Addressing 2035 Climate Change Risk to Water Quality TMDL in the Patapsco and Back Rivers Using Data Analysis and Next-generation Models

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BALTIMORE

Outline:

I. Watershed characteristics of Patapsco/Back River Basin

II. Water quality issues and the sources of pollutants

III. Proposed MTM model domain and tasks for Patapsco/Back River

IV. Bringing in additional WQ data complementing the existing database

V. Improve CBP estuarine science and analysis

I. Watershed characteristics of Patapsco/Back River Basin

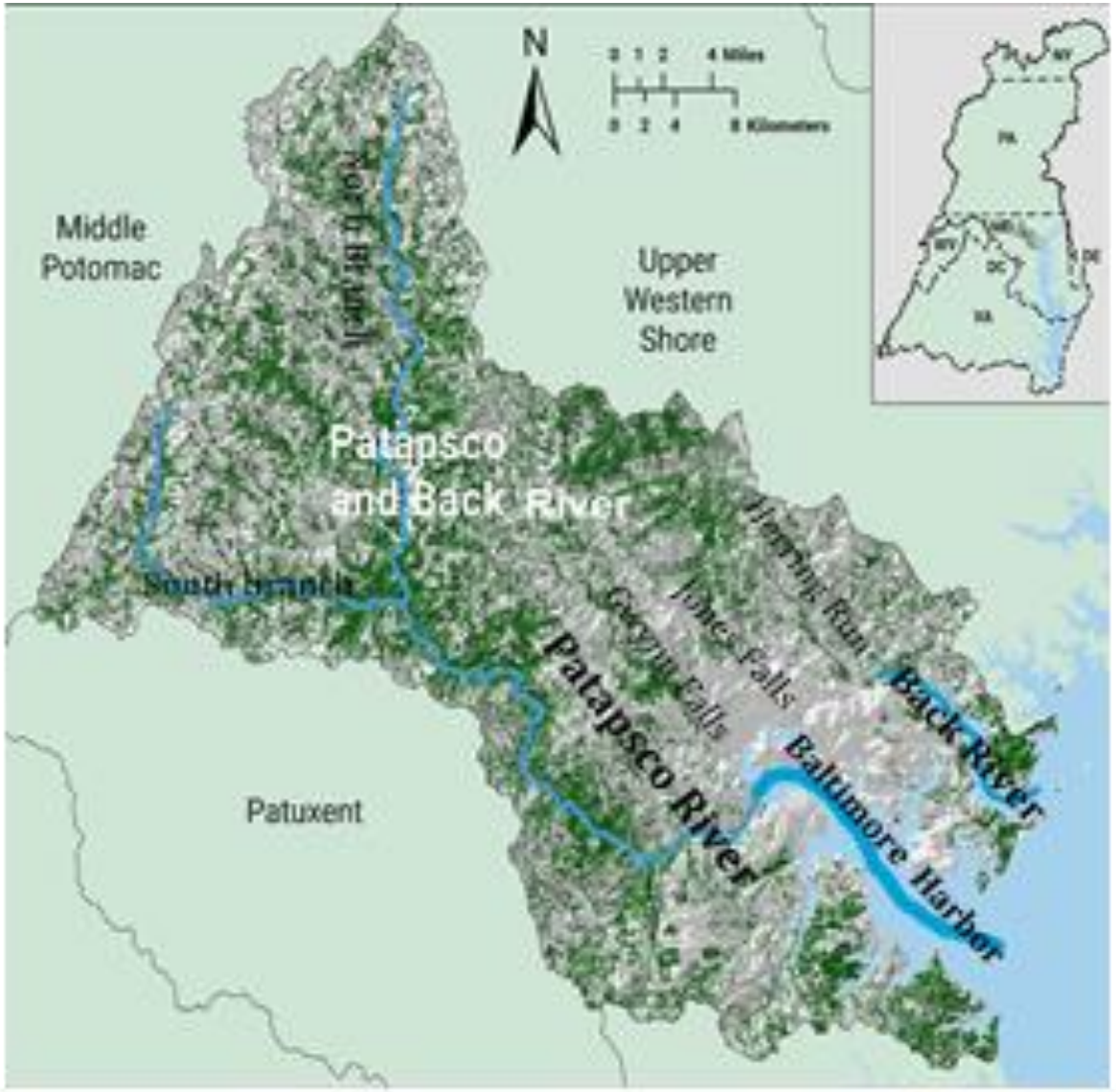


Figure 1: The Patapsco and Back Rivers watershed has 630 square miles of drainage including Patapsco and Back Rivers, Gwynn Falls, Jones Falls, and Herring Run.

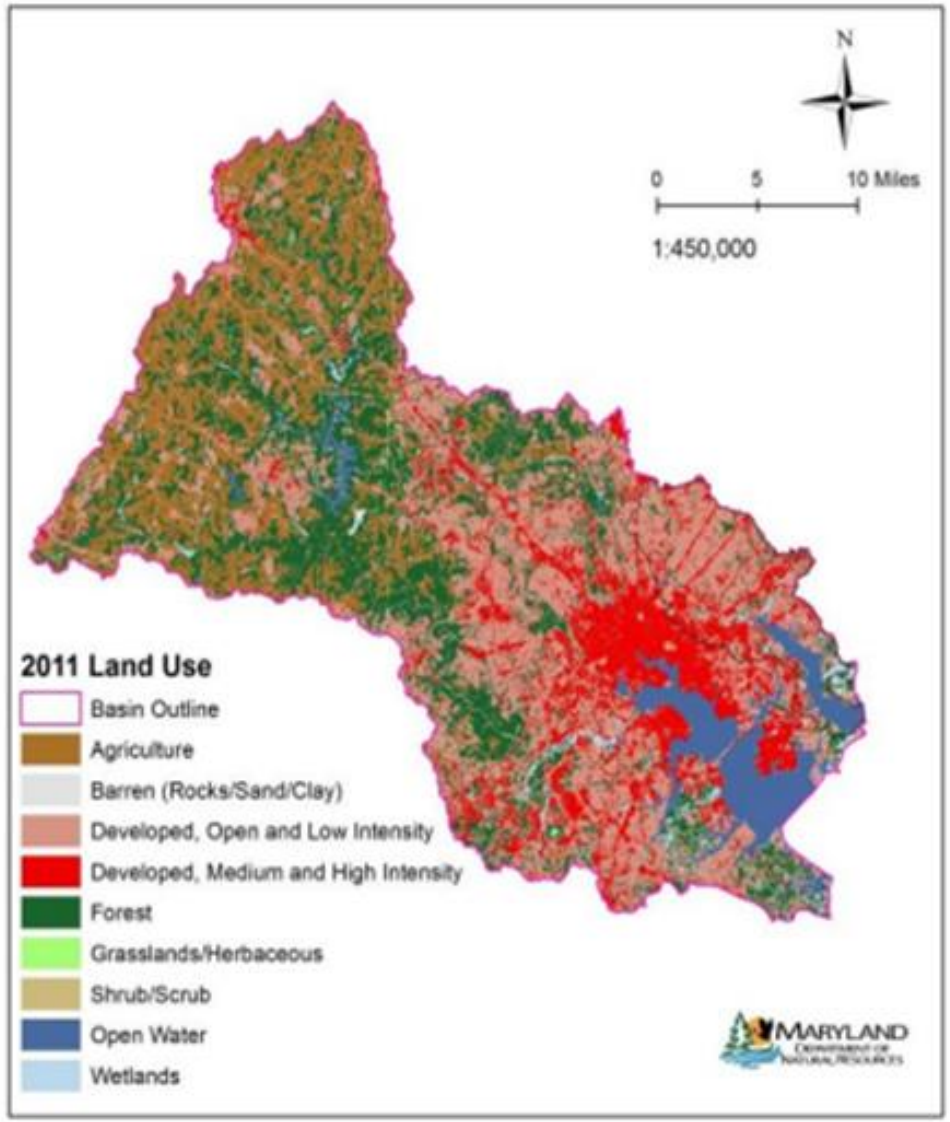
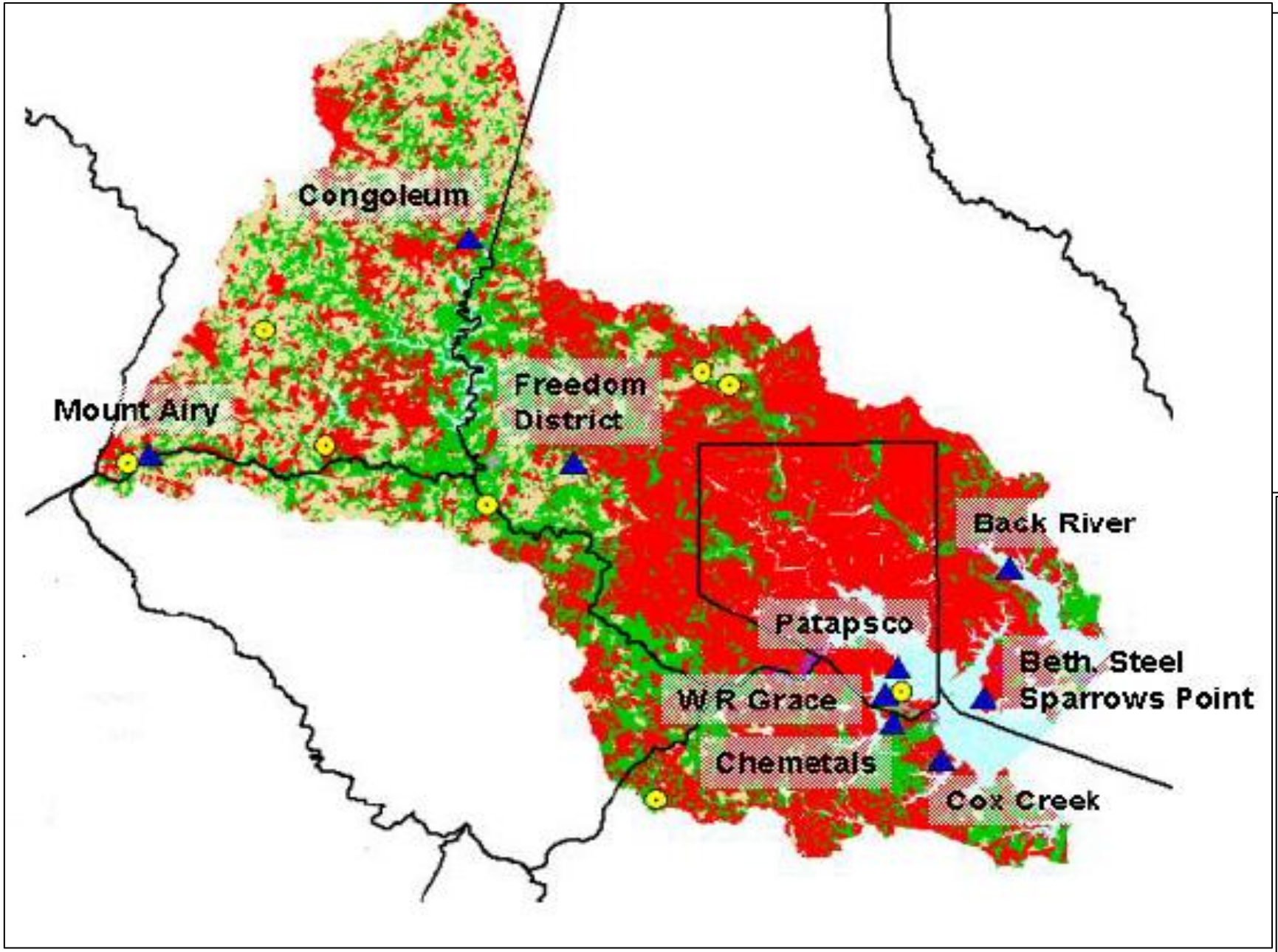
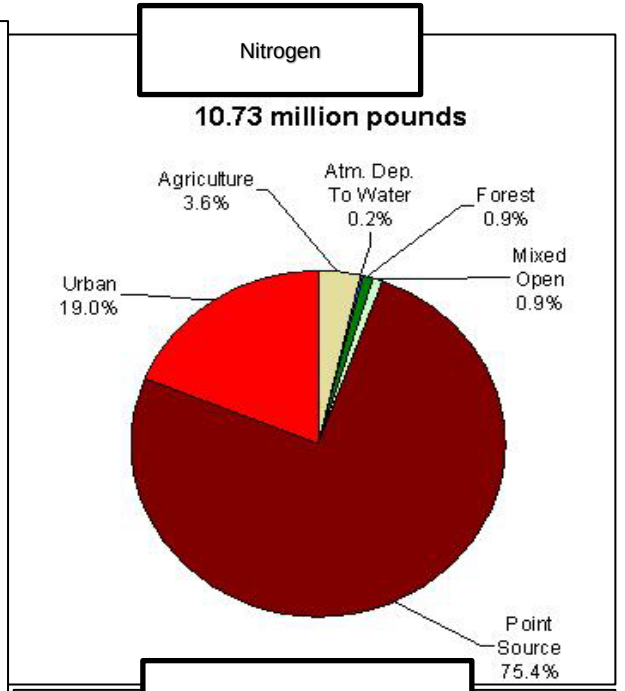


