Management Effects on Estuarine Water Quality Trends

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Meeting Participants:
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Background and Meeting Objective:
Under the Chesapeake Bay Program's (CBP), Scientific, Technical Assessment and Reporting (STAR) group, the Partnership has committed to investigating connections between trends in watershed management actions, watershed loads, and estuarine water quality and living resources. This intiative will be completed through the cooperative efforts of members of the Tidal Monitoring and Analysis Workgroup (TMAW) and the Nontidal Water Quality Workgroup (NTWG). The objective of this meeting was to develop a strategy for assessing factors affecting estuarine trends. In short, we identified the immediate need to update our current means of trend analysis. We agreed to use Generalized Additive Models (GAMs) for identifying tidal trends. Concurrently, we will work closely with STAC and CBPO to identify those factors that may describe the observed trends and develop approaches for analysis.

Meeting Summary:

We identified a list of variables to consider when examining estuarine responses. Data from 1985-present is readily and widely available for *most* variables, though not all (noted). Therefore, our analyses will be focused on the 1985-present time period. In the limited cases where pre-1985 tidal data is avaialbe, we will include it if and when appropriate.

Forcing Variables:

- RIM loads
- Below fall line sources
- Atmospheric deposition
- Climate factors such as changes in wind direction and speed, temperature, the rate of sea level rise, etc.
- Biological factors: still need to determine which
- Resuspension of loads from the bottom
  - NOTE: data are very limited
- Circulatory sources (i.e., loads from downstream segments)
- Groundwater
  - NOTE: data are very limited

We identified a list of estuarine responses we would will be measuring as a function of the natural and anthropogenic forcing variables:

- Dissolved Oxygen
- Water Clarity
- SAV
- Chlorophyll a
- Nutrients
  - Concentrations:
    - Measuring and evaluating concentrations has value in and of itself (e.g., Walter Boynton's work on the Back River) and has use in box model analyses, especially when they can be run over many years -- important trends emerge which are not obvious from just concentration data
  - Limitations:
    - Evaluating nutrient limitations is a means of averaging over space and may serve as a synoptic indicator when able to evaluate over multiple years (e.g., Karrh and Fisher work)

Use of Generalized Additive Models (GAMs) for Estuarine Trend Analyses:

The group agreed on the use of GAMs for detecting baywide/regional/segment level trends in the above identified estuarine responses. GAMs have the ability to detect trends not attributable to flow or season over time. This process requires further development and an initial exercise prior to understanding the level of effort that will be required to complete baywide trend analyses. The initial exercise will be completed by Elgin Perry and Mike Lane and their findings will be presented to TMAW at the December 4, 2013 meeting. Thereafter, we will need to determine the best course of action for going about completing the work. Options are outlined below:

1) Elgin develop computer code package for GAM analysis and transfer to CBPO staff for internal baywide/regional/segment level analysis
2) Elgin develop computer code package for GAM analysis and conduct baywide/regional/segment level analyses funded through an RFP
3) Bring aboard a new hire through UMCES, JHU, etc. to conduct baywide/regional/segment level analyses

ACTION:
Develop a GAM to evaluate chlorophyll a trends in different segments of the Patuxent River; use interpolations of chlorophyll a over large regions (i.e., tidal fresh, oligohaline, mesohaline, polyhaline) (E. Perry and M. Lane).

The general analytical approach that will be employed for identifying tidal trends describes the estuarine response as a fucntion of time and all natural factors:

Estuary ~ (T, D, S)
T (time) = anthropogenic factors
D (discharge) and S (season) = *all* natural factors which include, but are certainly not limited to, discharge, seasonality, wind, and temperature

Use GAMs to relate water quality parameters to the various forcing functions:

Once we've identified the trends in the tidal waters, then we can begin to start to formulate theories on what anthropogenic forcing factors we believe may be causing the observed trends. These can be described as being proximate or ultimate causes and can be evaluated using GAMs.

Proximate causes may be described through the WSM or SPARROW (or other models) and represent the loads at the watershed-estuary boundaries. It can be expressed as:

e.g., GAM ~ (loads, D, S)

Ultimate causes would exclude load data; the observed estuarine trends are then expressed as a function of all non-point sources and BMPs:

e.g., GAM ~ (manure, fertilizer, BMPs, D, S)

Connecting the Watershed and the Estuary:

This topic will be thoroughly discussed at the 2014 STAC Factors Affecting Trends workshop through presentations and discussions led by experts with hands-on experience in this type of work. It is anticipated that this workshop will help to identify approaches for separating management actions from climatic effects on trends in riverine water quality and fluxes and on estuarine water quality and living resources.

NEXT STEPS:

1) Completion of initial GAM exercise by Elgin Perry and Mike Lane. Presentation of results to TMAW in December.
2) 2014 STAC workshop to identify factors that may describe observed trends and develop analytical approaches to connecting the watershed to the estuary.
3) Identify resources (i.e., financial and personnel) for the completion of this work