Initial James River Chlorophyll Criteria Attainability Evaluation

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JRCS RAP Meeting
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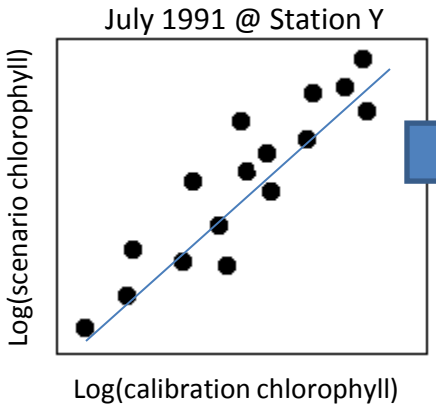
DEQ
Virginia Department of Environmental Quality

A major focus of the James River Chlorophyll Study has been the development of a watershed model specific to the James River that provides enhanced predictive capabilities over EPA's Phase 5.3 watershed model.

Under contract with VADEQ, scientists at Tetra Tech, HDR, and Virginia Institute of Marine Science have developed a model that allows for the exploration of different nutrient loading scenarios and their effect on James River chlorophyll-*a*.

The output of the EPA and James River models were used to "scenario modify" the historical chlorophyll observations (data collected at fixed stations from 1991-2000).



month-year-station regression equation

Historical Observation taken on July X 1991 @ Station Y	Scenario Modified Value
20	10

$$\text{Relative change} = \frac{10 - 20}{20} = -0.5 = 50\% \text{ decrease}$$

The Bay TMDL loading scenario was the only one available to explore using the EPA model.

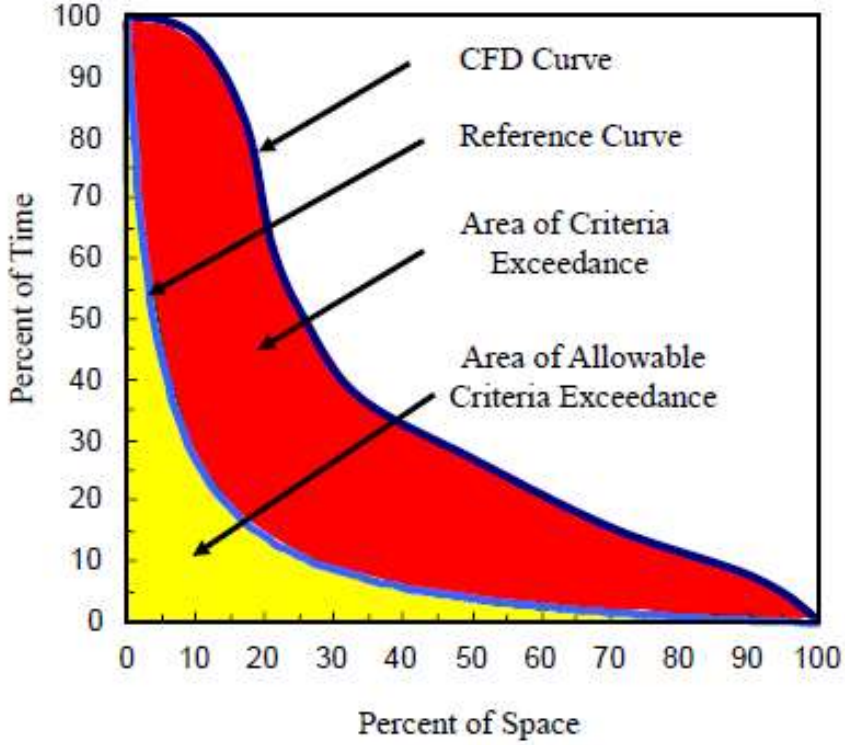
However, output was available for two management scenarios using the JR model.

- DO reduction scenario (26.7 mpy TN, 2.67 mpy TP)
- Bay TMDL scenario (23.5 mpy TN, 2.35 mpy TP)

Attainability of the *current* criteria was determined using two separate procotols:

- Current assessment method (developed by CBP Partnership)
- Alternative assessment method (proposed by VADEQ)

