Oysters – A Bit of History

- We developed the oyster model circa 2000 – 2005, on the 12,000-cell grid, to assess the impact of a ten-fold increase in oyster population.
- We moved the oyster model to the 50,000-cell grid in 2008.
- We ceased all activity shortly thereafter.
- The oyster model is operational in our current model but has not been calibrated or compared to data for biomass and distribution.

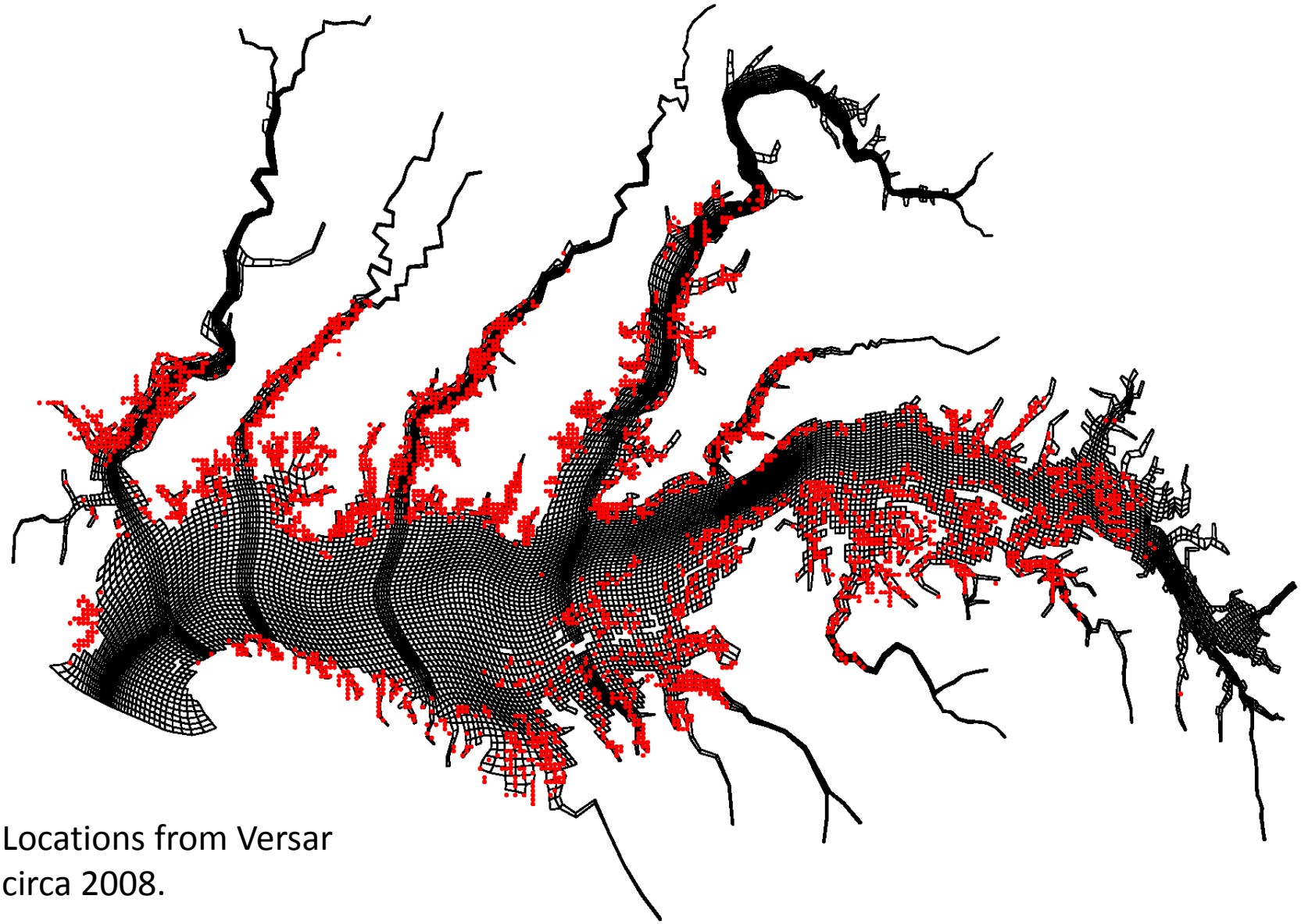
New Factors to Consider

- Estimates of the current natural population vs. estimates completed circa 2000.
- Designation of oyster sanctuaries.
- Development of aquaculture.

What Do We Have to Do?

- Locate oysters on the present grid.
  - Oyster Bars
  - Sanctuaries
  - Aquaculture
- Obtain biomass estimates.
- Tune our model to represent current biomass in each group.
- Execute scenarios.

Oyster bars mapped to 50,000-cell grid.



Locations from Versar circa 2008.

