ITAT Workshop on Integrating Findings to Explain Water Quality Change

December 12-13, 2017

Annapolis, MD

STAC publication 18-005

Workshop Purpose

Interdisciplinary Dialogue

- To convene research synthesis groups in one venue, to share their findings and identify complementary and contradictory insights across disciplinary and geographical boundaries;

- To foster a dialogue between these scientists and a group of managers representing each jurisdiction of the Chesapeake Bay Program (CBP) Water Quality Goal Implementation Team (WQGIT).

Workshop Purpose

Cross-discipline dialogue: Introduction

Decision Support and Challenges Faced:

- **Timing:** The CBP's "accountability schedule" drives decision-making for the jurisdictions. As a result, information must be available in an accessible format, with insights for application, within that timeframe.

- **Technical:** Decision-making is complicated by the watershed's highly variable landscape and the local scale at which several of these decisions must be made. Extrapolating scientific insights to scales and locations outside of their original scope adds uncertainty with regard to source attribution and BMP effectiveness.

- **Social and Political:** The degree to which science-based information can guide decision-making is mediated by an array of factors over which managers may have little to no control. Decisions are constrained by the availability of limited public resources, with multiple public needs competing for attention and prioritization. The desire to place BMPs in those locations where they will be most effective is complicated by the need to consider fair and equitable distribution of resources across communities. Finally, private property rights and lack of a regulatory mandate for most non-point sources limit the options open to managers when it comes to optimal BMP placement.

Workshop Purpose

Cross-discipline dialogue: Research Synthesis Sessions

- 4 sequential sessions
- For each session:
  - 2-3 synthesis presentations
  - 80 minutes of breakout discussion
  - Outcomes:
    - Science messages for further communication
    - Potential implications for management
    - Research recommendations

Workshop Purpose

Cross-discipline dialogue: Research Sessions

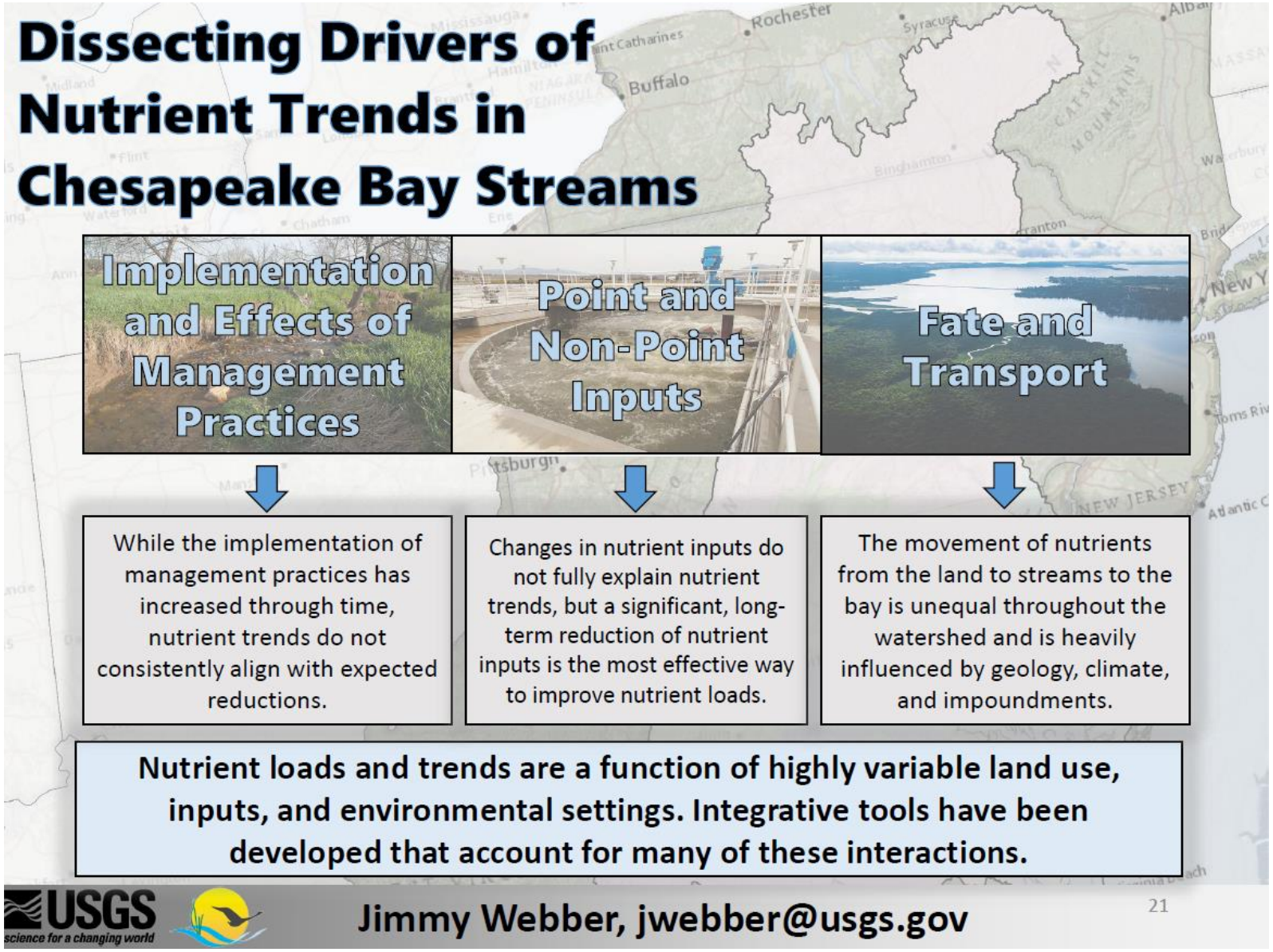
I. Insights from USGS Monitoring and Analysis of the Chesapeake Bay Watershed

