James River Chlorophyll Assessment: Proposed Changes to the Procedure and Motivation for using the 2005-2013 Period for Determining Criteria Attainability

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VADEQ-Office of Ecology
Modeling Workgroup Quarterly Meeting
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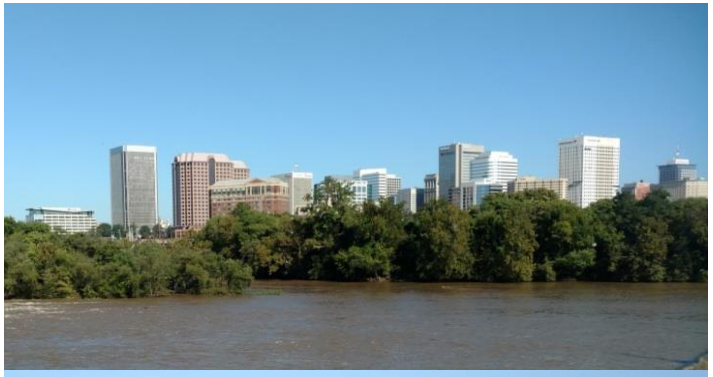
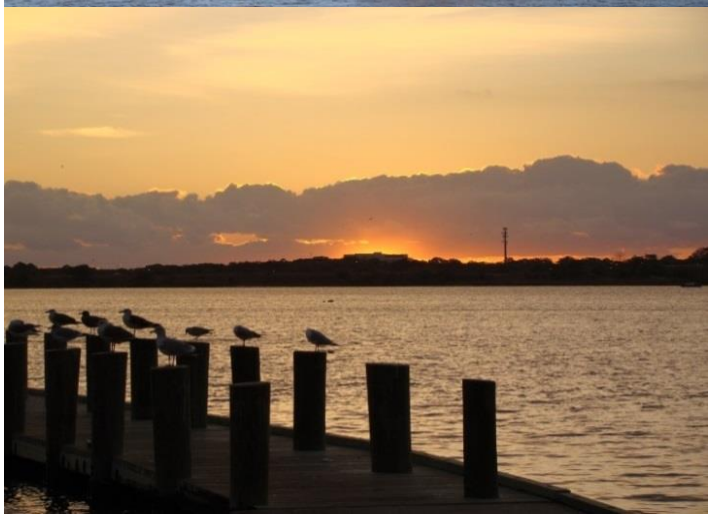
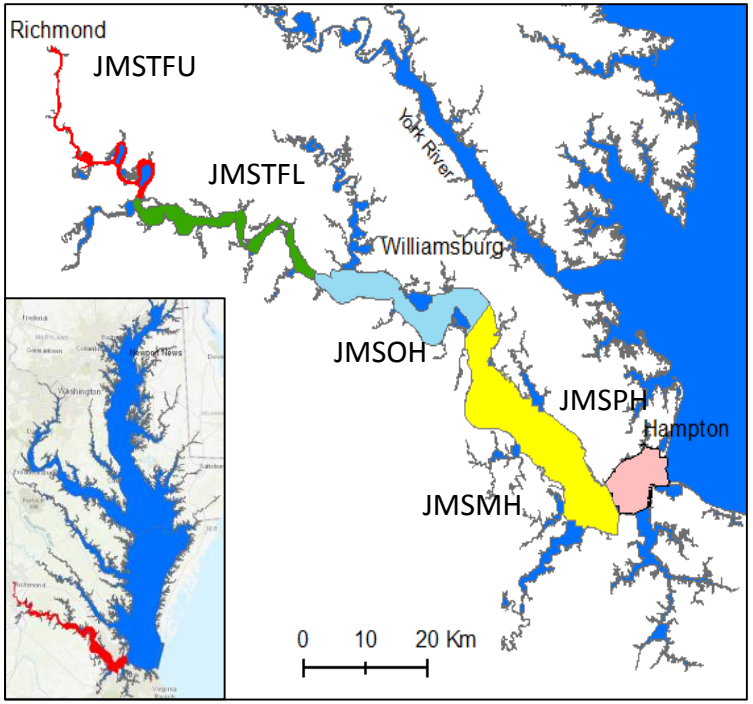
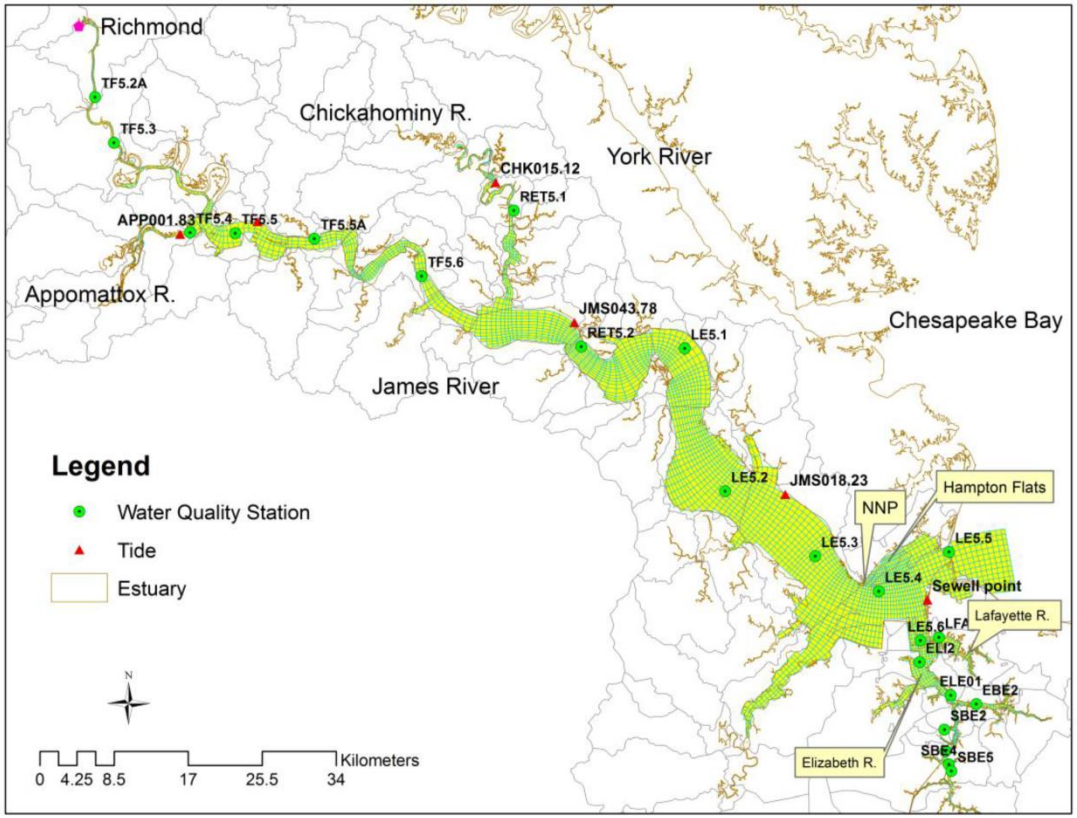




Since the completion of the Bay TMDL, VADEQ has been reviewing the James River chlorophyll criteria and assessment method.