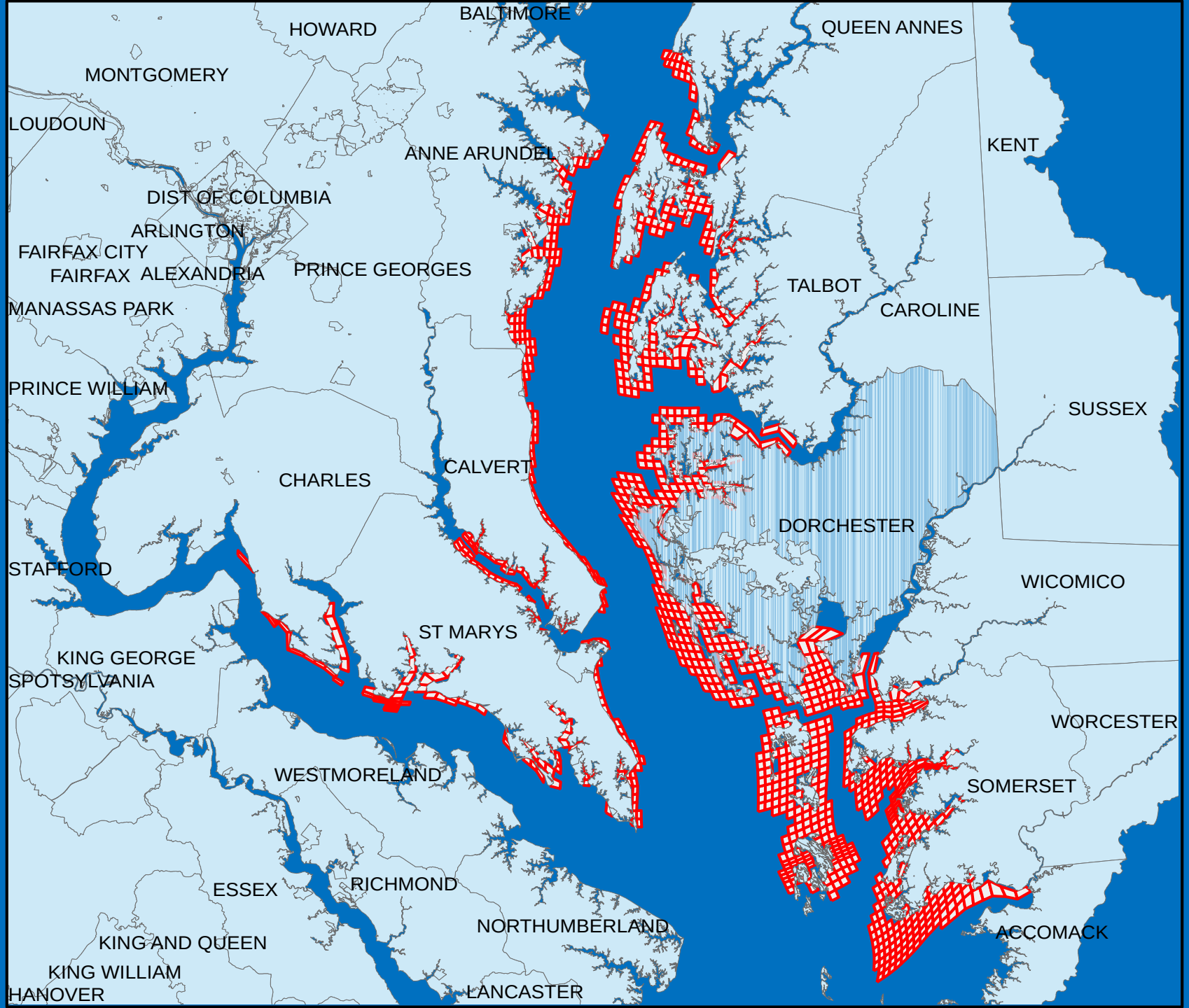
Maryland oyster leases by county, October 2015

Lease type	Anne Arundel	Calvert	Charles	Dorchester	Kent	Queen Anne	St. Mary's	Somerset	Talbot	Wicomico	Worcester	Total
Submerged land (SL)	24	11	1	57	1	5	64	24	52	40	10	289
Water column (WC)	2	2	0	19	1	2	22	6	1	0	8	63
Total	26	13	1	76	2	7	86	30	53	40	18	352

Oyster farmers are trying a variety of high-tech and low-tech *approaches to growing this bivalve in Maryland waters, but the state Department of Natural Resources classifies them in only two categories: Submerged Land Leases (SL) and Water Column Leases (WC). The first category primarily covers on-bottom techniques that feature loose shell to catch natural spat set or plantings of spat-on-shell. The second category covers cages, bags, floats, and any other device that holds oysters off the bottom. As the map shows, the busiest centers for both styles of aquaculture are Dorchester County on the Eastern Shore and St. Mary's County on the western side of the Bay.* TABLE SOURCE: KARL ROSCHER; MAP, CREATED BY SANDY RODGERS ON A BASE MAP FROM VECTORSTOCK.COM

Aquaculture

- We have Maryland harvest by county.
- We do not have location of aquaculture facilities.
- As a start, we are assigning aquaculture activity to Maryland waters with salinity > 7 and depth < 12 feet.
- At present, we have no information on Virginia aquaculture.


BALTIMORE
HOWARD
QUEEN ANNES
MONTGOMERY
LOUDOUN
ANNE ARUNDEL
KENT
DIST OF COLUMBIA
ARLINGTON
FAIRFAX CITY
FAIRFAX
ALEXANDRIA
PRINCE GEORGES
TALBOT
CAROLINE
MANASSAS PARK
PRINCE WILLIAM
SUSSEX
CALVERT
CHARLES
DORCHESTER
STAFFORD
WICOMICO
ST MARYS
KING GEORGE
SPOTSYLVANIA
WORCESTER
WESTMORELAND
SOMERSET
ESSEX
RICHMOND
NORTHUMBERLAND
ACCOMACK
KING AND QUEEN
KING WILLIAM
HANOVER
LANCASTER

