James River Chlorophyll Assessment Webinar

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Office of Ecology—Monitoring and Assessment
Virginia DEQ, July 15, 2015

Presentation Outline

- Background
- Description of current assessment method
- Challenges of current assessment method
- Straw-man proposal
- Discussion

The protectiveness of a numeric criteria is three-pronged

- Magnitude
- Duration
- Frequency

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The protectiveness of a criteria is three-pronged

- Magnitude→ the “amount” of pollutant
- Duration → instantaneous, 24-hr, 30-day, seasonal, annual
- Frequency → - allowable exceedence rate in time and/or space
  - assessment period

Assessment methodology concentrates on the <u>frequency</u> component of criteria.

- Magnitude→ the "amount" of pollutant
- Duration → instantaneous, 24-hr, 30-day, seasonal, annual
- Frequency → - allowable exceedence rate in time and/or space
  - assessment period

Water Quality Standard

Assessment methodology also includes monitoring techniques, statistical tools, and rules for dealing with uncertainty.

Assessment Methodology

Considerations that are <u>NOT</u> addressed by assessment methodology

- "Should we use a mean, median, or a 90th percentile?"
- "Should we assess individual observations or temporally-aggregated data?"
- "Should we round data to the nearest whole number?"
- "Should June data be included in the assessment?"
- "Should JMSMH and JMSPH be merged into one segment?"

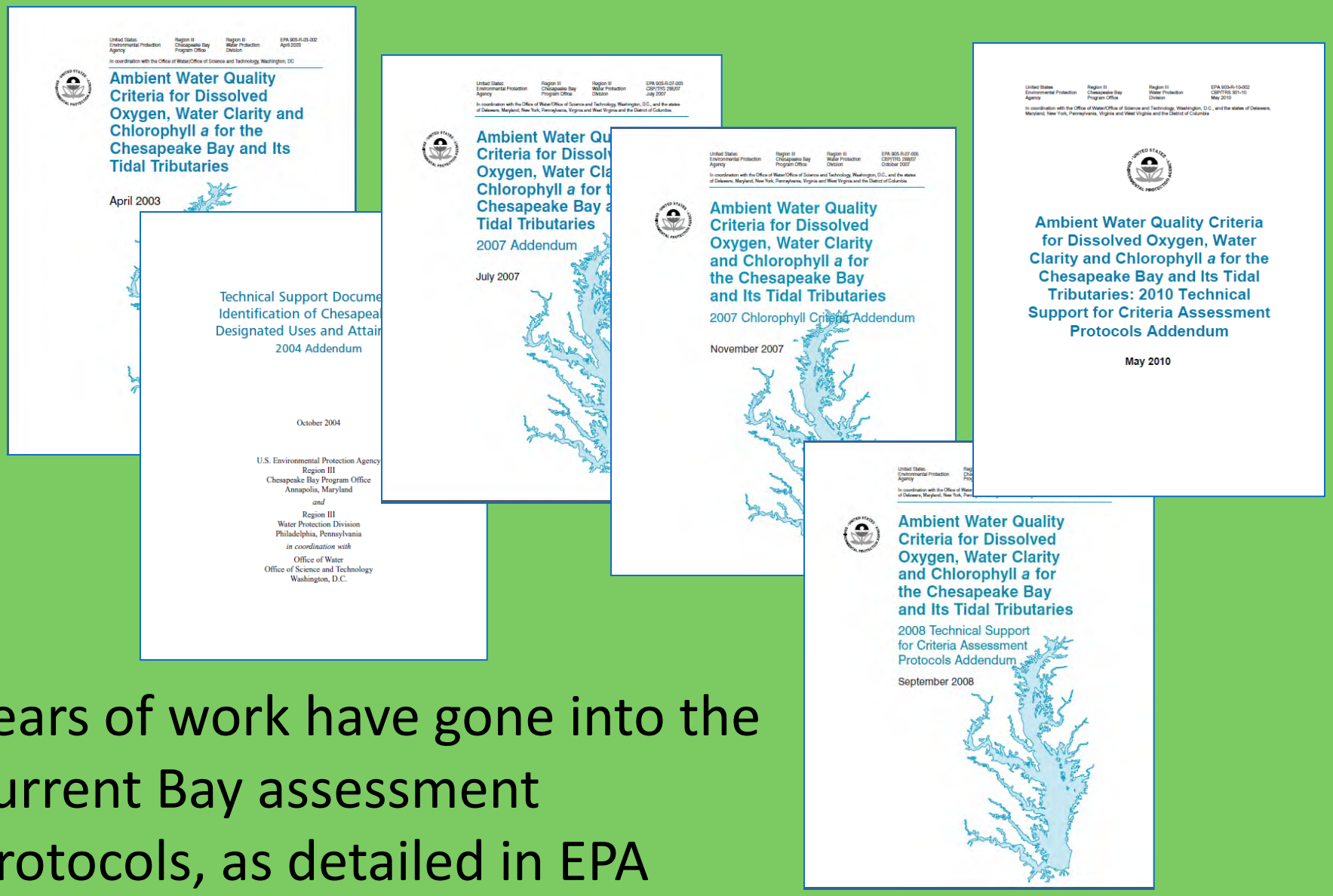
Excerpt from Virginia's Water Quality Standards

bb. The following site specific numerical chlorophyll a criteria apply March 1 through May 31 and July 1 through September 30 as seasonal means to the tidal James River (excludes tributaries) segments JMSTF2, JMSTF1, JMSOH, JMSMH, JMSPH and are implemented in accordance with subsection D of 9VAC25-260-185.

Designated Use	Chlorophyll a µ/l	Chesapeake Bay Program Segment	Temporal Application
Open Water	10	JMSTF2	March 1 - May 31
	15	JMSTF1	
	15	JMSOH	
	12	JMSMH	
	12	JMSPH	
	15	JMSTF2	July 1 - September 30
	23	JMSTF1	
	22	JMSOH	
	10	JMSMH	
	10	JMSPH	

Considerations that are addressed by assessment methodology

- "Should we spatially interpolate the data?"
- "What proportion of space and/or time should we allow to violate?"
- "What's the minimum sample size we must have to make a determination?"
- "How much uncertainty are we willing to tolerate?"
- "What is the assessment window we are going to use?"



Years of work have gone into the current Bay assessment protocols, as detailed in EPA technical documents spanning more than ten years.

Excerpt from Virginia's Water Quality Standards

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	22	JMSOH	
	10	JMSMH	
	10	JMSPH	

Excerpt from **9 VAC 25-260 Virginia Water Quality Standards**

9VAC25-260-185 D

3. Attainment of these criteria shall be assessed through comparison of the generated cumulative frequency distribution of the monitoring data to the applicable criteria reference curve for each designated use. If the monitoring data cumulative frequency curve is completely contained inside the reference curve, then the segment is in attainment of the designated use. The reference curves and procedures to be followed are published in the USEPA, Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries, EPA 903-R-03-002, April 2003 and the 2004 (EPA 903-R-03-002 October 2004) and 2007 (CBP/TRS 285-07, EPA 903-R-07-003), 2007 (CBP/TRS 288/07, EPA 903-R-07-005), 2008 (CBP/TRS 290-08, EPA 903-R-08-001, and 2010 (CBP/TRS 301-10, EPA 903-R-10-002) addenda. An exception to this requirement is in measuring attainment of the SAV and water clarity acres, which are compared directly to the criteria.

The Bay criteria assessment protocols are referenced in the Water Quality Standards.

Question Break

Three basic ingredients of JR chlorophyll assessment:

- Spatial Interpolation
- Spatial Exceedence Rate
- Cumulative Frequency Diagram (CFD)

1. Spatial Interpolation

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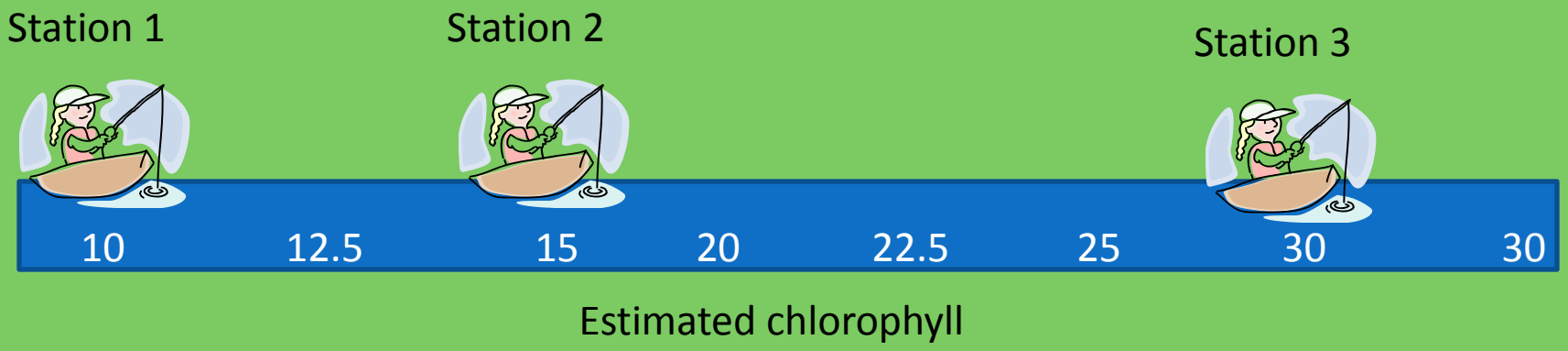
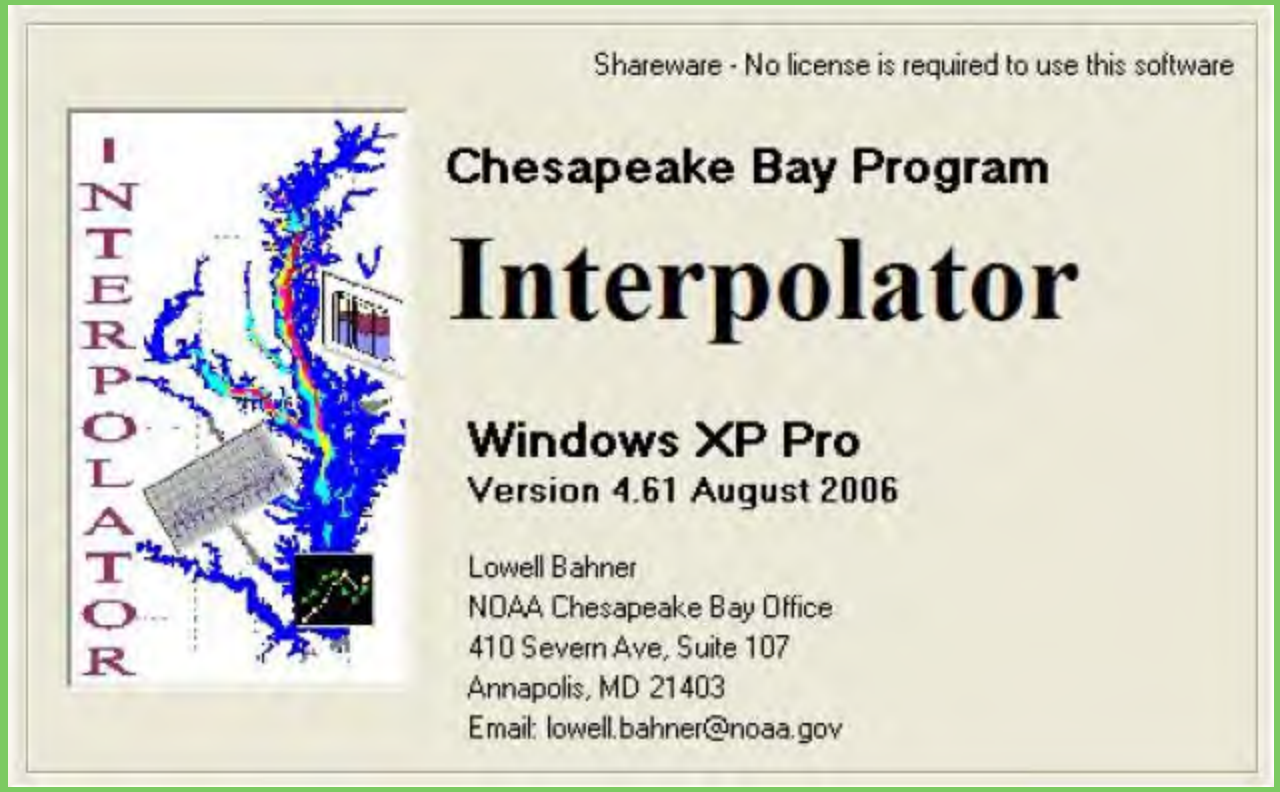
Observed chlorophyll

1. Spatial Interpolation

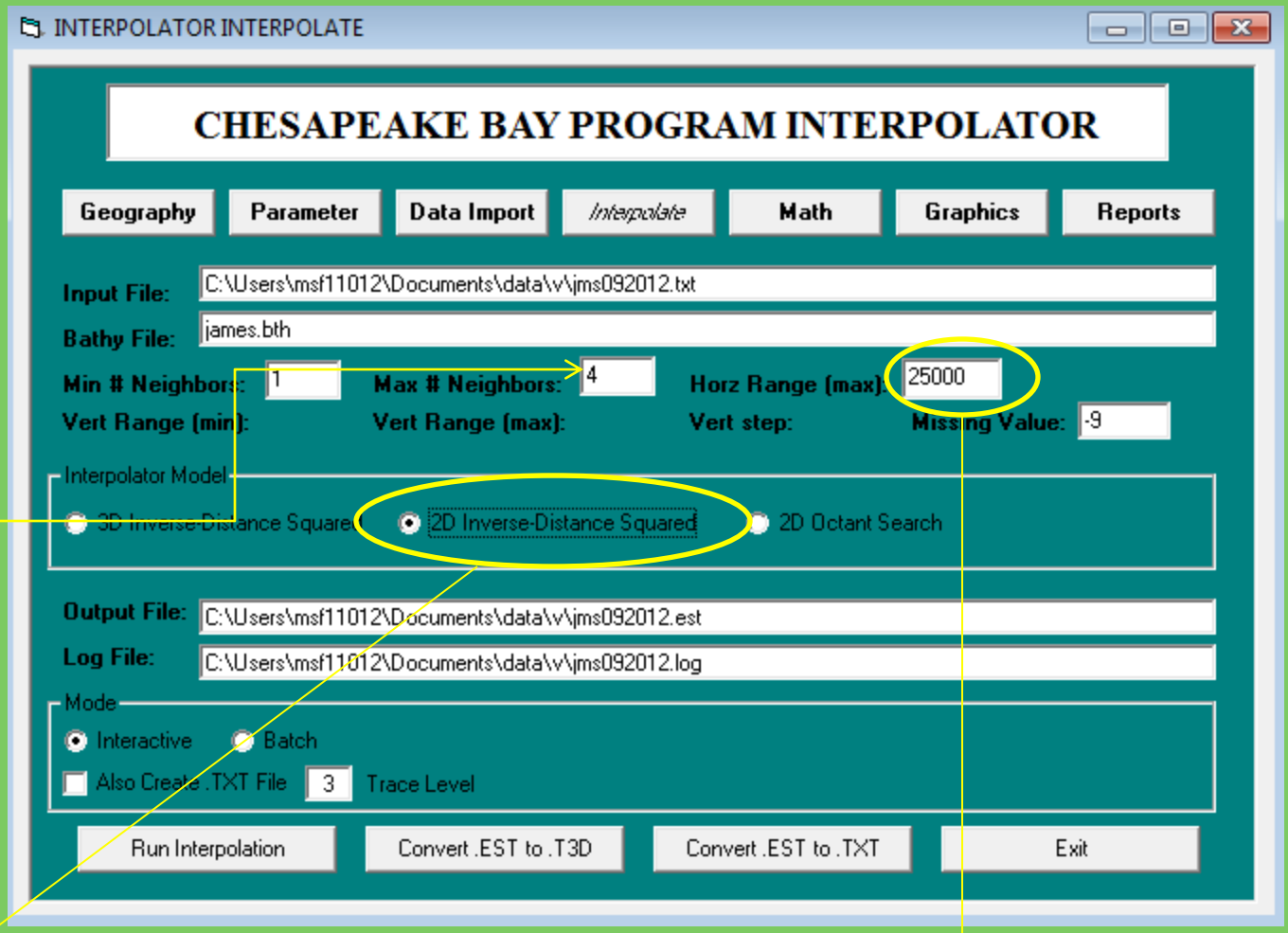


Interpolation is a way to “fill in” missing data. In this case, we have interpolated monitoring data so an entire water body is represented by values which can then be assessed.



We use the Bay Program Interpolator

We use the default settings…

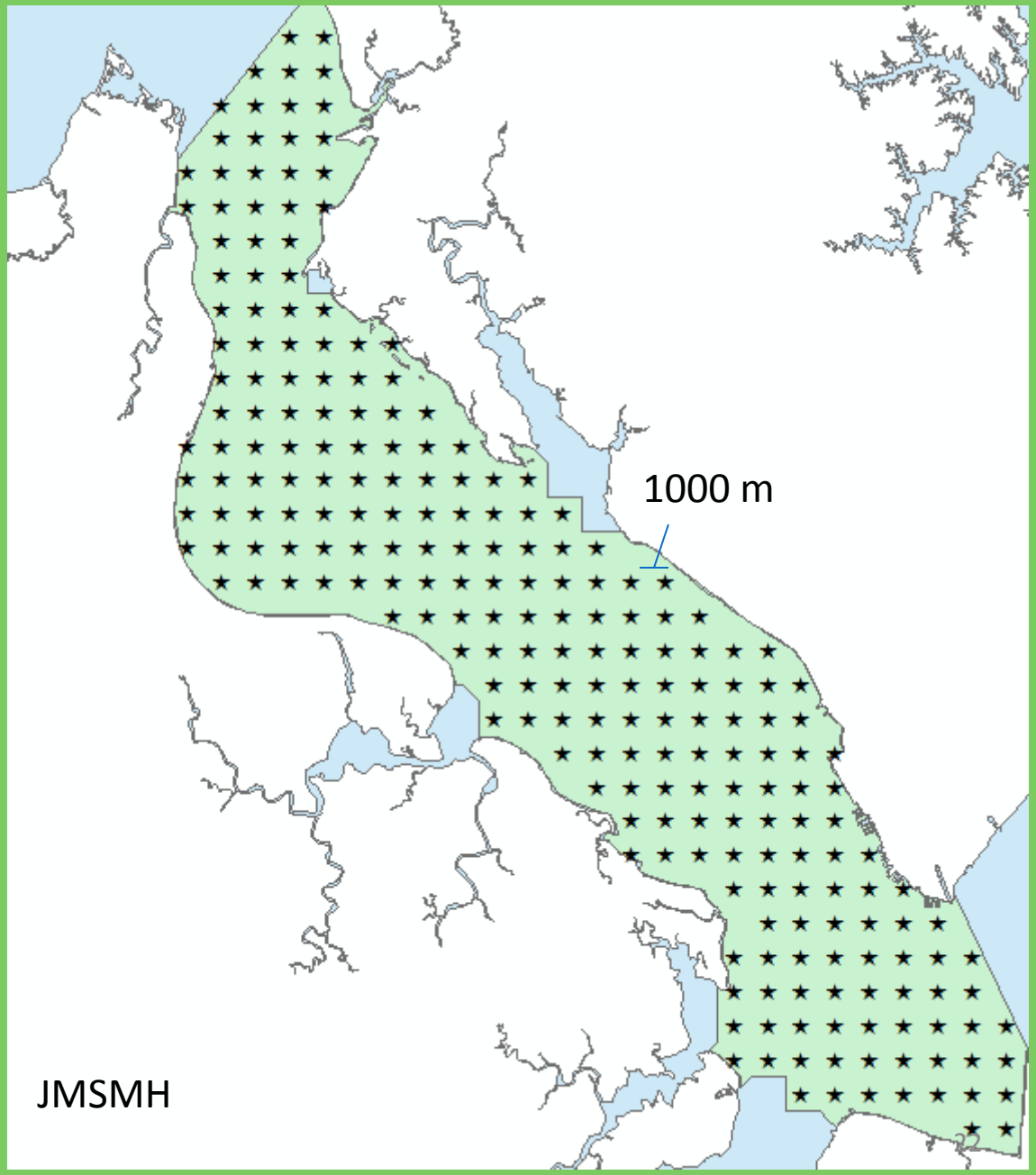


Maximum no. of data points used to generate an estimate

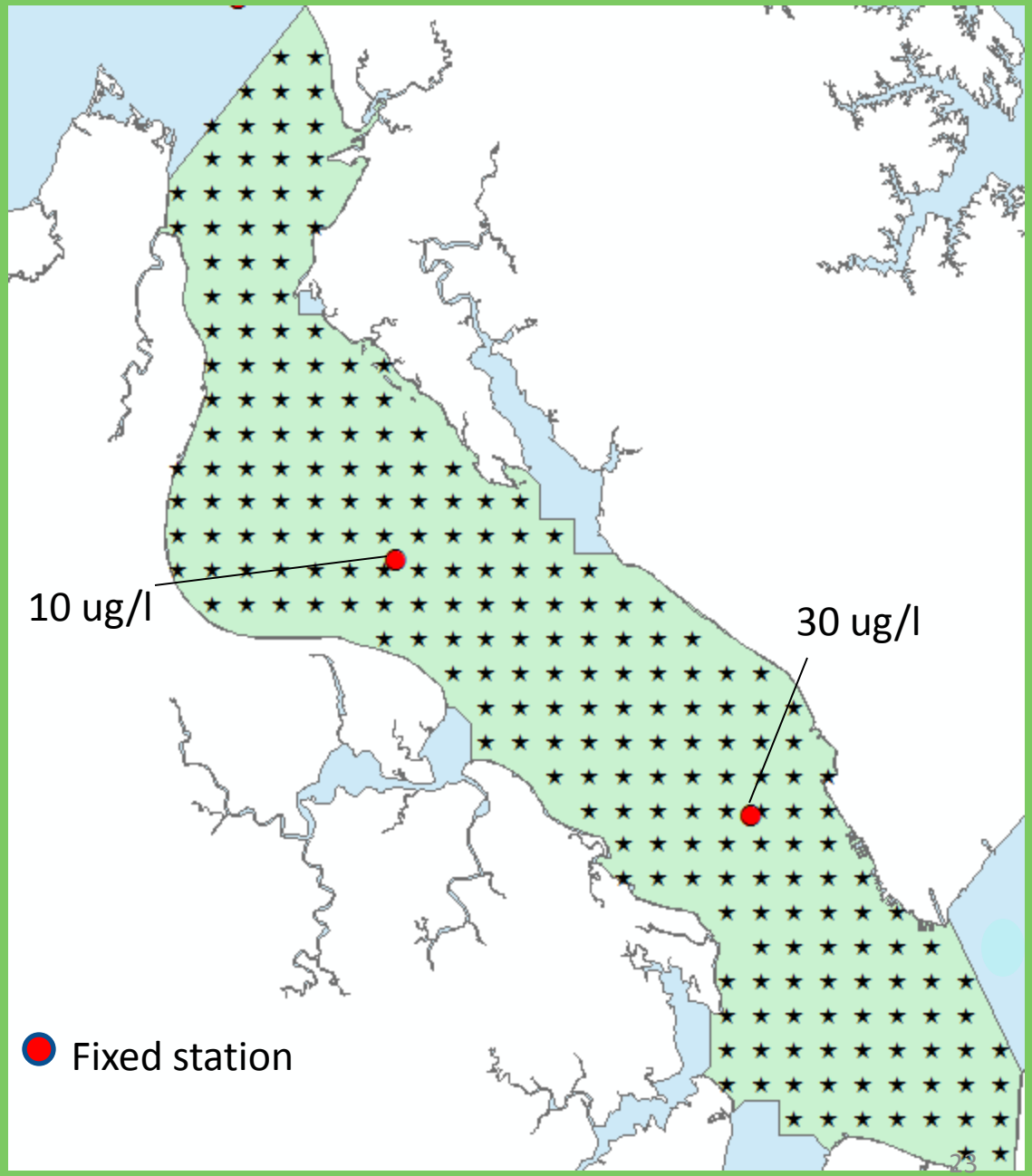
Search radius in meters

Specifies the interpolation model (for chlorophyll, it's two-dimensional)

The Interpolator generates estimates at point locations (centroids) distributed evenly throughout a segment.

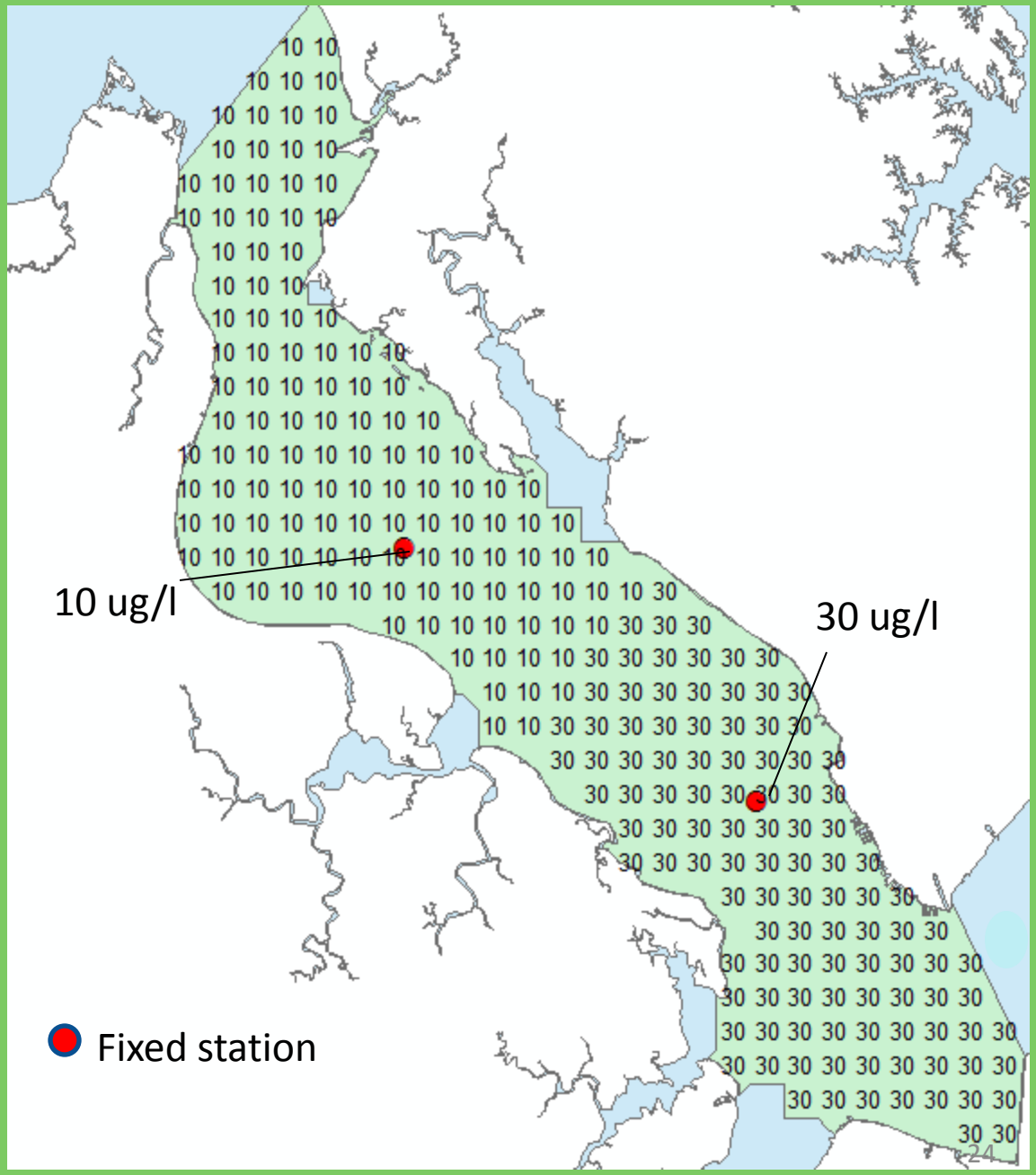


Let’s say we measure chlorophyll at two locations.

