



Creation and Usage of Model-based Sampling Strategies for Site Distribution



Criteria Assessment Protocol (CAP) Workgroup Meeting

August 11, 2025

Hybrid Chesapeake Bay Program Office

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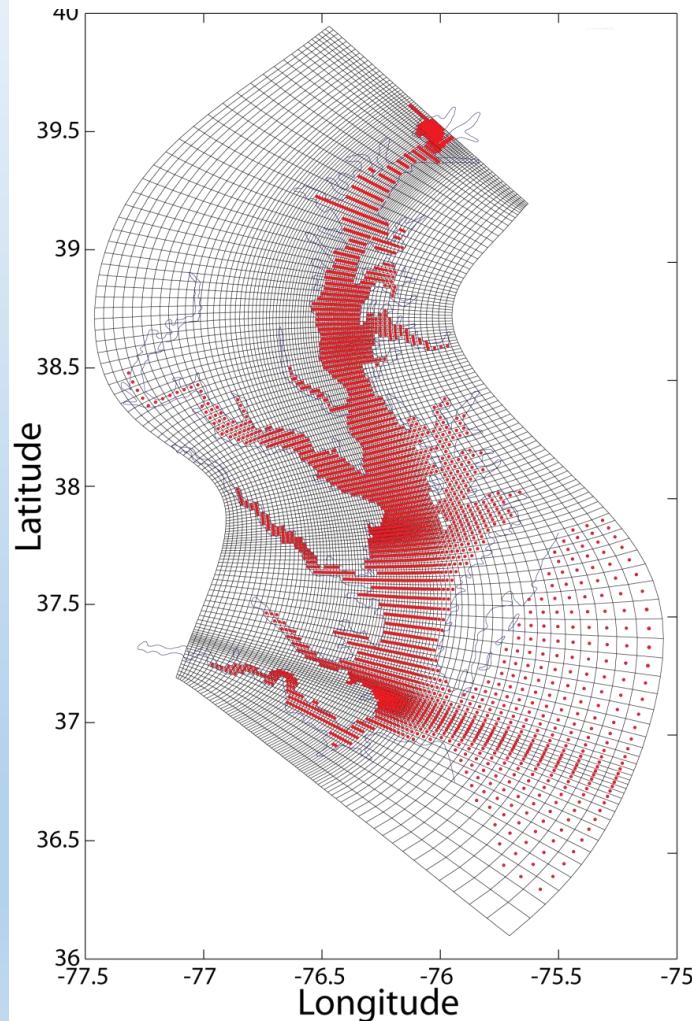
Outline and Motivation

- (1) Chesapeake Bay has a large monitoring program that aids in the assessment of water quality criteria (including dissolved O₂)
- (2) Given unavoidable limitations in the density of sampling stations in the program, do we sample enough to adequately assess criteria?

3 possibilities: (a) current sampling adequately captures criteria failure
(b) current sampling **underestimates** criterial failure (misses problem areas)
(c) current sampling **overestimates** criteria failure (biased sampling)
- (3) Can we optimize sampling technology and station density for effective criteria assessment?
- (4) An approach will be presented that uses numerical model simulations as “data” that can be sampled using a variety of existing technologies within a range of potential effort
 - How many more stations are needed to capture criteria failure?
 - Can those stations include discrete sampling, or are continuous sensors needed?

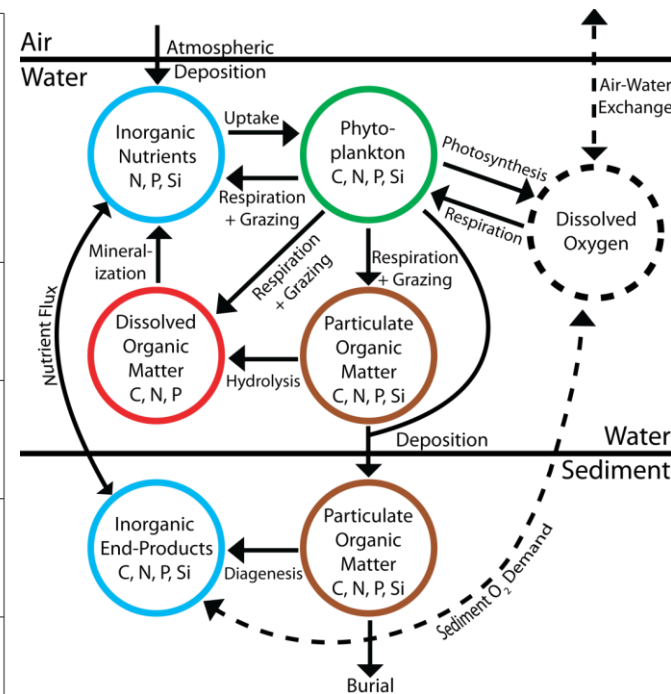
Models as Data to Fully Represent System in Time and Space

a) ROMS-RCA



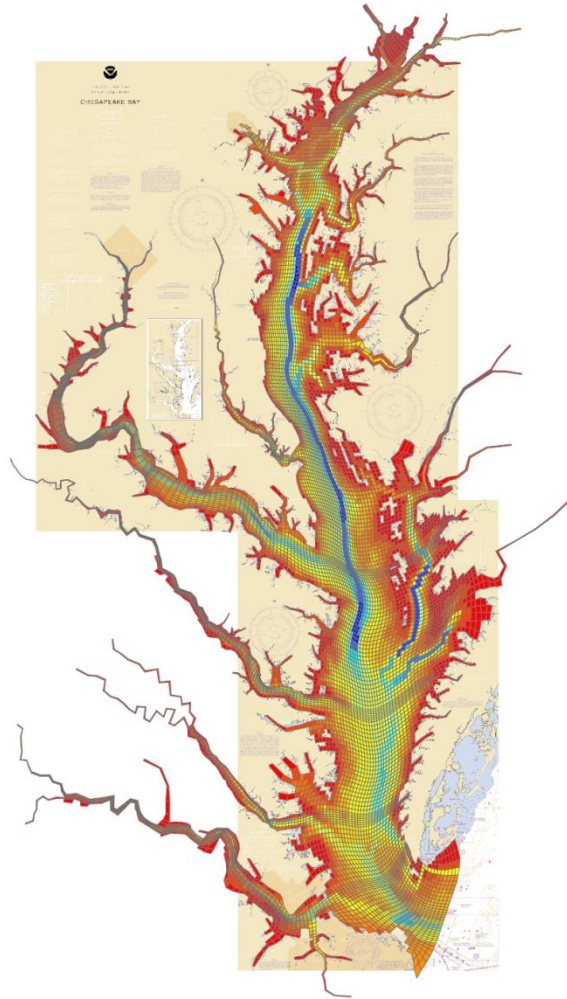
(Testa et al. 2014)