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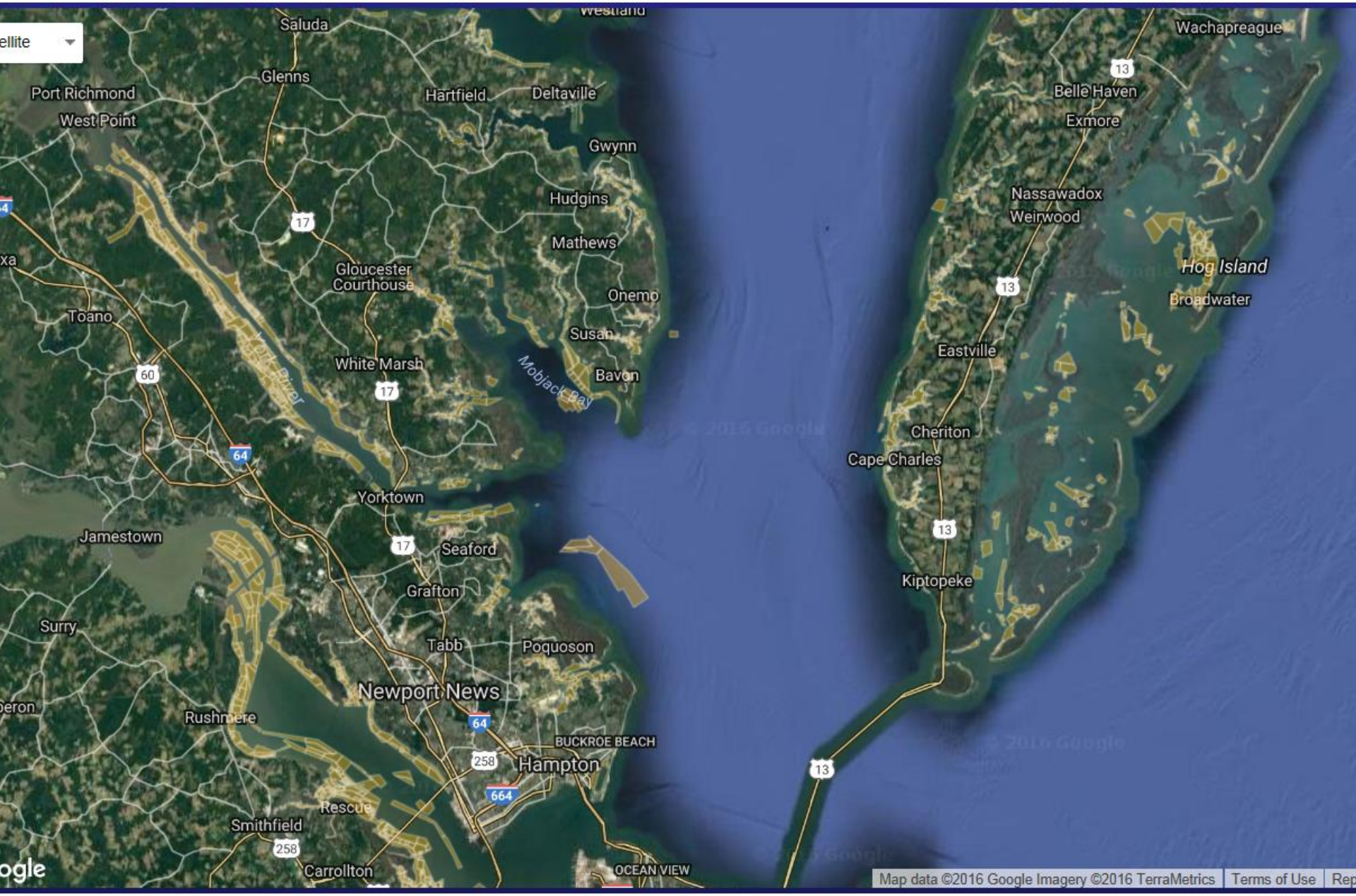
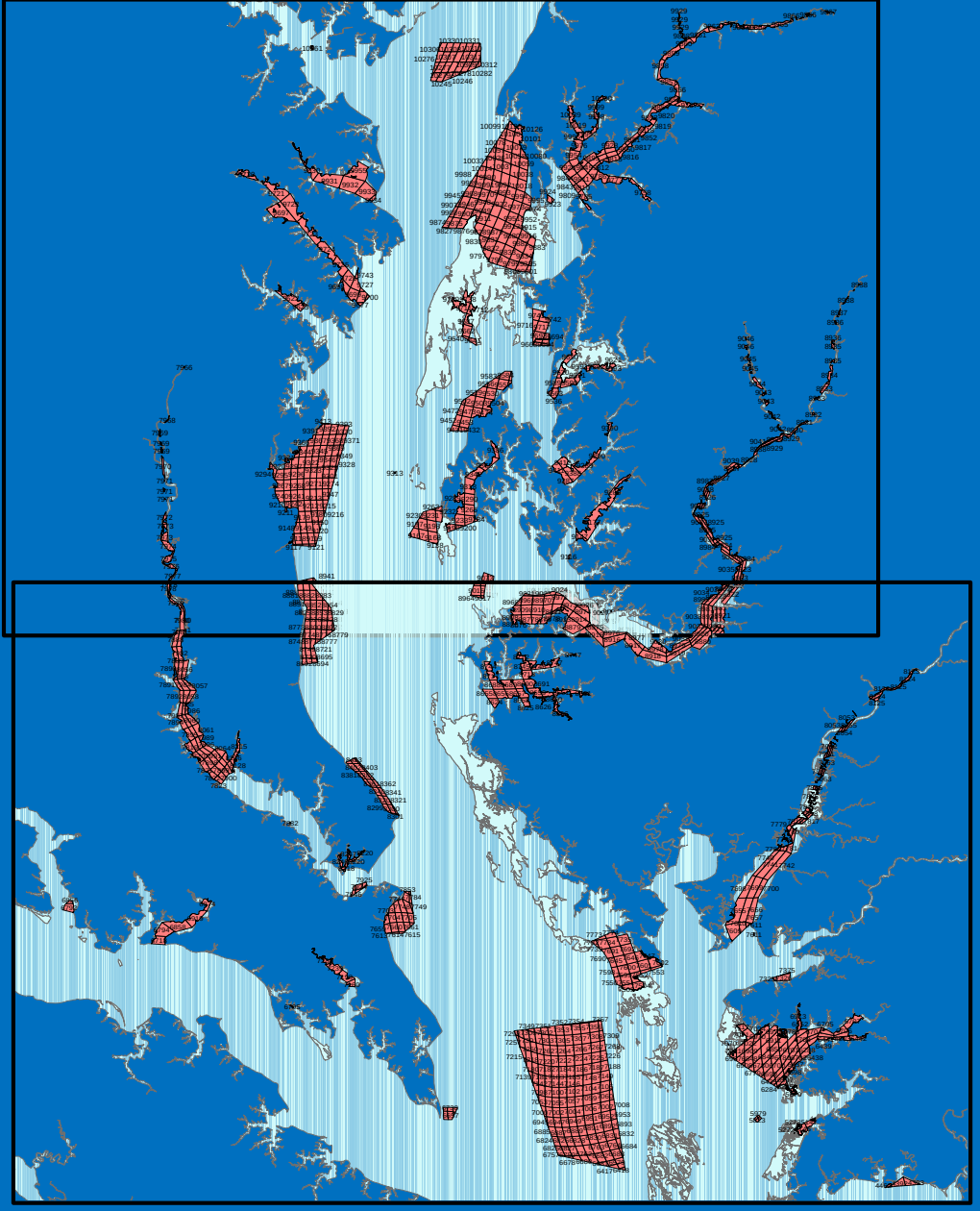
nd complete at any given time. Although it is expected that the data will be used for regulatory and permitting processes, any user of this data should verify their use of th
before taking action or otherwise using the data to make decisions, particularly when related to regulatory and permitting processes, or any other legal action.