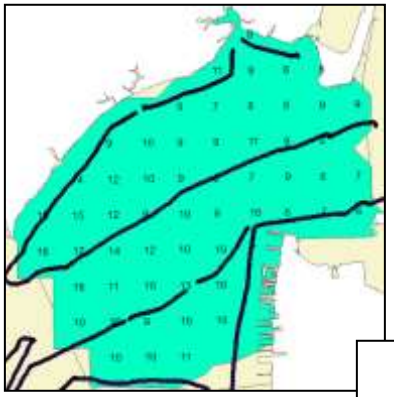
Current Assessment Method



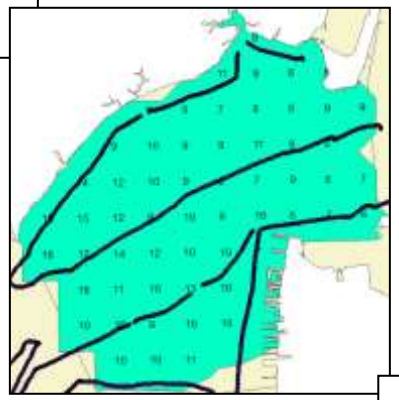
Cumulative Frequency Distribution

Spatial x temporal variability is the assessment target more than the segment-wide central tendency.

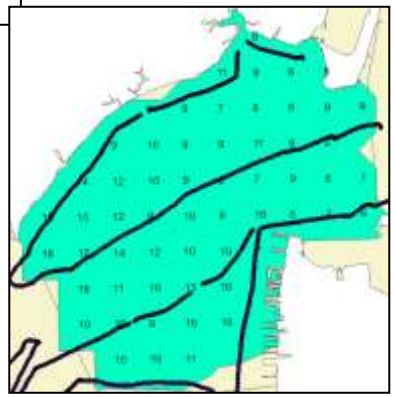
Alternative Assessment Method



Median concentration = 5



Median concentration = 9



Median concentration = 14

Seasonal mean = 9 µg/l

Segment-wide central tendency is the assessment target.

Attainability of current criteria according to the current assessment method

Baseline

	Spring					Summer				
assessment period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	5	5	0	30	39	36	53	0	0	22
92-94	1	2	0	6	21	35	53	0	0	22
93-95	1	6	0	0	11	31	37	0	0	0
94-96	1	6	4	7	22	10	12	0	0	22
95-97	5	19	9	15	22	22	22	2	6	46
96-98	1	11	9	15	22	35	37	2	6	57
97-99	1	30	5	10	0	40	41	2	22	33
98-00	1	16	6	3	0	18	16	0	36	36

Non-attainment in all segments-seasons at baseline.

EPA TMDL

	Spring					Summer				
assessment period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	0	0	0	0	0	0	0	0	0	0
92-94	0	0	0	0	0	0	0	0	0	0
93-95	0	0	0	0	0	0	0	0	0	0
94-96	0	0	0	0	0	0	0	0	0	0
95-97	0	0	0	0	0	0	0	0	0	0
96-98	0	0	0	0	0	0	0	0	0	0
97-99	0	0	0	0	0	0	0	0	0	7
98-00	0	0	0	0	0	0	0	0	0	7

JR TMDL

	Spring					Summer				
assessment period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	0	0	0	0	0	3	29	0	0	0
92-94	0	0	0	0	0	2	32	0	0	0
93-95	0	0	0	0	0	2	23	0	0	0
94-96	0	0	0	0	22	0	5	0	0	0
95-97	0	0	0	1	22	16	22	0	0	0
96-98	0	0	0	1	31	20	28	0	0	0
97-99	0	0	0	0	7	21	28	0	0	0
98-00	0	0	0	0	7	5	7	0	0	0

JR DO

	Spring					Summer				
assessment period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	0	0	0	0	0	6	39	0	0	0
92-94	0	0	0	0	0	4	42	0	0	0
93-95	0	0	0	0	0	4	31	0	0	0
94-96	0	0	0	0	22	0	7	0	0	0
95-97	0	0	0	2	22	12	22	0	0	0
96-98	0	0	0	2	32	18	34	0	0	0
97-99	0	0	0	7	8	18	34	0	0	0
98-00	0	0	0	5	8	8	15	0	0	0

Neither JR model run predicts full attainment.

Higher non-attainment predicted by JR model.

Values are space-time exceedence rates % above the allowable

Attainability of current criteria according to the alternative assessment method

JMSTFU-Spring					JMSTFU-Summer			
assessment period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	0	0	0	0	3	0	2	3
92-94	0	0	0	0	3	0	2	3
93-95	0	0	0	0	2	0	1	2
94-96	0	0	0	0	1	0	0	1
95-97	1	1	0	0	1	0	1	1
96-98	1	0	0	0	2	0	2	2
97-99	1	0	0	0	3	0	2	2
98-00	0	0	0	0	3	0	1	2