(b)



*Similar Biogeochemistry
in Both Models*

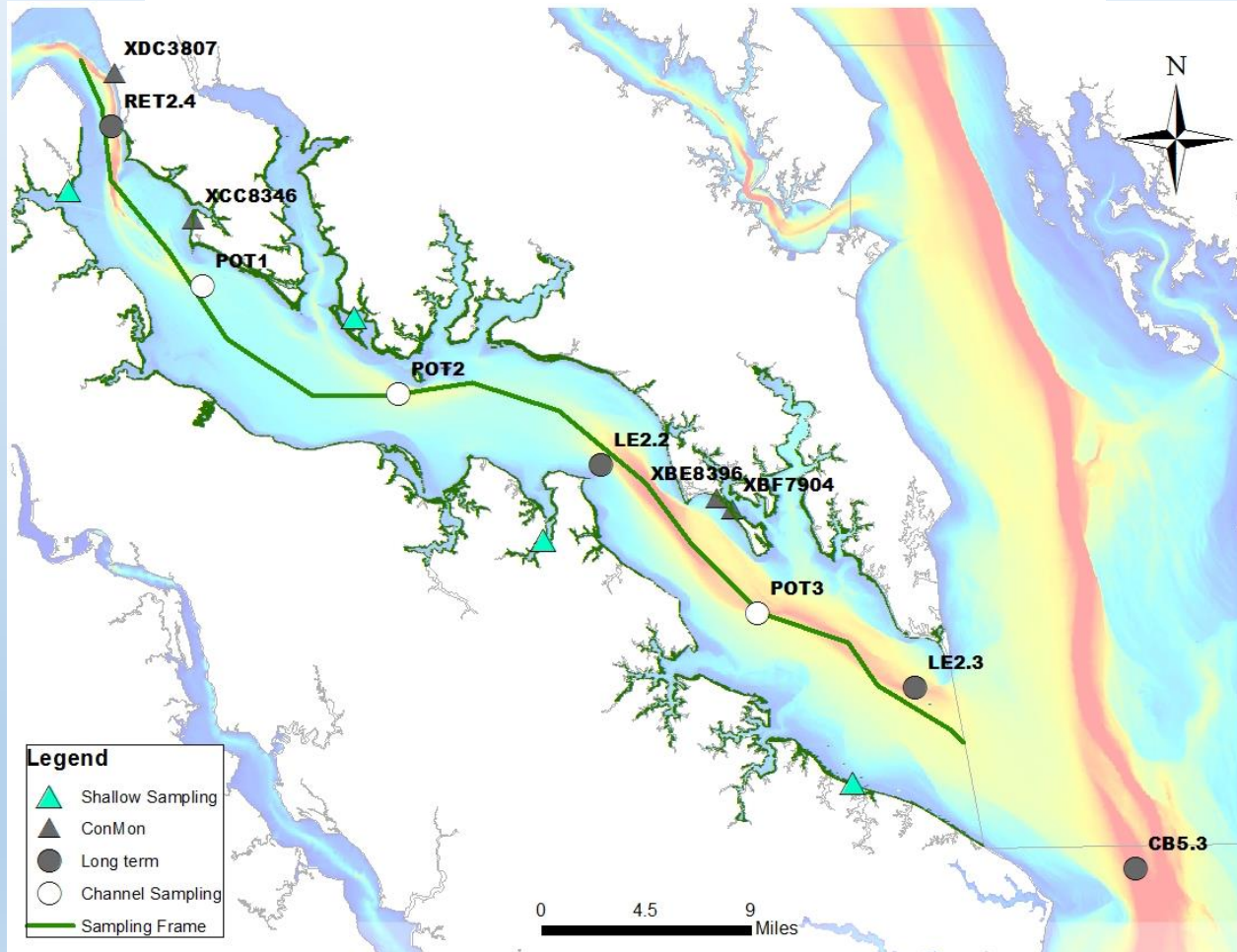
EPA/ACOE Water Quality and
Sediment Transport Model