Sanctuaries

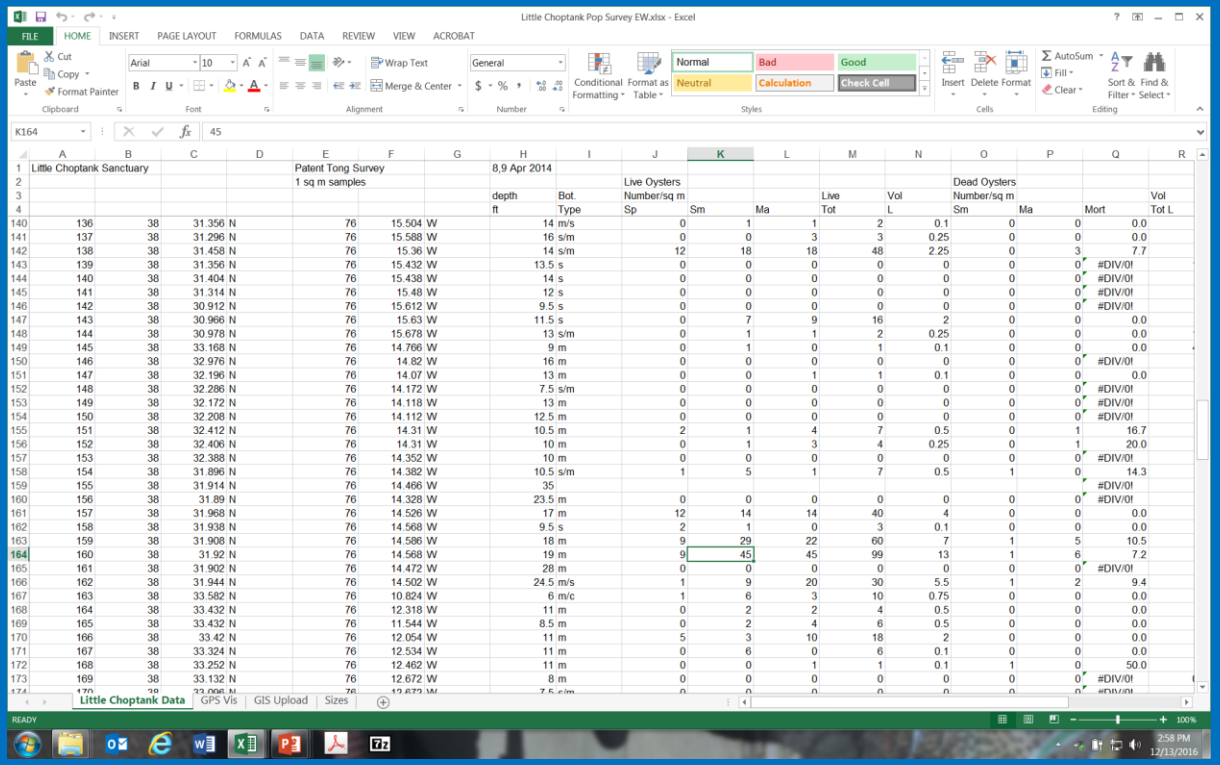
- We have Maryland oyster sanctuaries mapped to the grid.
- We have overlap with the oyster bar data from 2008.
- If a sanctuary and a bar coincide, we assume that bar is now a sanctuary.

Biomass

- Aquaculture – Assume the biomass is equivalent to the harvest. The farmer plants the seeds and harvests the crop. Actually a better assumption is that average biomass is half the final harvest.

Sanctuaries

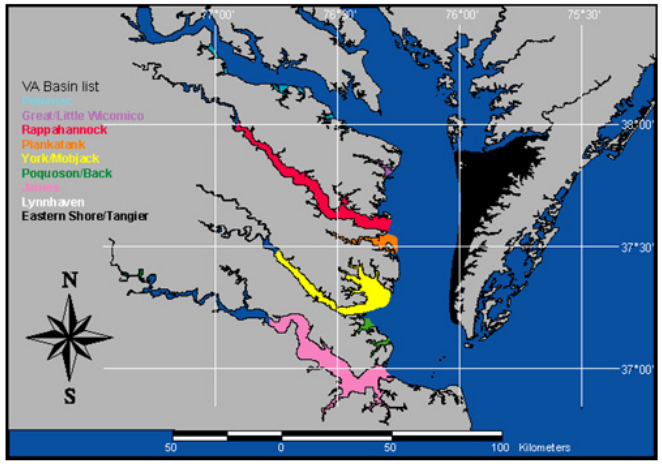
- We have the area of each sanctuary and some measure of density (quantity per unit area) for each sanctuary.



Chesapeake Bay Oyster Population Estimation (CBOPE)

Virginia Basin Estimates

Chesapeake Bay tributaries in Virginia waters were assigned to the following basin categories: Potomac tributaries (includes Nomini Creek, Coan River, Yeocomico River), Great/Little Wicomico, Rappahannock (includes Corrotoman River), Piankatank, York/Mobjack Bay (includes East, North, Ware, Severn, and Perrin River), Poquoson/Back, James (includes Elizabeth, Lafayette, and Nansemond Rivers), Lynnhaven, and Eastern Shore/Tangier (includes Tangier and Pocomoke Sounds as well as all Bay side tributaries of Virginia's Eastern Shore). These basins are shown on the map below.



