Integrating Climate Change with the Restoration of Chesapeake Bay and its Watershed

Michael Williams

CBL/UMCES

CBP Modeling Workgroup 10-3-12

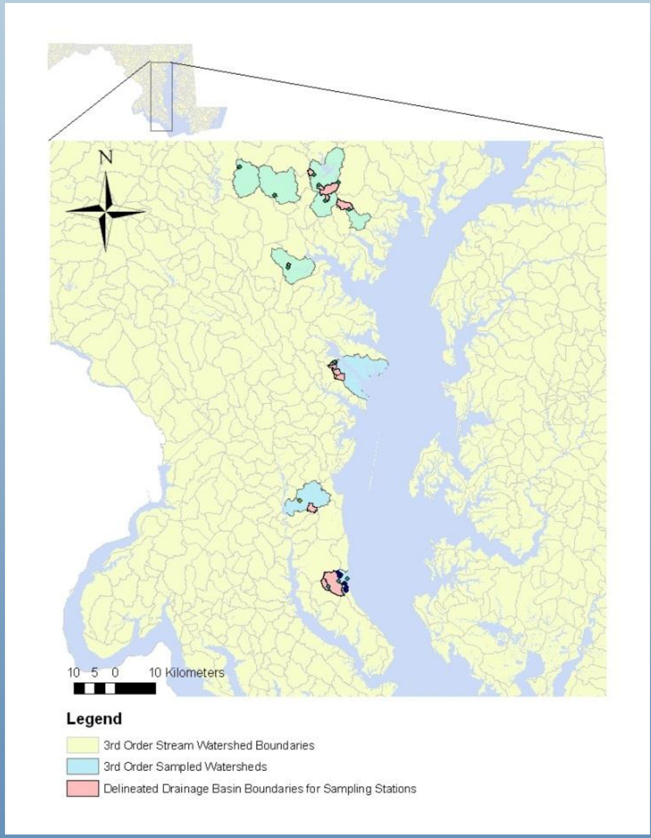
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Restoration with changing climate

- To achieve effective, long-term restoration, we should consider these questions:
  - What are the potential impacts of climate change on water quality and living resources?
  - Will changes in climate exacerbate or ameliorate the impacts of other stressors (e.g., land use change)?
  - How will stream restoration strategies and intertidal marshlands perform under changing climatic conditions?

Multifaceted Project

- Stream and stormwater BMP efficiency
- Stoichiometric relationships (N:P:C) at stream restoration sites
- Intertidal marshland responses to changes in nutrient and sediment loading, SLR
- Macroinvertebrate community shifts w/ higher flow and temp
- Carbon quality changes

