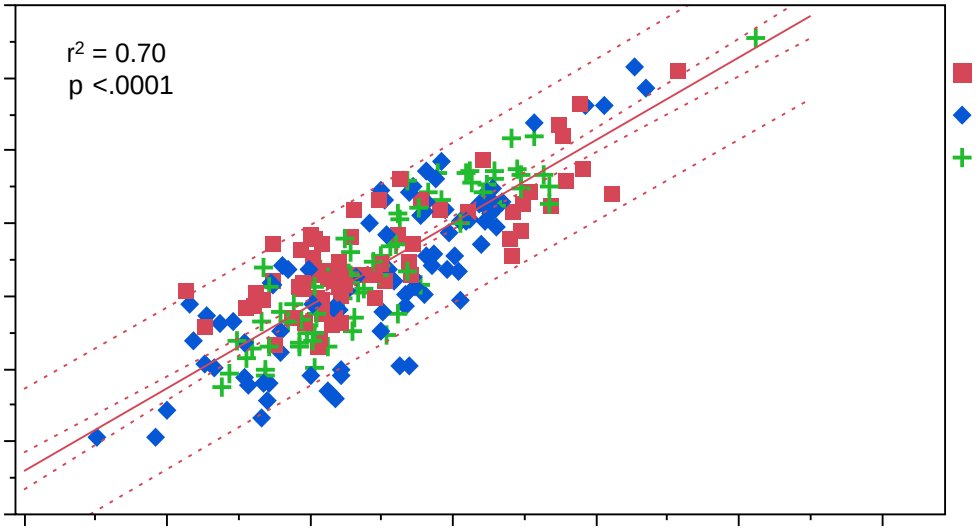
Plot interpretation

As the 7 day mean nears the 7 day criterion (4.0 mg/l) it becomes "questionably" protective of the instantaneous criterion (3.2 mg/l)

- **This may be further support for the 7-day mean being protective of the instantaneous minimum for open water (in the York River)**

York River Results

10th percentile of instantaneous observations in relation to 1-day mean (Deep Water)



Plot explanation

Each dot is the 10th percentile value of each one day grouping plotted against the sone day mean. 95% confidence intervals are for the fitted line and the predicted observations.

Plot interpretation

As the 1 day mean nears 3.0 mg/l (1 day criterion is 2.3 mg/l) it crosses the instantaneous criterion (1.5 mg/l)

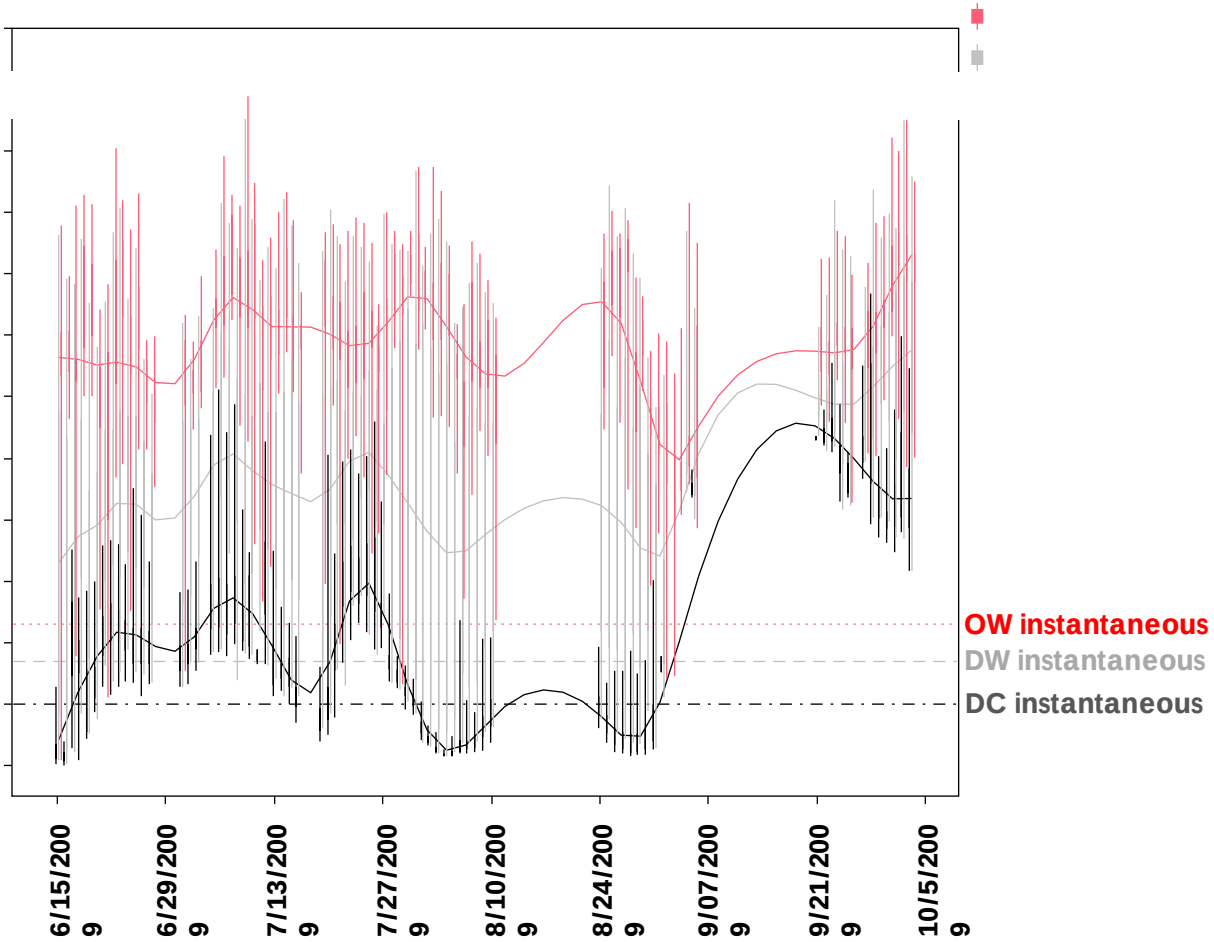
- **1 day Deep Water criterion may not be protective of the instantaneous minimum as it nears the criterion.**

