Estimated Oyster Aquaculture Influence on Chesapeake Water Quality

Modeling Workgroup Conference Call

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Chesapeake Bay Program
Science, Restoration, Partnership

Oyster Aquaculture Buildout Scenario on 2025 WIP Conditions

Sensitivity Runs

- Oyster aquaculture buildout scenario on 2025 WIP conditions with load reduction representing harvested aquaculture oysters.
- Oyster aquaculture buildout scenario on 2025 WIP conditions with load reduction representing harvested aquaculture oysters and the representation of filtering capacity and other ecosystem functions of aquaculture oysters.

Oyster Aquaculture Buildout Scenario on 2025 WIP Conditions

Aquaculture Oyster Biomass In the water

- The standing stock (biomass) of aquaculture oysters is related to the harvest. We assume a linear accumulation of biomass over the grow-out period. For a three-year grow-out (bottom culture) the standing stock is then two times the harvest. For a two-year grow-out (cages), the standing stock is 1.5 times the harvest. In Maryland, roughly 80% of aquaculture is represented by cages, the remainder by bottom culture. In Virginia, roughly 80% of aquaculture is bottom culture, the remainder in cages. We will get the standing stock in both states by a weighted average of cage and bottom culture.
- The estimated maximum buildout of aquaculture harvest comes Julie Reichert and Ward Slacum of the Oyster Recovery Program and is now in CAST. This gives the number of oysters removed from the Bay at estimated maximum buildout. The spreadsheet also gives the nitrogen and phosphorus content of individual oysters. Our WQSTM quantifies oysters in carbon units. We obtain the harvest in carbon units through multiplication: # of oysters x nitrogen per oyster x carbon-to-nitrogen ratio (C:N = 6).

Oyster Aquaculture Buildout Scenario on 2025 WIP Conditions

Oyster Location

- To allocate the aquaculture oyster biomass to WQSTM cells first there was distribution of the biomass uniformly in cells that meet aquaculture criteria of salinity => 7 ppt and depth =< 12 ft.
- Then a model run was made where oysters were oysters grow freely where they could. They didn’t survive everywhere due to lack of food or other conditions.
- Aquaculture oyster biomass were in WQSTM cells which both met the salinity and depth criteria AND supported growth.

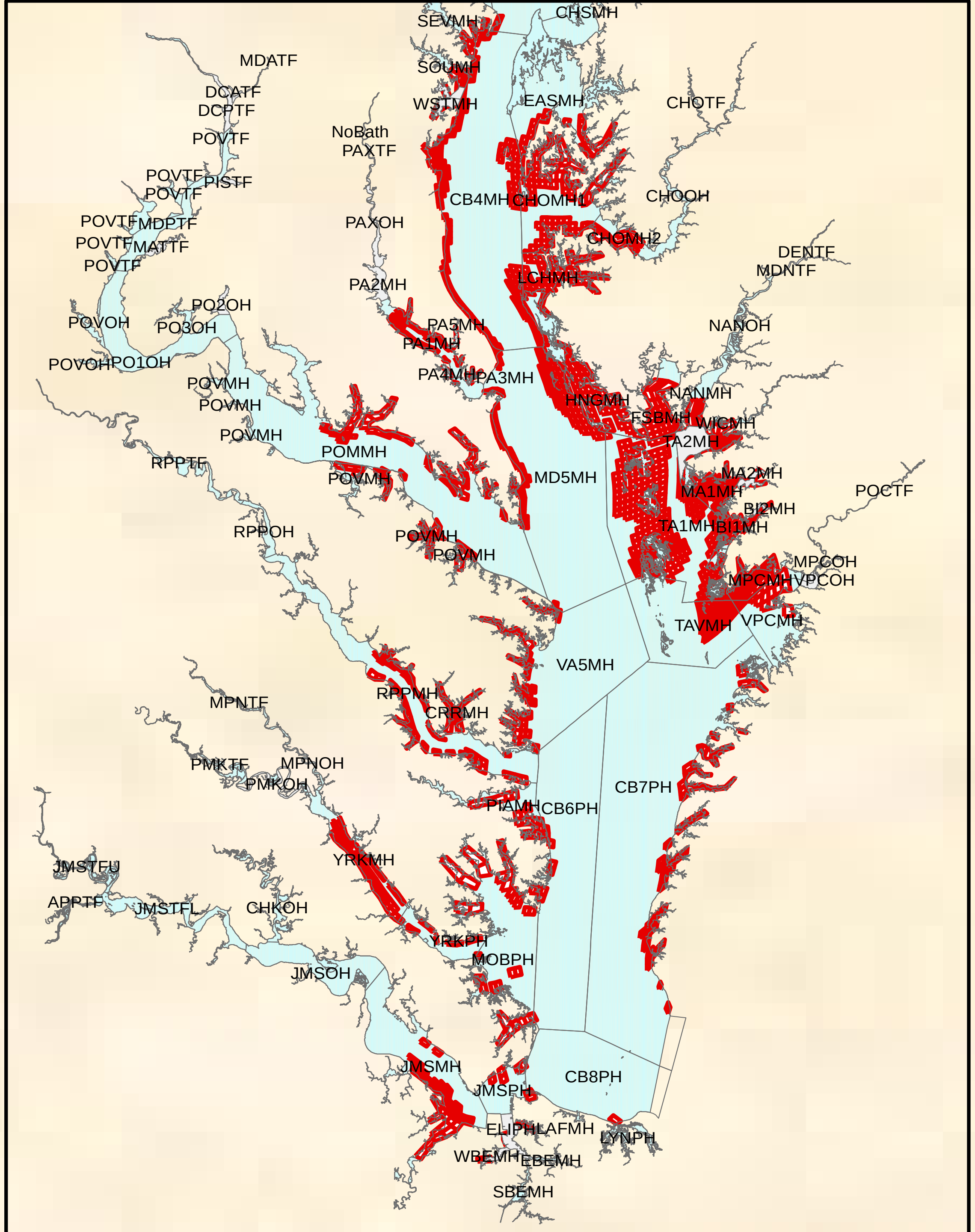
Oyster Aquaculture Buildout Scenario on 2025 WIP Conditions

