James River Science Advisory Panel

Comments on September 2015 Empirical Relations Report

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Overview of Comments

- Effects-based methods pursued by SAP represent a major improvement in defensibility over past efforts to derive CHLa targets.
- Some metrics represent stronger CHLa-use linkages than others ➔ Affects range recommendations.
- Additional background/explanation would aid STAC review.
- Criteria derivation method should inform the spatial and temporal components of application.

General Comments on Overall Approach

USEPA-Recognized Methods for Deriving Nutrient-Related Criteria

Method

- **Reference conditions**
- **Stressor response** (empirical effects-based)
- **Modeling** (mechanistic effects-based)

Example

- Historical data evaluation
- Conditional probability
- 2022 DO-based nutrient allocations for James

Contrast in Approach: Example from Wadeable Streams

Reference condition

- At what nutrient concentration can we detect a statistically significant change in the stream diatom assemblage?
- "Balanced" community: Diatoms associated with lower nutrient concentrations.

Effects-Based

- At what nutrient or CHLa concentration are stream macroinvertebrates or fish impacted?
- "Balanced" community: Algal community that supports the larger trophic structure and living resources.

Preferred Characteristics of CHLa Criteria

- Effects-based
- Linked to actual designated use attainment, not just statistical differences in metrics
- Not merely redundant of other water quality criteria
- Realistically attainable for the system of interest

Benefits:

- More consistent with other established water quality criteria (e.g., metals, organics)
- More explainable to public.
- More defensible to justify large control expenditures.

Previous Efforts (CBP 2000-02, VA 2004-05, etc.) to Derive CHLa Criteria Fell Short of These Characteristics

Methods	Effects-Based	Avoid Redundancy	Attainable
Historical ref. conditions	No	--	No
Trophic classifications	No	--	?
DO/clarity linkages	Yes	No	?
Phytoplankton ref. comm.	No	--	No
Harmful algal blooms	Yes	Yes	?

Improving on these Older Approaches Is a Major Driver of the James River CHLa Study

“The Commonwealth concludes that additional scientific study is needed to provide a ***more precise and scientifically defensible basis*** [emphasis added] for setting the final nutrient allocations. New information must be evaluated to ensure the Commonwealth’s chlorophyll criteria for the tidal James River are appropriately protective of the river’s designated uses and are based on the best scientific information and data currently available.”

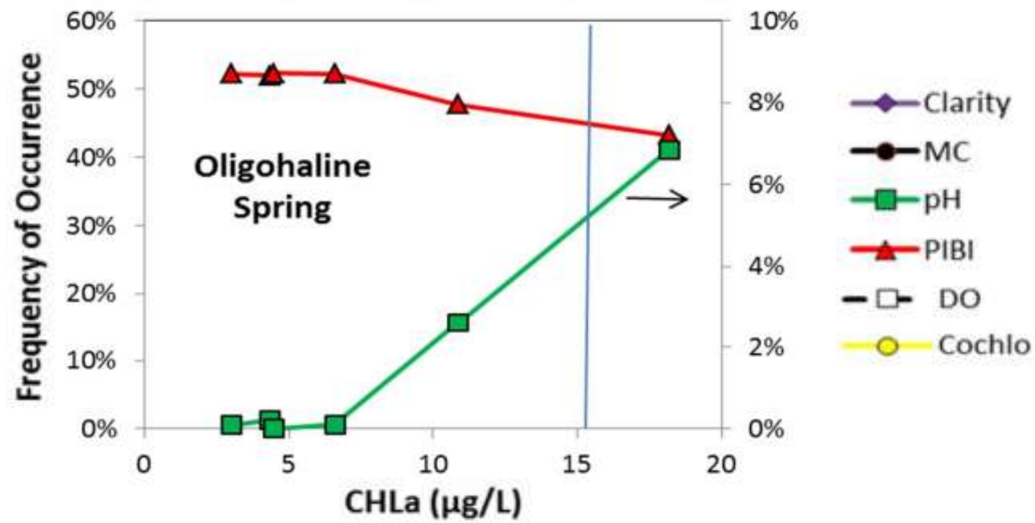
--Commonwealth of Virginia, Phase I WIP

The combined probability approach represents a significant advancement over past efforts

- Primarily <u>effects-based</u>
- Incorporates a great deal of new <u>James-specific data</u> and <u>experimental results</u>
- Also uses wider literature
- Significant advancement in linkages to <u>harmful algal effects</u>
  - *Cocholodinium*
  - *Microcystis*
  - Microcystin
- Modeling framework to provide insights into attainability

