Chesapeake Bay Program
Science. Restoration. Partnership.

Management Effects On Water Quality Trends (MEOWQT) Workshop

CBP Response To STAC Workshop Recommendations

December 9, 2015
STAC Quarterly Meeting
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Management Effects On Water Quality Trends

Workshop Background

We conducted 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;

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

- **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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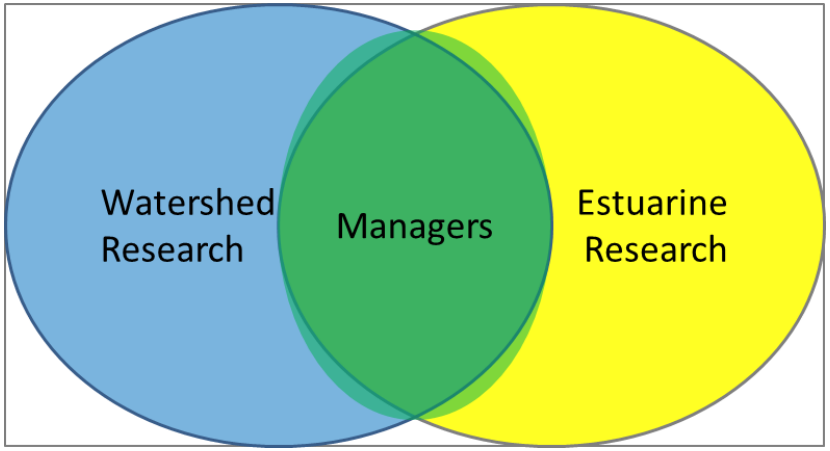
Workshop Background

About 20 different organizations

More Collaboration → More Integration → More Understanding

Watershed Science Questions



Estuarine Science Questions

Municipal, State and Federal Managers' Questions

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STAC Recommendations

1. **Prioritize work that adds the ability to estimate uncertainty** to the Weighted Regressions on Time, Discharge, and Season (WRTDS) method.

2. **Continue to develop and apply General Additive Models (GAMs)** to the appropriate response variables in tidal waters, and develop a process of "artificial intelligence" that enables automated application of GAMs.

3. **Continue efforts to improve reporting and tracking of Best Management Practices (BMPs).** Ensure that any partnership-derived assumptions and decision rules are transparent in the processing of reported BMP data.

4. **Prioritize more comprehensive and improved monitoring of BMP effectiveness.** This includes assessing BMP effectiveness over time, both with and without proper operation as well as required periodic maintenance.

5. **Implement continuous monitoring** for locations, times, and constituents that maximize utility for improving assessment of effectiveness of management actions.

6. **Engage in a concerted effort to energize the academic and federal research communities** to conduct collaborative studies using the most capable and feasible techniques from among those suggested in this report.

7. **Evaluate the potential of proposed analytical techniques and approaches** to explain observed water quality changes for both small watershed studies and regional analysis.