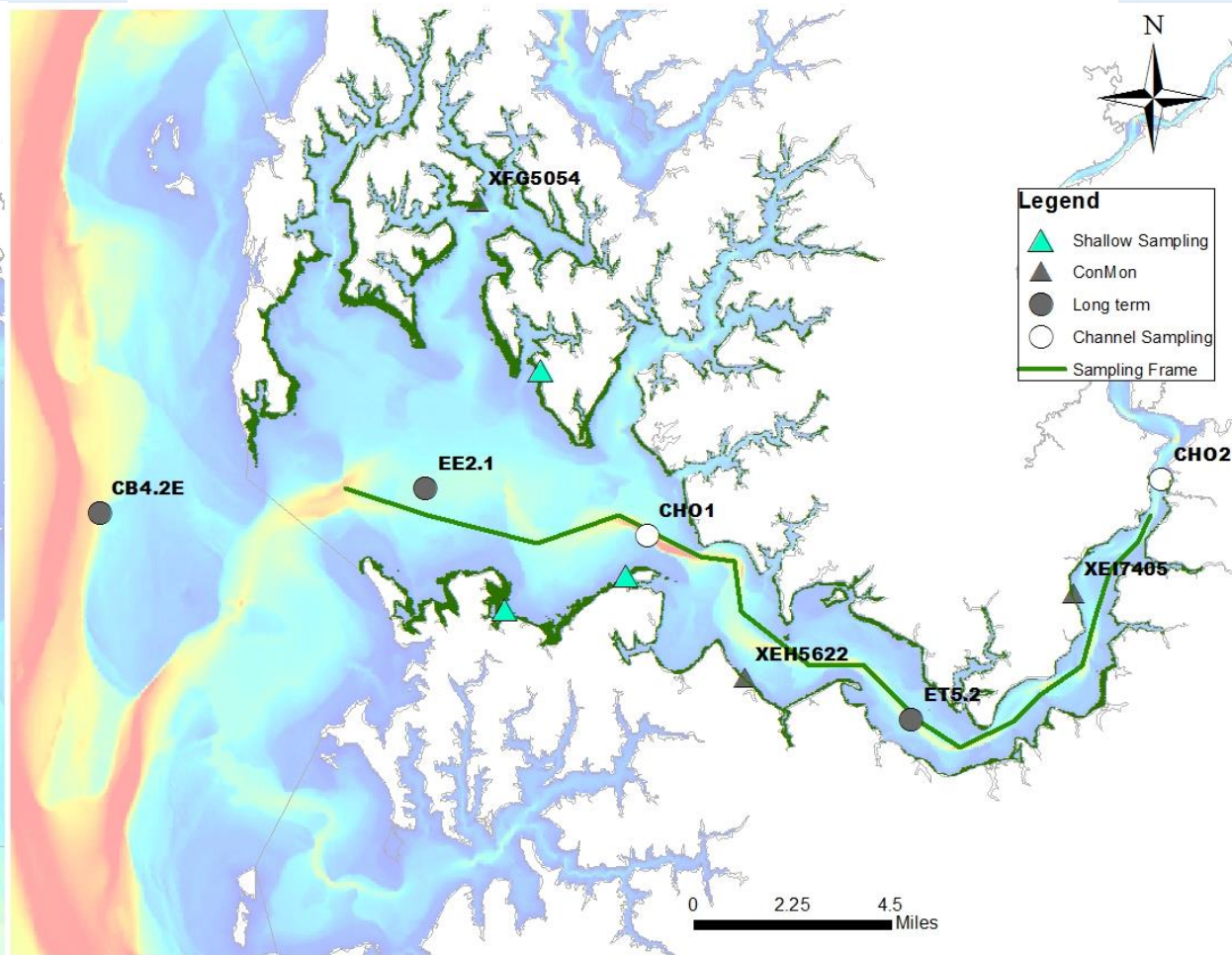
(Cercio and Noel 2010)

Sampling Designs

Mesohaline Potomac River

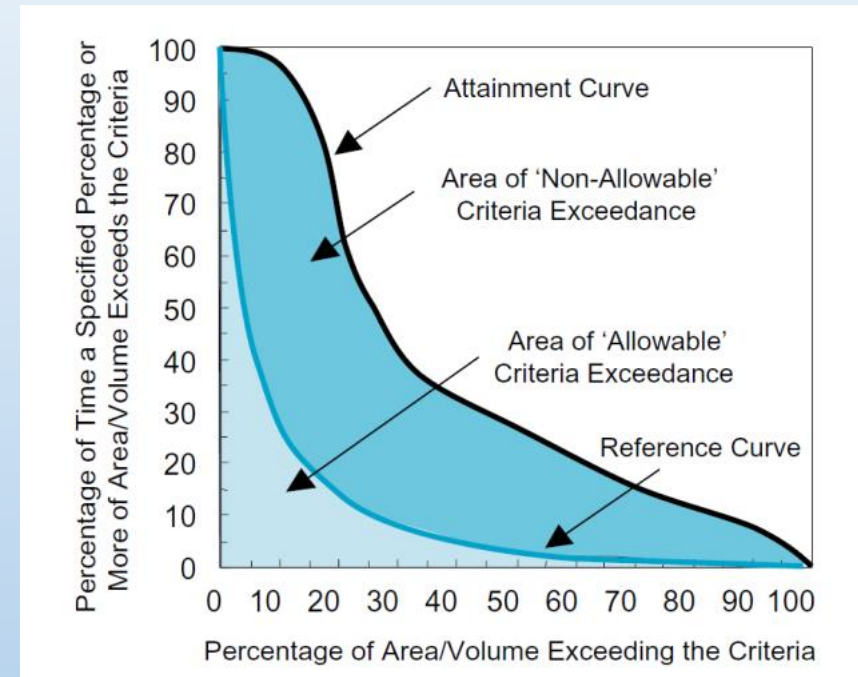
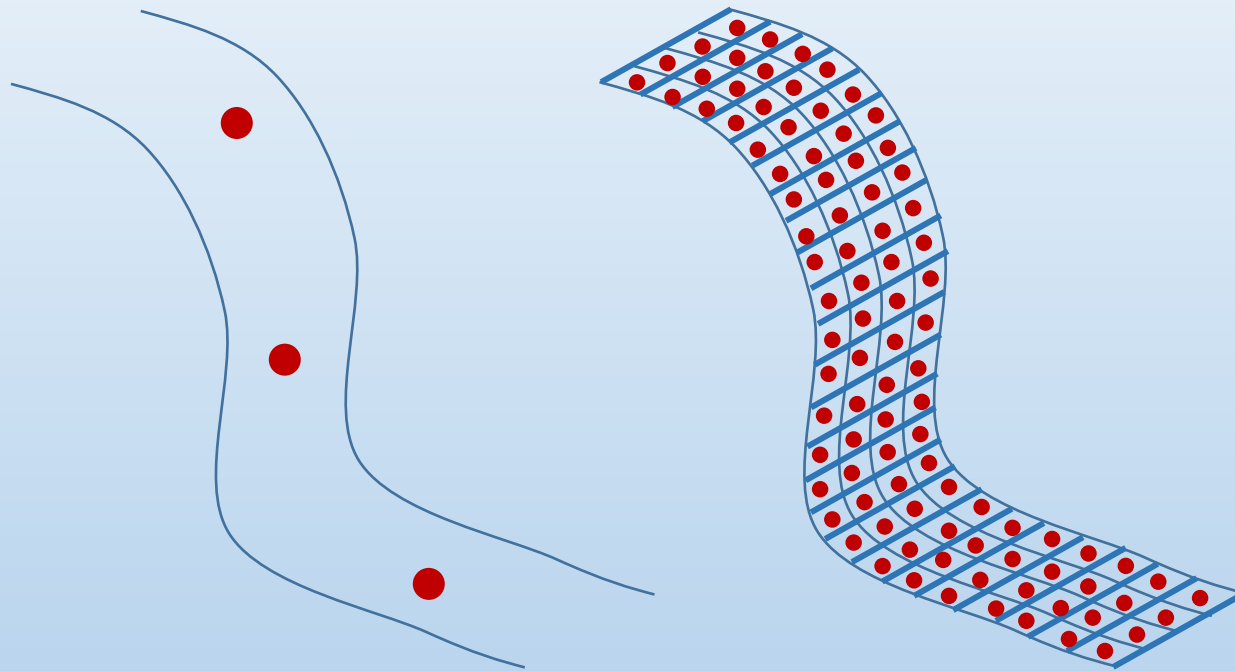