Representation of Aquaculture

- The WQSTM is parameterized for market-size native oysters. We will use the present parameters to represent aquaculture oysters as well. We have a distinct aquaculture group coded into the WQSTM. For this group, nutrients in harvested oysters are removed from the system.
- The WQSTM places oysters on the bottom. For the initial run, we will continue with this representation. The maximum depth we consider for aquaculture is 12 feet, represented by at most two model layers. In the future, if we wish to place oysters in the surface layer, we can do so. This requires a new filter-feeding group and some code revisions.

Oyster Aquaculture Sites

- An estimated 392 million oysters to be harvested at maximum buildout, equivalent to 468k lbs C in biomass.
- This is a 78k lbs N and 8k lbs P reduction by ingestion.
- Oyster biomass in the water column is 1.5 times the annual harvest for aquaculture in cages (80% in MD and 20% in VA).
- Oyster biomass on the bottom is twice the annual harvest for bottom culture (20% in MD and 80% in VA).



Estimated DO Attainment for Deep Channel and Deep Water With Full Oyster Aquaculture Build Out

Deep Channel DO

		WIP	Harvest	Harvest + Biogeo-chemistry
CB3MH	MD	0.00%	0.00%	0.00%
CB4MH	MD	5.87%	5.70%	5.24%
CB5MH_M	MD	0.00%	0.00%	0.00%
CB5MH_VA	VA	0.00%	0.00%	0.00%
POTMH_M	MD	0.00%	0.00%	0.00%
RPPMH	VA	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%
CHSMH	MD	0.00%	0.00%	0.00%
EASMH	MD	6.24%	6.10%	5.98%

Deep water

		WIP	Harvest	Harvest + Biogeo-chemistry
CB3MH	MD	0.05%	0.05%	0.05%
CB4MH	MD	5.00%	4.98%	4.87%
CB5MH_M	MD	0.94%	0.88%	0.80%
CB5MH_VA	VA	0.00%	0.00%	0.00%
CB6PH	VA	0.00%	0.00%	0.00%
CB7PH	VA	0.00%	0.00%	0.00%
PATMH	MD	0.67%	0.67%	0.67%
MAGMH	MD	1.21%	0.41%	0.41%
SOUMH	MD	2.96%	2.96%	2.96%
SEVMH	MD	0.00%	0.00%	0.00%
PAXMH	MD	0.00%	0.00%	0.00%
POTMH_M	MD	0.00%	0.00%	0.00%
RPPMH	VA	0.00%	0.00%	0.00%
YRKPH	VA	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%
CHSMH	MD	0.00%	0.00%	0.00%
EASMH	MD	0.45%	0.45%	0.45%