Management Effects On Water Quality Trends

STAC Recommendations: WRTDS

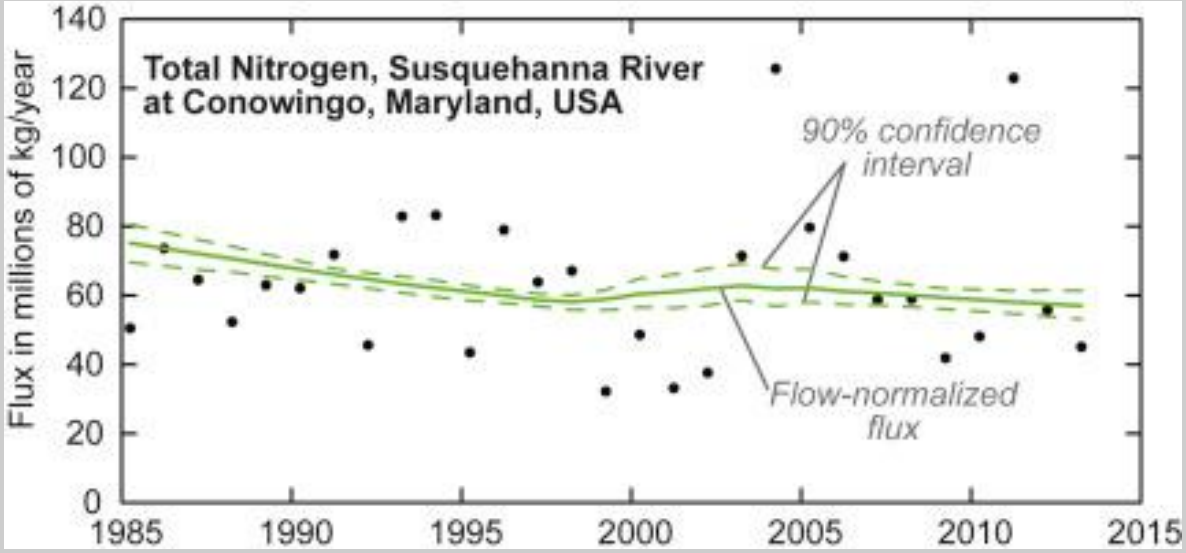
"Prioritize work that adds the ability to estimate uncertainty to the Weighted Regressions on Time, Discharge, and Season (WRTDS) method."

Peer-reviewed journal article published:

- Hirsch, R.M., Archfield, S.A., De Cicco, L.A. A bootstrap method for estimating uncertainty of water quality trends. Environmental Modeling & Software 73 (2015), pp. 148-166.

Highlights:

- Block bootstrap approach for water quality trends is developed.
- Used in conjunction with a flexible statistical model for river water quality.
- Trends in concentration and trends in flux can be evaluated.
- Confidence intervals can be estimated for trend magnitude.



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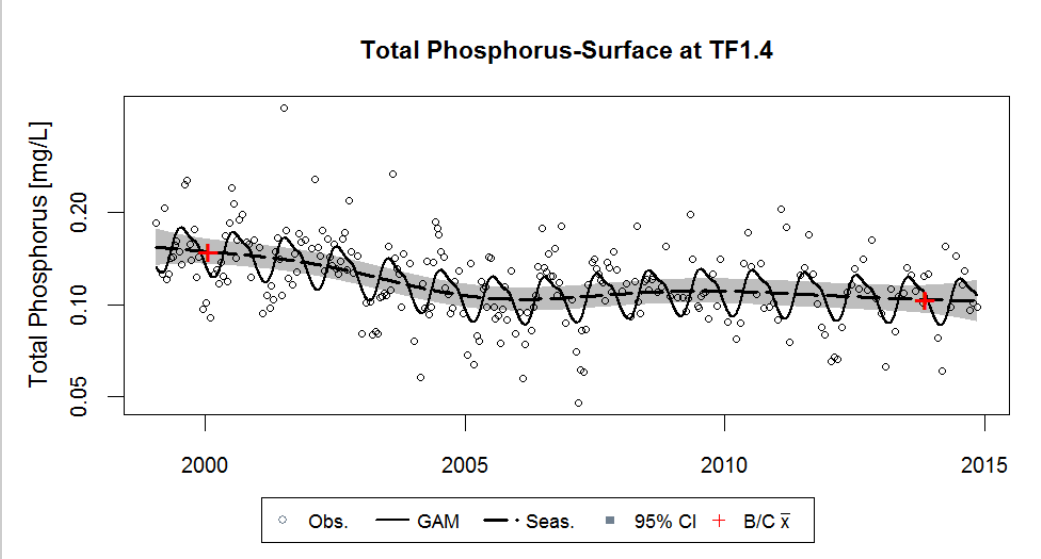
STAC Recommendations: GAMs

"Continue to develop and apply General Additive Models (GAMs) to the appropriate response variables in tidal waters, and develop a process of 'artificial intelligence' that enables automated application of GAMs"

Some 2015 Accomplishments:

- A preliminary analysis of trends in concentrations of key tidal water quality parameters at all long-term tidal water quality monitoring stations using GAMs (CBP, MD DNR, VA DEQ, partners).