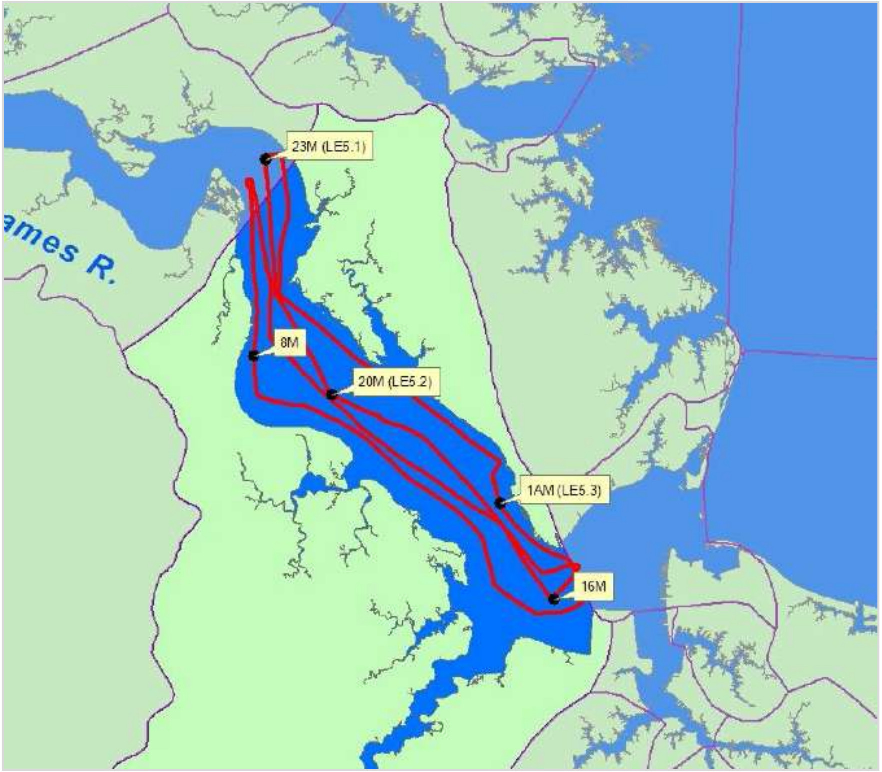
The method integrates effects across a wide range of conditions

- Underlying data represent variable hydrologic, water quality conditions.
- Risks are integrated and robust over the entire range of observed CHLa.
- The integrated risk is correlated to segment-wide, seasonal mean CHLa.



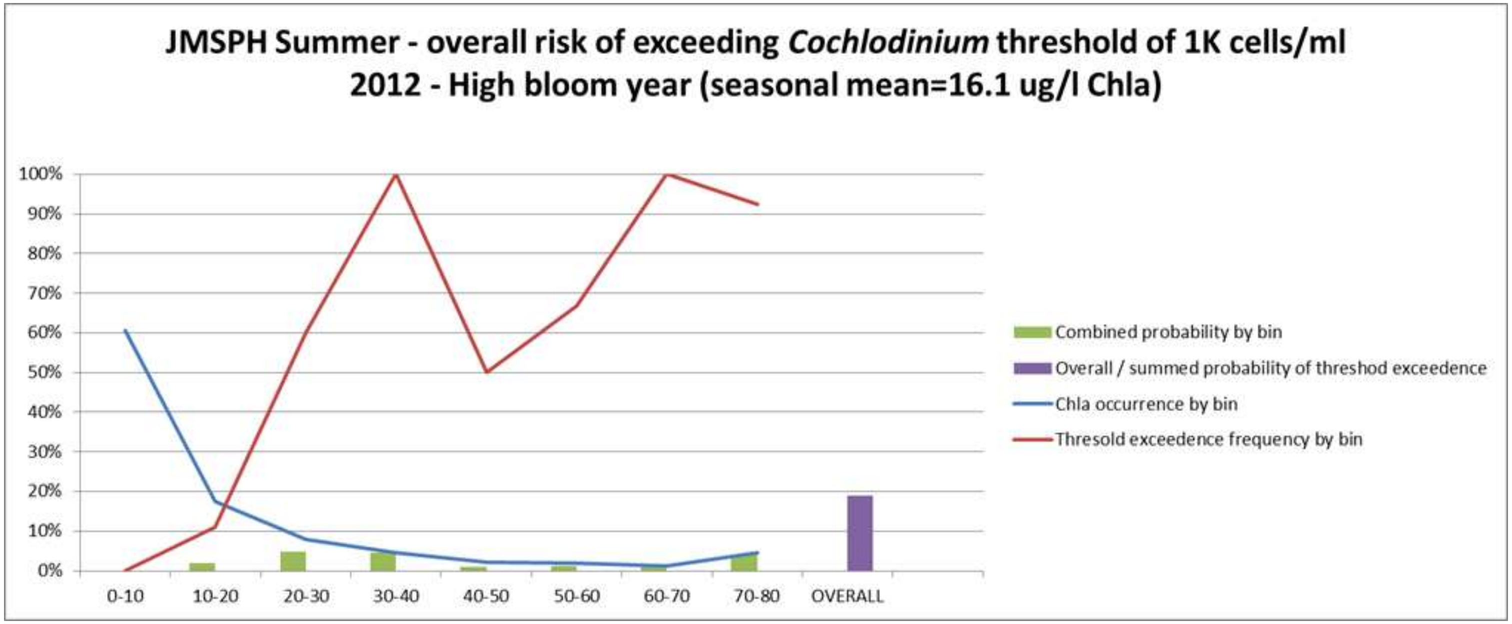
Resulting CHLa targets are inherently <u>segment-wide</u>, <u>seasonal</u> means

- CHLa targets should not be divorced from the spatial, temporal aspects of their derivation
  - i.e., application as short-duration criteria
  - i.e., 303(d) listing based on subsegment areas
- Seasonal means are also most compatible with models (most reliable at average scale)



Additional explanation/examples would aid reviewers

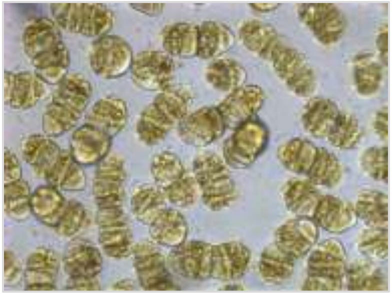
- More background on study drivers; why previous approaches were not considered sufficient
- More detailed explanation of combined probability approach
- Step-by-step example calculation