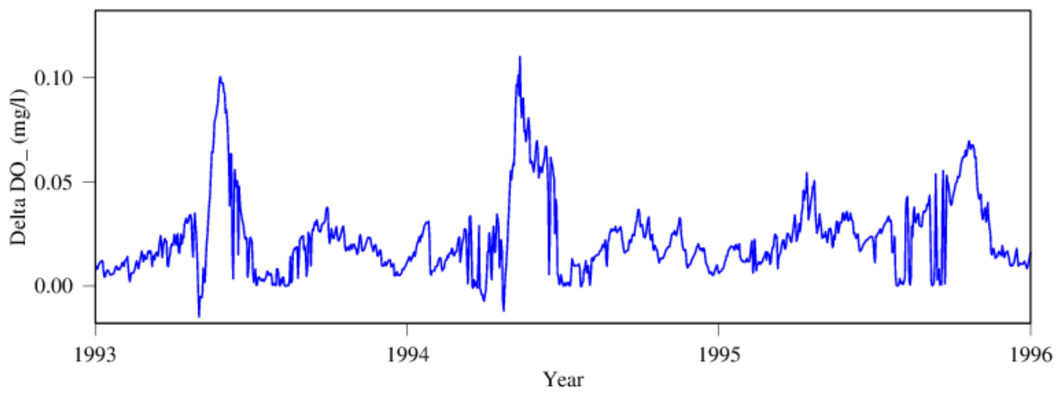
DO Open Water Attainment

No change estimated anywhere in the Open Water DO standard

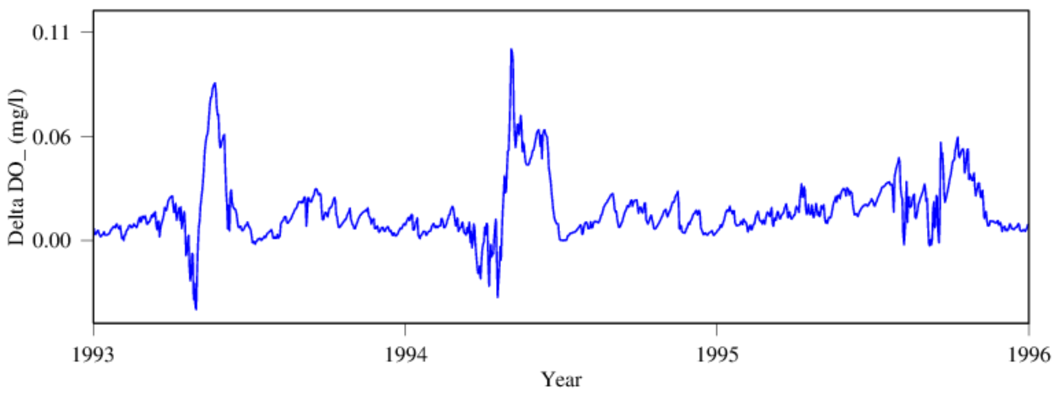
		WIP	Harvest	Harvest + Biogeo-chemistry
JMSPH	VA	0.00%	0.00%	0.00%
WBEMH	VA	7.80%	7.80%	7.80%
SBEMH	VA	25.64%	25.67%	25.66%
EBEMH	VA	8.20%	8.20%	8.20%
ELIPH	VA	0.00%	0.00%	0.00%
NORTF	MD	0.00%	0.00%	0.00%
C&Dcanal	MD/DE	0.00%	0.00%	0.00%
BOHOH	MD	0.00%	0.00%	0.00%
ELKOH	MD	0.00%	0.00%	0.00%
SASOH	MD	0.56%	0.56%	0.56%
CHSTF	MD	0.00%	0.00%	0.00%
CHSOH	MD	0.00%	0.00%	0.00%
CHSMH	MD	0.00%	0.00%	0.00%
EASMH	MD	0.00%	0.00%	0.00%
CHOTF	MD	0.00%	0.00%	0.00%
CHOOH	MD	0.00%	0.00%	0.00%
CHOMH2	MD	0.00%	0.00%	0.00%
CHOMH1	MD	0.01%	0.01%	0.01%
LCHMH	MD	0.00%	0.00%	0.00%
FSBMH	MD	0.00%	0.00%	0.00%
NANTF_DE	DE	0.00%	0.00%	0.00%
NANTF_MD	MD	0.00%	0.00%	0.00%
NANOH	MD	0.00%	0.00%	0.00%
NANMH	MD	0.00%	0.00%	0.00%
WICMH	MD	4.96%	4.96%	4.96%
MANMH	MD	0.63%	0.63%	0.63%
BIGMH	MD	0.00%	0.00%	0.00%
POCTF	MD	0.00%	0.00%	0.00%
POCOH_MD	MD	0.00%	0.00%	0.00%
POCOH_VA	VA	0.00%	0.00%	0.00%
POCMH_MD	MD	0.00%	0.00%	0.00%
POCMH_VA	VA	0.00%	0.00%	0.00%
TANMH_MD	MD	0.00%	0.00%	0.00%
TANMH_VA	VA	0.00%	0.00%	0.00%