Figure 2: 2000 land used in Patapsco/Back River basin





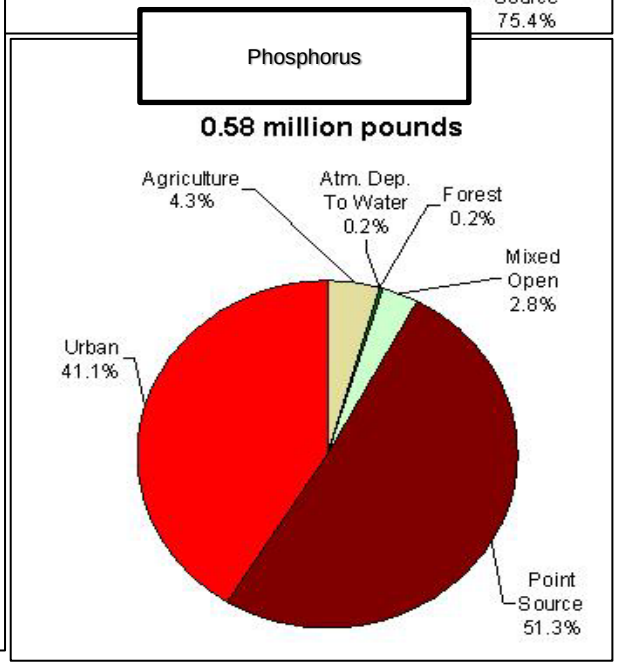


Figure 3:(L) Wastewater Treatment Plants and point sources of the industries in the P/B River Basin; (R)1985-2002 nitrogen and phosphorus contribution by source [4].

II. Water quality issues and the sources of pollutants

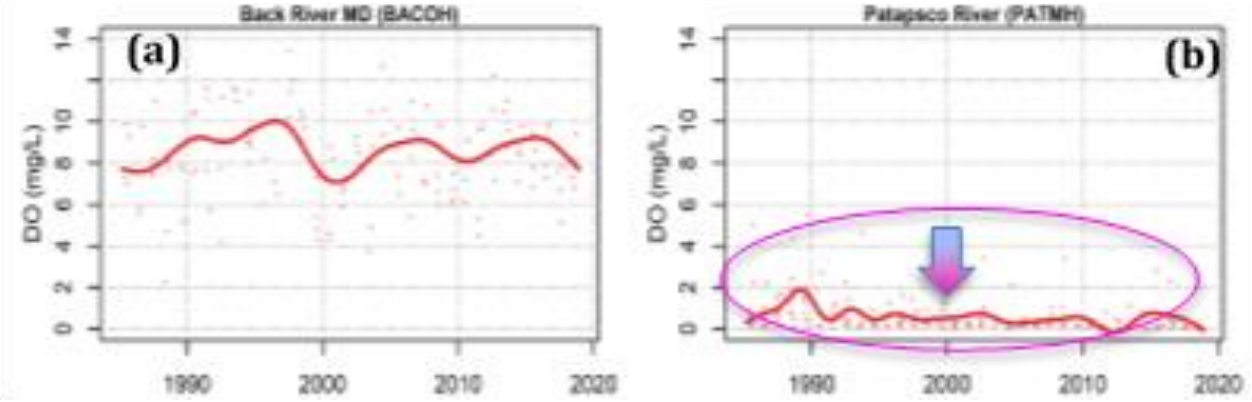
1. The high population density and the industries developed in the Patapsco/Back River have resulted in large nutrient loads from point sources, including 2 major wastewater treatment plants, 3 water filtration plants, 1 dredge material containment facility, and several large industrial facilities. They contribute nitrogen loading of 10.73 million lbs/year and phosphorus loading 0.58 million lbs/year to the Bay, among which point source represents 75% and 51% of the total loading to the P/B Rivers basins (see right panel Fig. 3).

2. The largest source of sediment loadings is urban stormwater runoff. In *[2], it indicated that although the watershed area and river volume of the P/B Rivers are only about 0.6% and 1% of the Bay respectively, its annual nitrogen and phosphorus loads are actually larger than those of the York, Patuxent, and Choptank Rivers, highlighting the significance of the pollution caused by the point source and urban stormwater runoff from the P/B Rivers basin.

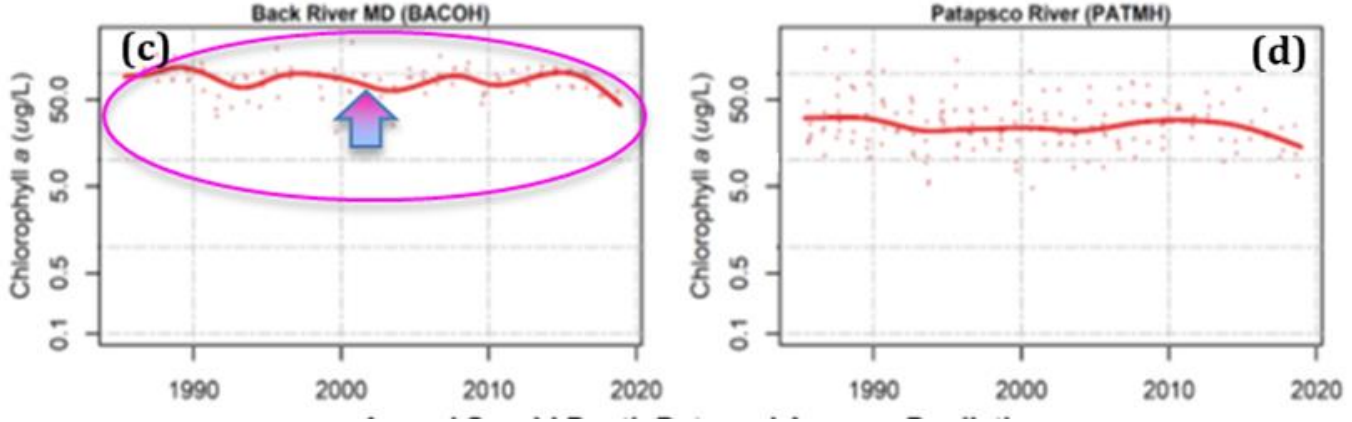
3. Recognizing that nutrient loading from the P/B Rivers is a major source to the Bay proper, the P/B system itself is experiencing degraded water quality conditions.