Comments on Individual Metrics

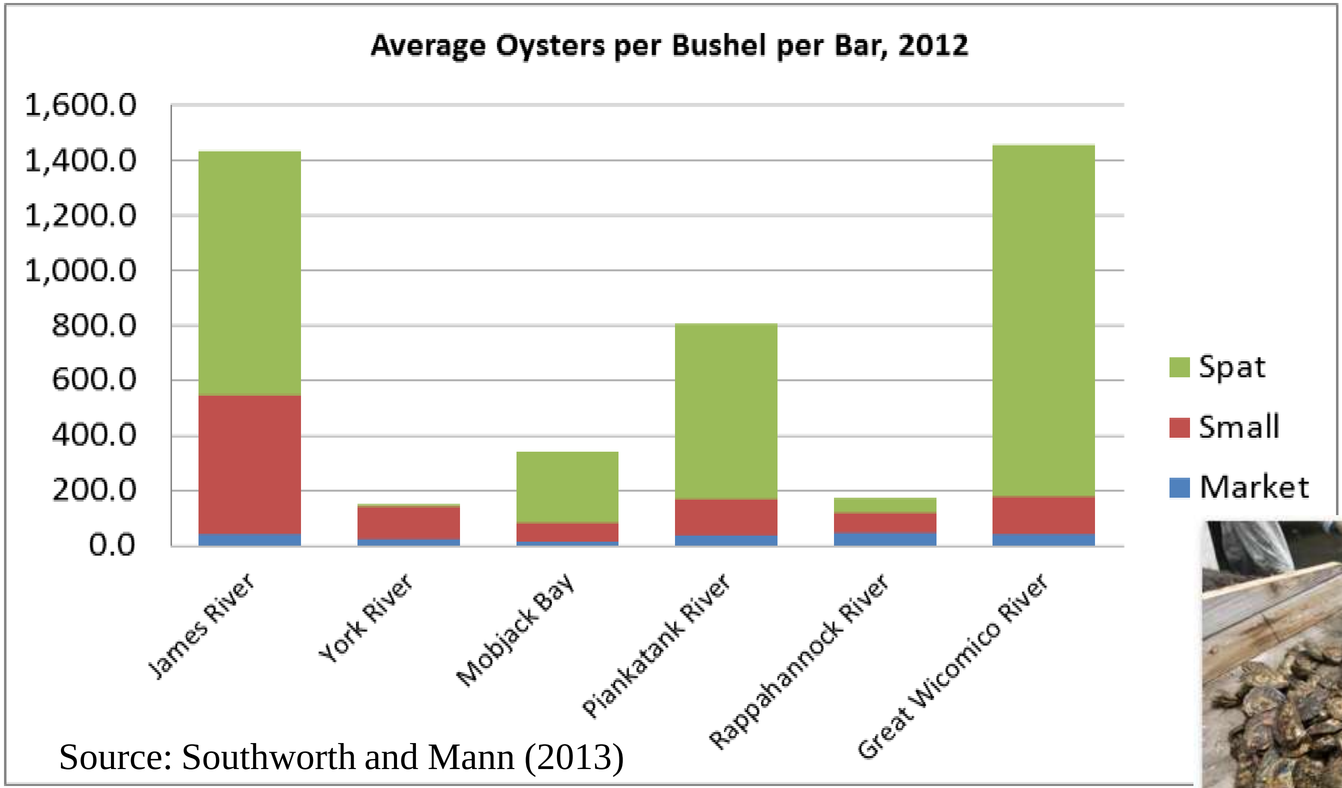
HAB-Related Indicators Are Strongest Metrics

- Technical justification, use linkage is strong
  - James-specific data, experiments
  - Extensive literature review
- Conservative *C. polykrikoides* threshold
  - Inclusion of isolates
  - Inclusion of non-local strains
  - Field vs. lab impacts



- Microcystin threshold may also be very conservative
  - e.g., Uncertainty regarding wider ecological impacts of *Rangia* feeding effects
  - Low end of literature range re. aquatic life impacts

James is Virginia’s Most Productive Oyster Fishery



- Oysters low statewide compared to historical values
- Oysters increasing statewide since 2007
- Bottom line: James River has good oyster status relative to major tributaries

Oysters (cont.)

- “The James River…remains as the only river of note in Virginia that has supported and continues to support a commercial public fishery. Modest harvests are periodically taken from other rivers, but these are both inconsistent and small in volume compared with the James River harvests.”