VADEQ has also contracted with VIMS to develop a water quality model specific to the tidal James River.



VADEQ is considering the adoption of revised criteria and a different assessment method.

The agency plans to use the VIMS water quality model to determine the attainability of both current and proposed criteria under a number of load reduction scenarios.

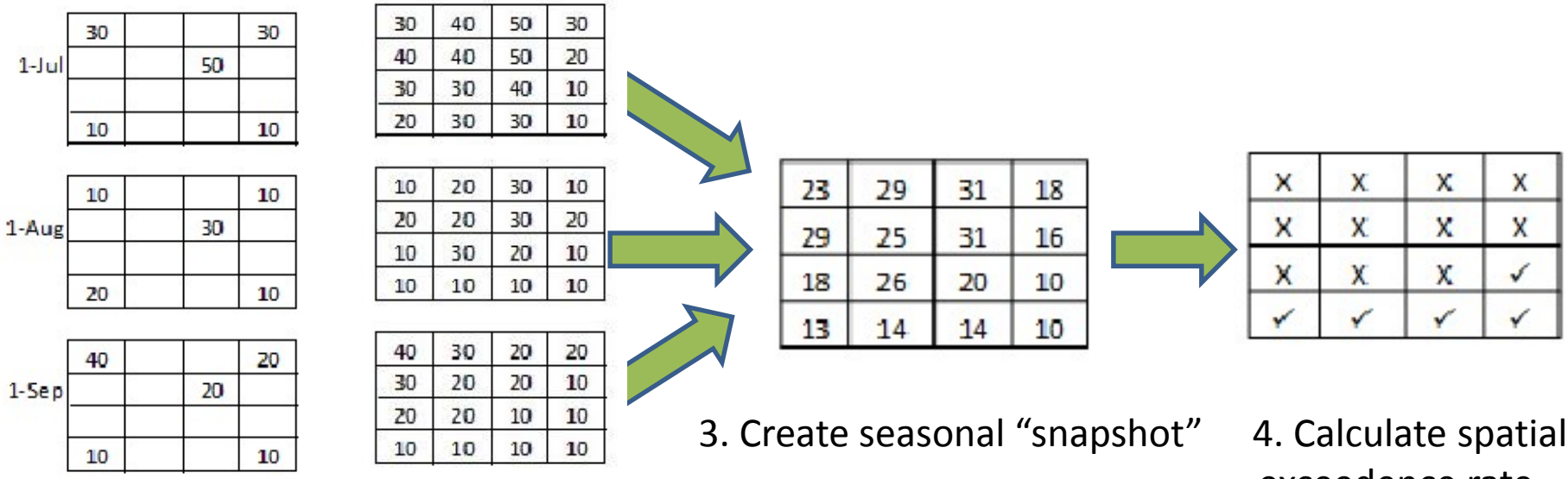
VADEQ will be running both assessment procedures on the VIMS model output to determine criteria attainability.

The Current Method

Table IV-2. Previously published Chesapeake Bay chlorophyll *a* criteria assessment methods and recommended modifications.

U.S. EPA 2008 Addendum	U.S. EPA 2010 Addendum
1. Chlorophyll *a* data used for scenario assessments comprise all chlorophyll a values in the CIMS water quality database with layer flagged "S" for surface.	
2. Data are organized into individual "cruise" files for interpolation.	
3. Individual cruise files are interpolated using the Chesapeake Bay Interpolator (version 4.61), with the "ln-transform" and the "2-D Inverse-Distance Squared" options selected. *The Interpolator automatically back-transforms chlorophyll a values in its output files.*	
	4a. Interpolated chlorophyll a surfaces are ln-transformed 4b. Seasonal means are calculated on ln-transformed chlorophyll a values.
	5. Ln-transformed seasonal means are assessed (cell-by-cell) against the ln-transformed criterion for the relevant river segment-season.

Source: U.S. EPA 2008.



1. Conduct monthly monitoring runs

2. Interpolate each monitoring run using the Bay Interpolator

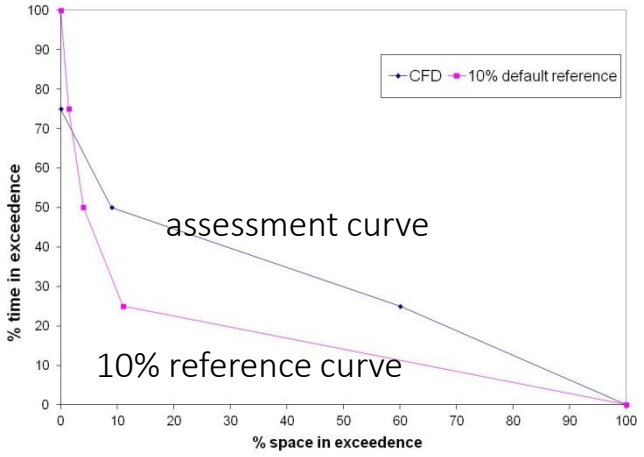
3. Create seasonal "snapshot"