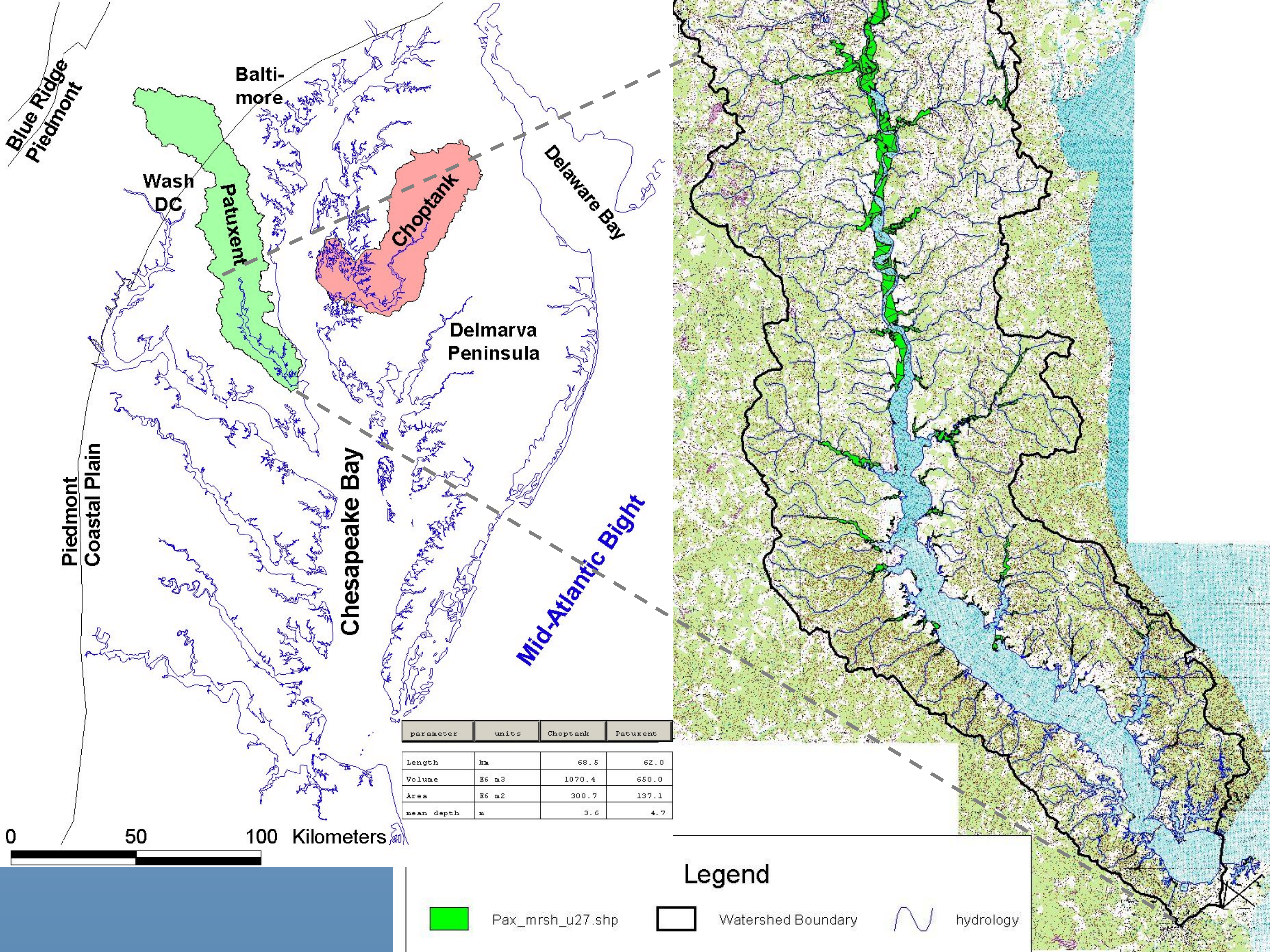


Conceptual Model

- Develop conceptual model that evaluates:
  - Factors controlling restoration/recovery of nutrient uptake, sediment removal and biodiversity in streams and wetlands
  - Likely impacts of climate change on these 'dependent' variables; scenarios to 2030 and/or 2100
  - Interaction of climate change and other stressors (i.e., urb and agr land use) expected on a similar time horizon
  - Mitigating measures (BMPs, etc.)