II. Insights from monitoring and analysis of watershed sediment transport, estuarine water clarity, and SAV abundance

III. The history of major tributary loads and conceptual models of estuarine response

IV. Integrating research and science communication from watershed to estuary to inform management strategies

Non-Tidal Network 1



Session I: Insights from USGS Research and Monitoring

Non-Tidal Network 2

- N flux to the bay declined between 1992 and 2012, but not at a pace that would be sufficient to attain goals by 2025.
- The decline in flux is due primarily to point-source reductions, and to a lesser extent by declines in atmospheric deposition and in inputs from urban non-point sources.
- Agricultural fluxes provide the majority of loads to the bay, and changed little between 1992 and 2012.
- P fluxes to streams declined between 1992 and 2012, due primarily to point-source reductions.
- P fluxes to Chesapeake Bay increased, due to reduced retention in the Conowingo reservoir.
- The increasing importance of dissolved phosphorus from agricultural areas may reflect soil saturation.

Session I: Insights from USGS Research and Monitoring

Some Discussion Highlights

Science messages for further communication:

- Existing spatial information on geology, loading hotspots, land use, and other relevant factors can be applied locally to inform BMP implementation decisions.
- Local management efforts have resulted in changes to local water quality in some areas.

Implications for management:

- Consider targeting newly urban and urbanizing areas for urban BMPs rather than well-established urban areas

Suggestions for future research:

- Identify and map primary flow paths for each pollutant in various places, in order to inform how BMPs can be targeted to better interrupt those flow paths.

Sediment

The Sediment Story: take home points

Excessive sediment harms fish and wildlife in the Chesapeake Bay and its watershed

Three important geomorphic principles to guide management:

Scale	Sediment started in uplands and is now moving through stream storage compartments Sediment processes differ in headwater streams than in larger rivers Sediment 'hops and rests' downstream, in and out of different storage zones (like floodplains), trapping large amounts of sediment (and nutrients), and causing lag times (sometimes fast, often slow) of response to management actions
Time	Historical legacy matters for understanding current sediment issues, and may impact BMP and management effects on loads
Land Use	Nutrients and other pollutants are attached to sediment Agricultural, developed land, and stream banks are all important sources of sediment, but locally and temporally variable Based on models, BMPs are expected to have reduced the 2014 sediment load to streams by about 23% in the Chesapeake Bay watershed

New scientific advances continue to improve our ability to understand and manage local and regional sediment problems

