Chesapeake Bay Program
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Integrated Trends Analysis Team (ITAT)

Wednesday, January 22nd, 2025

10:00 AM – 11:00 AM

Meeting Materials: Link

This meeting was recorded for internal use only to assure the accuracy of the meeting notes.

MINUTES

10:00 – 10:05 AM *Welcome – Breck Sullivan (U.S. Geological Survey, USGS) and Kaylyn Gootman (Environmental Protection Agency, EPA)*

Announcements:

- Scientific and Technical Advisory Committee (STAC) Sponsored Workshop Proposals due ***COB February 10, 2025***.

- ITAT was able to get an intern from Franklin and Marshall (F&M) - Eva Smith. Her first day will be January 27th. They will be helping with updating the Tributary Summary StoryMaps.

Upcoming Conferences, Meetings, Workshops and Webinars:

- 14th National Monitoring Conference – March 10-12, 2025, Green Bay, Wisconsin.
- The 35th Annual Environment Virginia Symposium – April 8-10, 2025, Lexington, VA.

10:05 – 10:35 AM *Physical and Biological Controls on Diel Dissolved Oxygen and Water Quality Dynamics along the Potomac River Continuum: from Non-tidal to Tidal Waters*

Presenter(s): *Weston Slaughter (University of Maryland, College Park, UMD, wslaught@umd.edu)*

Description: This research investigates the longitudinal gradients and drivers of dissolved oxygen (DO) and other water quality parameters in the Potomac and Anacostia watersheds, spanning over 200 km from freshwater to tidal zones. Using high-frequency sensors, routine sampling, and longitudinal monitoring, it reveals significant seasonal patterns and relationships, offering insights into biogeochemical processes and advancing remote sensing applications for sub-daily DO estimation.

This presentation will focus on the Potomac River between 2007 and 2008. Maryland Department of Natural Resources (MD DNR), Virginia Institute of Marine Science (VIMS), and Estuary and Coastal Observation System maintained a series of sensors. These sensors were strategically placed along the Potomac River, measuring water quality at 15-minute intervals from April through October in both years. The stations spanned from the tidal fresh portion of the river down to where the Potomac meets the Chesapeake Bay. These sensors recorded data on Dissolved Oxygen (DO), Chlorophyll-*a* (Chl-*a*), turbidity, temperature, salinity, and depth.

The questions we posed to this dataset fall into two main categories. First, we explored the basic chemical gradients. Using the high-frequency data spanning this large tidal river, we investigated whether the observed pH, salinity, or other water quality parameters align with textbook expectations—for example, the expected pH of freshwater compared to saltwater. The second line of inquiry focused on ecosystem productivity, particularly as inferred from dissolved oxygen and other data. In this context, we asked, "What does water do in the dark?" More specifically, we examined sub-daily-scale water quality parameters and whether there are repeated patterns in the timing of water quality minima or maxima within the dataset.

Looking at the chemical gradients – we examined the distribution of daily mean salinity along the hydrologic continuum. Along the longitudinal gradient of this tidal river, we observe patterns that align with our understanding. At the tidal fresh stations upstream, salinity distributions cluster tightly around zero. As we move downstream, closer to the Chesapeake Bay, the mean salinity increases, and the distribution broadens. Interestingly, while tidal fresh environments show a nearly perfect normal distribution of salinity, more saline environments exhibit less predictable distributions.

Next, we examined turbidity across the longitudinal dataset. When plotting mean daily turbidity against the distance from the most upstream station, we found evidence of an estuarine turbidity maximum. However, intriguingly, this particular dataset revealed what appears to be a "double peak" in turbidity. This phenomenon warrants further investigation, potentially influenced by sensor placement relative to the middle of the river or tributary mouths.

When examining pH, another fascinating pattern emerges. Freshwater is generally expected to have a pH closer to 7, while ocean water is more basic, around 8.1. During spring, this gradient is clear. However, in summer and fall, we observe significantly higher pH values in the tidal fresh zones, which then normalize further downstream. The cause could relate to biological activity or anthropogenic factors, such as urban outflows from areas like Washington, D.C.

Looking into ecosystem productivity, we wanted to explore if there was any evidence of a gradient of net autotrophy to heterotrophy along the river-estuary continuum.

Considering non-tidal inputs and ecosystem productivity, we wanted to explore whether biological and chemical responses to freshwater input vary along the estuarine gradient. To achieve this, we separated our data between the tidal fresh, oligohaline and mesohaline portions. As we separate them out, we see light increases in mean monthly Chl-*a* along the continuum.