Mesohaline Choptank River



Approach to Computing Cumulative Frequency Diagram from Sub-Sampling of Numerical Model

(25 Monthly Cruises: BAY524 – BAY566)

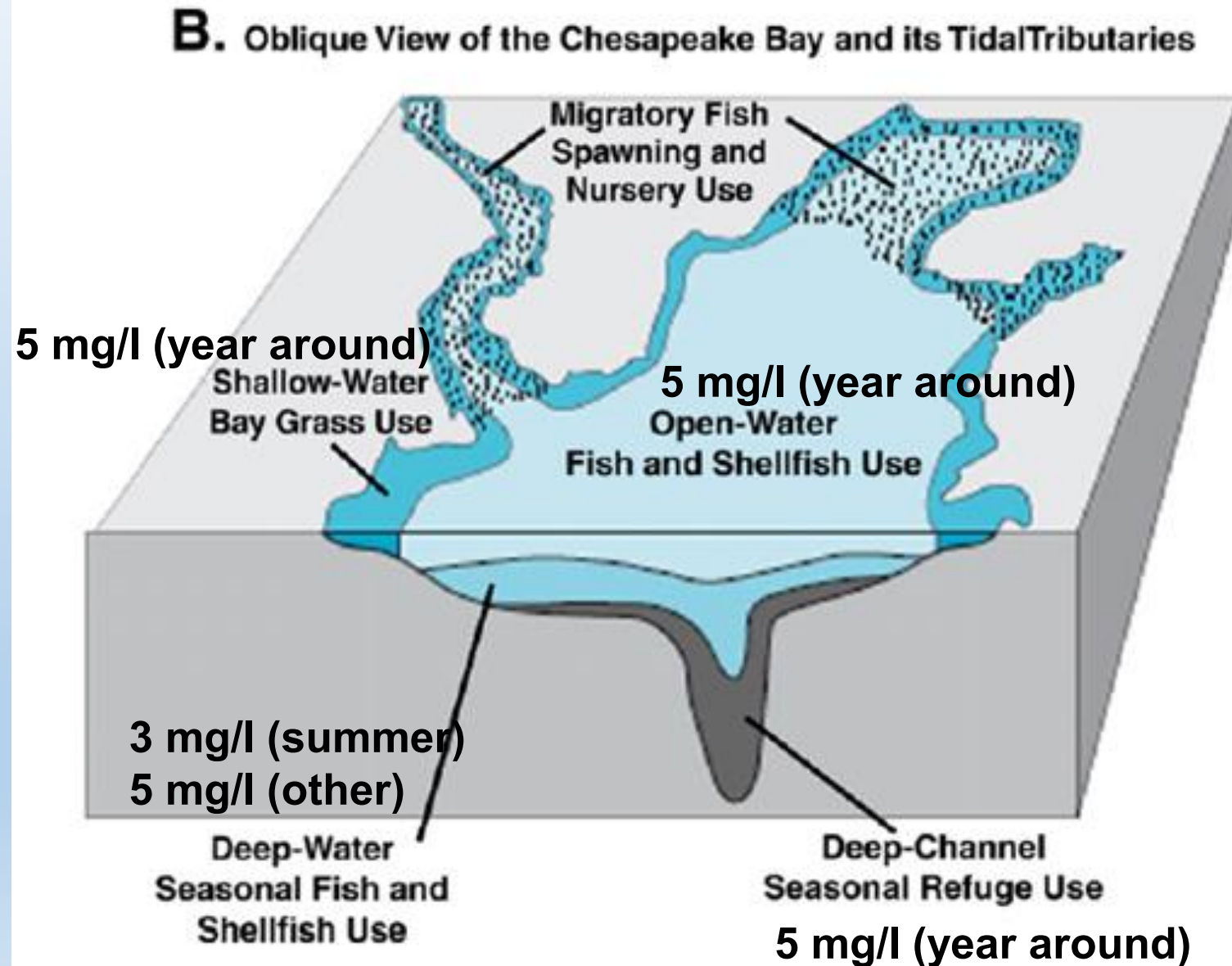


(1) Sample Water Body → Interpolate to Grid → Compute CFD (space, time)

Vol3DInterp



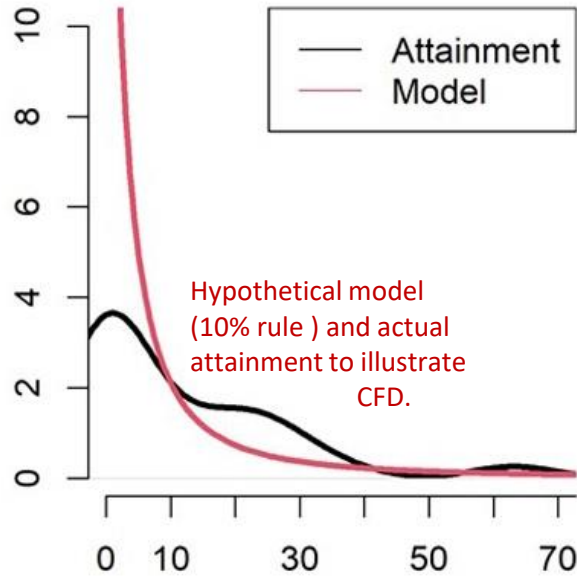
Habitat Assessment for Dissolved Oxygen Criteria