Basin estimates are available for Virginia oyster populations from 1994 through 2008. These basin estimates rely on a variety of different data types that are collected by different agencies and institutions. All data used in Virginia oyster population estimates fall into one of 4 categories: fishery independent, fishery dependent, restoration, or oyster aquaculture. Each of these categories is described briefly below.

A. Fishery Independent data - These data are collected during annual patent tong surveys conducted by the Virginia Institute of Marine Science and the Virginia Marine Resources Commission. These surveys use a hydraulic patent tong deployed from the research vessel *J.B. Baylor* which samples 1 square meter of bottom at each sample. 2005 data also reflect the extensive survey of the Lynnhaven River system completed by Dr. Mark Luckenbach and colleagues at the VIMS Eastern Shore Laboratory for the NORM program.

B. Fishery Dependent data

B1. Public/Commercial fishery - These data are based on the oyster landings as reported to the Virginia Marine Resources Commission by commercial fishermen. The data are provided for this exercise by the Virginia Marine Resources Commission Fishery Statistics Department.
B2. Private fishery - These data are based on the oyster landings as reported to the Virginia Marine Resources Commission by private leaseholders. The data are provided for this exercise by the Virginia Marine Resources Commission Fishery Statistics Department.

C. Restoration Efforts

C1. Reefs - unexploited sanctuaries - since the early 1990s, the Virginia Marine Resources Commission Shellfish Replenishment program in collaboration with the Virginia Institute of Marine Science, the Virginia Department of Environmental Quality, and other state and federal agencies has been actively building three dimensional reefs in an effort to restore some of oyster reef habitat that was historically dominant in the lower Chesapeake Bay. These reefs are sanctuaries for oysters in that the oysters are neither fished nor disturbed and these reefs serve as sources of oyster larvae for the surrounding waters. The Virginia Marine Resources Commission Shellfish Replenishment program conducts annual surveys of the oyster populations on these reefs. These data are provided courtesy of the Virginia Marine Resources Commission Shellfish Replenishment Program.

C2. Replenishment areas - exploited shellplants and reefs - each year the Virginia Marine Resources Commission Shellfish Replenishment program plants shell and oyster seed at various

State: VIRGINIA Year: 1994

A. Fishery Independent survey	Potomac	Great/Little Wicomico	Rappahannock	Piankatank	York/Mobjack Bay	Poquoson/Back	James	Lynnhaven	Eastern Shore/Tangier	Total number of oysters	Total oyster biomass
Average number of oysters/m2			2.1				56.8				
Average oyster biomass/m2			1.7				20.2				
Number of reefs surveyed			7				23				
Acres surveyed			214				5955.6				
Number of samples			193				800			1.37E +09	4.89E+08
B. Fishery Dependent survey											
B1. Public/Commercial effort											
Public VA landings (bushels x 1000)	18.6									9.29E+06	7.91E+06
B2. Private effort											
Private VA landings (bushels x 1000)	36.8									1.84E+07	1.57E+07
C. Restoration efforts											

Basic Equation

$$\frac{dO}{dt} = \propto \cdot Fr \cdot POC \cdot IF \cdot (1 - RF) \cdot O - BM \cdot O - \beta \cdot O$$

In which:

O = oyster biomass (g C m^{-2})

α = assimilation efficiency ($0 < \alpha < 1$)

Fr = filtration rate (m^3 g^{-1} C d^{-1})

POC = particulate organic carbon (g m^{-3})

IF = ingestion fraction ($0 < IF < 1$)

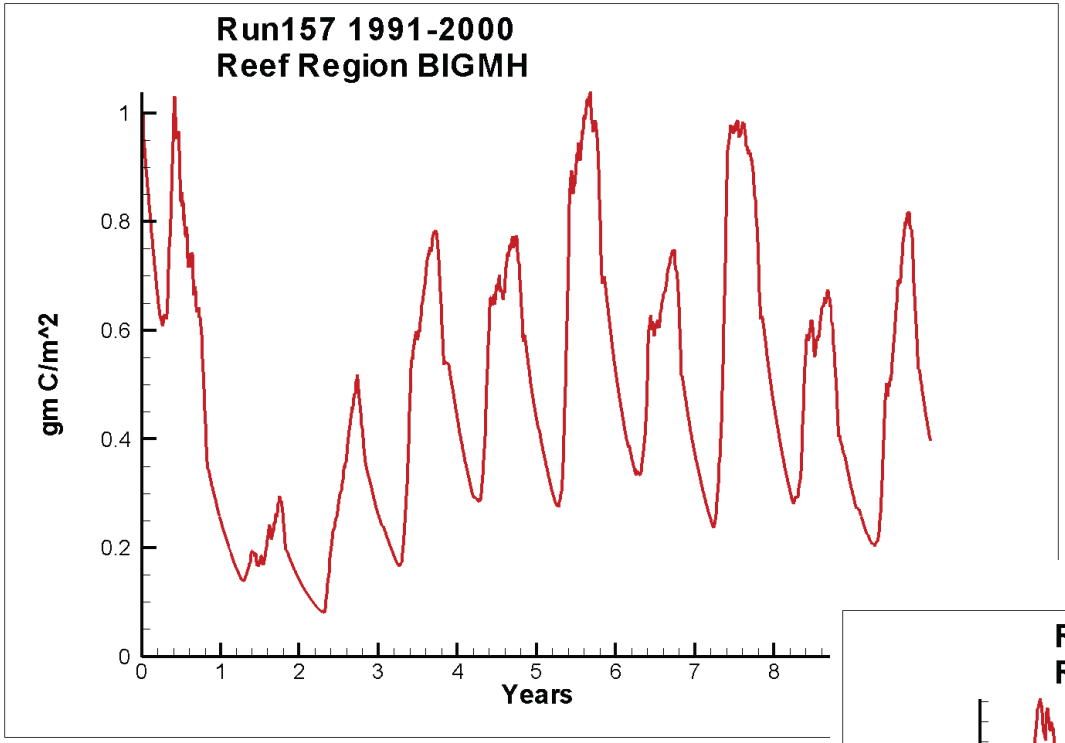
RF = respiration fraction ($0 < RF < 1$)