- A comparison of results using the newly developed GAMs method with results using the Season Kendall methods currently in use by the MD DNR and VA DEQ (CBP, MD DNR, VA DEQ, partners).

- An R package for analyzing trends in tidal waters using GAMs and Seasonal Kendall methods, "CBPTrends version 1" (CBP, MD DNR, VA DEQ, Tetratech).

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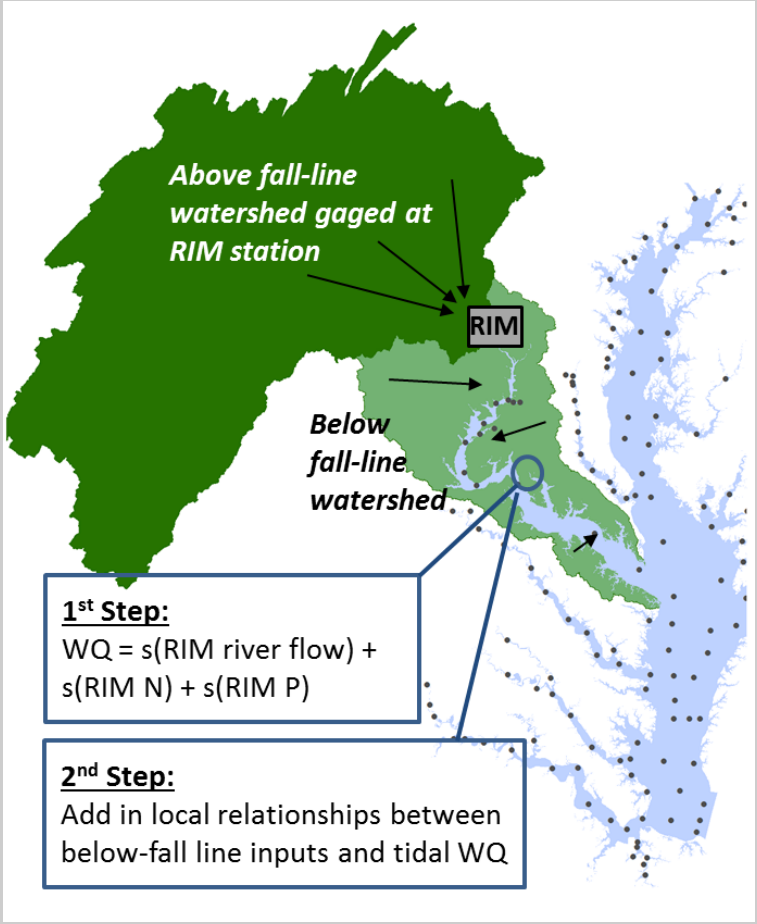
STAC Recommendations: GAMs

"Continue to develop and apply General Additive Models (GAMs) to the appropriate response variables in tidal waters, and develop a process of 'artificial intelligence' that enables automated application of GAMs"

Some 2016 Plans:

- CBPTrends version 2, to include flow-adjusted trends analysis.
- STAC GAMs Review
- Develop methodology and produce preliminary results using GAMs to link all tidal stations to fall-line loads.