*[2]:Patapsco and Back River watershed (2007) Eco Health. https://ecoreportcard.org/report-cards/chesapeake-bay/watershed-regions/patapsco-and-back/

Summer (June-Sept) Bottom DO data and average predictions



Summer (June-Sept) Surface Chlorophyll data and average predictions



Annual Secchi Depth data and average predictions

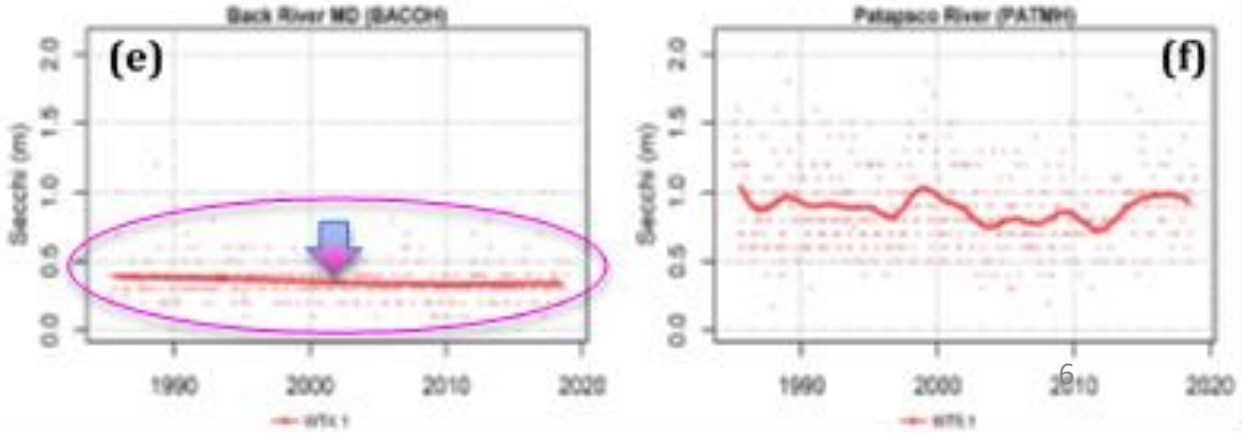


Figure 4: (a)-(b) summer bottom DO data vs prediction, (c) – (d) summer surface Chlorophyll data vs prediction (e)–(f), annual Secchi depth data vs prediction for Back and Patapsco River, respectively [5].

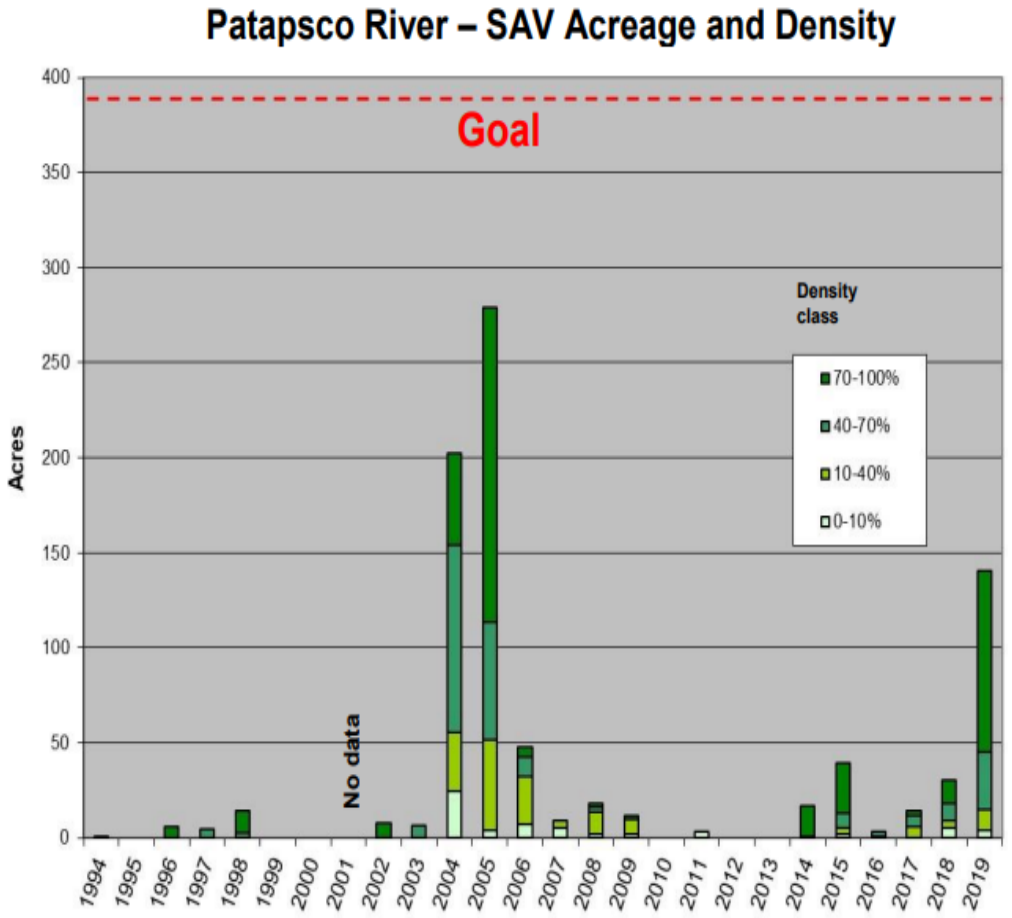


Figure 5:The P/B Rivers seagrass distribution

Table 1: Surveyed seagrass area for Patapsco and Back Rivers quadrangle [6]

Quadrangle	2013	2014	2015	2016	2017	2018	2019	2020	2021
(012) Baltimore East, Md.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30
(013) Middle River, Md.	0.00	0.00	0.66	0.00	1.50	0.00	0.10	1.00	11.10
(018) Curtis Bay, Md.	0.00	0.79	2.99	0.00	1.24	3.43	19.46	18.32	18.48
(019) Sparrows Point, Md.	0.00	6.00	12.37	1.40	3.03	8.94	32.92	32.51	31.38
(023) Round Bay, Md.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(024) Gibson Island, Md.	0.00	0.00	0.00	0.00	0.00	0.00	0.28	1.54	0.99
(259) Relay, Md.	0.00	0.00	0.00	0.00	0.00	0.00	4.21	4.68	4.26