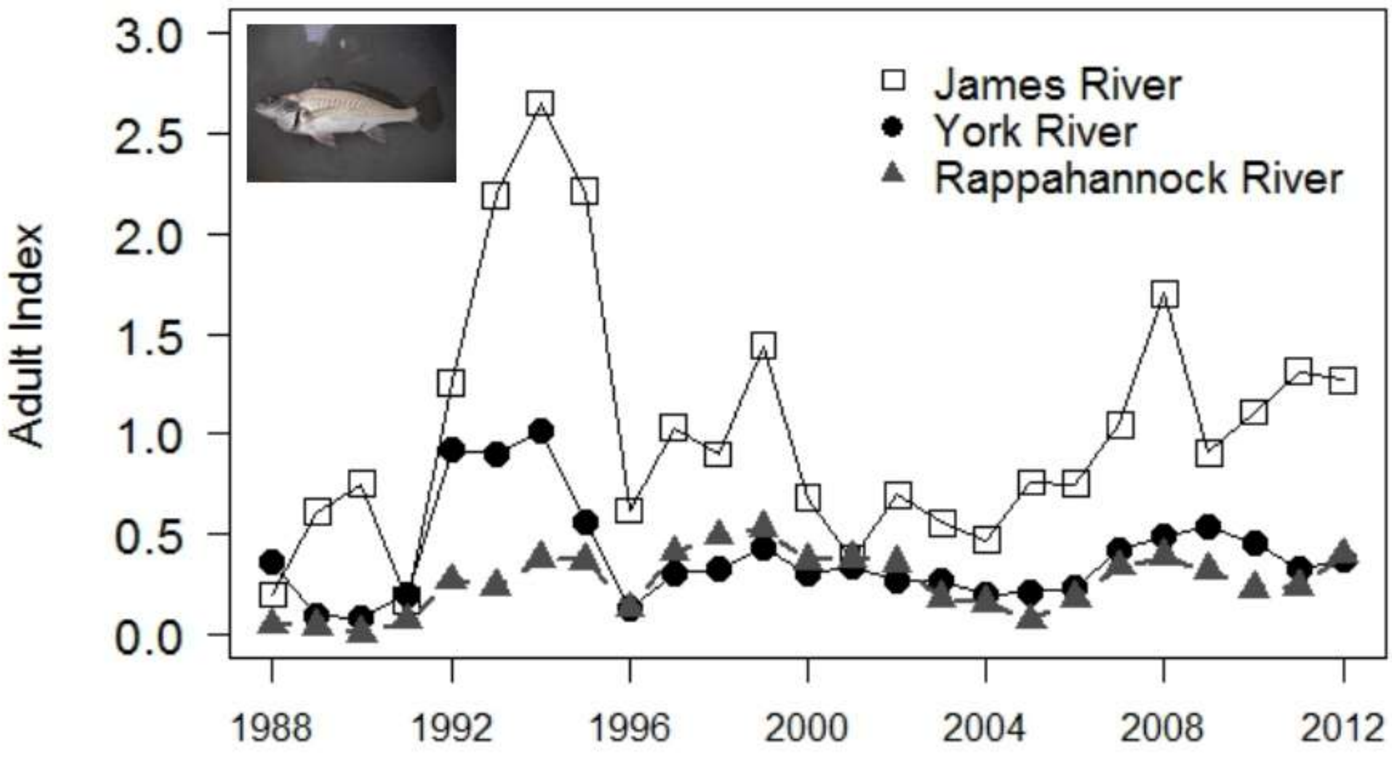
  -Mann and others (2009)

Biological Survey: Fish

- James excellent sport fishery
  - Blue catfish, channel cats, etc.
  - Largemouth bass
  - White perch
- Positive signs for sturgeon
  - Juveniles, evidence of spawning

Fish (cont.)

- Less hypoxia in James appears to benefit some species (e.g., Atlantic Croaker)



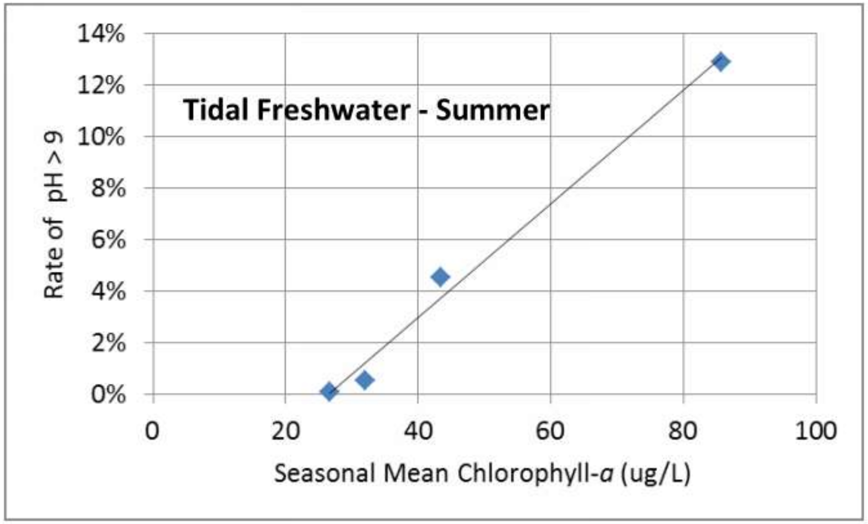
Source: Tuckey and Fabrizio (2013)

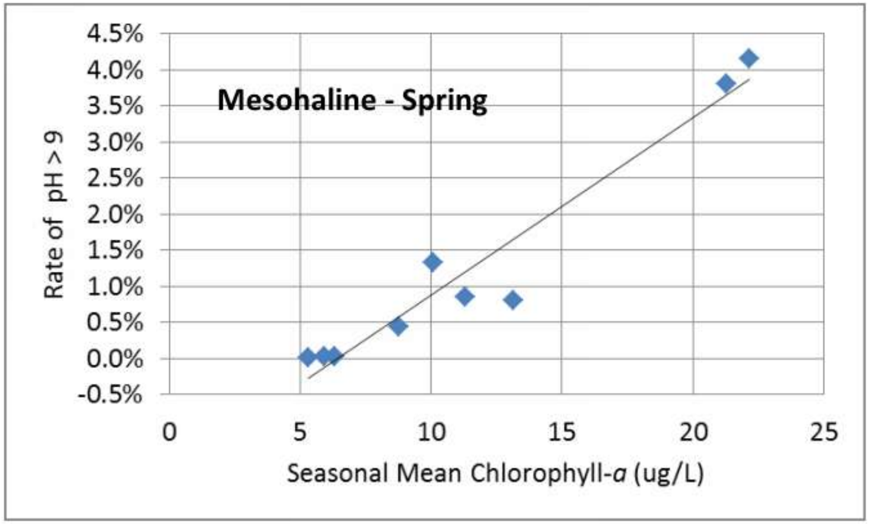
Fish (cont.)

- Some fish species struggling in James and Baywide
  - American shad
  - American eel
- Bottom line: James appears to be most productive fishery of major tributaries.