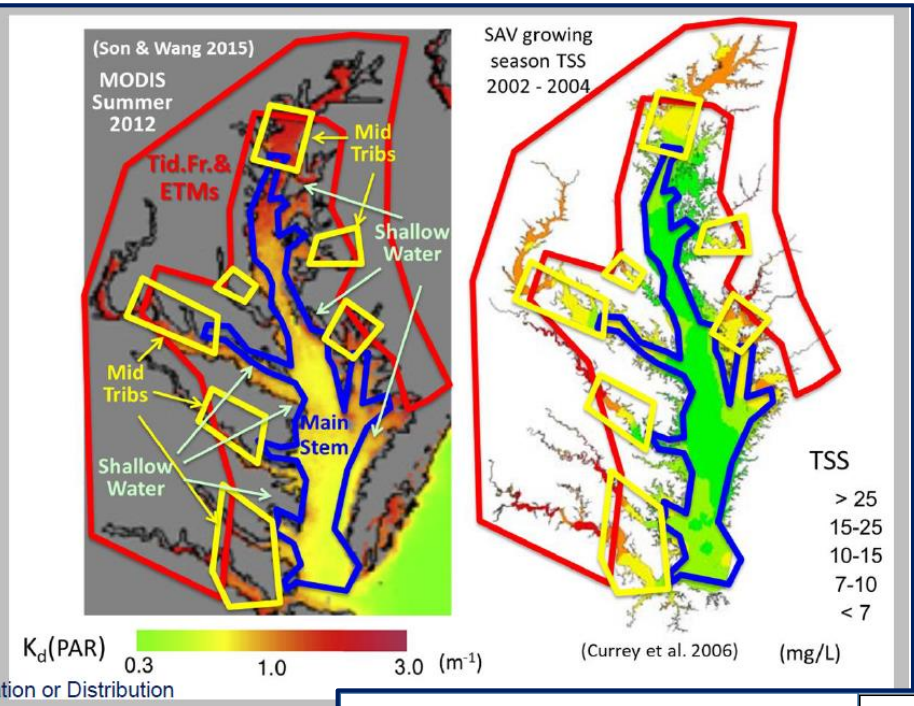
USGS

- Active sediment storage can delay detection of effects of BMPs on sediment loads
- Least certain elements of current conceptual models include:
  - time spent in different storage zones and how this varies across watersheds;
  - interactions of sediment transport and storage with phosphorus;
  - how individual BMPs affect downstream sediment processes.
- Scientific expertise and technical tools for addressing questions relevant to management are available and continue to expand.

Session II: Insights on sediment transport, water clarity, and SAV abundance

Water Clarity

- Previous work highlights distinct patterns in water clarity in different parts of the Chesapeake Bay.
- There are systematic differences in clarity and suspended solids between the tidal rivers, the ETMs, and the middle tributary regions separating them.
- Additional distinct regions:
  - Shallow water and highly localized variability such as small systems (not shown) that are poorly flushed.



Preliminary Information-Subject to Revision. Not for Citation or Distribution

Contemporary riverine sediment plays a role

Sediment inputs have transient role, but internal productivity of ETM dominates long-term trends

Long-term reductions in shoreline sediment interact with internally derived particulate and dissolved compounds.

Salinity Zone	Depth	coastal morphology
Tidal Fresh (< 0.5 ppt)	< 2 meters	open
		semi-enclosed
	>= 2 meters	open
		semi-enclosed
Oligohaline (0.5 - 5 ppt)	< 2 meters	open
		semi-enclosed
	>= 2 meters	open
		semi-enclosed
Mesohaline (5 - 18 ppt)	< 2 meters	open
		semi-enclosed
	>= 2 meters	open
		semi-enclosed
Polyhaline (>= 18 ppt)	< 2 meters	open
		semi-enclosed
	>= 2 meters	open
		semi-enclosed

In embayments with longer residence times in all salinity zone, shoreline sediment inputs interact with biological factors

Session II: Insights on sediment transport, water clarity, and SAV abundance

SAV Synthesis

SAV SYN produced 3 papers and working on a segment analysis

1. Eelgrass declines (Global Change Biology, published)
2. SAV as sentinel species (Bioscience, published)
3. Nutrient reductions (Proc. Natl. Acad. Sci., in revision)
4. SAV segment analysis (in progress)