Estimated DO Improvement In Selected CB Segments With Full Build Out of Oyster Aquaculture and Under WIP Conditions

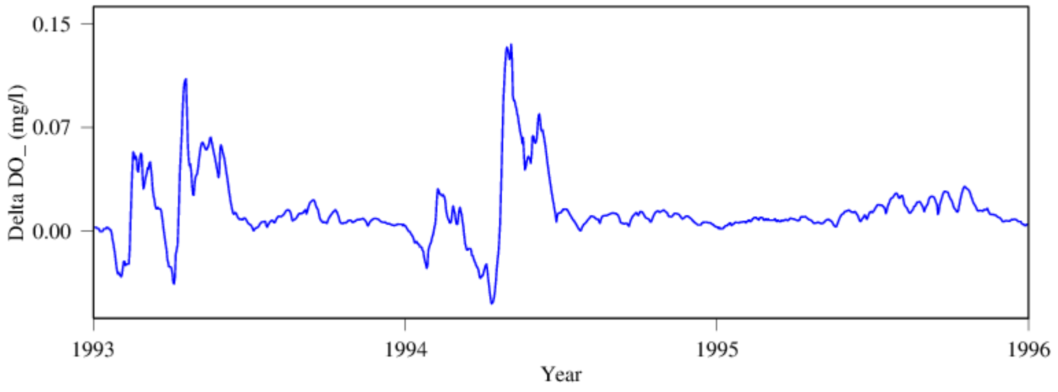
CB4 Bottom (CB4.2C)



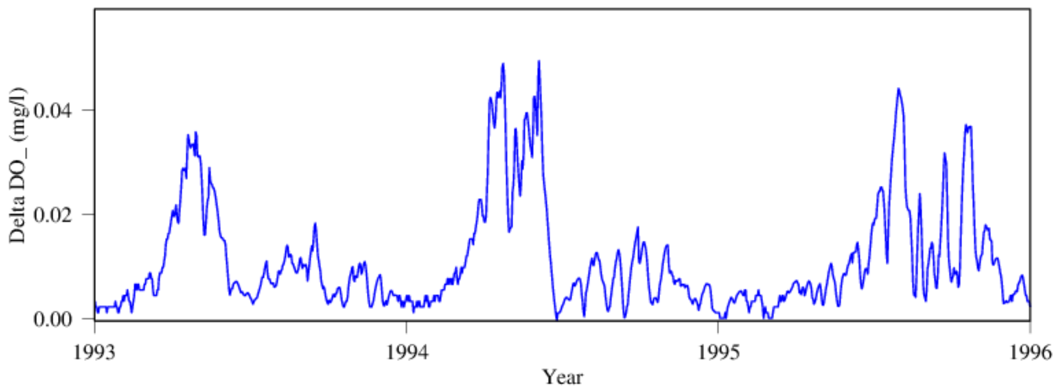
CB5 Bottom (CB5.2)



Tangier Sound (EE3.2)

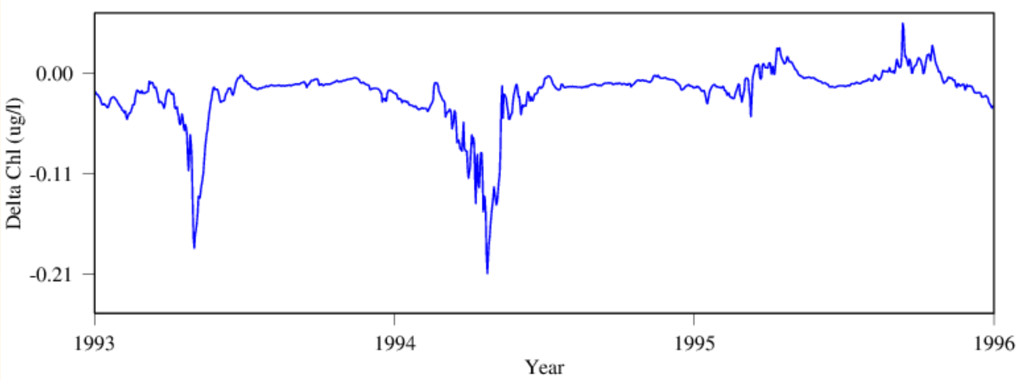


York River (LE4.2)

