

Proposed Options for Moving Forward with Establishing Chlorophyll *a* Criteria for the James River



James River Chlorophyll *a* Criteria Regulatory Advisory Panel

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Joe Wood, Chesapeake Bay Foundation

Rich Batiuk, U.S. EPA Chesapeake Bay Program Office

8 Proposed Decisions on Which the RAP Needs to Reach Consensus

1. What line of evidence should be used—reference condition vs. empirical relationships
2. What central tendency should be used—arithmetic vs. geometric
3. Use of baywide or tidal James River specific arithmetic mean to geometric mean relationships to convert defensible ranges
4. Use of monthly means in addition to seasonal means
5. Utilize 10% threshold for the HAB, pH, DO and clarity and a 50% threshold for the PIBI as a frame of reference for decision making
6. Rank the relative importance of the individual lines of evidence
7. How to address the two segment seasons with no empirical evidence of adverse impairments
8. How to evaluate the existing tidal James River chlorophyll *a* criterion values for protectiveness & how to revise if necessary

Lines of Evidence

Option A: Reference Conditions

PROs:



- Best estimate of James River conditions prior to degradation
- Very protective of aquatic life
- Protective of anthropogenic impairments which have not been documented

CONs:



- Based on bay wide data → unclear these values truly represent James River reference condition
- Unclear specifically what these protect from

Option B: Effects based approach

PROs:



- Based upon season- and segment-specific effects based impacts of algae to aquatic life in the tidal James River using multiple lines of evidence

CONs:



- Rely upon only ecological impairments which have been documented in this study

Lines of Evidence

Option A: Reference Conditions

PROs:



- Best estimate of James River conditions prior to degradation

CONs:



- Based on bay wide data → unclear these values truly represent James River conditions

Recommendation: Select the effects-based approach using multiple lines of evidence.

Rationale: strongest, quantitative connections between ambient chlorophyll a concentrations and well recognized and documented adverse impacts

algae to aquatic life in the tidal James River using multiple lines of evidence

documented in this study

Central Tendencies

$$\text{Arithmetic Means } [\bar{a}_{\text{arithmetic}} = (a_1 + a_2 + a_3) / n_a]$$

PROs:



- Illustrate stronger correlation coefficients with threshold exceedances
- Represent the original basis for chlorophyll *a* criteria from 2005.

CONs:



- DEQ's current/ proposed assessment methods utilize geometric means consistent with EPA guidance and scientific literature
- criteria based upon arithmetic relationships which would be assessed upon the geometric means would be inconsistent and un-protective.

$$\text{Geometric Means } [\bar{a}_{\text{geometric}} = \sqrt[n_a]{a_1 * a_2 * a_3}]$$

PROs:



- consistent with Virginia's current and proposed chlorophyll *a* criteria assessment approach, EPA guidance

CONs:



- Threshold exceedance relationships not as strong as for arithmetic means (although still significant)

Central Tendencies

$$\text{Arithmetic Means } [\bar{a}_{\text{arithmetic}} = (a_1 + a_2 + a_3) / n_a]$$

PROs:



- Illustrate stronger correlation coefficients with threshold exceedances
- Represent the original basis for chlorophyll a criteria from 2005.

CONs:



- DEQ's current/ proposed assessment methods utilize geometric means consistent with EPA guidance and scientific literature
- criteria based upon arithmetic relationships which would be assessed upon the geometric means would be inconsistent and un-protective.

Recommendation: Use geometric means.

Rationale: Geometric means are fully consistent with DEQ's assessment approach & EPA Guidance and geometric means do exhibit significant relationships associated with threshold exceedances.

assessment approach, EPA guidance

(although still significant)

Geometric to Arithmetic Conversion

Option A: Bay Wide

PROs:



- dataset has already been established and was considered by the SAP in their final report
- represents a much larger data set

CONs:



- not specific to the tidal James River which raises concerns if it is appropriate for this estuarine system which has unique physical, chemical and geomorphic characteristics

Option B: James River Specific

PROs:



- specific to the tidal James River and even to the individual season segment combination.

CONs:

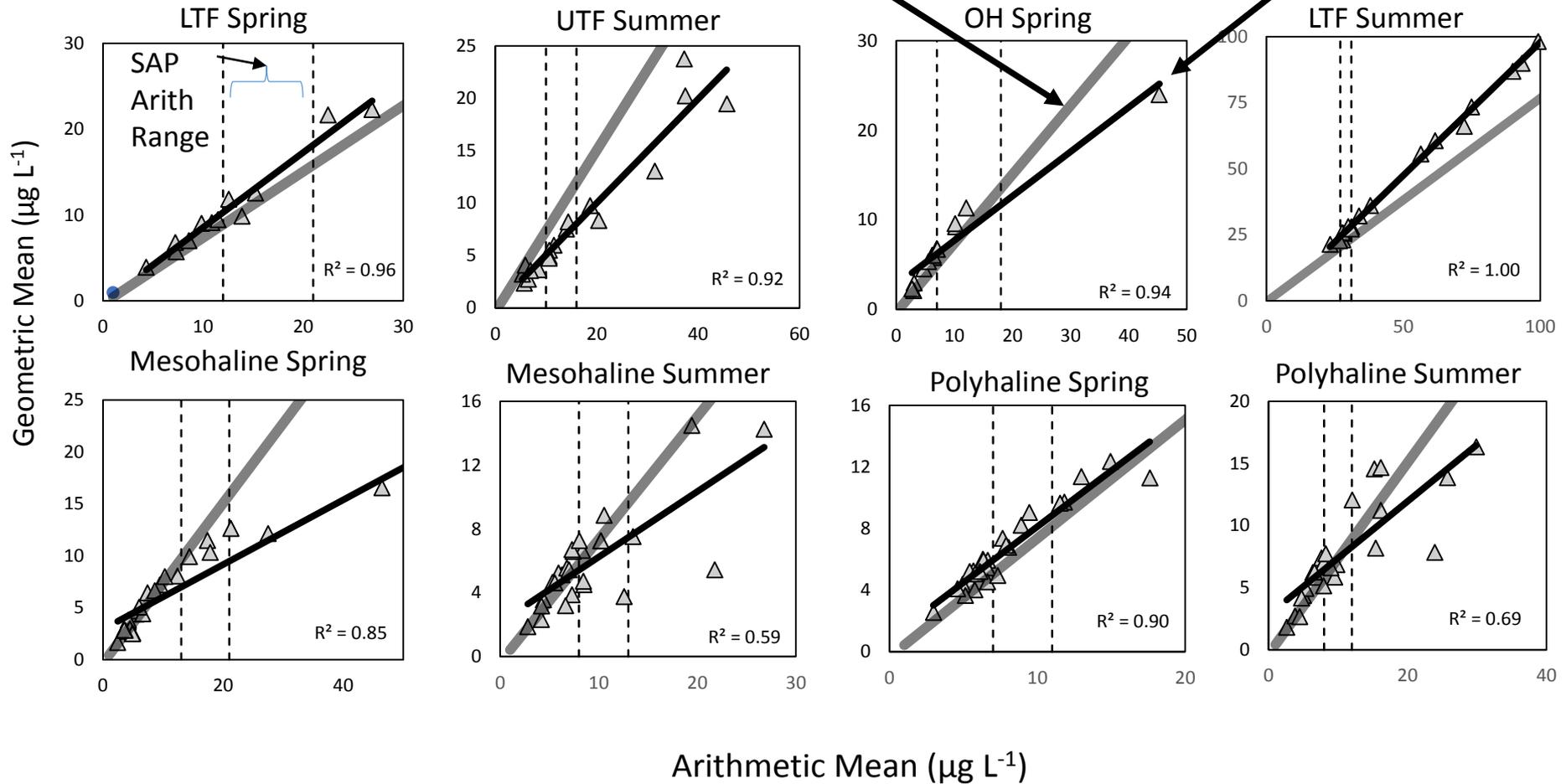


- This data set is limited to data available from the last decade

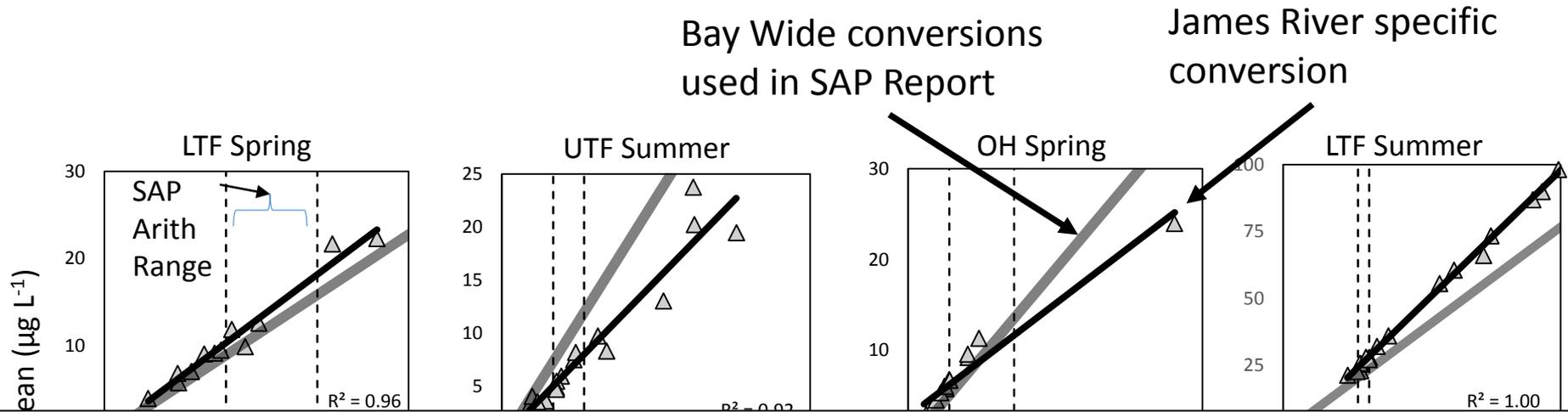
Geometric to Arithmetic Conversion

Bay Wide conversions
used in SAP Report

James River specific
conversion



Geometric to Arithmetic Conversion



Recommendation: Use the tidal James River arithmetic ~ geometric specific relationships.

Rationale: More accurately reflects the physical, chemical and geomorphic characteristics unique to the tidal James River as well as the various season segment combinations.

Use of monthly means in addition to seasonal means to help increase resolution of empirical relationships

PROs:

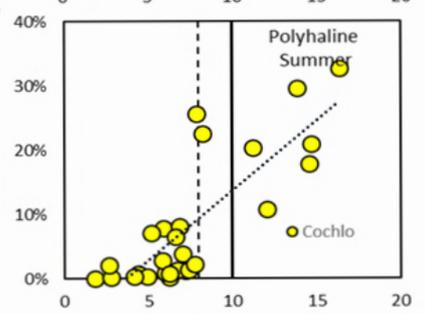
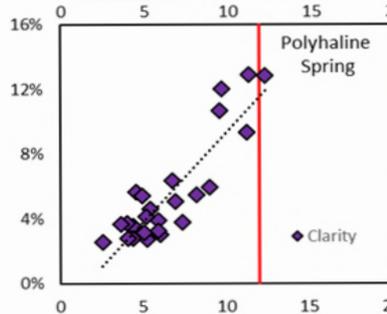
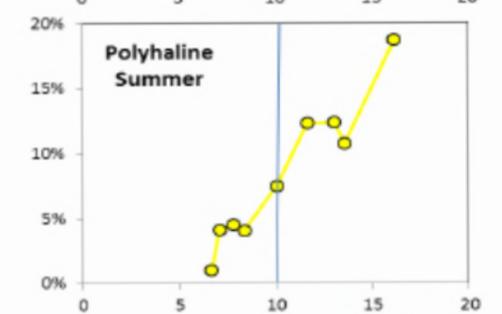
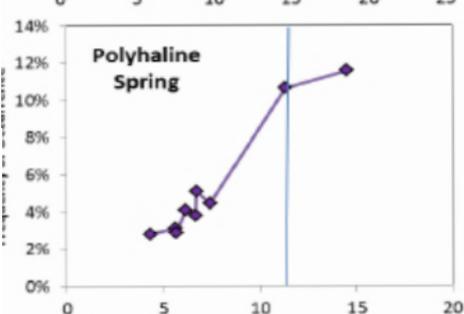
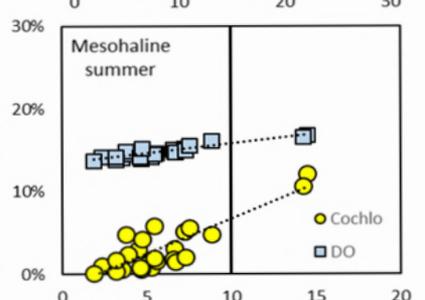
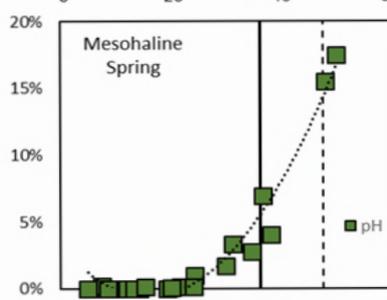
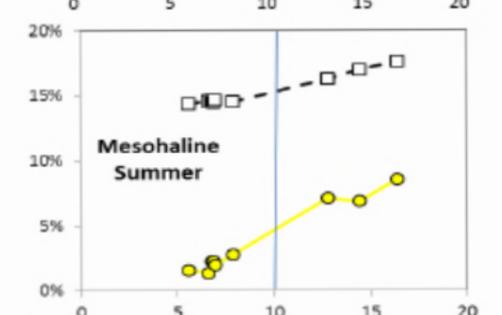
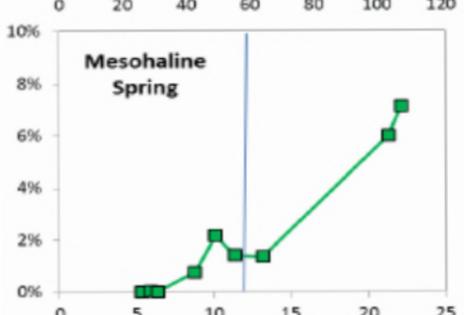
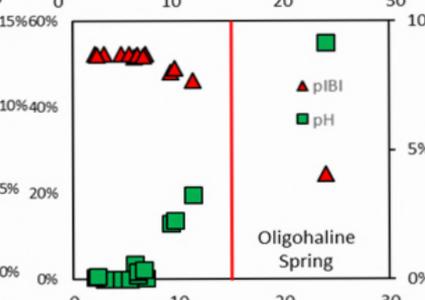
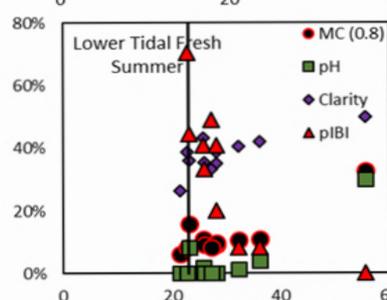
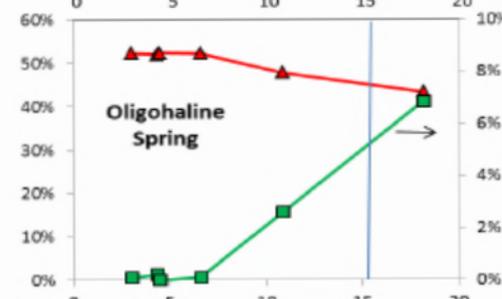
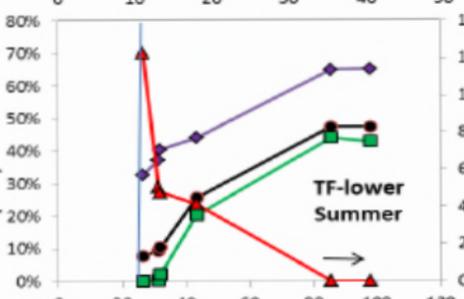
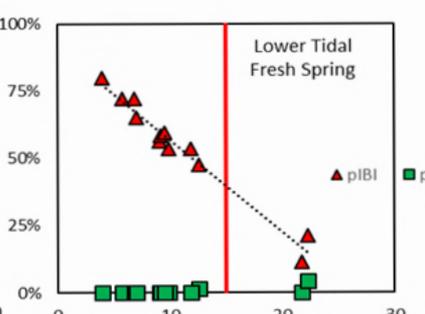
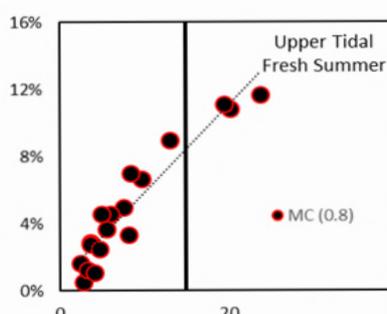
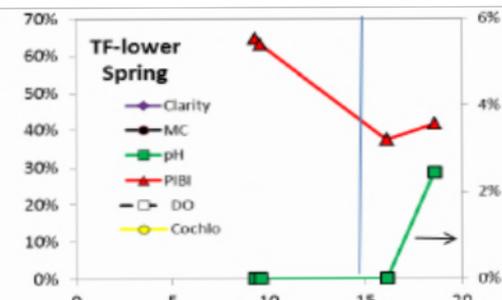
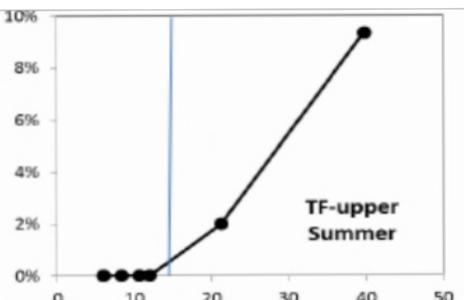


- Significantly improves the resolution of the relationships between chlorophyll *a* means and threshold exceedances.
- Provides more reliable relationships between geometric means and threshold exceedances in the mesohaline and polyhaline James River segments.
- Sample sizes associated with these means are more similar to actual data availability

CONs:

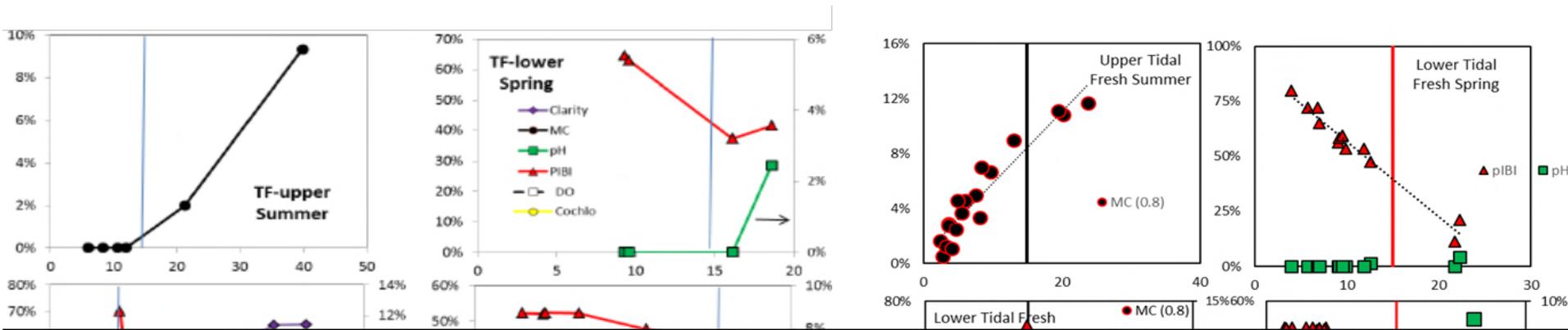


- The current criteria assessment period is seasonal rather than monthly so there would be some inconsistency between the criteria derivation method and the criteria assessment procedure.
- The SAP did not consider this approach in their report



Seasonal Arithmetic Mean CHLa

Monthly Geometric Mean CHLa



Recommendation: Use Monthly Means

Rationale: Allow for consideration of geometric specific threshold exceedance and provide for significantly improved resolution of the relationships between chlorophyll *a* concentration means and the threshold exceedances.

Seasonal Arithmetic Mean CHLa

Monthly Geometric Mean CHLa

Continue to use the SAP's "least risk", "defensible", and "not protective" concentration ranges and supplement with the application of 10% and 50% thresholds as a frame of reference.

PROs:



- consistent with the SAP's recommended concentration ranges
- Provides a consistent frame of reference which adds further evidence to protective nature of these ranges.

CONs:



- The SAP did not consider these additional specific numeric thresholds.

Continue to use the SAP's "least risk", "defensible", and "not protective" concentration ranges and supplement with the application of 10% and 50% thresholds as a frame of reference.

PROs:



CONs:



Recommendation: Continue to use the SAP's "least risk", "defensible", and "not protective" concentration ranges along with the 10% and 50% thresholds.

Rationale: These values are consistent with SAP's published methodology and provide a consistent frame of reference for considering aquatic life impacts.

Reach agreement upon the relative importance of the individual lines of evidence

PROs:



- Recognizes that all lines of evidence are not equivalent when it comes to protecting aquatic life in the tidal James River and in relation to how appropriate these factors are for establishing chlorophyll criteria.

CONs:



- The SAP did not rank the relative importance of the individual lines of evidence with regard to protecting aquatic life in the tidal James River and this can be challenging.