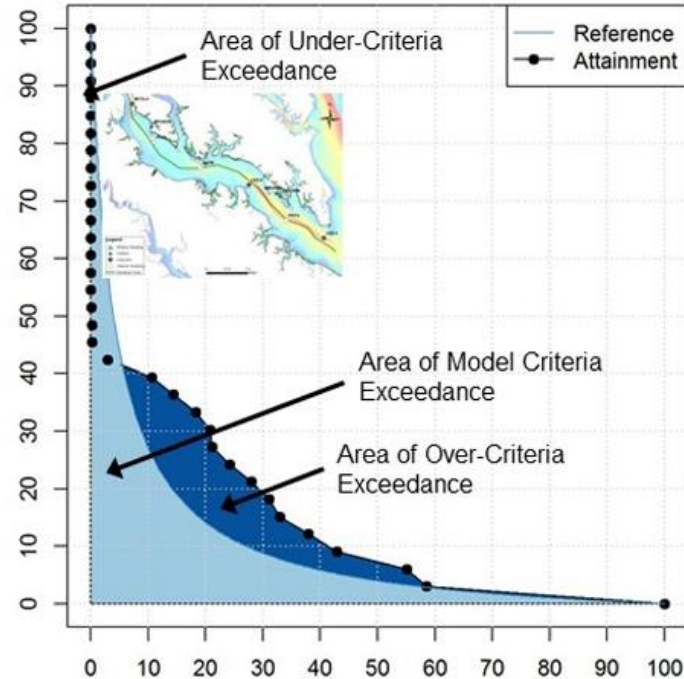
(Batiuk et al. 2014)

CFD Plots as Metrics of Attainment: Example from model output POTMH

Probability a Specified Percentage of Volume Exceeds the Criteria

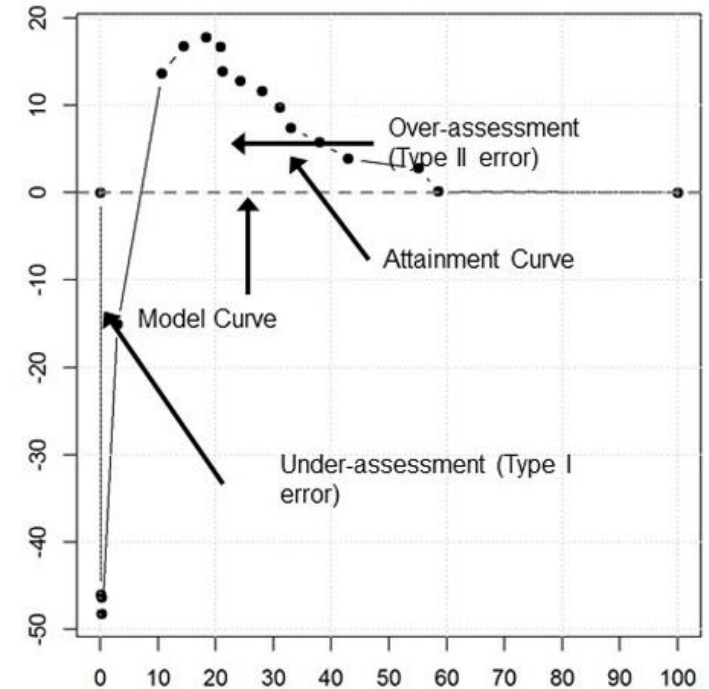


Percentage of Time a Specified Percentage of Volume Exceeds the Criteria



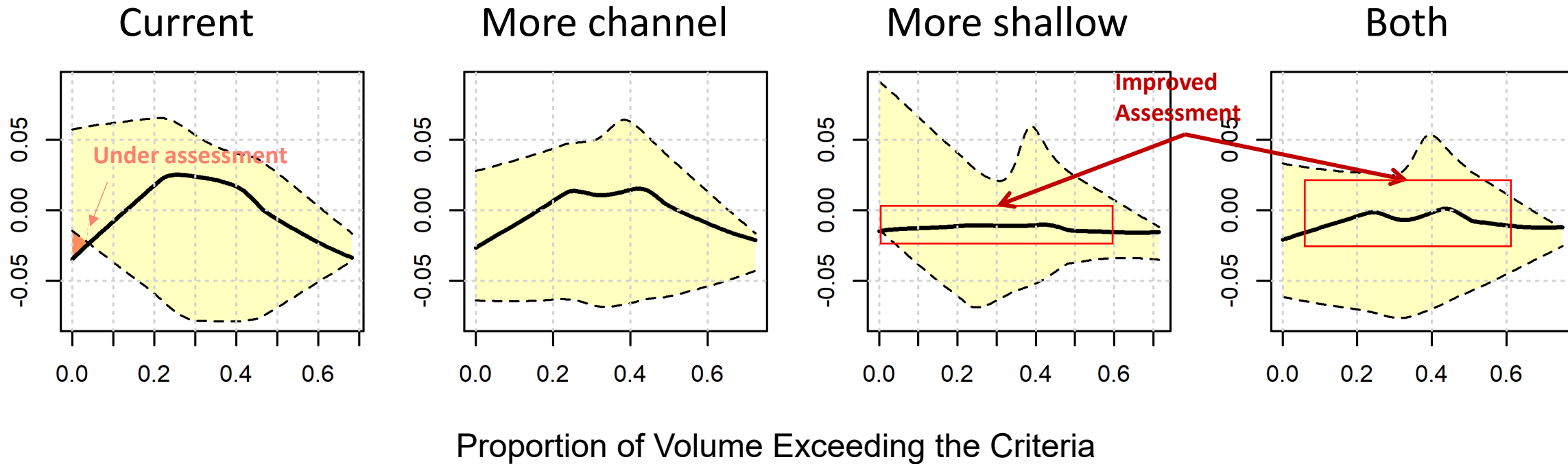
Percentage of Volume Exceeding the Criteria