Recommendation to use longer-duration pH metric

- CHLa-pH linkages useful for water quality management
- Existing report uses daily max. (90th perc.) pH
- pH criterion has no explicit duration component…
- …but original technical bases were longer-term (e.g., 30-day) effects studies.
- Linkage remains but threshold changes



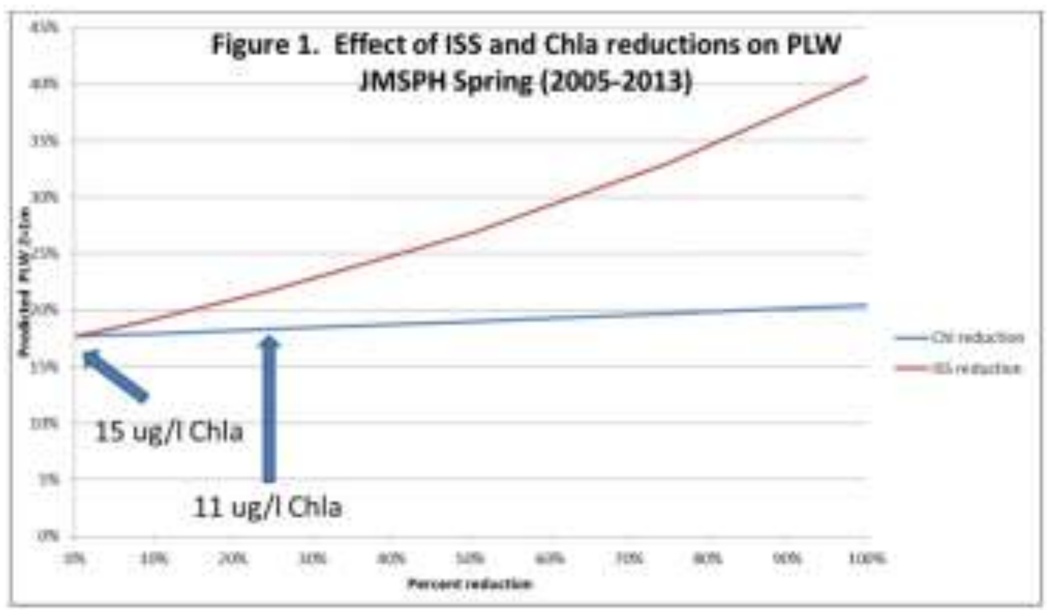


DO a secondary metric for CHLa criteria derivation

- System can be modeled, managed for DO independently.
  - 2022 DO-based allocation already represents a “ceiling” for nutrient load management
- Existing report compares daily minimum (10^{th} percentile) DO to <u>30-day mean</u> DO criterion
- <u>Recommendation</u>: If short-term DO concentrations are used in analysis, compare to <u>instantaneous minimum</u> DO criterion.
- <u>Reason</u>: Better indicator of potential use impairment

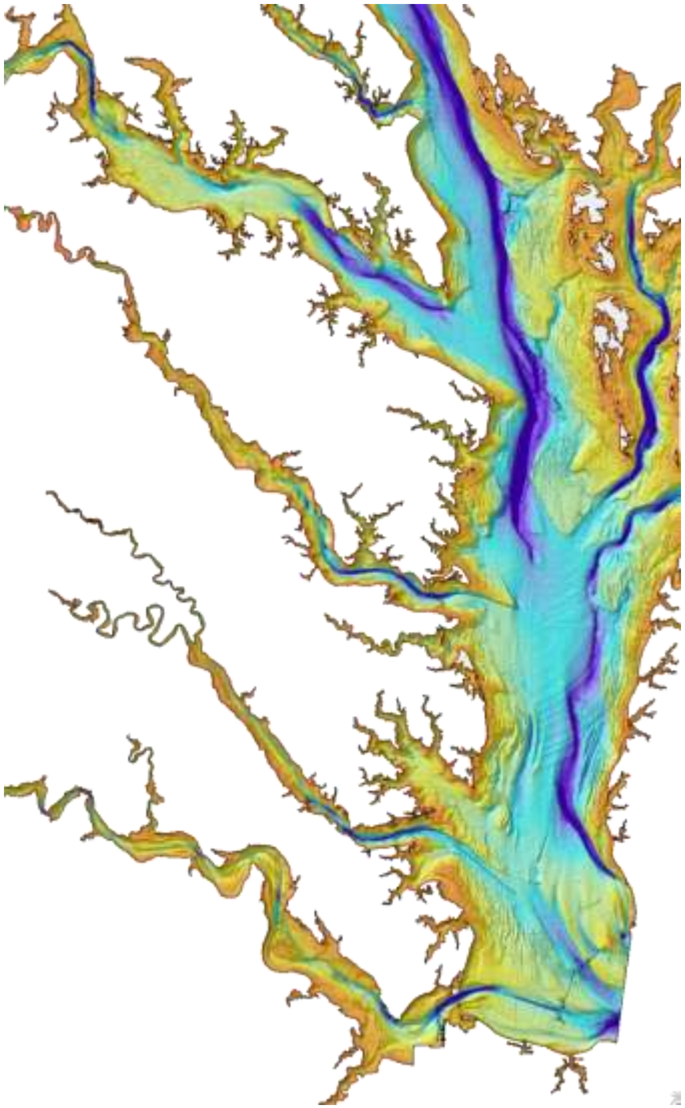
Water clarity in James not expected to be sensitive to CHLa/nutrient reduction