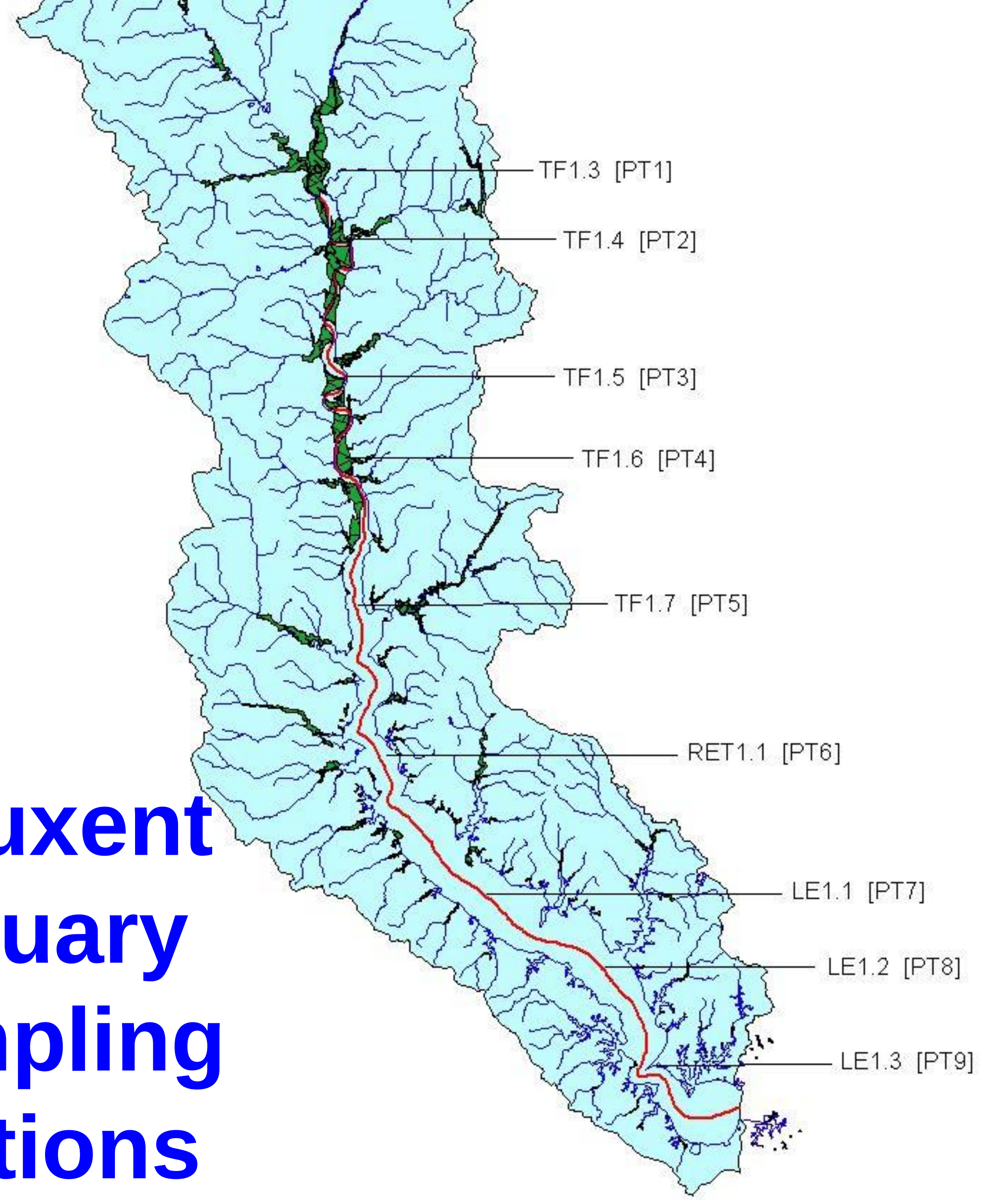
Hydrochemical Modeling

- Patuxent case study: Understanding the sensitivity of flow and WQ constituents to climate change (2030 / 2100)
  - Use CBP linked modeling system with potential modifications (i.e., land use change model, marshland coverage, SLR, increased water temperature, etc.)
- Assess:
  - interactions with other stressors (e.g., urban and agricultural land use)
  - performance of stream restoration and intertidal marshlands under changing conditions

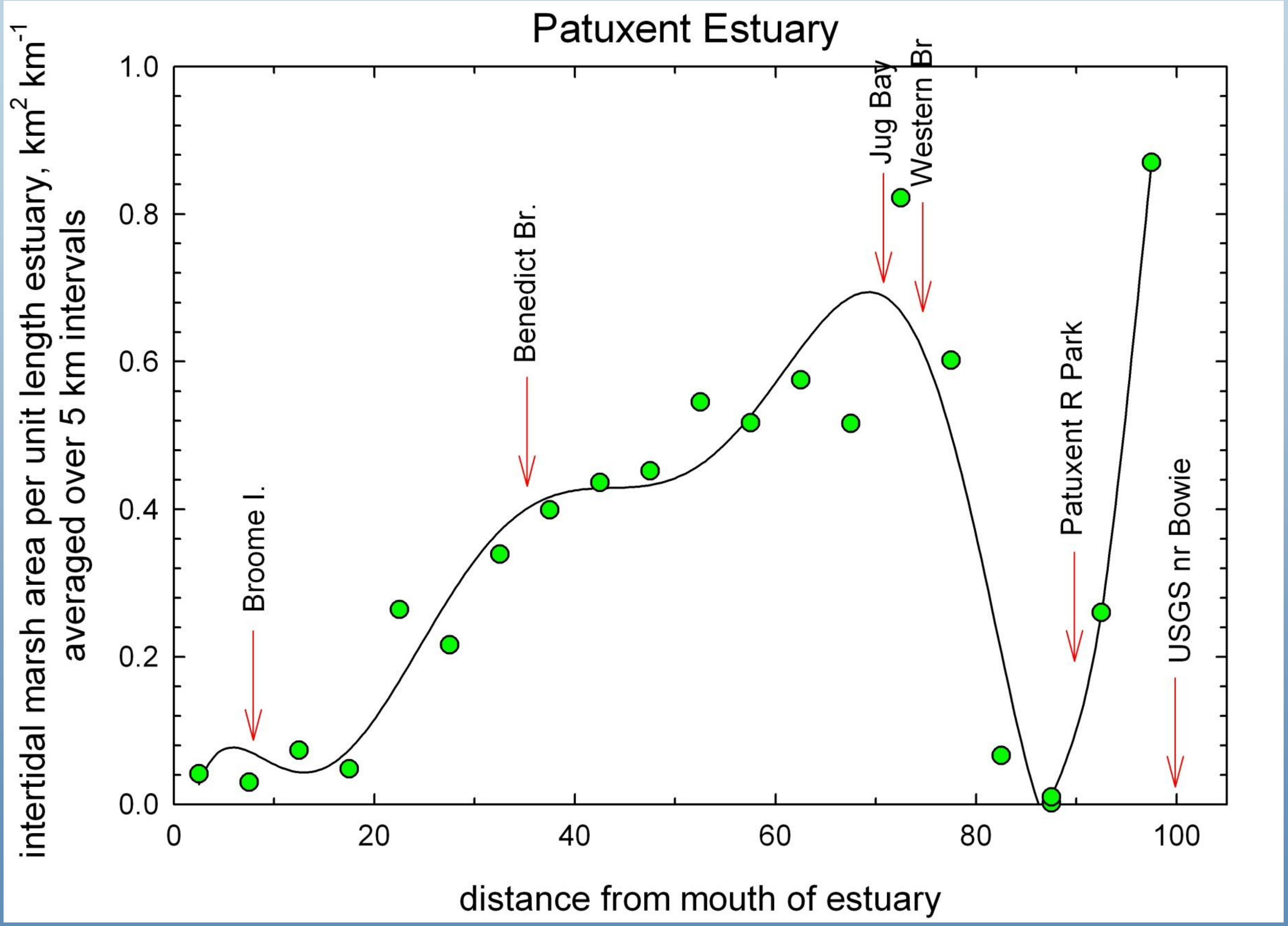


parameter	units	Choptank	Patuxent
Length	km	68.5	62.0
Volume	E6 m3	1070.4	650.0
Area	E6 m2	300.7	137.1
mean depth	m	3.6	4.7