* Unit in acres

III. Proposed MTM model domain and tasks for Patapsco/Back River

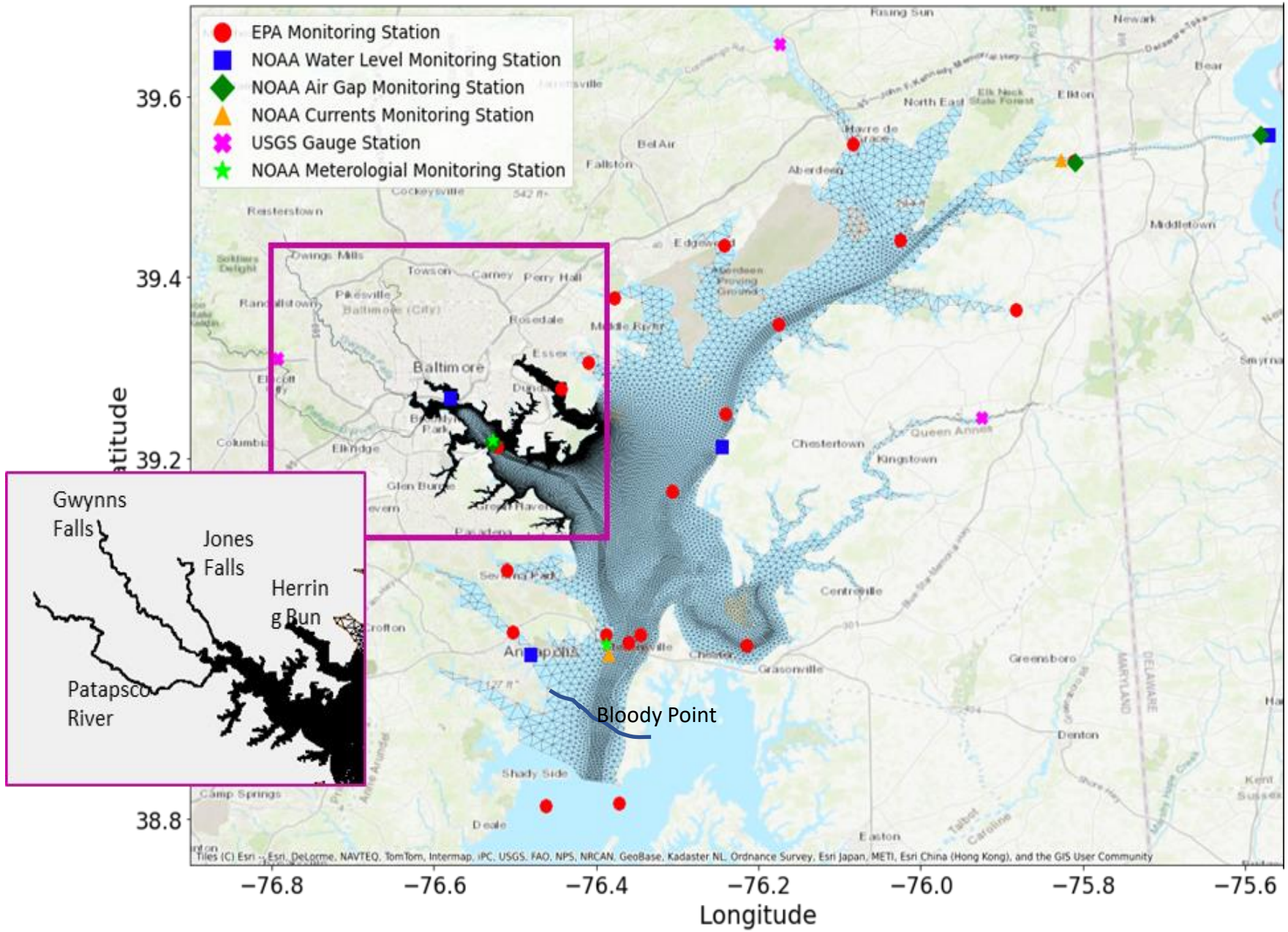
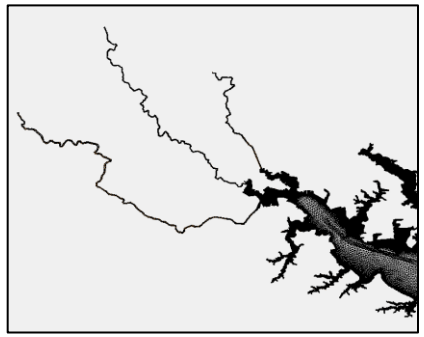
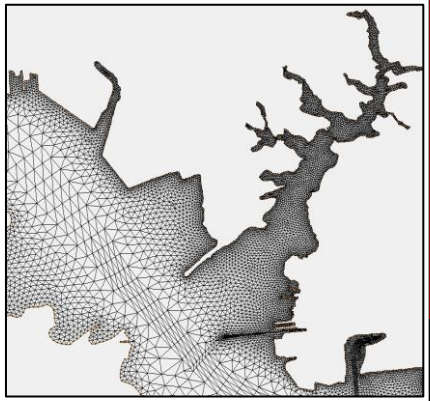
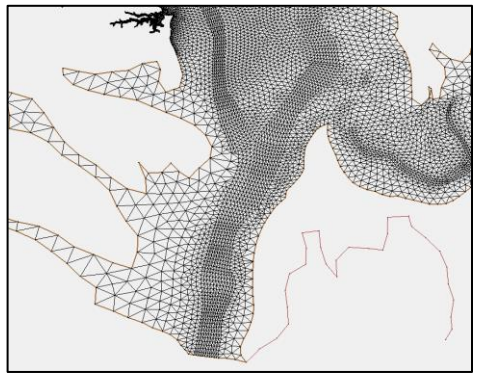


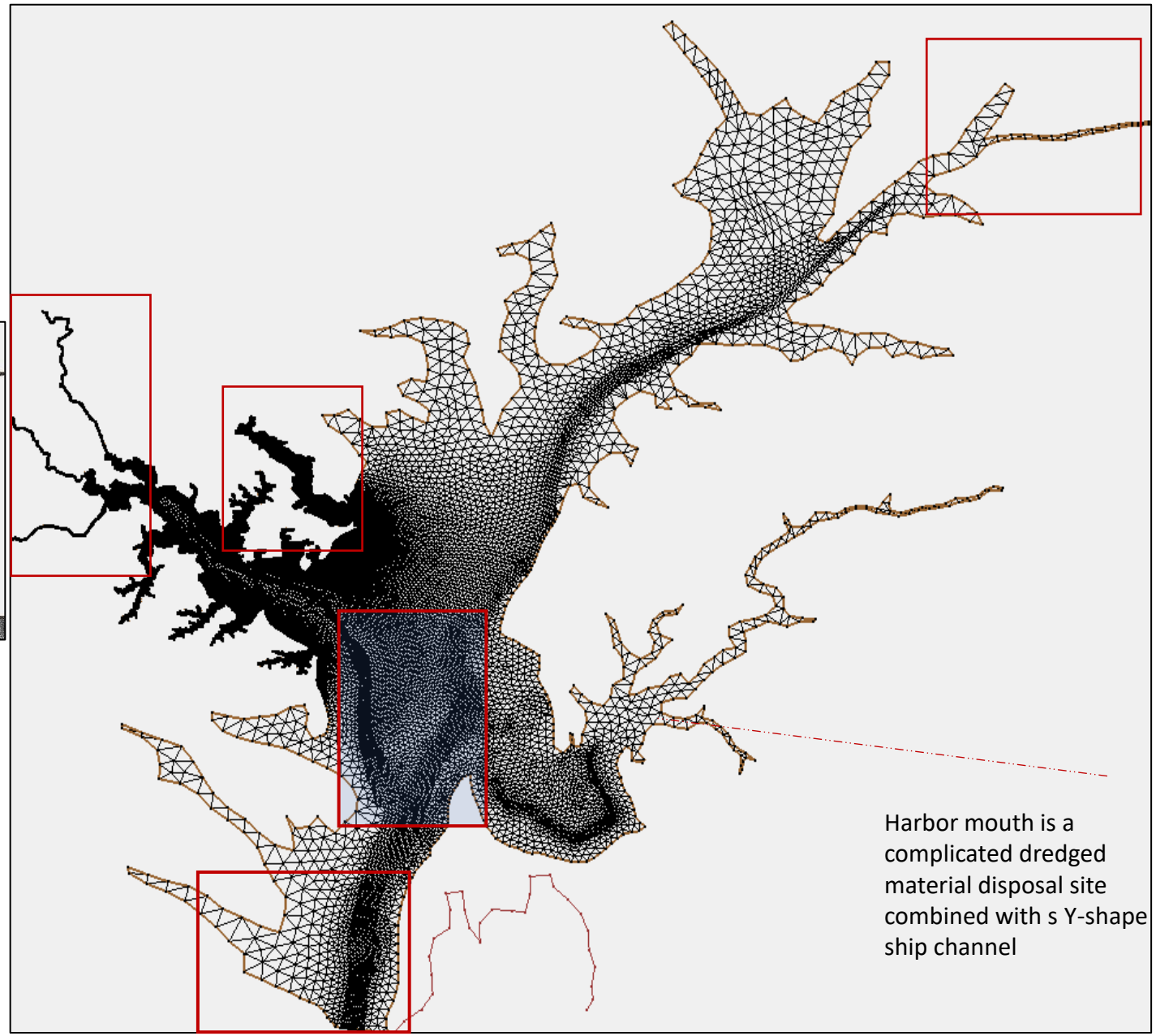
Figure 8: The high-resolution P/B Rivers MTM modeling domain (purple box) linking to Upper Chesapeake Bay. The domain includes Patapsco River (above Middle Branch), Gwynns Falls, Jones Falls, Baltimore Harbor, and Back River. The southern open boundary is overlapped with MBM at a transect in the southern tip of Kent Island near Blood Point and the northern open boundary is extended to Reedy Point, DE via C&D canal. The symbols are measurement stations where observation data from EPA, NOAA, USGS are available.