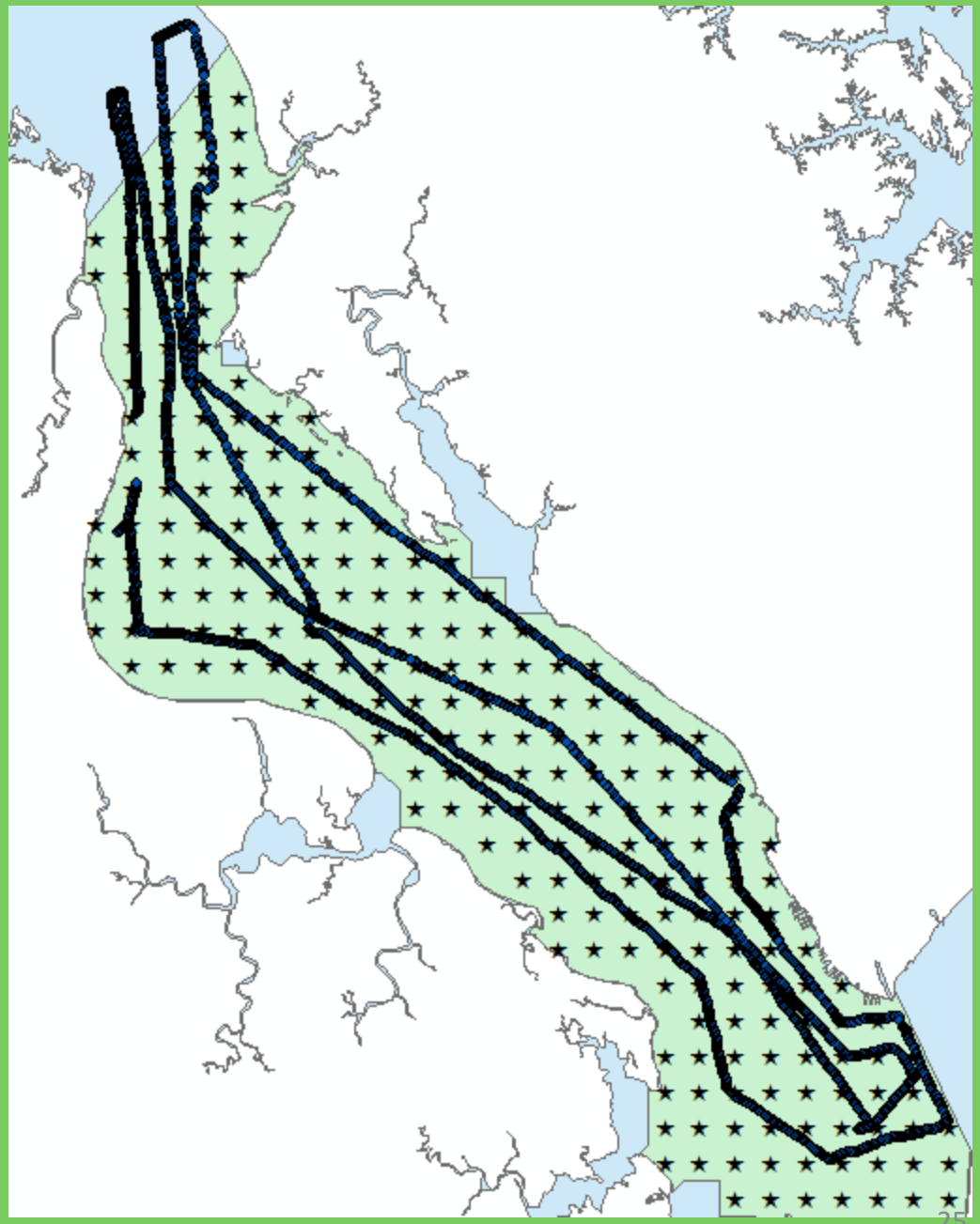


The Interpolator fills “in” and “out” so that we can calculate the aerial extent of exceedence.

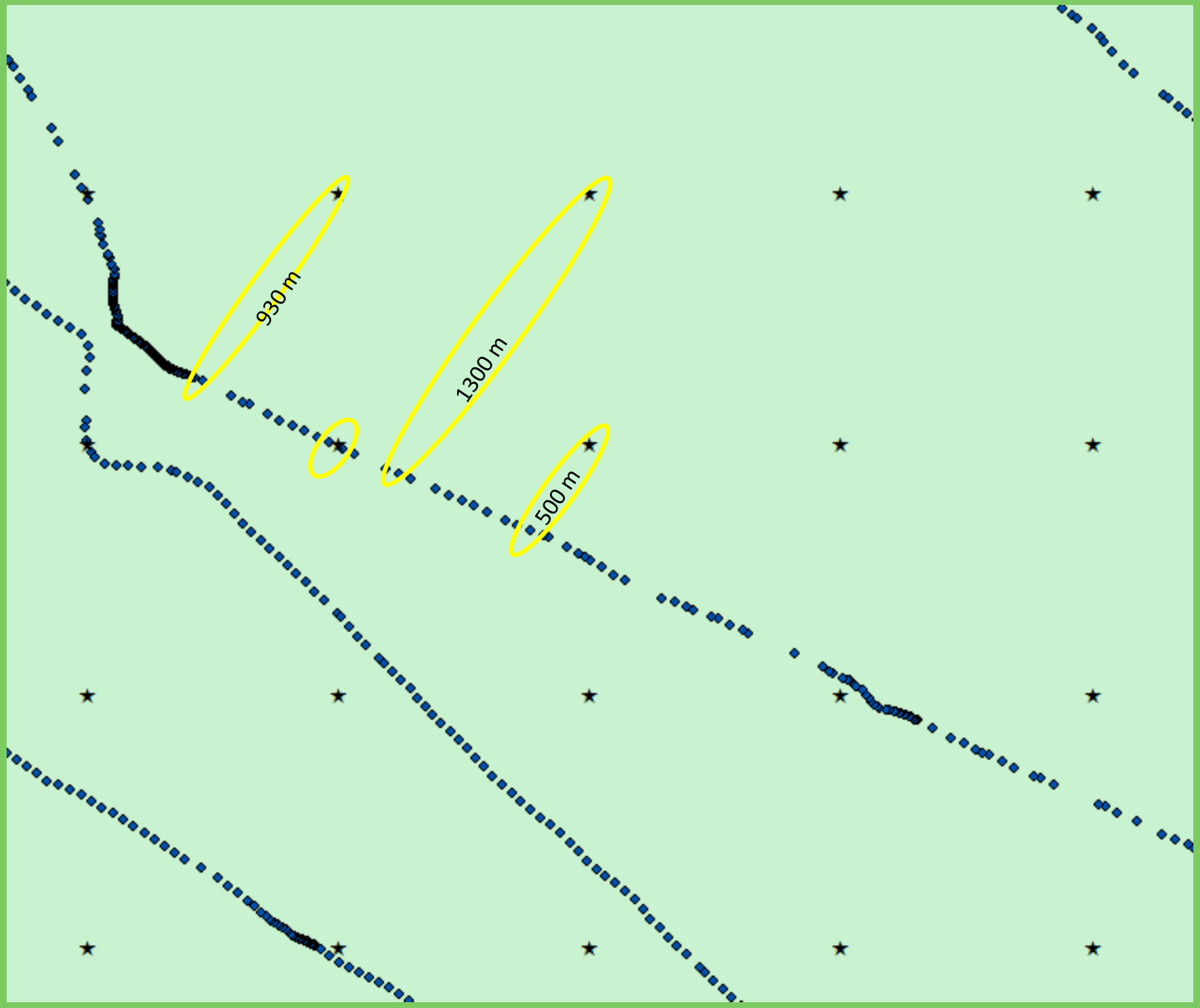
Note: It does not create or rely on any statistical model of spatial variation (e.g., a variogram).



Dataflow cruises are interpolated, too.

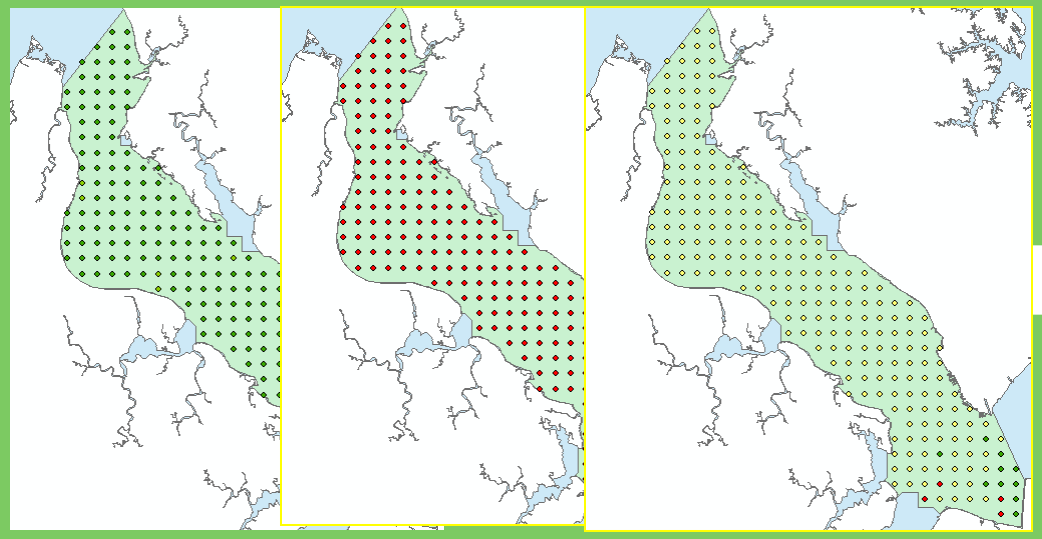


The Interpolator grabs “neighbors” from both near and far.



Dataflow observations

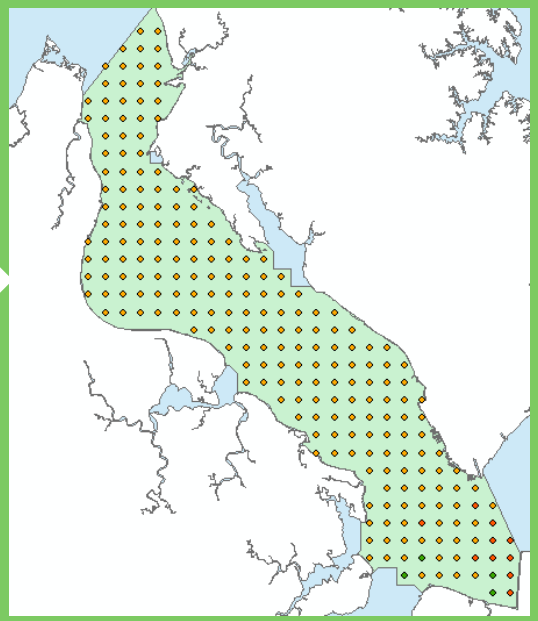
2. Calculation of Spatial Exceedence



July August September

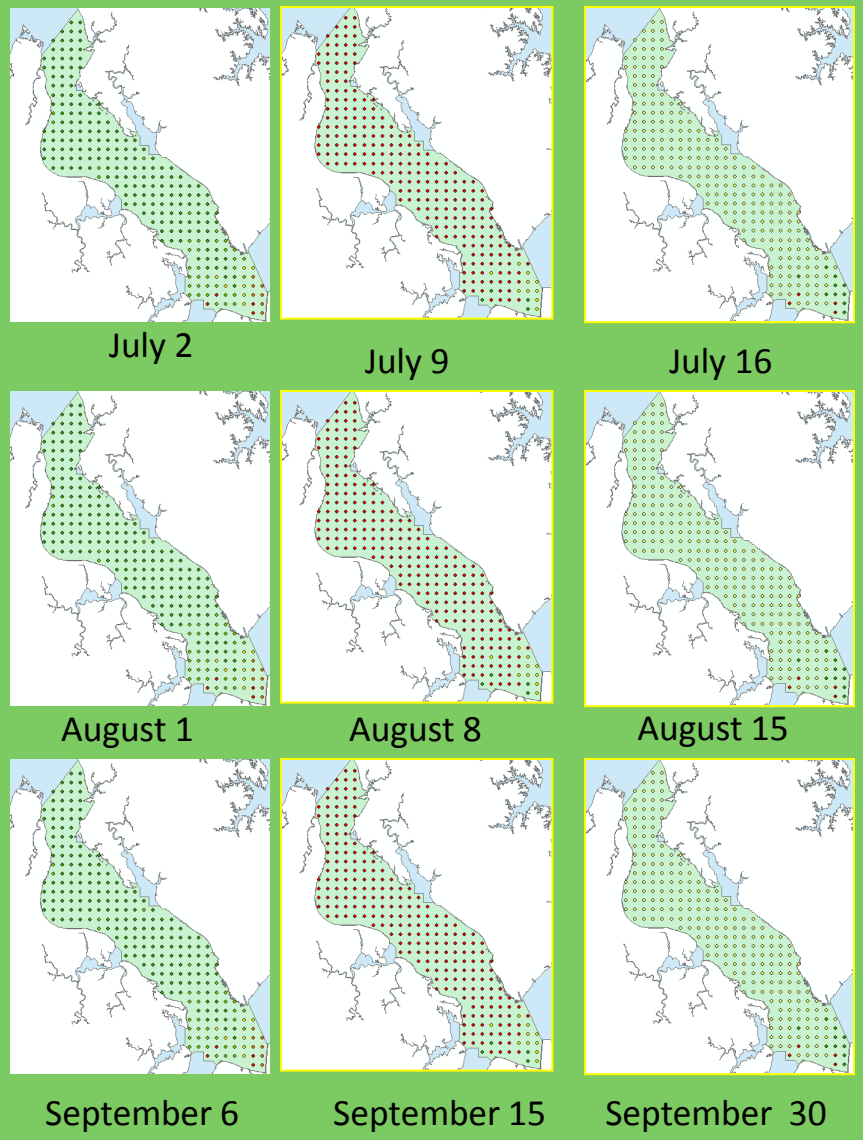
averaging

Season Geometric Mean



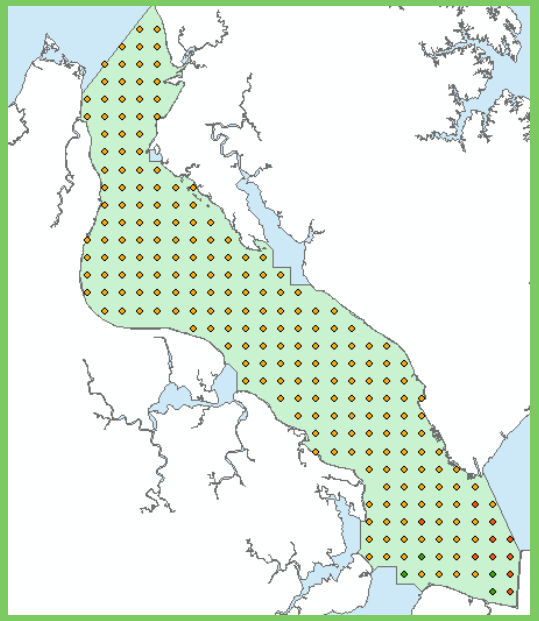
Create a seasonal “snapshot” by averaging all the interpolations.

2. Calculation of Spatial Exceedence



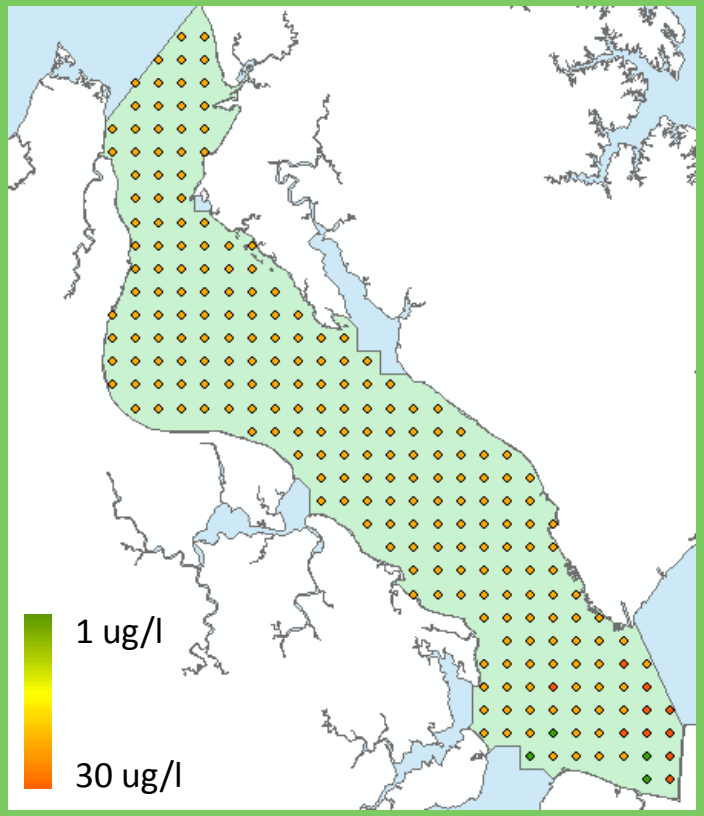
averaging

Season Mean



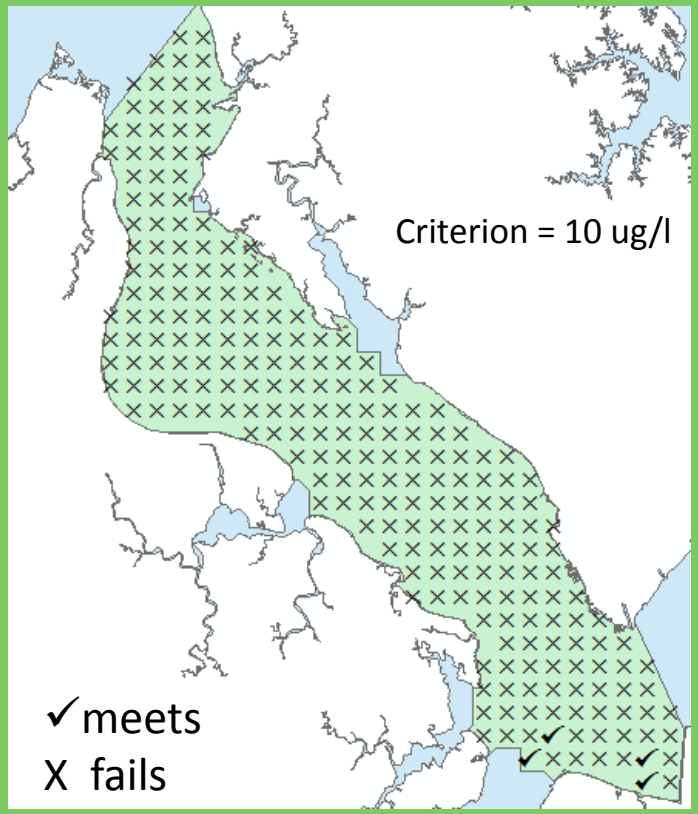
Create a seasonal “snapshot” by averaging all the interpolations.

Season Mean



Assessment

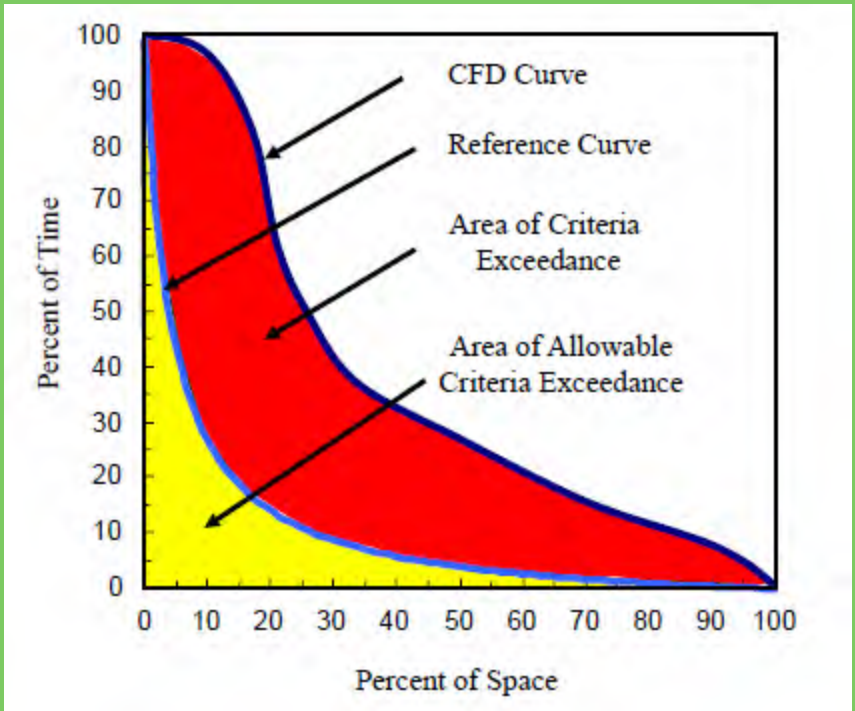
Season Assessment



Then count how many of the resulting estimates fail the criterion. Divide this into the total to calculate the spatial exceedence rate.

3. Cumulative Frequency Diagram (CFD)

- Used to determine if spatial exceedences are “excessive”



Good reading…

The Cumulative Frequency Diagram Method for Determining Water Quality Attainment

Tango, Peter J. and Richard A. Batiuk, 2013. Deriving Chesapeake Bay Water Quality Standards. Journal of the American Water Resources Association (JAWRA) 1-18.

First…

We organize our seasonal exceedence rates in a table like this one.

Rank	Season-Year	Space Exceedence Rate (hypothetical)	Cumulative Probability= Rank/(n+1)
1	Worst Year	60%	25%
2	2nd Worst Year	9%	50%
3	Best Year	0%	75%

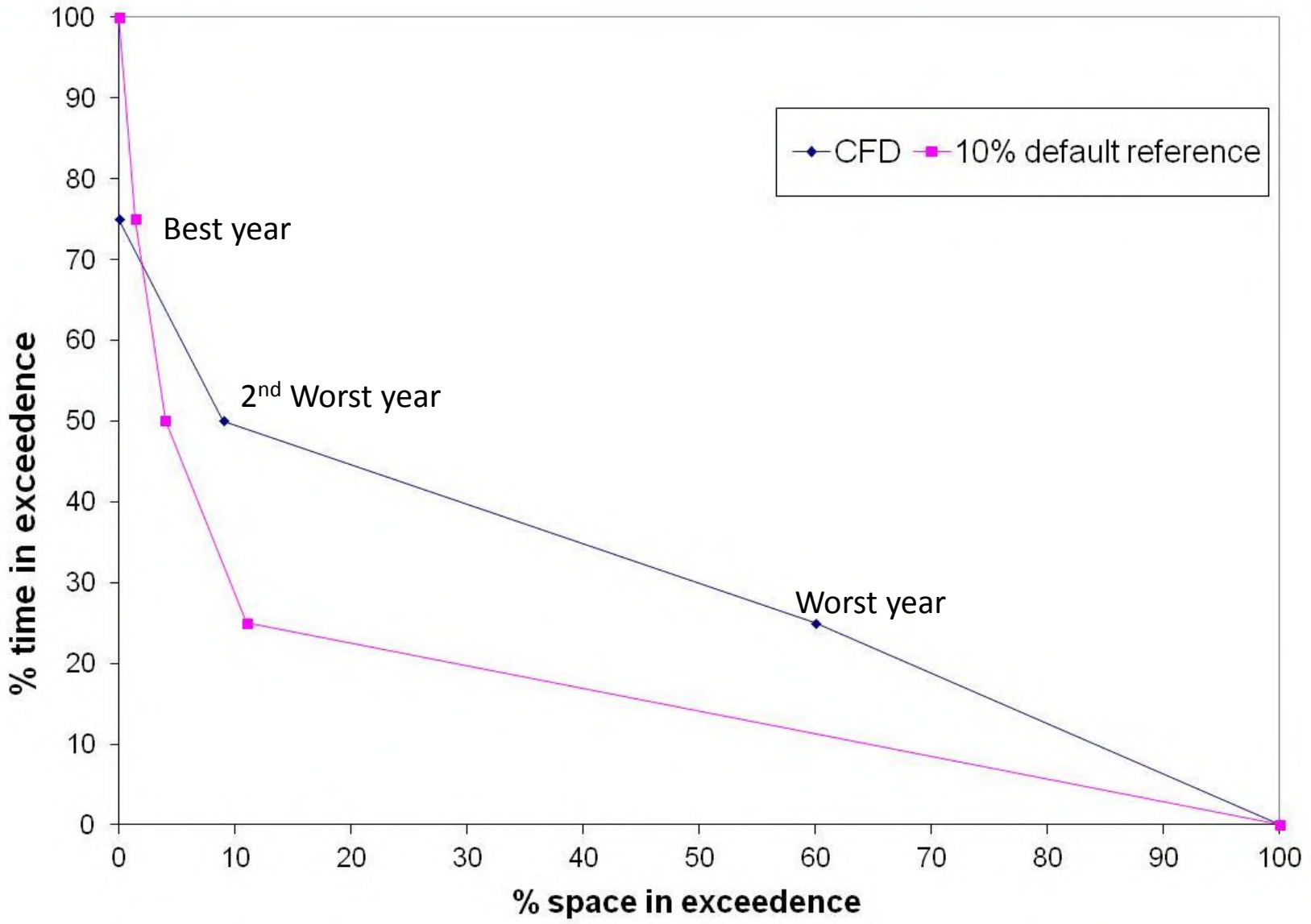
% time in exceedence

First…

We organize our seasonal exceedence rates in a table like this one.