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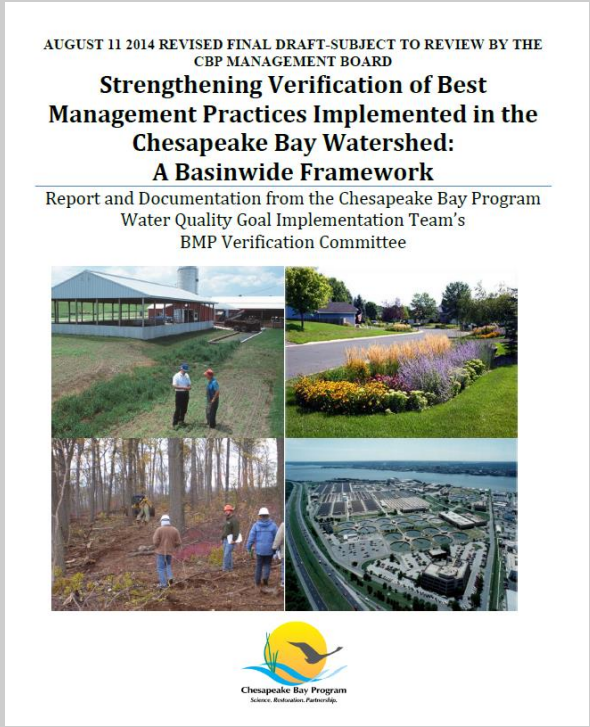
STAC Recommendations: BMP Implementation Data

"Continue efforts to improve reporting and tracking of Best Management Practices (BMPs). Ensure that any partnership-derived assumptions and decision rules applied are transparent in the processing of reported BMP data."

- The CBP BMP Verification Committee is responsible for developing the elements of a basinwide BMP verification framework, including verification principles, protocols, review panel, and other verification related procedures
- A basin-wide BMP Verification Framework document was finalized in August 2014 for review by the CBP Management Board.
- ***The CBP will continue to work with the help of STAC and the partnership's Citizen and Local Government advisory committees to further adapt and improve the partnership's accountability system.***


AUGUST 11 2014 REVISED FINAL DRAFT-SUBJECT TO REVIEW BY THE CBP MANAGEMENT BOARD

Strengthening Verification of Best Management Practices Implemented in the Chesapeake Bay Watershed: A Basinwide Framework

Report and Documentation from the Chesapeake Bay Program Water Quality Goal Implementation Team's BMP Verification Committee

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- More information on the Verification Committee's activities can be found at: http://www.chesapeakebay.net/groups/group/best_management_practices_bmp_verification_committee
- Additional BMP verification resources can be found at: http://www.chesapeakebay.net/groups/group/best_management_practices_bmp_verification_committeeresources

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STAC Recommendations: BMP Implementation Data

"Prioritize more comprehensive and improved monitoring of BMP effectiveness. This includes assessing BMP effectiveness over time, both with and without proper operation as well as required periodic maintenance."

- **The effectiveness of BMPs accounted for in the partnership's Watershed Model are established by expert panels** and approved through relevant source workgroups and the Water Quality Goal Implementation Team.
  - Experts typically consider many types of data and studies across many scales and conditions, following a process that is consistent, transparent, and scientifically defensible. More information can be found at http://www.chesapeakebay.net/groups/group/bmp_expert_panels

- **A protocol was approved in July 2015** that calls for giving the highest priority to peer-reviewed monitoring studies with data sources at operational scales – over small-scale, carefully controlled research scales. This document can be accessed at: http://www.chesapeakebay.net/documents/CBP_BMP_Expert_Panel_Protocol_WQGIT_approved_7.13.15.pdf