JMSTFL-Spring					JMSTFL-Summer			
assessment period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	0	0	0	0	3	0	1	1
92-94	0	0	0	0	3	0	1	1
93-95	0	0	0	0	2	0	1	1
94-96	0	0	0	0	1	0	0	0
95-97	0	0	0	0	1	0	1	1
96-98	0	0	0	0	2	0	1	1
97-99	1	0	0	0	2	0	1	1
98-00	1	0	0	0	3	0	1	1

JMSOH-Spring					JMSOH-Summer			
assessment period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	0	0	0	0	0	0	0	0
92-94	0	0	0	0	0	0	0	0
93-95	0	0	0	0	0	0	0	0
94-96	0	0	0	0	0	0	0	0
95-97	0	0	0	0	0	0	0	0
96-98	0	0	0	0	0	0	0	0
97-99	0	0	0	0	0	0	0	0
98-00	0	0	0	0	0	0	0	0

JMSMH-Spring					JMSMH-Summer			
assessment period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	1	0	0	0	0	0	0	0
92-94	0	0	0	0	0	0	0	0
93-95	0	0	0	0	0	0	0	0
94-96	0	0	0	0	0	0	0	0
95-97	1	0	0	0	0	0	0	0
96-98	1	0	0	0	0	0	0	0
97-99	1	0	0	1	1	0	0	0
98-00	0	0	0	1	1	0	0	0

JMSPH-Spring					JMSPH-Summer			
assessment period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	1	0	0	0	0	0	0	0
92-94	1	0	0	0	0	0	0	0
93-95	1	0	0	0	0	0	0	0
94-96	1	0	1	1	1	0	0	0
95-97	1	0	1	1	1	0	0	0
96-98	1	0	2	2	1	0	0	0
97-99	0	0	1	1	1	0	0	0
98-00	0	0	1	1	2	0	0	0

Full attainment predicted by EPA model (TMDL scenario).

JR model predicts attainment for all segments except for JMSTFU-summer and JMSPH-spring under both scenarios.

Attainability is significantly enhanced using the alternative assessment approach vs. the current one.

Values represent the number of seasonal mean exceedences. Red values are above the allowable (1 out 3).

Attainability of *proposed* criteria according to the alternative assessment method

Segment-Season	Recommended
JMSTFU-spring	8
JMSTFU-summer	21
JMSTFL-spring	10
JMSTFL-summer	24
JMSOH-spring	13
JMSOH-summer	11
JMSMH-spring	7
JMSMH-summer	7
JMSPH-spring	8
JMSPH-summer	7

Attainability of *proposed* criteria according to the alternative assessment method

	JMSTFU-Spring				JMSTFU-Summer			
period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	2	0	0	0	2	0	1	1
92-94	1	0	0	0	2	0	1	1
93-95	0	0	0	0	1	0	1	1
94-96	0	0	0	0	0	0	0	0
95-97	1	1	0	0	1	0	1	1
96-98	1	0	0	0	2	0	1	1
97-99	1	0	0	0	2	0	1	1
98-00	1	0	0	0	2	0	0	0

	JMSTFL-Spring				JMSTFL-Summer			
period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	2	0	0	0	3	0	1	1
92-94	1	0	0	0	2	0	1	1
93-95	0	0	0	0	1	0	1	1
94-96	0	0	0	0	0	0	0	0
95-97	1	1	0	0	1	0	1	1
96-98	1	1	0	0	2	0	1	1
97-99	2	2	0	0	2	0	1	1
98-00	2	1	0	0	2	0	0	0

	JMSOH-Spring				JMSOH-Summer			
period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	1	0	0	0	3	0	0	0
92-94	0	0	0	0	2	0	0	0
93-95	0	0	0	0	1	0	0	0
94-96	0	0	0	0	0	0	0	0
95-97	0	0	0	0	1	0	0	0
96-98	0	0	0	0	1	0	0	0
97-99	0	0	0	0	2	0	0	0
98-00	0	0	0	0	1	0	0	0

	JMSMH-Spring				JMSMH-Summer			
period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	2	2	2	2	0	0	0	0
92-94	1	1	1	1	0	0	0	0
93-95	0	0	0	0	0	0	0	0
94-96	1	1	0	0	0	0	0	0
95-97	2	1	1	1	1	0	1	1
96-98	2	1	1	1	1	0	1	1
97-99	2	0	2	2	2	0	1	1
98-00	1	0	1	1	1	0	0	0

	JMSPH-Spring				JMSPH-Summer			
period	Baseline	EPA TMDL	JR TMDL	JR DO	Baseline	EPA TMDL	JR TMDL	JR DO
91-93	3	1	2	2	1	0	1	1
92-94	2	1	3	3	1	0	0	1
93-95	1	1	2	2	1	1	1	2
94-96	1	1	2	2	2	2	2	3
95-97	2	1	2	2	3	2	3	3
96-98	2	1	3	3	3	1	3	3
97-99	1	0	3	3	3	1	3	3
98-00	0	0	2	3	3	1	2	2

Neither model under any scenario predict full attainment.