Rank	Season-Year	Hypothetical Space Exceedence Rate	Cumulative Probability= Rank/(n+1)
		100%	0%
1	Worst Year	60%	25%
2	2nd Worst Year	9%	50%
3	Best Year	0%	75%
		0%	100%

Then we create a plot like this one.



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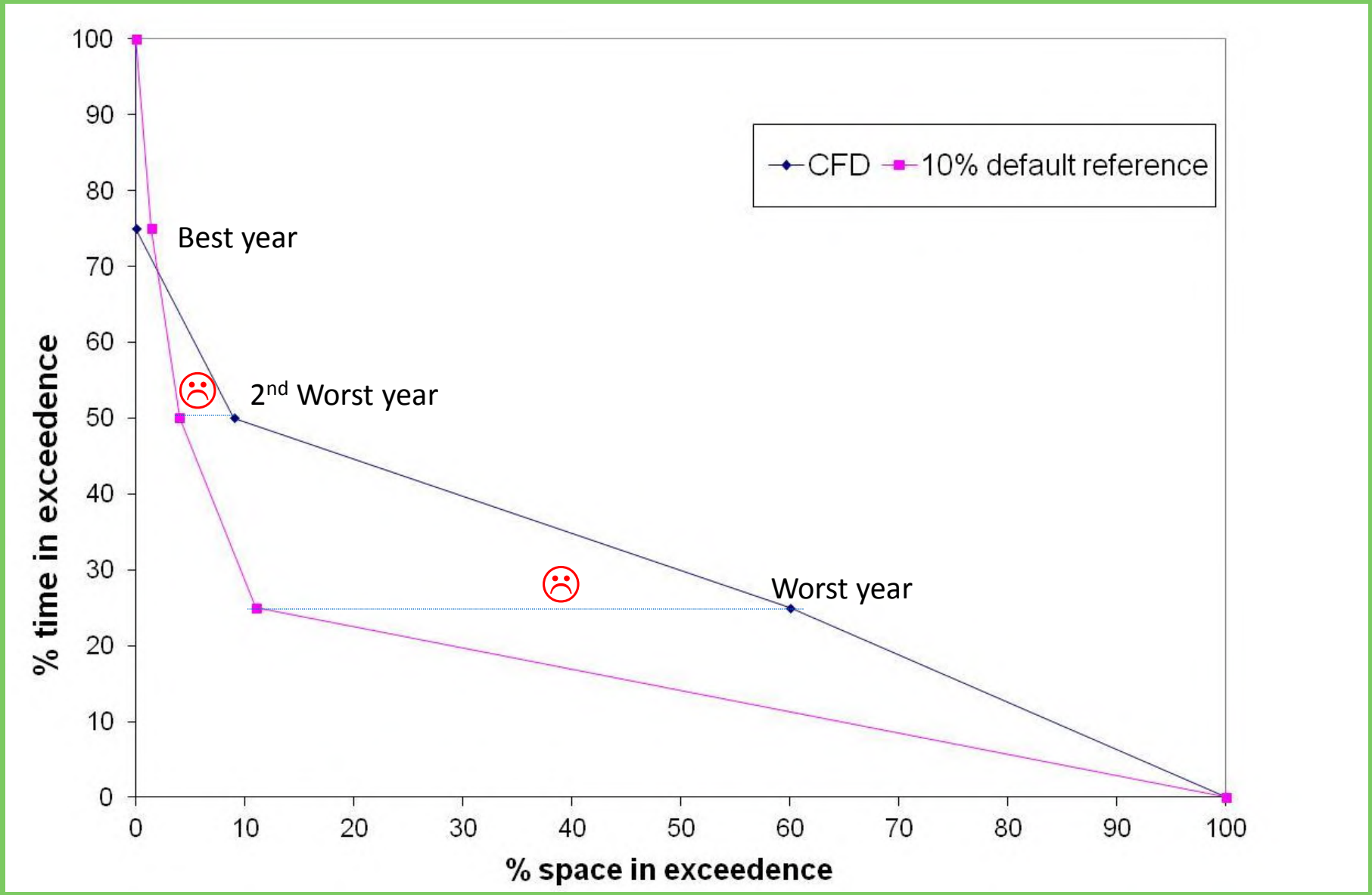
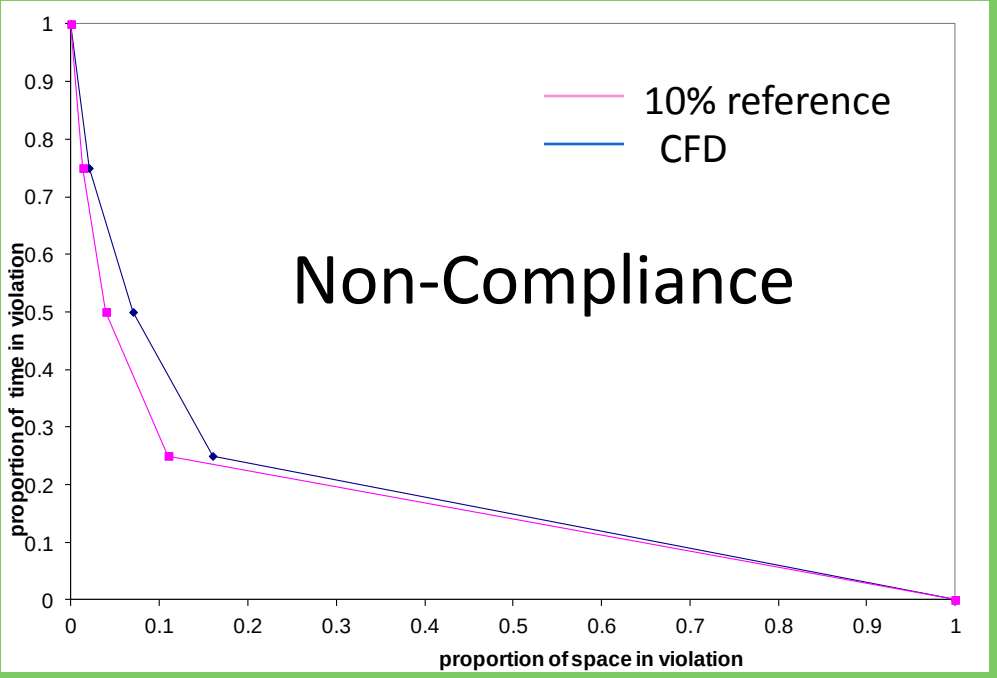
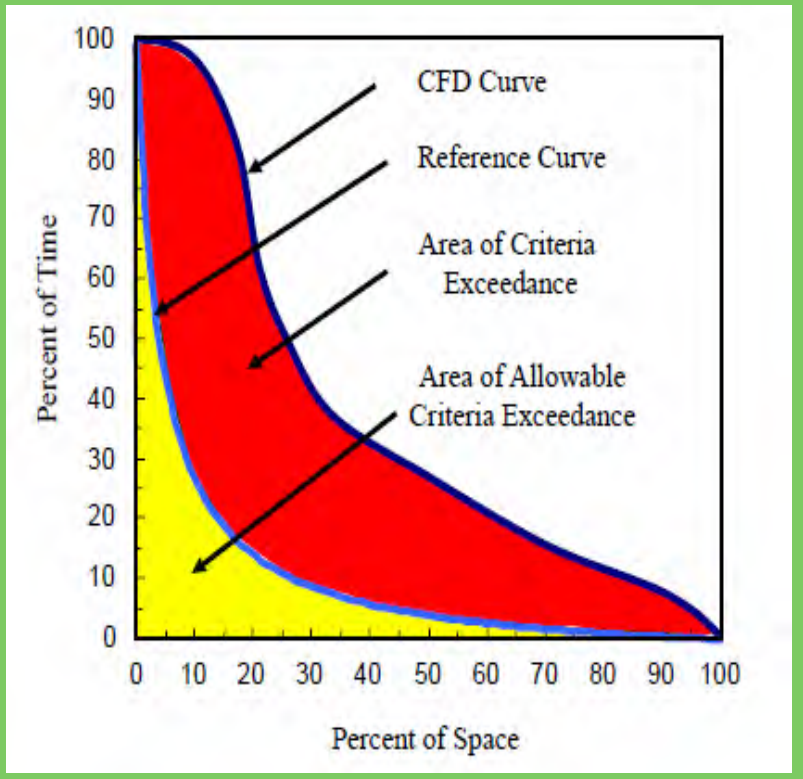
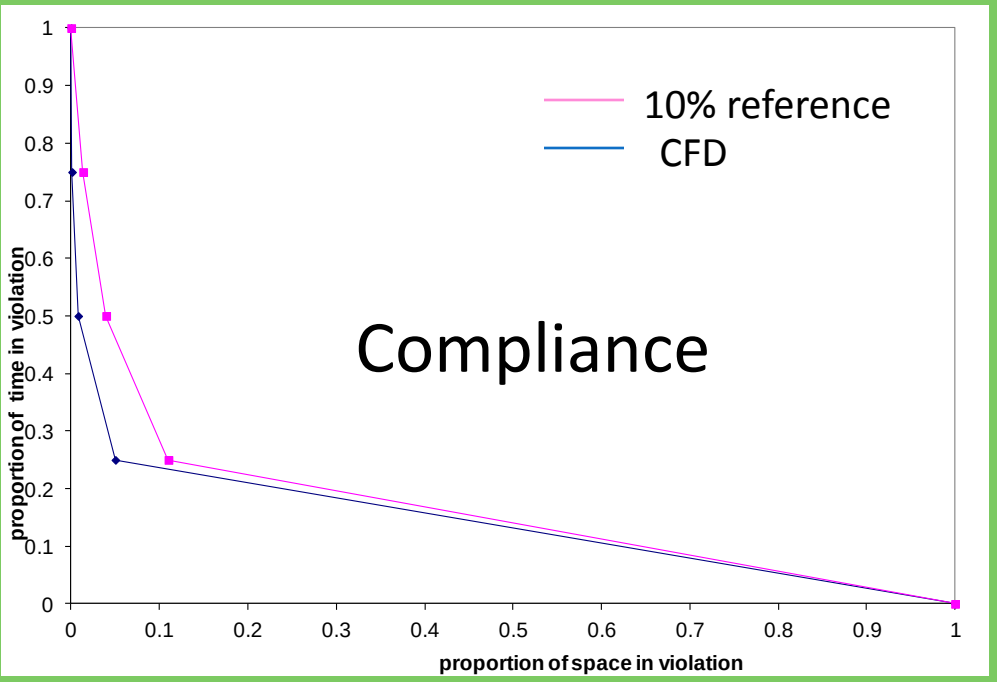



10% reference
CFD
Non-Compliance
proportion of time in violation
proportion of space in violation
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


CFD Curve
Reference Curve
Area of Criteria Exceedance
Area of Allowable Criteria Exceedance
Percent of Time
Percent of Space
0
10
20
30
40
50
60
70
80
90
100


10% reference
CFD
Compliance
proportion of time in violation
proportion of space in violation
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Default 10% Reference

Rank	Season-Year	Seasonal Spatial Exceedence Rate		Allowable Spatial Exceedence Rate%
1	Worst Year	60.0%	⇔	11.0%
2	2nd Worst Year	9.0%	⇔	4.0%
3	Best Year	0.0%	⇔	1.4%

Generated from the 10% hyperbolic function

Another example…

Default 10% Reference

Rank	Season-Year	Hypothetical Space Exceedence Rate		Allowable Space Exceedence Rate%
1	Worst Year	5.0%	⟺	11.0%
2	2nd Worst Year	5.0%	⟺	4.0%
3	Best Year	0.0%	⟺	1.4%

Under the CFD framework, the exceedence rate must conform to a rigid distribution.
In the above example, the overall magnitude of exceedence is within the “allowable” limit, but the segment is nonetheless deemed to be in non-compliance.

All of these segments fail too…

Rank	Season-Year	Hypothetical Space Exceedence Rate	Allowable Space Exceedence Rate%
1	Worst Year	11.5 %	11.0%
2	2nd Worst Year	4.1%	4.0%
3	Best Year	1.5%	1.4%

Scenario 1

Rank	Season-Year	Hypothetical Space Exceedence Rate	Allowable Space Exceedence Rate%
1	Worst Year	13.0%	11.0%
2	2nd Worst Year	0%	4.0%
3	Best Year	0%	1.4%

Scenario 2

Rank	Season-Year	Hypothetical Space Exceedence Rate	Allowable Space Exceedence Rate%
1	Worst Year	10.0%	11.0%
2	2nd Worst Year	3.0%	4.0%
3	Best Year	2.0%	1.4%

Scenario 3

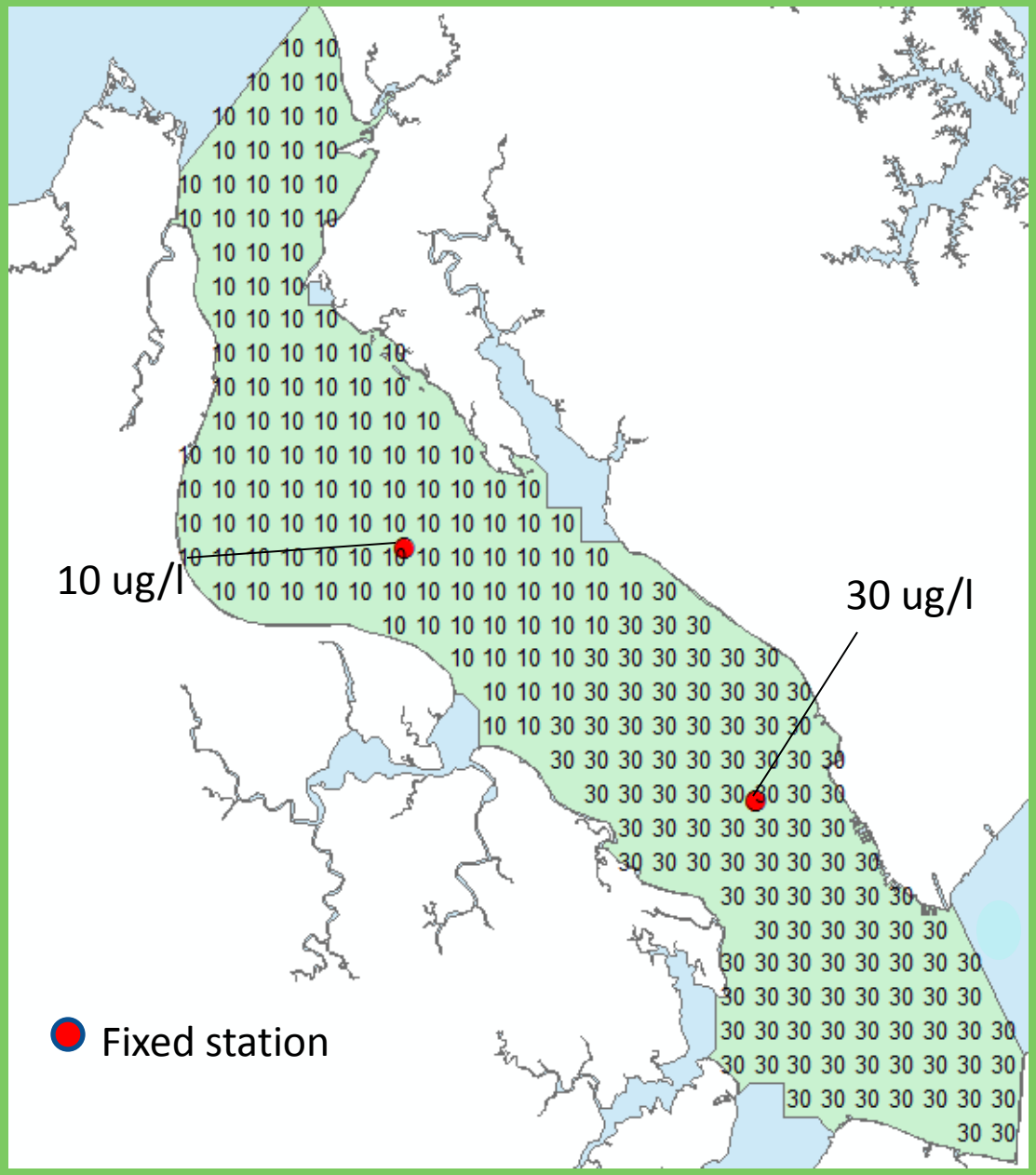
Rank	Season-Year	Hypothetical Space Exceedence Rate	Allowable Space Exceedence Rate%
1	Worst Year	2.0%	11.0%
2	2nd Worst Year	2.0%	4.0%
3	Best Year	2.0%	1.4%

Scenario 4

Question Break

Evaluation of Methodological Weaknesses

Does it make sense to interpolate a small dataset like this one?



Plotting the variance between 2 points over distance may helps us to answer this question. This variogram shows that sampling locations cease to be correlated with one another when they are more than 2 km apart.

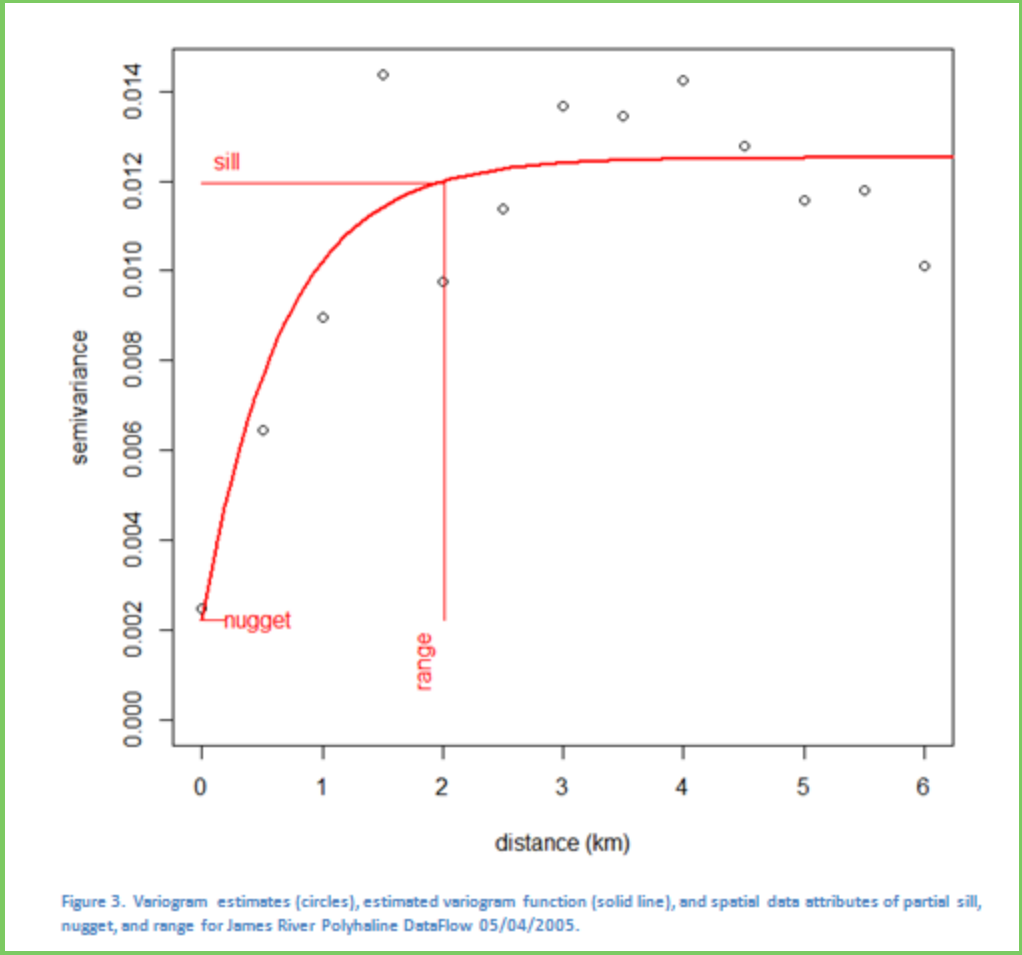
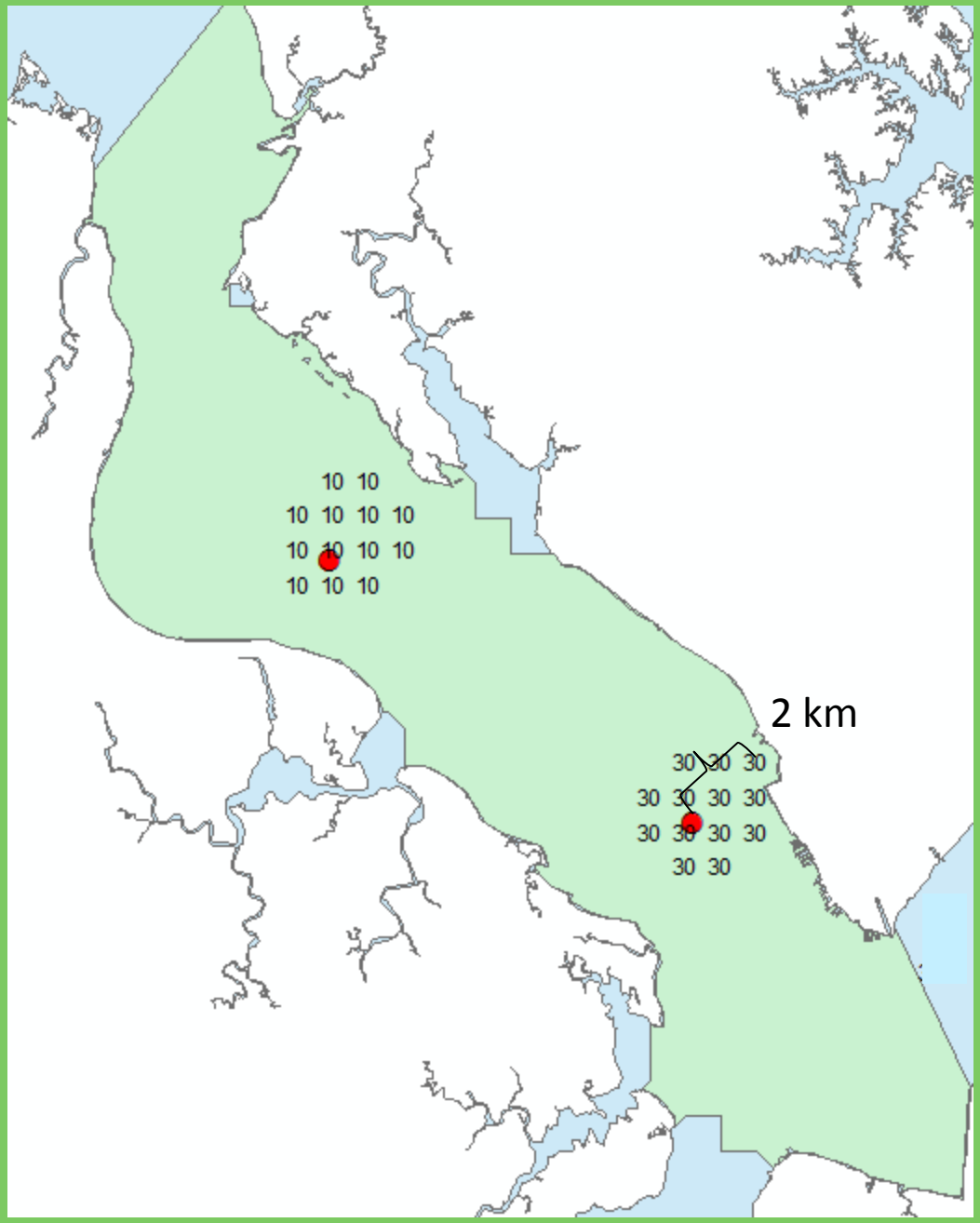
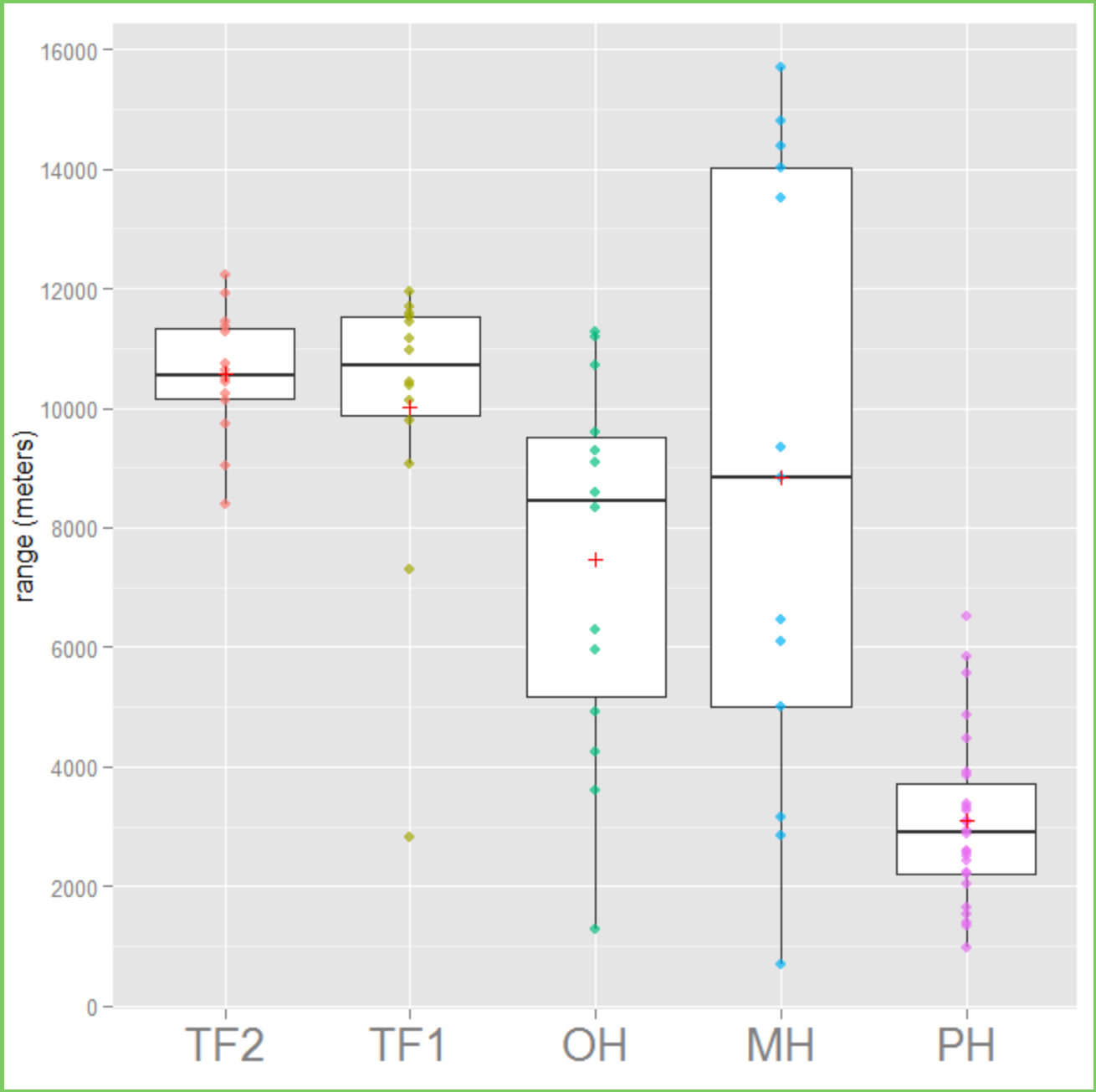


Figure 3. Variogram estimates (circles), estimated variogram function (solid line), and spatial data attributes of partial sill, nugget, and range for James River Polyhaline DataFlow 05/04/2005.