- 70-90% of TSS from non-algal material
- In existing document, clarity is basis for reducing CHLa target in JMSPH-Spring (12 to 11 ug/L)
- But this segment is attaining shallow water use
- 25% reduction in CHLa predicted to cause <0.5% increase in PLW (z = 1 m)



Data source: HRSD (2005-2013)

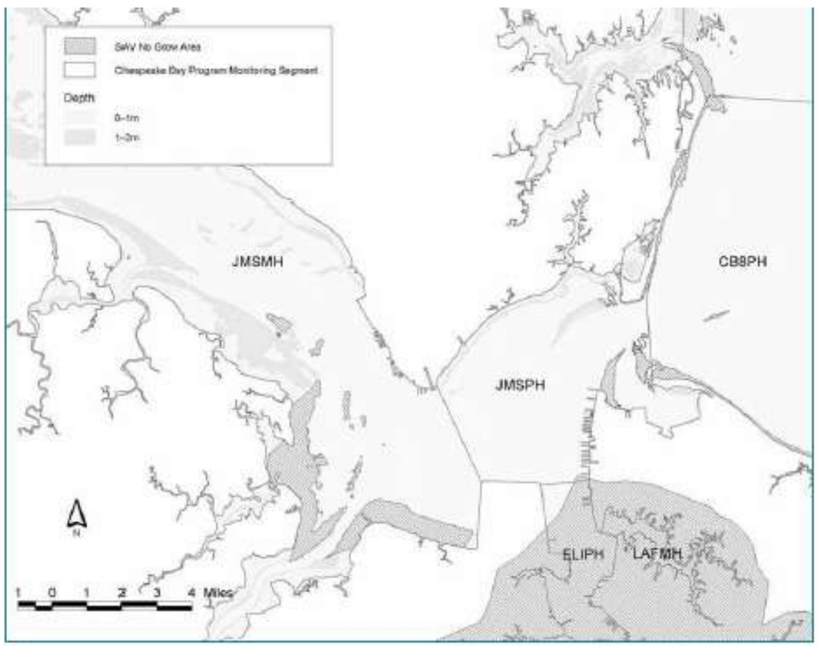
James River has naturally higher ISS, lower clarity than other portions of Bay system



- More extensive shoals relative to deep channel width
- Tidal & wind-driven resuspension
- Areas of high proportion of fines in shoreline sediments (Hardaway and others, 1992)
- Areas of high shoreline erosion rates (Hopkins and Halka, 1997)

James River has naturally higher ISS, lower clarity than other portions of Bay system (cont.)

- SAV goals based on historical evaluation of “single best year” of coverage
- James has low SAV goals and target depths of water clarity criteria, compared to other tributaries
- More“no grow” zones

