Explaining Management Effects On Water Quality Trends

STAC Workshop Outcomes and Next Steps

May 12-14, 2014
USGS Chesapeake Bay Science Workshop

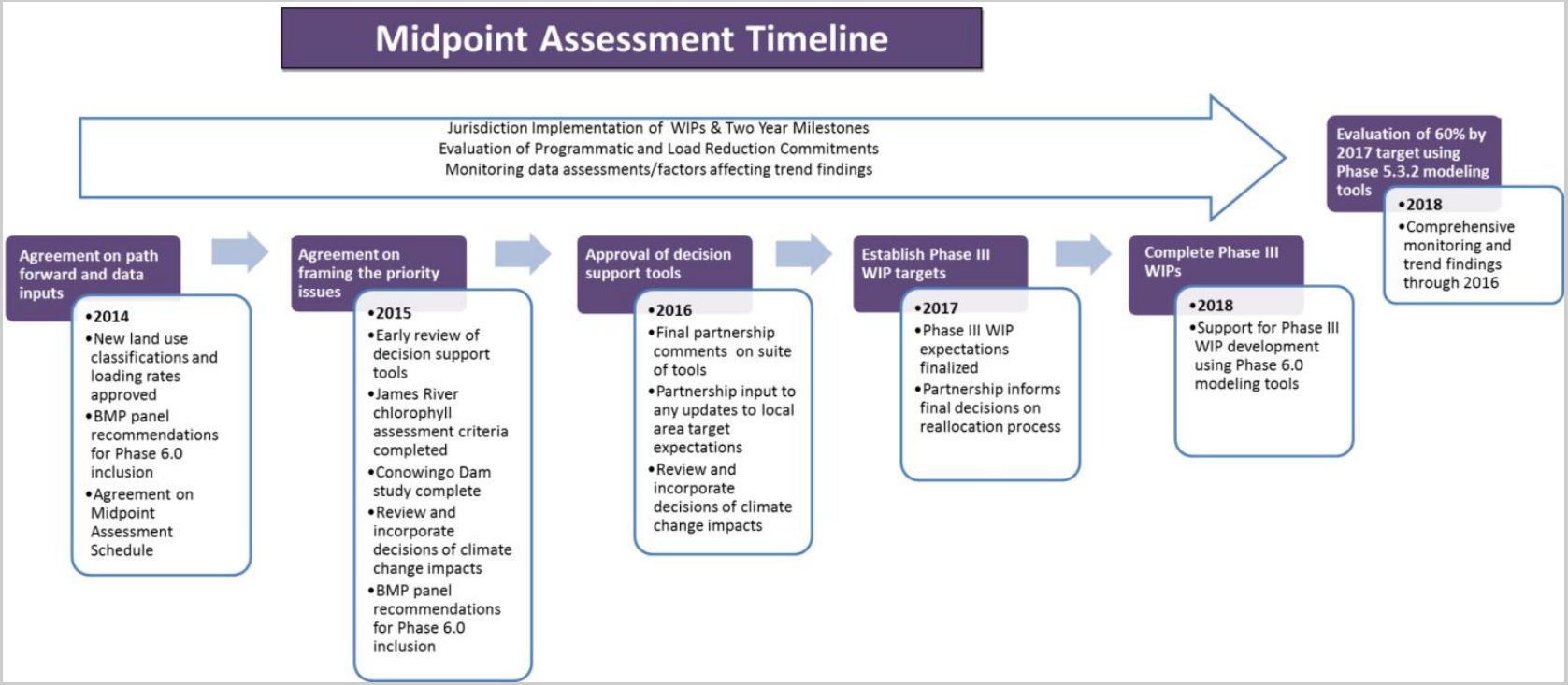
Contact: Jeni Keisman, MD-DE-DC Water Science Center
jkeisman@usgs.gov

Management Effects On Water Quality Trends

Background

- 2014 USGS Chesapeake Bay Science Plan (draft)
  - Theme 2: Understand Landscape and Human Effects on Water Resources and Linkages to Ecological Responses
  - Theme 3: Assess and Forecast Effects of Land and Climate Change on Ecosystem Conditions

- 2010 Chesapeake Bay Total Maximum Daily Load (TMDL)
  - 2017 TMDL Midpoint Assessment
  - 2025 “All practices in place”



Management Effects On Water Quality Trends

Why Have A Workshop?