Reach agreement upon the relative importance of the individual lines of evidence

PROs:



- Recognizes that all lines of evidence are not equivalent when it comes to protecting aquatic life in the tidal James River and in relation to how appropriate these factors are for establishing chlorophyll

CONs:



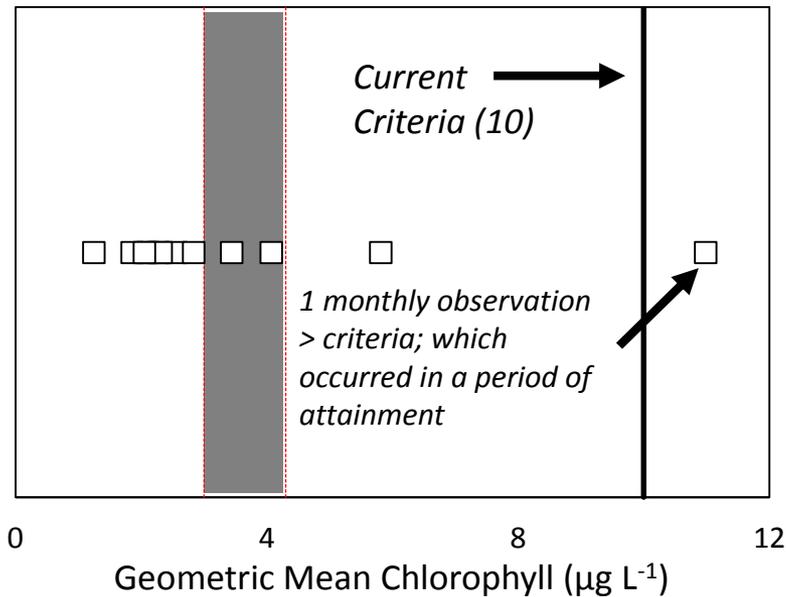
- The SAP did not rank the relative importance of the individual lines of evidence with regard to protecting aquatic life in the tidal James River and this can be

Recommendation: Rank the relative importance of the lines of evidence as follows:

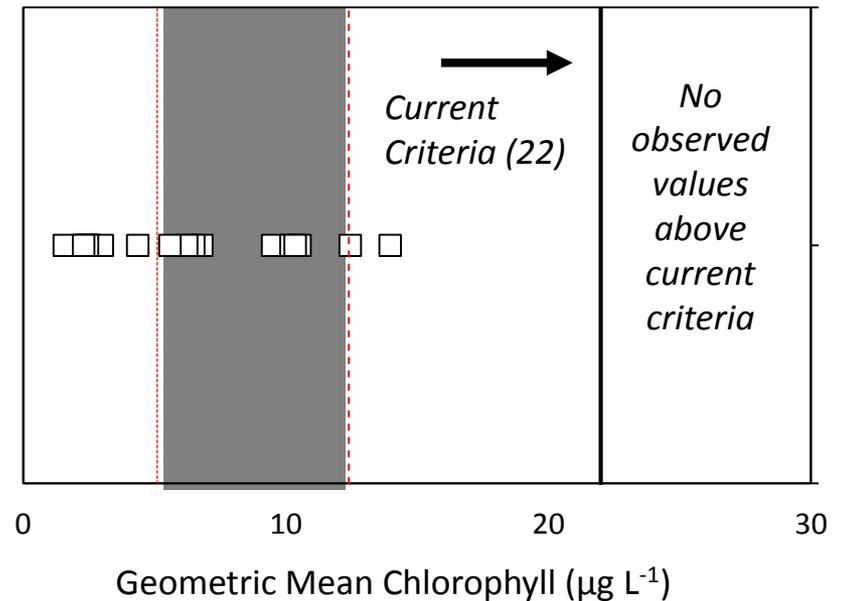
HAB > PIBI > pH > DO > clarity.

Address the two segment seasons with no empirical evidence of adverse impairments

Upper Tidal Fresh Spring



Oligohaline Summer



Address the two segment seasons with no empirical evidence of adverse impairments

Upper Tidal Fresh Spring

Oligohaline Summer

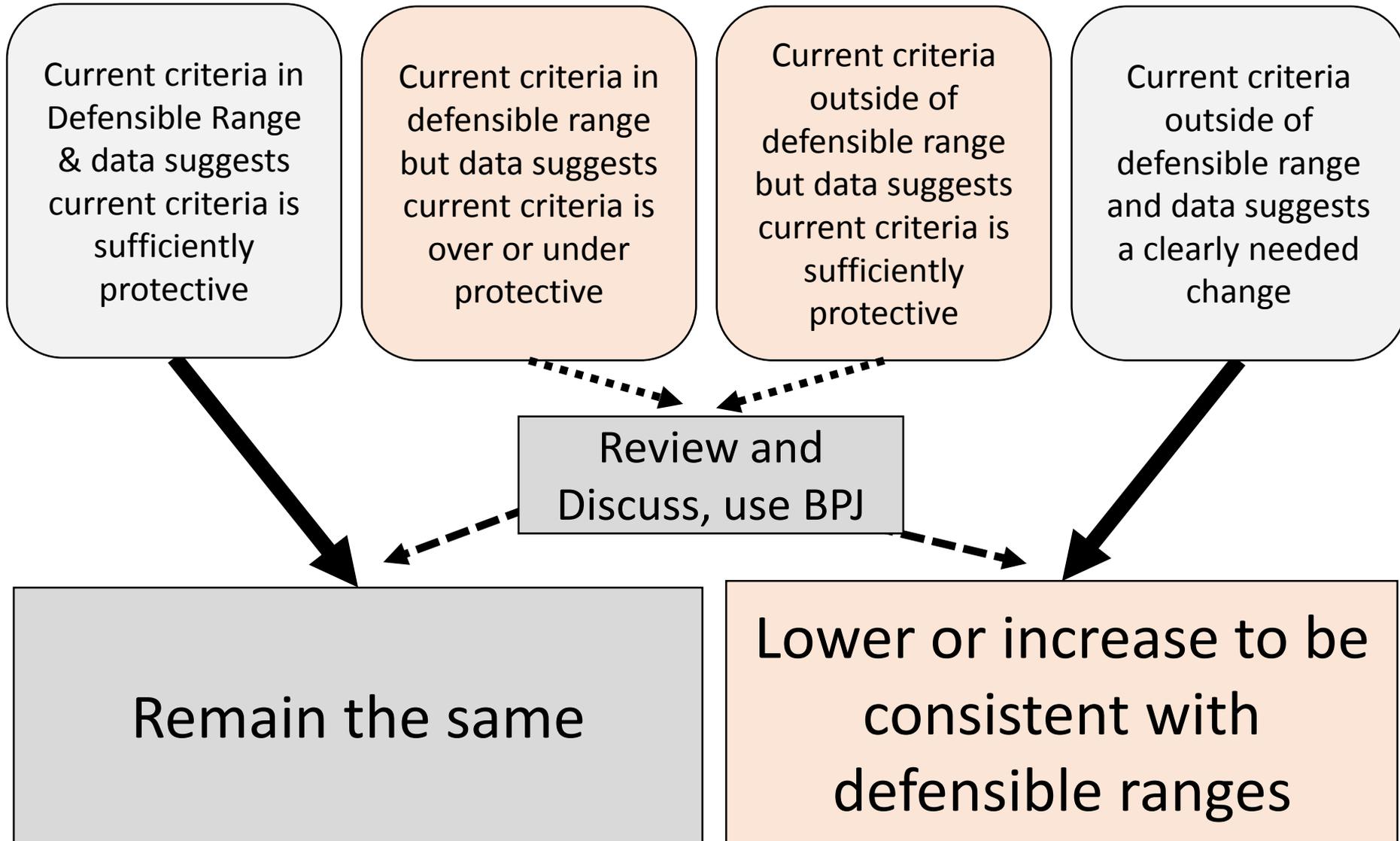


Recommendation: Keep existing chlorophyll a criteria for the upper tidal fresh spring segment and oligohaline summer segment

Rationale: no observations of non-attainment were observed which likely prevented documentation of harmful effects. Algal bloom impacts occur in both segments in different seasons suggesting potential for impacts. These criteria are unlikely to influence management decisions given current criteria.

How to evaluate the existing tidal James River chlorophyll a criterion values for protectiveness & how to revise if necessary

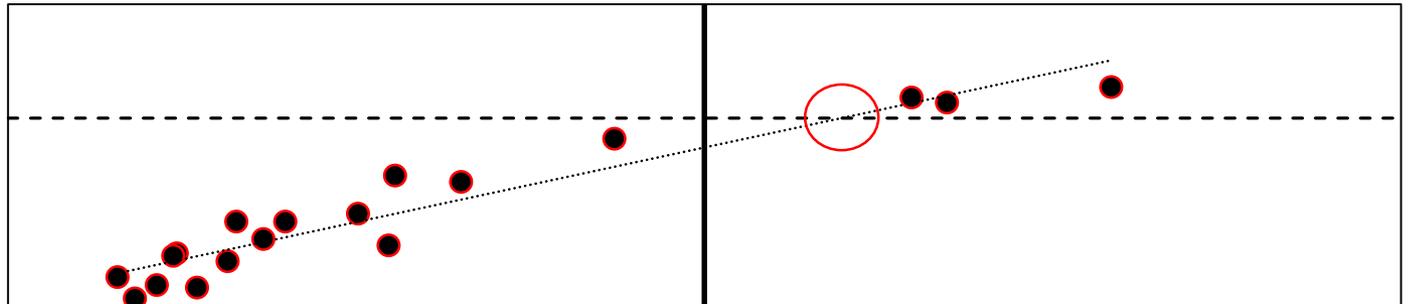
Exceptions



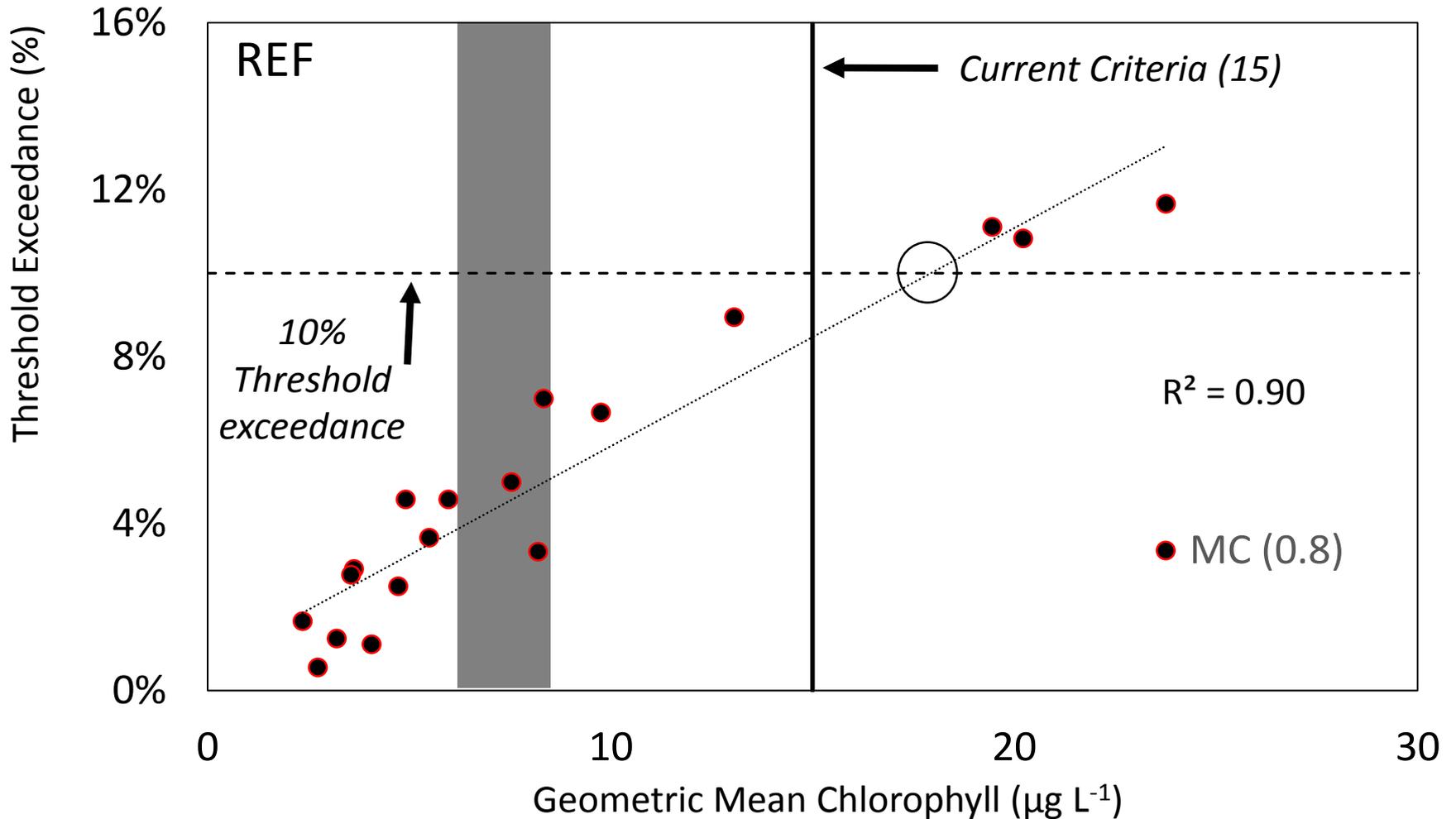
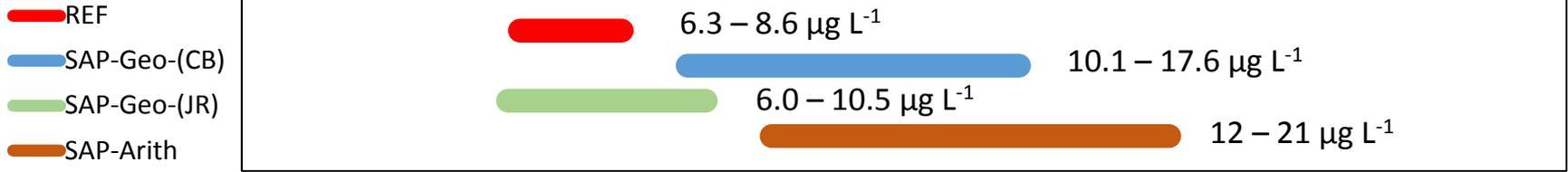
Items for consideration

REF	Reference conditions, reflective of Bay wide “more pristine” water quality conditions (1950s- current)
SAP (Arith.)	Ranges reported in SAP report based upon arithmetic mean CHLa associated with James River effects based approach
SAP (Geo-CB)	SAP (Arith) ranges converted to geometric means using <u>Chesapeake Bay data</u> in order to be consistent with assessment approach
SAP (Geo-JR)	SAP (Arith) ranges converted to geometric means using <u>James River specific data</u> in order to be consistent with assessment approach

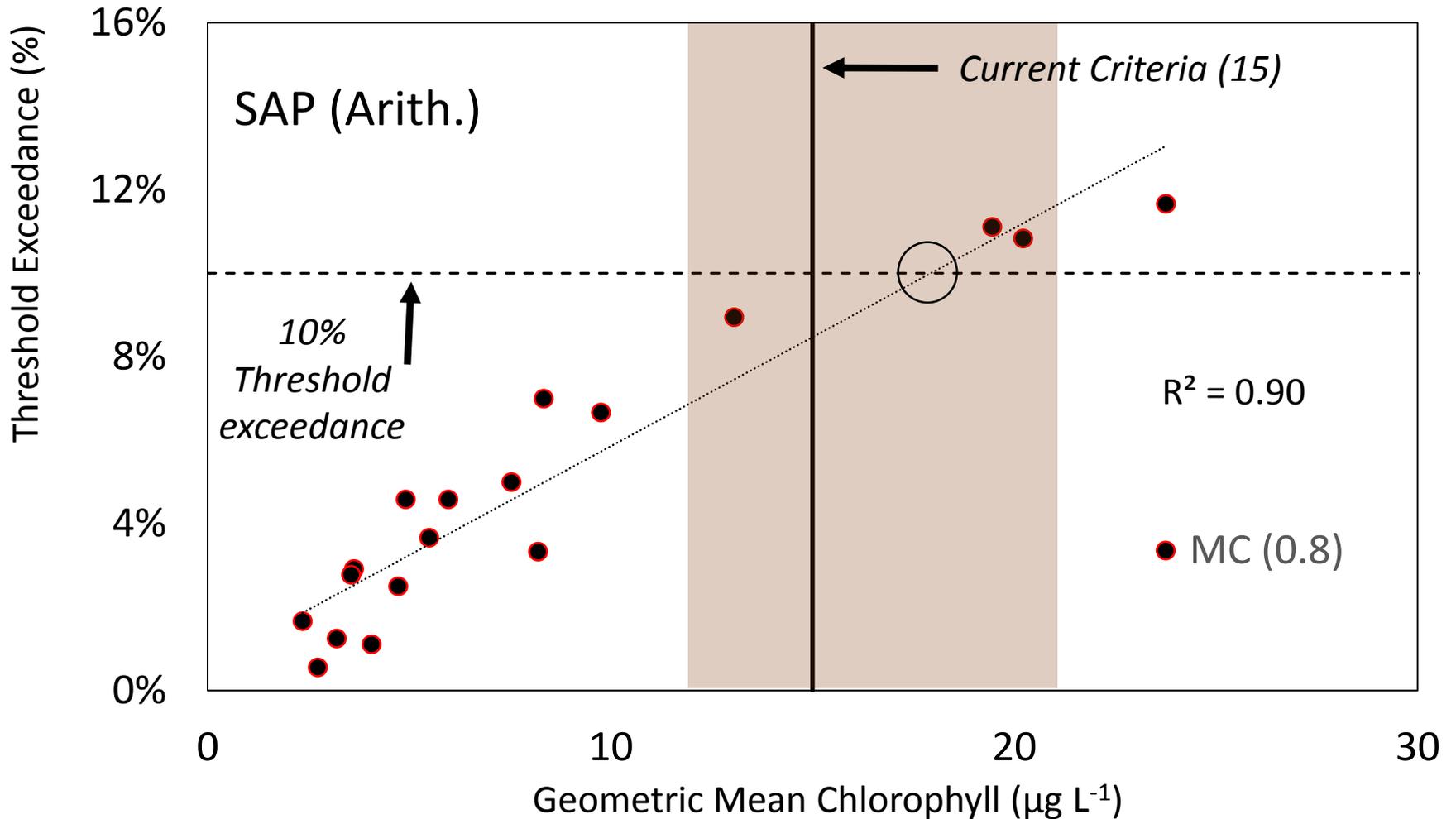
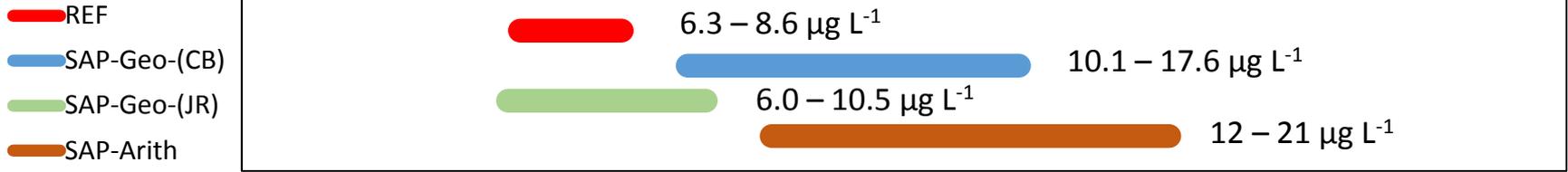
Intersection
between linear
model & 10/50%
thresholds



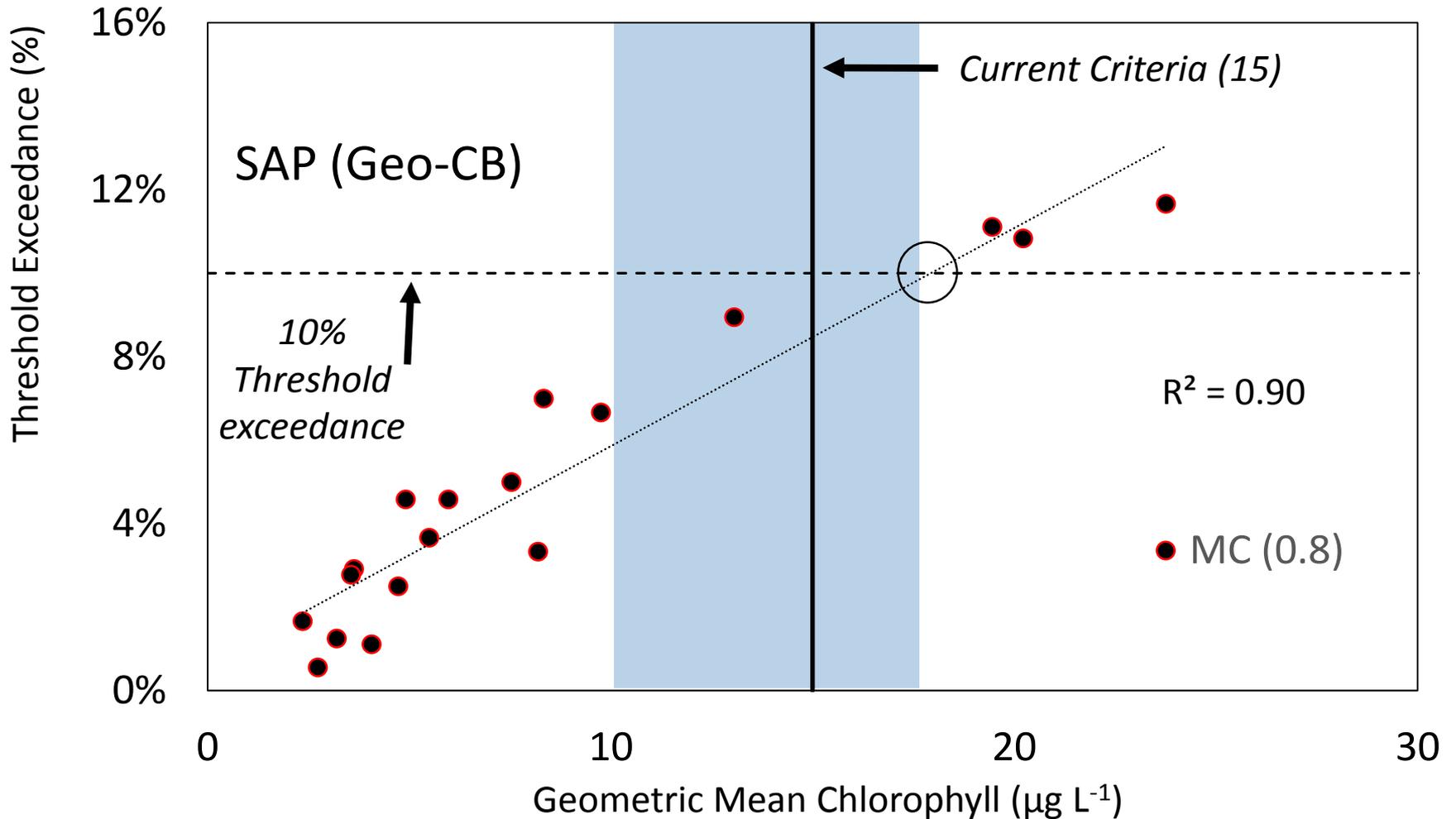
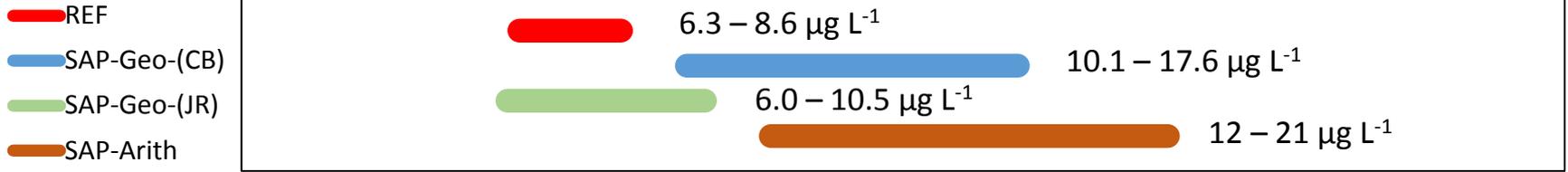
Upper Tidal Fresh Summer