BM = basal metabolism (d^{-1})

β = mortality (d^{-1})

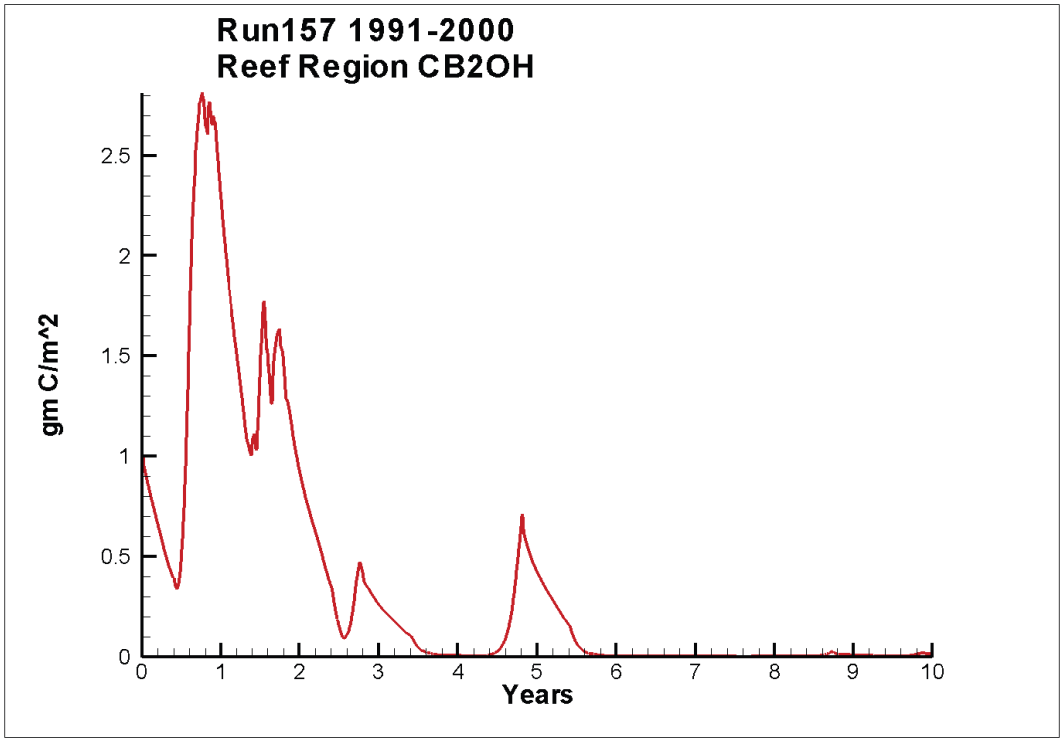
The Approach

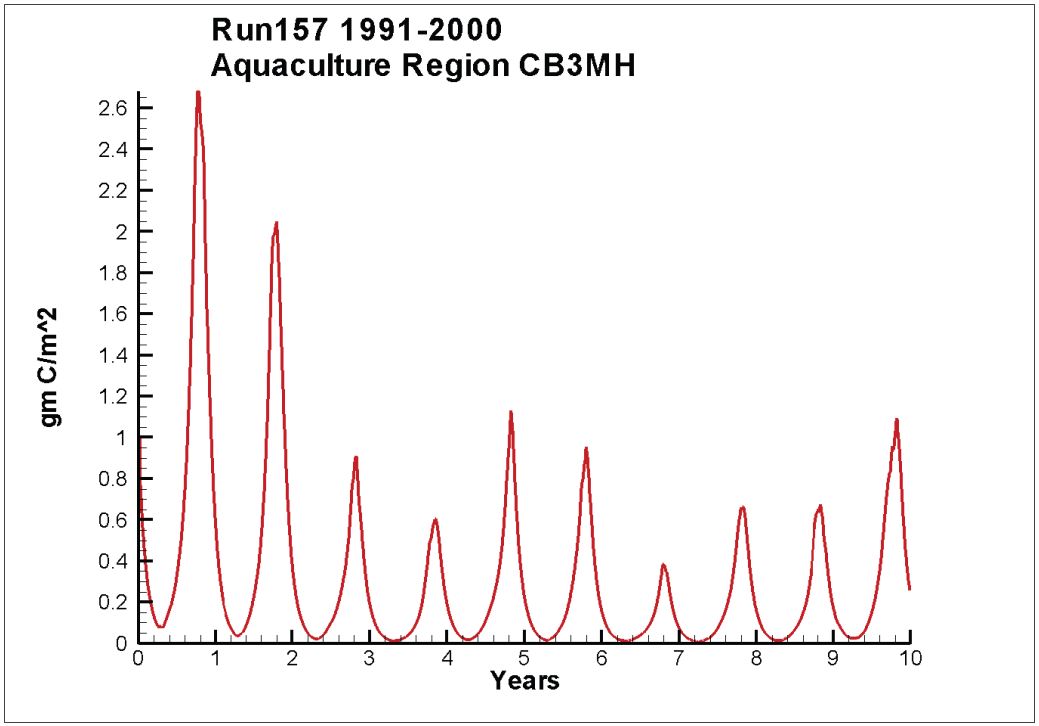
- Adapt most parameters from 2005 oyster model.
- The mortality term includes predation, disease, and harvest. Tune the mortality term until computed biomass is consistent with observations.
- We can implement a “fix” for aquaculture. Set dO/dt to zero and impose reported biomass.
- To an extent, we let the oysters locate themselves in regions with appropriate conditions.



In our initial simulations, the Big Annemessex supports viable oyster reefs.