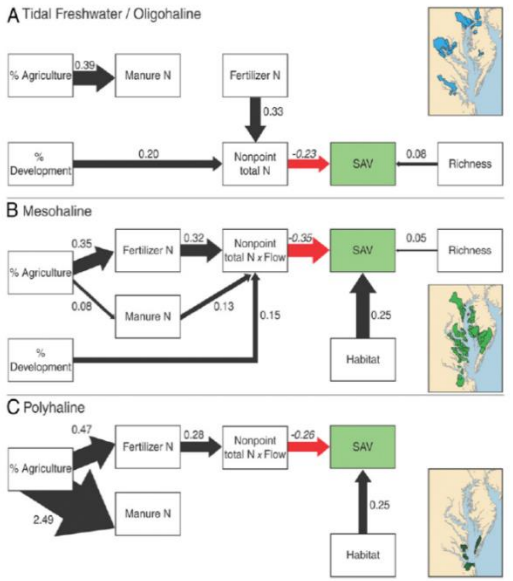
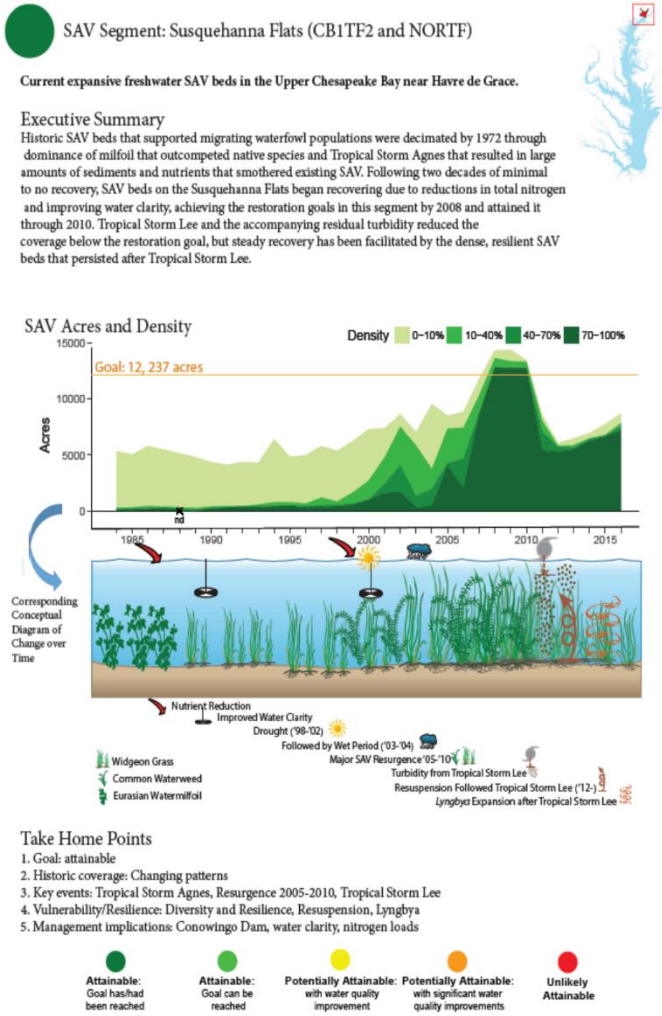


Fig. 1. Structural equation models for total nitrogen (N) fit to subestuaries and their watersheds by salinity zone. (*A*) Tidal freshwater/oligohaline (0–5 psu), (*B*) mesohaline (5–15 psu), and (*C*) polyhaline (15–25 psu). Arrow width is proportional to the standardized effect size, given next to the arrows. Black arrows denote positive effects; red arrows, negative effects. Nonsignificant relationships ($P > 0.05$) have been omitted for clarity, including the nonsignificant effects of point source nutrients and total suspended solids (TSS) (*SI Appendix*, Fig. S5). Map *Insets* denote the location of watersheds. Units and unstandardized path coefficients are given in *SI Appendix*, *Supplementary Materials*.



Session II: Insights on sediment transport, water clarity, and SAV abundance

Some discussion highlights

Science messages for further communication:

- In places where nutrient loads and concentrations have been reduced, SAV has shown recovery within about 3-4 years.
- Controlling sediment erosion is important for local stream health, and local sediment management benefits local fish populations and farm productivity.

Implications for management:

- Target fine sediment transport and suspension rather than coarse sediment.

Suggestions for future research:

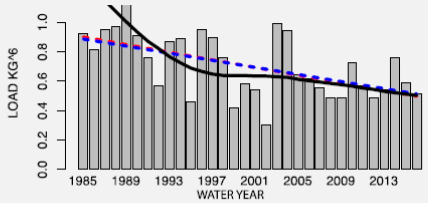
- Conduct more research on sediment effects on insects, algae, and nutrient concentrations in small stream areas.
- Collect and analyze data to better characterize causes of change in suspended particle size and composition in tidal waters