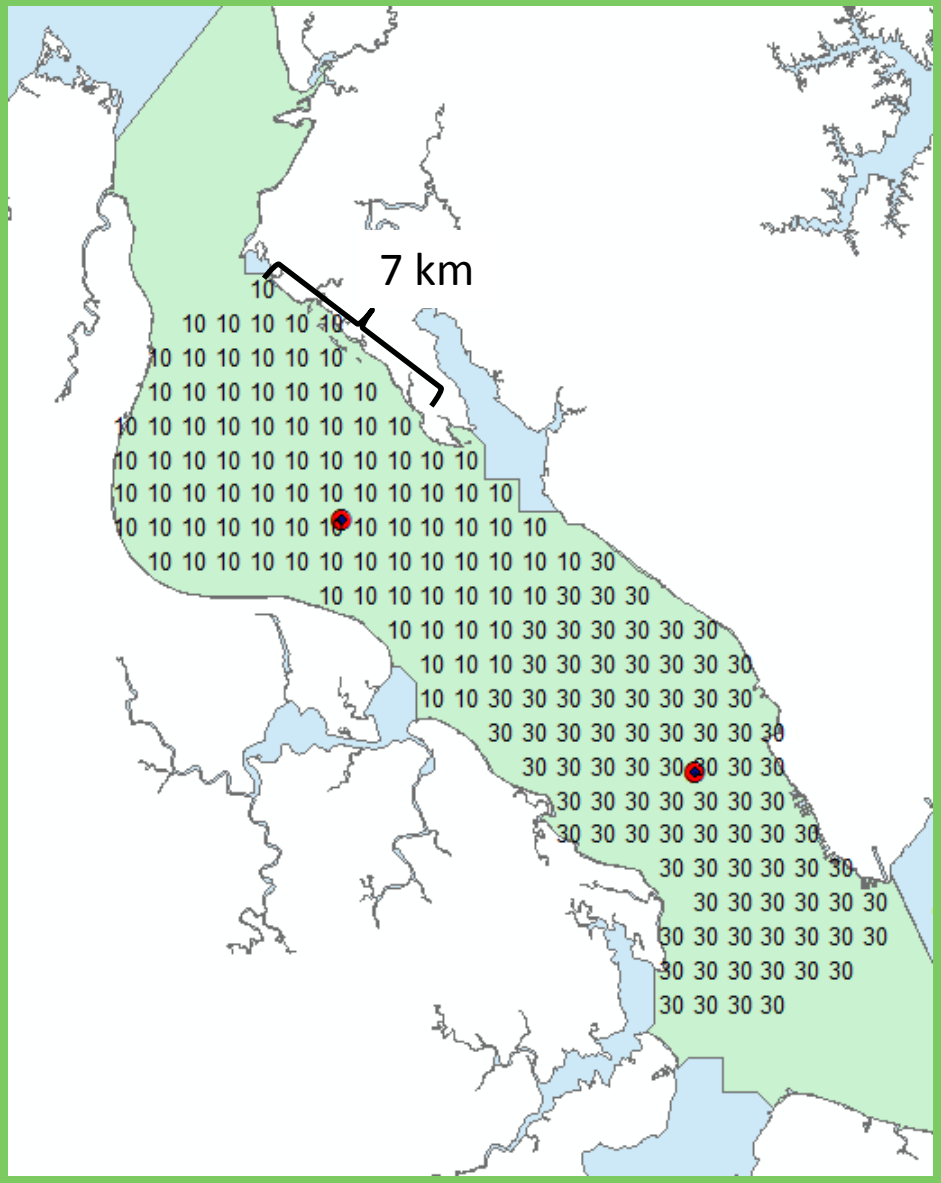
*Excerpt from Elgin Perry "**Notes on James River Chlorophyll Simulator and CFD validation". The variogram for JMSPH 5/4/2005 Dataflow cruise is shown.***


10 10
10 10 10 10
10 10 10 10
10 10 10
2 km
30 30 30
30 30 30 30
30 30 30 30
30 30

The range was calculated for a number of Dataflow cruises for each segment. The ability to confidently predict chlorophyll from 2-3 monitoring stations decreases as we move downstream.



Median range = 7.3 km


7 km
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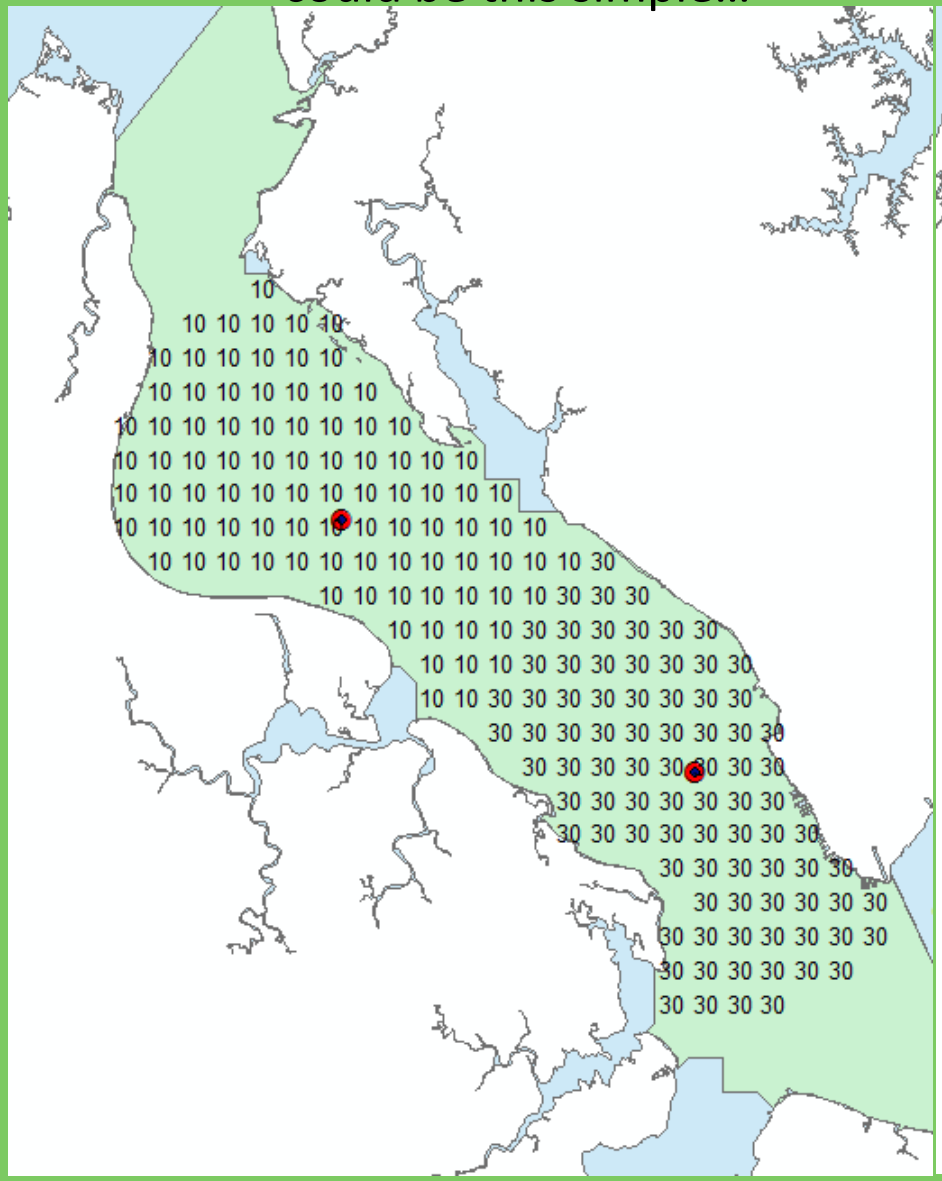
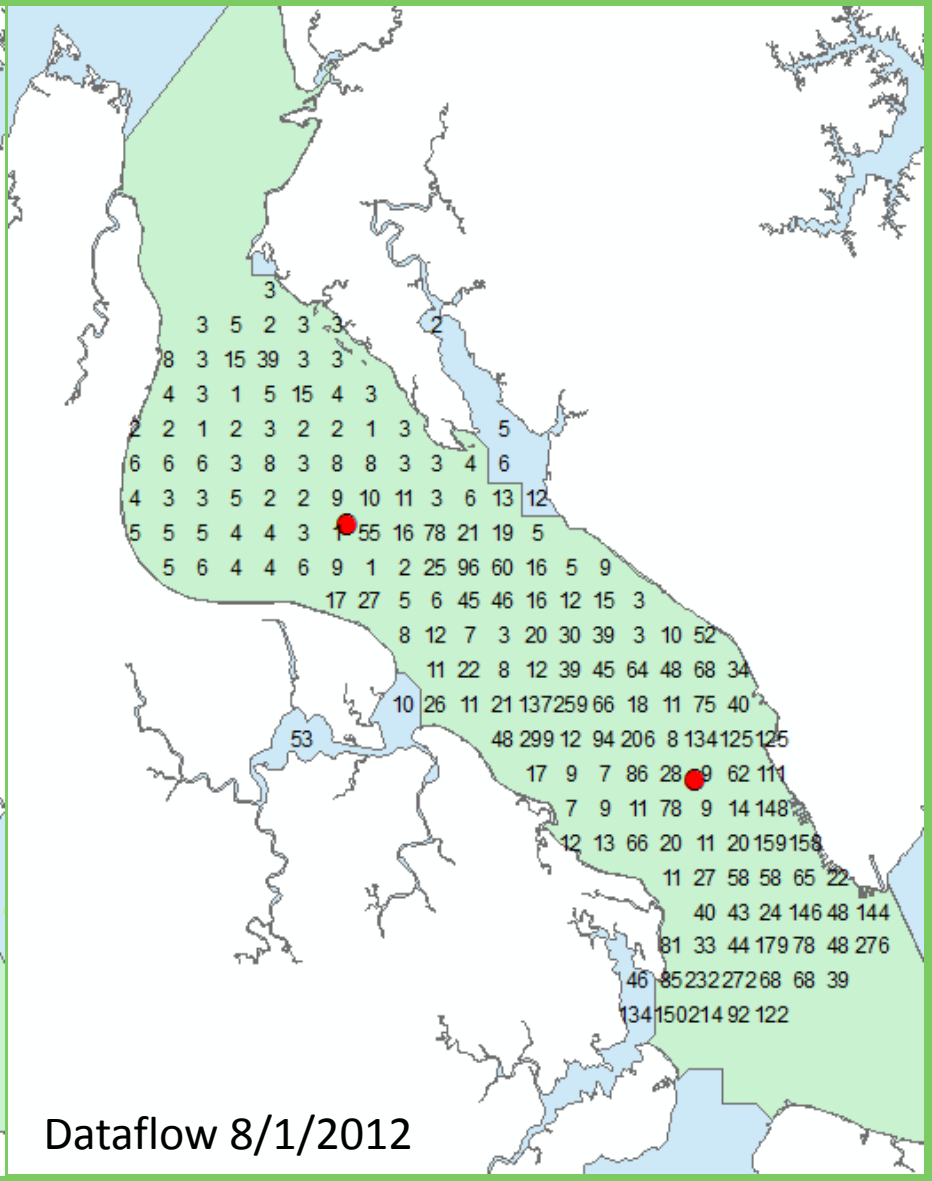
We wish the world could be this simple…



But it is not!!



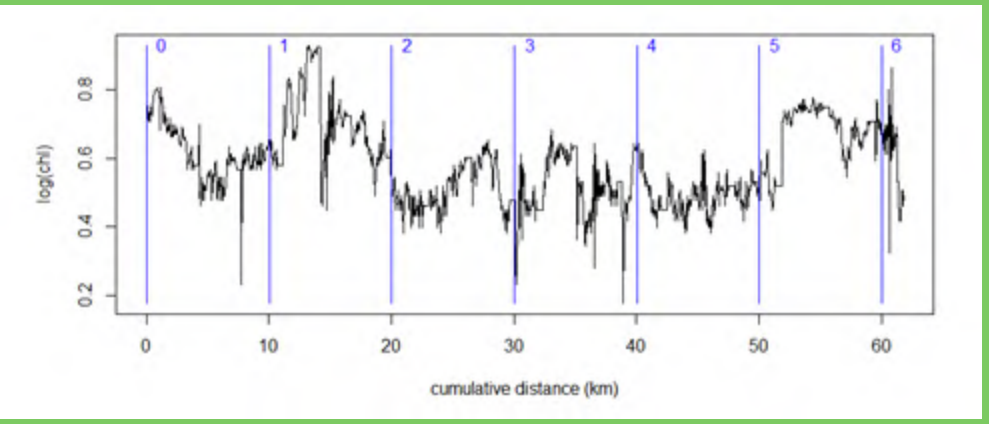
Dataflow 8/1/2012

So what? Our estimates are not perfect. We can handle some uncertainty!!

Yes, but don't we need to know how much uncertainty we're talking about before we say we can handle it?!

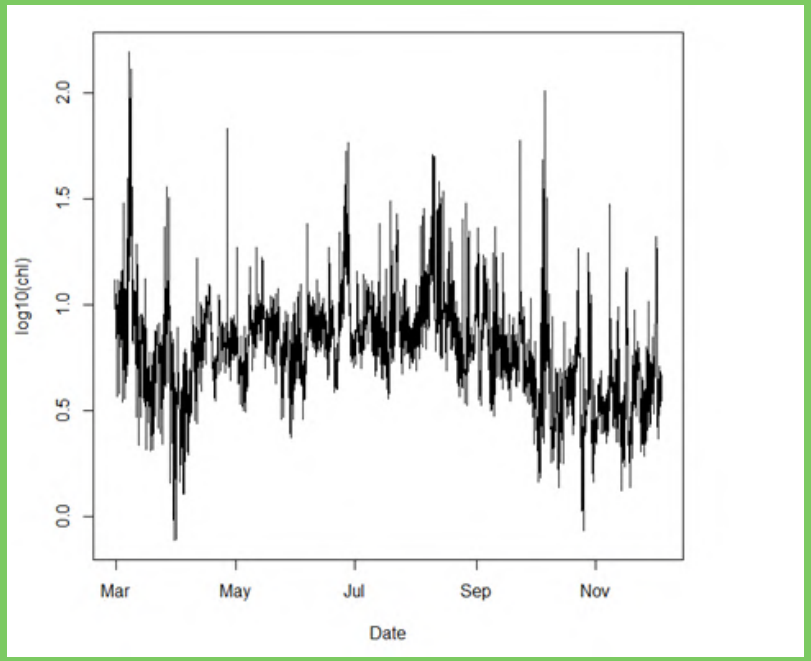
Just how much uncertainty are we talking about with a fixed station assessment?

In a pilot study conducted by Elgin Perry, Dataflow and ConMon were used to simulate the “true” chlorophyll during the spring and summer seasons 2005-2007 in JMSPH.

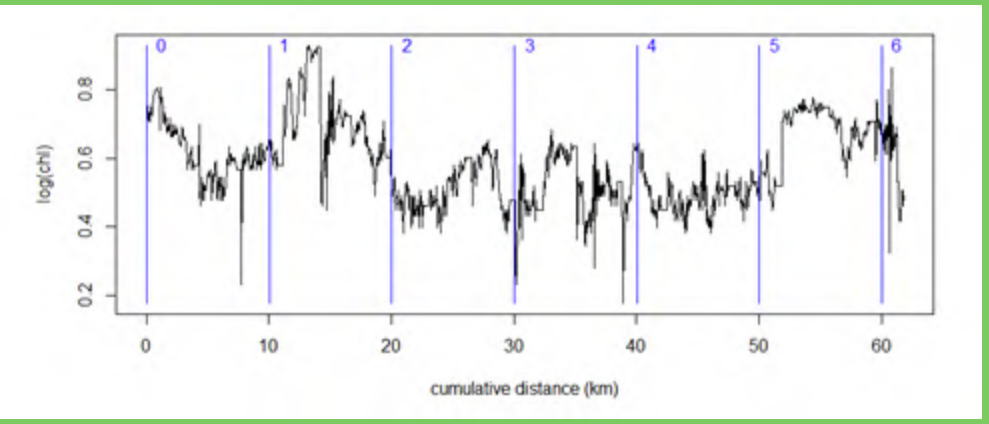


Spatial variability (Dataflow)

+

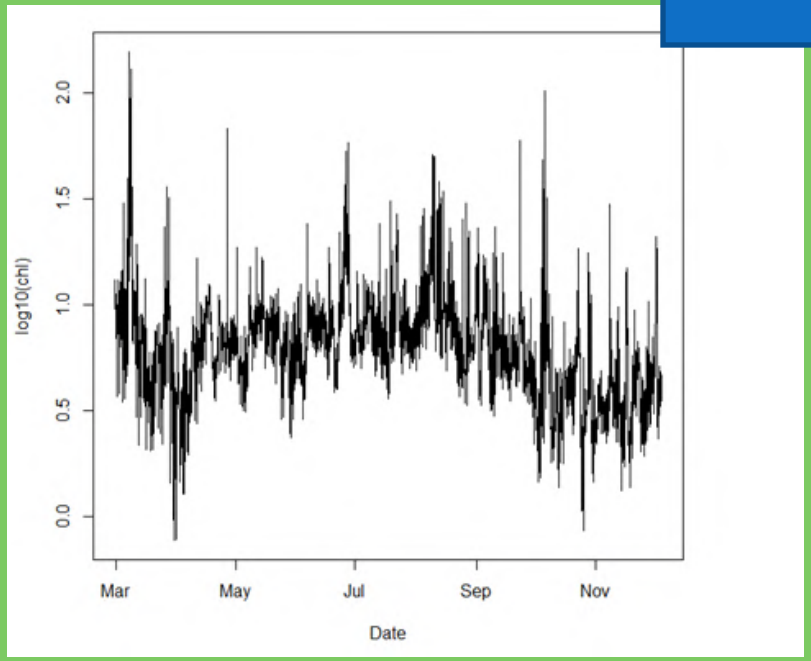


Temporal variability (ConMon)

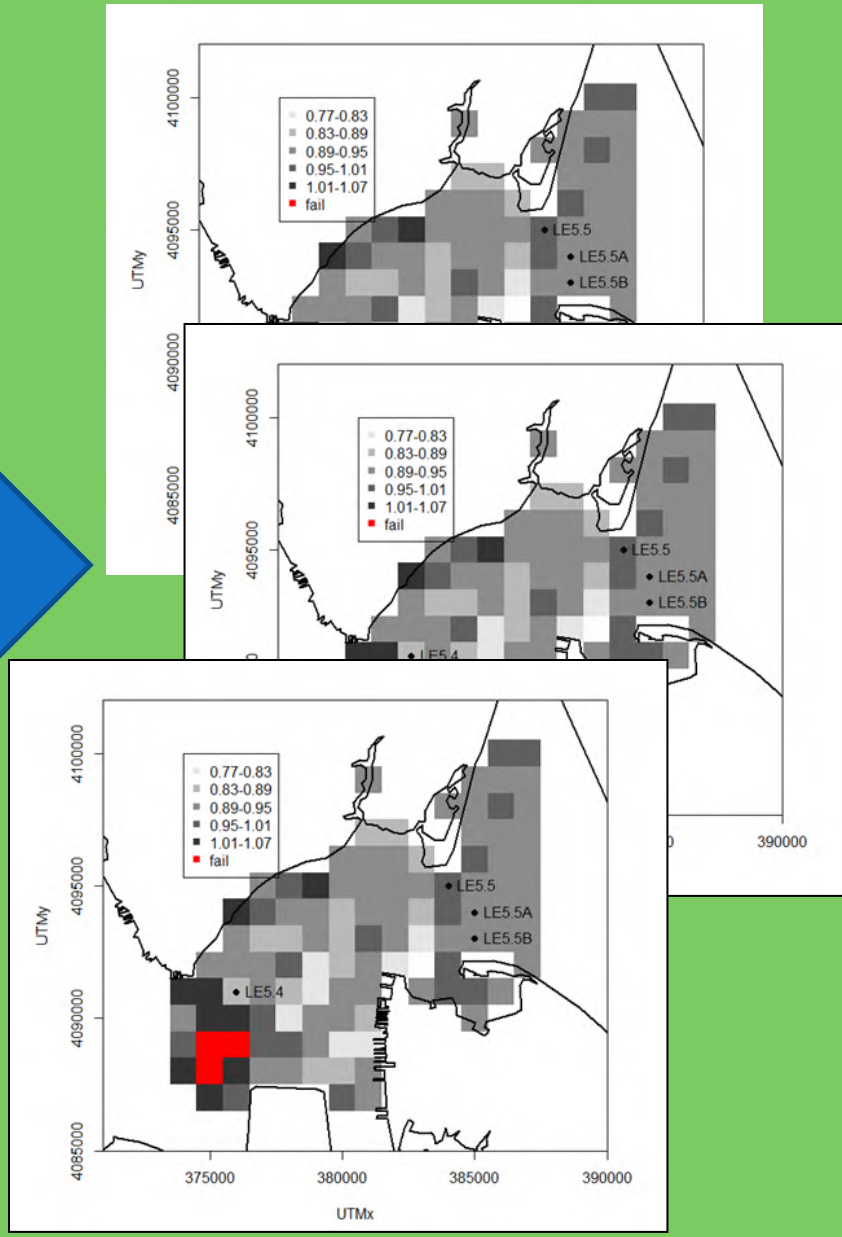


Spatial variability (Dataflow)

+

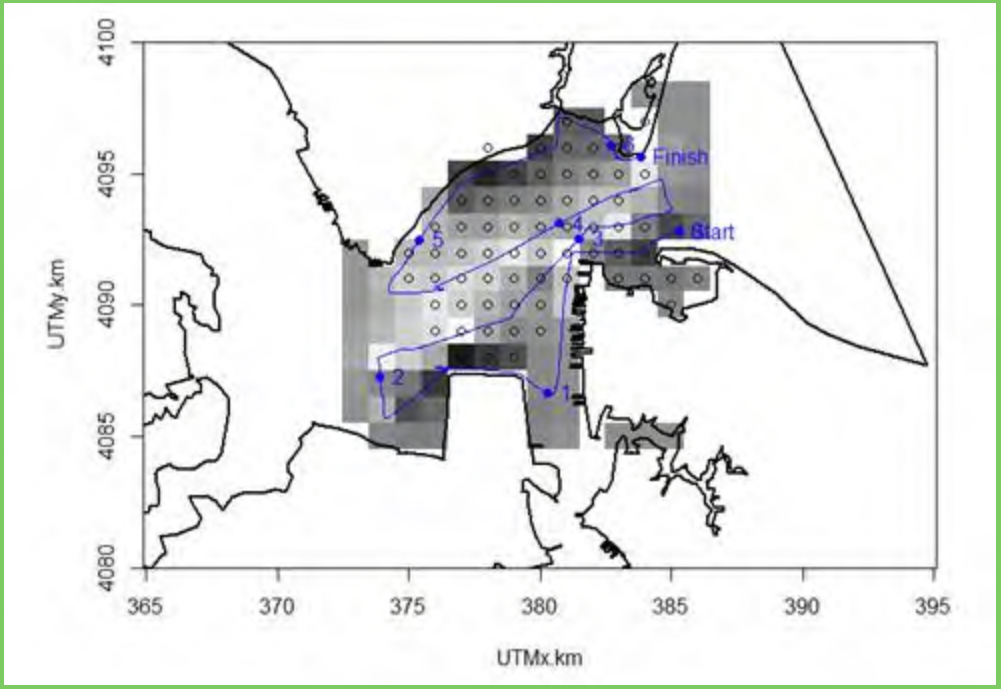


Temporal variability (ConMon)

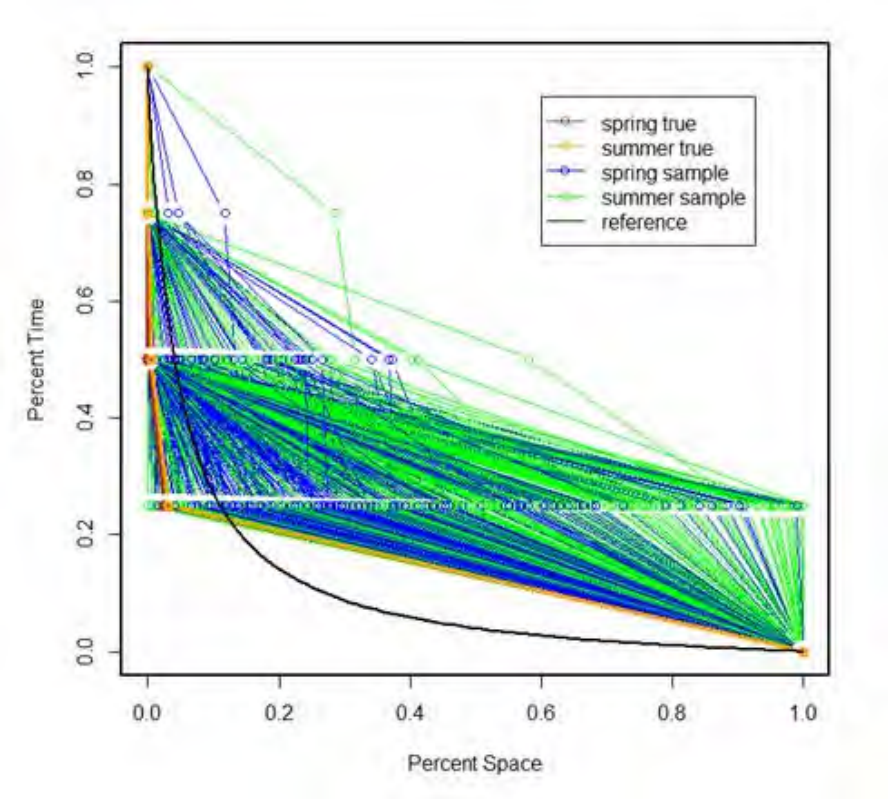


“true” season means

Elgin then asked…
How well does a fixed station assessment characterize the "true" state of chlorophyll?