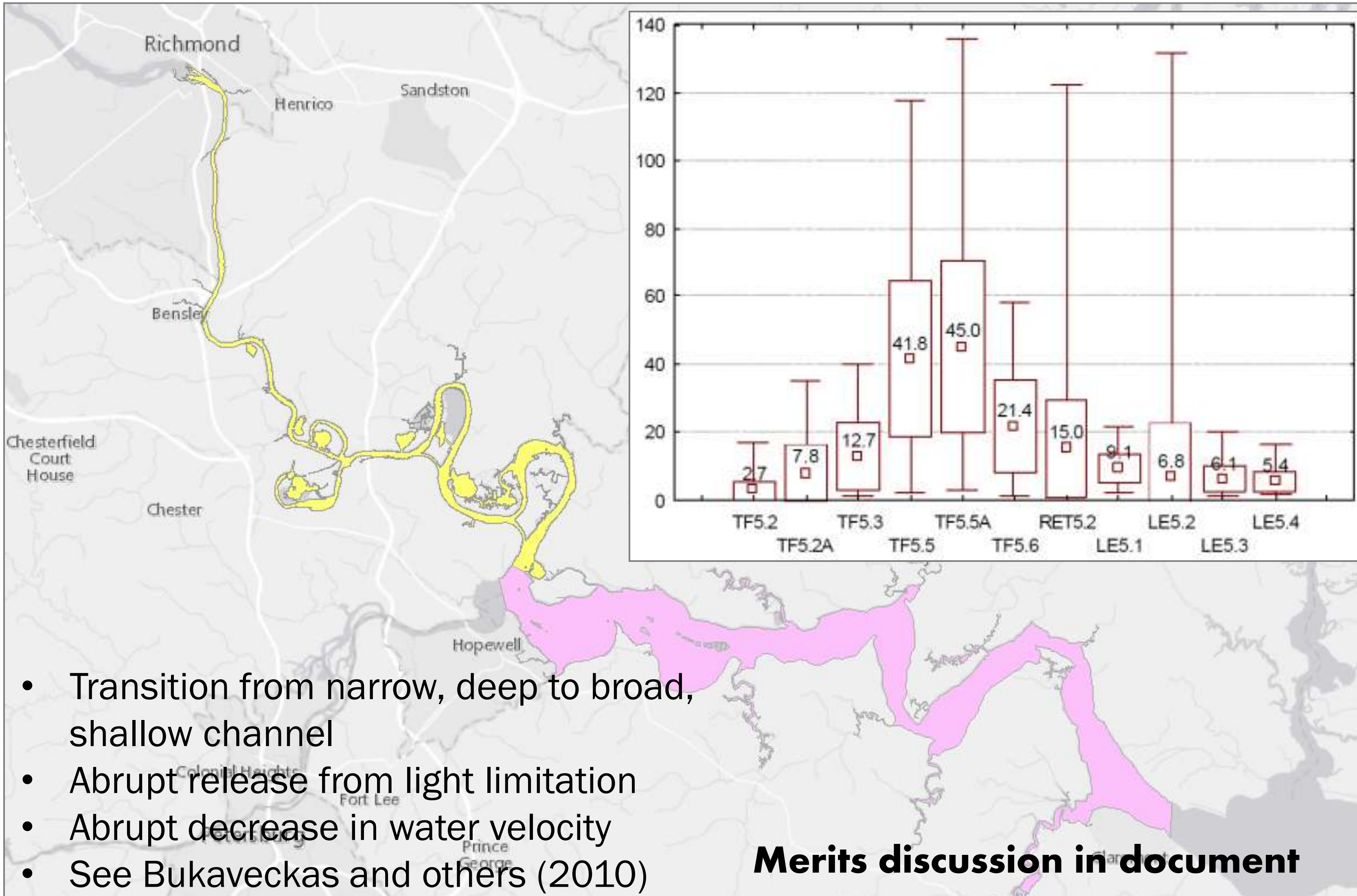


Source: USEPA (2004)

Segment Name from USEPA (2003)	Recommended Depth of Application
Lower Potomac	1 m
Lower Rappahannock	1 m
Lower York River	1 m
Lower James	0.5 m

Source: USEPA (2003)

Unusual CHLa Peak in TF Also Partly Driven by Natural Factors



- Transition from narrow, deep to broad, shallow channel
- Abrupt release from light limitation
- Abrupt decrease in water velocity
- See Bukaveckas and others (2010)

Merits discussion in document

Perspectives on Phytoplankton Reference Community

Utility of Phytoplankton Reference Work / PIBI

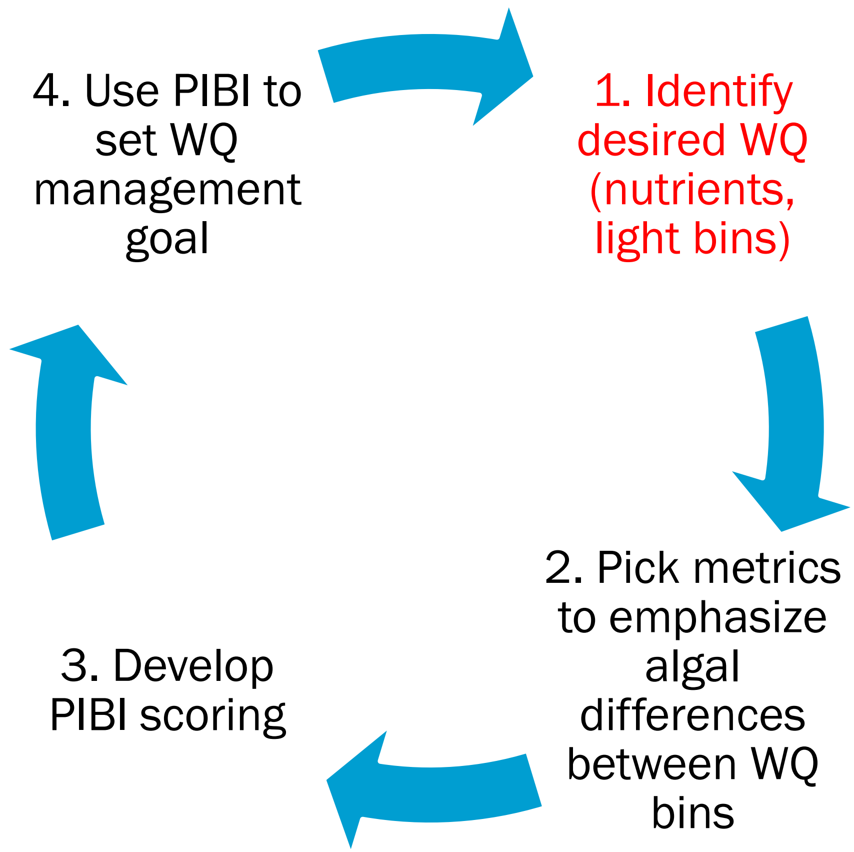
- Demonstrates that we can detect differences in some algal-related metrics between different light, nutrient conditions
- One indicator of variability in phytoplankton characteristics across Bay system

PIBI and related metrics should not be used (as is) directly for water quality management

- Not an appropriate indicator of use attainment
  - Detectable variability ≠ impairment
  - Weak relations with higher trophic levels
  - We have better definitions of balance
- Not an appropriate goal for the James River Estuary
  - Not validated for James
  - Driven by water clarity
  - Not practical/attainable in James
- Better used as a diagnostic than basis for criteria
  - As in elsewhere in Bay system
  - Opportunity for research on relations to higher trophic levels

Not an appropriate indicator of impairment

- Statistical differences in metrics do not necessarily indicate lack of attainment of designated uses
- Sub-metrics specifically chosen to emphasize differences between WQ bins, not similarities
- Requires *a priori* definition of desired WQ, which leads to circular reasoning for management



“Balanced” community better defined by overall ecological support and lack of harmful effects

VA’s Narrative CHLa Criterion

Concentrations of chlorophyll a in free-floating microscopic aquatic plants (algae) shall not exceed levels that result in undesirable or nuisance aquatic plant life, or render tidal waters unsuitable for the propagation and growth of a balanced, indigenous population of aquatic life or otherwise result in ecologically undesirable water quality conditions such as reduced water clarity, low dissolved oxygen, food supply imbalances, proliferation of species deemed potentially harmful to aquatic life or humans or aesthetically objectionable conditions.