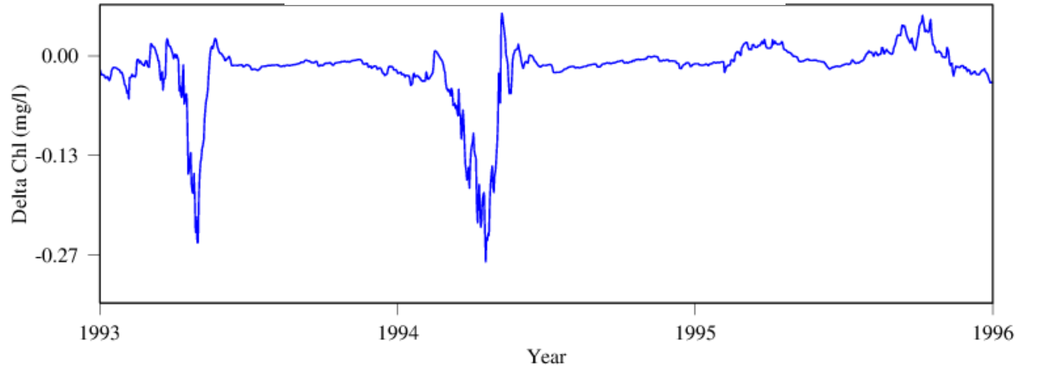


Estimated Chlorophyll Improvement In Selected CB Segments With Full Build Out of Oyster Aquaculture and Under WIP Conditions

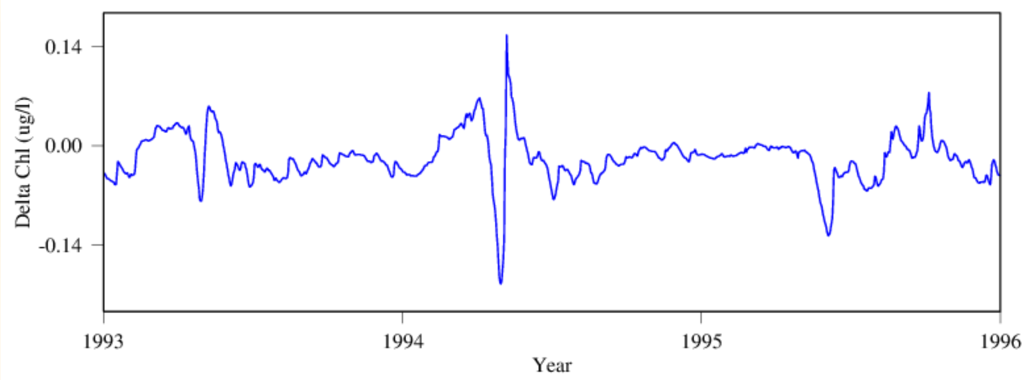
CB4 Bottom (CB4.2C)



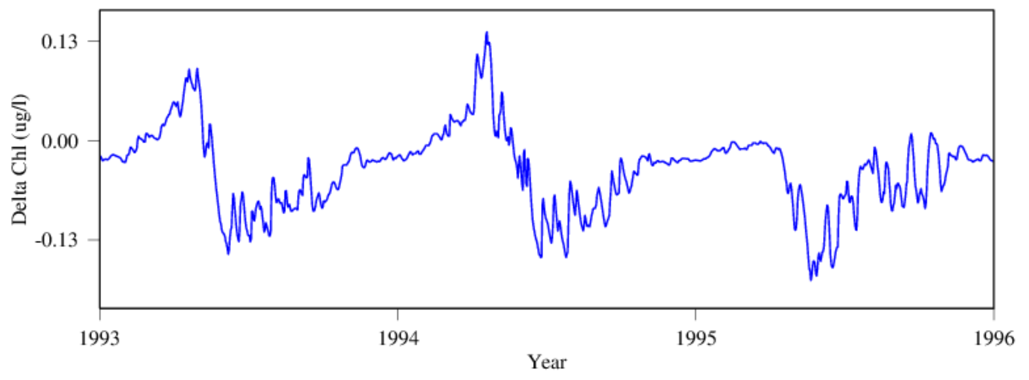
CB5 Bottom (CB5.2)