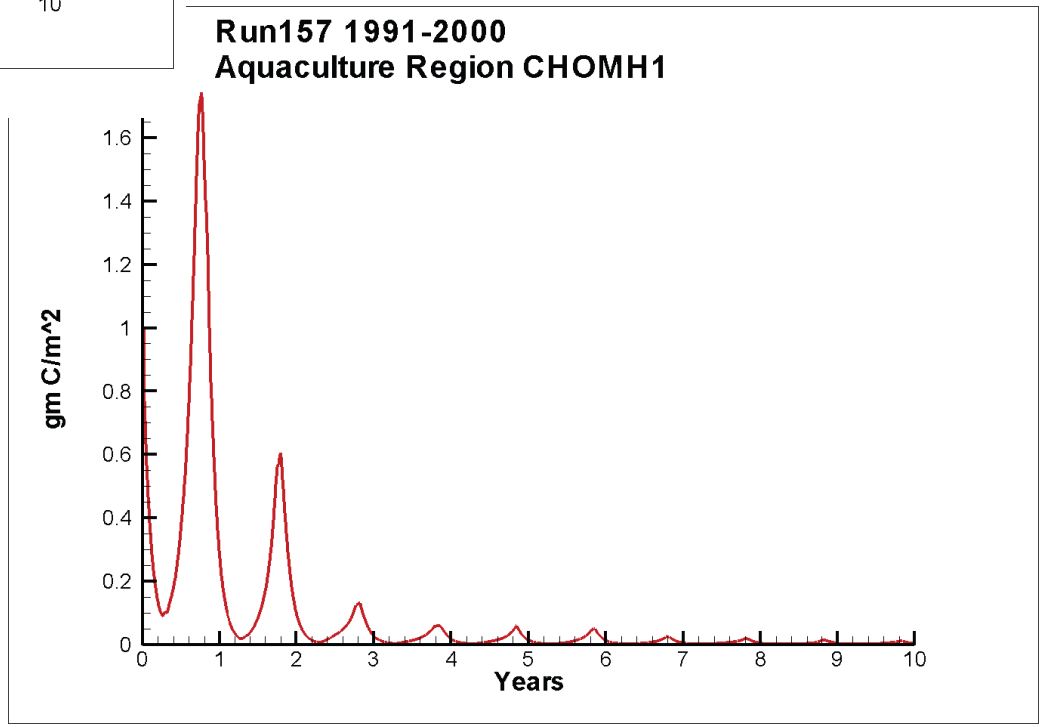
Region CB2 does not.

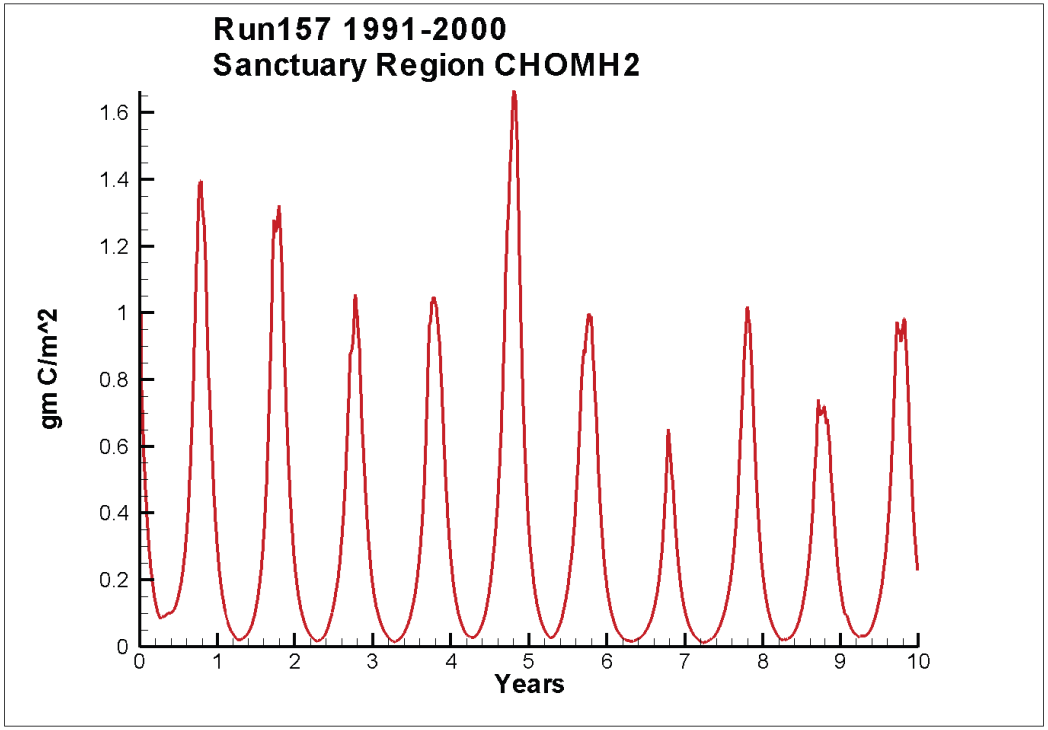




In our initial simulations, region CB3 supports viable aquaculture.