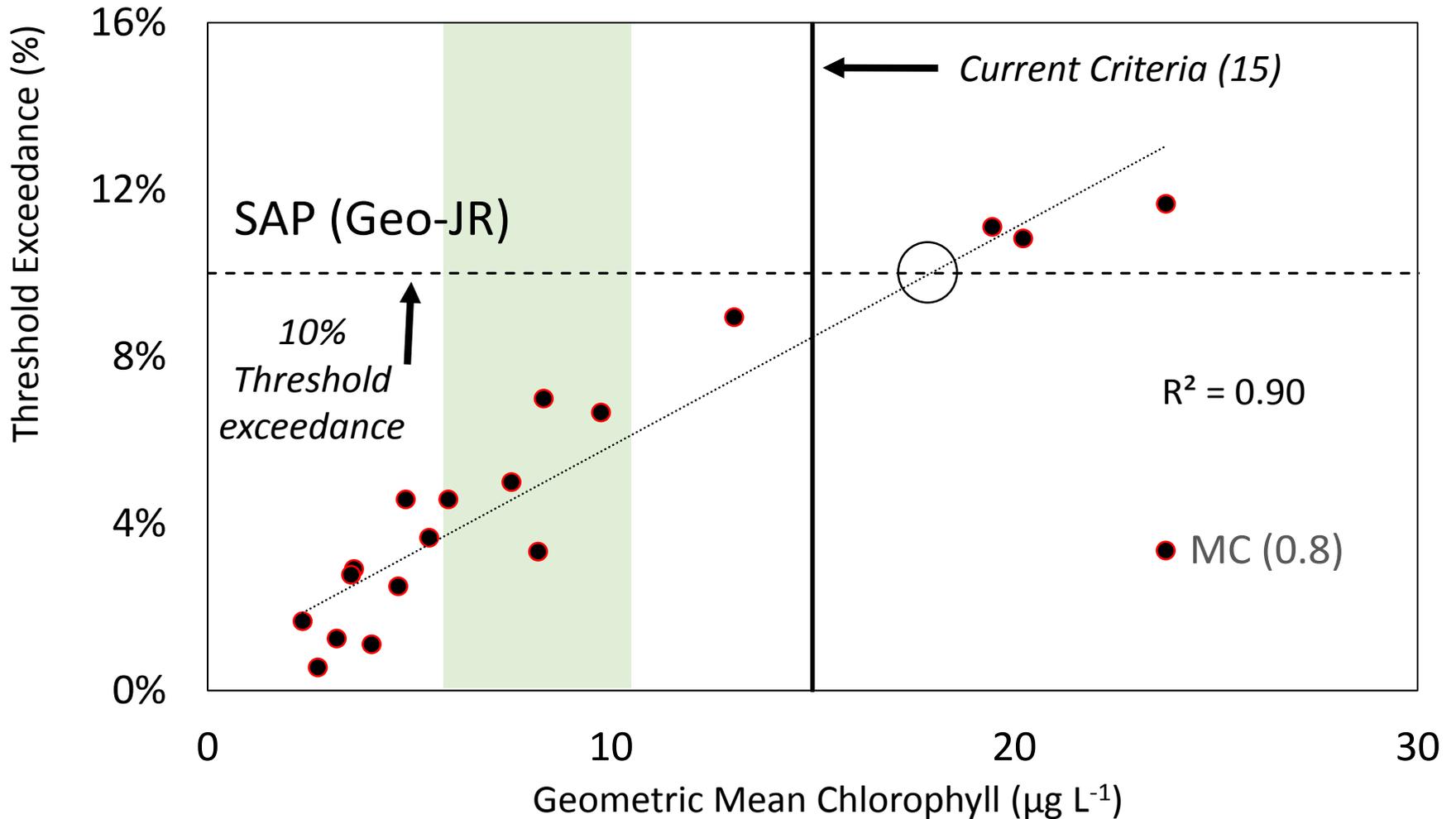
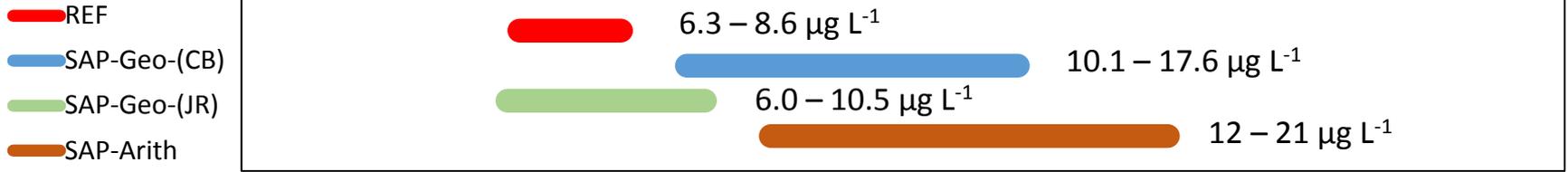
Upper Tidal Fresh Summer



Upper Tidal Fresh Summer



Upper Tidal Fresh Summer



Upper Tidal Fresh Summer

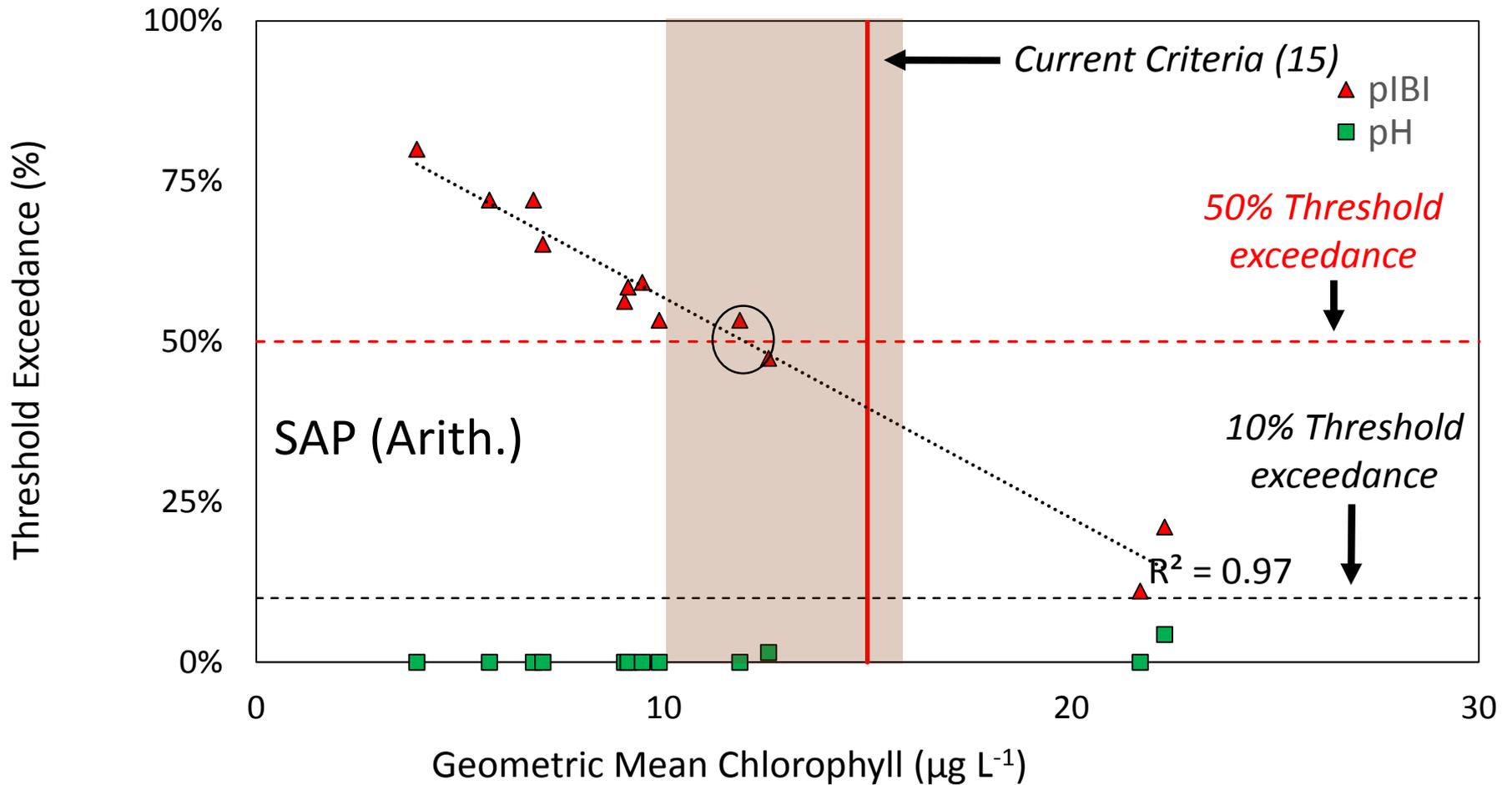
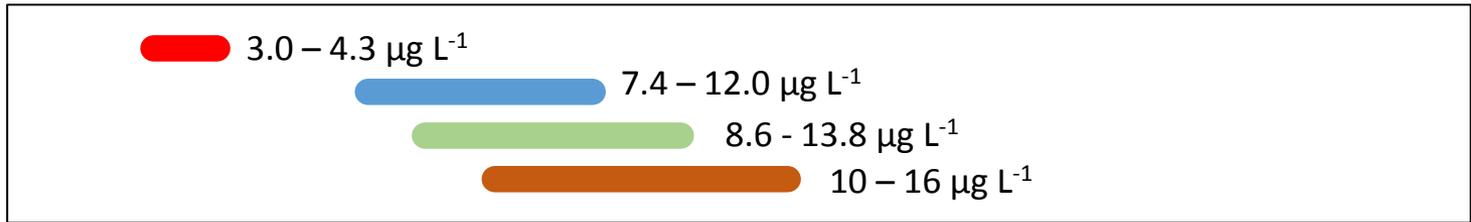
Evaluation:

- Current criterion falls above the James River specific defensible range
- HAB regression line intersection with the 10% threshold suggests current criterion is protective

Recommendation: Keep the existing criterion value (15)

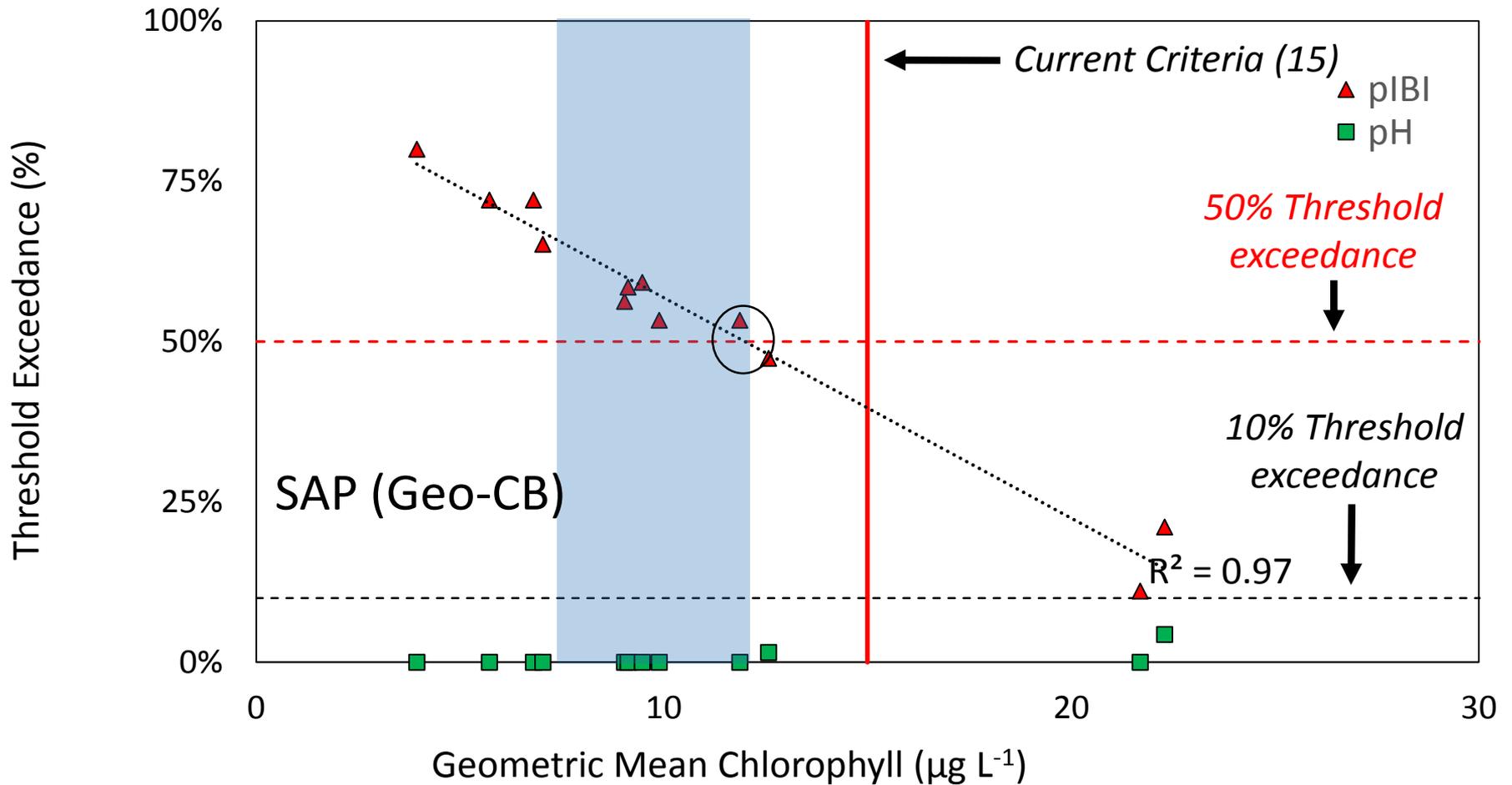
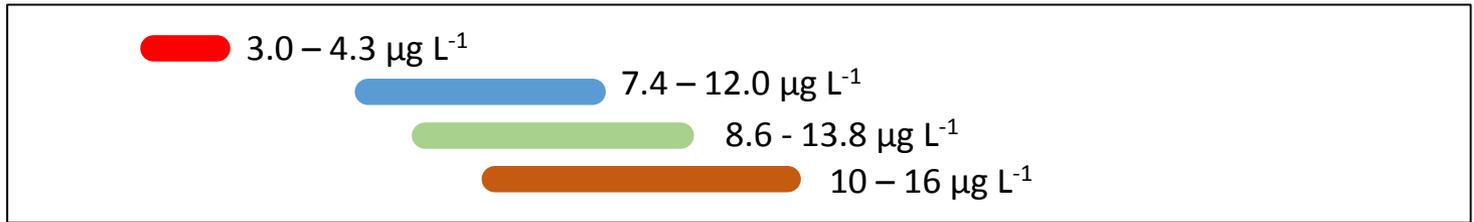
Lower Tidal Fresh Spring

- REF
- SAP-Geo-(CB)
- SAP-Geo-(JR)
- SAP-Arith



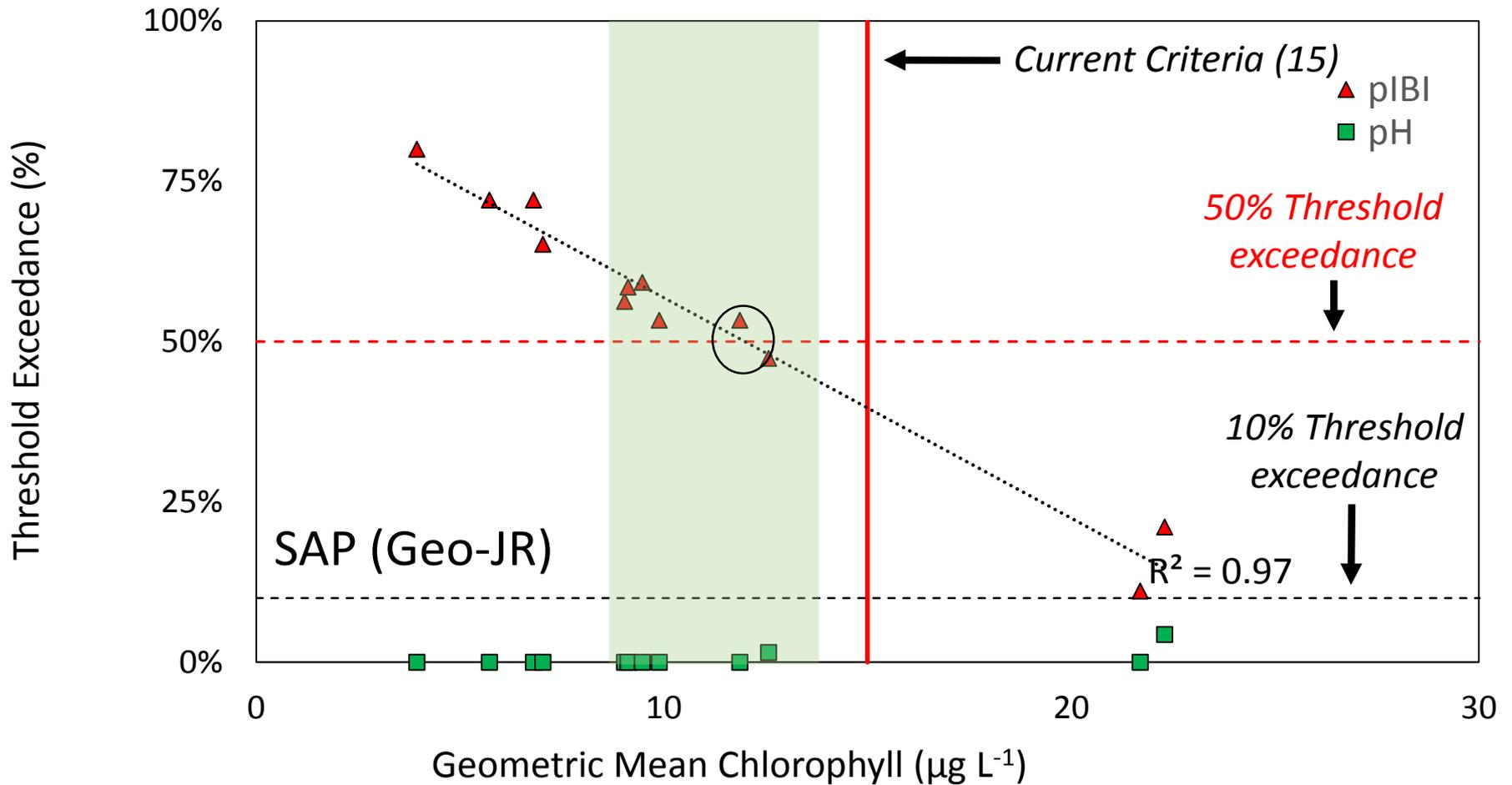
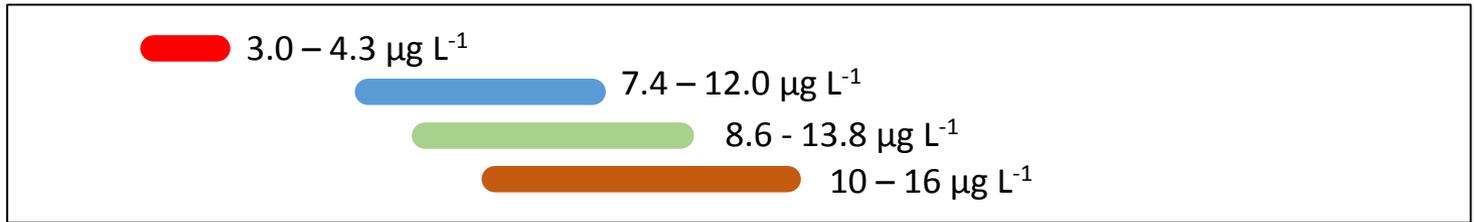
Lower Tidal Fresh Spring