Tangier Sound (EE3.2)

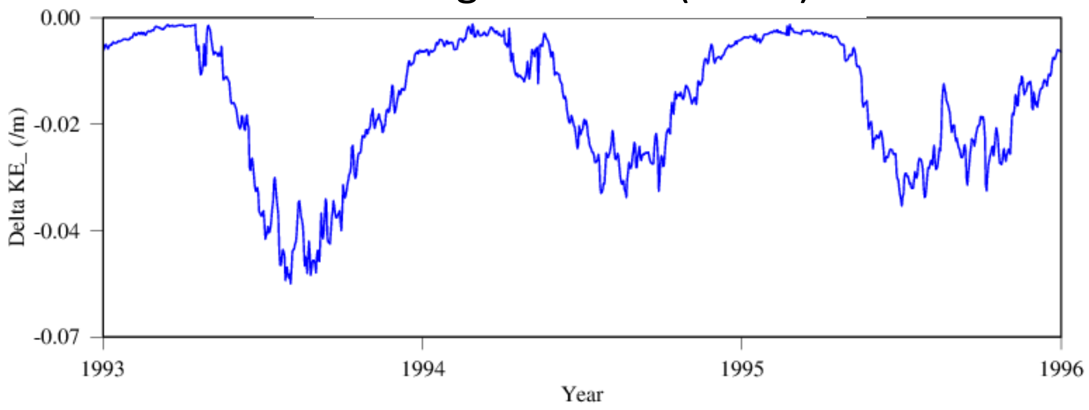


York River (LE4.2)

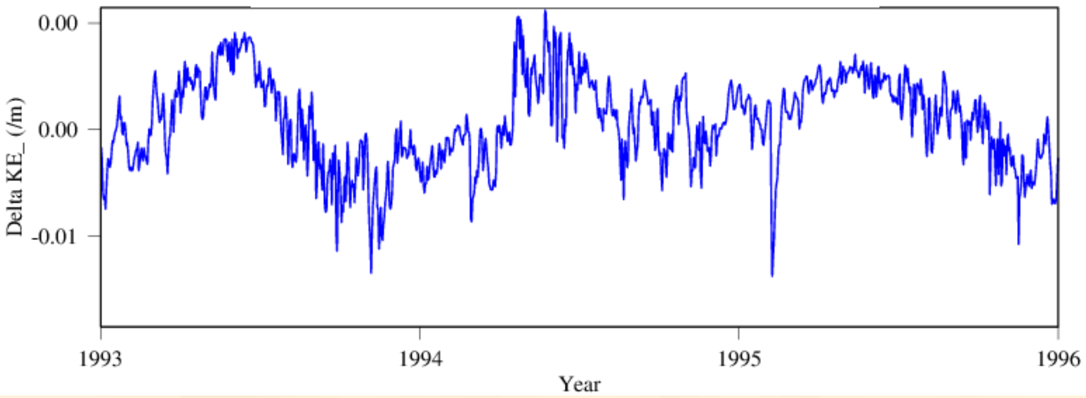


Estimated Light Attenuation Improvement In Selected CB Segments With Full Build Out of Oyster Aquaculture and Under WIP Conditions

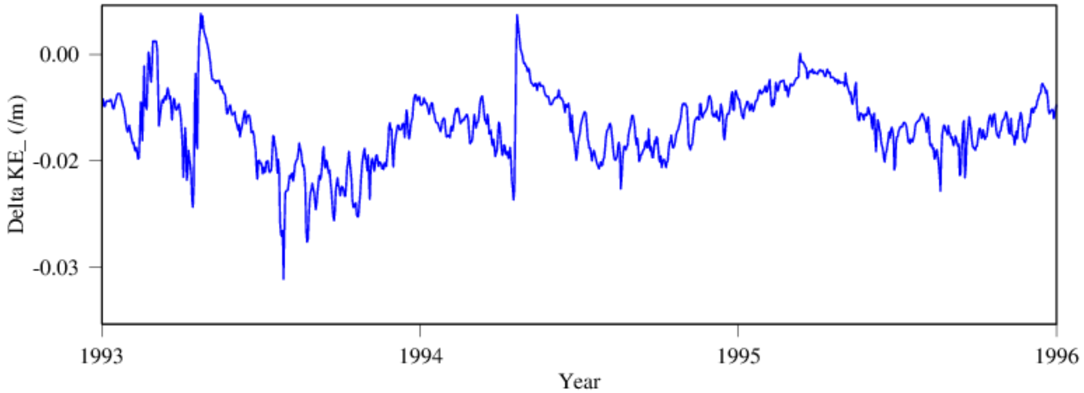
Tangier Sound (EE3.2)