"Samples" were taken from six "stations" and interpolated via IDW. CFDs were then created. Repeat 1000 times.



"When the true condition of the estuary is either passing or failing, the sample CFD has a high probability of reaching the wrong conclusion. ***The odds of making the right decision are very little better than if the decision were reached by flipping a coin."***

-Elgin Perry

From "Notes on James River Chlorophyll Simulator and CFD validation"

Big Weakness #1

The current assessment method is not appropriate for low-density datasets generated from monthly site visits.

Does this really describe the distribution of exceedences for reference water quality?

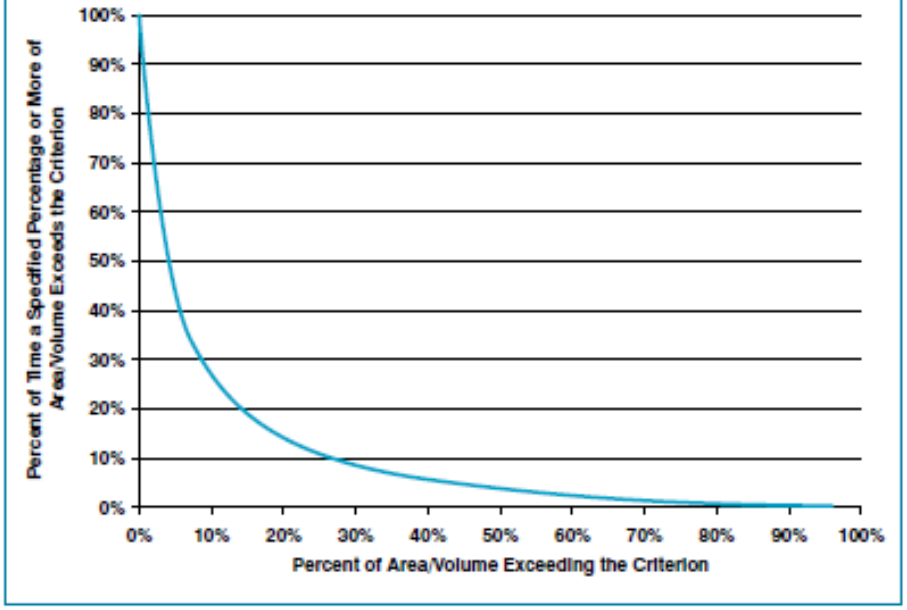


Figure II-4. Default reference curve for application in the attainment assessment of Chesapeake Bay water quality criteria for which biologically based reference curves cannot be derived.

From July 2007 Technical Addendum

First we need to define what a reference condition is.

	Spring	June	Summer	Autumn	Winter
Secchi depth (m)					
TF	>0.9	>0.8	>0.8	>0.9	>0.6
OH	>0.7	>0.6	>0.6	>0.5	>0.6
MH	>1.8	>1.45	>1.45	>2.0	>1.8
PH	>2.15	>1.85	>1.85	>2.5	>2.3
DIN (mg/liter)	≤0.07 (all seasons and salinity zones)				
PO_4 (mg/liter)	≤0.007 (all seasons and salinity zones)				

Reference thresholds

Table 2. Water quality categories. See Table 1 for classification thresholds.

Category name	Description
Better/Best	meets all thresholds for Secchi, DIN, & PO_4
Mixed Better Light (MBL)	meets Secchi threshold, fails DIN and/or PO_4 threshold
Mixed Poor Light (MPL)	fails Secchi threshold, meets DIN and/or PO_4 threshold
Poor/Worst	fails all thresholds for Secchi, DIN, & PO_4

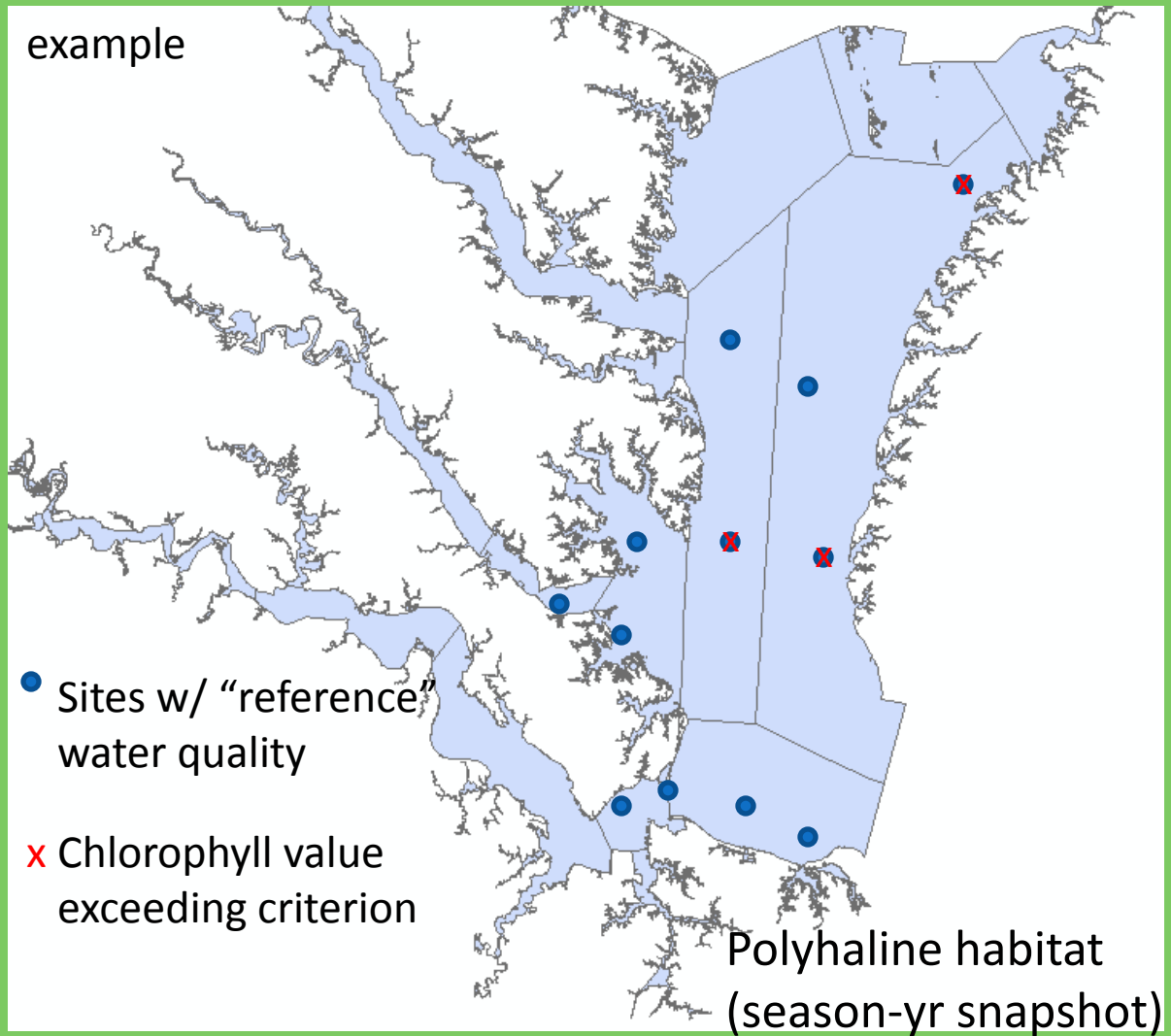
Reference conditions

From Claire Buchanan's "Biological Reference Curves for Assessing the James River Chlorophyll a Criteria"

- Using the Chesapeake Bay water quality database, Claire selected all the chlorophyll values collected during "reference water quality" condition and sorted them by habitat (salinity) and season-year.

- These values were compared to JR segment-season criteria

The reference samples were assumed to be adequately spatially representative of the habitat's area.

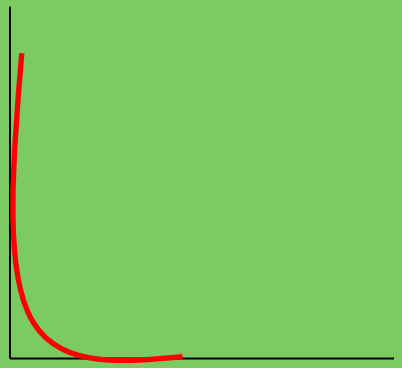


In this example, 25% of the fixed stations have chl values which exceeded the criterion. Thus, we assume 25% of the area of under "reference water quality" exceeded the criterion.

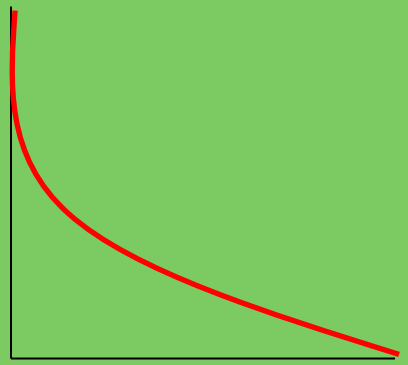
Claire's bioreference curves are based on instantaneous exceedences of the criteria, rather than seasonal mean exceedences.

Thus, we can't assume that Claire's bioreference curves are representative of seasonal mean exceedences under reference condition.

HOWEVER, if her bioreference curves depart considerably from 10% CFD, then it is reasonable for us to assume that seasonal-mean based bioreference curves would likely also depart from the 10% CFD.



more stringent



more lenient

The area under the reference curve determines how stringent the assessment is.

For this habitat-season, the default 10% curve is more stringent than the bioreference (shown in red)

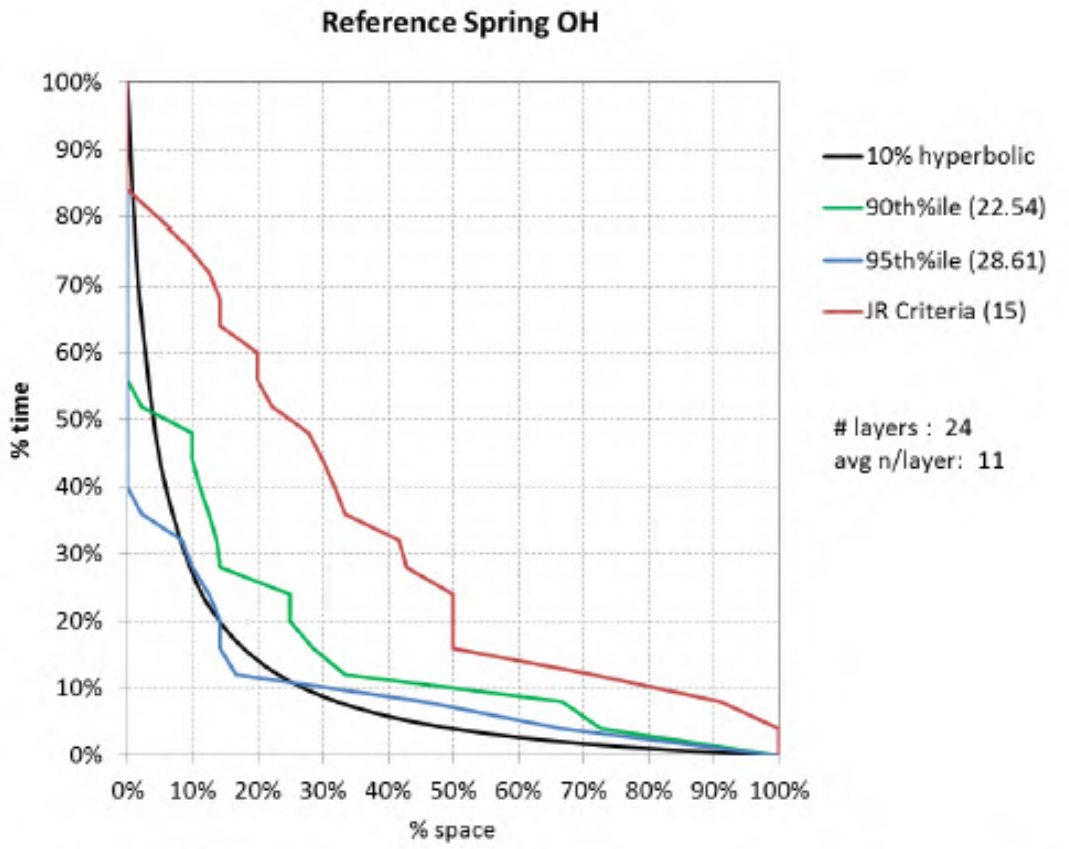


Figure 4b. Spring oligohaline CFD curves for chlorophyll *a* from reference water quality conditions.

From Claire Buchanan's "Biological Reference Curves for Assessing the James River Chlorophyll a Criteria"

The bioreference (shown in red) is more stringent than 10% default curve.

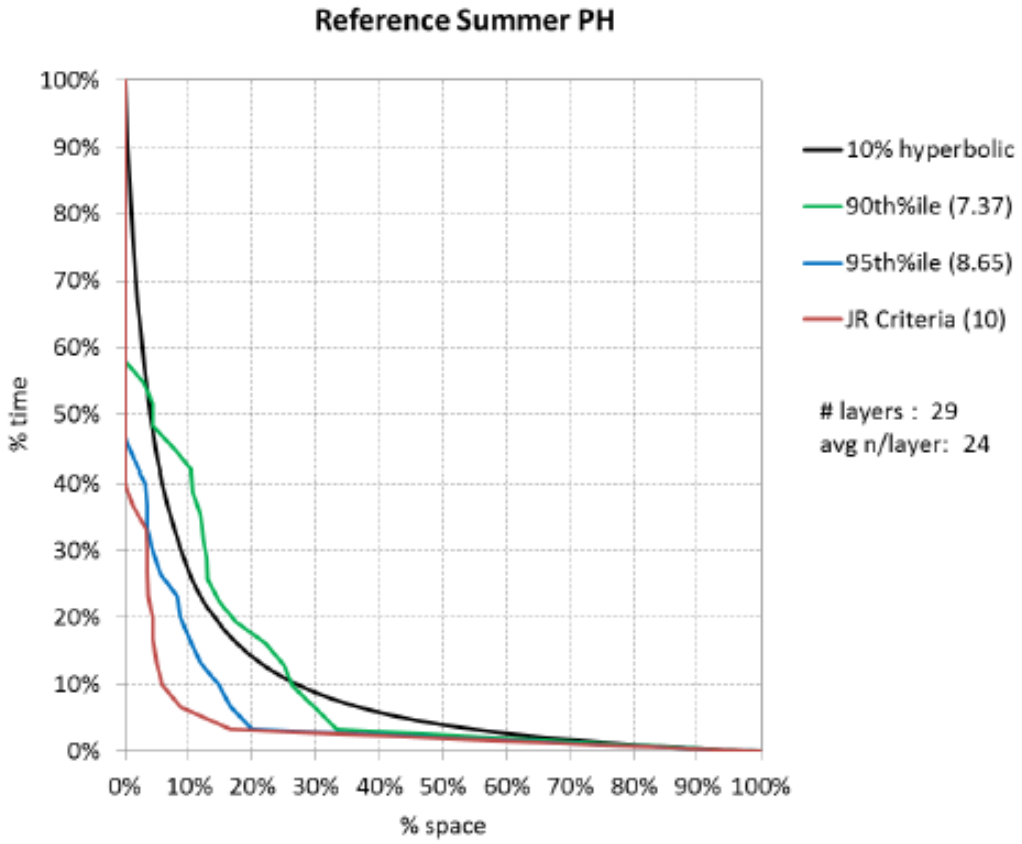


Figure 4h. Summer polyhaline CFD curves for chlorophyll *a* from reference water quality conditions.

From Claire Buchanan's "Biological Reference Curves for Assessing the James River Chlorophyll a Criteria"

This bioreference (shown in red) is pretty similar to the 10% hyperbolic curve

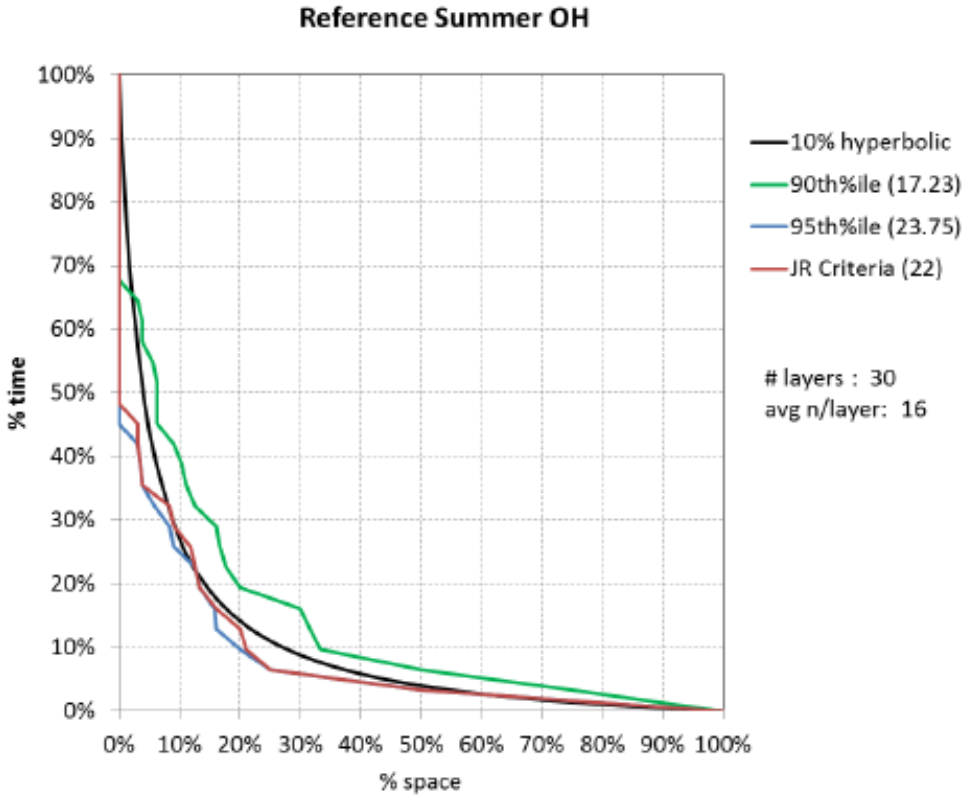
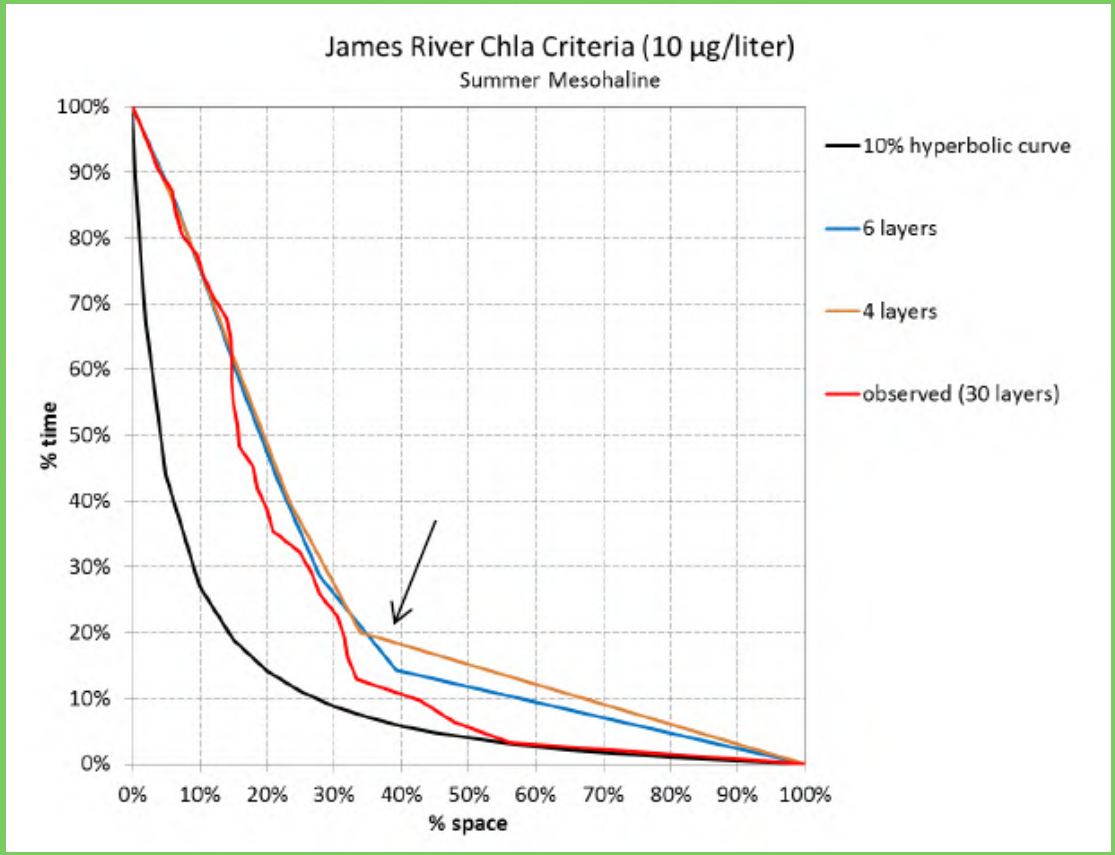


Figure 4f. Summer oligohaline CFD curves for chlorophyll *a* from reference water quality conditions.

From Claire Buchanan's "Biological Reference Curves for Assessing the James River Chlorophyll a Criteria"

season-salinity	stringency of biorefrence relative to 10% curve
spring TF2	slightly more lenient
spring TF1	more stringent
spring OH	much more lenient
spring MH	much more lenient
spring PH	more stringent
summer TF2	slightly more lenient
summer TF1	slightly more stringent
summer OH	similar
summer MH	much more lenient
summer PH	much more lenient

Claire also examined whether the number of points used to construct the bioreference curve affects the overall shape of the curve.



"When fewer than 9 assessment layers are used (i.e., 4 or 6), the points on the CFD curve in the middle and lower right corner begin to pull up and away from the observed 30-layer curve into the non-compliance zone. "

-Claire Buchanan

Big Weakness #2

The default 10% curve, especially when combined with a small number of points (e.g., 3), likely DOES NOT accurately predict “reference” chlorophyll exceedence rates.

Big Weakness #1

The current assessment method is not appropriate for sparse datasets generated from monthly site visits.

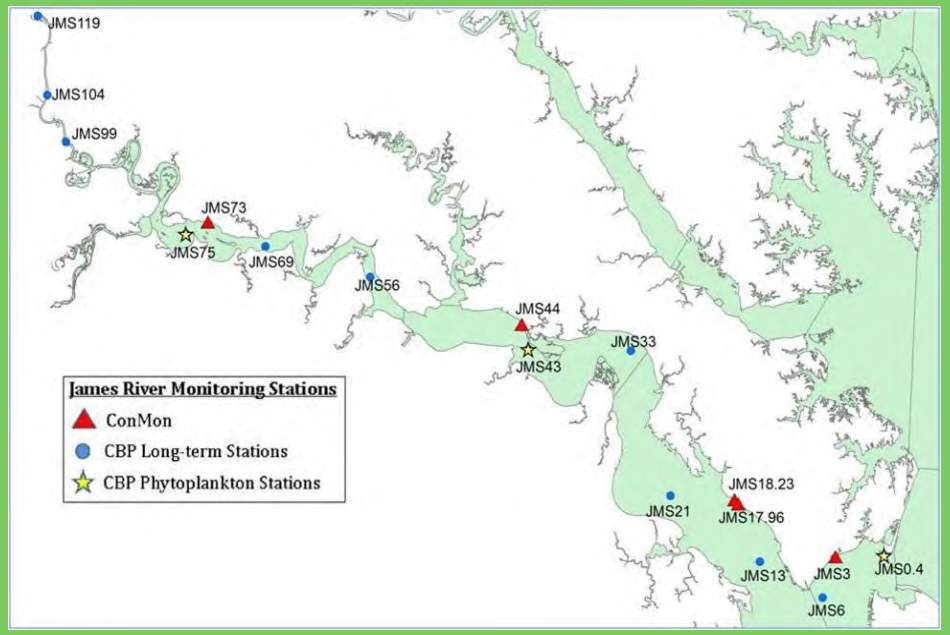
Big Weakness #2

The default 10% curve, especially when combined with a small number of points (e.g., 3), likely DOES NOT accurately predict “reference” chlorophyll exceedence rates.

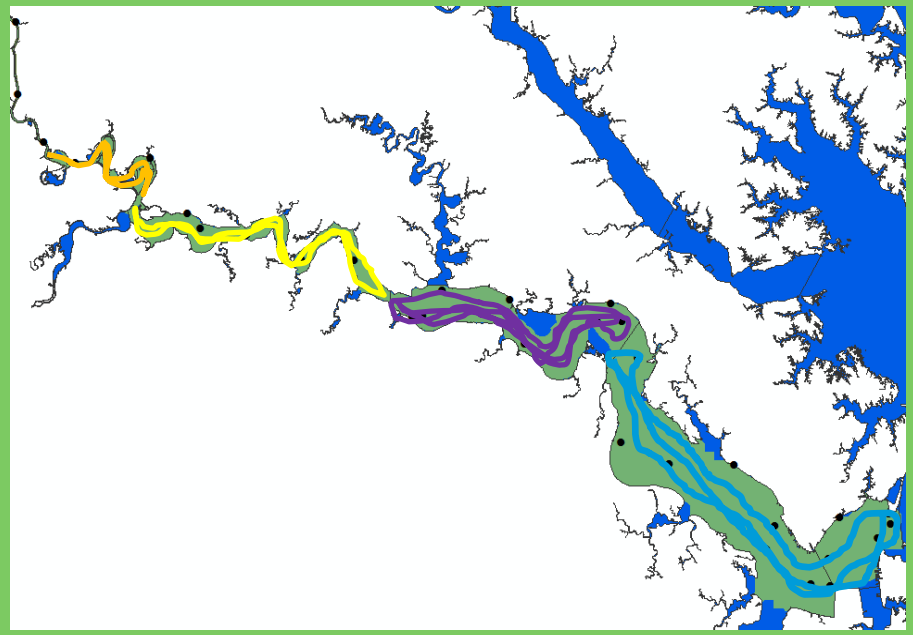
Question Break

Harmful Algal Bloom

Instead of treating fixed station and Dataflow datasets the same way, we should come up with two assessment methods that are suited to their strengths and weaknesses.



