Chesapeake Bay Program
Science. Restoration. Partnership.

Joint Integrated Trends Analysis Team (ITAT)

and Factors Team Meeting

Wednesday, September 24th, 2025
10:00 AM – 12:00 PM
Visit the meeting webpage for meeting materials and additional information.

Purpose: We will hear from Sujay Kaushal (University of Maryland) on Evaluating Stream Restoration Tradeoffs in Water Quality across Watershed Scales. We close out with a presentation from Tish Robertson (Virginia Department of Environmental Quality) on Developing Numeric Chlorophyll a Criteria Through Science, Enhanced Monitoring, and a Collaborative Stakeholder Partnership.

Minutes

I. Welcome

Lead: Breck Sullivan (U.S. Geological Survey, USGS) and Kaylyn Gootman (Environmental Protection Agency, EPA)

Announcements:

- Newly published Potomac Tributary Summary Report! You can access the report on the ITAT Tributary Summaries Project webpage here.
- New EPA Director, Dan Coogan, will take effect October 6th.
- Rebecca Murphy: 2024 Tidal trends are really close to completion with the help of great collaboration for the States trends. They are currently under review and soon to be at a future ITAT meeting.

Upcoming Conferences:

- Coastal & Estuarine Research Federation (CERF) 28th Biennial Conference, November 9-13th, 2025. Richmond, VA. Registration is now open!
- Alliance for the Chesapeake Bay – Chesapeake Watershed Forum, November 7-9, 2025. National Conservation Training Center, Shepherdstown, WV. Proposal for Posters now open!

II. Evaluating Stream Restoration Tradeoffs in Water Quality across Watershed Scales

Lead: Sujay Kaushal (University of Maryland, UMD)

Presentation:

Sujay Kaushal: This work is motivated by the excellent monitoring conducted at the Chesapeake Bay Program (CBP), which is crucial to understanding trends. However, at watershed scales, connecting management activities at small scales to downstream impacts remains a challenge. We invest significant time and resources in restoration and conservation strategies, but it can be difficult to determine what works. Oftentimes we focus on individual contaminants and benchmarks, but a more holistic approach can provide additional insight. The challenge is linking flow paths to receiving waters, and ITAT is a great venue to connect non-tidal and tidal perspectives.

One example comes from ITAT's recent Tributary Summary report on nitrogen trends across multiple stations in the Potomac. While we see improvements overall, patterns differ spatially where one station shows increases while downstream stations might show decreases or no change. This highlights the importance of local context. In our work, we've seen that small-scale interventions, like stream restorations, conservation practices, and stormwater management, require finer-resolution sampling to isolate effects. Long-term monitoring at watershed outlets is essential, but linking those outcomes to local actions requires connecting the dots upstream.

We use approaches like longitudinal synoptic sampling and typologies of spatial trends. For example, trends may be increasing, decreasing due to dilution, stable (chemostatic), transitional, or show complex piecewise patterns. Sydney Shelton applied this typology framework across U.S. rivers, including the Licking River in Ohio, quantifying spatial changes in water quality. From a practical perspective, these typologies help us detect transitions, trade-offs, and restoration effectiveness.

For instance, at Campus Creek (University of Maryland), stream restoration reduced nitrogen concentrations consistently along the flow path but increased organic carbon. Is that a trade-off or a co-benefit? That's an open question. Similarly, dissolved oxygen dynamics showed trade-offs, with some restoration features inducing localized hypoxia during summer. Restoration strategies can provide clear nutrient reductions but may introduce other stressors, emphasizing the need to assess trade-offs alongside benefits.

Additional case studies include Hickey Run in DC (where nitrogen declined through a restored Arboretum reach, except during road-salt events), Scotts Level Branch (showing strong nitrogen declines in headwater restorations), Sligo Creek (with clear transition zones linked to stormwater management and urbanization), and Watts Branch (showing variable patterns influenced by groundwater). Each illustrates how restoration effects differ depending on hydrology, design, and landscape context.

Scaling up, forest cover emerges as a critical predictor of water quality in urban watersheds – often more so than impervious surface cover. Conserving forested areas and riparian buffers provides long-term prevention that complements engineered restoration.

In conclusion, longitudinal sampling allows us to detect trade-offs, hotspots, and transition zones; quantify restoration effectiveness; and guide future strategies. Restoration can reduce nitrogen transport at watershed scales but may introduce trade-offs like increased carbon or hypoxia. Understanding persistence, spatial extent, and co-benefits is essential to improving designs and maximizing outcomes. This complements large-scale monitoring and helps connect watershed interventions with estuarine conditions.