Weak relations with higher trophic levels

- PIBI not explicitly tied to effects on higher trophic levels.
- Little evidence of food/nutrition limitations in James Estuary
- Mesozooplankton abundance positively correlated with CHLa in upper estuary
- HABs a stronger linkage to higher trophic levels

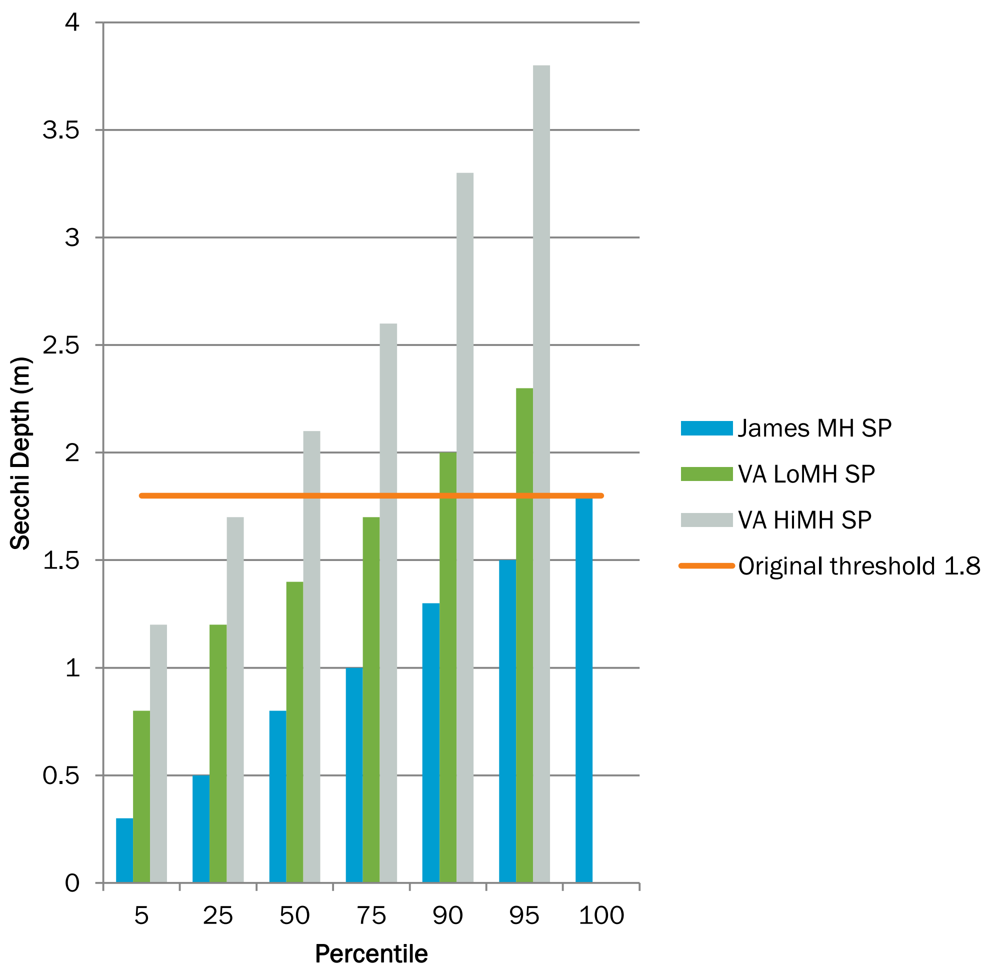
Mesozooplankton-CHLa Correlation 1985-2002

Segment Season	Spearman Rank Correlation
TF-Spr	0.530
TF-Sum	0.378
OH-Spr	Not sig.
OH-Sum	Not sig.
PH-Spr	Not sig.
PH-Sum	Not sig.

Source: Bell and Hunley, 2015

Inappropriate goal for James due to naturally lower water clarity

- Phyt. ref.comm. driven by light above all
- As discussed, James River has naturally lower light conditions than other part of the Bay system
- Not anywhere close to attaining “better” light condition bin
- Models do not predict major shifts to high clarity conditions



Data sources: Buchanan (2015) pp A-2, HRSD 2005-2015

Recommendations on phyto. ref. comm.

- Add text to place in proper context as scientific diagnostic.
- Do not use directly to set protective ranges or CHLa criteria.
- Revisit as research topic, in context of adapative management.
- Emphasize effects-based approaches

Summary and Conclusions

Agreement, Recommended Adjustments to CHLa Ranges

James River Segment	Spring					Summer				
	Existing CHLa Criteria (ug/L)	Proposed Protective Range (ug/L)	Review Opinion	Alternative Target Range (ug/L)	Upper End of Range Informed by Antideg.	Existing CHLa Criteria (ug/L)	Proposed Protective Range (ug/L)	Review Opinion	Alternative Protective Range (ug/L)	Upper End of Range Informed by Antideg.
Tidal Fresh Upper	10	None	Agree	N/A	N/A	15	12-21	Agree	12-40	Yes
Tidal Fresh Lower	15	10-16	Adjustments recommended	9-19	Yes	23	27-31 32-43	Agree with 32-43	N/A	No
Oligohaline	15	7-18	Agree	N/A	Yes	22	None	Agree	N/A	N/A
Mesohaline	12	13-21	Adjustments recommended	13-22	Yes	10	8-13	Agree	N/A	No
Polyhaline	12	7-11	Adjustments recommended	7-15	Yes	10	8-13	Agree	N/A	No

Final Thoughts

- Empirical relations report is a great improvement over past efforts to derive CHLa targets for James
- Methods are somewhat different from most past efforts with which some reviewers may be more familiar
  - Effects-based HAB linkages
  - Combined probability approach
- Recommended additions to aid STAC review
  - More background on limitations of past efforts
  - More background on study drivers, rationale behind approach
  - Somewhat more detailed explanation of combined probability methods with example