Patuxent Estuary Sampling Stations

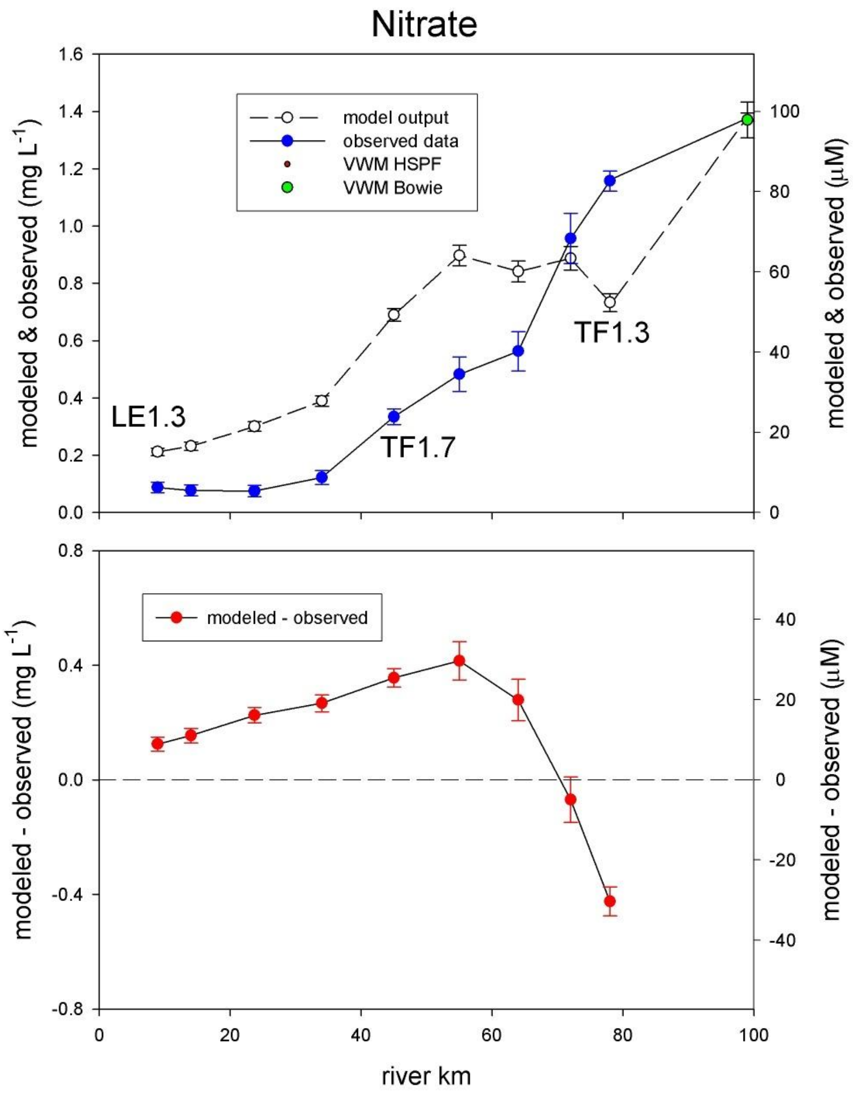


Marsh averaged over 5 km area

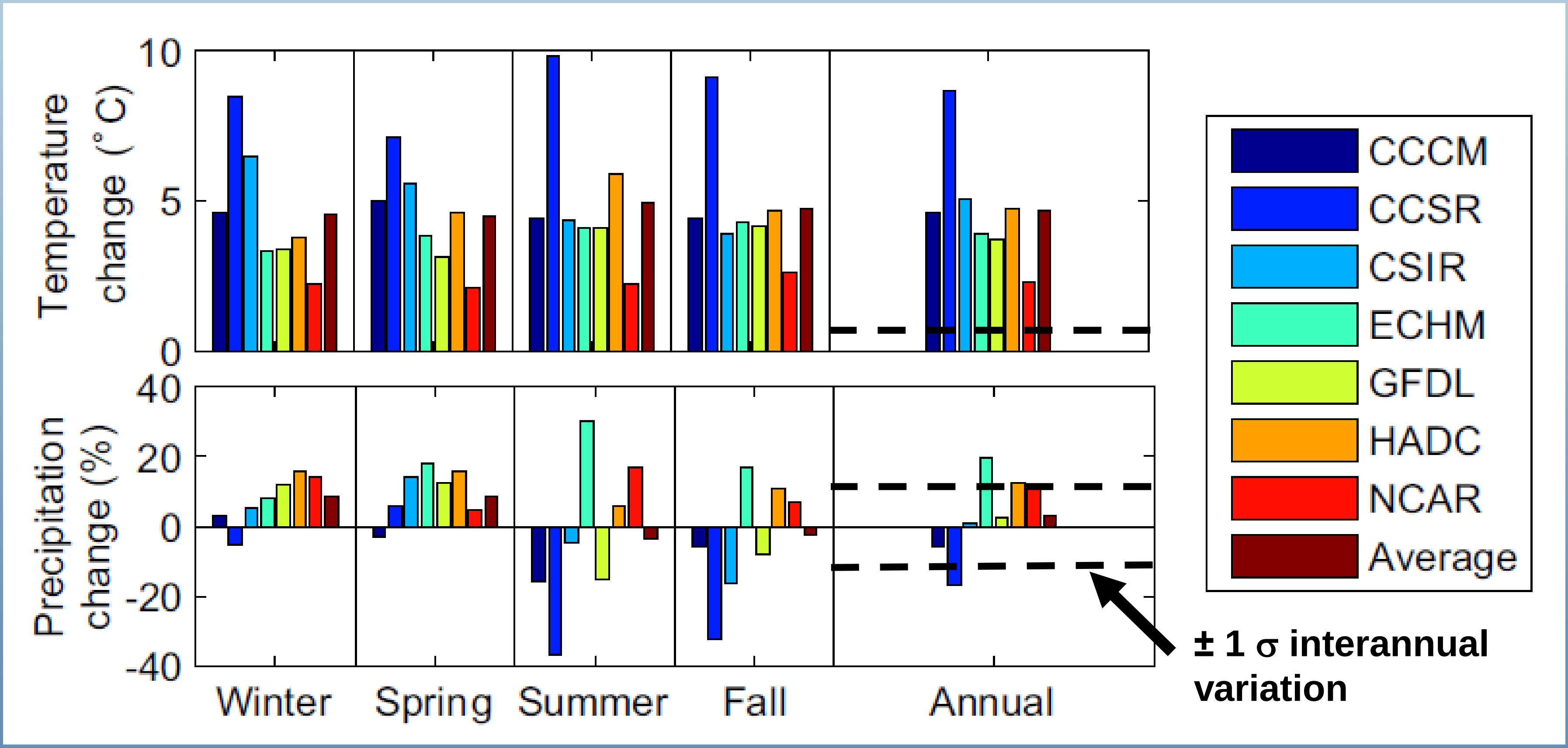


Modeled and observed NO_3 in Patuxent tidal fresh to mesohaline zones