- **To share the current state of the science** on quantifying and explaining water quality trends among a broader community of watershed and estuarine researchers;

- **To identify promising technical approaches to advance the science** of explaining effects of management actions on water-quality in the watershed and estuary;

- **To promote discussion and generate recommendations** on three primary topics:
  1. Enhancing trend detection methods;

  2. Suggesting quantitative approaches for an integrated approach to explain trends in the tidal waters and watershed;

  3. Identifying information that is needed to better explain trends.

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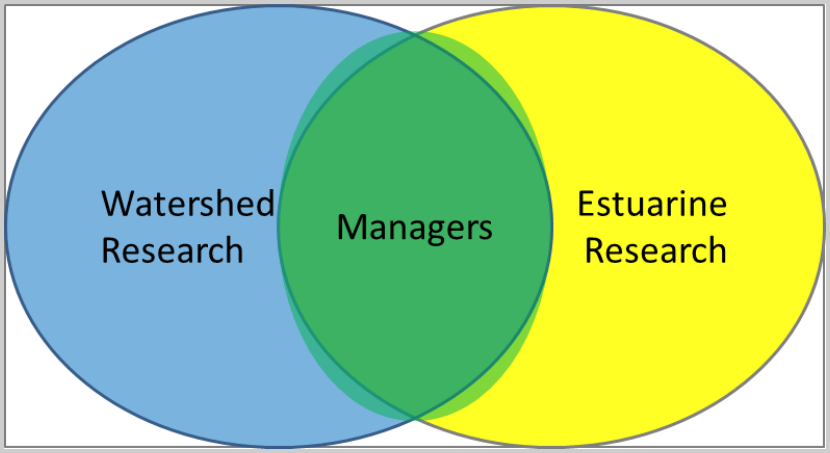
Science For Decision Support

More Collaboration → More Integration → More Relevance

Watershed Science Questions

- To what extent are nutrient and suspended sediment concentrations and loads changing in major tributaries to Chesapeake Bay?
- How can trend assessment techniques such as WRTDS provide insight on long-term and recent changes in conditions?



Managers' Questions

- Can you show us the degree to which management practices are improving water quality in the Bay and its watershed?
- How do we use the answers to this question to adjust our strategies and increase the impact of our investments in improving the water quality and ecosystem health of the Bay?

Estuarine Science Questions

- Are changes in pollutant loads resulting in changes in estuarine water quality and ecosystem health?
- Can the application of new techniques such as General Additive Models (GAMs) provide new insights into long-term and recent changes in estuarine water quality conditions?

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Organizations Represented

About 20 different organizations:

- Baltimore County Department of Environmental Protection and Sustainability
- Maryland Department of the Environment
- Maryland Department of Natural Resources
- Virginia Department of Environmental Quality
- West Virginia Department of Environmental Protection
- Metropolitan Washington Council of Governments (double-check)
- Bay Journal
- Johns Hopkins University
- University of Maryland Baltimore County
- University of Maryland Center for Environmental Science (UMCES) Appalachian Laboratory
- UMCES Chesapeake Biological Laboratory
- University of Maryland Wye Center
- University of Michigan
- Virginia Commonwealth University
- Virginia Institute of Marine Sciences
- Virginia Tech
- Smithsonian Environmental Research Center
- EPA
- USDA Agricultural Research Service
- USGS

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Breakout Discussions

Approaches For *Detecting* Trends.

Are existing methods adequate to characterize trends in water quality

Are there additional trend detection methods or variables that should be considered?

What near-term and long-term enhancements should be developed to better characterize water quality trends?