Leveraging this high-frequency data, we wanted to take this further and explore those diel moments – what is water doing in the dark? During summer and fall, tidal fresh areas exhibit elevated dissolved oxygen levels, likely linked to productivity. Downstream, these levels decrease, showing more normal distributions in saline environments. These findings underscore the biological contributions to dissolved oxygen dynamics upstream while highlighting physical controls further downstream. Further, in tidal fresh zones, minima typically occur around sunrise, consistent with a lack of photosynthesis overnight. However, as we move downstream, a significant number of minima shift to sunset, suggesting physical factors like temperature and salinity may exert stronger influences.

Looking ahead, we are excited to expand this analysis to other tributaries of Chesapeake Bay, like the Patuxent River, Rappahannock River, York River, and James River – leveraging broader datasets. This project has laid the groundwork for further exploration of these dynamic systems.

Discussion:

Q: *Breck:* Can you explain the connection between what you are seeing and the fieldwork being conducted?

- ***A:*** *Weston:* All of the stations are shallow water stations (<2 m water depth at the mean water tide). One of our main goals was to examine DO dynamics in shallow water. We were fortunate enough that our sites coincided with other lab groups, and we were able to overlap our efforts. This expands into the nontidal portion.

Q: *Kaylyn:* The results presented here, are they in line with what we would expect to see in the Potomac?

- ***A:*** *Claire Buchanan:* Yes. This is what we were finding around the time (2009) when we were doing criteria development.

10:35 - 11:00 AM ***Relating Management Practice Implementation and Modeled Load Reductions in the Chesapeake Bay Watershed***

Presenter(s): *Helen Golimowski and Olivia Devereux (Devereux Consulting)*

Description*: The Chesapeake Bay watershed's restoration efforts under the Total Maximum Daily Load (TMDL) plan are hindered by insufficient actions to reduce nonpoint nutrient sources, with unexpected variations in nutrient loading rates despite best management practice (BMP) implementation. Using data from the Chesapeake Assessment Scenario Tool (CAST), this study identifies geographic and sector-specific opportunities for water quality improvement, revealing that nutrient application changes and modeling assumptions significantly influence outcomes, particularly for agricultural nitrogen, and provides insights for refining future strategies. Please watch our Free Training Videos and seminars to learn more (under "Develop a Plan" and "Modeling Conservation" presentation).*

Olivia: This work has been done in support of the USGS Best Management Practice (BMP) team. Our goal is to examine changes in modeled water quality with different BMP implementations and explore the relationship with monitored water quality data in the next phase. All information in this presentation is open-source data from CAST. Anyone can download these datasets—links are in the PowerPoint available on the website (slide 2).

The Bay community released the Comprehensive Evaluation of System Response (CESR) report in 2023, accompanied by summaries. This report determined that current implementation actions are insufficient to achieve the Total Maximum Daily Load (TMDL) goals for nitrogen, phosphorus, and sediment. While conservation practices remain a valuable tool, they alone cannot meet these goals. Helen's work identifies areas where BMP implementation is effective and areas where it falls short, highlighting correlations and relationships in the data.

This presentation focuses on model data, but the next steps include integrating monitoring data from Nontidal Network (NTN) sites. Recent NTN data, expected by February or March, will enhance our analysis. This work aligns with USGS's Theme One, supporting the Stream and Watershed Assessment teams. This effort builds on work initiated last fiscal year. Helen presented at the July 19th Factors meeting, and further presentations are planned.

Helen: To achieve this, we used modeled data using CAST-23 for Total Nitrogen (TN) and observing the load change between 2009 and 2023 paired with levels of BMP implementation. It's important to note that while the loads reflect change over time, BMP implementation is assessed based on the percent of implementation at 2023 levels, so it does not represent a change over time.

The first step was to group agricultural practices based on their effectiveness and type. I separated animal practices from land practices and, within land practices, grouped them by their effectiveness values (high and low). CAST assigns an efficiency value—essentially a percent reduction for nitrogen, phosphorus, and sediment for each practice. Some practices have higher percentage reductions than others.