Residual of Time a Specified Percentage of Volume Exceeds the Criteria



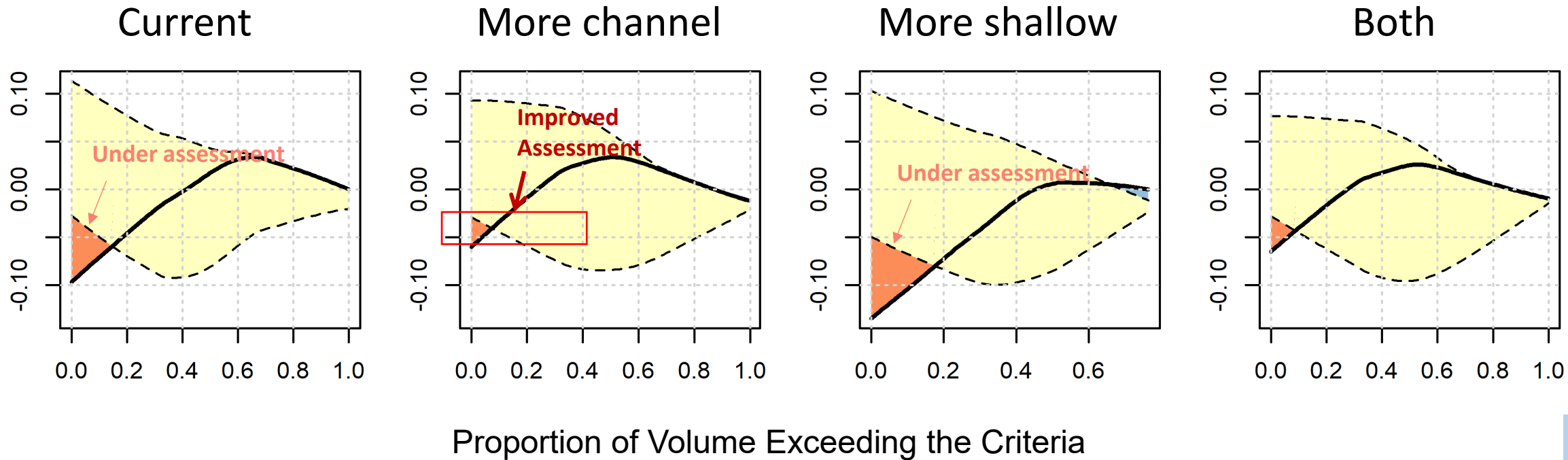
Effects of Additional Sampling in Potomac Mesohaline (POTMH)

Residual Proportion of Time a Specified Percentage of Volume Exceeds the Criteria



Effects of Additional Sampling in Choptank Mesohaline (CHOMH)

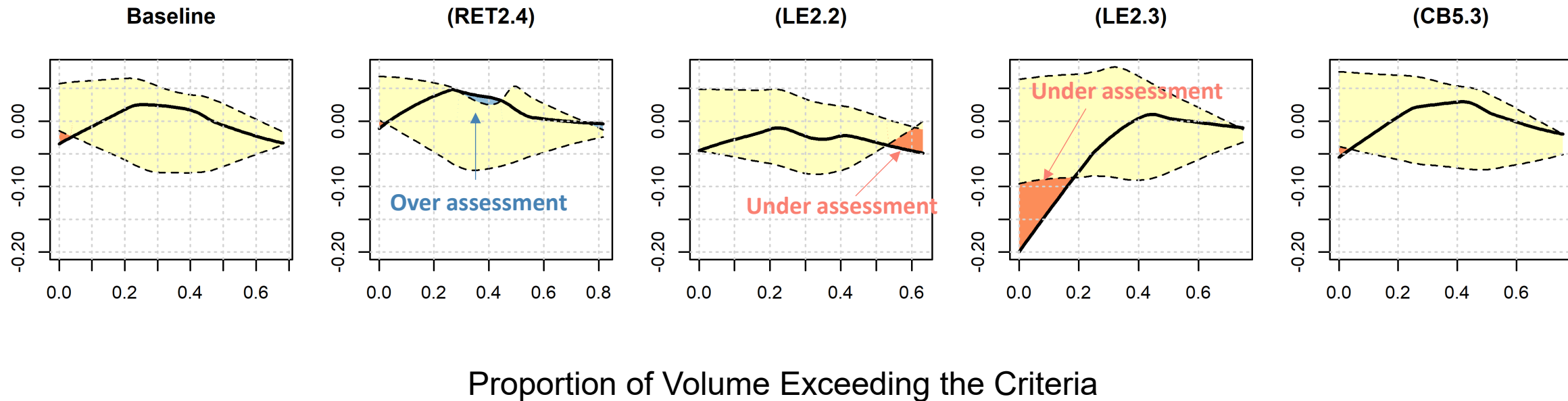
Residual Proportion of Time a Specified Percentage of Volume Exceeds the Criteria



Effects of Removing One Fixed Station on Criteria Exceedance (POTMH)

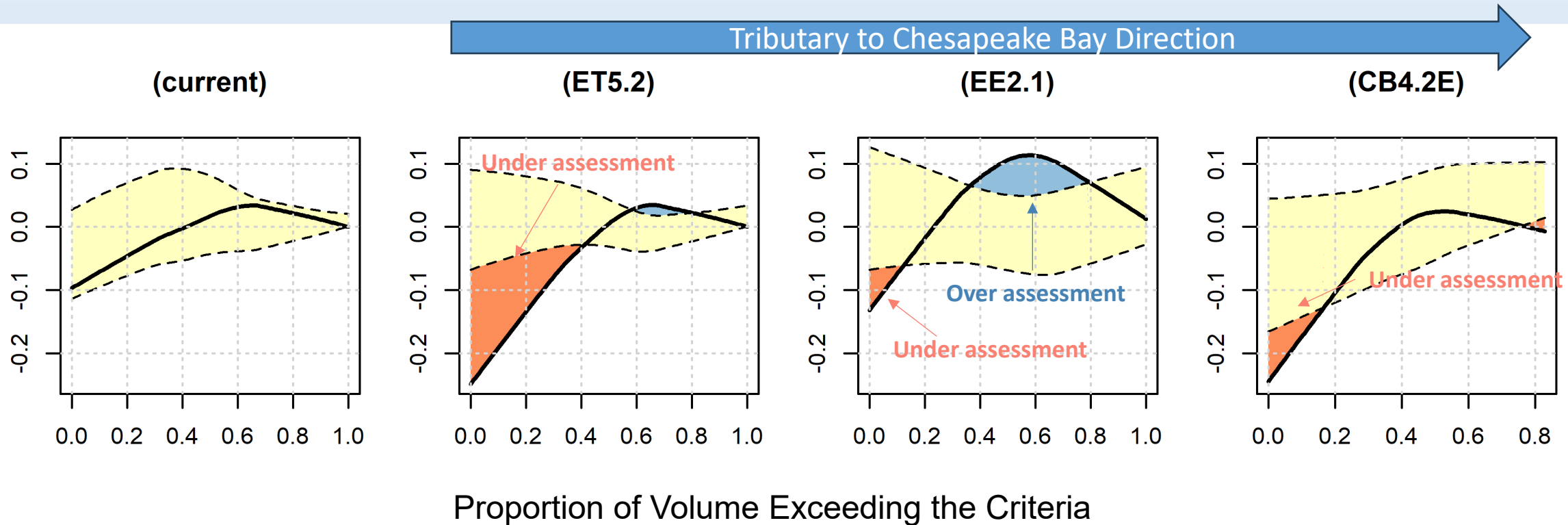
Residual Proportion of Time a Specified Percentage of Volume Exceeds the Criteria

Tributary to Chesapeake Bay Direction



Effects of Removing One Fixed Station on Criteria Exceedance (CHOMH)

Residual Proportion of Time a Specified Percentage of Volume Exceeds the Criteria



Results

- Additional long-term biweekly channel and short-term continuous shallow sampling efforts can lead to statistically unbiased and improved assessments at local spatial extents (less than 20% of the assessed waterbody).
- Stations that represented seaward regions (~20% of the area) of the tributaries were more valuable in maintaining unbiased assessments of dissolved oxygen criteria attainment.