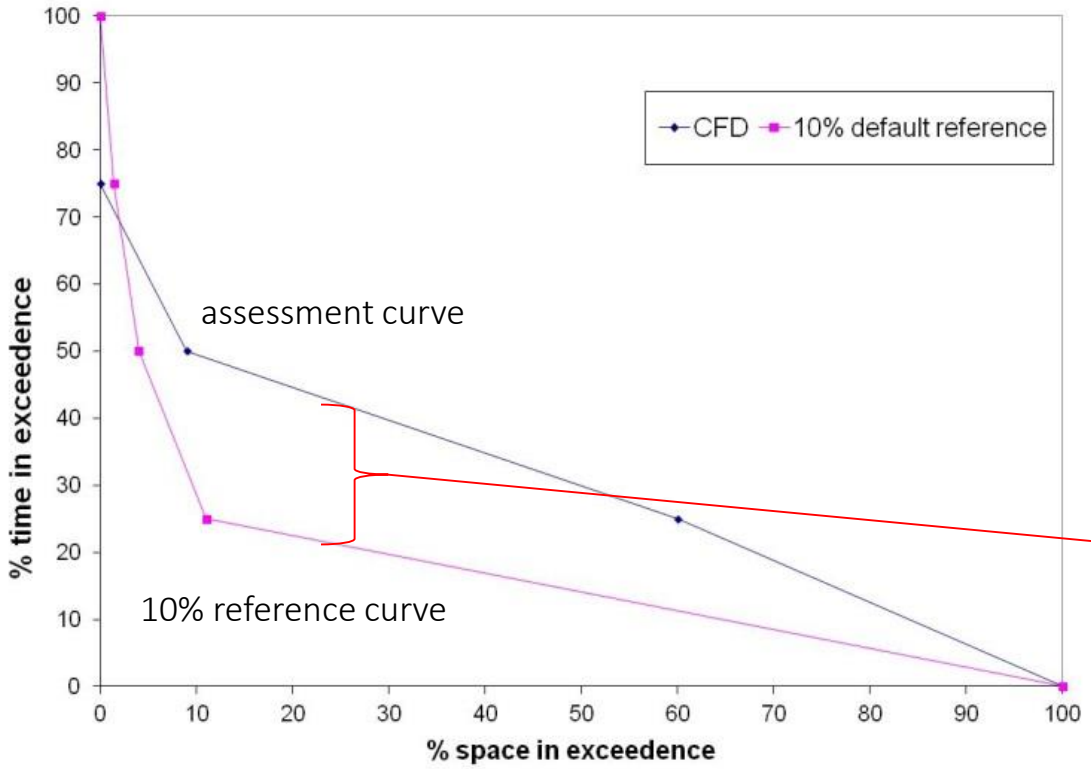
4. Calculate spatial exceedence rate

Perform the above steps for each season in the assessment period

Season-Year	Ranked Spatial Exceedence Rate	Temporal Exceedence Rate
	100%	0%
Spring Year2	33%	25%
Spring Year1	25%	50%
Spring Year3	10%	75%
	0%	100%

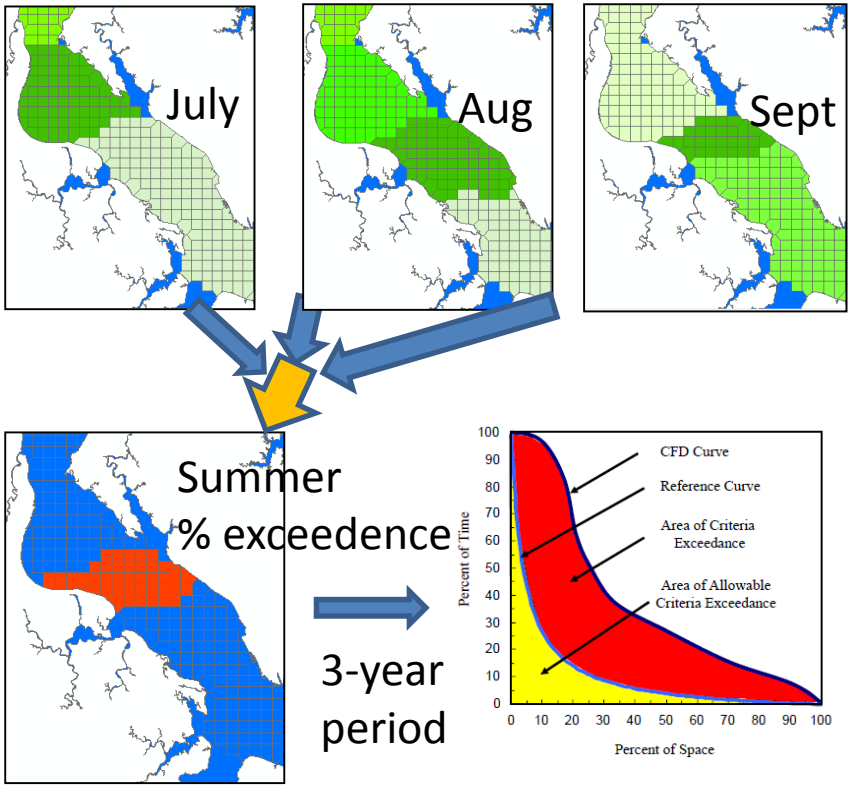
5. Rank spatial exceedence rates; assign a cumulative temporal exceedence rate based on rank





Area between the curves = excessive space-time exceedence rate

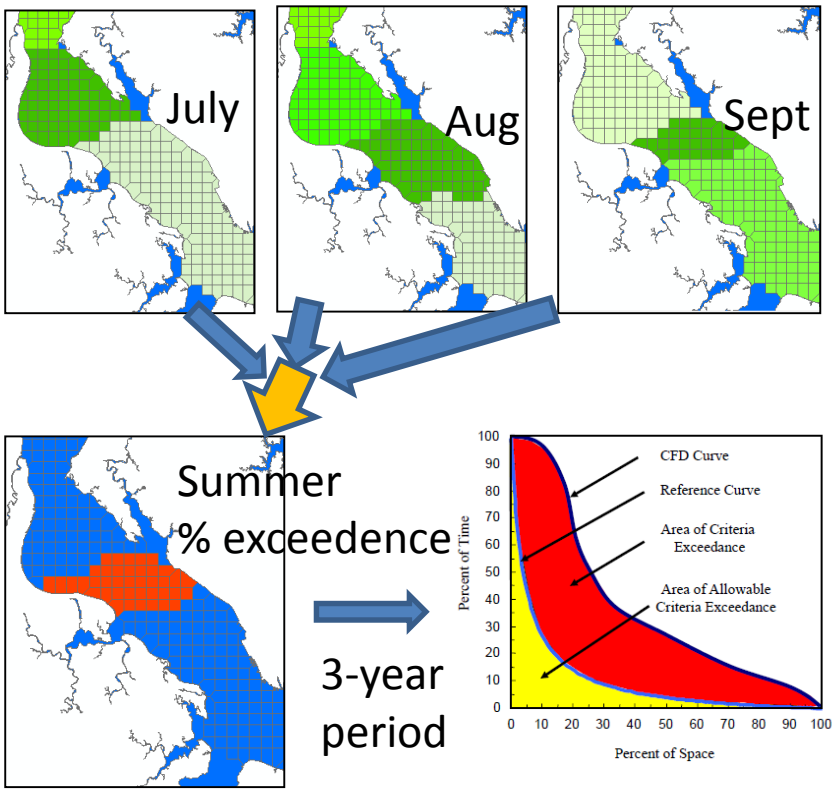
How is the proposed assessment method different from the current one?



Samples are interpolated to a grid for each cruise, then cell estimates are averaged over a season and assessed against the criterion.