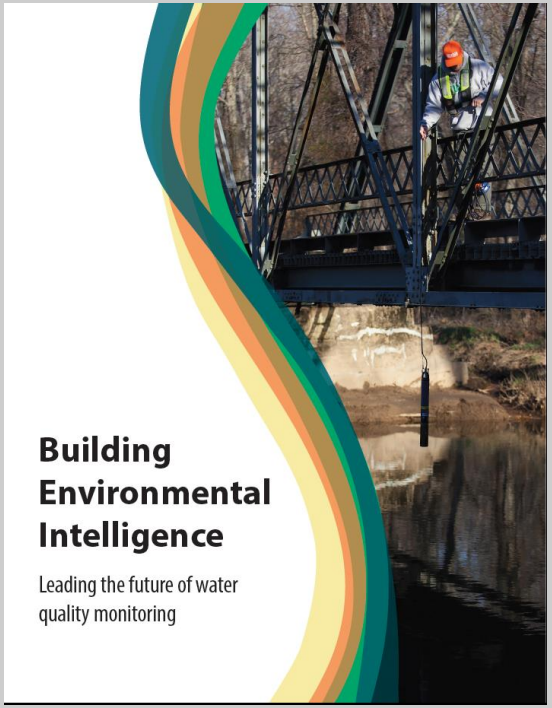
- **The Phase 6 version of the Watershed Model will include life-spans for each of the BMPs.** In other words, BMPs are retired and benefits no longer credited past the useful life of the BMP unless the practice is reported as inspected and maintained.

Management Effects On Water Quality Trends

STAC Recommendations: Continuous Monitoring

"Implement continuous monitoring for locations, times, and constituents that maximize utility for improving assessment of effectiveness of management actions."

- **The CBP agrees that the use of continuous monitoring should be enhanced in the watershed and tidal waters.**
- **Continuous monitoring data from tidal waters have been instrumental** in improving understanding of dissolved oxygen criteria attainment assessments.
- **The CBP "Building Environmental Intelligence (BEI) initiative** includes continuous monitoring strategies in its scope of work. The recently released "Building Environmental Intelligence" report calls for further incorporation of new continuous monitoring technologies.
- **Initial implementation of continuous monitoring at the Susquehanna, Potomac, and James RIM stations** has been proposed. If determined effective, use could be expanded to other RIM stations and smaller watersheds.



Rubin, L.J., P.J. Tango, S.W. Phillips, M.R. Bennett, W.C. Dennison. 2015. Building Environmental Intelligence: Leading the future of water quality monitoring.

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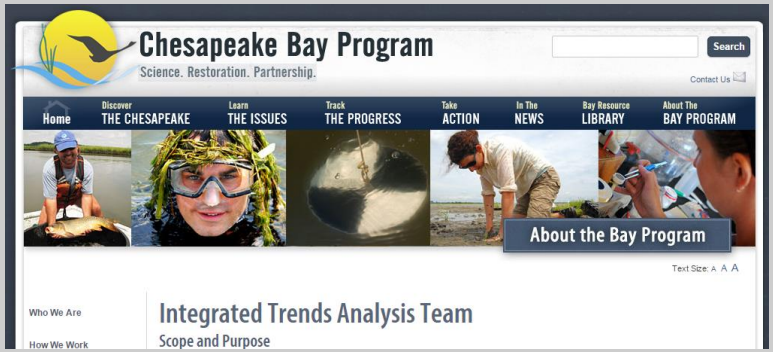
STAC Recommendations: Research Directions

"Engage in a concerted effort to energize the academic and federal research communities to conduct collaborative studies using the most capable and feasible techniques from among those suggested in this report."



- **The CBP Integrated Trends Analysis Team** was created to serve as a forum for researchers to discuss results of their ongoing and recent activities, as well as to exchange ideas and share their experiences with novel analytical techniques.

Purpose	Potential Product	Team
Evaluate climate-caused seasonal shifts that may complicate responses	journal article	Research partners and CBP team
Evaluate relative impact of non-tidal loads, point sources, and climatic factors on Potomac tidal water quality	journal article/ presentation	ITAT Potomac collaborate synthesis group
Review/link multiple Bay-wide efforts (including GAMs) to reveal large-scale patterns, factors, and responses	presentation (article later)	ITAT synthesis team and partners
Translate this new research into knowledge useful to management	presentation	CBP team

- **Several collaborative projects** are ongoing or in the planning stages.