Detailed views of different portion of the model domain

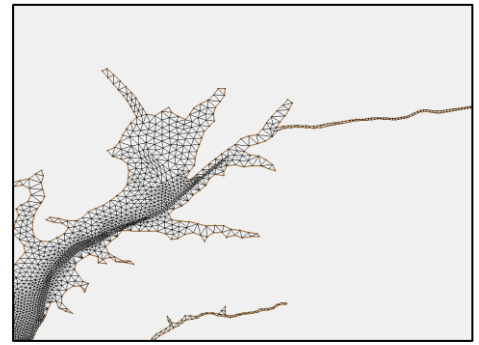


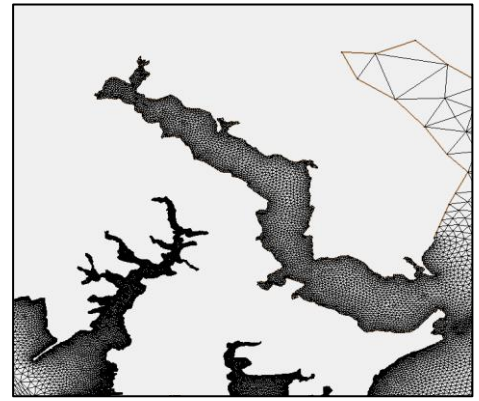


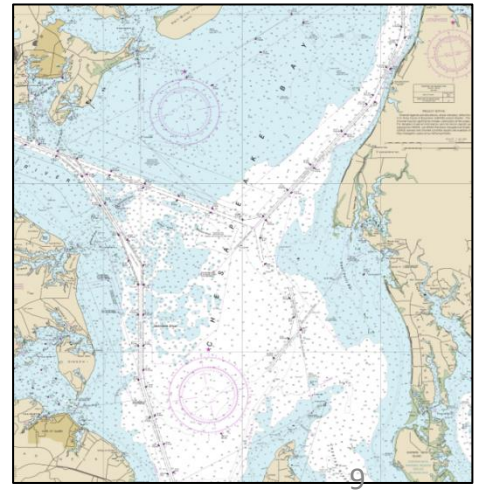




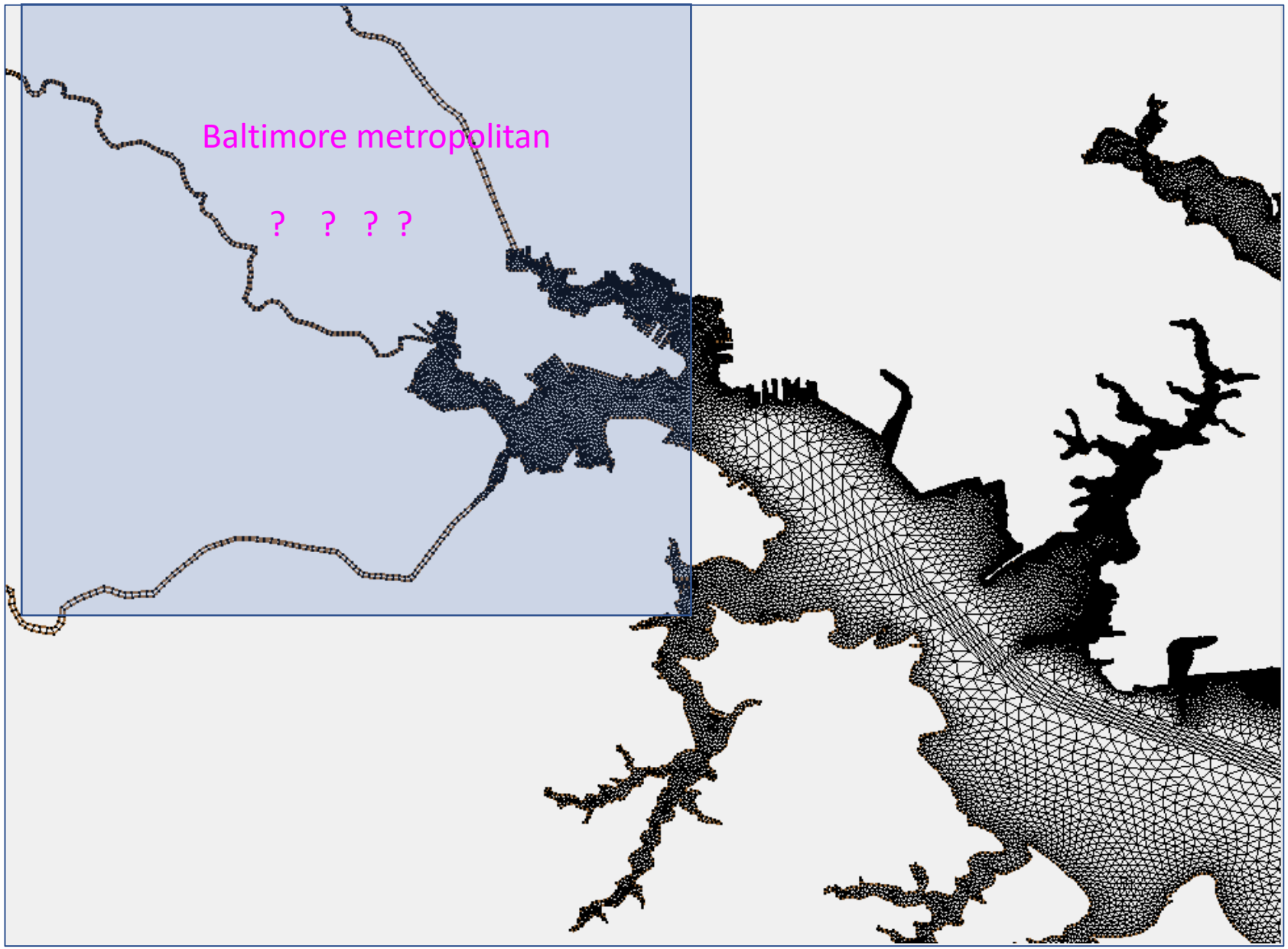
Harbor mouth is a complicated dredged material disposal site combined with s Y-shape ship channel







Challenge: How to link the estuarine model with the stormwater network in an urban city?



Approach:

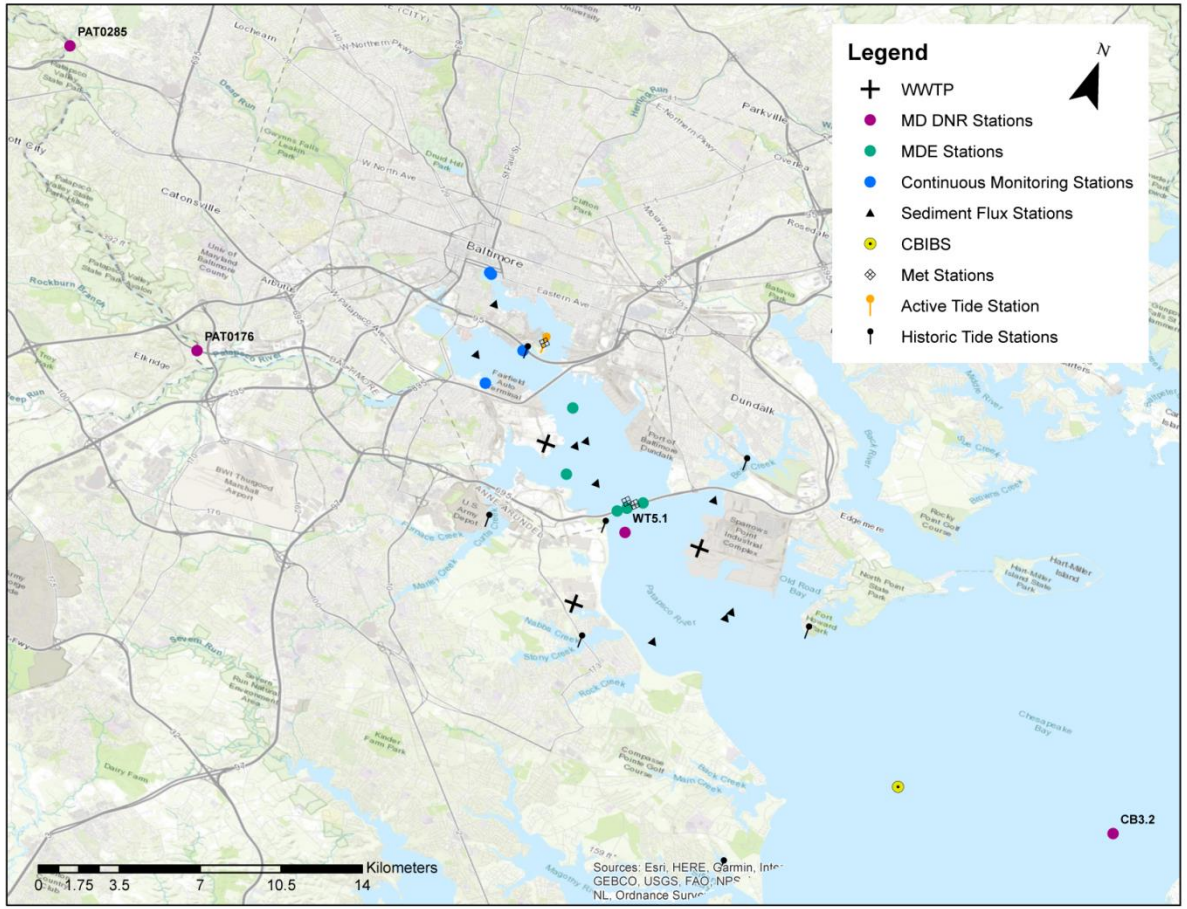
This 5-year project will be divided 5 years into two phases: (1) the first 3 years (2023-5) will concentrate on model development and model verification, and (2) the final two years will concentrate on CBP model review and for model application, scenario development, and analysis as directed by CBP decision-makers, as well as for model documentation.