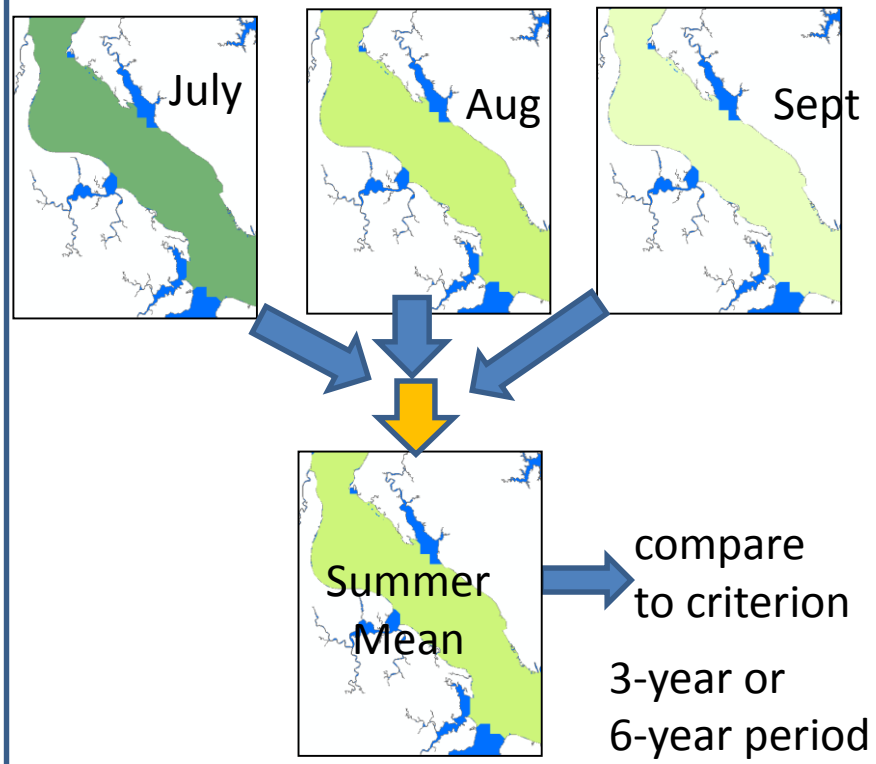
Current

How is the proposed assessment method different from the current one?



Samples are interpolated to a grid for each cruise, then seasonal means are calculated for each cell and assessed against the criterion. Spatial exceedence % calculated.

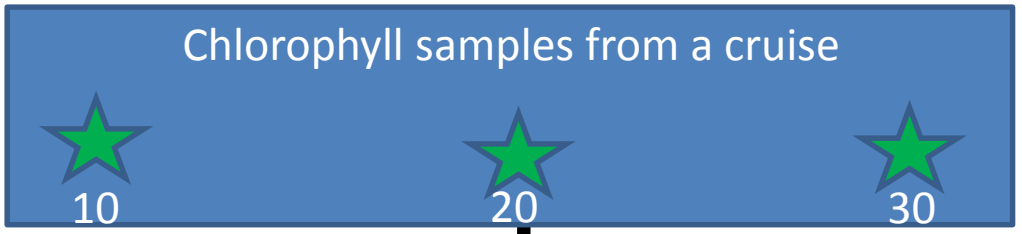
Current



Samples pooled within segment for each cruise, then composites are averaged over each season and assessed against the criterion.

Proposed

James River segment



Pooled sample = 20

Repeat for all cruises in a season-year

Calculate geometric mean of pooled samples over each season-year

single value to compare against WQS

Do the above steps for three or six years.
Allowable exceedence rate = 33%

How is the proposed assessment method different from the current one?

Historical Chlorophyll

SPRING					
period	**JMSTFU**	**JMSTFL**	**JMSOH**	**JMSMH**	**JMSPH**
91-93	0.0	0.0	0.0	29.6	19.8
92-94	0.0	0.0	0.0	5.2	5.4
93-95	0.0	5.6	0.0	0.0	5.4
94-96	0.0	5.6	9.4	6.5	21.8
95-97	0.0	19.5	20.9	13.0	21.8
96-98	0.0	11.3	24.7	13.0	21.8
97-99	0.0	30.0	25.2	7.9	0.0
98-2000	0.0	16.1	19.6	1.4	0.0
SUMMER					
period	**JMSTFU**	**JMSTFL**	**JMSOH**	**JMSMH**	**JMSPH**
91-93	22.3	53.6	0.0	0.0	0.0
92-94	21.7	52.6	0.0	0.0	0.0
93-95	17.1	36.5	0.0	0.0	3.7
94-96	1.7	12.2	0.0	0.0	6.0
95-97	16.2	21.8	0.6	3.8	6.0
96-98	27.7	37.1	0.6	3.8	0.1
97-99	29.9	41.5	0.6	24.5	21.8
98-2000	18.6	32.7	0.0	18.2	32.3

Excessive space-time exceedence rates (%)

SPRING					
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	10	12	14	**17**	9
1992	9	11	10	12	**11**
1993	3	3	3	4	**13**
1994	8	9	3	5	8
1995	**12**	12	6	7	5
1996	9	11	**18**	10	**20**
1997	**13**	15	15	**13**	9
1998	8	8	14	4	6
1999	10	**17**	13	12	9
2000	8	12	12	6	7
SUMMER					
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	**21**	**26**	14	5	7
1992	**24**	**27**	16	6	8
1993	**41**	**48**	13	7	7
1994	**20**	**24**	10	3	7
1995	13	11	5	4	9
1996	7	8	6	5	**12**
1997	**53**	**58**	15	10	8
1998	**30**	**31**	10	6	9
1999	**17**	16	14	**11**	**17**
2000	**24**	**29**	8	5	**11**

Seasonal chlorophyll geometric means (ug/L)

Exceedences of current criteria

Current

Proposed

VADEQ is also proposing alternative criteria to go along with the alternative assessment method.

Segment-Season	Current criteria	Recommended
JMSTFU-spring	10	8
JMSTFU-summer	15	21
JMSTFL-spring	15	10
JMSTFL-summer	23	24
JMSOH-spring	15	13
JMSOH-summer	22	11
JMSMH-spring	12	7
JMSMH-summer	10	7
JMSPH-spring	12	8
JMSPH-summer	10	7

Preliminary Chlorophyll Criteria Attainment Results of the CBPO Ranging Scenarios

Scenario Descriptions

All scenarios assume 1991-2000 average hydrology

- 2010 No Action Scenario: 2010 land uses, animal numbers, atmospheric deposition, and point source loads but with NO CONTROLS on loading.
- 1985 Progress Scenario: 1985 land uses, animal numbers, atmospheric deposition, point source loads, and pollution controls.
- 1993 Progress Scenario: 1993 land uses, animal numbers, atmospheric deposition, point source loads, and pollution controls.
- 2013 Progress Scenario: 2013 land uses, animal numbers, atmospheric deposition, point source loads, and pollution controls.
- WIP2 Scenario: estimated 2010 land uses, animal numbers, atmospheric deposition, point source loads, and 2025 pollution controls.
- E3 (Everyone, Everything, Everywhere) Scenario: Management actions applied to the fullest possible extent on 2010 land uses, animal numbers, atmospheric depo, and point sources.