Can do same analysis for other constituents: PO_4, DO, TSS, chl*a*, etc.

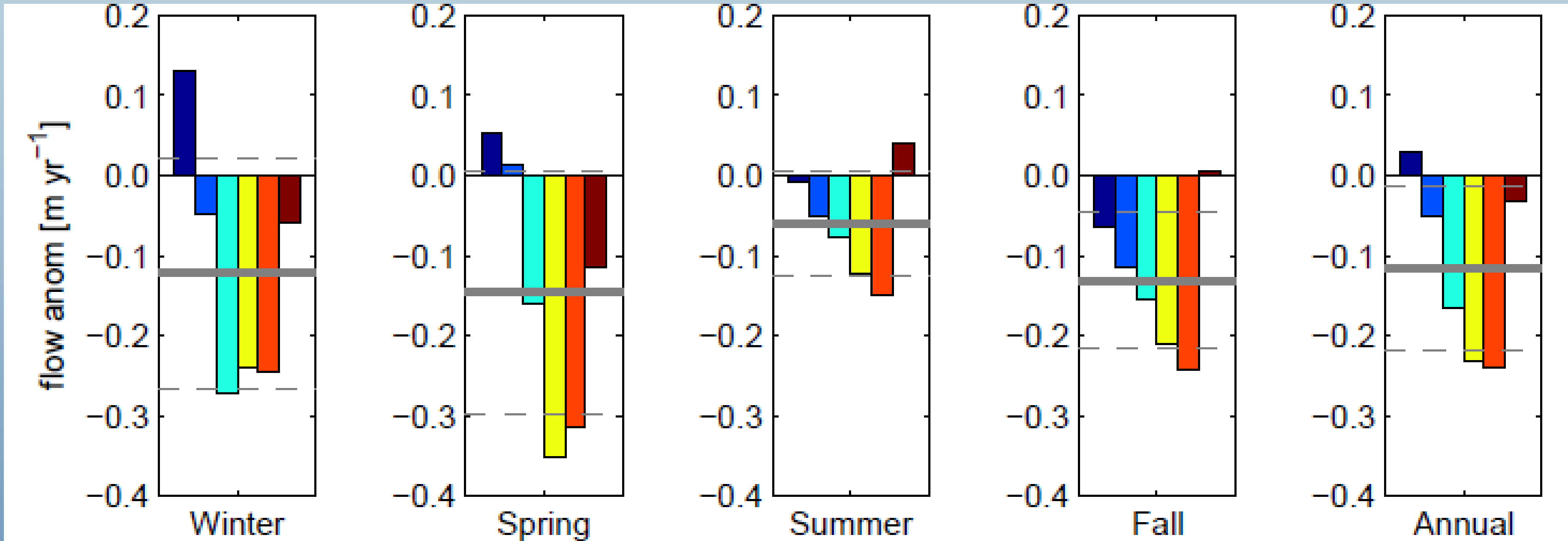


End-of-21st-Century climate projections for Chesapeake Watershed (A2 scenario)