- REF
- SAP-Geo-(CB)
- SAP-Geo-(JR)
- SAP-Arith



Lower Tidal Fresh Spring

- REF
- SAP-Geo-(CB)
- SAP-Geo-(JR)
- SAP-Arith



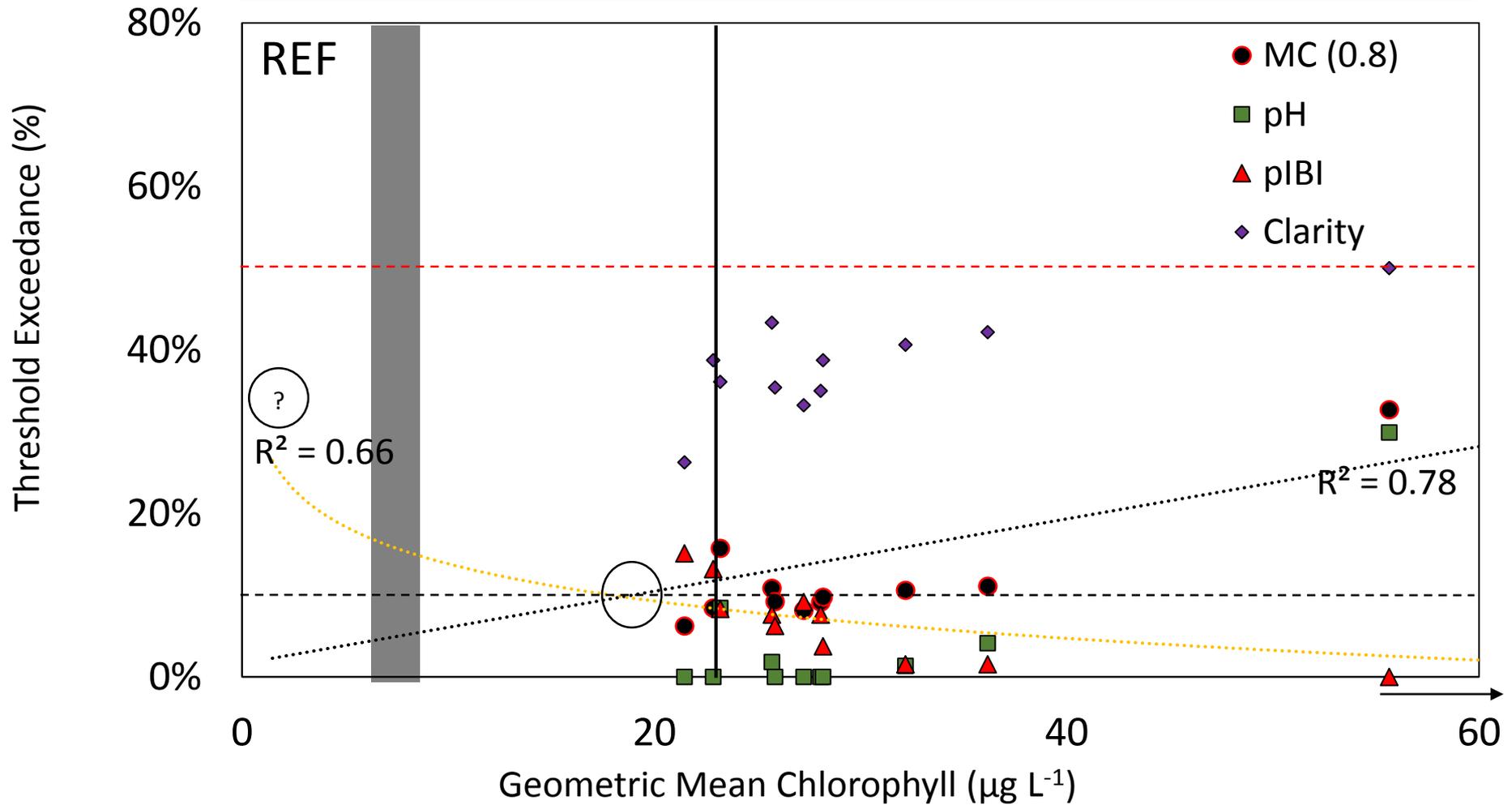
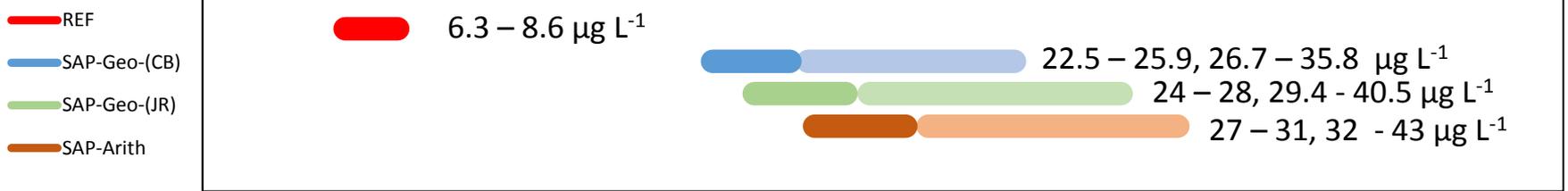
Lower Tidal Fresh Spring

Evaluation:

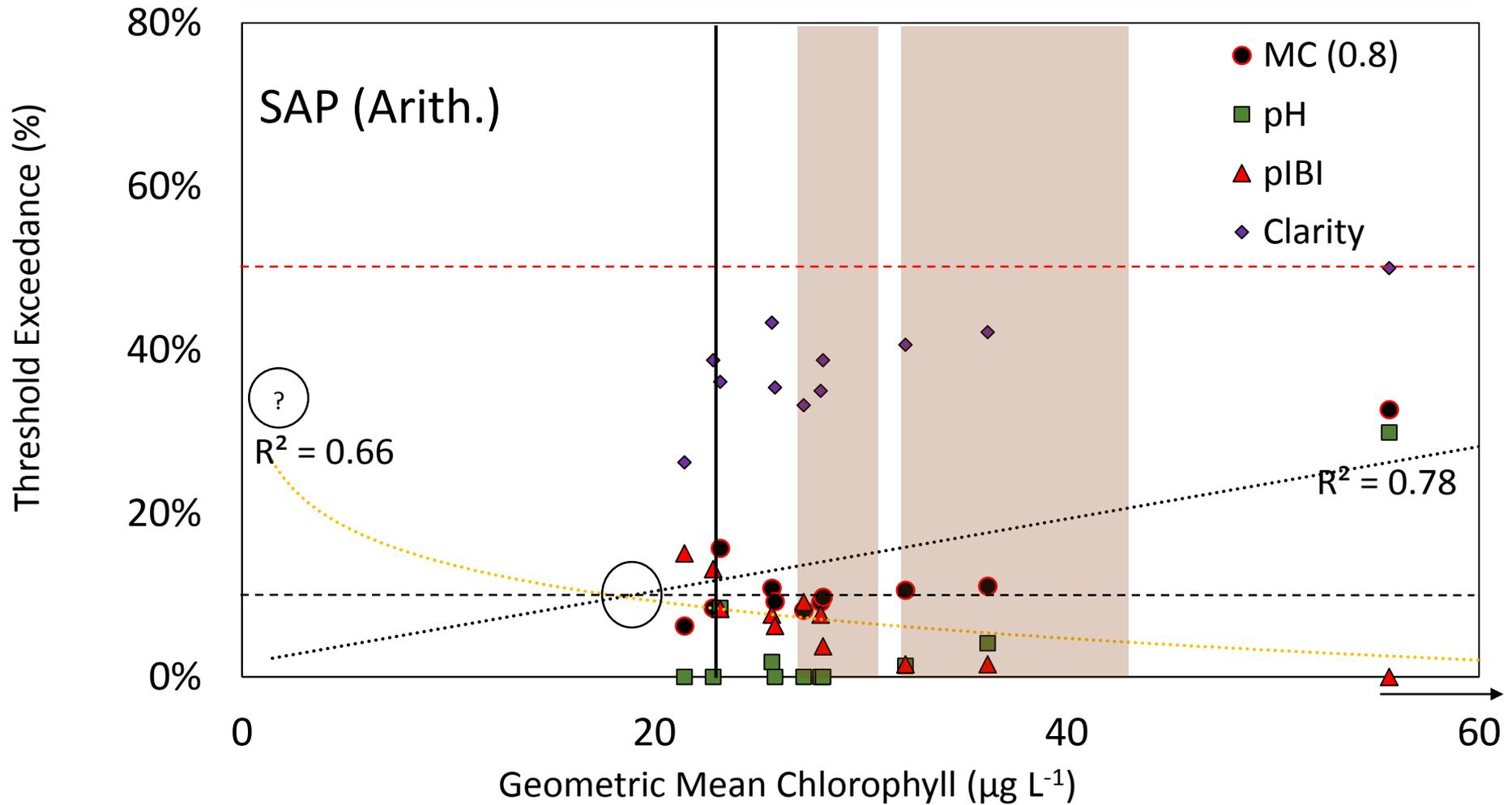
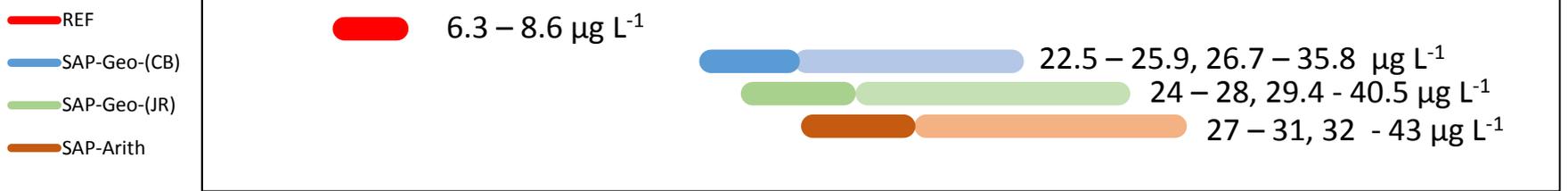
- Current criterion falls above the James River specific defensible range
- pIBI regression line intersection with 50% threshold indicates current criterion is not protective

Recommendation: Re-set the criterion value to 13 ug/L, the concentration where the PIBI regression line intersects with the 50% threshold (which also falls within the defensible range).

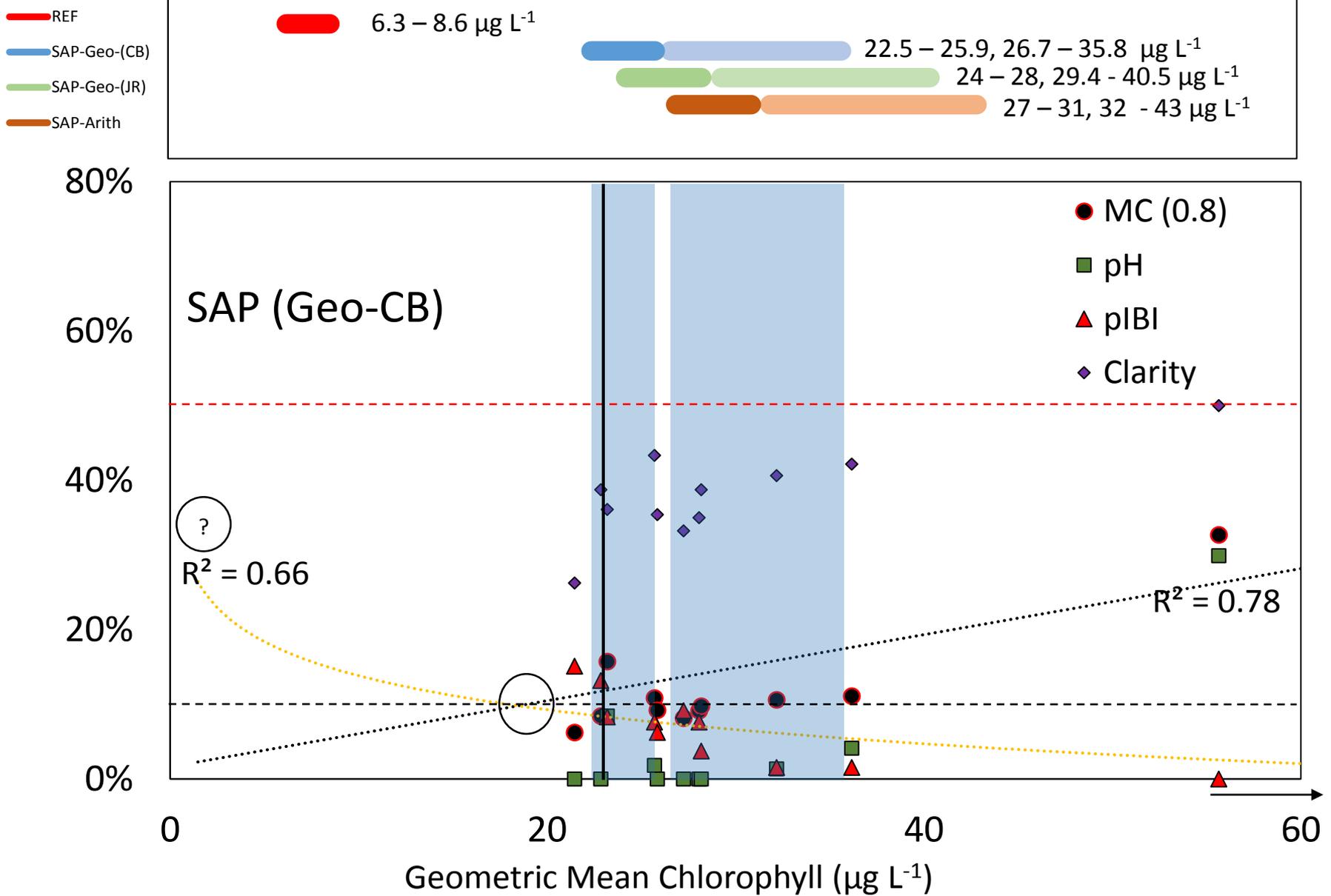
Lower Tidal Fresh Summer



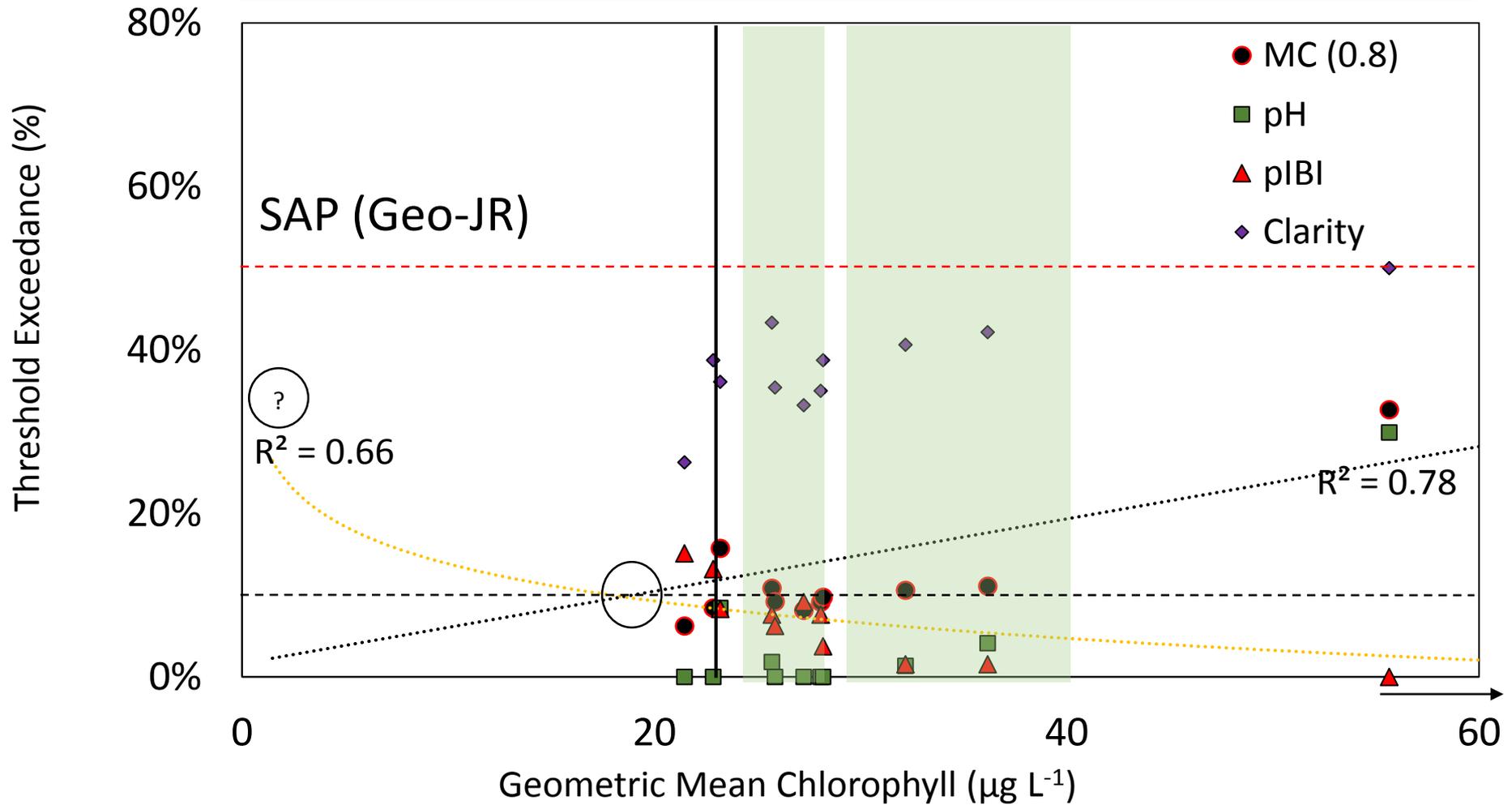
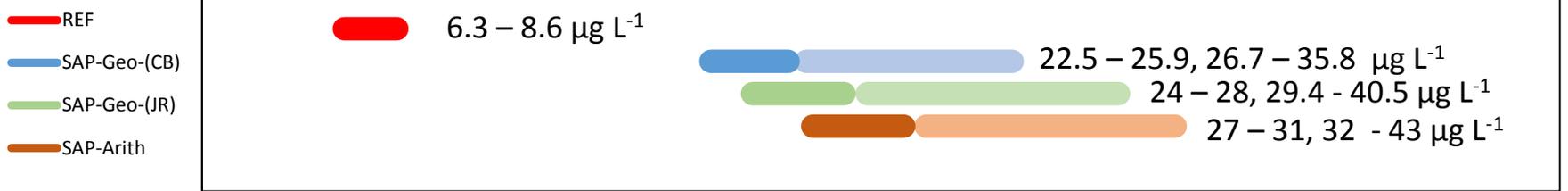
Lower Tidal Fresh Summer



Lower Tidal Fresh Summer



Lower Tidal Fresh Summer



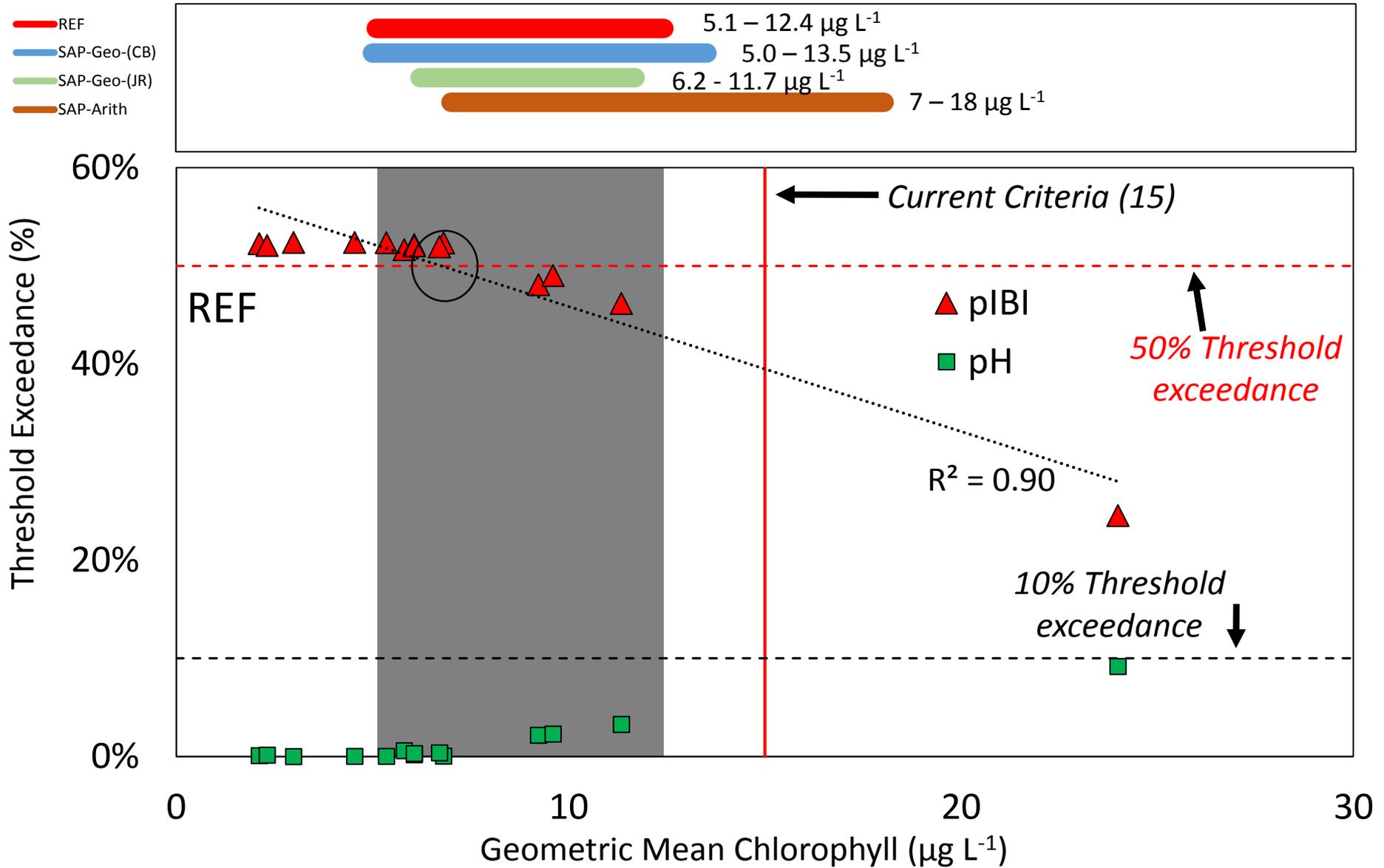
Lower Tidal Fresh Summer

Evaluation:

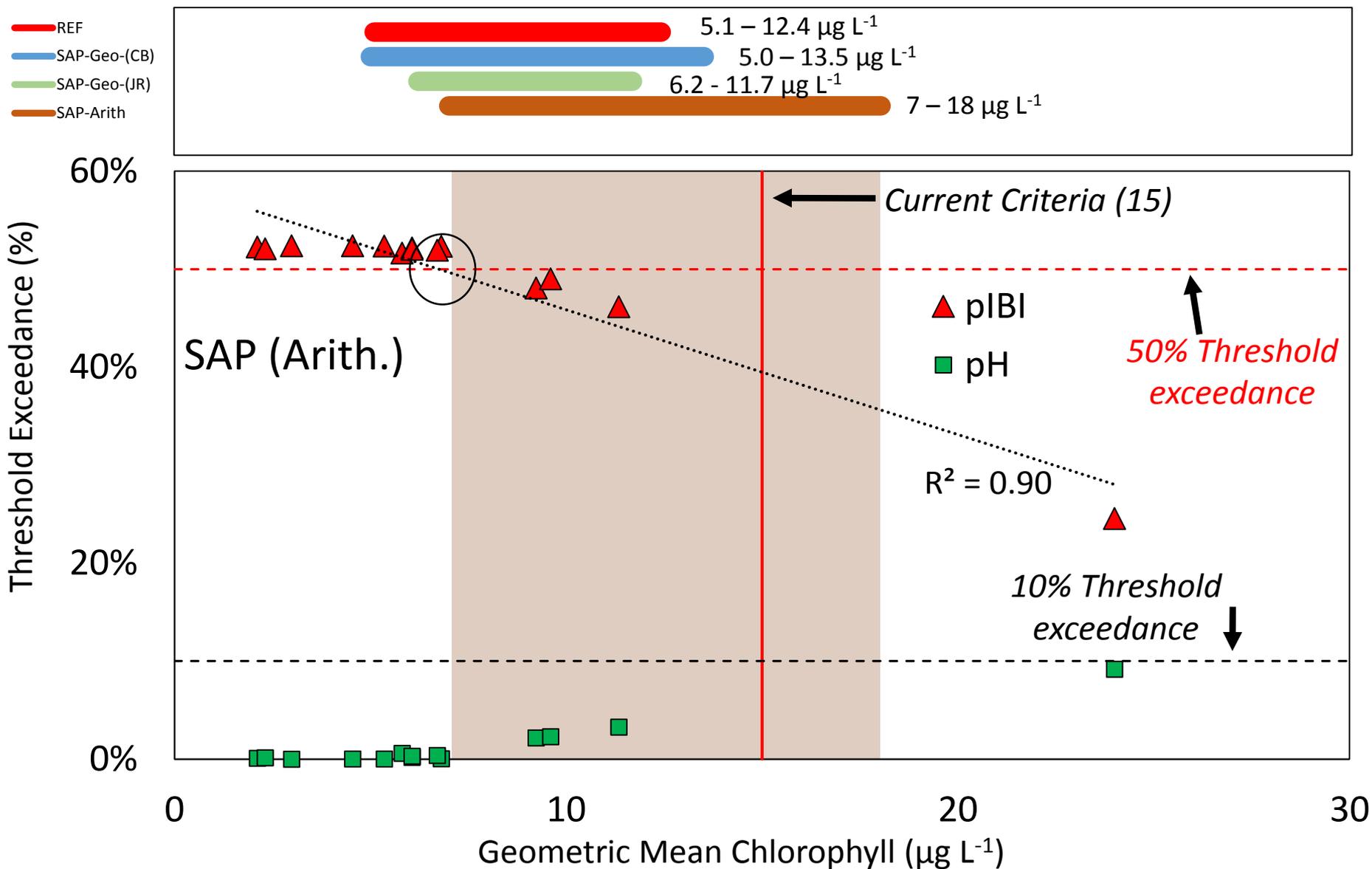
- Current criterion falls below the James River specific defensible range
- HAB regression line intersection with 10% threshold indicates current criterion is protective

Recommendation: Keep existing criterion (23)

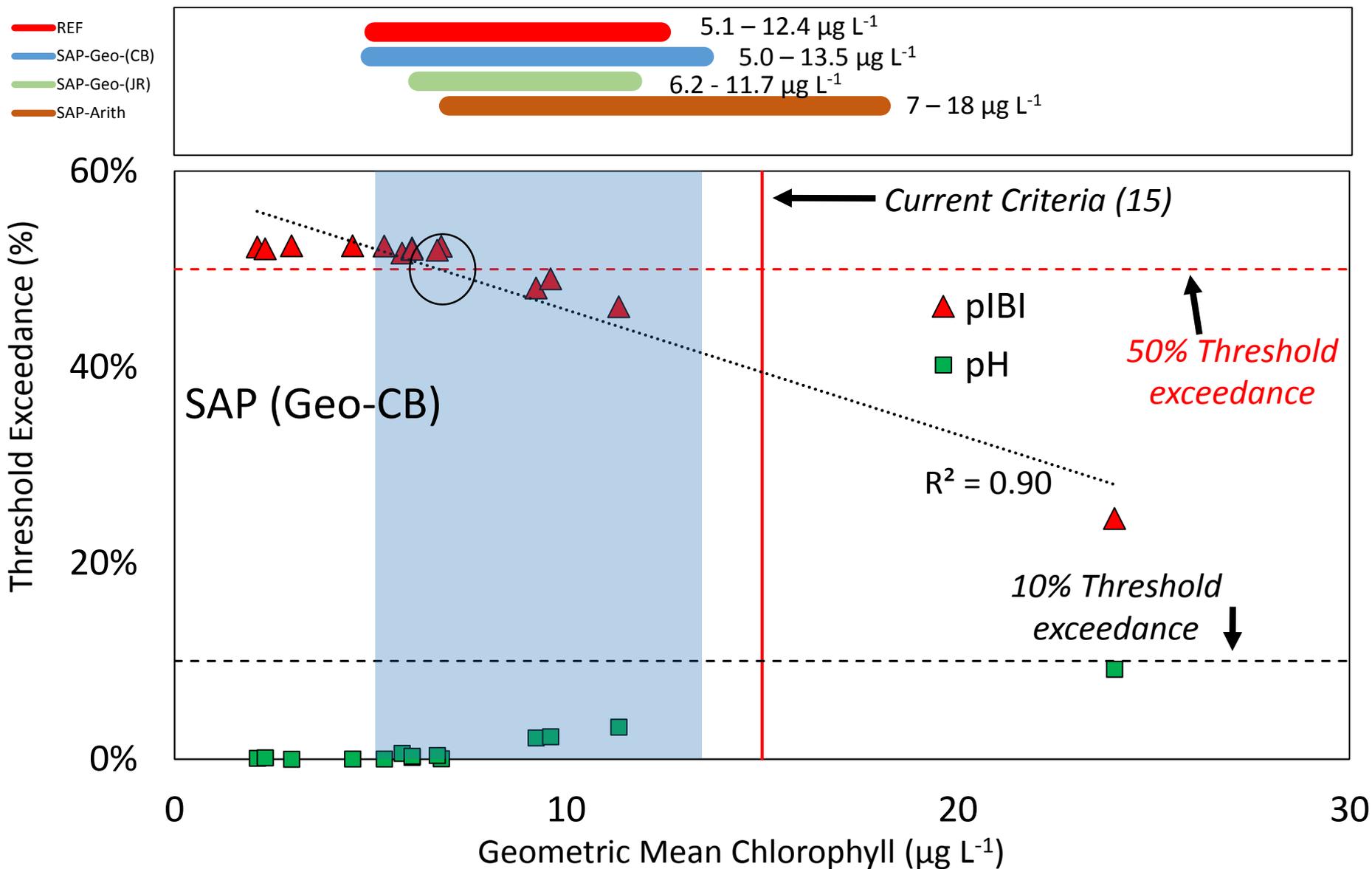
Oligohaline Spring



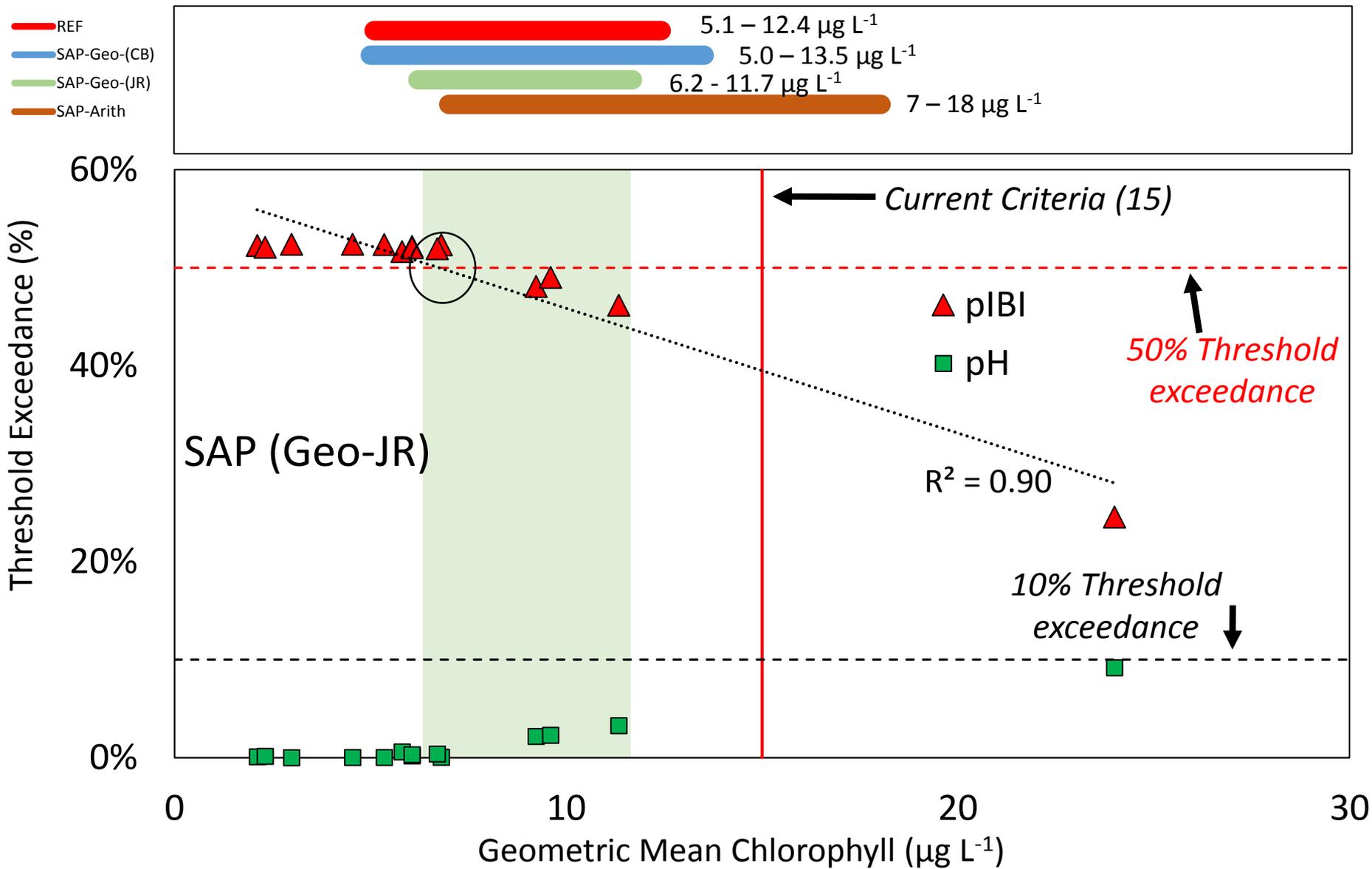
Oligohaline Spring



Oligohaline Spring



Oligohaline Spring



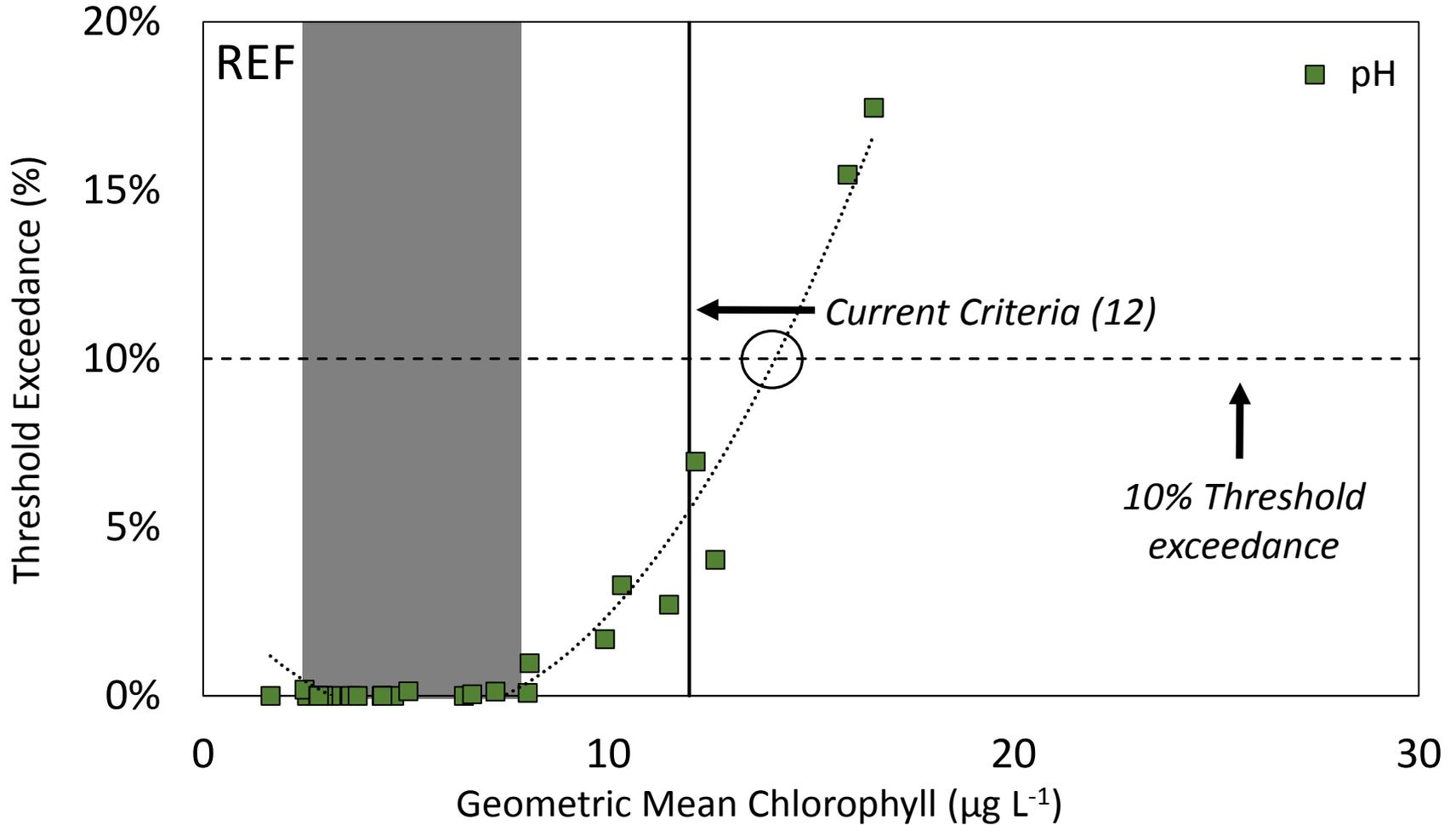
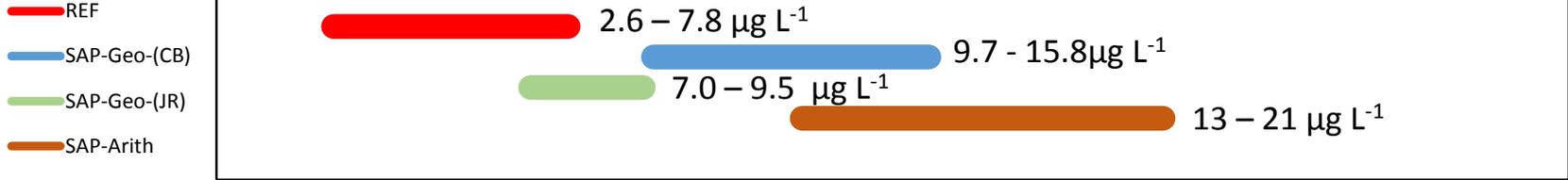
Oligohaline Spring

Evaluation:

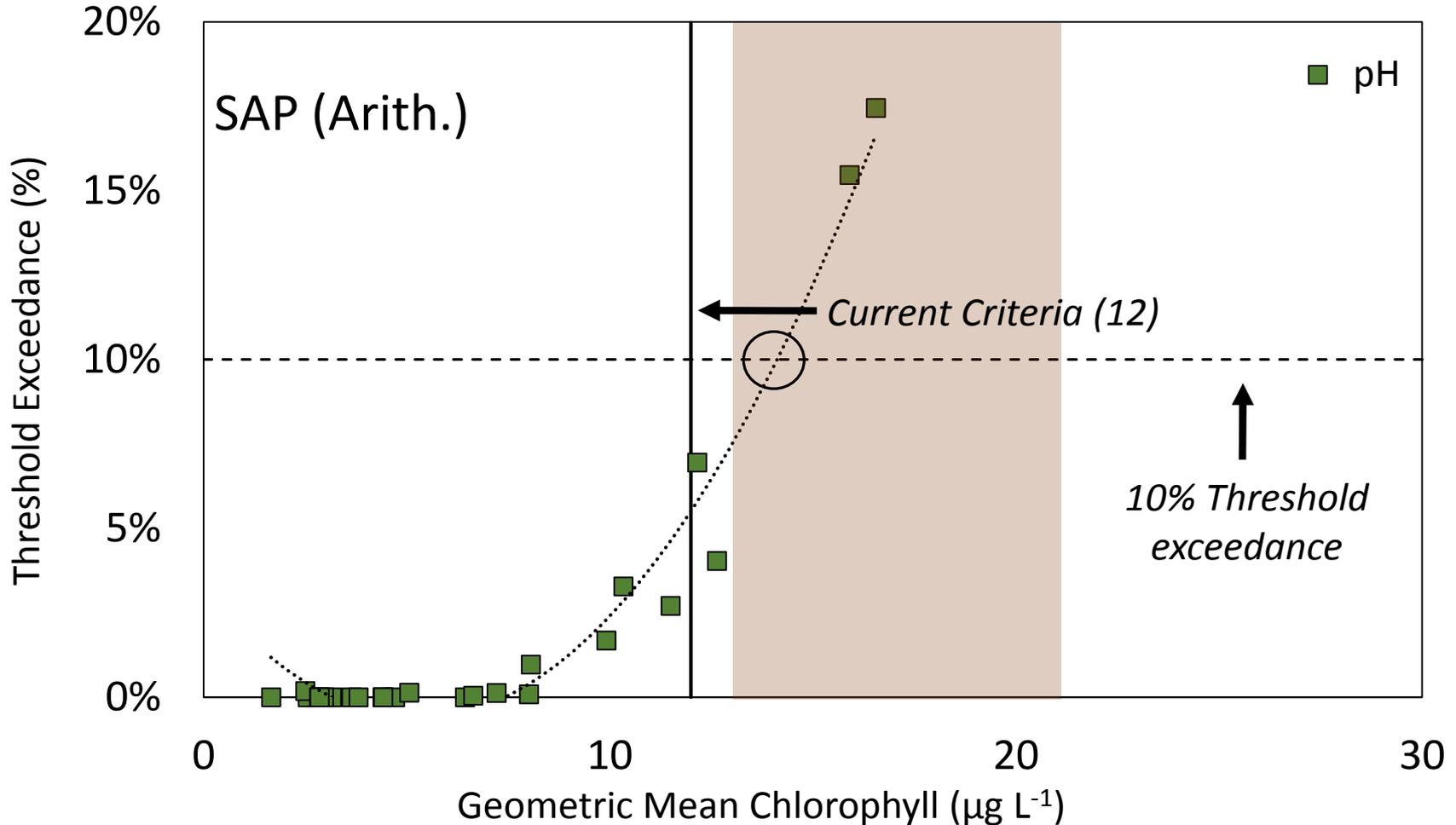
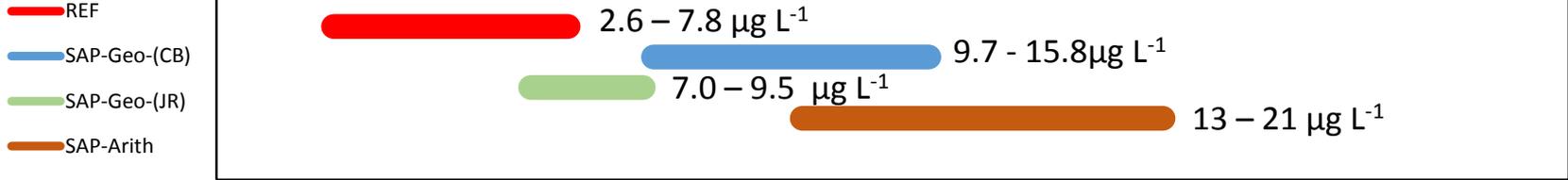
- Current criterion falls above the James River specific defensible range
- PIBI regression line intersection with 50% threshold indicates current criterion is not protective

Recommendation: Re-set the criterion value to 9 ug/L, the concentration where the PIBI regression line intersects with the 50% threshold (which also falls within the defensible range).