Fixed stations



Dataflow

Proposed Chlorophyll Assessment Procedure

Fixed Station-Only

Dataflow

Proposed Chlorophyll Assessment Procedure

Fixed Station-Only

6-year assessment window

Dataflow

3 to 6-year assessment window, depending on data availability

Proposed Chlorophyll Assessment Procedure

Fixed Station-Only

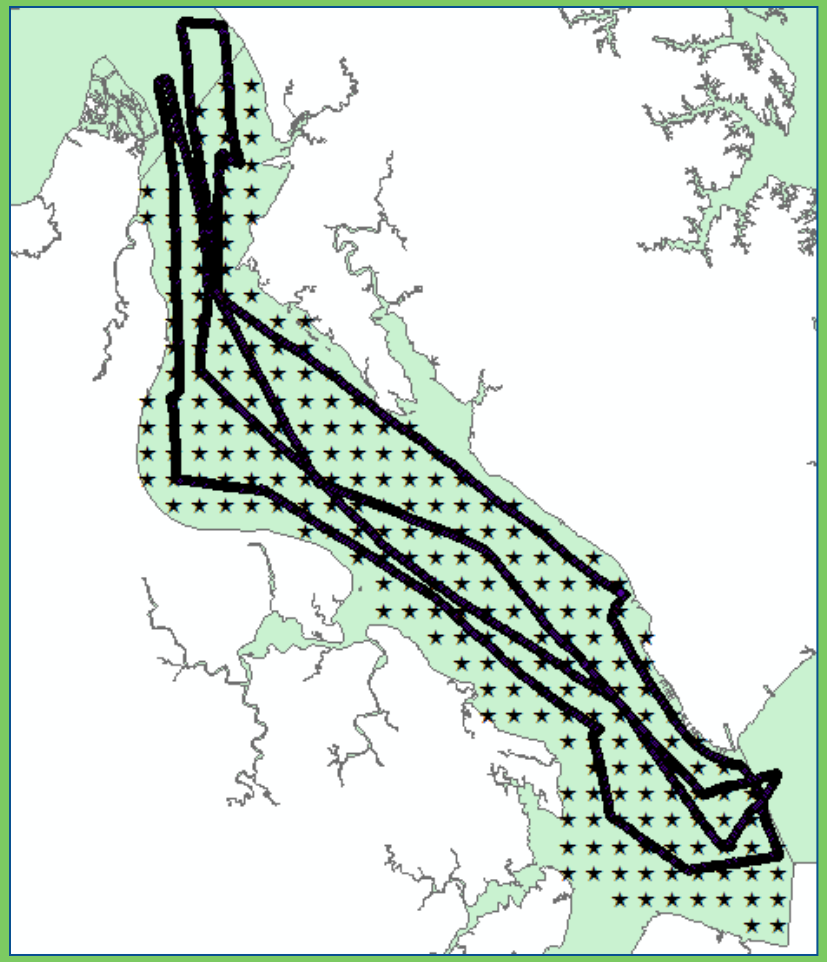
6-year assessment window

No interpolation

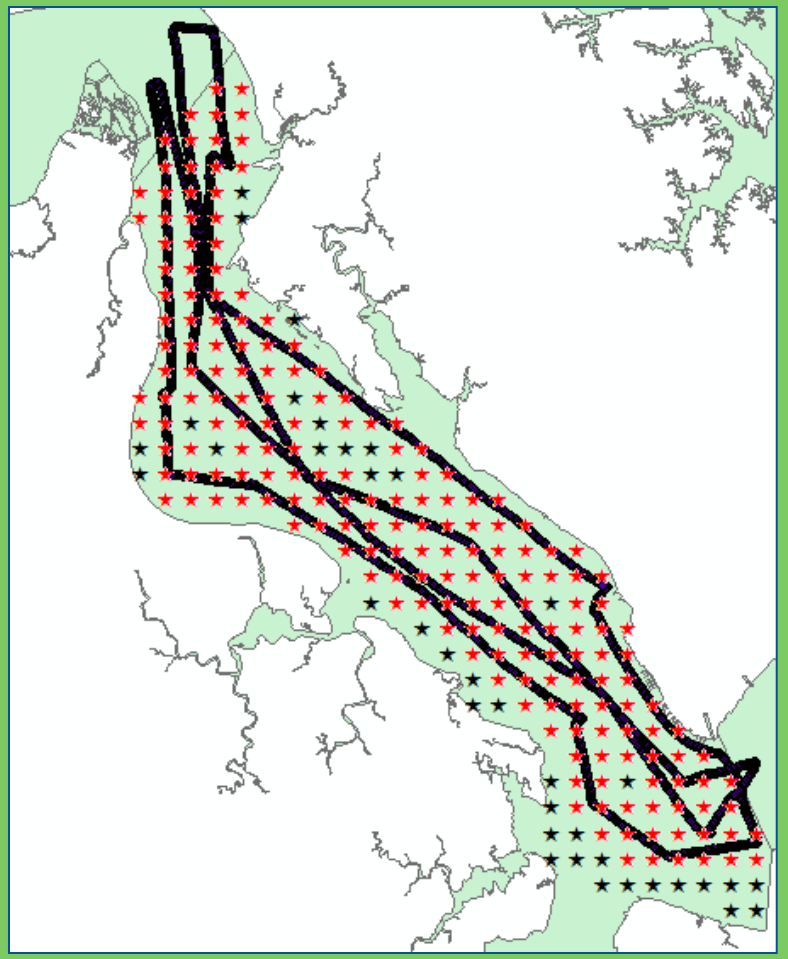
Dataflow

3 to 6-year assessment window, depending on data availability

Limit the range of interpolation



Instead of generating estimates for each point location in a segment….



…we would only estimate values at points within 1 km of the Dataflow cruise track.

Proposed Chlorophyll Assessment Procedure

Fixed Station-Only

- 6-year assessment window
- No interpolation
- Only assess station seasonal means. Two “bad” years allowed.

Dataflow

- 3 to 6-year assessment window, depending on data availability
- Limit the range of interpolation
- Continue to assess spatial exceedence rates

Fixed Station Assessment Dataset for JMSOH

		Monthly Grab Samples		Seasonal Means	
Year	**Month**	RET5.2	LE5.1	RET5.2	LE5.1
2007	March	3.6	8.1		
	April	10.8	7.7	8	8
	May	15.1	6.8		
2008	March	25.6	15.1		
	April	8.1	8.0	14	8
	May	12.5	4.8		
2009	March		168.8		
	April	10.8	12.7	10	20
	May	8.7	3.8		
2010	March	5.0	2.2		
	April	7.7	10.8	7	5
	May	10.4	6.6		
2011	March	2.5	2.3		
	April	9.9	4.5	6	3
	May	9.8			
2012	March	8.8	13.2		
	April	23.0	21.0	16	12
	May	21.0	6.6		

JMSOH criterion = 15 ug/l

A segment characterized solely by monthly samples would not be allowed to have more than 2 years with an observed violation during the six-year assessment period.

Fixed Station Assessment Dataset for JMSTF1

		Monthly Grab Samples			Seasonal Means		
Year	Month	TF5.5	TF5.5A	TF5.6	TF5.5	TF5.5A	TF5.6
2007	July	59.3	28.2	9.6	50	17	12
	August	27.7	42.7	6.5			
	September	67.1	3.9	30.2			
2008	July	37	23.6	5.4	25	22	6
	September	17.4	20.6	6.6			
2009	August	57.5	43	10.2	46	23	9
	September	37.5	12.8	7.97			
2010	July	37.6	27.5	12.5	50	35	7
	August	59.8	37.4	5.75			
	September	55.5	41.6	5.43			
2011	July	59.7	56.3	31.4	46	36	23
	August	71.9	64.6	28.9			
	September	23.2	12.5	12.6			
2012	July	47.3	40.4	28.8	48	48	17
	August	49.5	57.3	18.8			
	September	46.2	48.2	9.34			

TF1 criterion = 23 ug/l

My rationale behind the fixed station assessment procedure

Let's assume the chlorophyll criteria are equivalent to the long-term average condition anticipated once the James River target loads are reached. Isn't it possible that once targets are met, a segment can experience seasonal exceedences half the time while still attaining the criteria over the "long-term"?

Assuming the answer is "yes", we could argue that an allowable exceedence of 3 out of 6 years is justifiable.

But 2 out of 6 years is more protective and reduces the likelihood of making "false negative" determinations given the small sample sizes we're using to characterize each season.

Proposed Chlorophyll Assessment Procedure

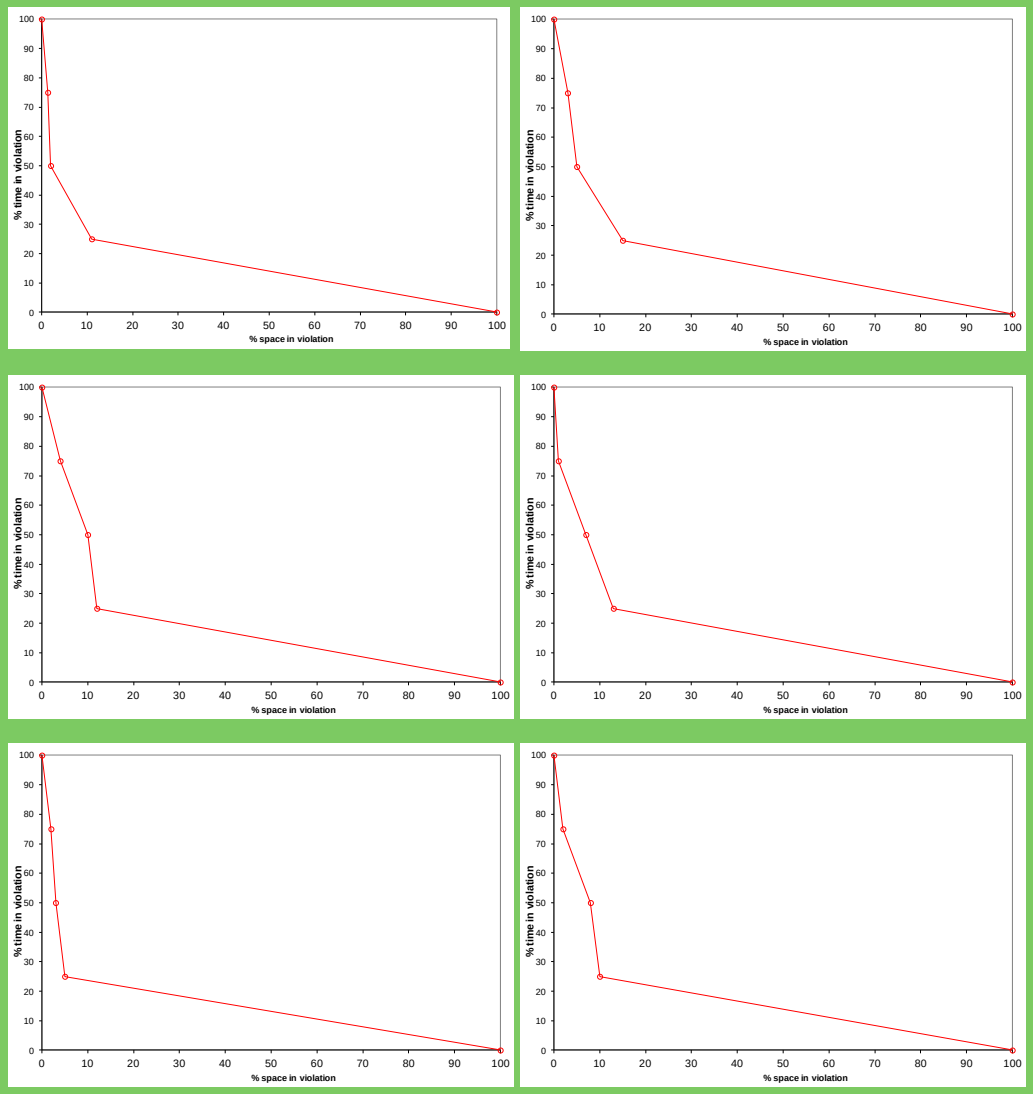
Fixed Station-Only

- 6-year assessment window
- No interpolation
- Only assess station seasonal means. Two “bad” years allowed.
- No CFD

Dataflow

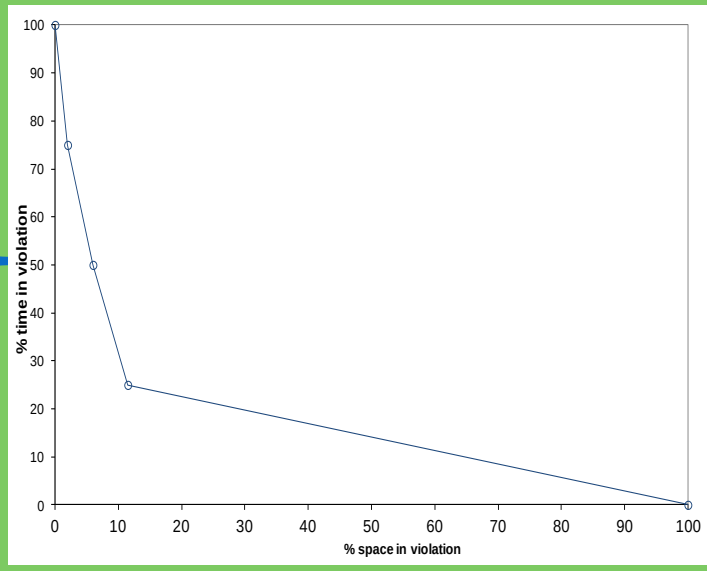
- 3 to 6-year assessment window, depending on data availability
- Limit the range of interpolation
- Continue to assess spatial exceedence rates
- Use a bioreferenced CFD with 95% confidence

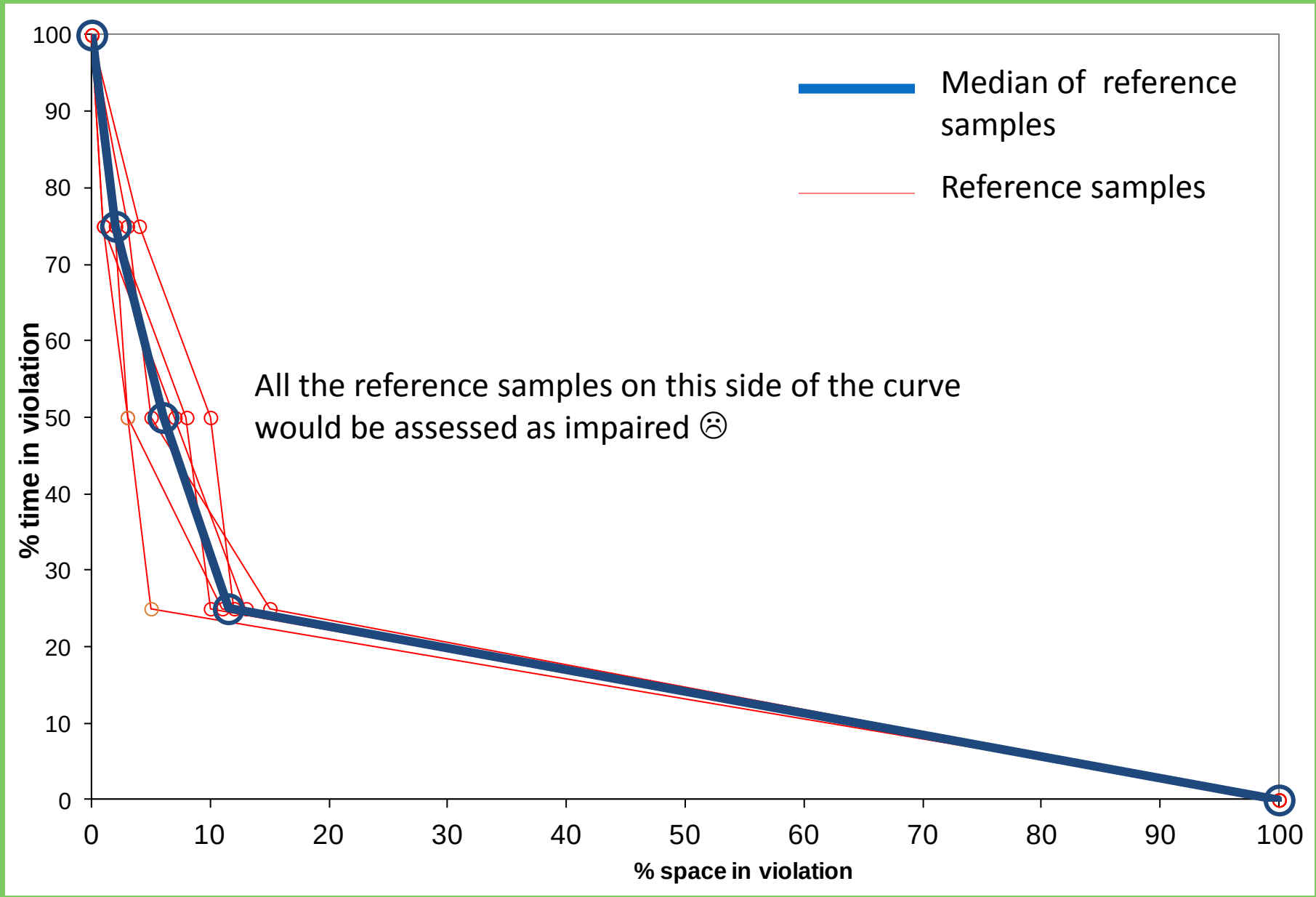
CFDs sampled from reference population

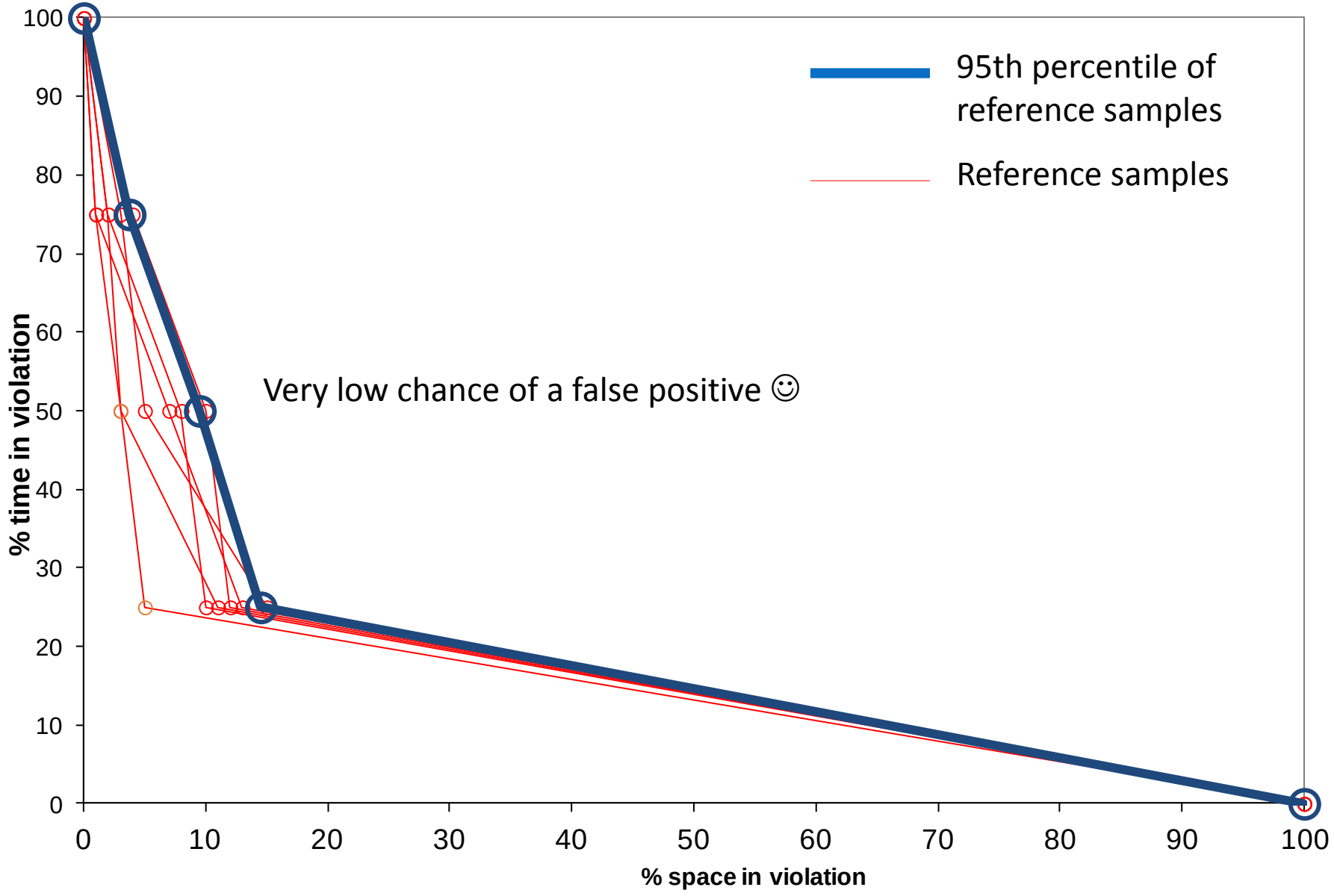


average

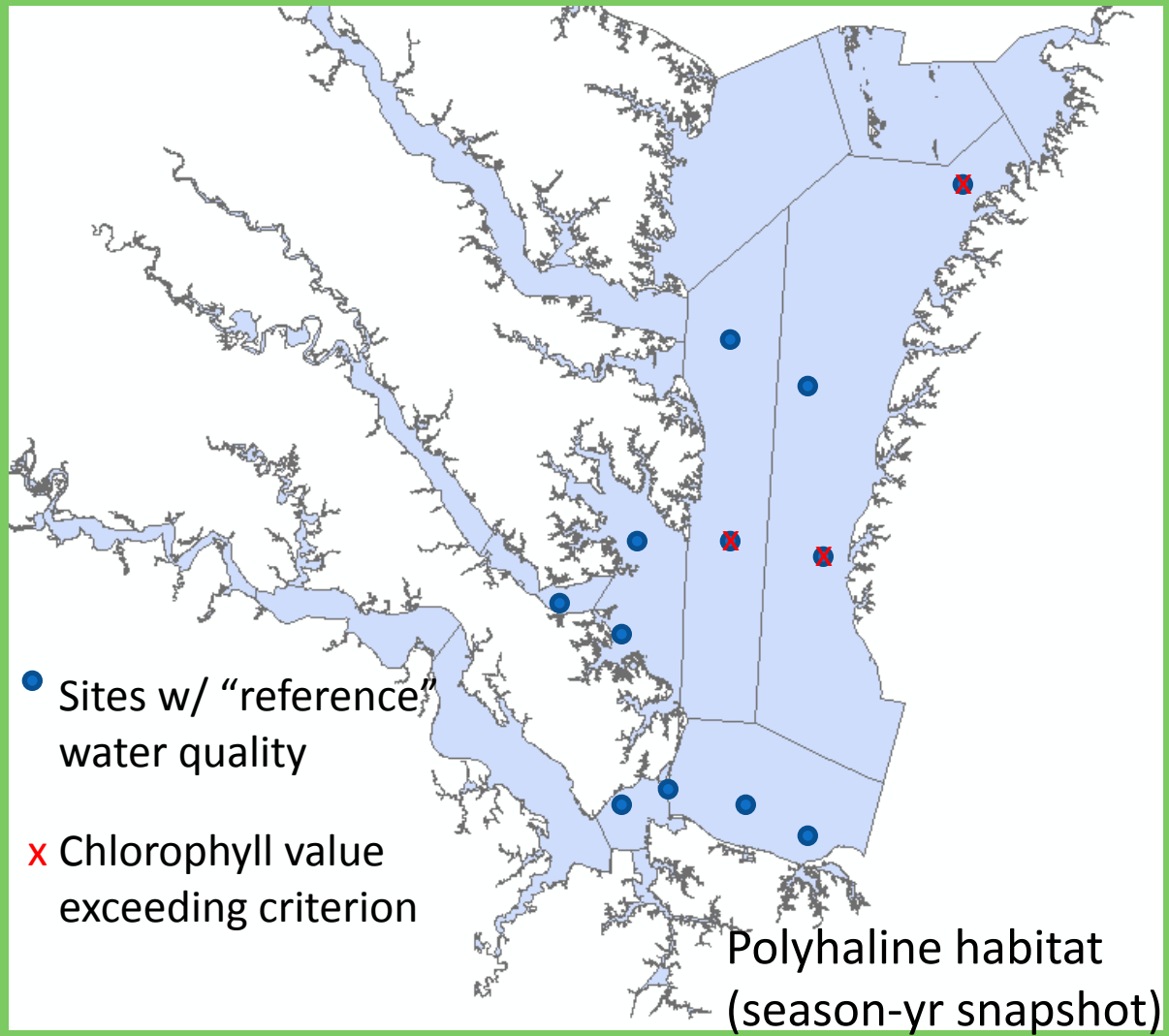
The median CFD




Median of reference samples
Reference samples
All the reference samples on this side of the curve would be assessed as impaired ☹
% time in violation
% space in violation
0
10
20
30
40
50
60
70
80
90
100

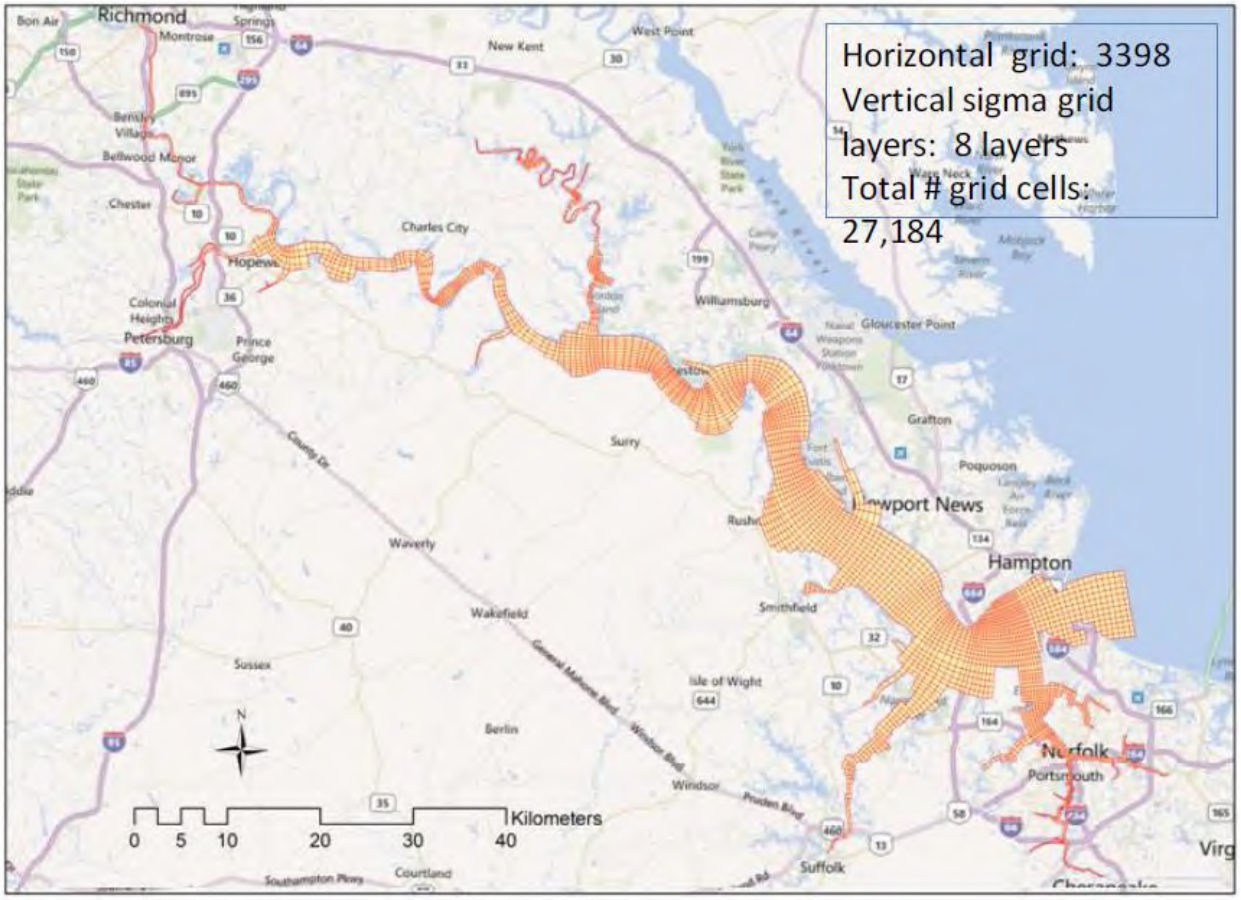

95th percentile of reference samples
Reference samples
Very low chance of a false positive ☺
% time in violation
% space in violation
0
10
20
30
40
50
60
70
80
90
100

Claire Buchanan's reference exceedence layers are based on "instances". They would have to be based on seasonal means for us to use them to construct bioreference curves.