Information Needed to Better Explain Trends

What data on watery quality parameters are currently available?

What new data collection efforts and research are need to better understand:

1. Physical settings affecting water quality;
2. Pollution sources affecting water quality;
3. Agricultural and urban best management practices for mitigating water quality?

Integrated Approaches For *Explaining* Trends

What are the most promising descriptive and quantitative approaches available for explaining trends in the estuary and watershed?

At what scale(s) can these approaches be applied (i.e. entire Bay/watershed; major river systems; smaller sites)?

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Some Comments and Suggestions

- **Enhancing trend detection methods**
  - The existing approaches that we are taking to quantify trends are appropriate and valuable
    - WRTDS
    - SPARROW
    - Enhancements:
      - Time-variable SPARROW approach is a promising long-term investment for directly linking changes in sources with changes in load.
      - Adding estimates of uncertainty to WRTDS

- **New/additional quantitative approaches to better explain drivers of change in water quality in the watershed and Bay**
  - More application of conceptual models, box models, mass balance approaches
  - Generally, correlation and cross-correlation approaches such as “lag correlation analysis”
  - Empirical orthogonal function analysis
  - Structural equation modeling
  - Hierarchical models/approaches
  - Path analysis
  - Bayesian approaches to deconvolve complexities
  - Use fingerprinting studies to help determine sources
  - Identify and attempt to explain outliers
  - ***Individual methods are not exclusive of each other. Rather, multiple analytical approaches need to be implemented and results compared.***

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Information Needs

Existing data:

- **We need to figure how to get more out of the data that we already have.**
  - We are still discovering new things through our current data.

- **Better sharing of data in formats that are accessible and explicable.**
  - Implementation of best management practices (data from USDA; data from the EPA CBP)
  - Input decks to Chesapeake Bay Program models
  - Documentation regarding the assumptions, gaps, and weaknesses of these datasets

New Information:

- **General theme: more comprehensive and greater resolution data (spatially and temporally)**
  - Large variance inherent in sediment measurements requires higher resolution of stream sampling than is currently conducted
  - More comprehensive and higher resolution monitoring of BMP implementation and effectiveness over time, with and without operations and maintenance.
  - Field-scale monitoring of hydrology, chemistry, and orthophosphorus.
  - Groundwater monitoring
  - Monitoring targeted at detecting climate change

- **Target and prioritize what is measured**
  - Placement should be an iterative, responsive process that justifies the sensors.

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Detecting & Explaining Trends

Detecting and Explaining Trends:

- **Fingerprinting studies** to track how nutrients are transported from the land surface to the monitoring location;
- **More use of box models** to quantify **mass balance** for watersheds and to estimate lag times between implementation and response in nontidal and tidal waters;
- Further develop and apply the **Time-variable SPARROW** (described in Dick Smith's presentation) to directly link changes in sources with changes in loads at a regional scale;
- **Empirical orthogonal function analysis**
- **Bayesian statistical models** in general; hierarchical approach in particular
- **Path analysis techniques** (encompasses a variety of methods that can be tailored to investigate causality among variables).
- Don't forget **ARS models**
- **Integrate different approaches** in order to increase explanatory strength
- **Measures of uncertainty** must be associated with new as well as with old methods.

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Next Steps

- **Complete workshop report**
  - Distribute first draft 1st week of July
- **Improve sharing of data**
  - Land use, BMP implementation, and CBP model inputs and assumptions;
- **Identify the most promising of suggested approaches for linking water quality changes to natural and anthropogenic drivers and pursue them;**
  - Use statistical models (i.e. SPARROW) to inform the CBP Watershed Model (2015);
  - Increase focus on synthesis of existing analyses for detecting trends
  - Investigate recommended methods for feasibility and timeframe
    - How quickly? By whom?
- **Strategize and collaborate to pull together all of this work going on into an integrated understanding of what we can explain**
  - What can we accomplish between now and 2017?
  - Between now and 2025?

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In Pictures