Non-attainment predicted for JMSMH-spring (both models), JMSPH-spring (JR model), and JMSPH-summer (both models)

Values represent the number of seasonal mean exceedences. Red values are above the allowable (1 out of 3).

Lack of full attainment is concerning, but it is important to note that model predictions are conveyed only at fixed stations.

Fixed station datasets tend to inflate segment-wide seasonal means compared to Dataflow-derived means.

	JMSMH		JMSPH	
Season-Year	**Fixed Station**	**Dataflow**	**Fixed Station**	**Dataflow**
spring-2005	10	9	16	12
spring-2006	9	6	8	5
spring-2007	7	4	12	7
spring-2008	5	6	6	5
spring-2009	11	6	10	6
spring-2010	5	5	10	10
spring-2011	9	4	10	6
spring-2012	10	5	10	4
spring-2013	10	8	9	5
spring-2014	8	6	10	9
spring-2015	8	6	8	5
summer-2005	7	10	11	9
summer-2006	6	6	8	6
summer-2007	9	5	16	7
summer-2008	6	9	13	8
summer-2009	5	6	16	8
summer-2010	28	4	10	3
summer-2011	7	4	11	5
summer-2012	9	3	13	8
summer-2013	12	4	8	6
summer-2014	13	6	9	6
summer-2015	7	3	17	5

Red values are exceedences of the proposed criteria.