Using these groupings, CAST scenarios were created to isolate each group of practices based on their 2009 and 2023 implementation levels. This allowed us to determine the loading rate change over time between these two years for each group. Additionally, I assessed the percent of BMP implementation versus available agricultural acres in 2023, grouping practices into high, low, and animal categories. Using these components, I created maps to spatially compare loading rate changes over time and BMP implementation levels. These maps helped identify areas with unexpected results. Unexpected results include instances where high BMP implementation coincides with increasing loading rates or where low BMP implementation coincides with decreasing loading rates. These discrepancies prompt further investigation into factors influencing modeled water quality.

For example, looking at agricultural land-based practices (slide 5), one map highlights areas with expected results, such as high BMP implementation leading to decreased nitrogen loads. However, many segments exhibit unexpected results, such as low BMP implementation paired with decreasing nitrogen loads. This raises questions about what other factors might be affecting these outcomes. Expected results include low implementation with increasing loads and high implementation with decreasing loads. Unexpected results, like high implementation with increasing loads or low implementation with decreasing loads, are the focus of further analysis. Examining Delaware, for instance, reveals high BMP implementation but increasing nitrogen loads, suggesting other factors are at play. Additional analysis of nutrient applications in the region showed a high increase in nutrients applied, potentially explaining the unexpected nitrogen increases.

Another analysis focused on low-effectiveness BMPs. Results indicate that modeled nutrient management practices may not fully capture their real-world effectiveness. When nutrient management was removed from the model, nitrogen loads stabilized. This discrepancy suggests a need to revisit how nutrient management is modeled.

To summarize, using BMP implementation and TN change over time, we identify areas where practices are not having the expected effects. Modeled nutrient applications may explain some unexpected results – despite high management practices implementation, loading rates are increasing. Modeled nutrient management practice may explain some unexpected results – the modeled practice does not explain load changes. Future work will expand to include phosphorus data and monitoring datasets.

Discussion:

Q from chat: *Jeremy Hanson:* does Nitrogen Loading Rate only represent agricultural loads since we're focused on agriculture BMPs?

- ***A:** Olivia:* yes, we pulled out just agriculture and excluded the animal feeding space areas to look at cropland, hay, and pasture. This same analysis has been done on urban land for Phosphorus and Sediment too, but that would be a lot to present at once.

***Q:** Normand Goulet:* Is there any one dominant BMP in the unexpected areas?

- A: Olivia: This is something that we will explore further.
- Response: Olivia: Since this is agriculture, there's a lot of nutrient management, particularly in Delaware. Additionally, there is a lot of tillage and cover crops but these are looking at the more highly effective BMPs. So, these practices were not included because they are not considered particularly highly effective.

***Q:** KC Filippino:* Can any of this be a function of how the states differ in BMP reporting? Also, there are some areas that are highly urban showing change in loading rates. Were only agriculture loading rates included here too or is it overall loading?

- ***A:** Olivia:* This is all just agriculture. We have done the same for urban with just urban BMPs and Loads.
- ***Q:** KC:* There are also segments here outside the Bay watershed, I assume you just did this at the county scale regardless?
- ***A:** Olivia:* We will need to change the methodology slightly when we use monitoring data. The nice thing about a model is that it does source assessment (agriculture vs. urban). That isolation cannot be done with monitoring data since the streams integrate the sources. We used the data for all counties intersecting the Chesapeake Bay watershed, not just the drainage to the Bay. We used edge of stream loads.

11:00 AM Adjourn

Next Meeting: Wednesday February 26th, 2025, from 10 AM – 12 PM

Attendees:

Breck Sullivan (USGS), Kaylyn Gootman (EPA), Gabriel Duran (CRC), Helen Golimowski (Devereux Consulting), Olivia Devereux (Devereux Consulting), Weston Slaughter (UMD), Qian Zhang (UMCES), Cynthia Johnson (VA DEQ), Claire Buchanan (ICPRB), Anthony Timpano (VA DEQ), Renee Karrh (MD DNR), Roger Stewart (VA DEQ), Bryce Bailey (RES), Mukhtar Ibrahim (MWCOG), Rebecca Murphy (UMCES), Richard Tian (UMCES), Tish Robertson (VA DEQ), Lewis linker (EPA), Andrew Keppel (MD DNR), Ashley Dann (EPA), Gary Shenk (USGS), Carl Friedrichs (VIMS), Jeremy Hanson (CRC), Rikke Jepsen (ICPRB), Christopher Mason (USGS), James Colgin (USGS), Jon Harcum (Tetra Tech), Normand Goulet (NVRC), Joseph Morina (VA DEQ), KC Filippino (HRPDC), Allison Welch (CRC).