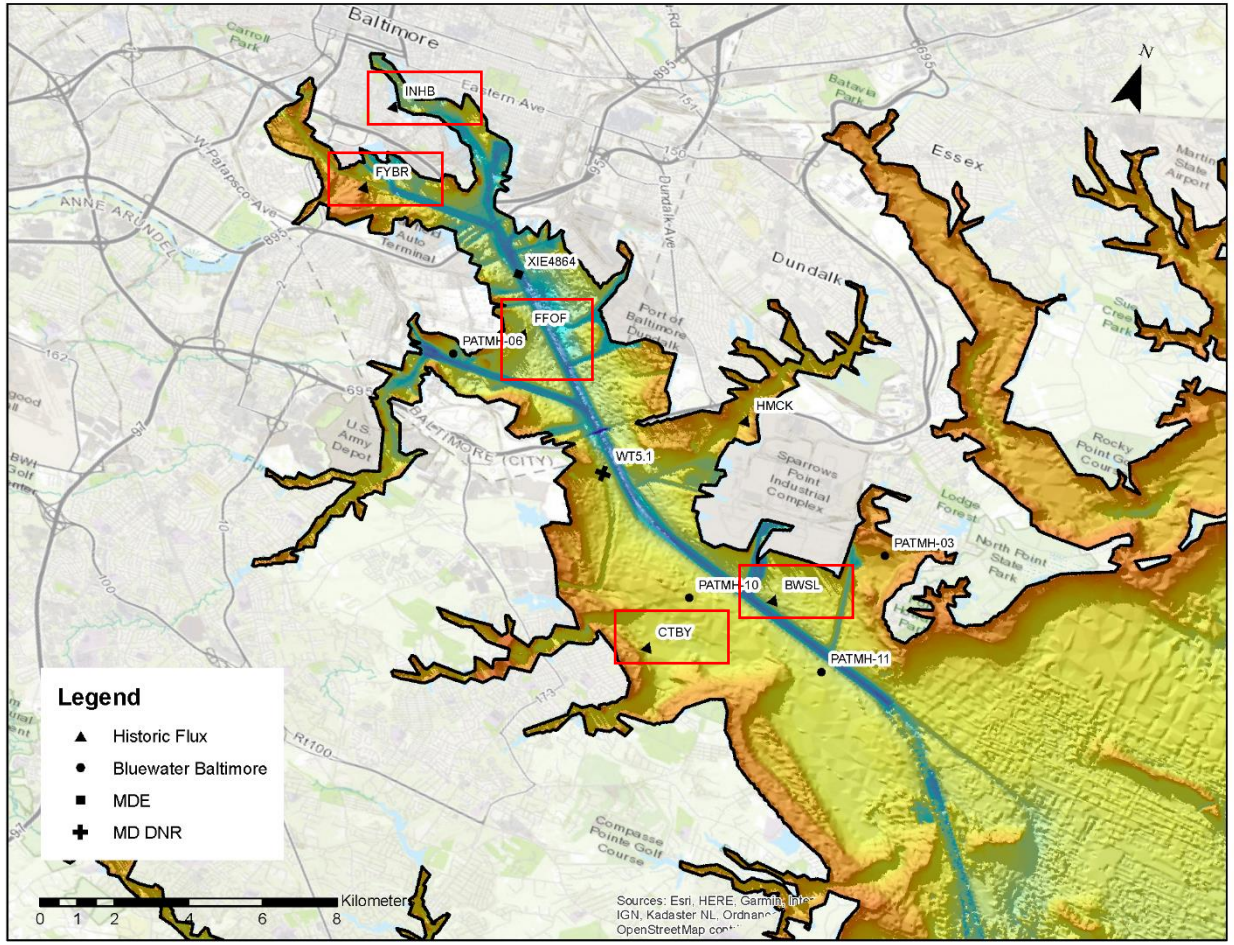
We intend to accomplish the following 5 tasks listed below, with estimated time, and specific output and outcome

Tasks:

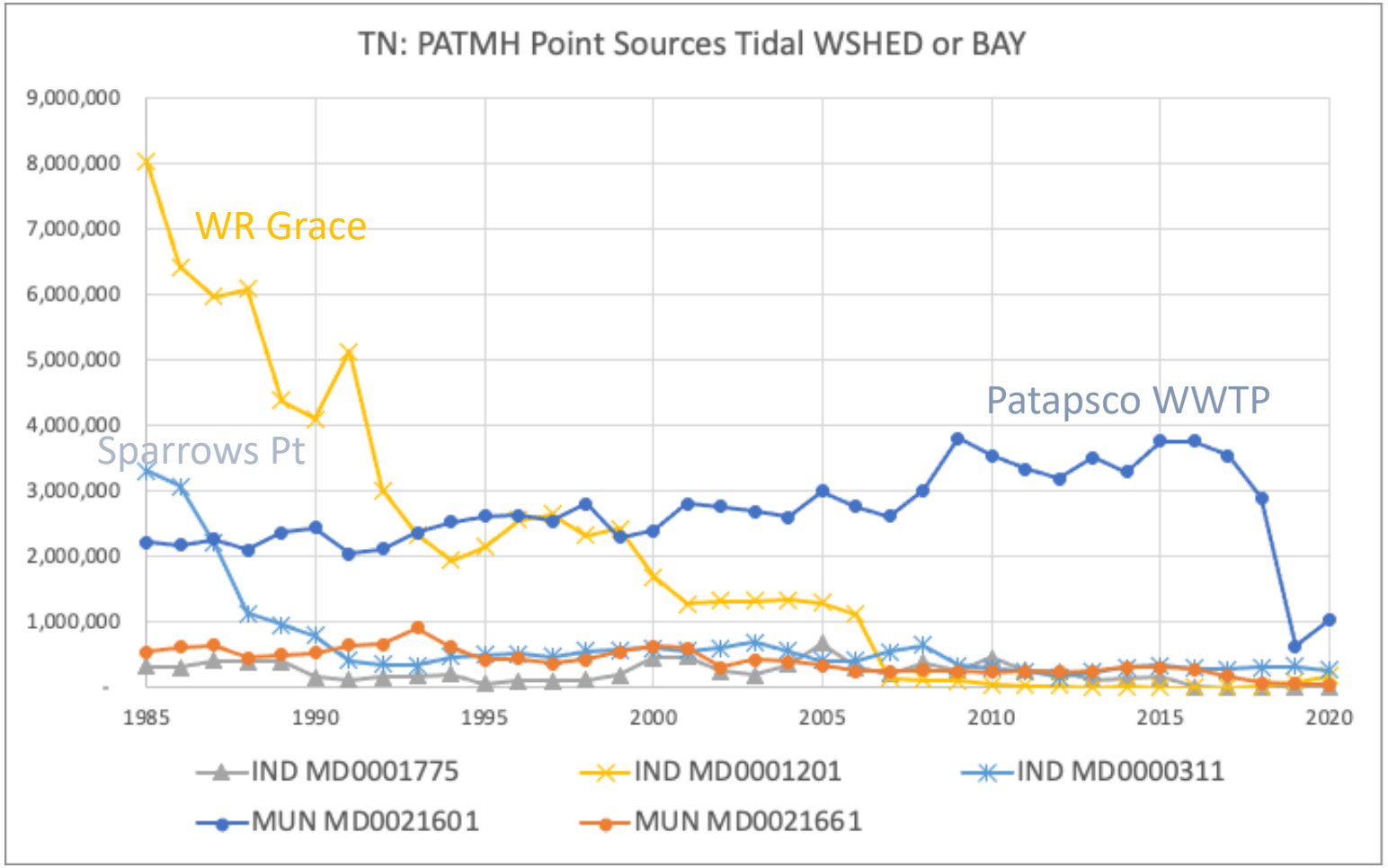
1. Improve the simulation and understanding of shallow water processes (2-5 years)
2. Collaborate with and support the Chesapeake TMDL regulatory model the MBM for the entire tidal Chesapeake (1-3 years)
3. Assist in improving tidal Chesapeake WQ assessment by bringing in additional WQ data that complement the latest phase 7 next-generation watershed, airshed, and estuary models (3-5 years)
4. Improve CBP estuarine science and analysis by integrating the MTMs with the MBM (1-5 years)
5. Providing MTM support for updating tidal TMDLs and other water quality assessments in the Chesapeake Bay under a 2035 hydrology, climate, and sea level rise (4-5 years)

IV. Assist in improving tidal Chesapeake WQ assessment by bringing in additional WQ data that complement the latest phase 7 next-generation watershed, airshed, and estuary models (3-5 years)