Attainment of Current Criteria using Current Assessment Procedure

2013 Progress

SPRING					
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	0.0	0.0	0.0	0.0	2.8
92-94	0.0	0.0	0.0	0.0	2.8
93-95	0.0	0.0	0.0	0.0	2.8
94-96	0.0	0.0	0.0	0.0	21.8
95-97	0.0	0.0	0.0	0.5	21.8
96-98	0.0	0.0	0.0	0.5	21.8
97-99	0.0	0.0	0.0	0.0	0.0
98-2000	0.0	0.0	2.5	0.0	0.0

SUMMER					
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	0.0	34.2	0.0	0.0	0.0
92-94	0.0	33.2	0.0	0.0	0.0
93-95	0.0	20.0	0.0	0.0	0.0
94-96	0.0	2.0	0.0	0.0	0.0
95-97	2.0	21.8	0.0	0.0	0.0
96-98	5.2	35.5	0.0	0.0	0.0
97-99	5.3	35.5	0.0	1.5	18.3
98-2000	5.4	25.1	0.0	1.5	26.3

WIP2

SPRING					
period	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	21.8
95-97	0.0	0.0	0.0	0.0	21.8
96-98	0.0	0.0	0.0	0.0	21.8
97-99	0.0	0.0	0.0	0.0	0.0
98-2000	0.0	0.0	1.9	0.0	0.0

SUMMER					
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	0.0	29.4	0.0	0.0	0.0
92-94	0.0	27.5	0.0	0.0	0.0
93-95	0.0	16.0	0.0	0.0	0.0
94-96	0.0	0.0	0.0	0.0	0.0
95-97	1.2	21.8	0.0	0.0	0.0
96-98	2.0	35.5	0.0	0.0	0.0
97-99	2.0	35.5	0.0	0.0	13.1
98-2000	2.0	25.0	0.0	0.0	17.2

E3

SPRING					
period	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	0.0
98-2000	0.0	0.0	0.0	0.0	0.0

SUMMER					
period	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
91-93	0.0	9.0	0.0	0.0	0.0
92-94	0.0	9.0	0.0	0.0	0.0
93-95	0.0	9.0	0.0	0.0	0.0
94-96	0.0	0.0	0.0	0.0	0.0
95-97	0.0	17.1	0.0	0.0	0.0
96-98	0.0	21.8	0.0	0.0	0.0
97-99	0.0	21.8	0.0	0.0	8.8
98-2000	0.0	2.0	0.0	0.0	8.8

Values are excessive space-time exceedence rates%.
Red values indicate periods with non-attainment of the current criteria.

The VIMS model does not predict full attainment of the current criteria under the E3 scenario.

Exceedences of Proposed Criteria using Proposed Assessment Procedure

2013 Progress

SPRING	2013 Progress Scenario				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	4	6	7	**14**	8
1992	4	5	5	**9**	8
1993	2	2	2	3	**11**
1994	4	6	3	3	6
1995	7	6	5	7	5
1996	3	4	8	7	**17**
1997	7	10	10	**10**	8
1998	5	6	11	3	5
1999	5	9	8	**10**	7
2000	4	7	13	4	6

SUMMER	2013 Progress Scenario				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	14	18	7	3	5
1992	17	19	8	4	6
1993	**26**	**32**	8	5	6
1994	14	16	6	2	7
1995	7	6	3	2	7
1996	4	5	4	3	**10**
1997	**31**	**39**	10	7	7
1998	**23**	24	7	5	**8**
1999	11	13	11	**9**	**15**
2000	20	**25**	7	4	**9**

WIP2

SPRING	WIP2 Scenario				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	4	6	7	**12**	7
1992	4	5	4	**9**	7
1993	1	2	2	2	**10**
1994	**11**	5	2	3	5
1995	6	5	4	5	4
1996	2	4	8	6	**14**
1997	6	8	9	**8**	7
1998	5	5	9	3	6
1999	4	8	8	**9**	5
2000	4	7	12	3	5

SUMMER	WIP2 Scenario				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	13	17	8	2	5
1992	15	18	8	3	5
1993	**25**	**31**	7	4	5
1994	11	14	5	1	6
1995	6	6	3	2	6
1996	3	4	3	3	**9**
1997	**34**	**41**	9	5	6
1998	**22**	24	6	4	7
1999	10	13	11	7	**14**
2000	19	24	7	3	**8**

E3

SPRING	E3 Scenario				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	2	5	4	**9**	6
1992	2	2	2	6	6
1993	1	1	1	2	8
1994	2	2	1	2	4
1995	3	2	4	5	4
1996	2	2	4	4	**11**
1997	3	4	6	6	6
1998	3	4	6	2	5
1999	2	4	3	6	5
2000	2	3	9	3	4

SUMMER	E3 Scenario				
Year	JMSTFU	JMSTFL	JMSOH	JMSMH	JMSPH
1991	7	10	7	2	4
1992	11	13	5	2	4
1993	16	19	4	2	4
1994	7	9	3	1	5
1995	4	4	2	1	5
1996	2	3	2	2	**8**
1997	20	**28**	5	3	5
1998	14	15	4	3	6
1999	5	7	6	4	**12**
2000	11	15	4	2	6

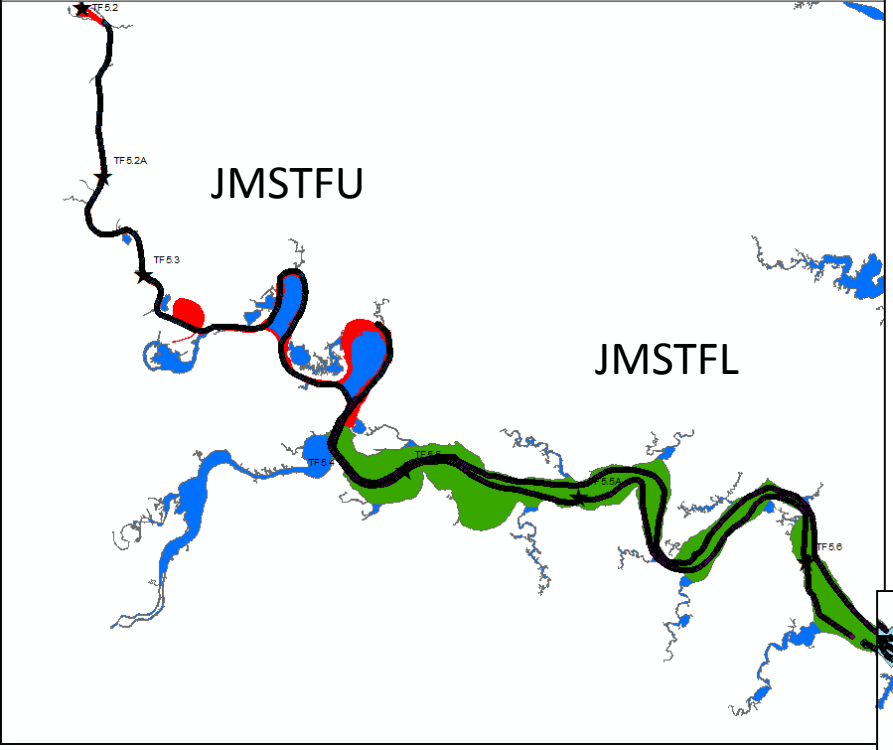
Values are season-year chlorophyll means.
Red values are exceedences of the proposed segment-season criteria.
Red boxes are 6-year periods with criteria non-attainment.