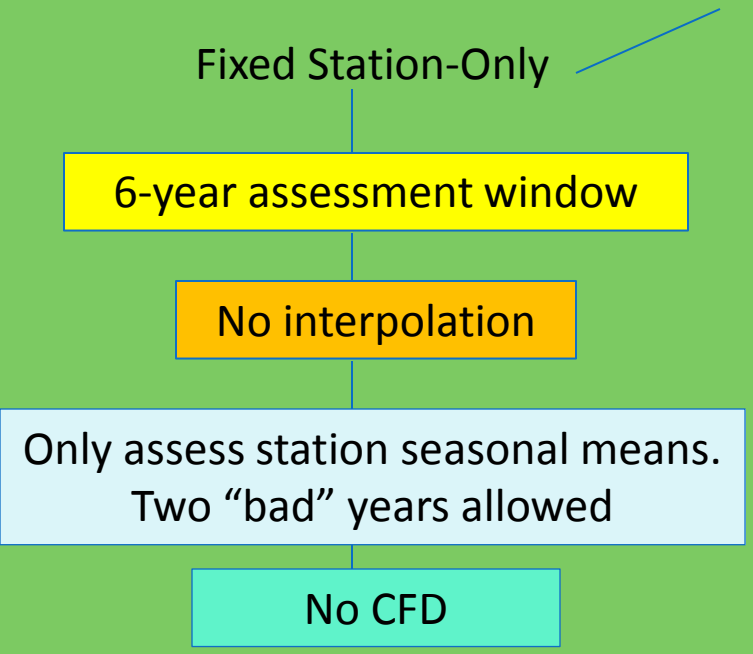


Alternatively, we could build a reference curve using the JR model output.

James River grid



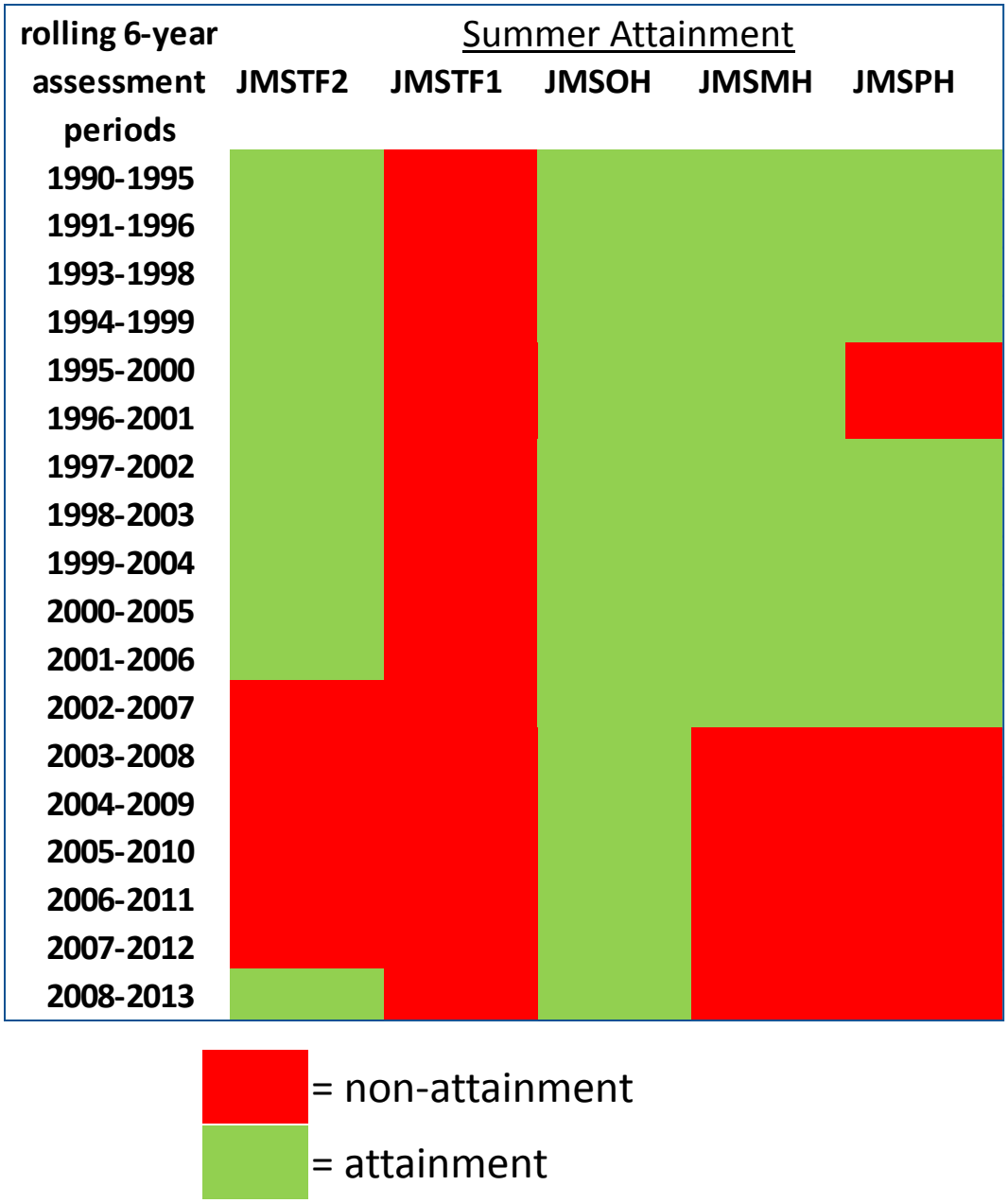
Proposed Chlorophyll Assessment Procedure



Benefits of "Fixed Station Only" Assessment

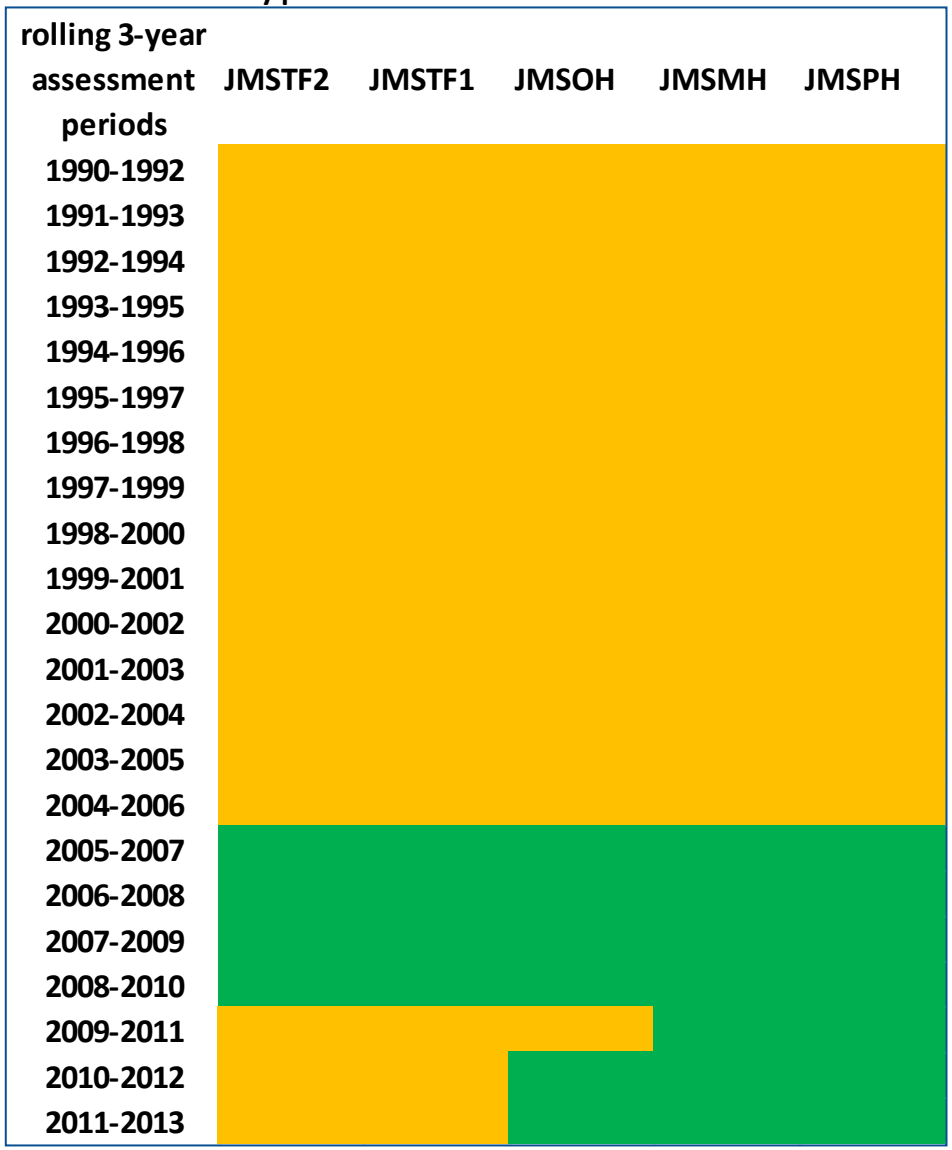
- Very protective
- Similar to more traditional assessment procedures
- Easy to implement, explain
- Few assumptions
- No extraordinary data requirements
- Can be applied to ConMon
- Allows "apples-to-apples" comparison of different assessment periods

Fixed Station Assessment Procedure Results



Because the CBP stations have been monitored consistently for the past 30+ years, the fixed station assessment procedure can be applied to historical datasets with few caveats. Retrospective assessments would allow us to detect whether long-term attainment rates are changing in response to management actions.

Data Type Available for Assessment



But it is more difficult to compare different assessment periods using the current method.

Is an assessment result based on Dataflow really comparable to one based solely on fixed station data?

= only fixed station data were available

= Dataflow data were available

Proposed Chlorophyll Assessment Procedure

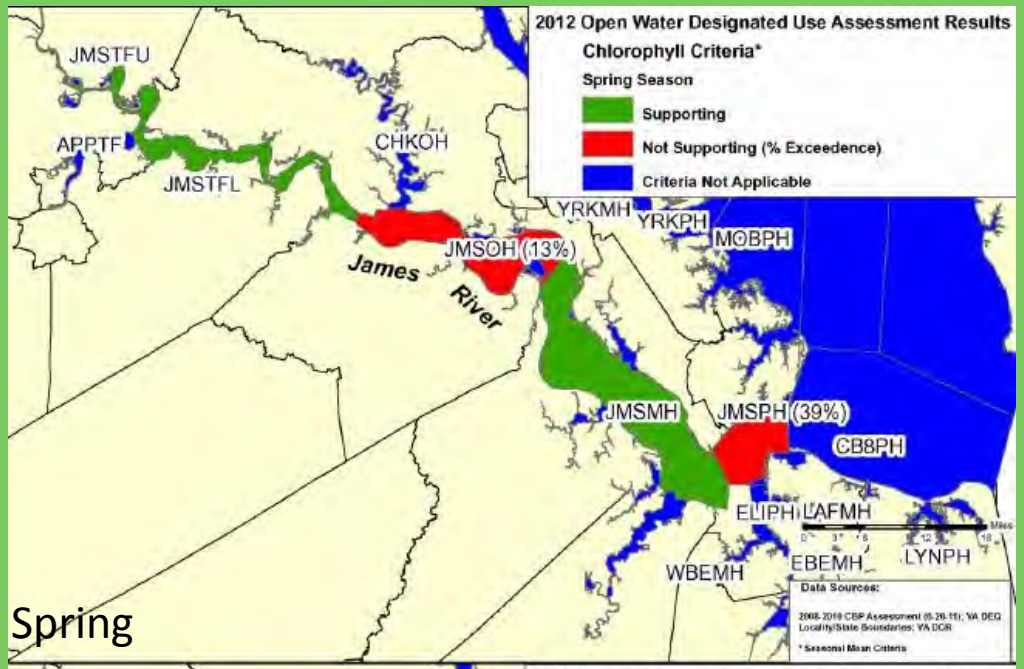
Fixed Station-Only

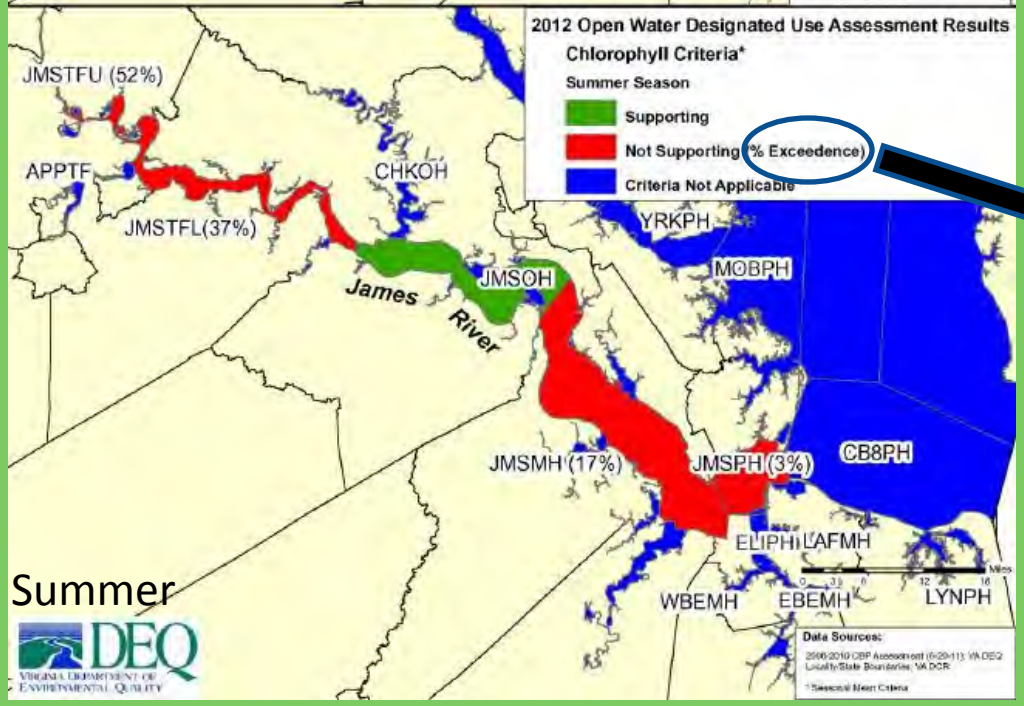
Dataflow

- 3 to 6-year assessment window, depending on data availability
- Limit the range of interpolation
- Continue to assess spatial exceedence rates
- Use a bioreferenced CFD with 95% confidence

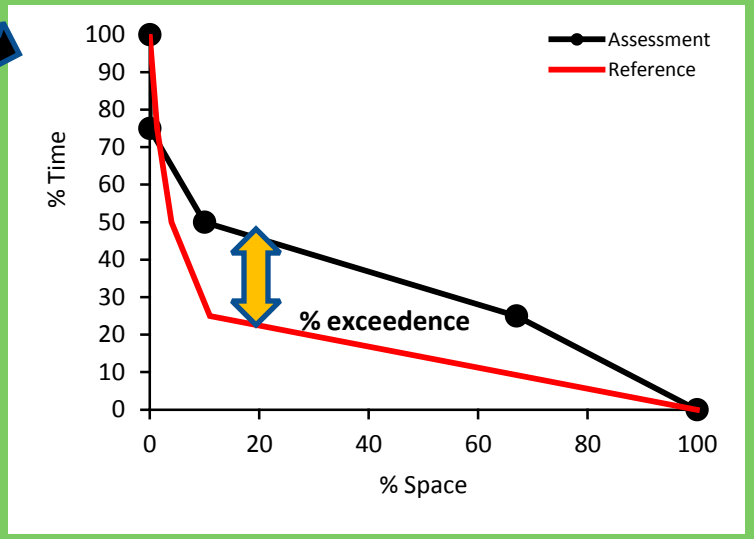
Benefits of the Dataflow Assessment

- Provides a detailed characterization, esp. “degree of non-attainment”





The Dataflow assessment procedure would allow us to continue reporting degree of non-attainment.

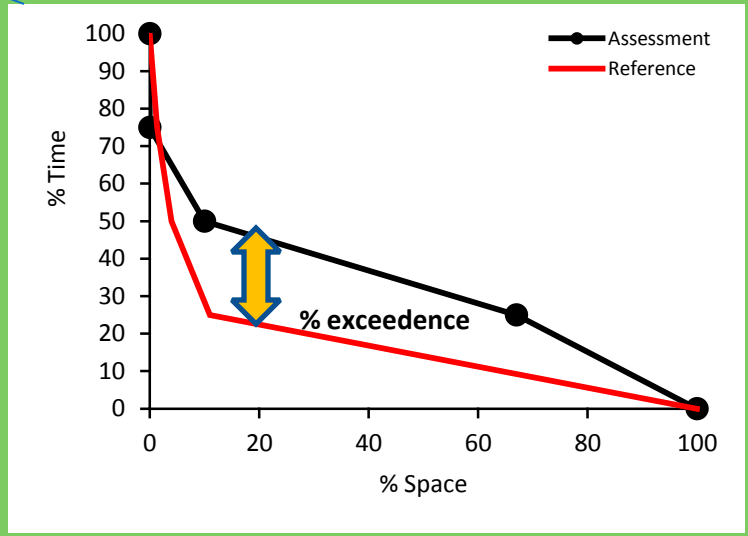


Cbseg	190 Loading Scenario 190TN, 12.7TP, 6030TSS '91-'93 CL Spring Seasonal	190 Loading Scenario 190TN, 12.7TP, 6030TSS '92-'94 CL Spring Seasonal	190 Loading Scenario 190TN, 12.7TP, 6030TSS '93-'95 CL Spring Seasonal	190 Loading Scenario 190TN, 12.7TP, 6030TSS '94-'96 CL Spring Seasonal	190 Loading Scenario 190TN, 12.7TP, 6030TSS '95-'97 CL Spring Seasonal	190 Loading Scenario 190TN, 12.7TP, 6030TSS '96-'98 CL Spring Seasonal	190 Loading Scenario 190TN, 12.7TP, 6030TSS '97-'99 CL Spring Seasonal	190 Loading Scenario 190TN, 12.7TP, 6030TSS '98-'00 CL Spring Seasonal
JMSTFL	0%	0%	2%	2%	2%	0%	0%	0%
JMSTFU	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	0%	0%	0%	4%	4%	4%	0%	5%
JMSMH	3%	1%	0%	0%	0%	0%	0%	0%
JMSPH	0%	0%	0%	0%	0%	0%	0%	0%
Cbseg	**CL Summer Seasonal**	**CL Summer Seasonal**	**CL Summer Seasonal**	**CL Summer Seasonal**	**CL Summer Seasonal**	**CL Summer Seasonal**	**CL Summer Seasonal**	**CL Summer Seasonal**
JMSTFL	0%	0%	0%	0%	5%	15%	15%	8%
JMSTFU	0%	0%	0%	0%	0%	0%	0%	0%
JMSOH	0%	0%	0%	0%	0%	0%	0%	0%
JMSMH	0%	0%	0%	0%	0%	0%	15%	14%
JMSPH	0%	0%	0%	0%	0%	0%	11%	11%

For this scenario, the James River Basin allocation is 26.6 mpy TN and 2.7 mpy TP. Failure to attain WQS is shown in red text as percent nonattainment.

Figure O-1. Attainment of numeric chlorophyll *a* WQS in the James River at the draft Target Load Chesapeake Bay basinwide allocation of 190 mpy TN and 12.7 mpy TP.

Percent exceedence was how criteria attainment was presented in the Bay TMDL report.



From Appendix O—Chesapeake Bay TMDL

Proposed Chlorophyll Assessment Procedure

Fixed Station-Only

Dataflow

- 3 to 6-year assessment window, depending on data availability
- Limit the range of interpolation
- Continue to assess spatial exceedence rates
- Use a bioreferenced CFD with 95% confidence

Benefits of the Dataflow Assessment

- Provides a detailed characterization, esp. “degree of non-attainment”
- State-of-the-art assessment methodology
- Could be adapted to other spatially intensive monitoring datasets (aerial flyovers, satellite imagery)

Combining these strengths together allows us to…

- Use the fixed station method as the primary means of assessing chlorophyll (and criteria attainability).
- Use the Dataflow method for communicating interim progress.
- Use the Dataflow method to supplement the fixed station assessment, providing two independent lines of evidence that the criteria are being attained/not attained.

Hypothetical Assessment for a Segment

	2017	2018	2019	2020	2021	2022
no. of stations	**3**	**3**	**3**	**3**	**3**	**2**
summer assessment result	no violations	no violations	no violations	no violations	no violations	no violations
assessor's comments	*missing July data @ one station*			*missing August data @ all stations*		*station was dropped from monitoring network*

"Monitoring data indicate that the chlorophyll criteria are being attained."

Hypothetical Assessment for a Segment

	2017	2018	2019	2020	2021	2022
no. of stations	**3**	**3**	**3**	**3**	**3**	**2**
summer assessment result	no violations	no violations	no violations	no violations	no violations	no violations
assessor's comments	*missing July data @ one station*			*missing August data @ all stations*		*station was dropped from monitoring network*

DATAFLOW ASSESSMENT SAYS THE SAME THING!!!!!

"Two independent analyses indicate that chlorophyll criteria are being attained in this segment."

Hypothetical Assessment for a Segment

	2017	2018	2019	2020	2021	2022
no. of stations	**3**	**3**	**3**	**3**	**3**	**2**
summer assessment result	**one violation!**	no violations	no violations	**one violation!**	**two violations!**	no violation
assessor's comments	*missing July data @ one station*			*missing August data @ all stations*		*station was dropped from monitoring network*

BUT DATAFLOW ASSESSMENT INDICATES COMPLIANCE!!

"Though violations were observed in three years of the assessment period, the evaluation of spatial exceedence rates indicates this segment is indistinguishable from reference."

Proposed Chlorophyll Assessment Procedure

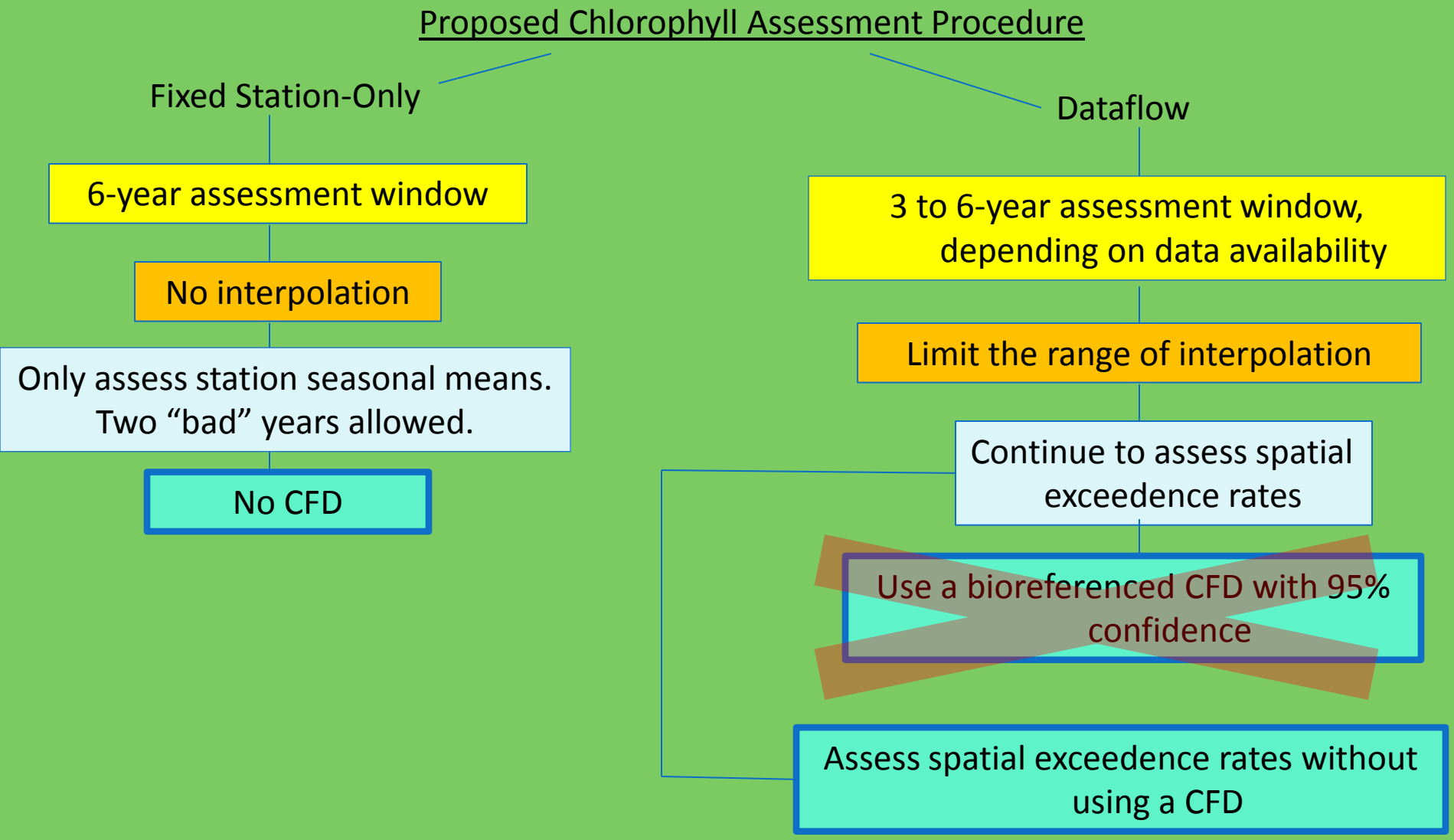
Fixed Station-Only

- 6-year assessment window
- No interpolation
- Only assess station seasonal means. Two "bad" years allowed.
- No CFD

Dataflow

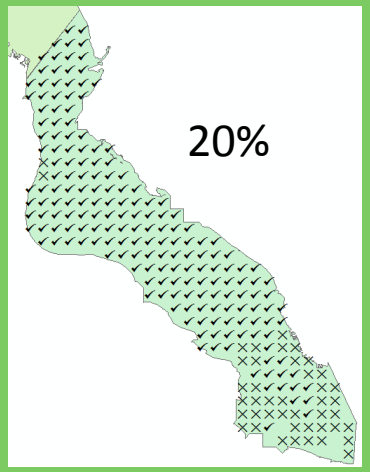
- 3 to 6-year assessment window, depending on data availability
- Limit the range of interpolation
- Continue to assess spatial exceedence rates
- Use a bioreferenced CFD with 95% confidence

Questions so far?