Rappahannock River Results

- Only one year of data.
- Pycnocline predominantly present with a reduced presence in the fall (September).
- Overall, deep channel accounted for 27% (n=5,884), deep water accounted for 45% (n=9,746), and open water accounted for 29% (6,258) of the readings
- For open water, there were 96 instantaneous violations (1.5% of the observations). For deep water, there were 1,207 instantaneous violations (~12% of readings were in violation). For deep channel, there were 1,976 violations (34% of the observations) of the instantaneous minimum criterion (1 mg/L)
- The 1-day, 7-day and 30-day means always met the designated DO criterion for open and deep water.

Rappahannock River Results

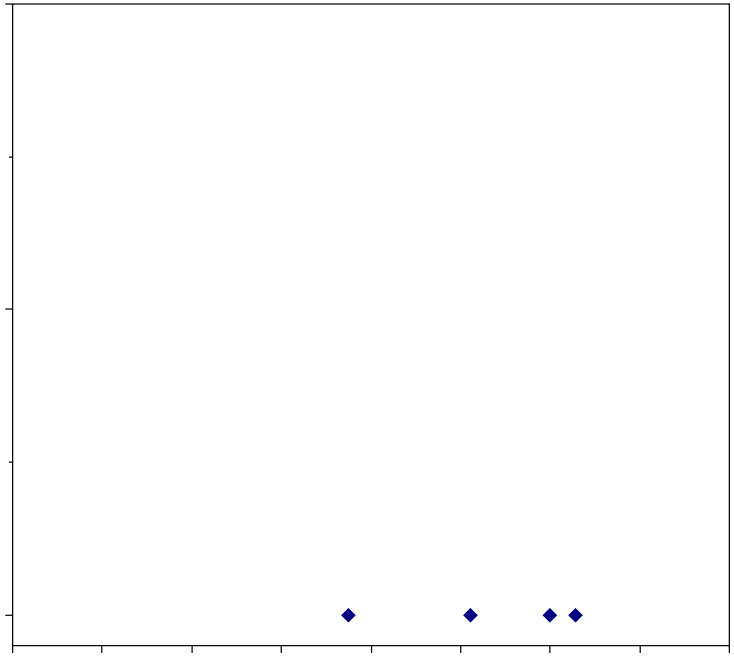
Profiler Data



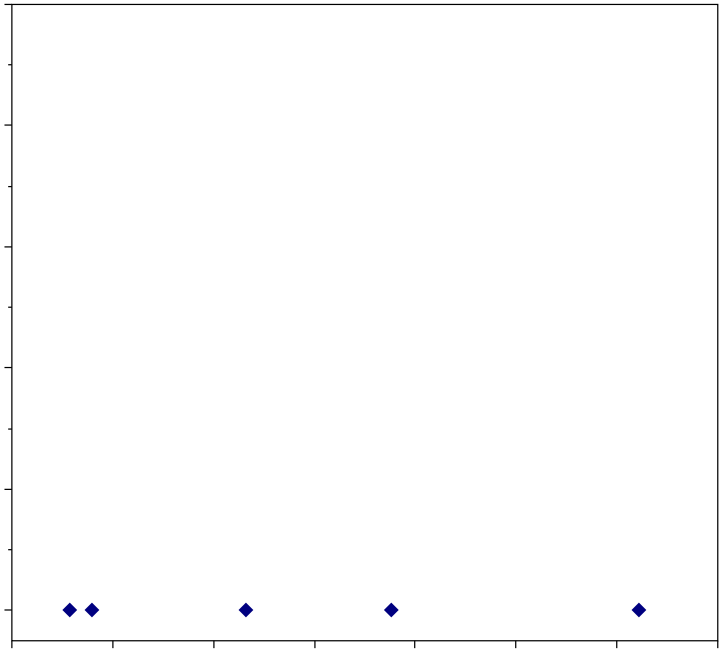
- **Several large gaps in data due to probe failures**

Rappahannock River Results

30 day mean in relation to 7-day mean violations (Open Water)



30 day mean in relation to 1-day mean violations (Deep Water)

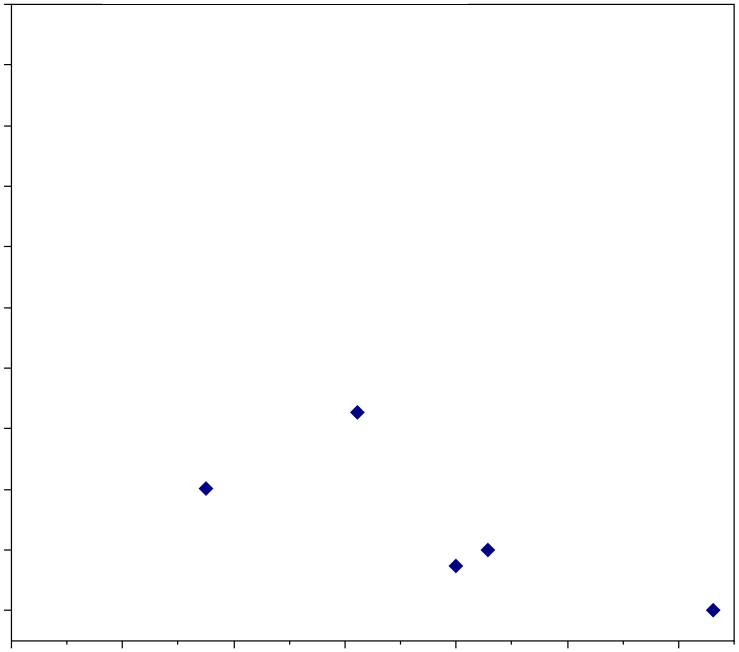


- There were <u>no</u> Open Water 7-day mean violations in a given 30-day period observed in 2009.
- There were <u>no</u> Deep Water 1-day mean violations in a given 30-day period observed in 2009.

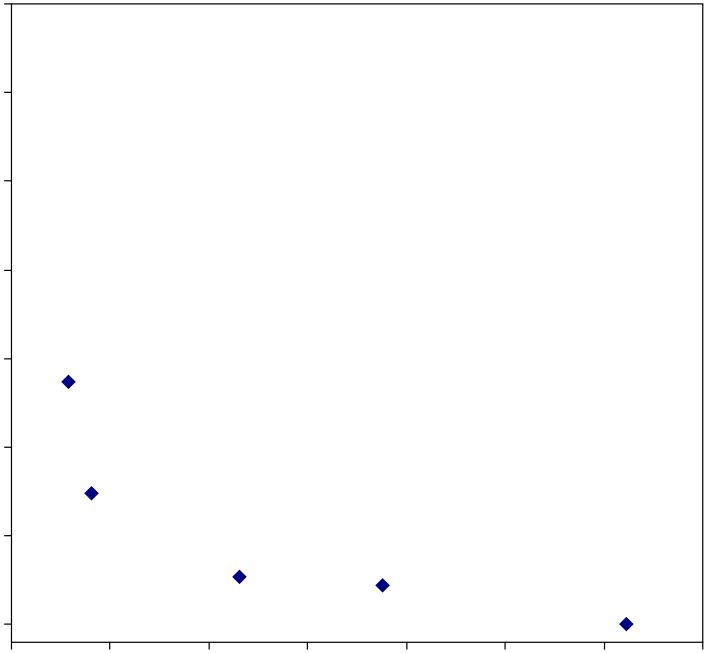
	OW	DW
30d	5.0	3.0
7d	4.0	
1d		2.3
Instant	3.2	1.7