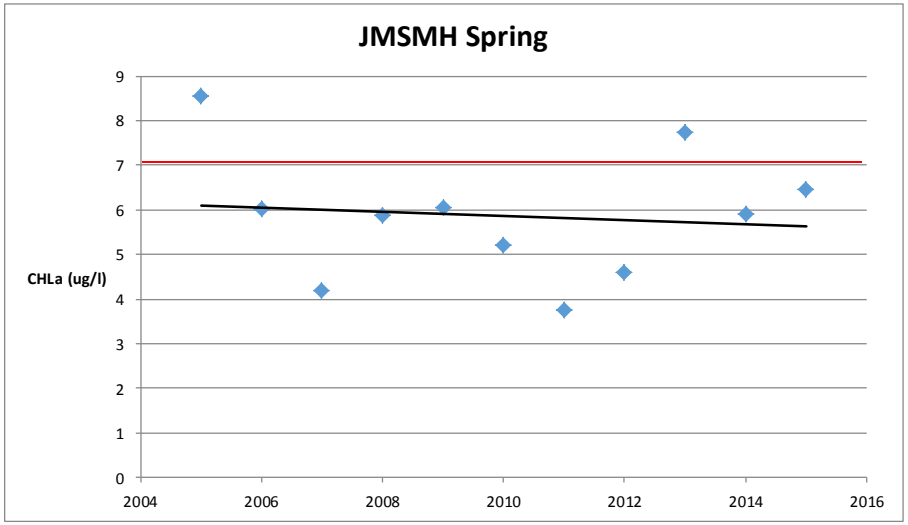
summer criterion = 7 ug/l

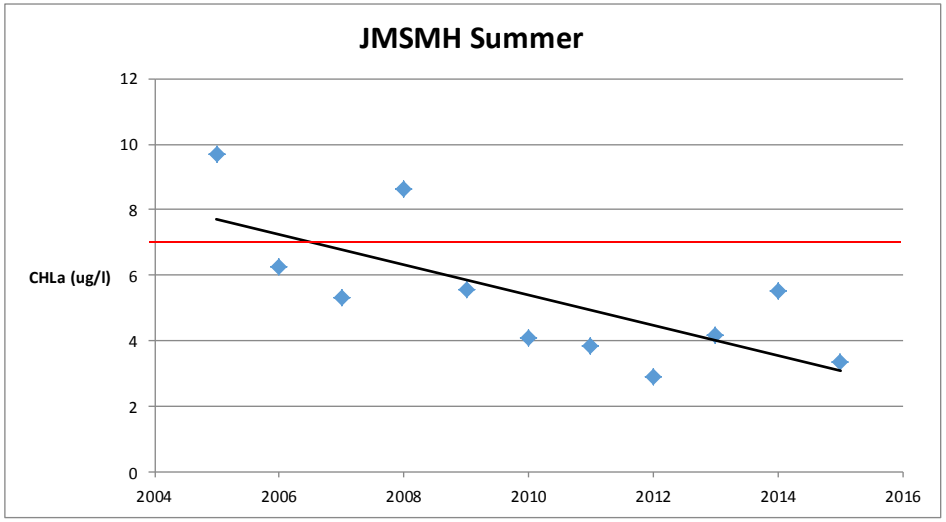
Season-Year	Baseline	EPA TMDL	Relative change	JR TMDL	Relative change	JR DO	Relative change
summer-1991	7	5	-0.3	5	-0.2	6	-0.2
summer-1992	8	6	-0.2	5	-0.3	5	-0.3
summer-1993	7	6	-0.1	7	0.0	7	0.0
summer-1994	7	5	-0.3	7	0.1	8	0.1
summer-1995	8	8	0.0	8	-0.1	8	-0.1
summer-1996	12	9	-0.3	8	-0.3	8	-0.3
summer-1997	8	6	-0.3	9	0.1	9	0.1
summer-1998	9	7	-0.3	9	-0.1	9	-0.1
summer-1999	17	10	-0.4	8	-0.5	8	-0.5
summer-2000	11	7	-0.3	7	-0.4	7	-0.4
average summer relative change			**-0.2**		**-0.2**		**-0.2**

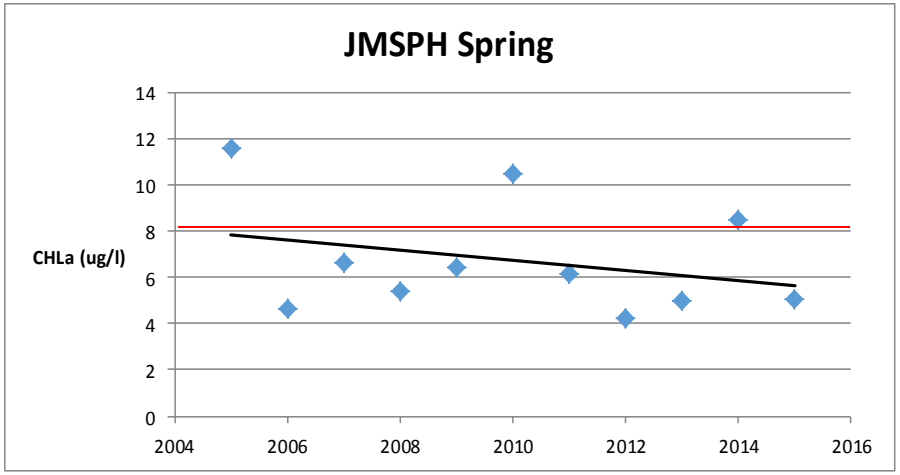
Both models predict that the proposed criterion for JMSPH-summer are achievable according to the predicted relative changes.
The JR model predicts similar changes under both management scenarios.

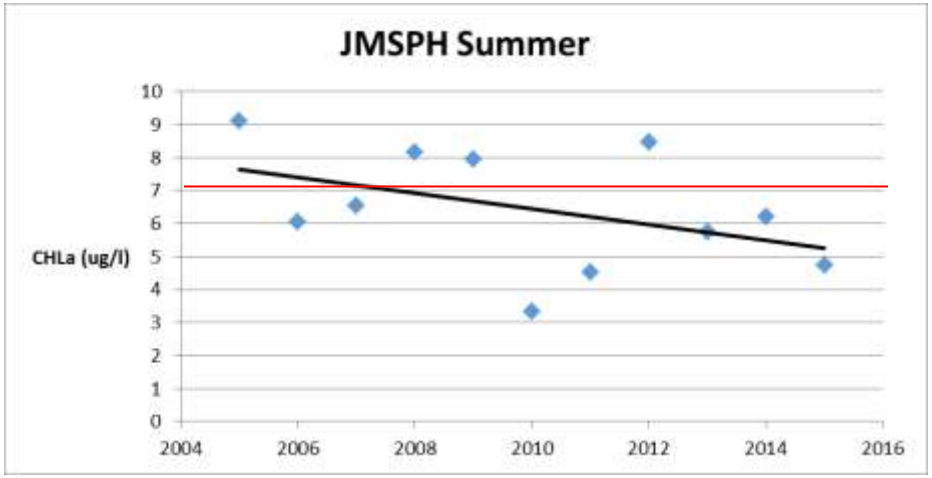
These results are preliminary.

There are signs that pollution control measures may already be having a positive effect.









Proposed criterion