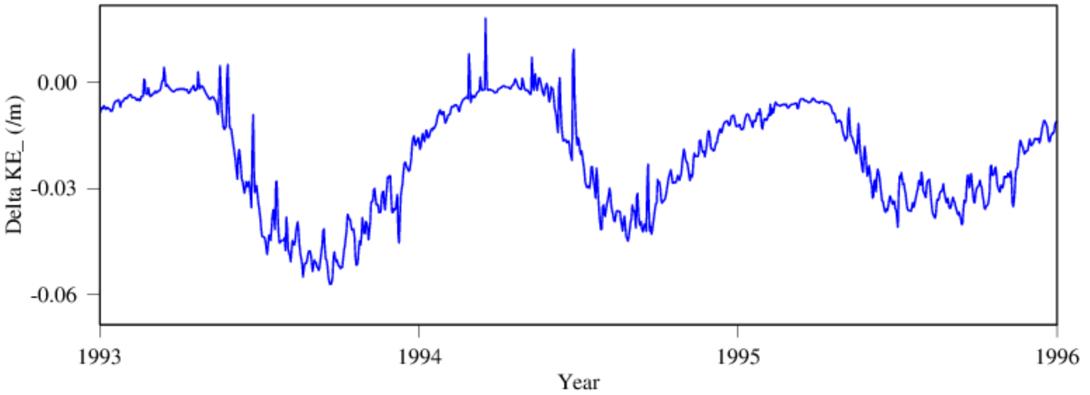
Patuxent (LE1.3)



Rappahannock LE3.2)

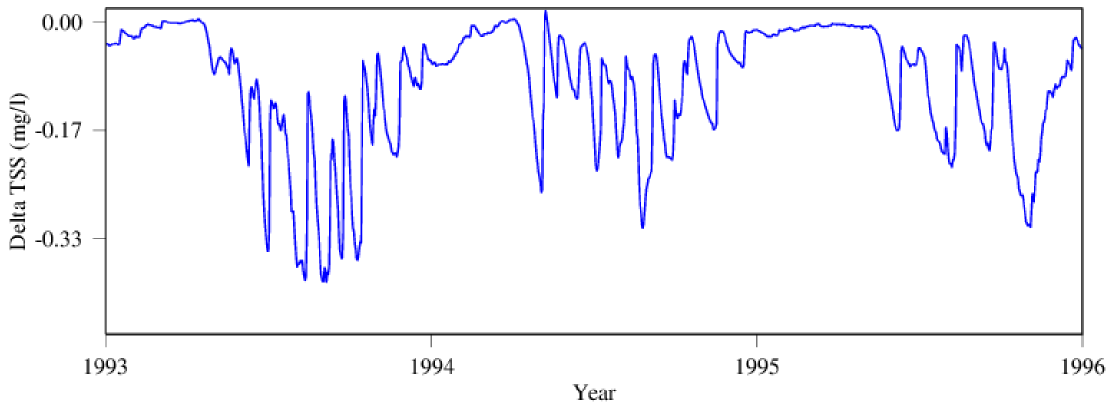


York River (LE4.2)