Rappahannock River Results

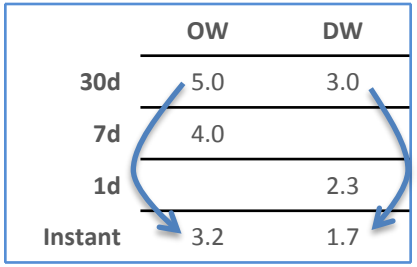
30 day mean in relation to instantaneous violations (Open Water)



30 day mean in relation to instantaneous violations (Deep Water)

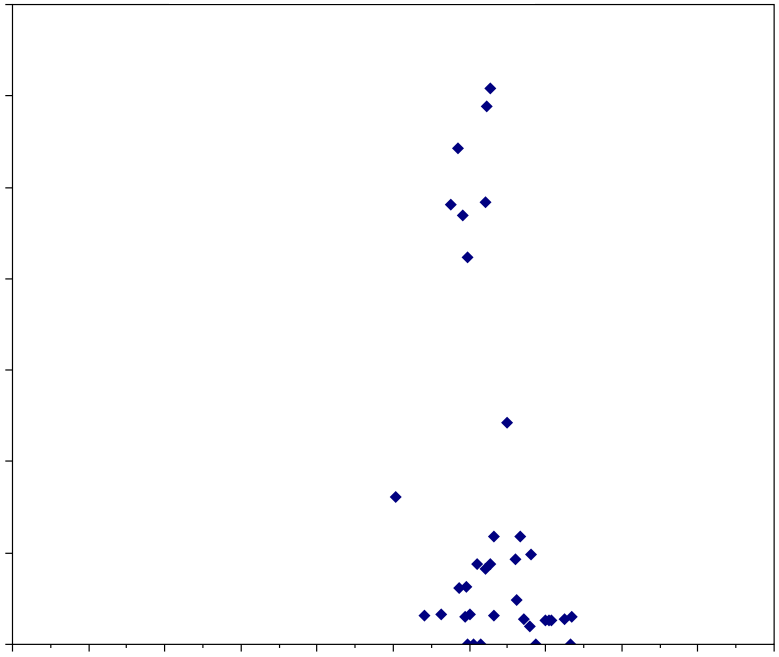


- **Open Water DO instantaneous violations in a given 30-day timeframe were <5% in all months.**
- **Deep Water DO instantaneous violations in a given 30-day timeframe ranged from 0-27% and indicate that the DW 30d mean is not protective of the instantaneous min.**

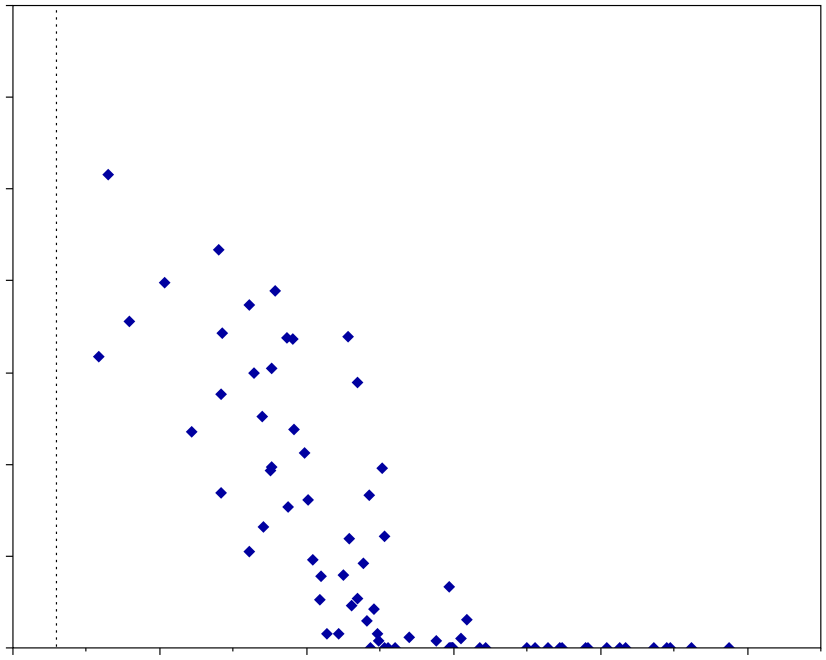


Rappahannock River Results

7-day mean in relation to instantaneous violations (Open Water)