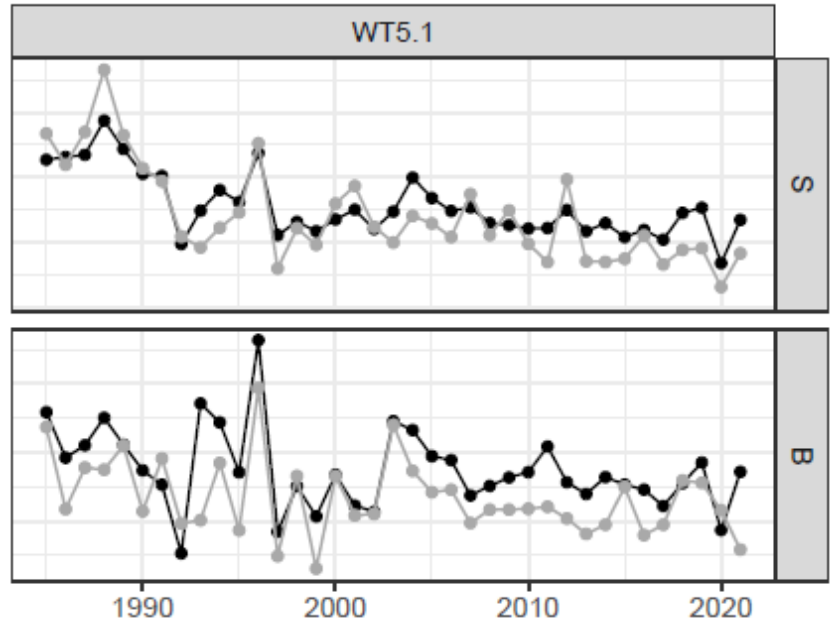




Wastewater Sources to Patapsco: A Mix of Industrial and Municipal

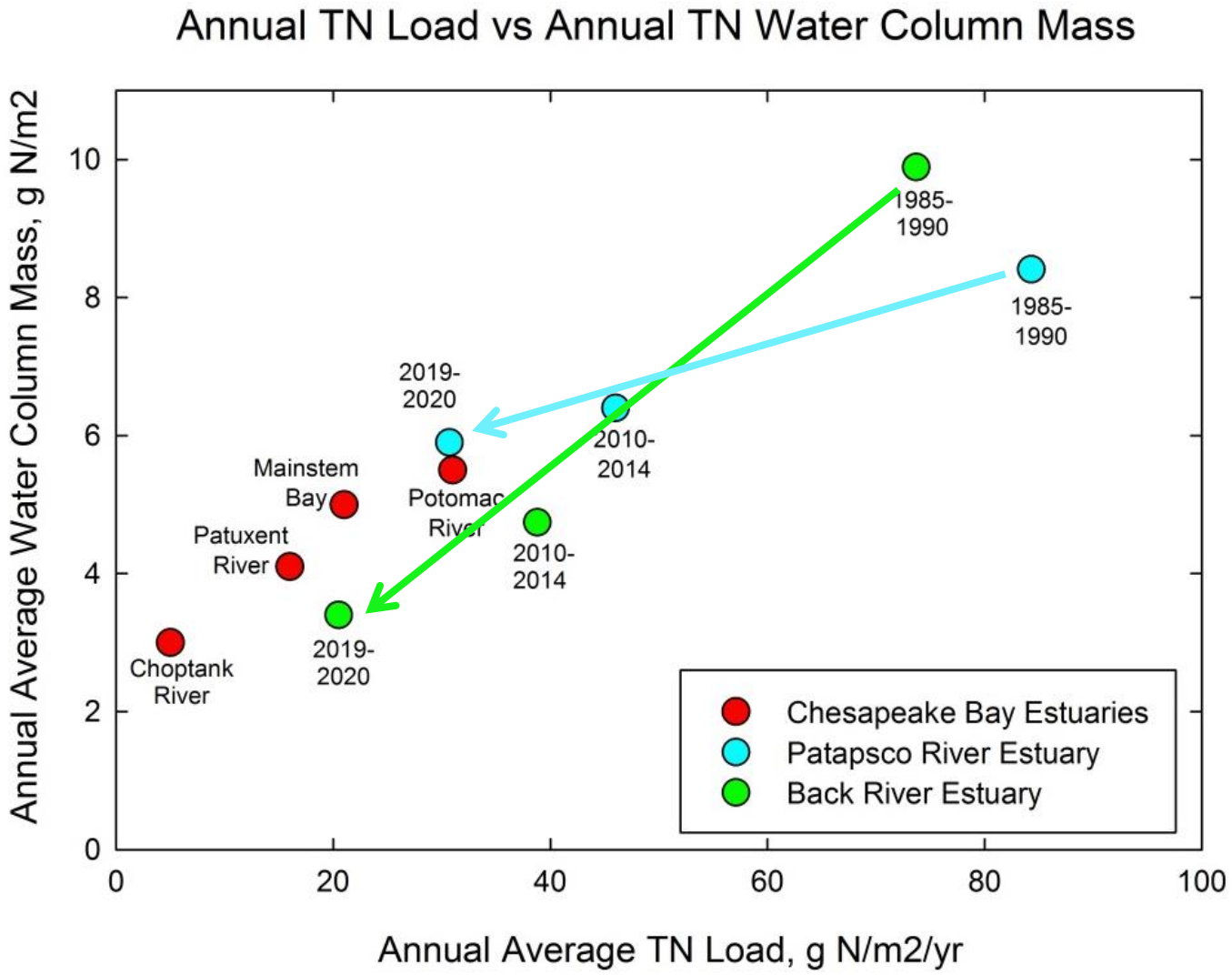


TN Concentrations at WT5.1

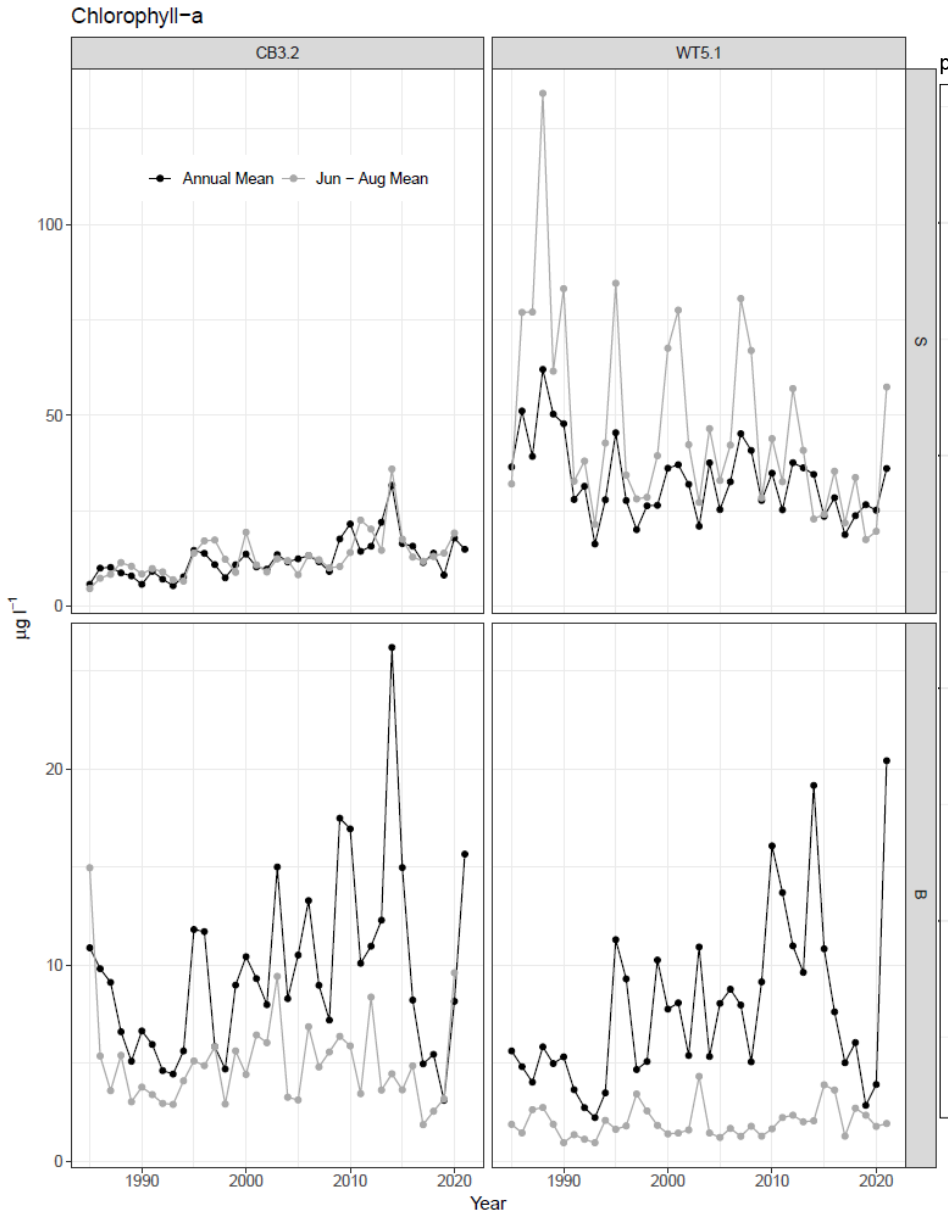


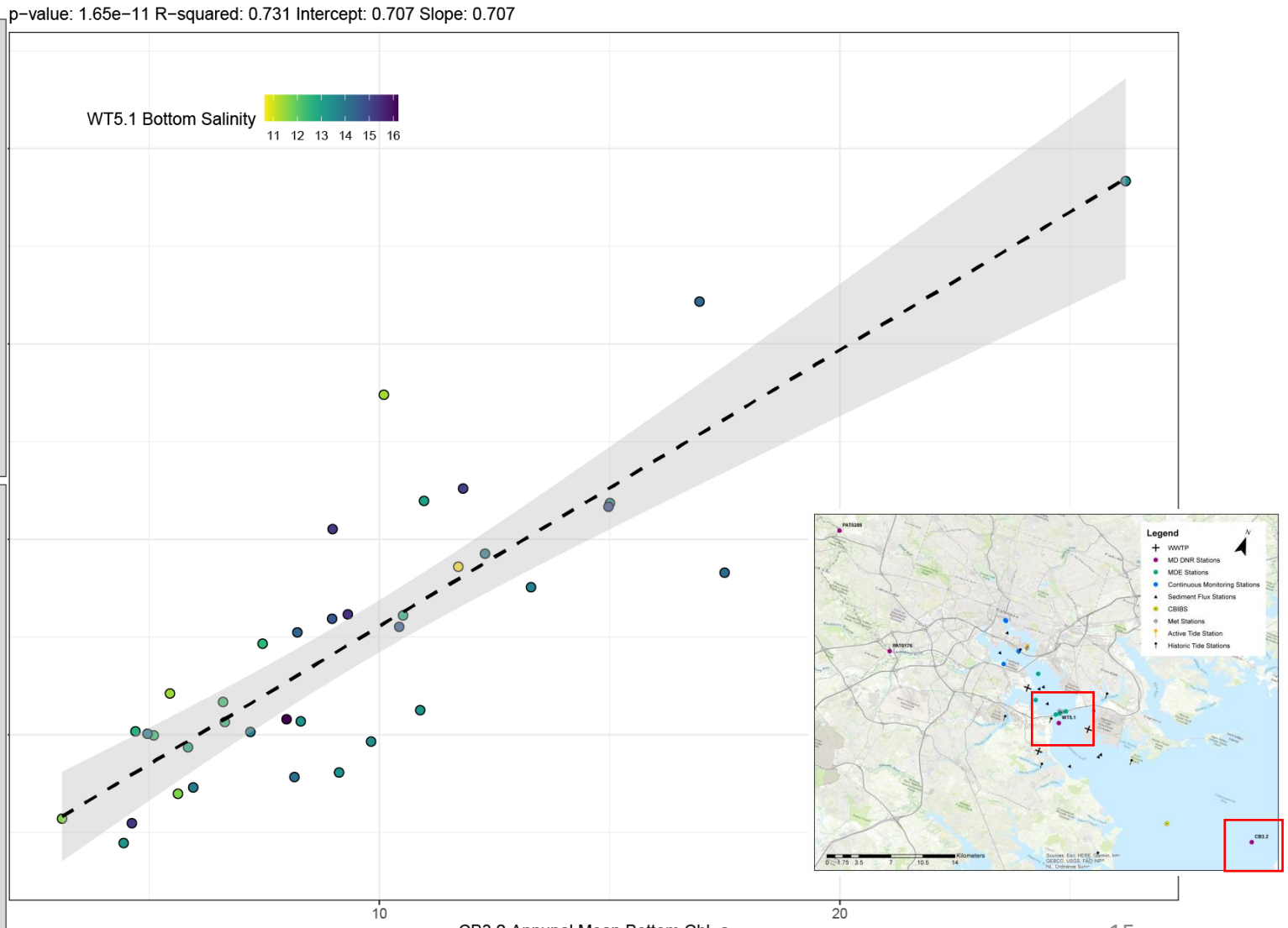
Data courtesy of Gopal Bhatt and Gary Shenk