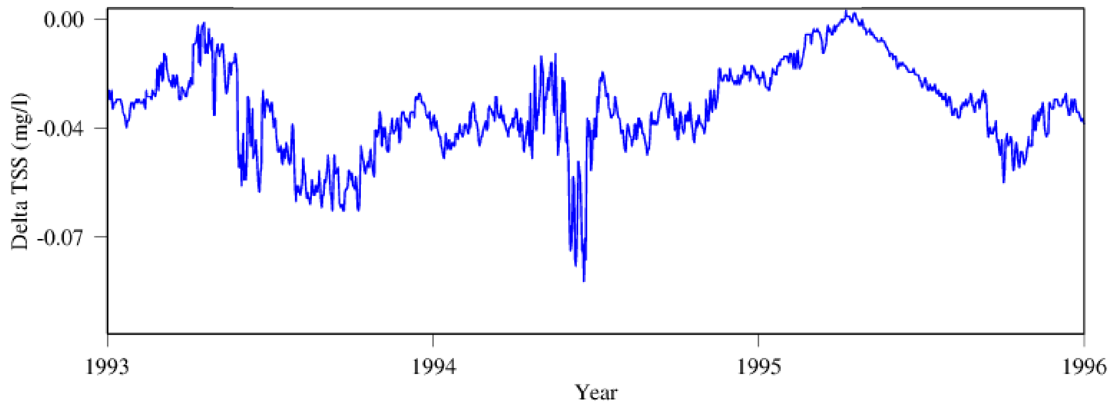


Estimated Total Suspended Sediment Improvement In Selected CB Segments With Full Build Out of Oyster Aquaculture and Under WIP Conditions

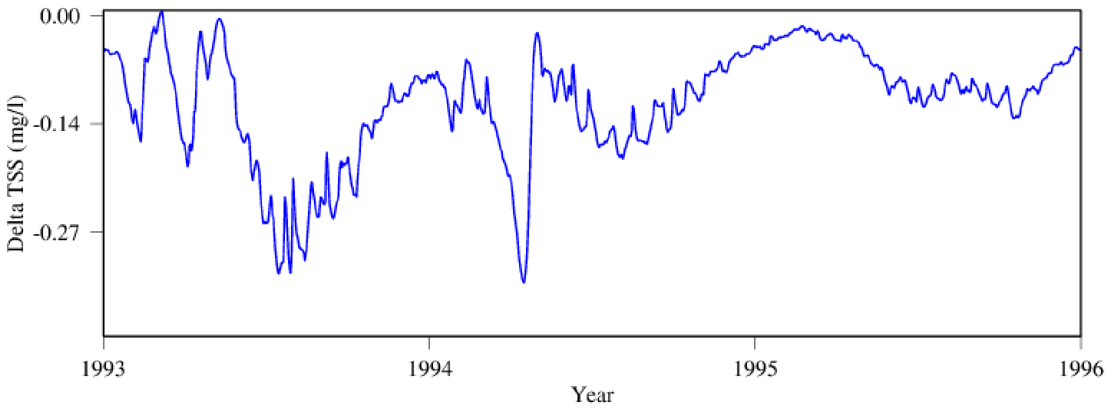
Tangier Sound (EE3.2)



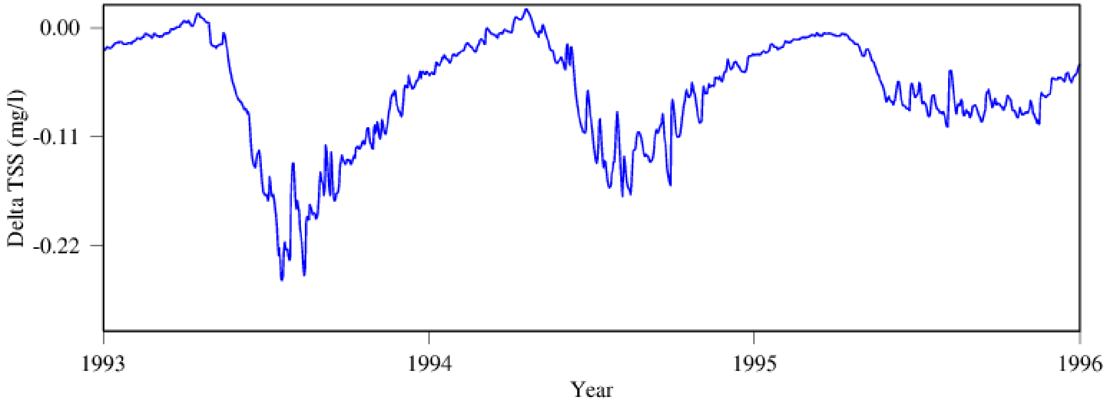
Patuxent (LE1.3)



Rappahannock LE3.2)



York River (LE4.2)



Conclusions

- Full oyster aquaculture buildout is estimated to improve water quality attainment in the Chesapeake locally and in deep hypoxic water.
- The simulated biogeochemical nutrient reductions are about twice as effective at improving CB4MH Deep Channel DO attainment than nutrient reductions from oyster harvest.
- The work will be used to complete the aquaculture oyster documentation in the final WQSTM report due April 1, 2018 and will support the work and decisions of the Oyster Expert Panel.