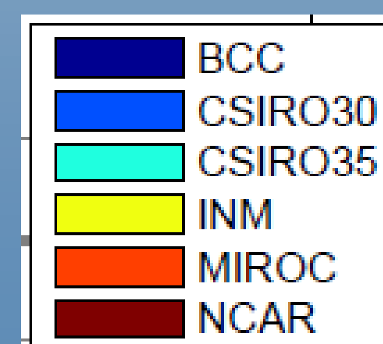


Najjar et al. (2010)

Projected flow change by end of century, A2 scenario

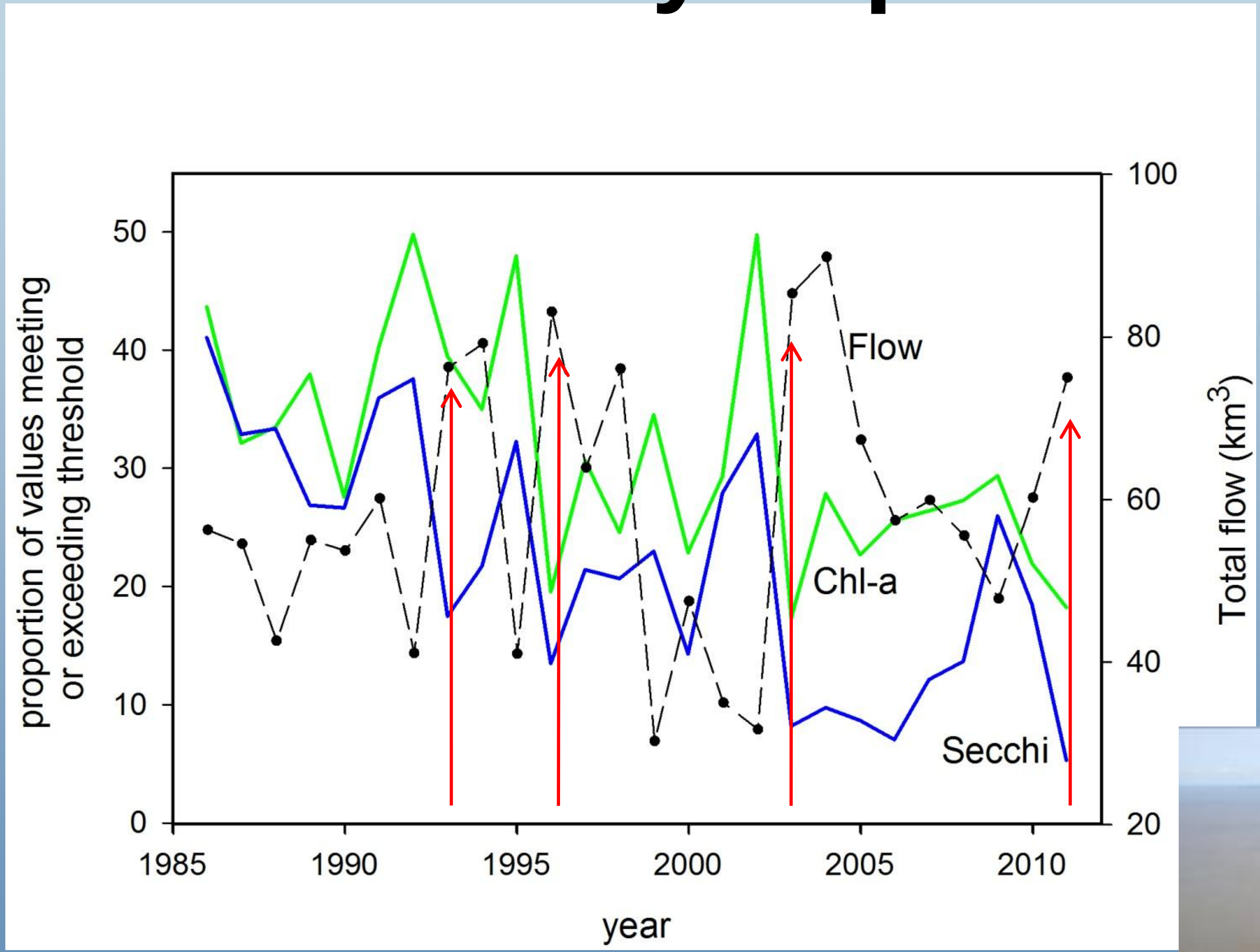