The VIMS model predicts full attainment only under the E3 scenario.

VADEQ would like to determine the attainability of the criteria by scenario-modifying observations from 2005-2013 instead of those from 1991-2000.

VADEQ analyzed 2005-2015 monitoring data to estimate the long-term central tendency of chlorophyll in each segment/season and used this information (along with other info) to derive alternative criteria.

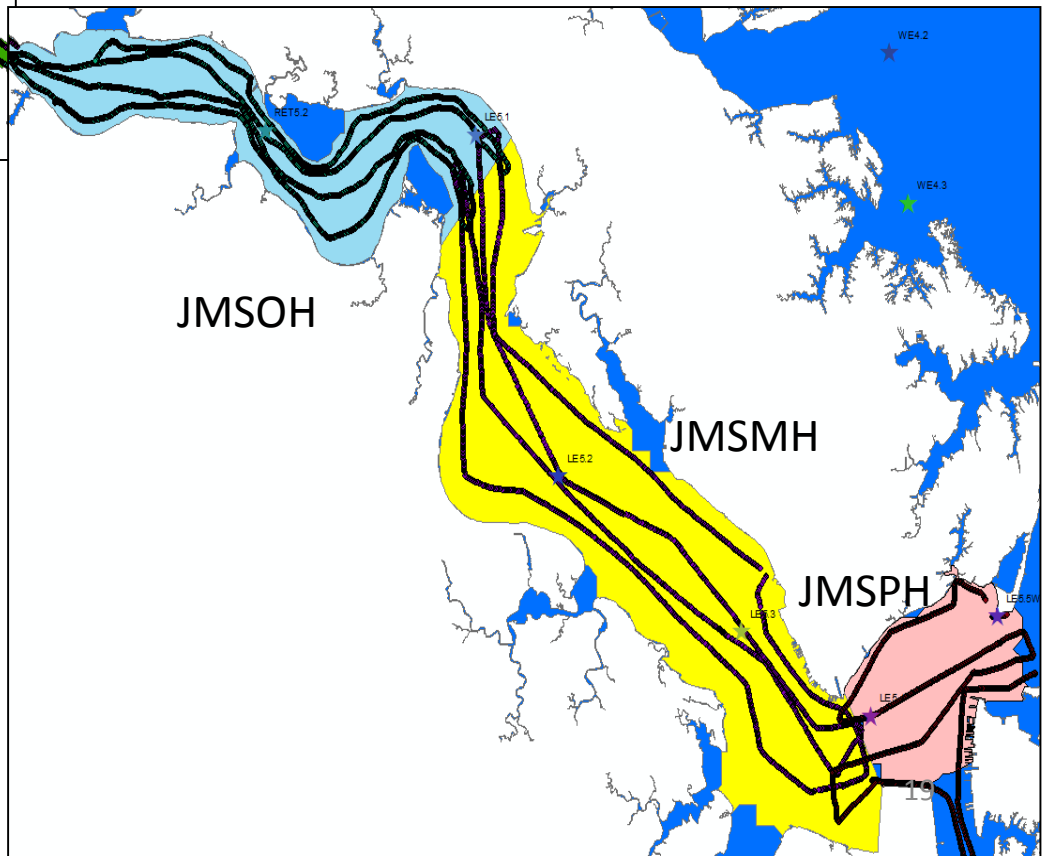
So we view the 2005-2015 period as the new “baseline period”.



JMSTFU

JMSTFL

The 2005-2015 datasets are quite spatially and temporally intensive.



JMSOH

JMSMH

JMSPH

Geometric means derived from 2005-2015 monitoring datasets

Segment-Season	Current criteria	Recommended	Basis for recommended criteria lower than baseline	Baseline
JMSTFU-spring	10	8		8
JMSTFU-summer	15	21	Enhanced protection from elevated pH	23
JMSTFL-spring	15	10		10
JMSTFL-summer	23	24	Enhanced protection from elevated pH and harmful algal blooms	28
JMSOH-spring	15	13		13
JMSOH-summer	22	11		11
JMSMH-spring	12	7		7
JMSMH-summer	10	7		7
JMSPH-spring	12	8		8
JMSPH-summer	10	7	Enhanced protection from harmful algal blooms	8

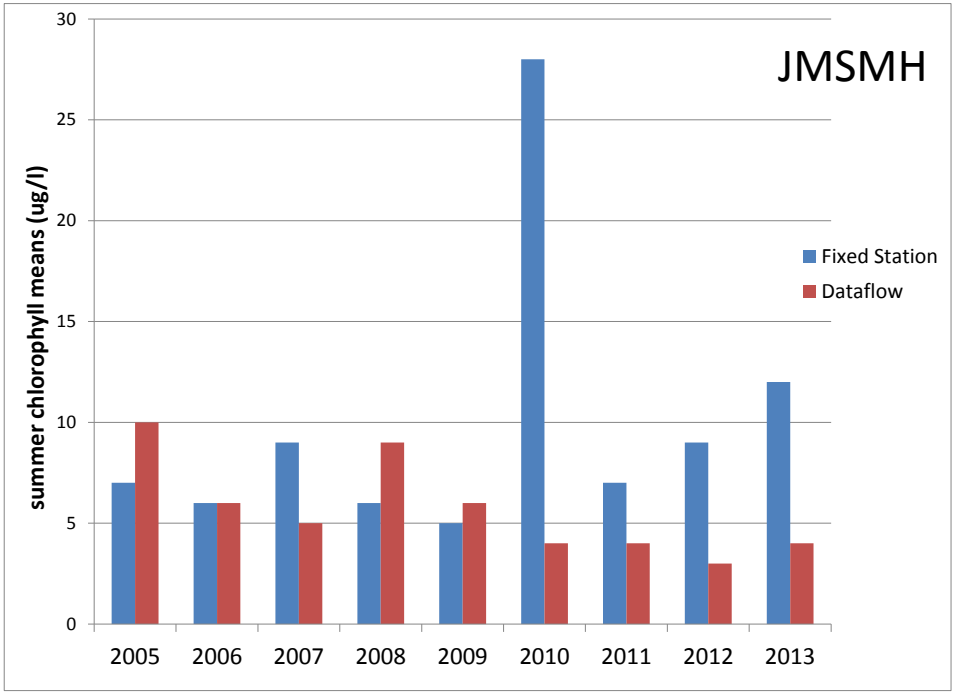
Justification for scenario-modifying more recent data:

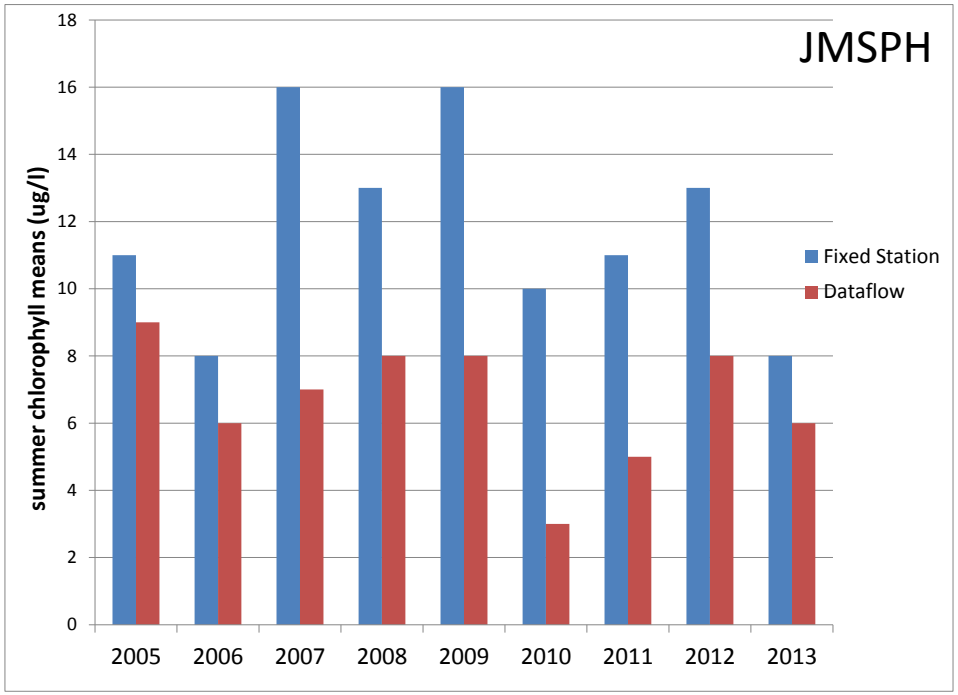
- The 2005-2013 monitoring data were used to derive the proposed criteria— most of which are developed to maintain *current* chlorophyll concentrations. The 1991-2000 monitoring data do not reflect current chlorophyll concentrations.

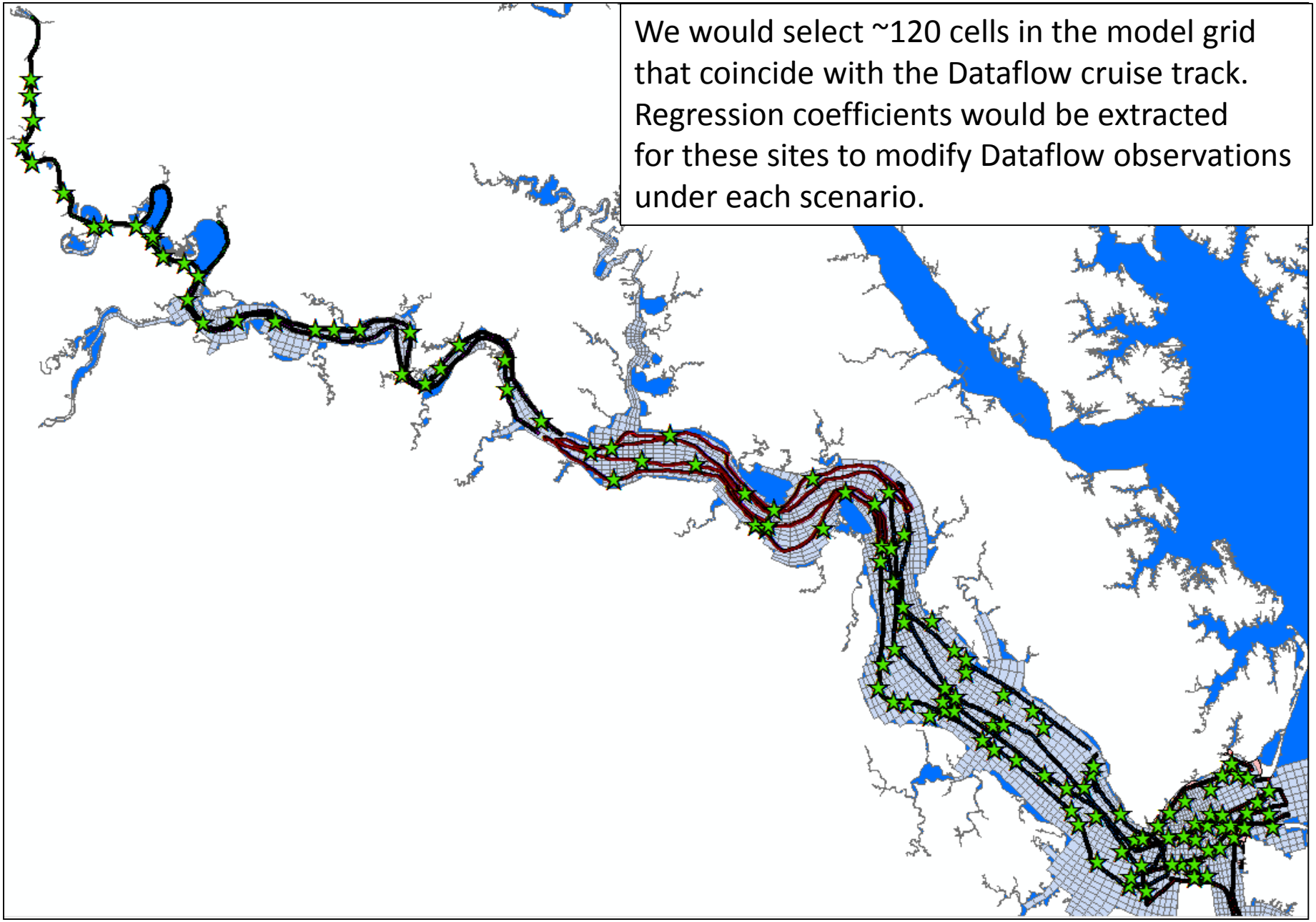
- The 2005-2013 monitoring datasets are much more refined than the 1991-2000 datasets. The former would be better indicators of "attainability" than the latter.

Dataflow-derived estimates of chlorophyll expression tend to be lower than CBP fixed station estimates.

Because the proposed criteria are derived from these lower estimates, we feel it is important that attainability be determined from the same source of data.