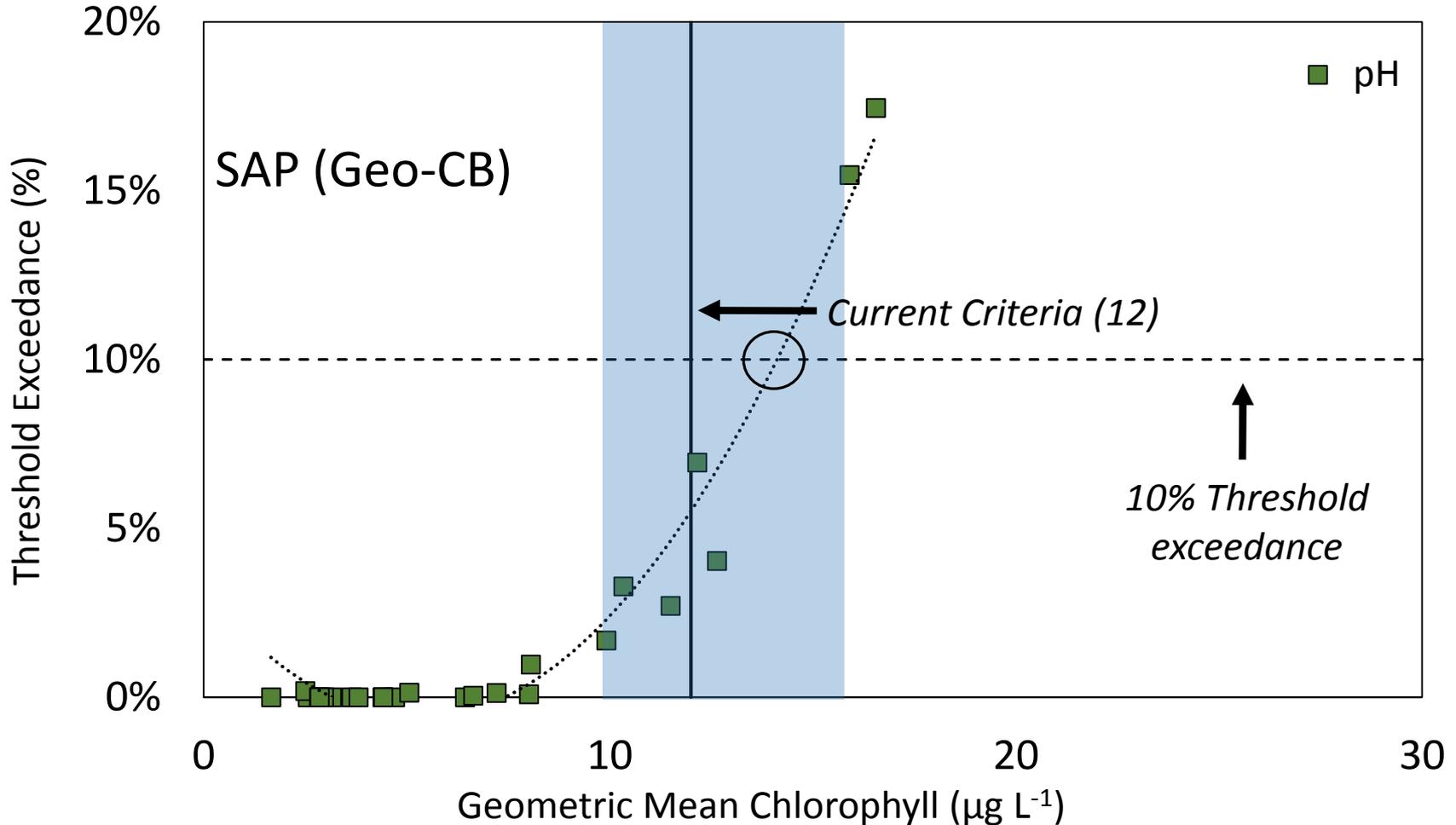
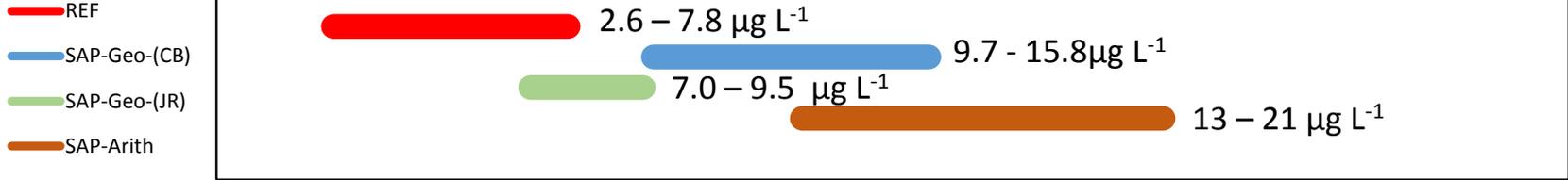
Mesohaline Spring



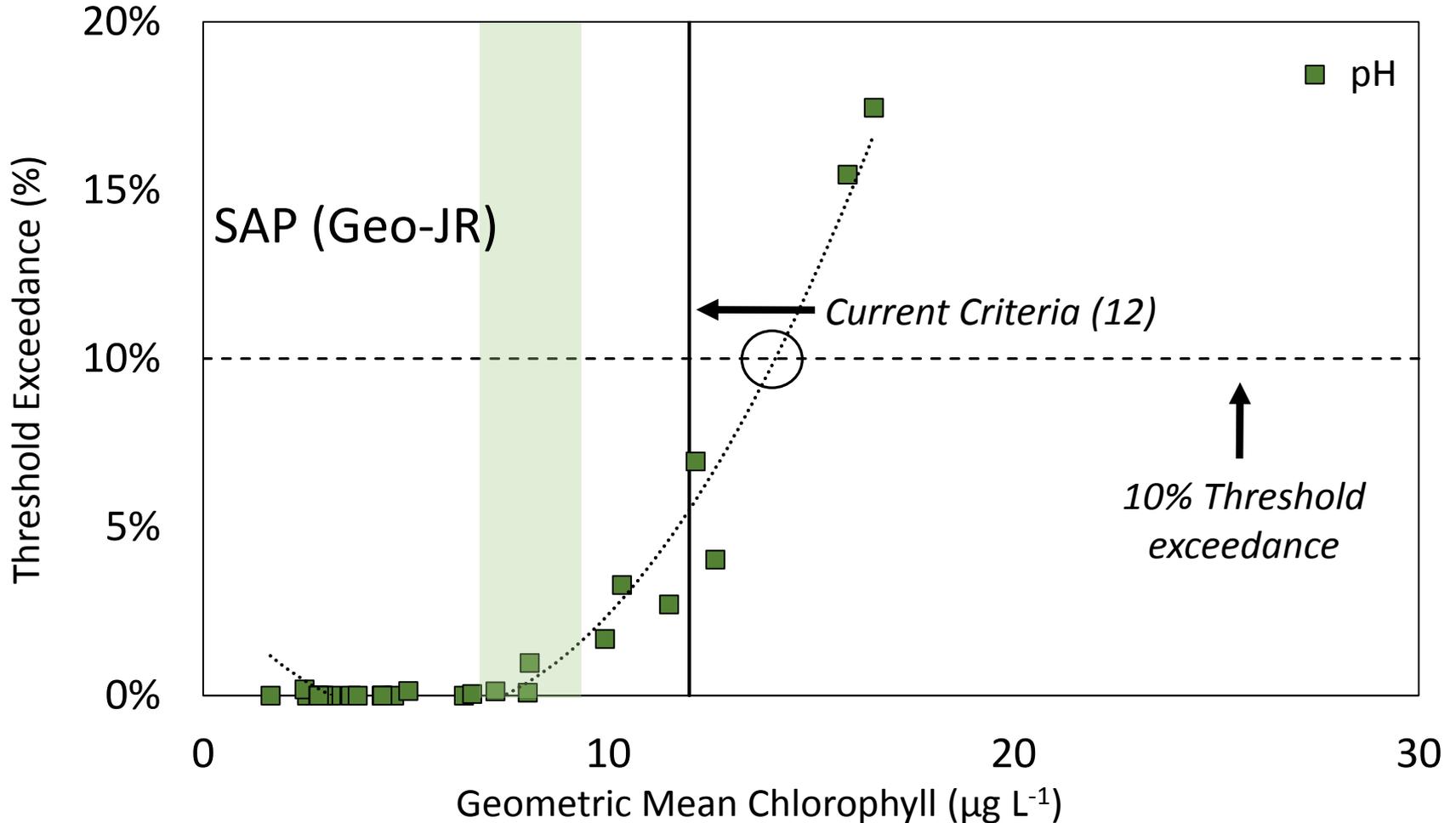
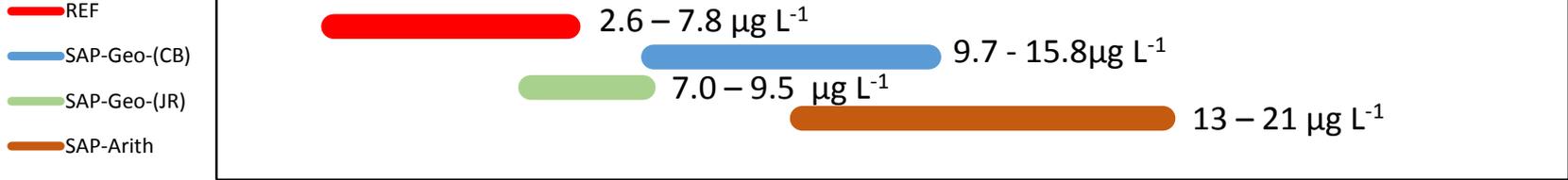
Mesohaline Spring



Mesohaline Spring



Mesohaline Spring



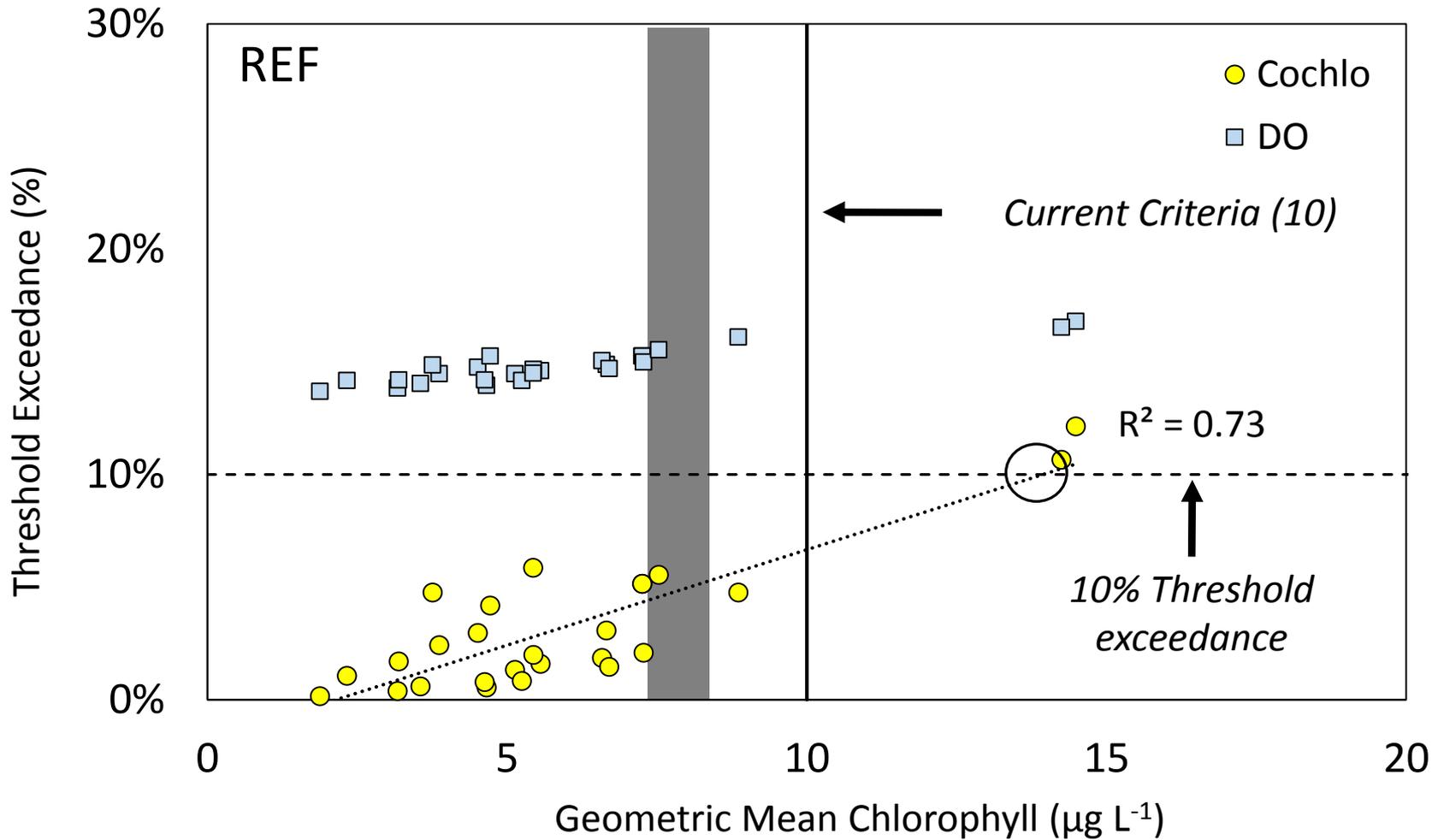
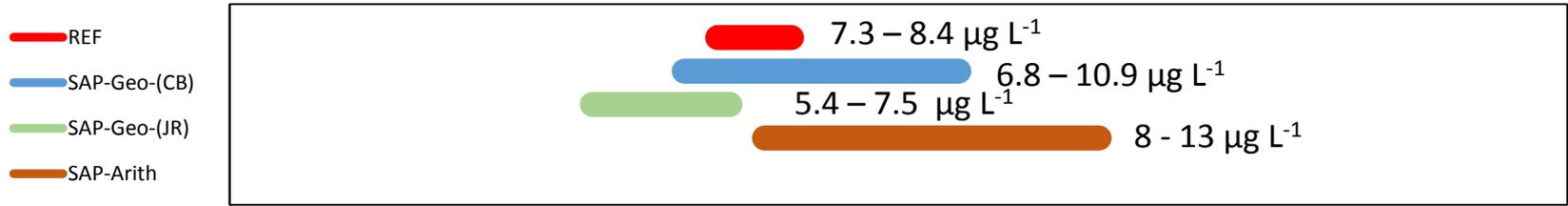
Mesohaline Spring

Evaluation:

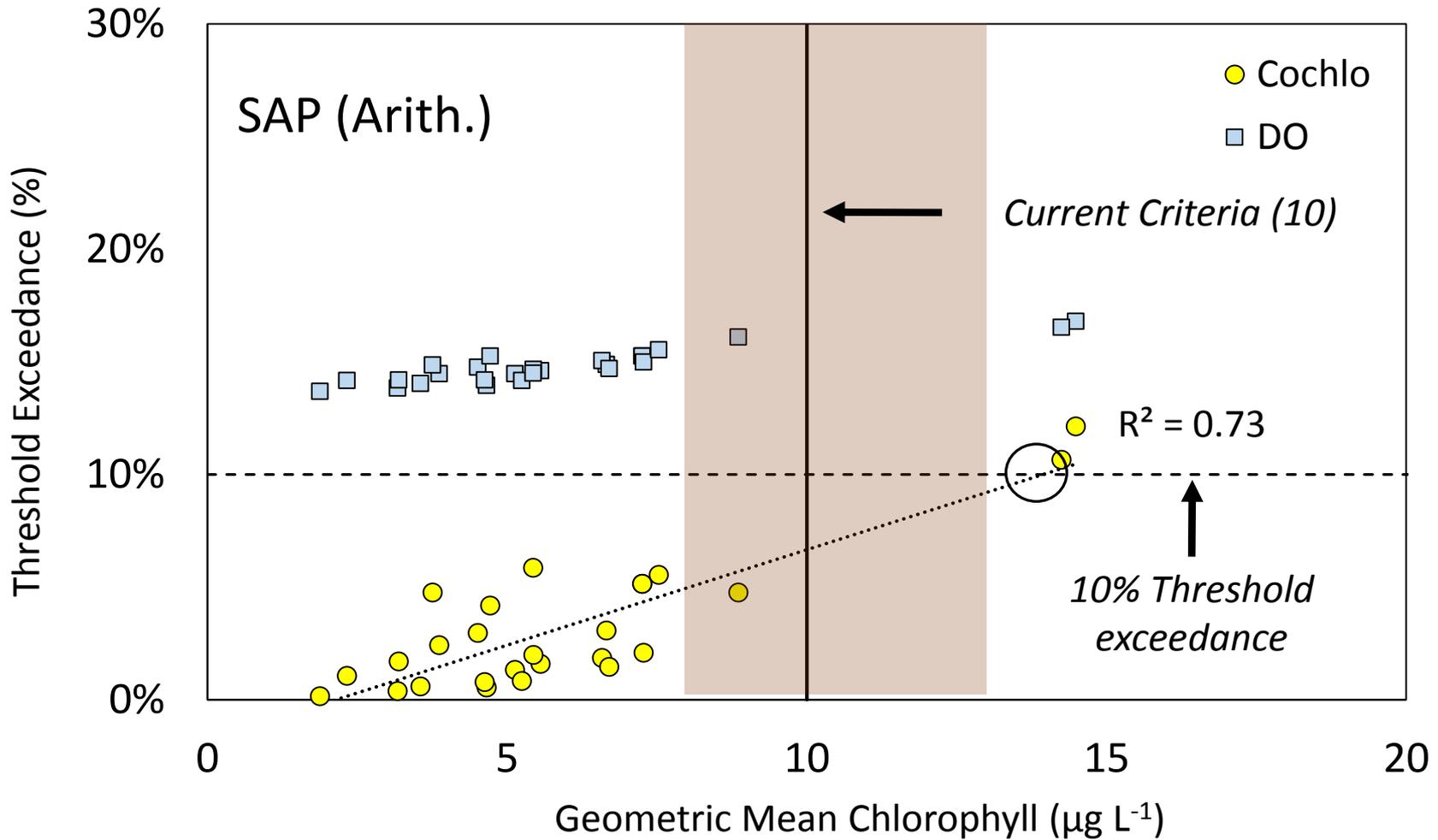
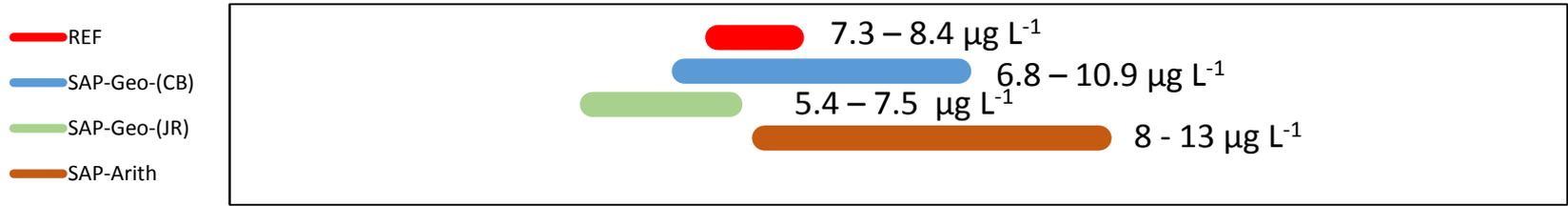
- Current criterion falls above the James River specific defensible range
- pH regression line intersection with 10% threshold indicates current criterion is protective

Recommendation: Keep the current criteria

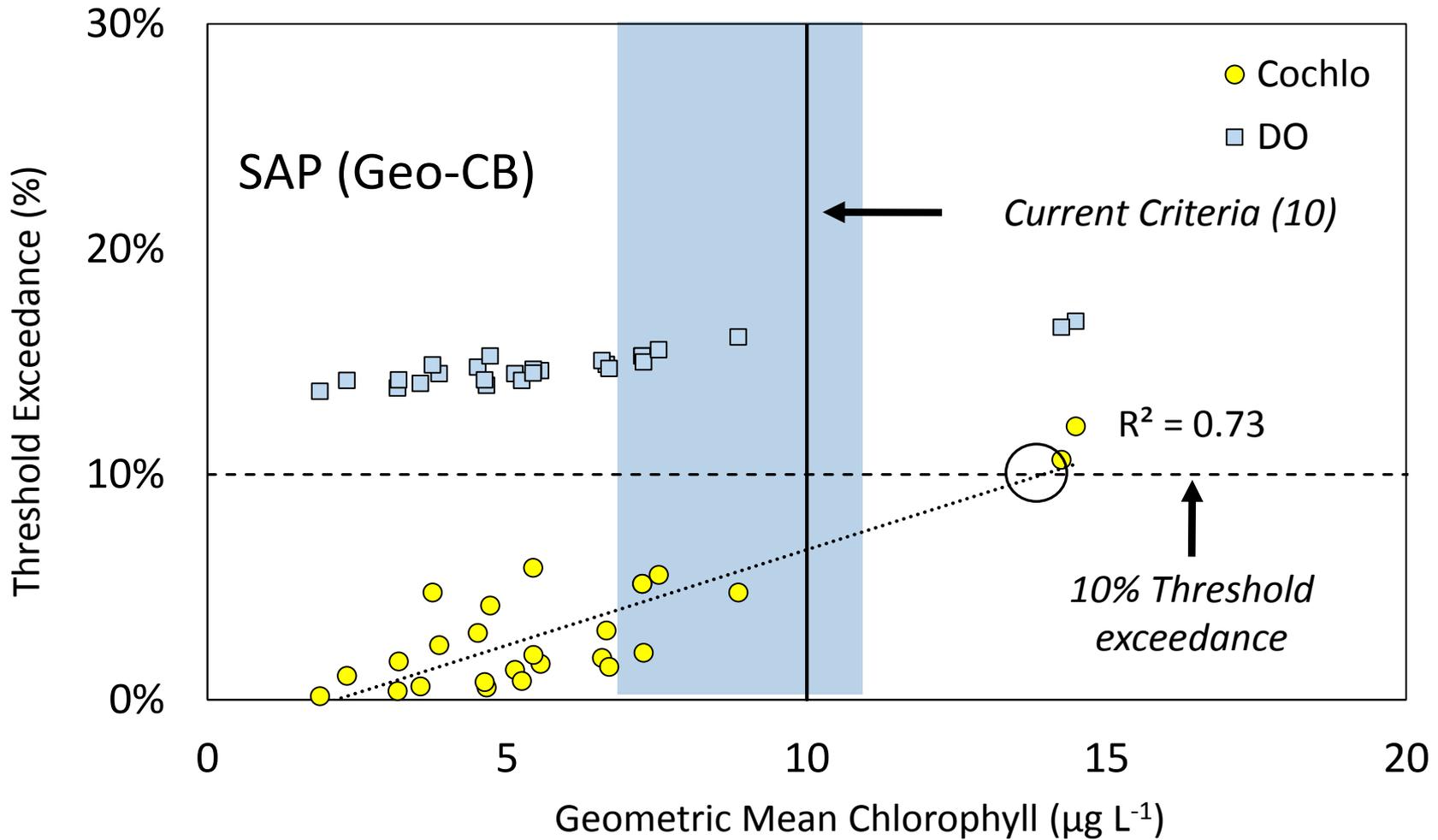
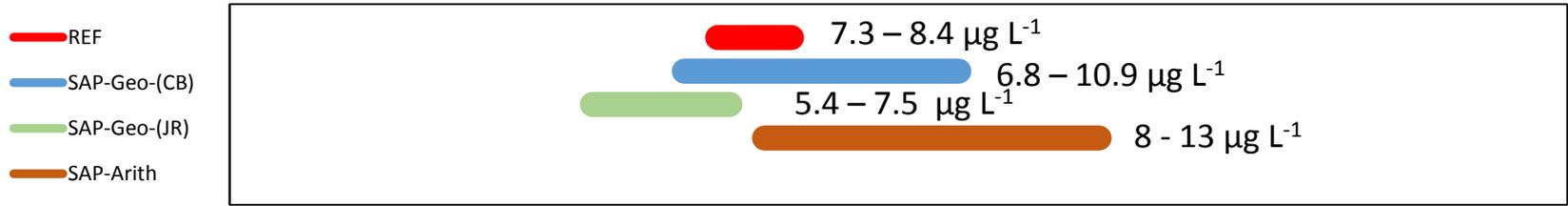
Mesohaline Summer