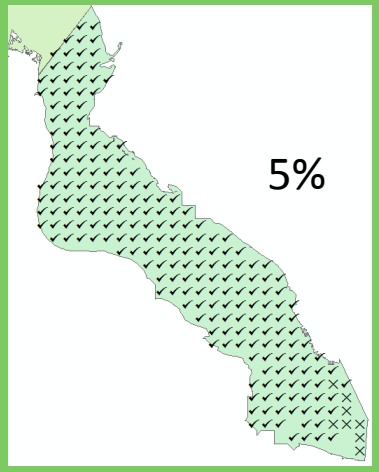

Proposed Chlorophyll Assessment Procedure
Fixed Station-Only
6-year assessment window
No interpolation
Only assess station seasonal means.
Two "bad" years allowed.
No CFD
Dataflow
3 to 6-year assessment window,
depending on data availability
Limit the range of interpolation
Continue to assess spatial
exceedence rates
Use a bioreferenced CFD with 95%
confidence
Assess spatial exceedence rates without
using a CFD

We have a number of variations of the “10% rule” outside of the CFD framework to choose from.

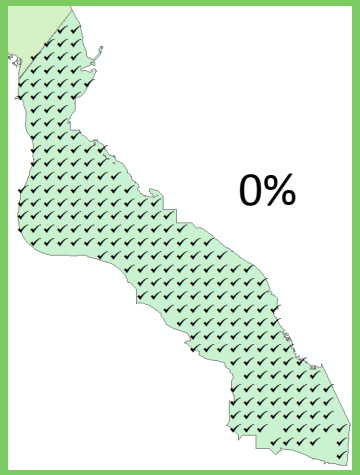
Year 1



Year 2

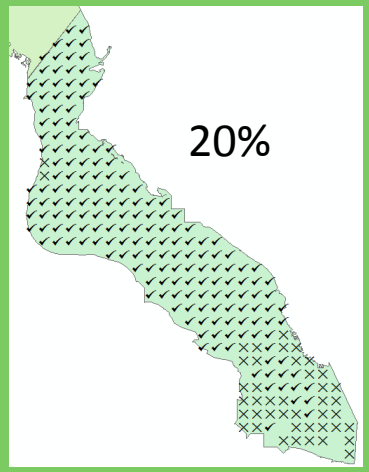


Year 3

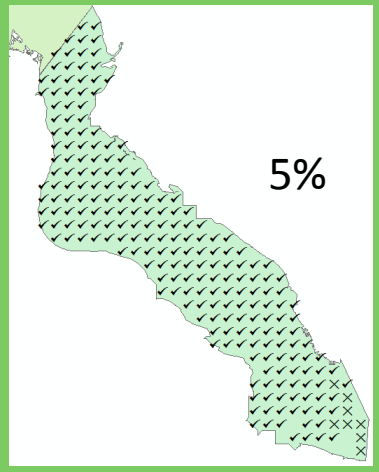


Option # 1

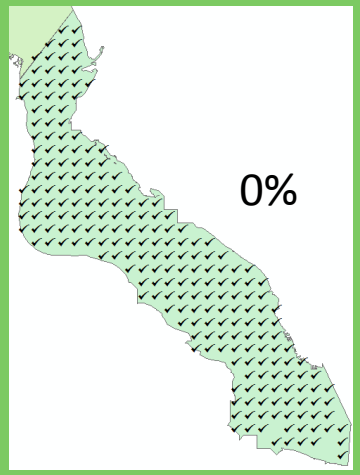
Year 1



Year 2



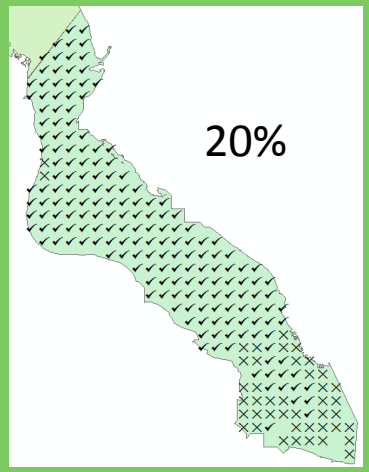
Year 3



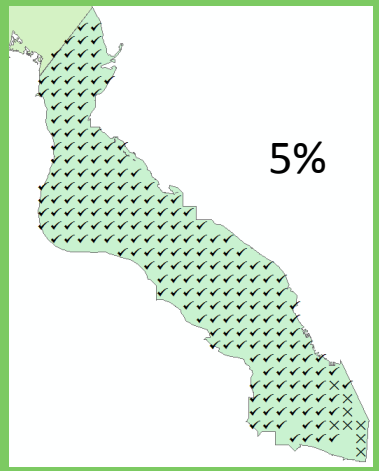
Assessment Rule	Assessment Result
"No single season shall have more than a 10% spatial exceedence rate."	Because Year 1 > 10%, segment FAILS

Option # 2

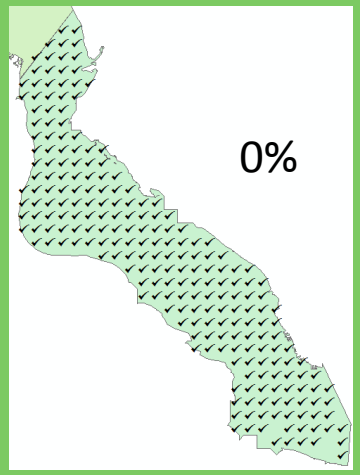
Year 1



Year 2



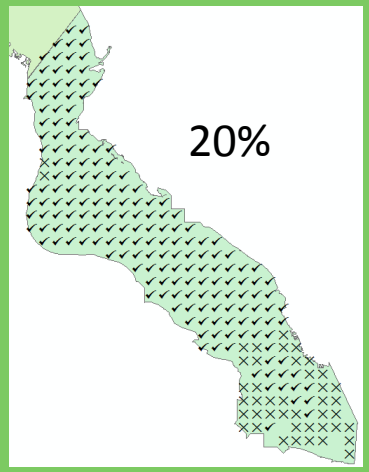
Year 3



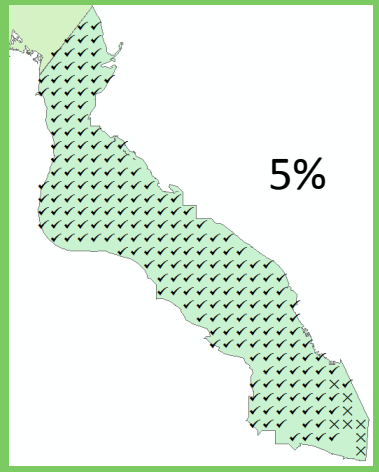
Assessment Rule	Assessment Result
"The average spatial exceedence rate for the assessment period shall not exceed 10%."	Because the average exceedence rate is 8%, segment MEETS

Option #3

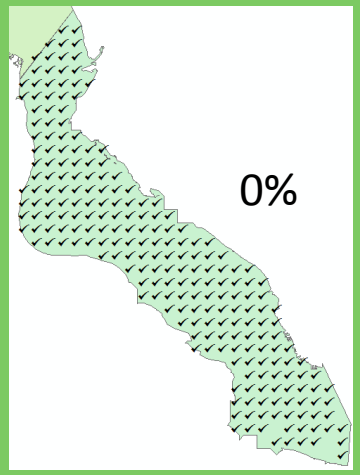
Year 1



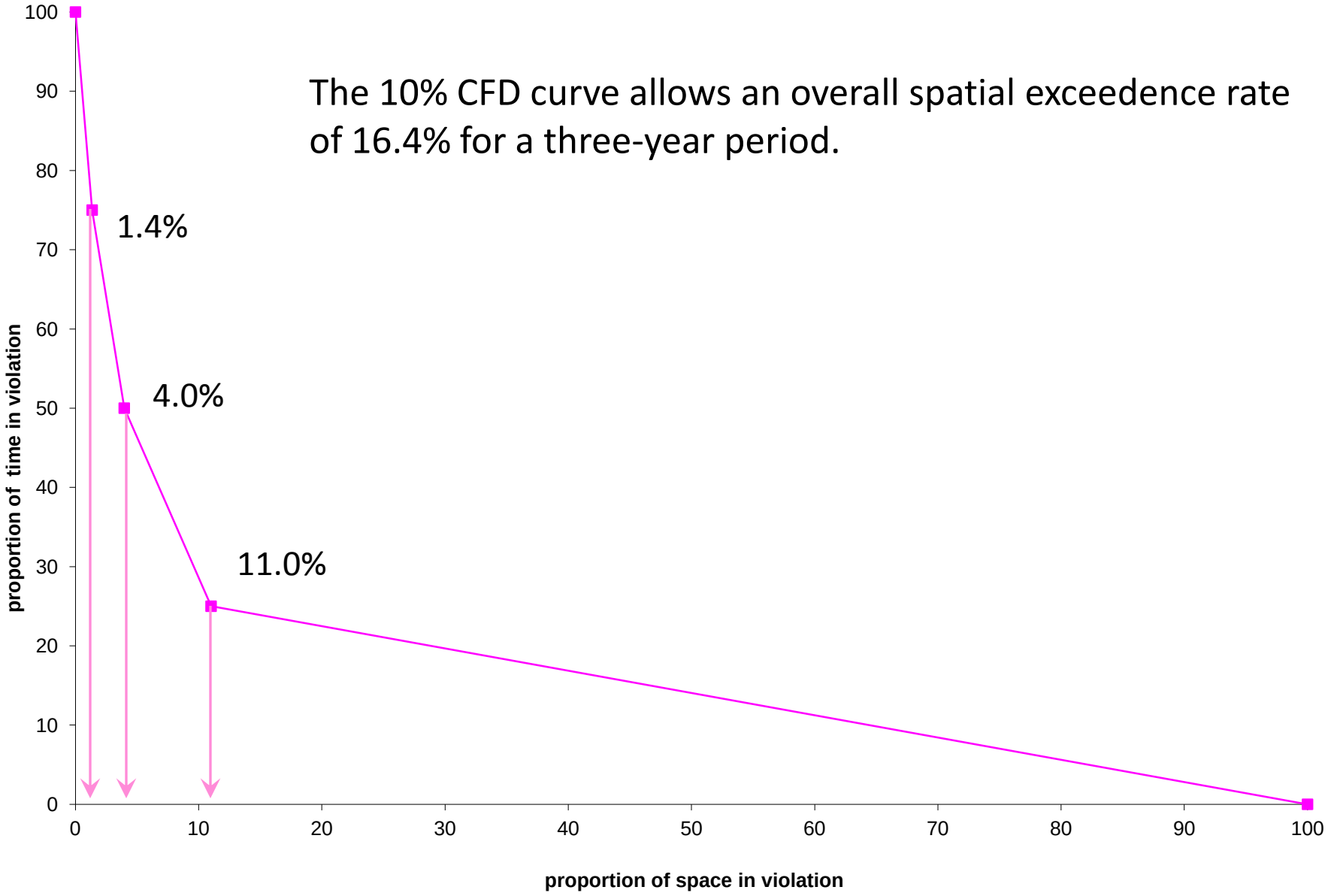
Year 2



Year 3



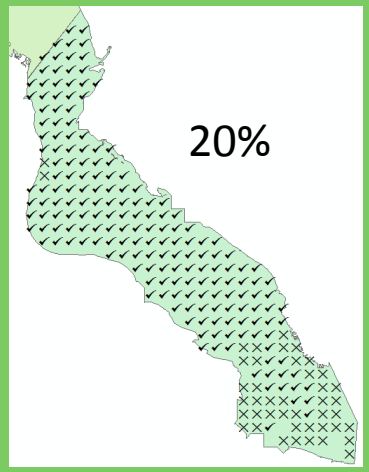
Assessment Rule	Assessment Result
"The sum of spatial exceedences over the assessment period shall be no greater than what the 10% CFD allows."	


The 10% CFD curve allows an overall spatial exceedence rate of 16.4% for a three-year period.
1.4%
4.0%
11.0%
proportion of time in violation
proportion of space in violation
0
10
20
30
40
50
60
70
80
90
100

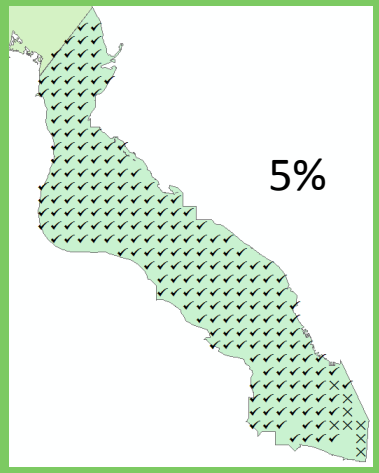
Assessment period	Total Allowable Spatial Exceedence Rate via 10% CFD
3-year	16%
4-year	24%
5-year	32%
6-year	40%

Option #3

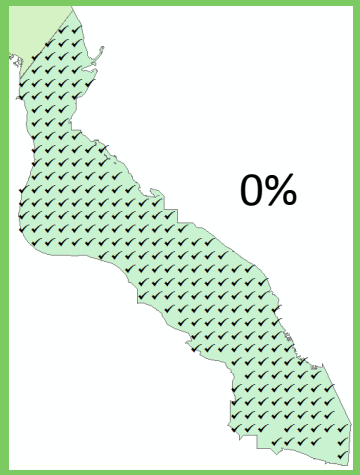
Year 1



Year 2



Year 3



Assessment Rule	Assessment Results
"The <u>sum</u> of spatial exceedences over the assessment period shall be no greater than what the 10% CFD allows."	10% CFD based on 3 years →16% is allowable Cumulative Exceedence Rate = 25% ➔ FAILS

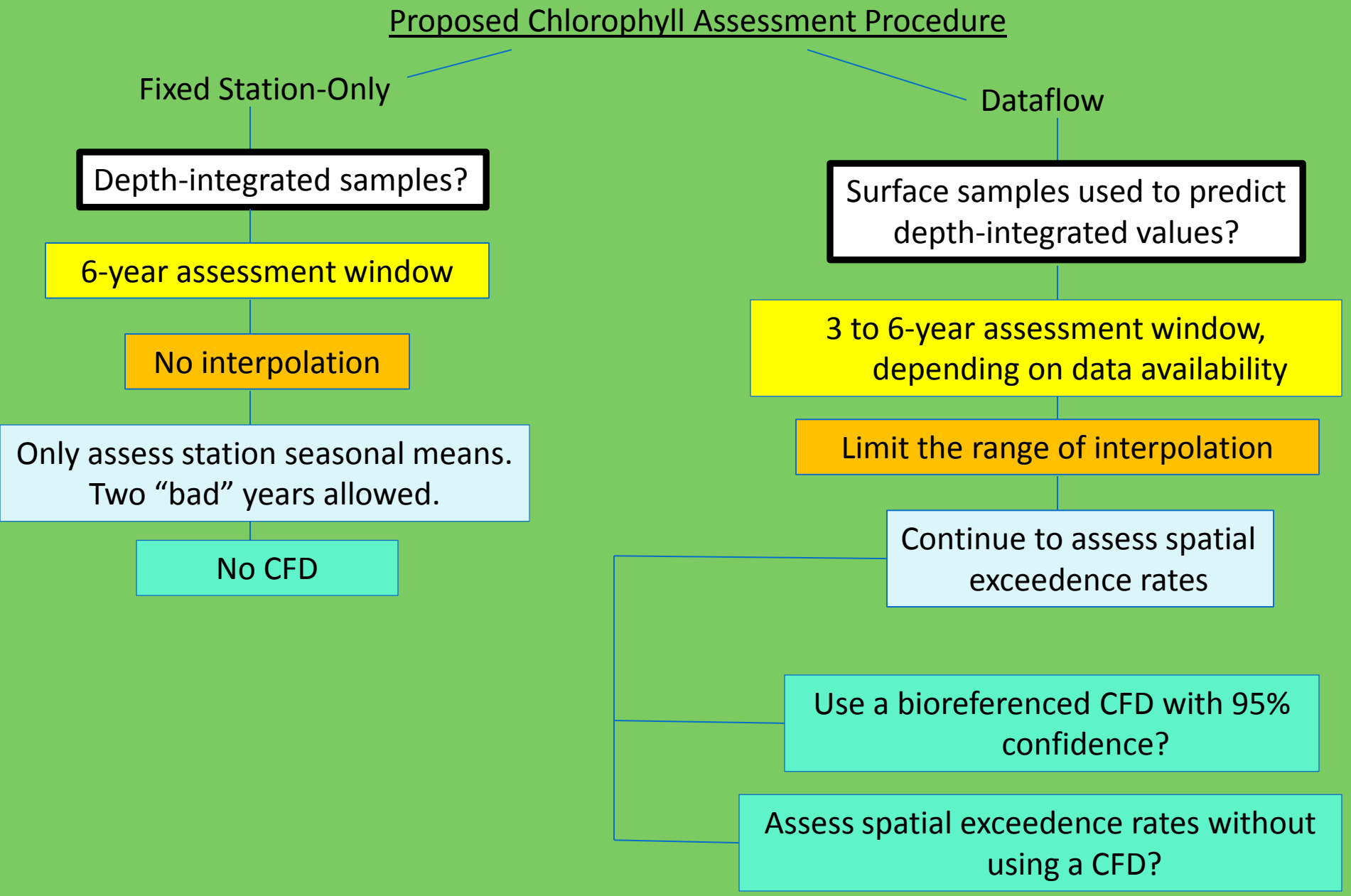
Segment	Summer Dataflow Exceedence Rates (2006-2008)	Assessment Rule #1	Assessment Rule #2	Assessment Rule #3
JMSTF2	77, 34, 30			
JMSTF1	57, 45, 38			
JMSOH	0, 0, 0			
JMSMH	15, 2, 0			
JMSPH	0, 0, 0			
	Number of segments in attainment	2	3	2

Assessment Rule #1 : no single year exceedence $\leq$ 10%
Assessment Rule #2: 3-year average exceedence $\leq$ 10%
Assessment Rule #3: 3-year sum $\leq$ 16%

Segment	Summer Dataflow Exceedence Rates (2006-2008)	Assessment Rule #1	Assessment Rule #2	Assessment Rule #3	Current CFD
JMSTF2	77, 34, 30				
JMSTF1	57, 45, 38				
JMSOH	0, 0, 0				
JMSMH	15, 2, 0				
JMSPH	0, 0, 0				
	Number of segments in attainment	2	3	2	2

Assessment Rule #1 : no single year exceedence $\leq$ 10%
Assessment Rule #2: 3-year average exceedence $\leq$ 10%
Assessment Rule #3: 3-year sum $\leq$ 16%
CFD: current method

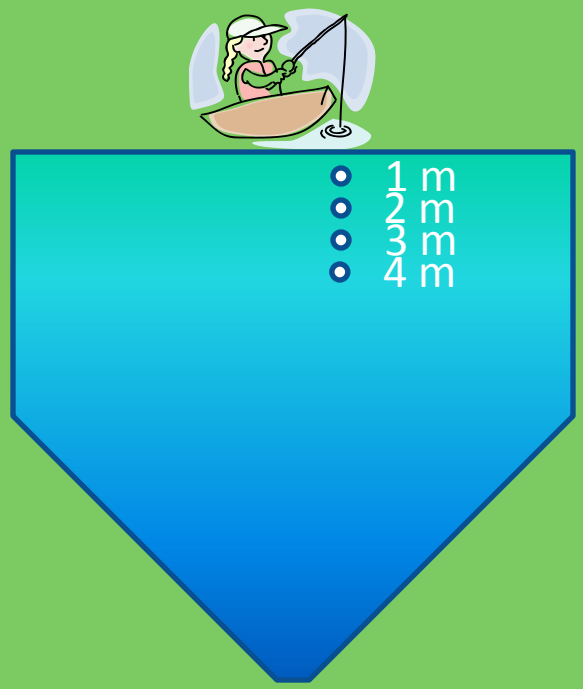
Assessment Rule	Selling Point	Stringency compared to current method
"No single spatial exceedence rate shall exceed 10%"	• Consistent with traditional application of 10% rule.	Lenient
"The average spatial exceedence rate for the assessment period shall not exceed 10%."	• Makes an allowance for a "bad" year as long as the other years are really "good"	Very lenient
"The sum of spatial exceedences over the assessment period shall be no greater than what the 10% CFD allows."	• Gives a nod to the CFD but is less rigid.	Less stringent without being lenient. 

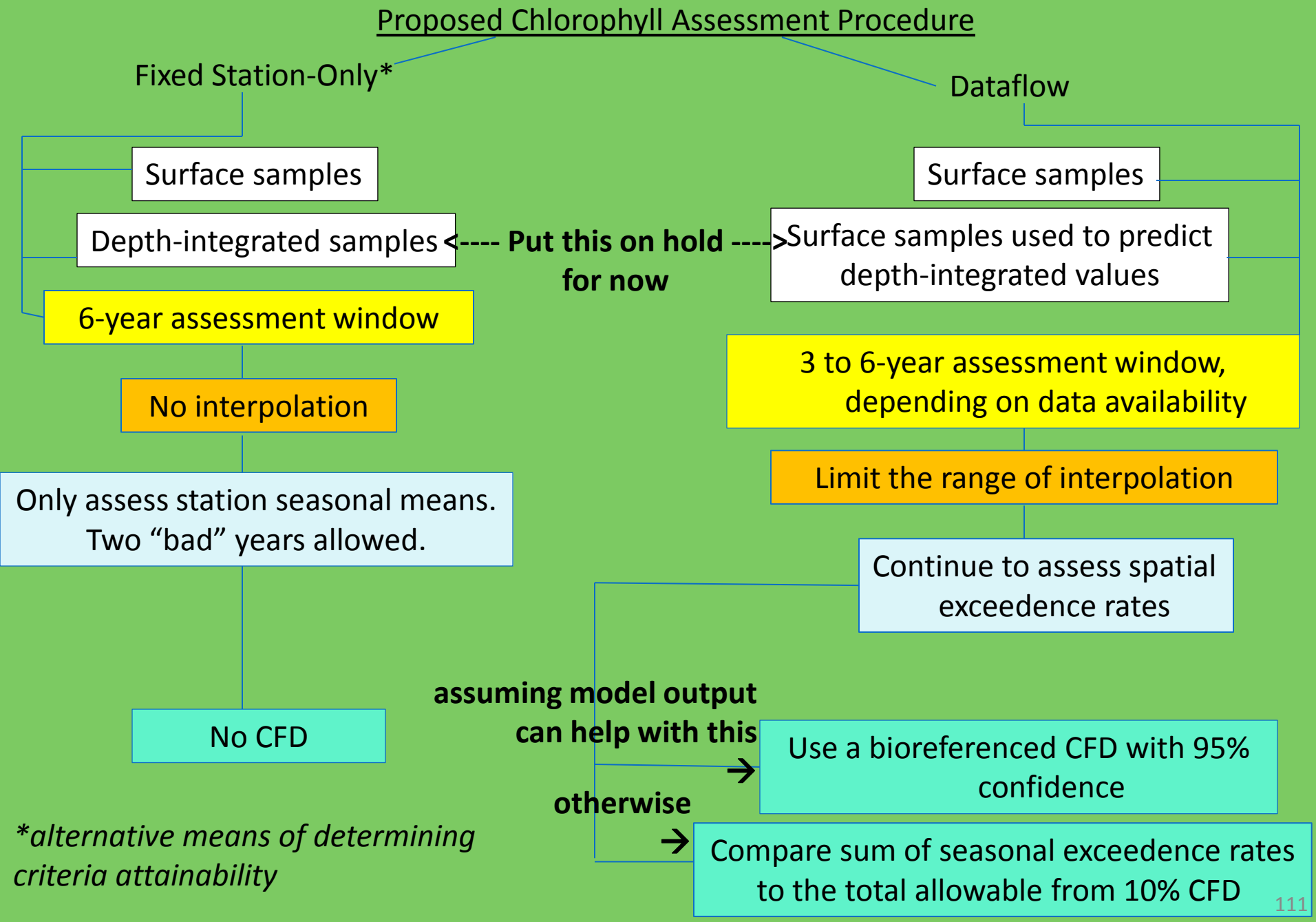

Proposed Chlorophyll Assessment Procedure
Fixed Station-Only
Depth-integrated samples?
6-year assessment window
No interpolation
Only assess station seasonal means. Two "bad" years allowed.
No CFD
Dataflow
Surface samples used to predict depth-integrated values?
3 to 6-year assessment window, depending on data availability
Limit the range of interpolation
Continue to assess spatial exceedence rates
Use a bioreferenced CFD with 95% confidence?
Assess spatial exceedence rates without using a CFD?

Current procedure
(1 surface measurement)

Secchi Depth (2.0 m)
Photic zone (4.0 m)

Depth-Integrated procedure
(average of vertical profile)




Proposed Chlorophyll Assessment Procedure
Fixed Station-Only*
Dataflow
Surface samples
Depth-integrated samples
<---- Put this on hold ----
for now
Surface samples
Surface samples used to predict depth-integrated values
6-year assessment window
3 to 6-year assessment window, depending on data availability
No interpolation
Limit the range of interpolation
Only assess station seasonal means. Two "bad" years allowed.
Continue to assess spatial exceedence rates
assuming model output can help with this
No CFD
Use a bioreferenced CFD with 95% confidence
otherwise
Compare sum of seasonal exceedence rates to the total allowable from 10% CFD
*alternative means of determining criteria attainability

Please send feedback to…

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