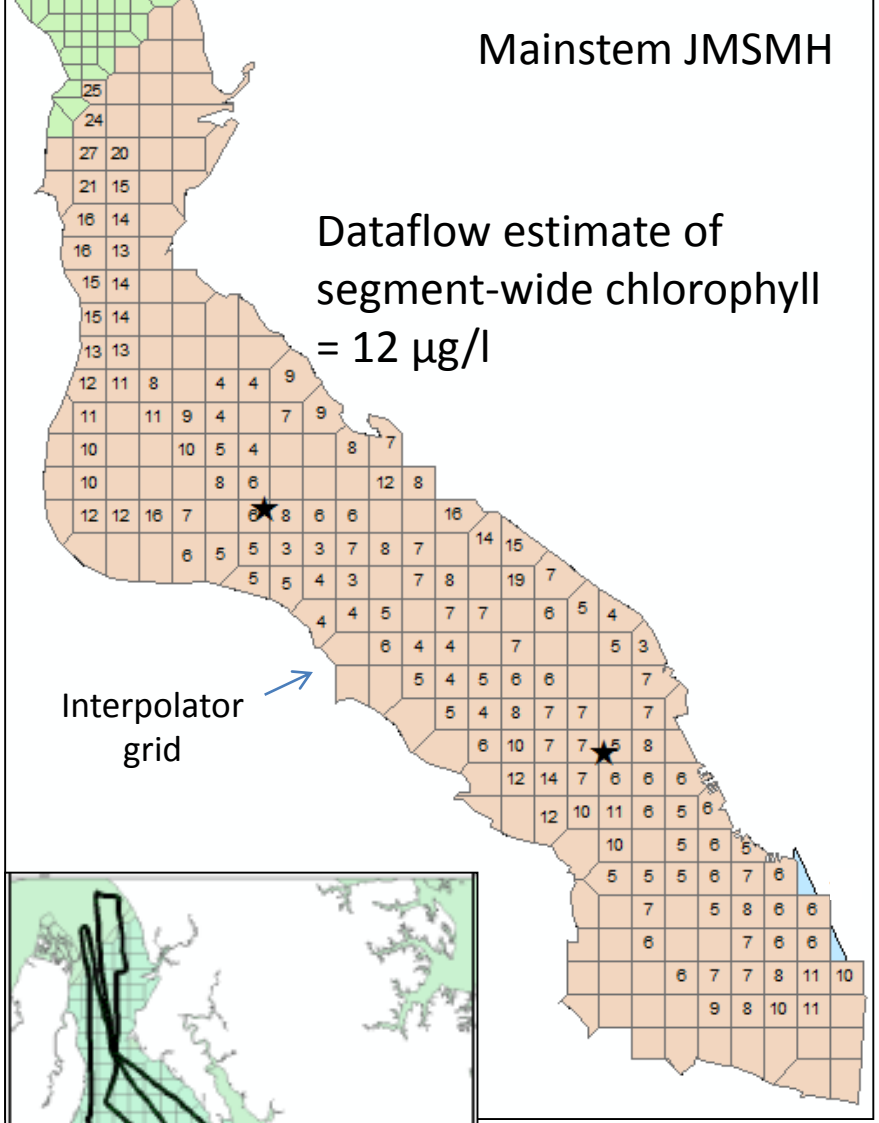


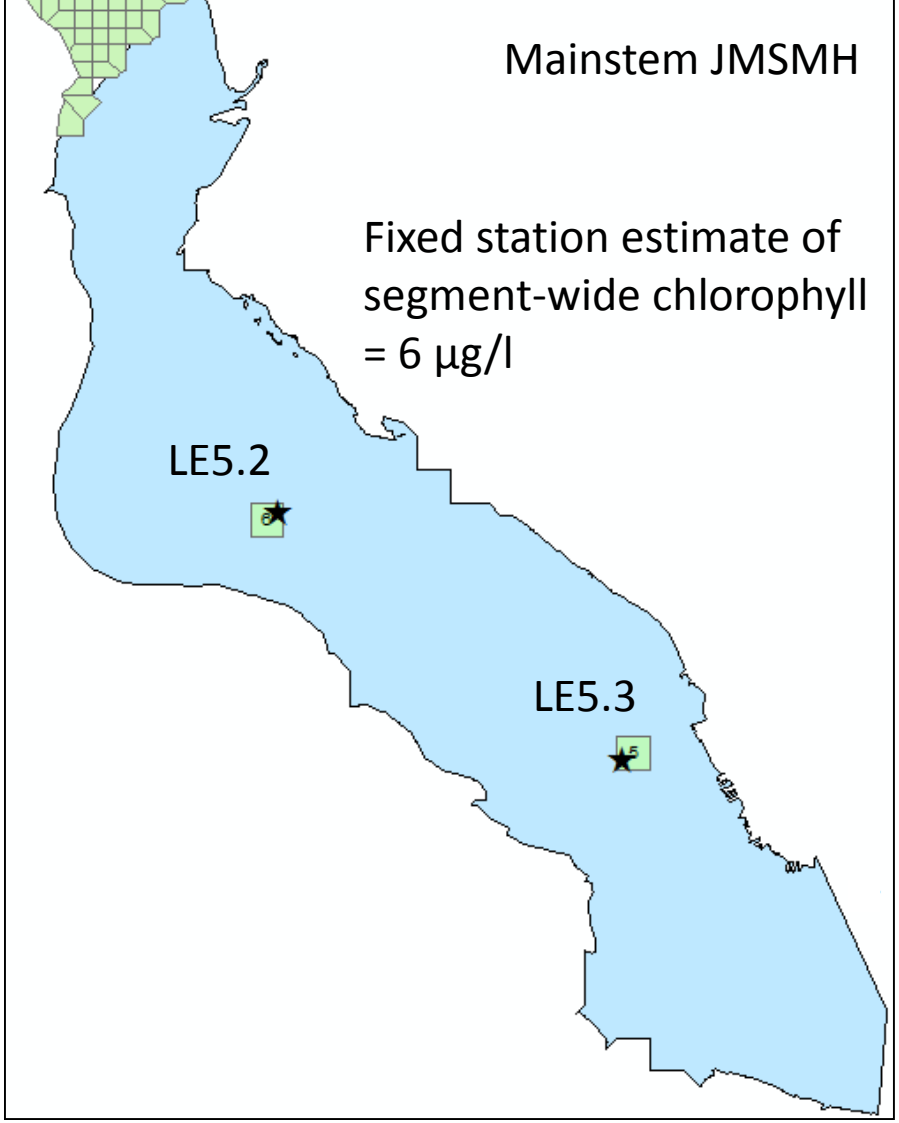


We would select ~120 cells in the model grid that coincide with the Dataflow cruise track. Regression coefficients would be extracted for these sites to modify Dataflow observations under each scenario.

VADEQ needs the 2005-2013 scenario loadings estimated by the Bay Watershed Model.

Questions?


Mainstem JMSMH
Dataflow estimate of segment-wide chlorophyll = 12 µg/l
Interpolator grid


Mainstem JMSMH
Fixed station estimate of segment-wide chlorophyll = 6 µg/l
LE5.2
LE5.3