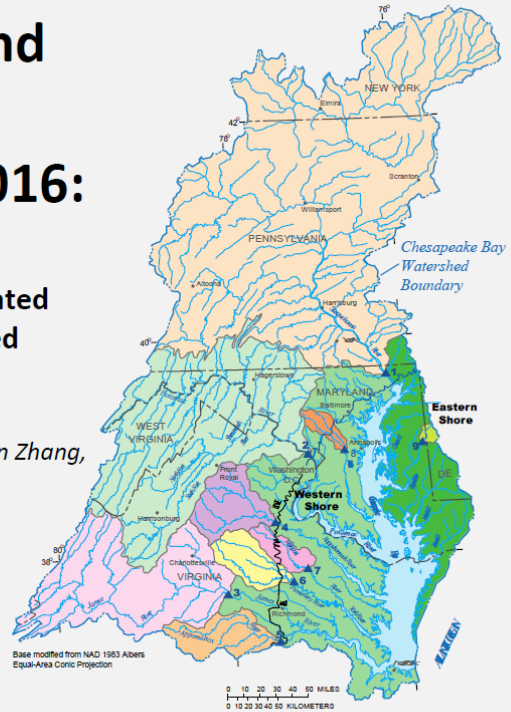
RIM Synthesis

A History of Nutrient and Sediment Inputs to Chesapeake Bay, 1985-2016:

Three decades of monitoring and coordinated restoration in the Chesapeake Watershed

Joel D. Blomquist, Rosemary M. Fanelli, Jeni Keisman, Qian Zhang, Doug L. Moyer and Michael J. Langland





USGS science for a changing world

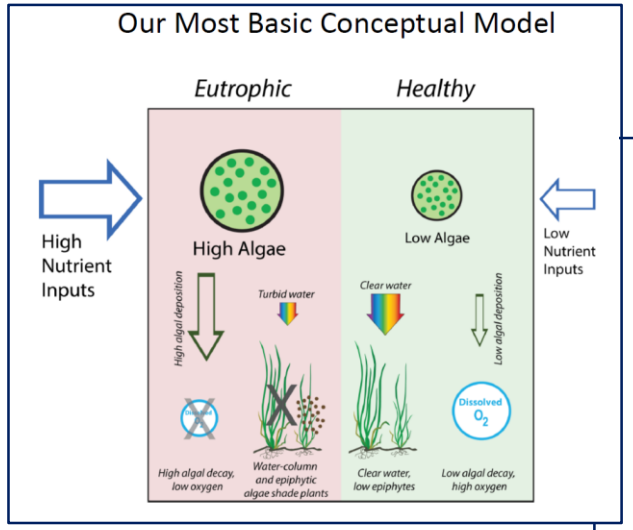
Summary of Findings

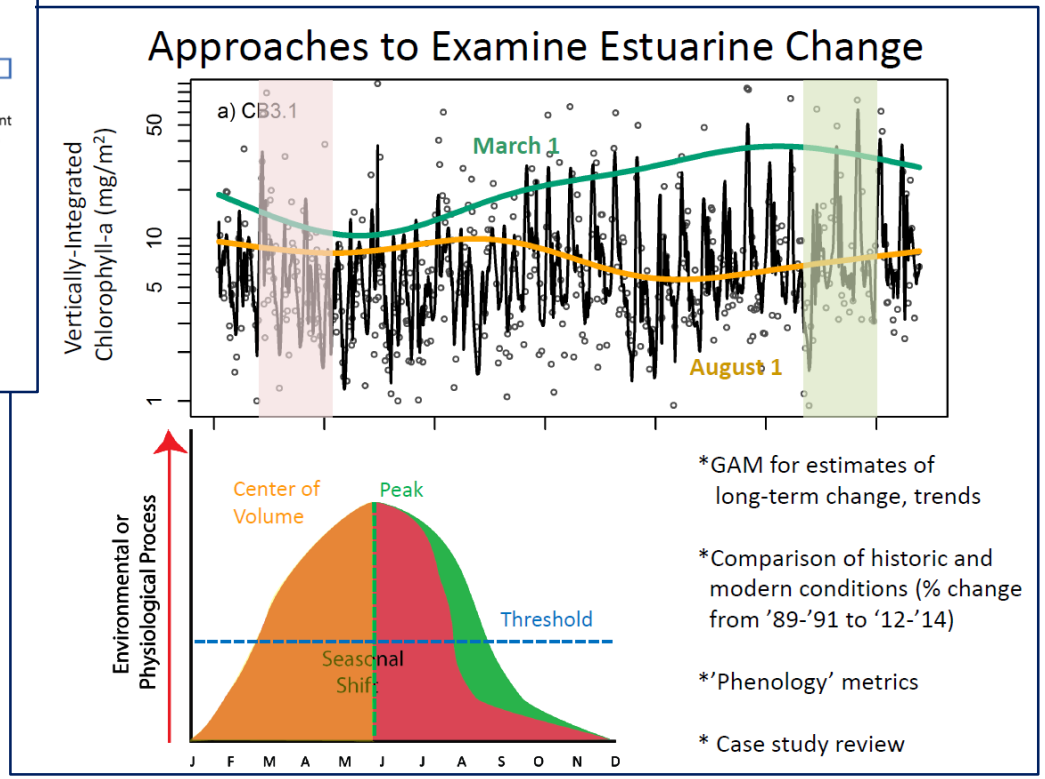
- Observed long-term trends in loads at times differ from flow-normalized trend estimate.
- Realized changes are often considerably smaller than flow-normalized results suggest.
- Interannual variations in weather and streamflow can mask real changes in mass flux delivery to the bay.
- Flow-Weighted concentration trends indicate a real difference in the quality of water entering the bay.