1-day mean in relation to instantaneous violations (Deep Water)

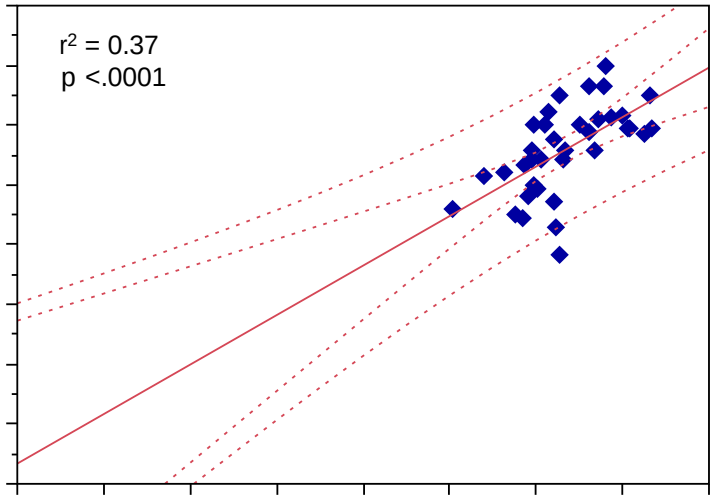


- **Open Water DO instantaneous violations in a given 7-day period are less than 7.0%.**
- **Deep Water DO instantaneous violations in a given 1-day period were frequent. 1 day mean is not protective of Instantaneous Min DW**

	OW	DW
30d	5.0	3.0
7d	4.0	
1d		2.3
Instant	3.2	1.7

Rappahannock River Results

10th percentile of instantaneous observations in relation to 7-day mean (Open Water)



Plot explanation

Each dot is the 10th percentile value of each seven day grouping plotted against the seven day mean. 95% confidence intervals are for the fitted line and the predicted observations.

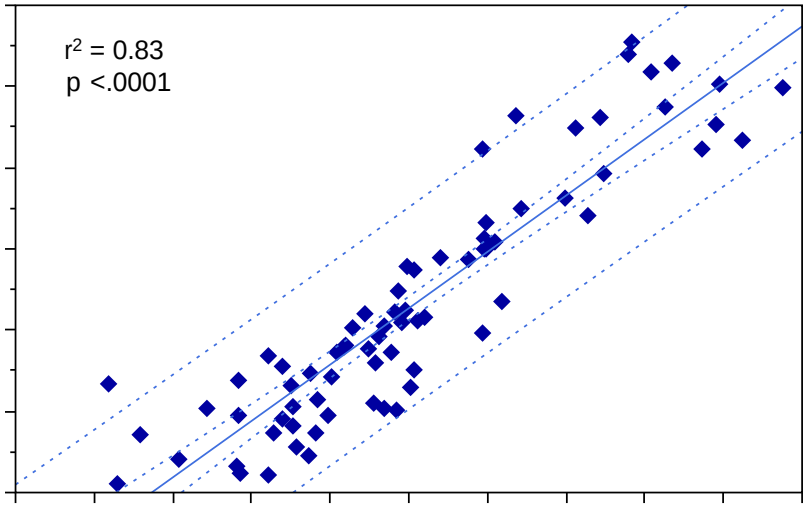
Plot interpretation

There were not any observed values for the 7d that did not meet the criterion. Bad fit to the regression. Additional data will improve fit.

- **Suggests that as the 7d mean nears 4 mg/l, instantaneous violations may exceed 10%.**

Rappahannock River Results

10th percentile of instantaneous observations in relation to 1-day mean (Deep Water)



Plot explanation

Each dot is the 10th percentile value of each one day grouping plotted against the same day mean. 95% confidence intervals are for the fitted line and the predicted observations.

Plot interpretation

For observations near the 1-day criterion (2.3 mg/L), the 10th percentile of observed instantaneous values was often < 1.7 mg/L

- **For deep water, as the 1-day mean nears the criterion, the instantaneous minimum violations exceed 10%.**

Conclusions

- General support for the 30-day mean being protective over the 7 and 1-day mean in the York and Rappahannock Rivers
- Questionable support for the 30-day mean being protective over the instantaneous minimum, particularly for deep water
- For 7-day and 1-day mean observations near the criterion (4 and 2.3 mg/L, respectively), regression analysis suggests that these criteria may not be completely protective of the instantaneous minimum.