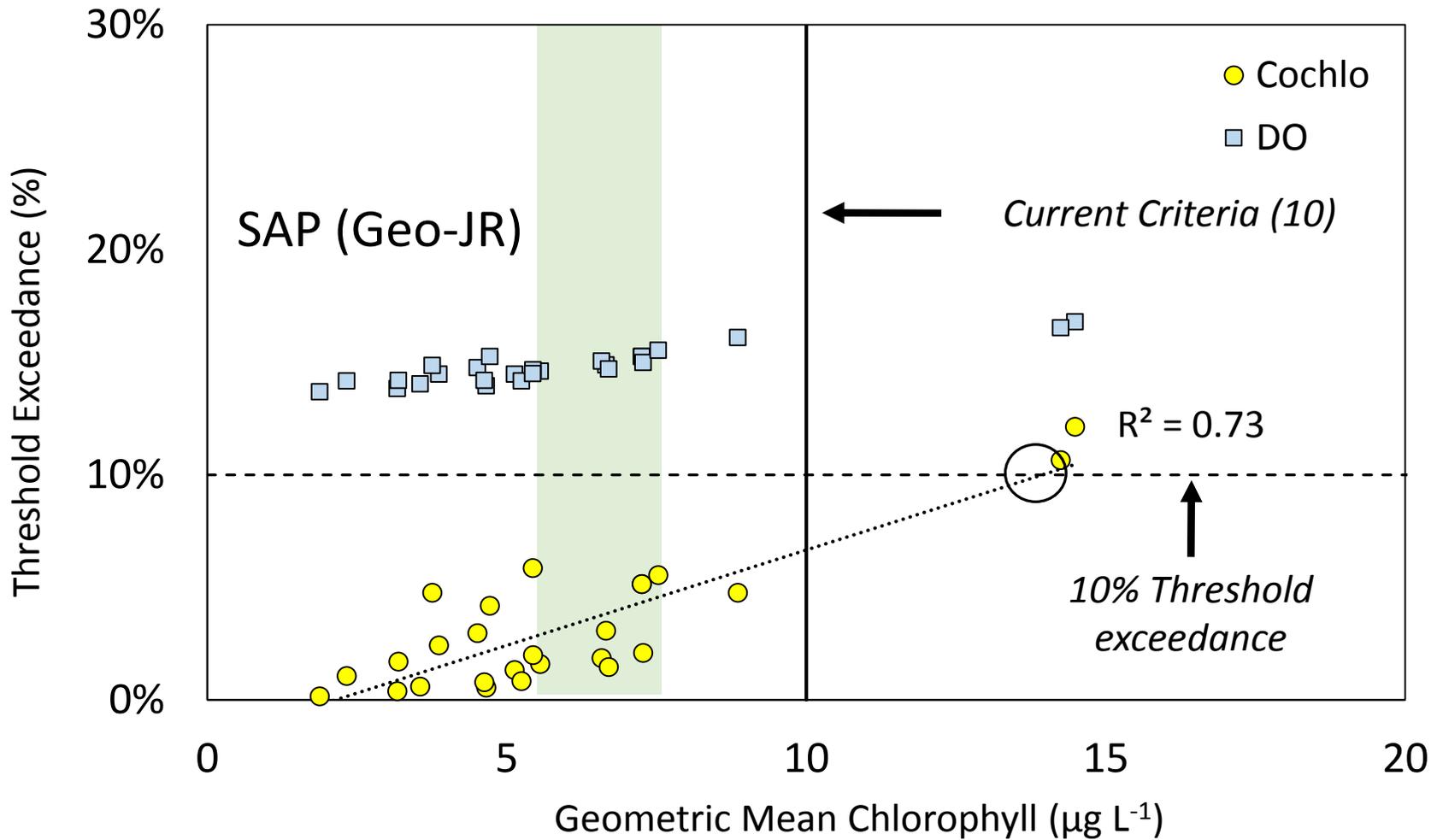
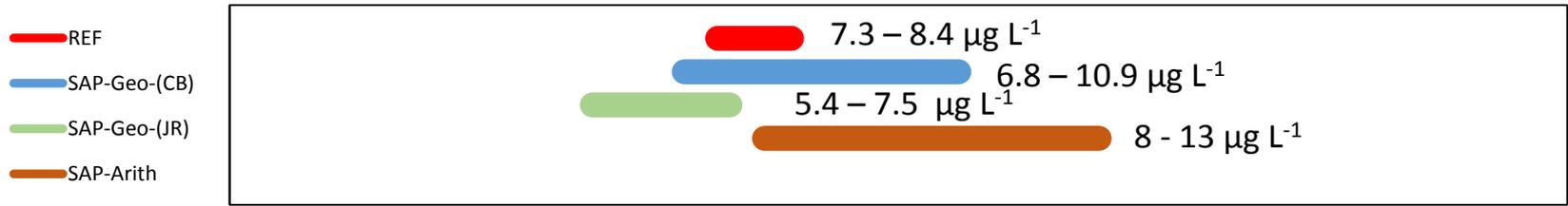
Mesohaline Summer



Mesohaline Summer



Mesohaline Summer



Mesohaline Summer

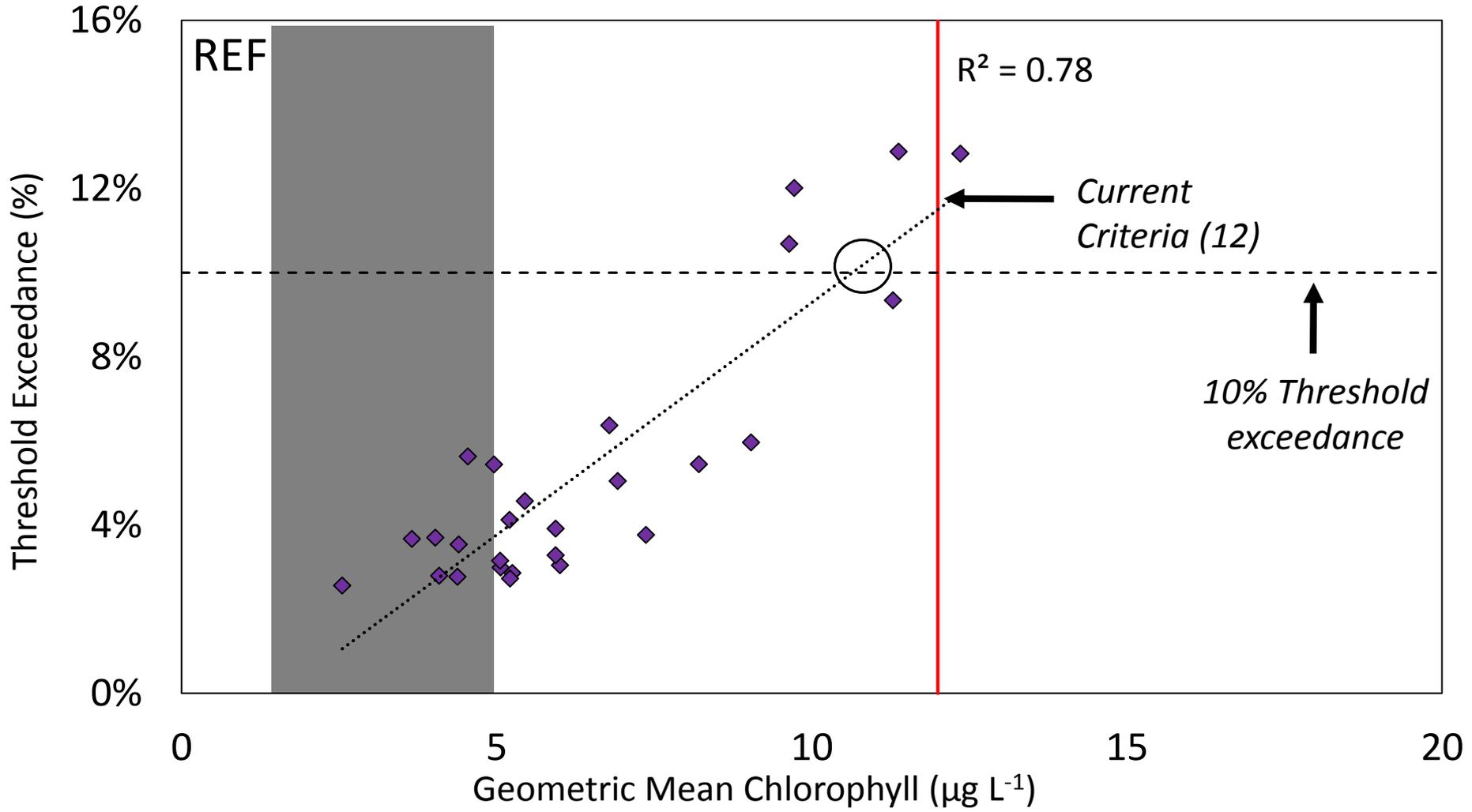
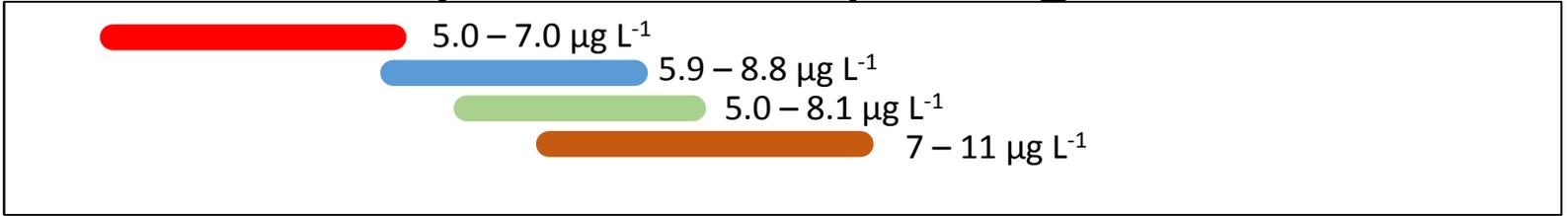
Evaluation:

- Current criterion falls above the James River specific defensible range
- HAB regression line intersection with 10% threshold indicates current criterion is protective

Recommendation: Keep the Same

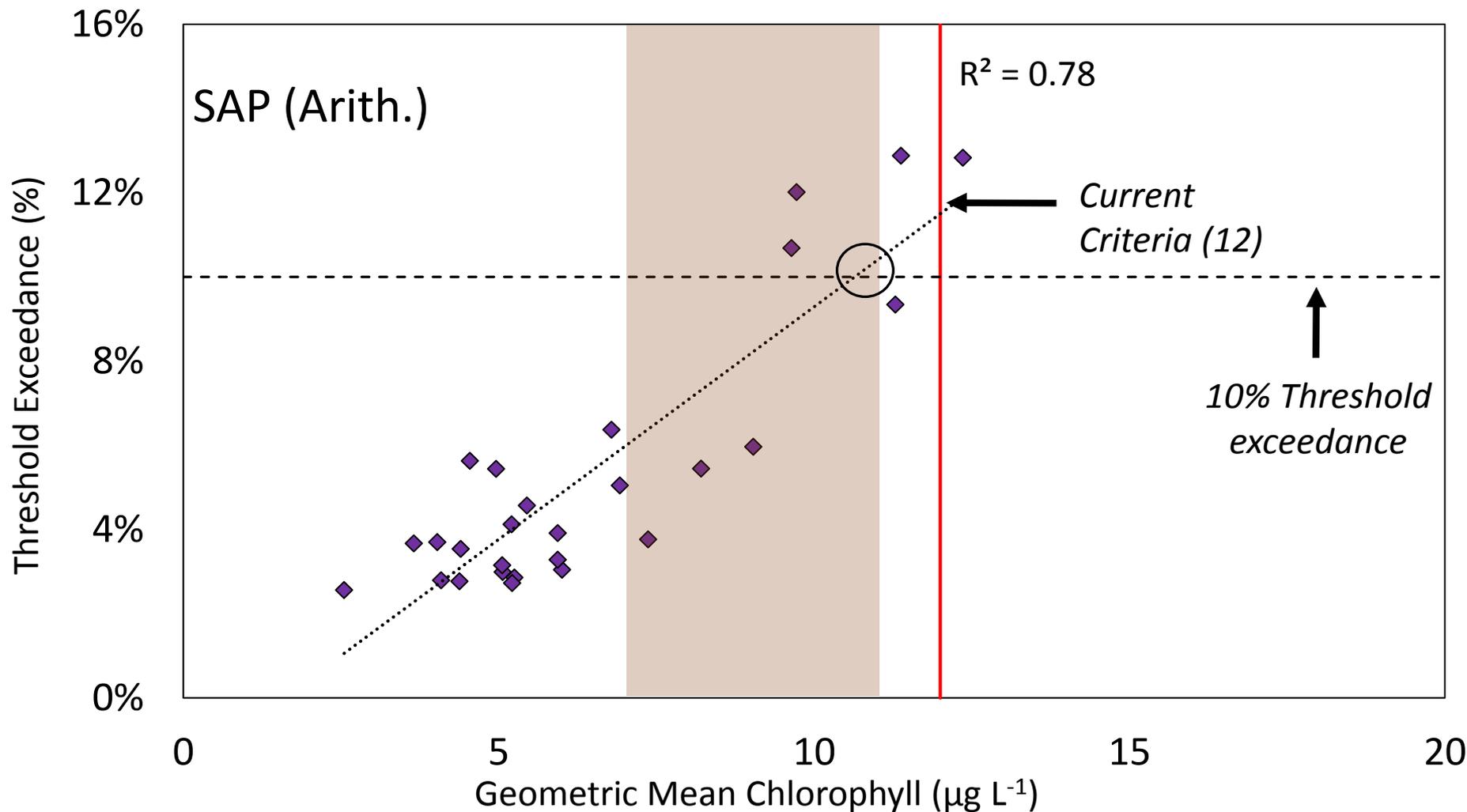
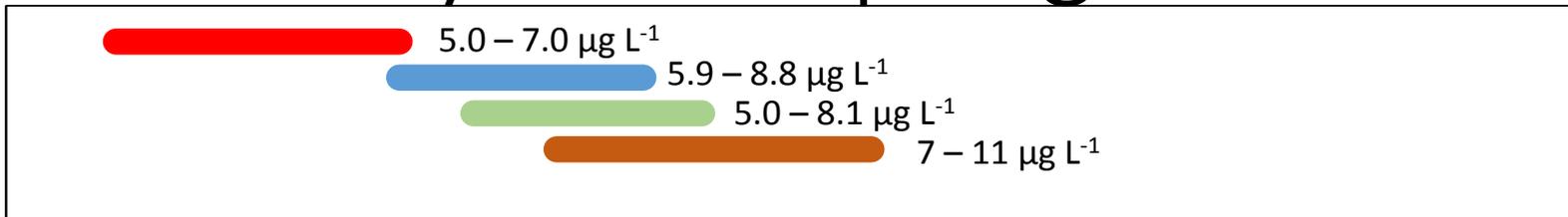
Polyhaline Spring

- REF
- SAP-Geo-(CB)
- SAP-Geo-(JR)
- SAP-Arith



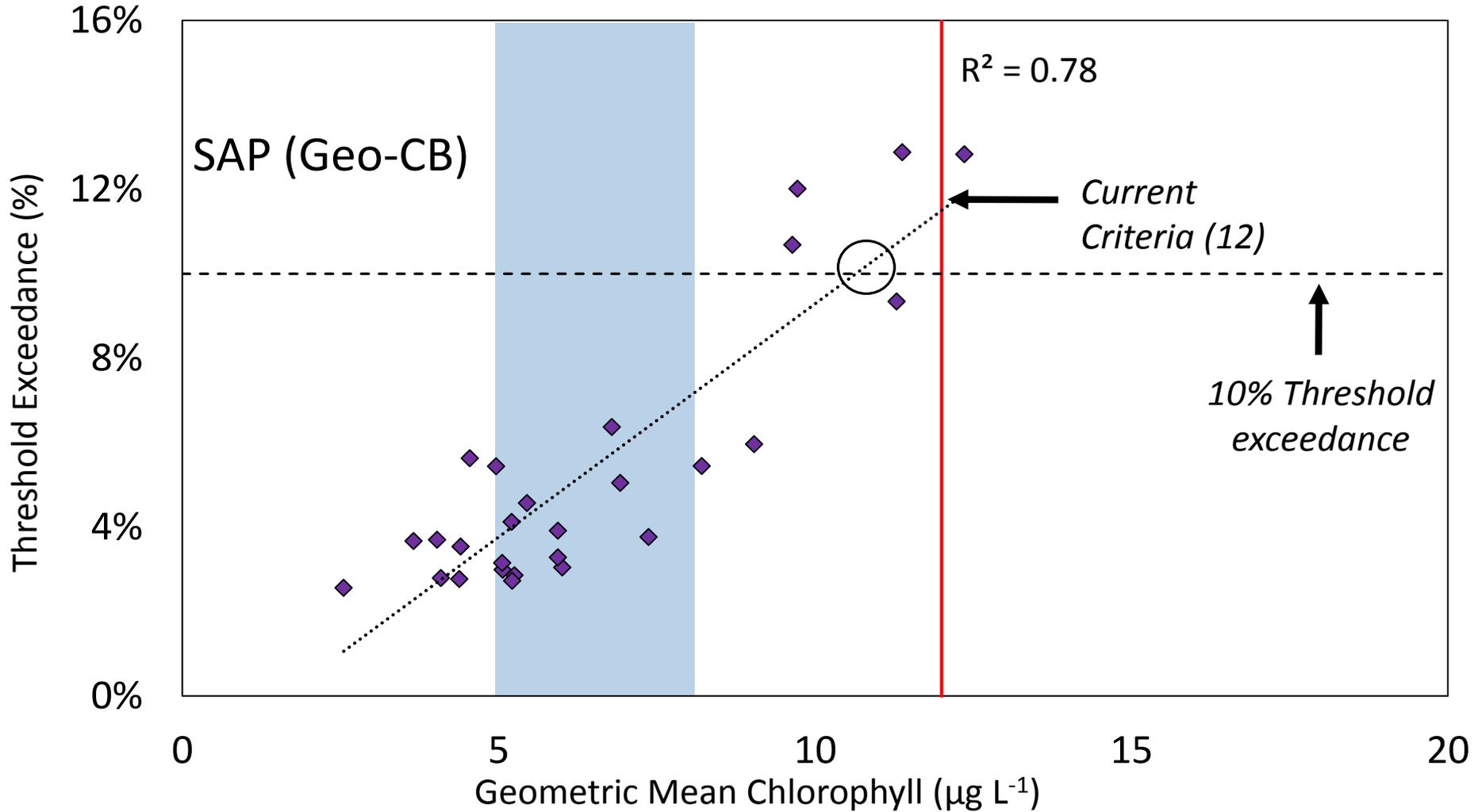
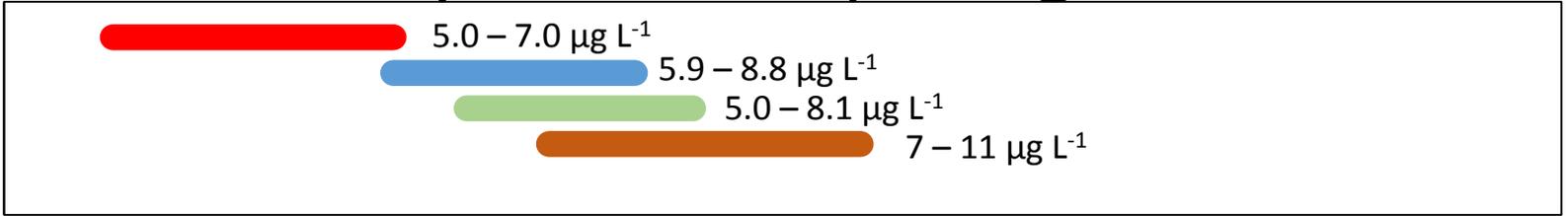
Polyhaline Spring