USGS science for a changing world

Session III: Major tributary loads and conceptual models of estuarine response

Estuarine Biogeochemistry synthesis





Conclusions

- Nutrients have been reduced from the watershed, and we see a corresponding reduction in the tidal waters
- There have been some positive responses to these nutrient reductions (the case studies)
- But there are additional complexities (climate change, clarity) that are still being unraveled to fully understand the current response to the nutrient reductions
- There are spatial and seasonal dependencies of response to nutrient reductions

Session III: Major tributary loads and conceptual models of estuarine response

Some discussion highlights

Science messages for further communication:

- Flow-normalized loads and concentrations are useful for detecting effects of management actions and other changes in the watershed, and for comparing to TMDL models.
- Observed loads and concentrations are important for understanding what the estuary is experiencing and how it is responding.

Implications for management:

- Information on geographic distribution of nutrient sources can be used to target areas that provide most of the loads to the bay for BMP implementation.
- The value of local tradeoffs in N, P, and sediment reductions varies depending on local conditions and BMP choices.

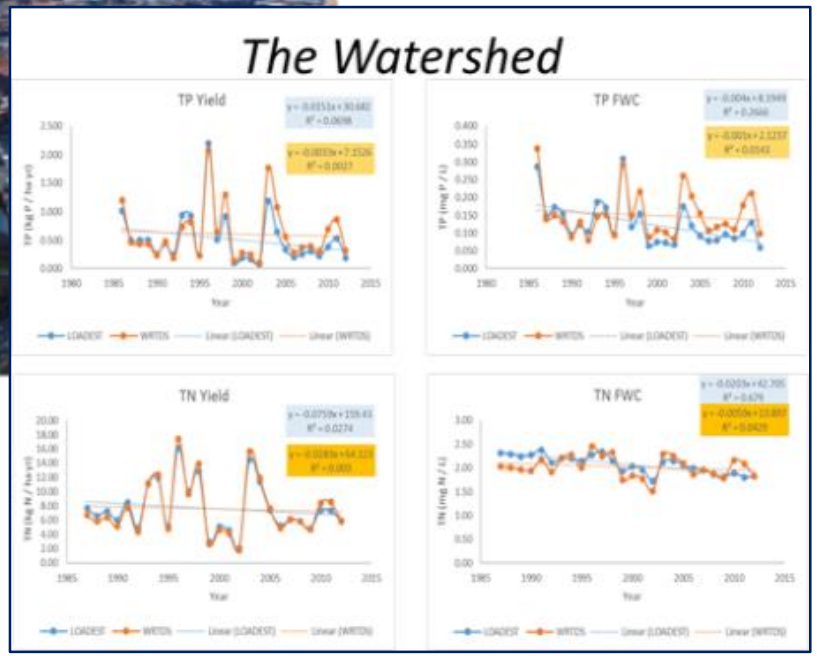
Suggestions for future research:

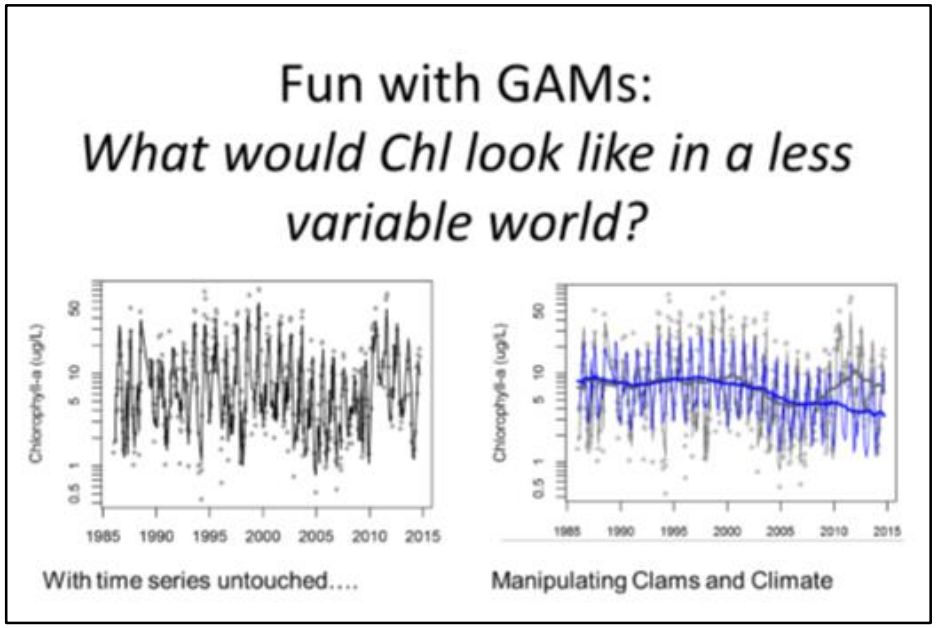
- Improve our understanding of how lag times vary across the watershed, at the RIM stations, and across the estuary.
- Update conceptual models to consider the effects of location on estuarine response

Potomac Synthesis

Documenting Impacts of Climate, Clams, and a Changing Watershed on the Potomac Estuary

Lora Harris, Rebecca Murphy, Robert Sabo, Keith Eshleman, Ryan Woodland, Dong Liang, Hal Walker





- **Quantifying** management effects is possible from empirical data
- **Changing** agricultural practices mask some declines in nutrient sources
- **Climatic** factors and **ecological** considerations are helpful in understanding lack of expected response
- Potomac estuary water quality is responsive to different factors in the **tidal fresh** than in the **meso-haline** regions.

Session IV: Integrating research from watershed to estuary to inform management

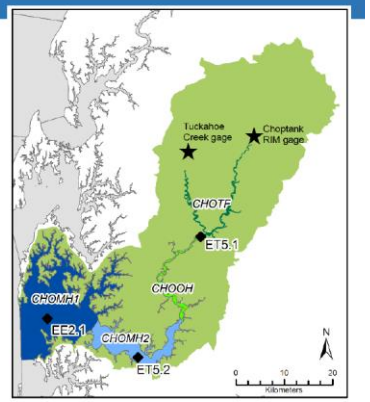
Tributary summary reports and storylines

Pull together: your groups' findings, existing research, trends

To address segment-by-segment:

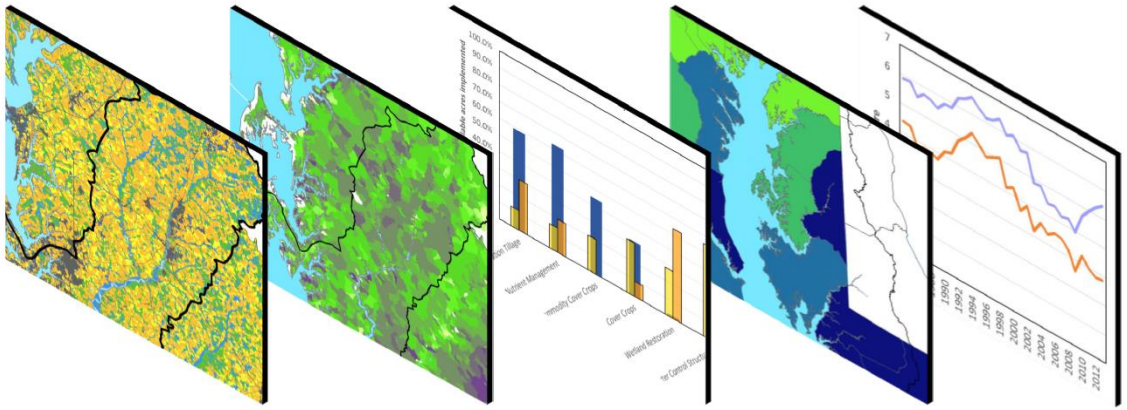
Tidal
1. How are water quality criteria and DO concentrations related?
2. What is impacting DO concentrations?
3. What should we expect for the future of meeting water quality criteria?