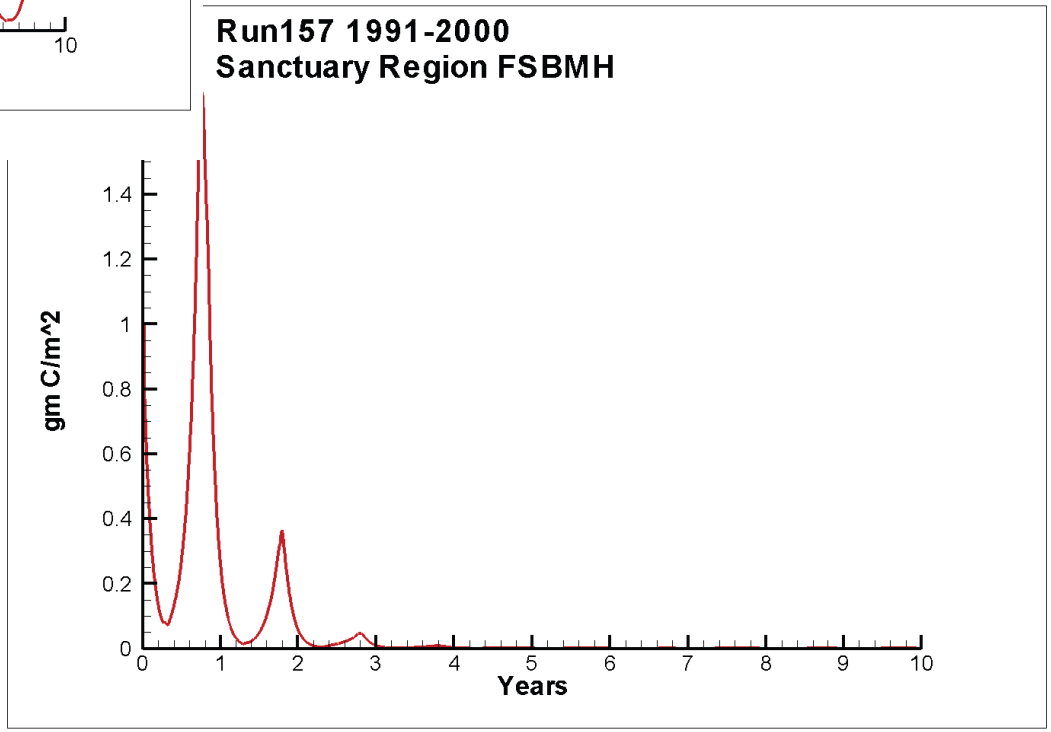
The lower Choptank does not.



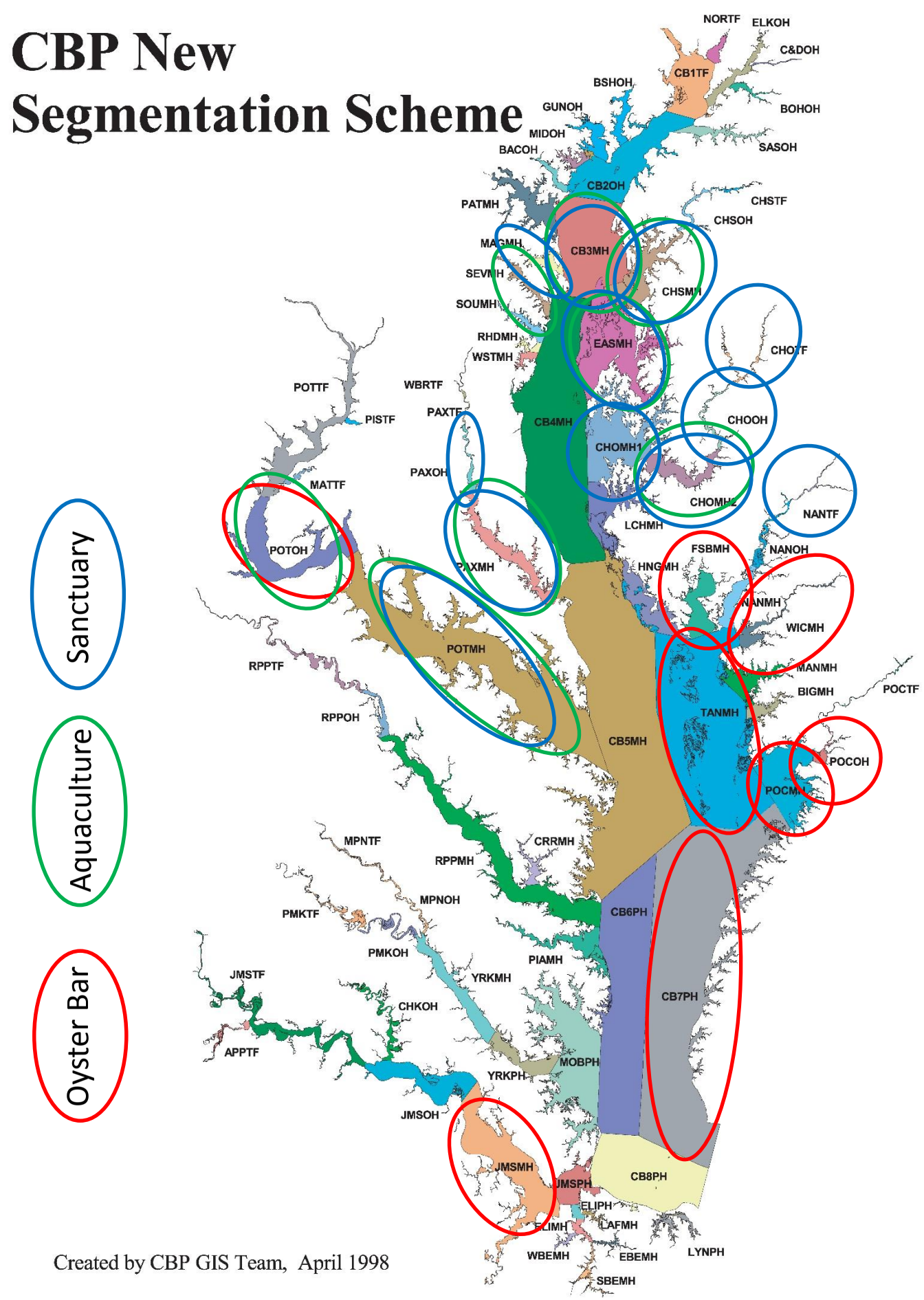


In our initial simulations, the middle Choptank is a good place for an oyster sanctuary.

Fishing Bay is not.



CBP New Segmentation Scheme



Sanctuary

Aquaculture

Oyster Bar

Created by CBP GIS Team, April 1998

Next Steps

- Compare model results to biomass estimates.
- Implement aquaculture fix.
- Assess the impact of Maryland aquaculture. If the impact is negligible, we may decide to use resources (manpower) elsewhere.