Patapsco ‘Recovery’ Consistent with Other Larger Bay Environments

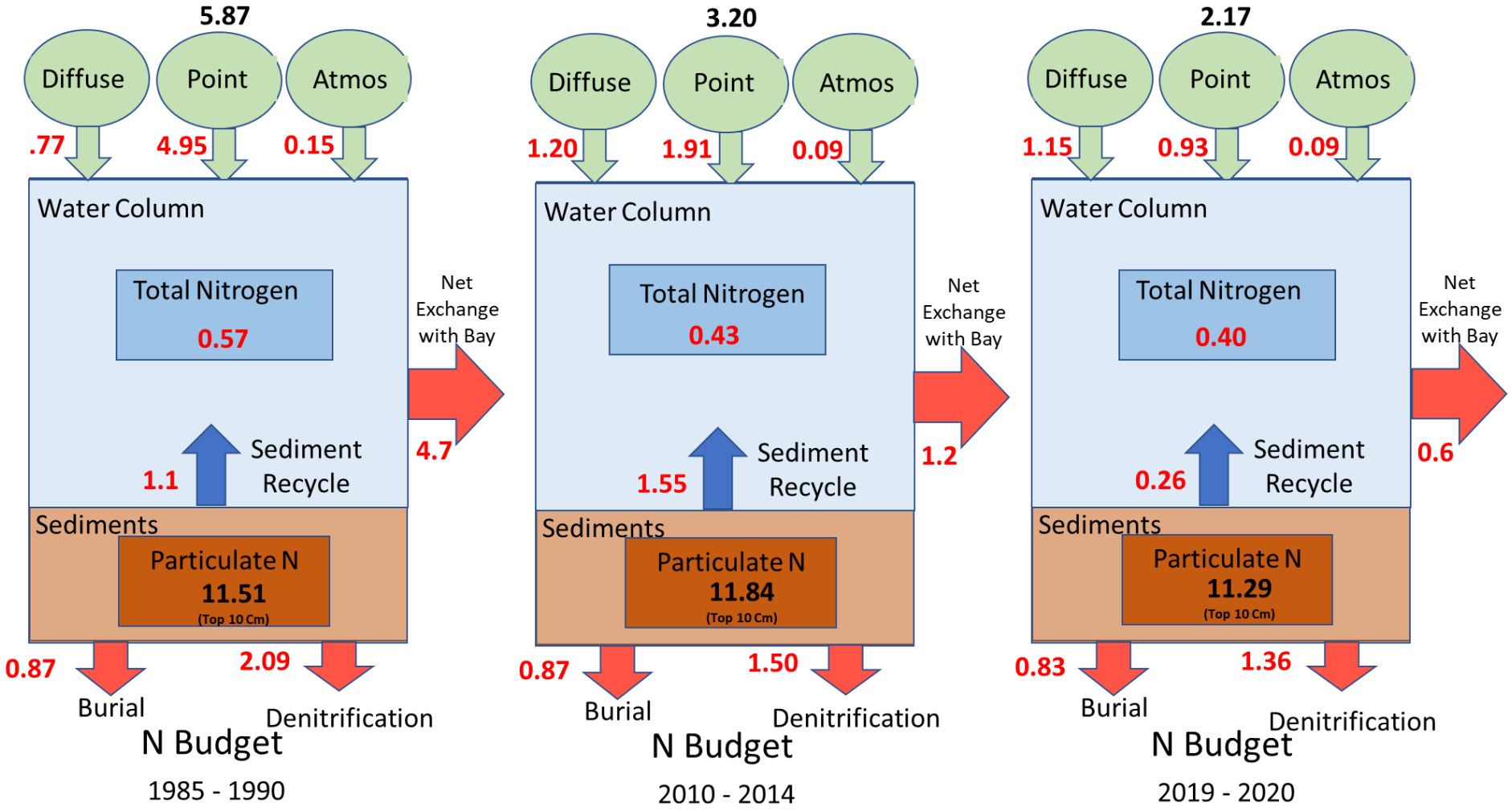


V. Improve CBP estuarine science and analysis by integrating the MTMs with the MBM (1-5 years)

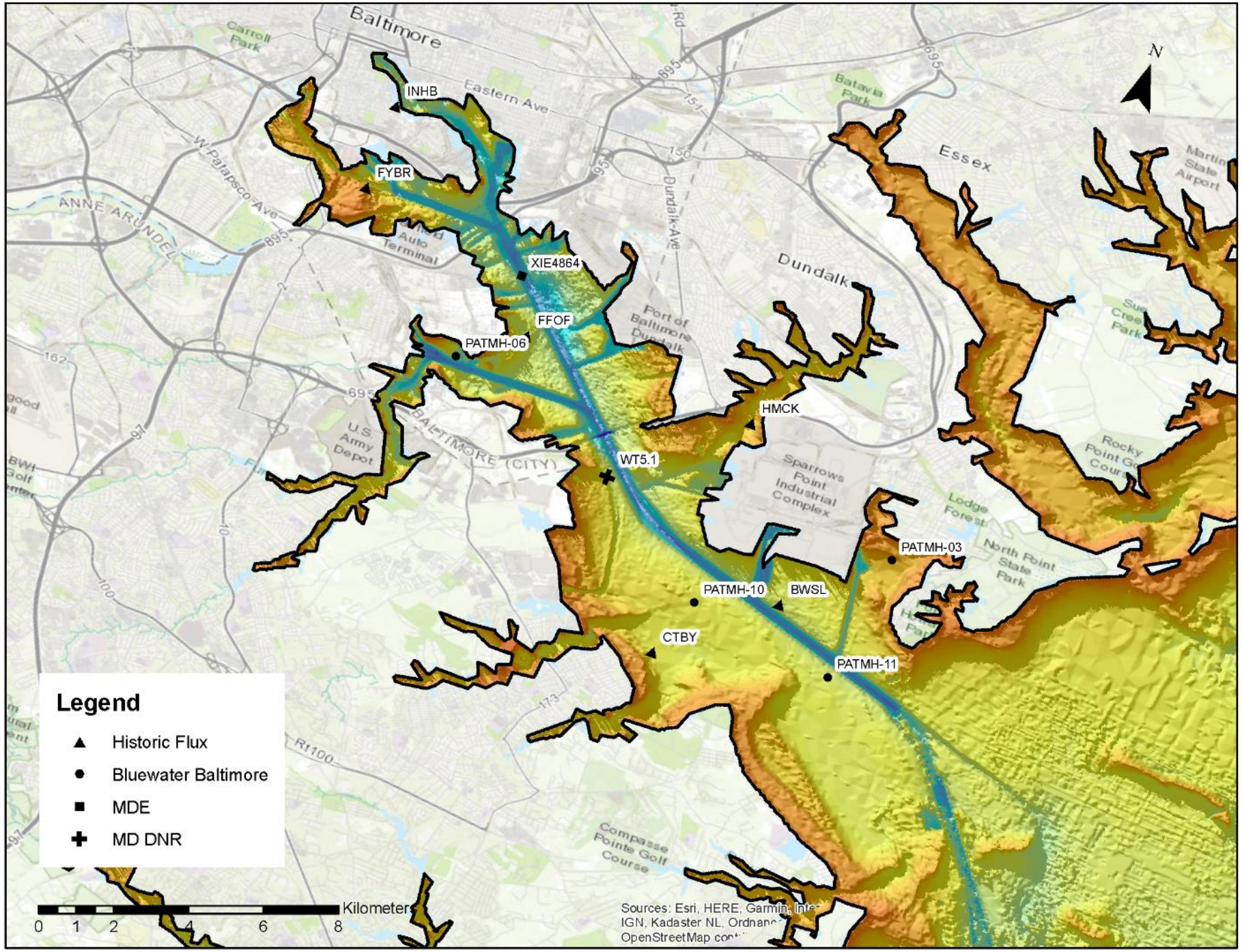




Nitrogen Budget: Export to Bay has Declined, Sediment Recycling Important: *Need Model Testing*



Units for all flows = Kg N year $^{-1}$ x 10^6 Units for storages = Kg N x 10^6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Eastern Ave
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FYBR
XIE4864
FFOF
PATMH-06
HMCK
WT5.1
PATMH-03
PATMH-10
BWSL
CTBY
PATMH-11
Essex
Dundalk
Sparrows Point Industrial Complex
Compasse Pointe Golf Course
North Point State Park
Lodge Forest
Legend
Historic Flux
Bluewater Baltimore
MDE
MD DNR
Kilometers
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