***Analysis by Maria Herrmann, PSU**



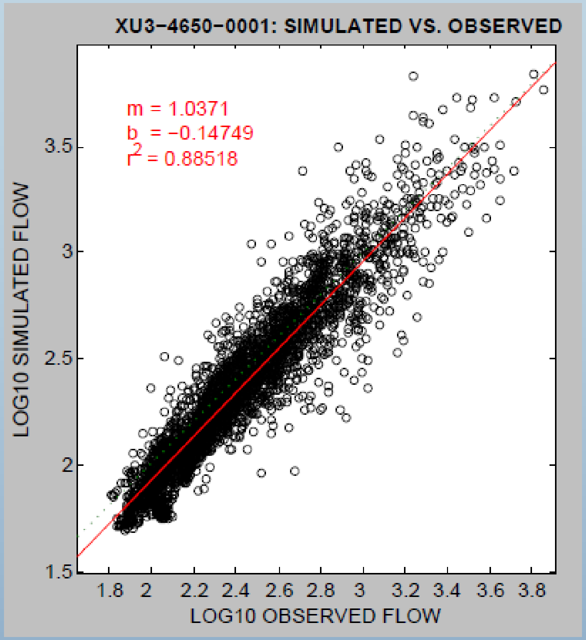
Current baseline ~0.5 m yr^{-1}

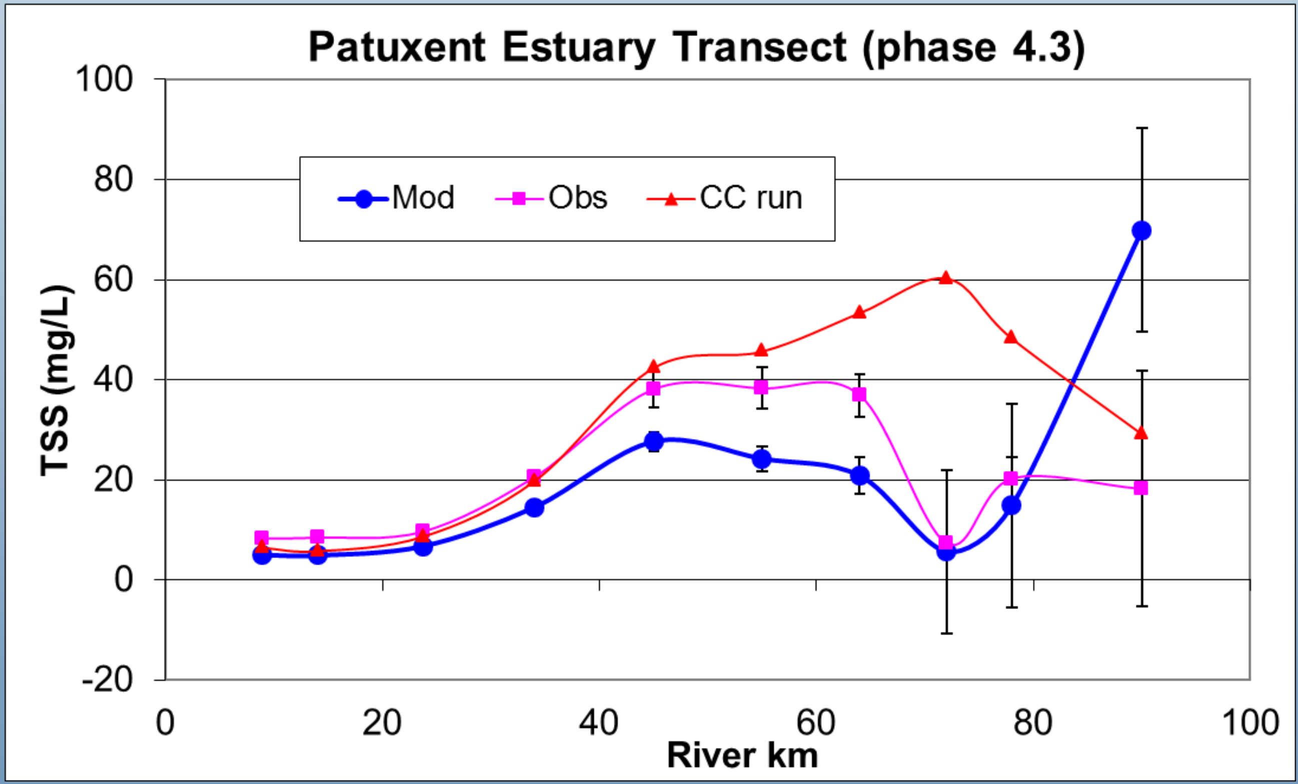
High flows after 1992 and poor resiliency to pollutant loads