- REF
- SAP-Geo-(CB)
- SAP-Geo-(JR)
- SAP-Arith



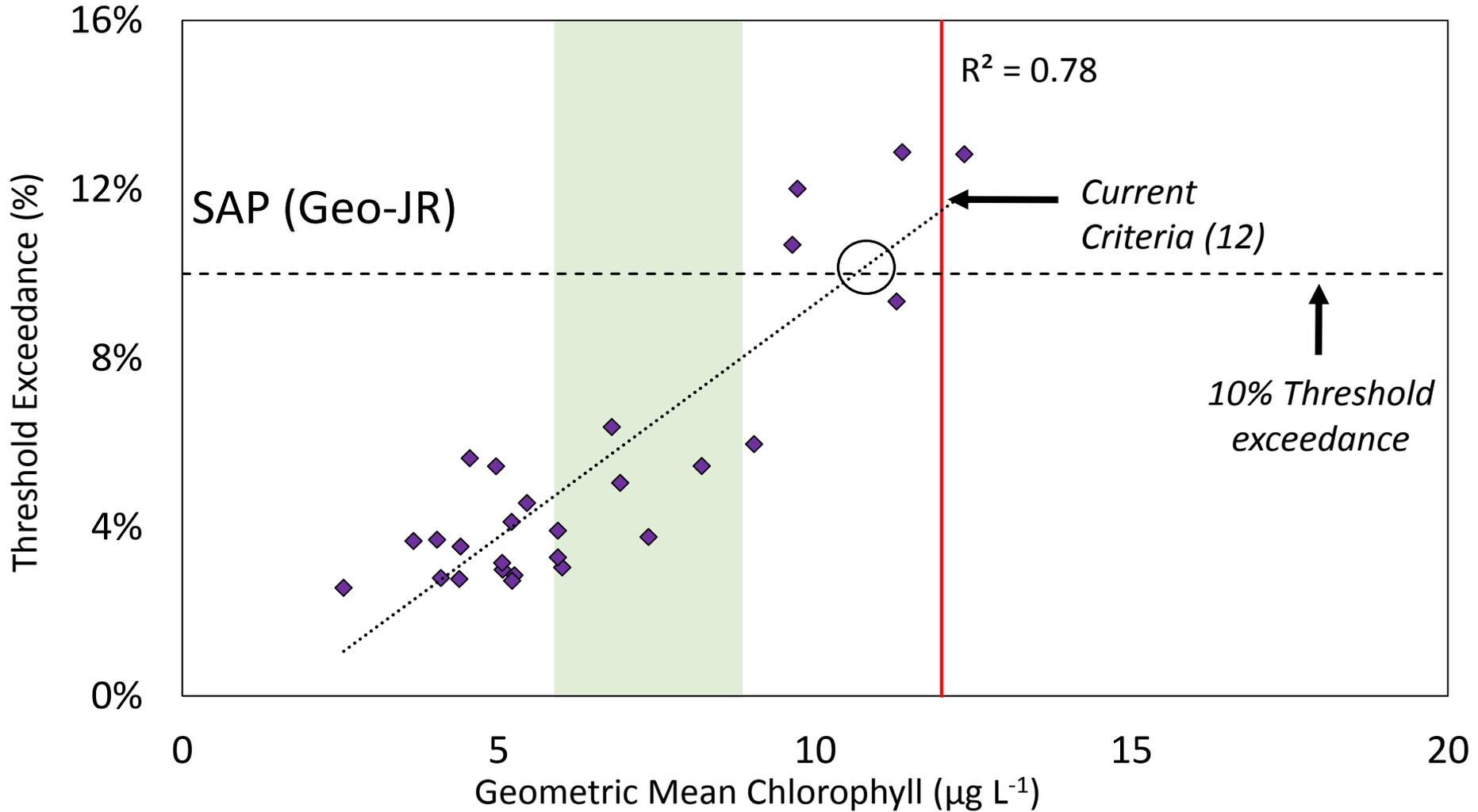
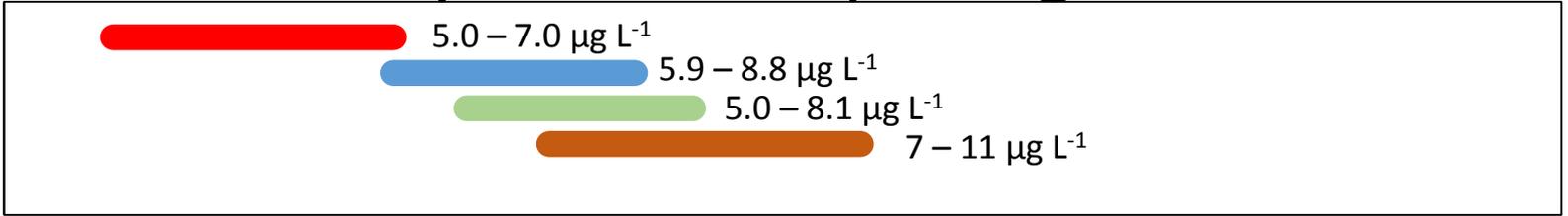
Polyhaline Spring

- REF
- SAP-Geo-(CB)
- SAP-Geo-(JR)
- SAP-Arith



Polyhaline Spring

- REF
- SAP-Geo-(CB)
- SAP-Geo-(JR)
- SAP-Arith



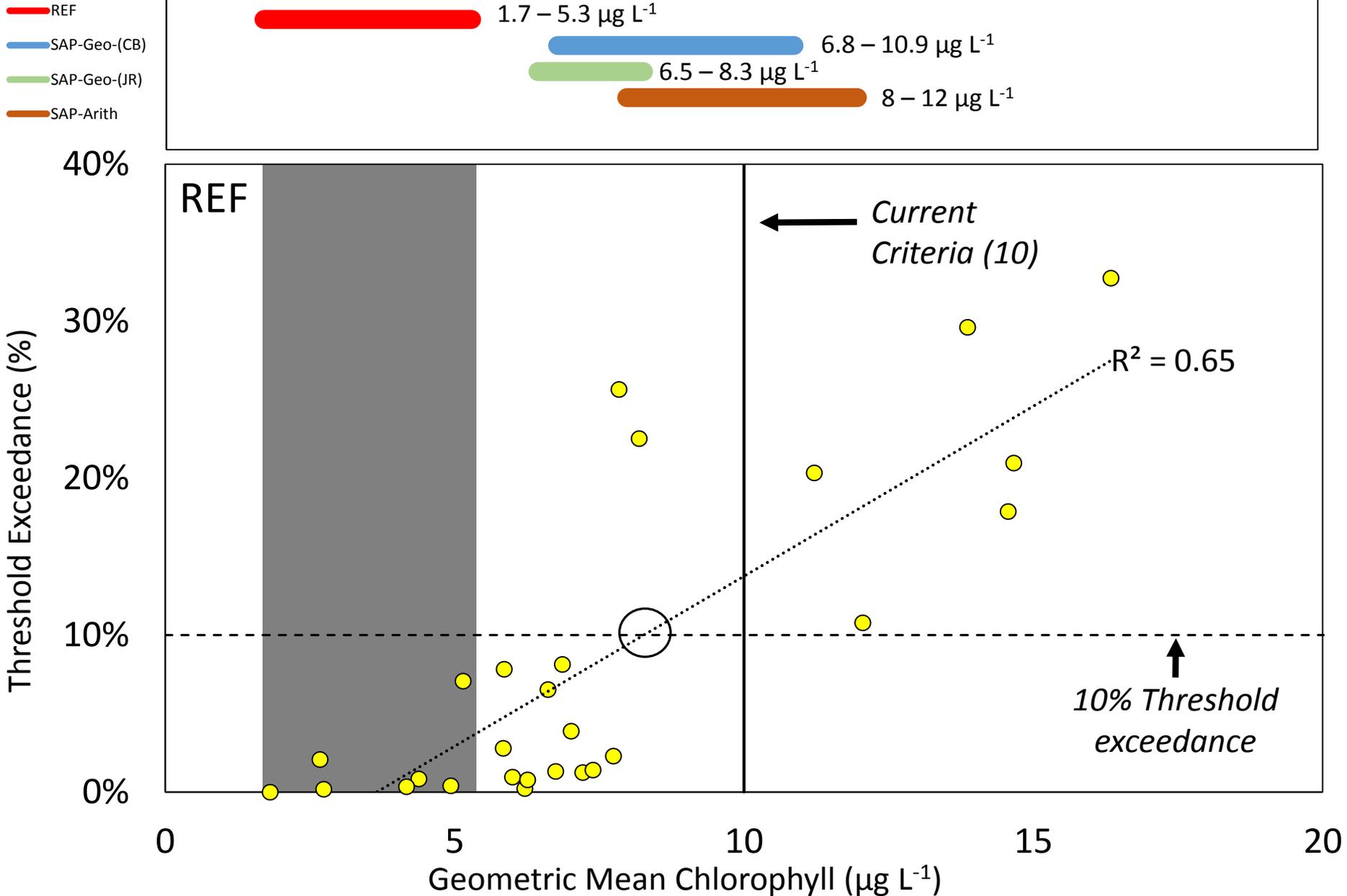
Polyhaline Spring

Evaluation:

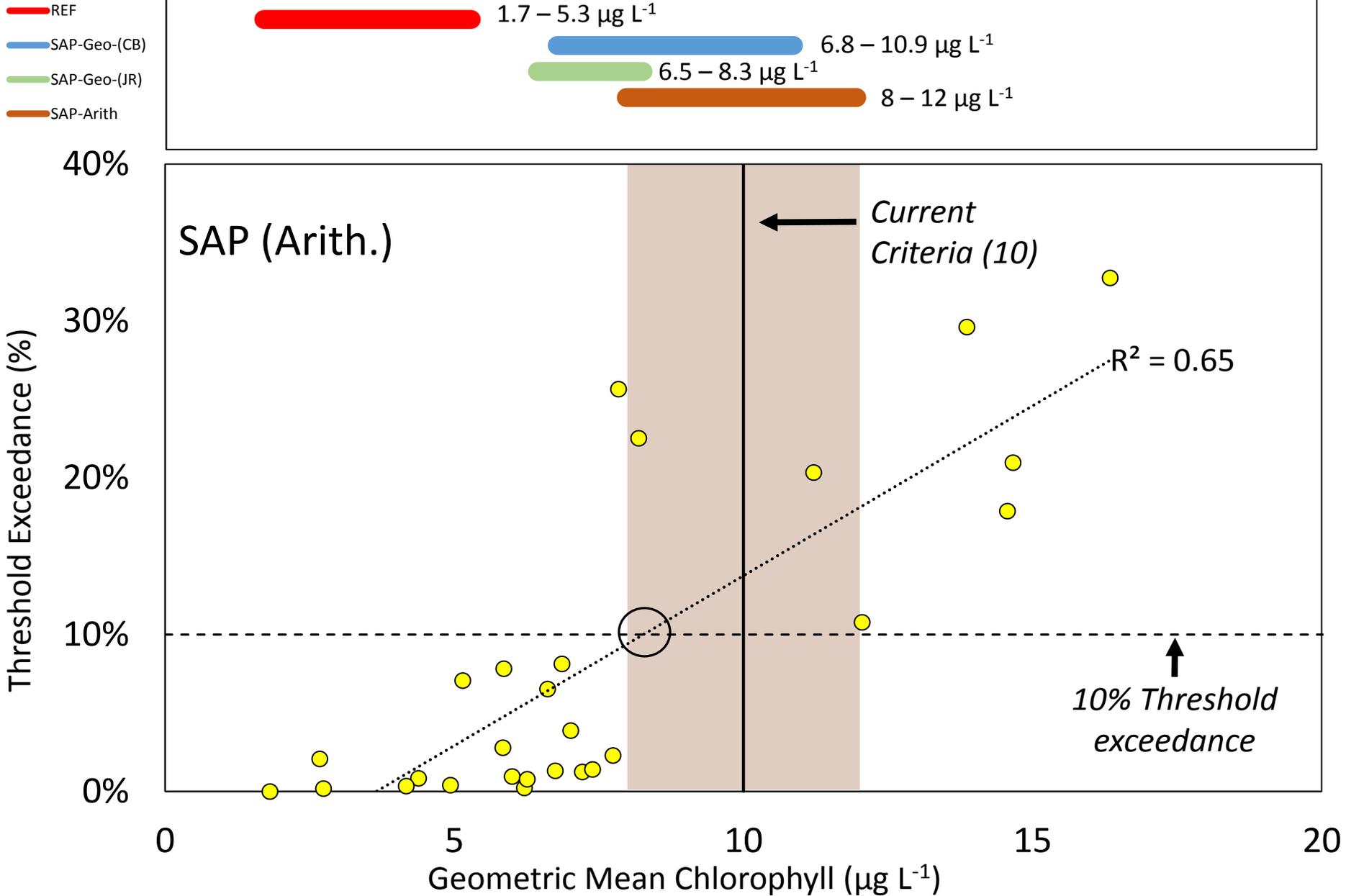
- Current criterion falls above the James River specific defensible range
- Water clarity regression line intersection with 10% threshold indicates current criterion is not protective

Recommendation: Re-set the criterion value to 11 ug/L, to be protective of the 10% threshold.

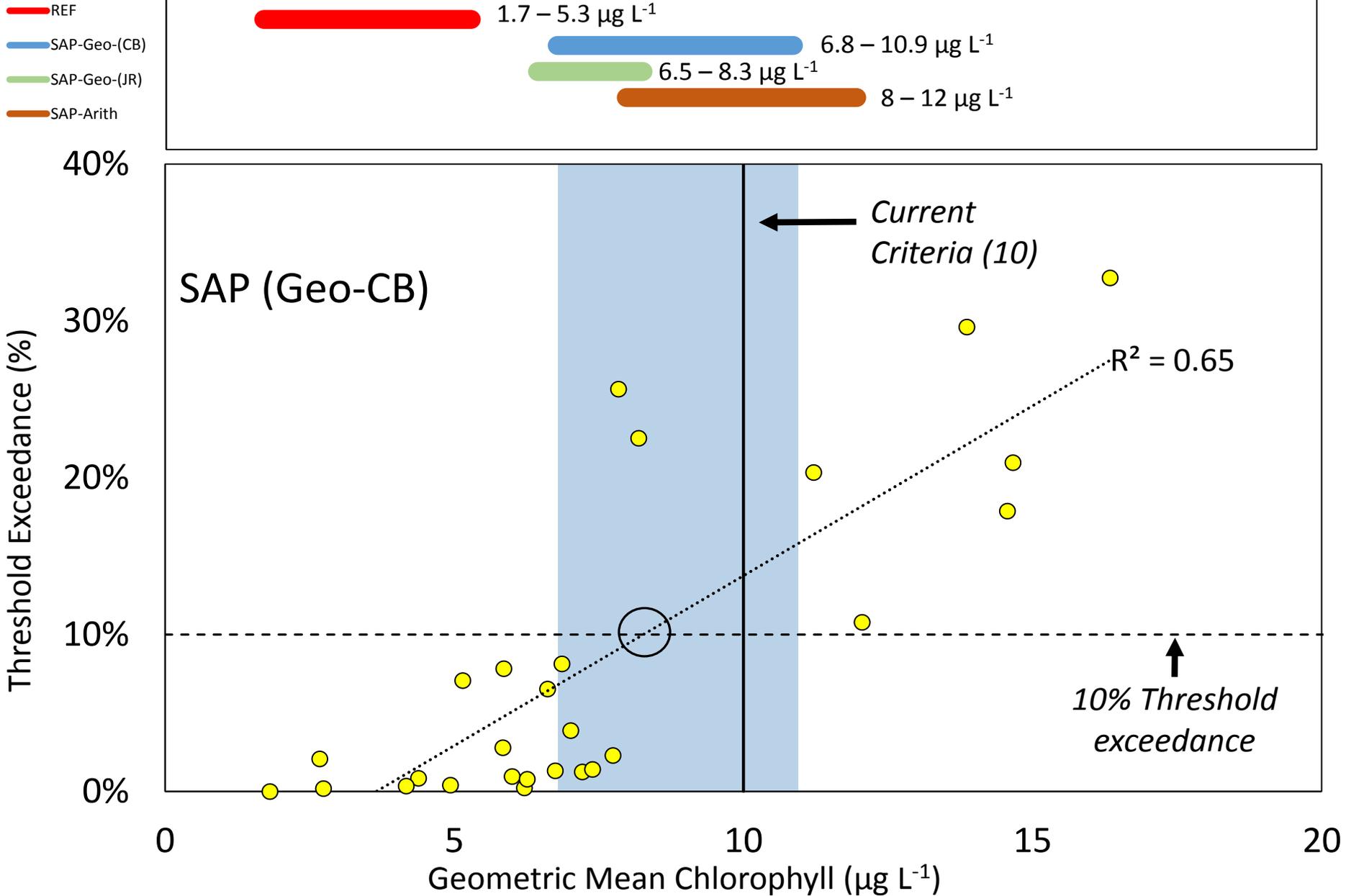
Polyhaline Summer



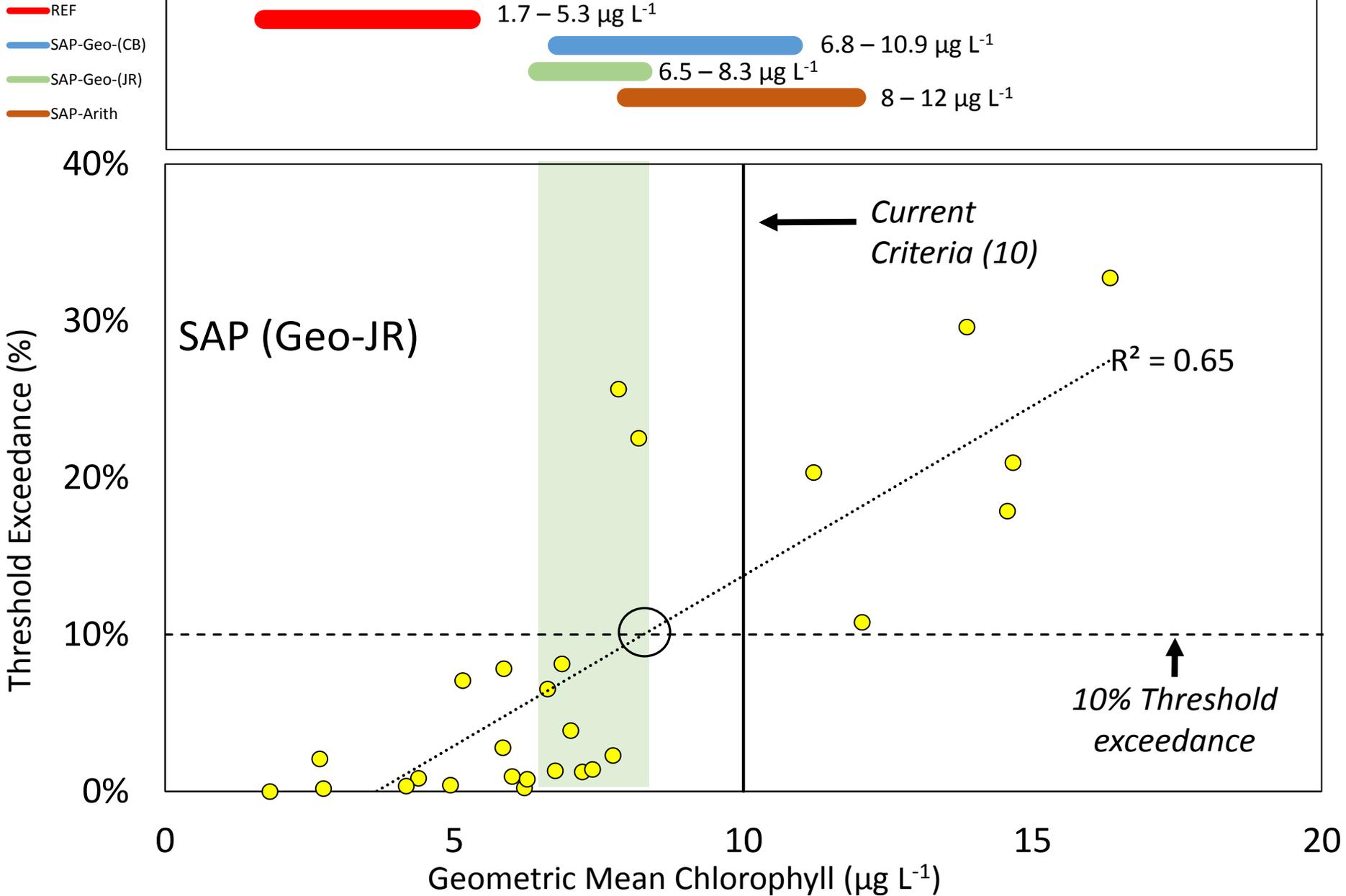
Polyhaline Summer



Polyhaline Summer



Polyhaline Summer



Polyhaline Summer

Evaluation:

- Current criterion falls above the James River specific defensible range
- HAB regression line intersection with 10% threshold indicates current criterion is not protective

Recommendation: Re-set the criterion value to 8 ug/L, the concentration where the HAB regression line intersects with the 10% threshold (which is also just below the upper concentration of the defensible range).

Recommended Next Steps

- Invest some time to more carefully review:
 - The list of 8 decisions and are we missing any key decisions
 - The pros and cons and what we may have missed
 - The recommendations and supporting rationale
- Provide feedback directly to DEQ, including the above as well as to allow for further discussion at future RAP meetings:
 - Interpretation of each set of segment-season graphics
 - Resultant criterion recommendations following each set of segment-season graphics

Recommended Next Steps (Con't)

- Share back with all RAP members a revised version of the proposed decisions briefing paper and supporting presentation, factoring in feedback received from members
- At the next RAP meeting, work through revised set of proposed decisions and see where we have consensus and where we need to do some more work together to reach consensus