Management Effects On Water Quality Trends

STAC Recommendations: Research Directions

"Evaluate the potential of proposed analytical techniques and approaches to explain observed water quality changes for both small watershed studies and regional analysis."

- **Numerous projects are underway testing and utilizing novel analytical techniques to explain water-quality changes in the Chesapeake Bay watershed and estuary. These include:**
  - Several independent applications of the USGS SPARROW model to link nutrient fluxes with land use and BMP effects and to account for groundwater transit times.
  - Time series analysis changing source histories, flux histories, and changes in constituent ratios in selected catchments.
  - A pilot application of Structural Equation Modeling in the Chesapeake Bay watershed.
  - Lag correlation analysis to link appropriate nutrient loads to receiving tidal water quality.
  - Box model applications by multiple ITAT academic partners to understand fluxes of nutrients, carbon, and related variables between regions of the tidal waters and changes over time.
  - Applications of empirical orthogonal function analysis, principle component analysis, and cluster analysis to explore groupings of variables and relationships among factors in non-tidal and tidal water quality analysis.

Management Effects On Water Quality Trends

Acknowledgements

The Harry R. Hughes Center for Agro-Ecology, for additional financial support

Our Invited speakers:

- Bob Hirsch, Elgin Perry, Jim Cloern, Walter Boynton, Dan Obenour, Keith Eshleman, Bill Ball, Dick Smith, Ana Garcia, Claire Welty, Don Weller, Tom Jordan, Jean Spooner

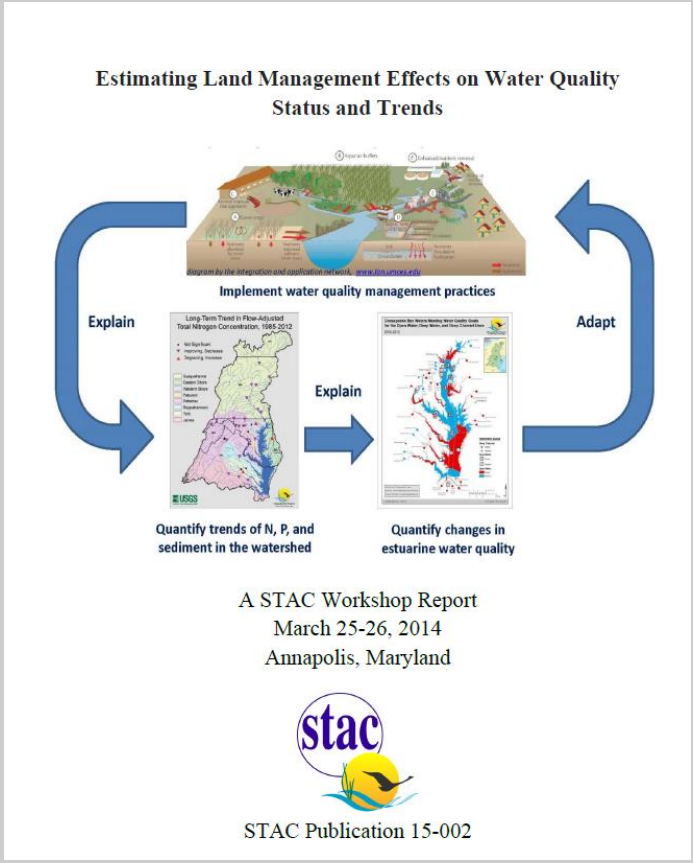
The 60+ individuals from ~20 different organizations who lent their time and expertise

The workshop steering committee:

- Russell Brinsfield, Jeni Keisman, Michael Kemp, Andy Miller, Adel Shirmohammadi, Ken Staver, Gene Yagow

Chesapeake Research Consortium staff:

- Matthew Ellis, Natalie Gardner



Keisman, J., J. Blomquist, S. Phillips, G. Shenk, E. Yagow. Proceedings of the March 25-26, 2014 workshop. STAC Publication Number 15-002, Edgewater, MD. 33 pp.