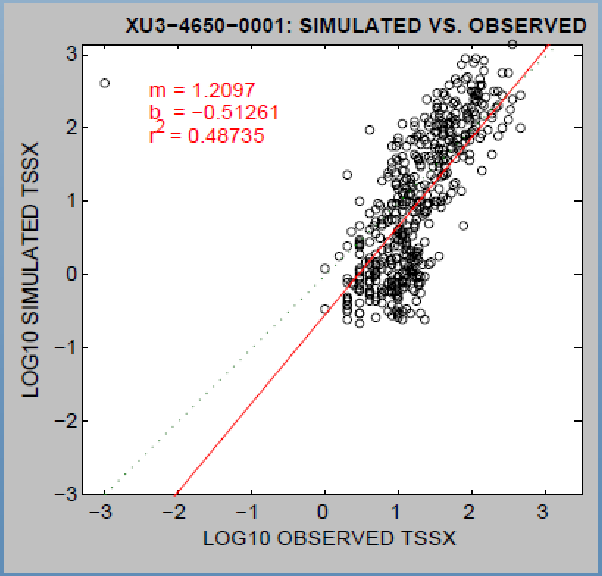


- **Loss of biogeochemical efficiency and positive feedback on eutrophication**
- **Continual resuspension of detrital, organic and sediment particles**

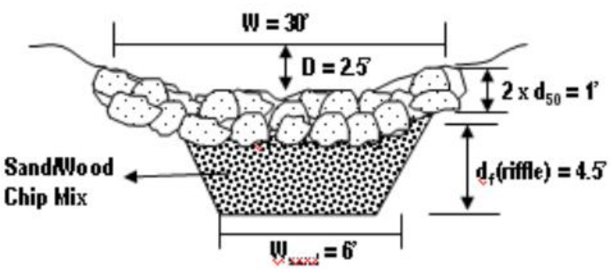
Patuxent at Bowie - Phase 5.32

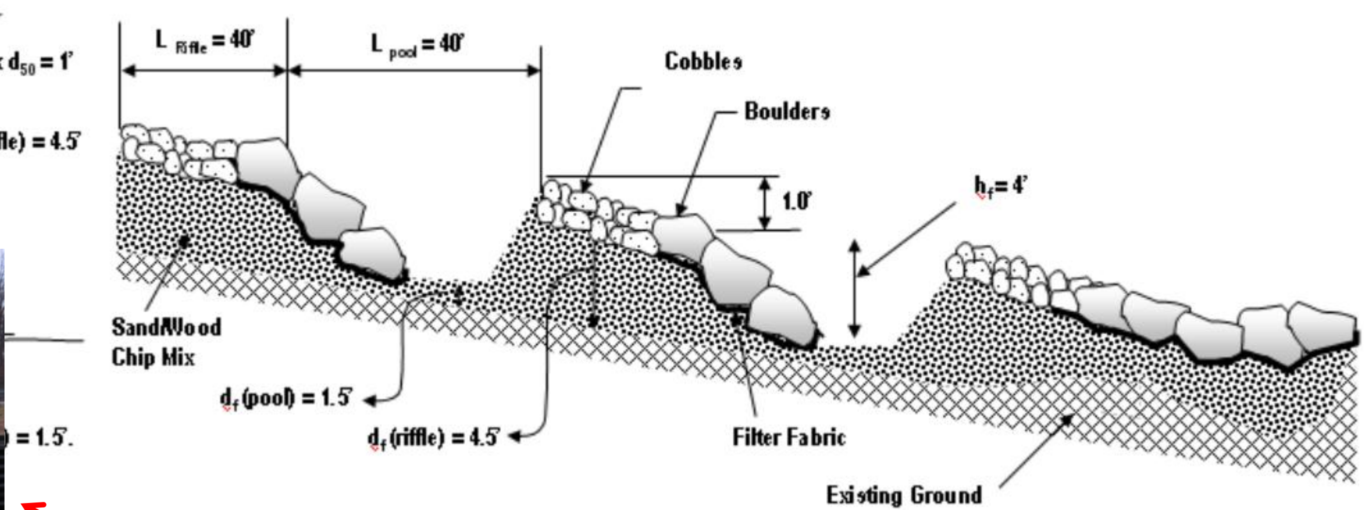






Remediation - Regenerative Stormwater Conveyance Structures





Before implementation

Concluding Remarks

- Multiple stressors, such as continued population growth in addition to bay warming and sea-level rise associated with global change, will influence the effectiveness and eventual success of restoration efforts in Chesapeake Bay
- Precipitation w/in long-term variability, but ^{o}C is much higher (may seriously effect SAV), runoff less certain. This uncertainly makes it difficult to inform water resource managers about the likely impacts of CC and how to ameliorate these impacts with various types of BMPs

Next Steps

- Refine model simulations by including:
  - Projected land use to 2030 and beyond
  - Sea level rise and increase water temp in estuarine water quality/hydrodynamic models
  - Range of intertidal marshland areas and nutrient efficiencies
  - Range of BMP efficiencies
- Timeline for running scenarios
- CERF 2013 session (Najjar and Williams)