Conclusions

- It was clear that sampling design is sensitive to the placement of deep water stations. Thus we recommend sampling in areas representing a larger portion of the estuary areas, such as additional channel stations in the seaward portion of the estuary. Additional shallow sampling efforts can also contribute to improved assessment at larger spatial extents,

Ongoing Work and Discussion

- Goal: Define a prioritization scheme for monitoring segments. How is the scheme structured?
 - Focus on where restoration has happened?
 - Re-orient sampling to historically unmeasured locations?
 - We explored more shallow, more deep, and both scenarios. What do we want to explore now?
- Ensure monitoring resource availability and limitations in creating an accurate assessment of habitat conditions.

Interpretation Batiuk et al. 2014

Legend

Batiuk report

Taken from the closest reported criteria in the same habitat

Taken from the Deep-water criteria

Habitat	Depth description	Assessment period	O2criteria (mg/L)			
			30-day mean	7-day mean	1-day mean	Instantaneous minimum
Open-water fish and shellfish use / Migratory fish spawning and nursery use	Cells less than or equal to 2 m in cells deeper than 2 m	Feb 1 to May 31	6	6	6	5
		June 1 to Jan 31	5	4	4	3.2
Deep-water fish and shellfish use	All cells between 2 and 8 m	June 1 to Sep 30	3	3	2.3	1.7
		Oct 1 to May 31	5	4	4	3.2
Deep-channel Seasonal refuge use	All cells deeper or equal to 8 m	June 1 to Sep 30	3	3	2.3	1
		Oct 1 to May 31	5	4	4	3.2
Shallow-water bay grass use/ Migratory fish spawning and nursery use	Entire cell depth is 2 m or less	Feb 1 to May 31	6	6	6	5
		June 1 to Jan 31	5	4	4	3.2

Effects of Profiler Sampling in Choptank Mesohaline (CHOMH) on Monthly Criteria

Tributary to Chesapeake Bay Direction

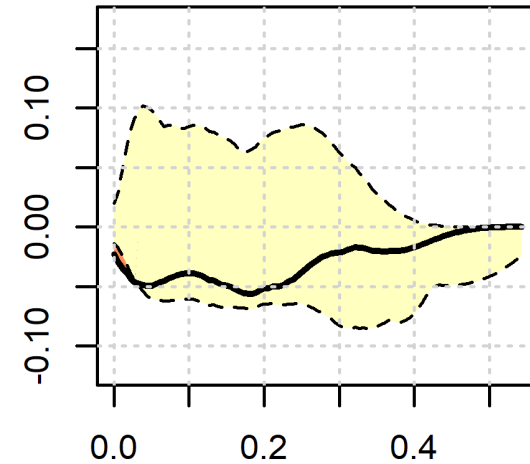
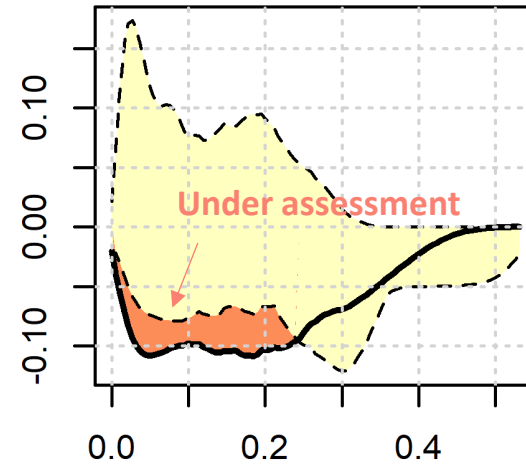
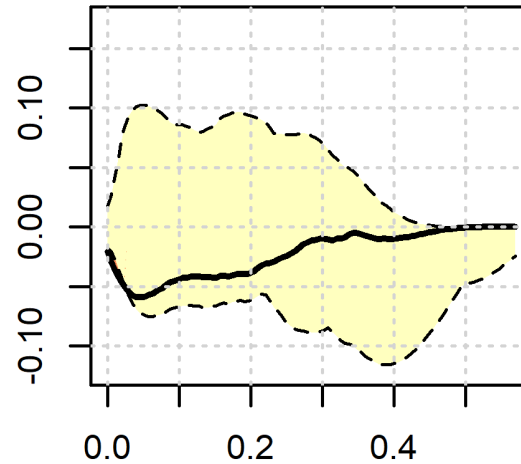
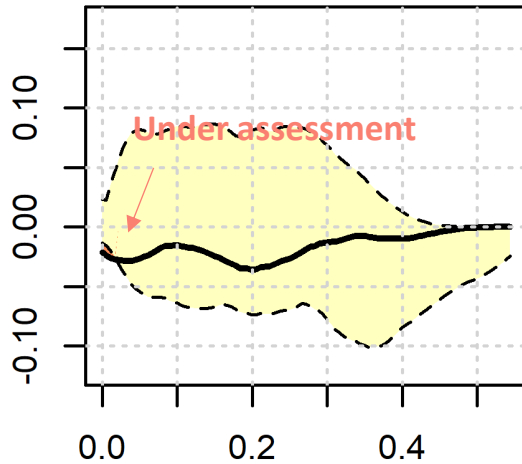
(Current)

(Chlora Point)

(Lower Choptank)

(Sharps Island)