Watershed
1. What are the sources and drivers behind water quality?
2. Have we been addressing these issues thus far?
3. What are our opportunities moving forward?



A LOT of new and updated info available…

…that can be used together to inform management and restoration efforts



Choptank Watershed Summary

Key Takeaways

1. Heterogeneity of watershed and practices means one size doesn't fit all for restoration efforts
2. The current science **can** help to inform management and restoration efforts
3. We have useful information for focusing restoration efforts spatially, by practices, by county, and by sector

Session IV: Integrating research from watershed to estuary to inform management

Some discussion highlights

Science messages for further communication:

- Continue to communicate that nutrient reductions have an effect. Do not exclude the roles of uncertainty and complexity in how streams, rivers, and the estuary respond.
- Show how the problems on land relate to the problems in the water using the fact sheet approach to communicate key messages accessible to both politicians and practitioners.

Implications for management:

- Consider mechanisms to allow county-scale planning to reach across county boundaries, to better match scale of research findings.

Suggestions for future research:

- Connect nutrients and water-quality trends to living resources in both directions, i.e. effects of living resources on water quality and effects of water quality on living resources.

Jurisdiction Panel

What was useful

- Examples showing that point source reductions have worked; the fact that local improvements to an action have been observed gives us more confidence to write our WIP.
- To see that there actually is a lot of scientific information that you can apply locally.
- Information that there is a scientifically established lag effect.
- That there are ways that science can inform prioritizing resources. This makes resource decisions easier, and is a good direction for future synthesis projects.
- Direct communication between managers and scientists, without ulterior motives or agendas.
- The opportunity to give feedback directly to scientists on what we need, such as more information at local scales.

Jurisdiction Panel

What was missing (1)

- The full atmospheric deposition story. Communicate the importance of change in atmospheric deposition at the local level, even if its importance is relatively small over larger areas.
- Sufficient actionable information diffuse (i.e. nonpoint source) loads to water quality.
- Sufficient actionable information tying water quality to fishable and swimmable goals.
- The incorporation of economic cost into science that informs BMP effectiveness. This will help us prioritize resources with regard to BMP decisions.
- A holistic discussion of uncertainty, confidence levels, and variability in a management context. Distinguish between variability (which in some cases is well understood) and uncertainty (which is less well understood). Managers can handle uncertainty. They want to hear what the best currently available science is, what the gaps are, and that the research community is working towards filling those gaps.
- Analysis of whether the Bay TMDL is more or less restrictive than local TMDLs. This will drive restoration action.

Jurisdiction Panel

What was missing (2)

- A clear statement about what on the land is causing the problem, and whether there is solid science and technology to manage it.
- A scientific analysis of what works and what doesn't, what doesn't work if you mess it up, and whether practices implemented in the past are still working. Examples include prioritizing the number of septic replacements over installation of more efficient septic systems, and street sweeping that mobilizes fine sediment.
- An analysis of whether it would be more cost-effective to fully fund agricultural non-point source BMPs than to spend money on nutrient trading.
- More local basin storylines for all synthesis topics, that can be taken to both the Secretary level and the local conservation group level.

Workshop Findings and Recommendations

Recommendation categories

- Recommendations to the Chesapeake Bay Program to support jurisdiction implementation
- Recommendations to the Chesapeake Bay Program for science communication
- Recommendations to the Chesapeake Bay Program to promote research for BMP implementation decision support
- Recommendations to Chesapeake Bay Watershed jurisdictions
- Recommendations to the Chesapeake Bay Watershed research community

Workshop Findings and Recommendations

Lessons Learned

- Original workshop goals to have a very targeted discussion of remaining research gaps and receive feedback on prioritization from managers were *not quite* met.

- Watershed and estuarine researchers should collaborate and communicate more to integrate analysis of ecosystem trends and their explanations.

- Unanticipated benefit:
  - Direct communication between this group of researchers and managers
  - Relationship building through sincere exchange of information

Workshop Findings and Recommendations

Where do we go from here?

- This workshop generated a LOT of recommendations
- Those of direct relevance to WIP planning were immediately acted upon by the CBP
- Regarding remaining recommendations for science communication and research prioritization...
- Regarding the original workshop goals….