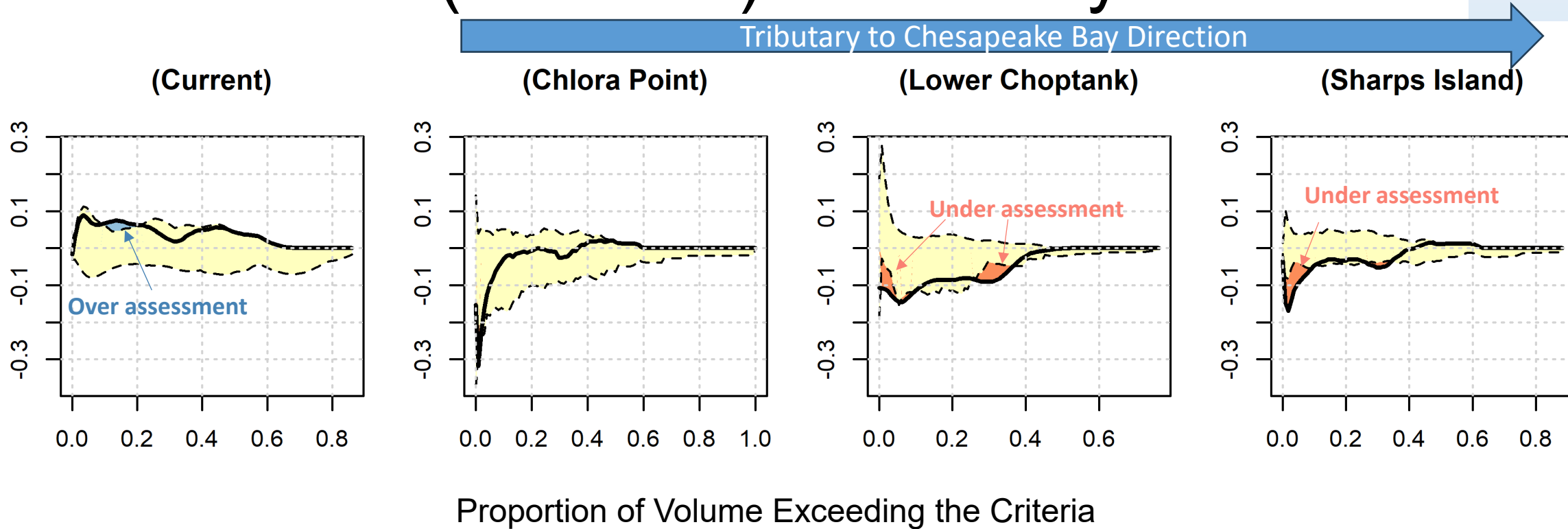
Residual Proportion of Time a
Specified Percentage of Volume
Exceeds the Criteria



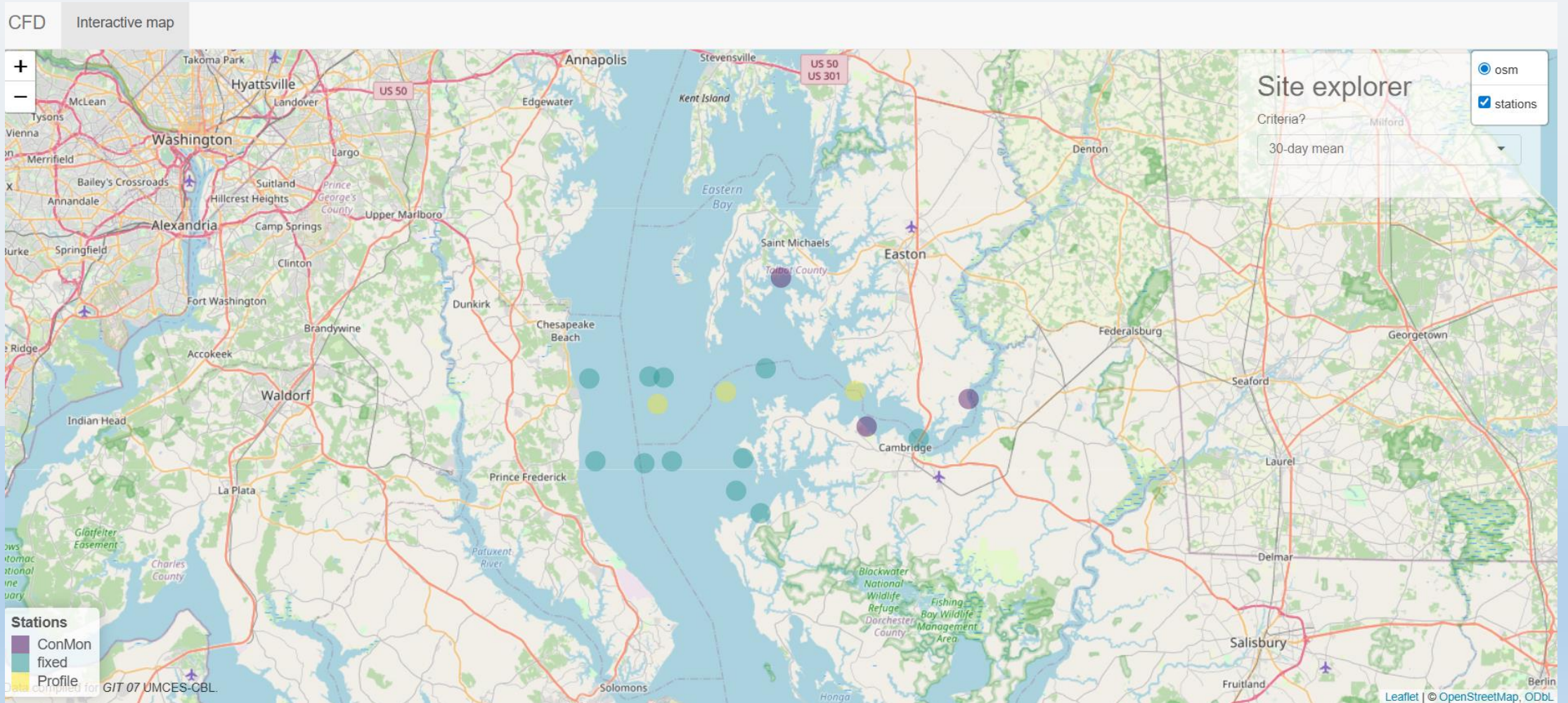
Proportion of Volume Exceeding the Criteria

Effects of Profiler Sampling in Choptank Mesohaline (CHOMH) on Weekly Criteria

Residual Proportion of Time a Specified Percentage of Volume Exceeds the Criteria



A Shiny Dashboard for assessment results (Live).



4-D Interpolation to expand the CFD methodology?