Discussion Notes:
Q: *Elgin Perry:* You discussed trade-offs with reducing nitrogen while possibly increasing dissolved organic carbon and noted that within your study area it looks like a trade-off, but farther downstream it could become a win-win. Even if it appears mixed locally, downstream re-aeration and processing might yield net benefits. Could you comment on that?

- ***A:*** *Sujay Kaushal:* It could. The organic carbon question is something we're actively considering as a research community. The Bay Program has long monitored carbon, and we're finding links to metals and to 6PPD. Organic carbon can bind contaminants and subsidize denitrification, so it may be beneficial rather than detrimental. Also, hypoxic patches associated with certain features tend not to persist far downstream because flow promotes re-aeration. I can't speak to potential biotic impacts, but I agree this could be a net benefit.

- ***Response:*** *Elgin perry:* If oxygen demand occurs upstream in flowing water, re-aeration can mitigate it. That seems preferable to transporting that demand into a stratified pool downstream where hypoxia at depth is harder to resolve.

- ***Comment:*** *Sujay Kaushal:* Alongside some help from Lew and others, we are organizing a salt Scientific and Technical Advisory Committee (STAC) workshop if anyone is interested. From a modeling perspective, I hadn't fully considered managing the amount of organic carbon created in the watershed. Stoichiometrically, if we estimate carbon production, we might infer how much nitrogen or metals that carbon could bind. Practitioners account for organic matter in restoration and stormwater designs, but we don't always factor in potential downstream water-quality benefits or risks like contributing to hypoxia. Linking local carbon dynamics to down-river conditions is an important next step.

- ***Comment from chat:*** *Olivia Devereux:* I know there is a C:N ratio used in the Estuarine model. There is also carbon in the watershed model, but I don't know much about it. Is there carbon data that is available across a broad area? this would also help with BMP effectiveness, since carbon is so tied to fluxes in the soil as well as water.

- ***Q from chat:*** *Claire Buchanan:* Will tradeoffs change over a longer period of time as a new equilibrium is established?

- ***A:*** *Sujay Kaushal:* Over longer time scales, trade-offs can shift. For example, salts may initially be retained in watershed features, but as storage capacity saturates, they can break through and mobilize other contaminants. Similarly, organic-matter production in soils can dilute metal concentrations over time. So yes, the effectiveness and direction of trade-offs can be time-dependent and tied to system equilibration.
- ***Comment:*** *Kaylyn Gootman:* My broader takeaway is that your group's work can inform BMP selection, like type and placement relative to urban or green spaces and clarify how specific water-quality priorities relate to trade-offs. There's no one-size-fits-all BMP; effectiveness depends on position along the stream continuum. The question is how to translate this research into Bay Program practice so implementers can use it – getting information in front of them in a digestible way to maximize co-benefits and manage trade-offs.

- ***Response:*** *Sujay Kaushal:* I agree. Building on your point, and on Claire's time-scale question and Lew's comments from our STAC workshop, there's a spatial analog: where to site these practices. I wonder if we could develop simple scenario tools that estimate rates of reduction per watershed area or stream reach under different settings and then scale them up. Those quick-turn estimates could complement more comprehensive Bay Program modeling. For example, using stoichiometric relationships for organic carbon (as Elgin raised) we could estimate potential nitrogen or metal binding and run scenarios: "if installed here, what downstream effect might we expect?" That kind of screening tool could help answer siting and scaling questions quickly, before applying full modeling frameworks.
- ***Comment:*** *Lewis Linker:* From other Bay Program perspectives: tidal wetlands generate substantial organic carbon that is exported to adjacent waters and can depress dissolved oxygen; with extensive wetlands, a 1 mg/L DO depression in surface waters isn't unusual

and can challenge the 5 mg/L standard. SAV also takes up nutrients from the water column and from buried sediments; when it senesces in fall, that organic carbon can lower DO in deep channels. In short, many valued resources increase organic carbon and can depress DO. The question becomes, what Bay do we want? Likely a more mesotrophic Bay than today's eutrophic state, accepting that some productivity carries an oxygen cost. By that lens, more organic carbon from healthy streams may be beneficial overall, even if it modestly depresses DO as it discharges to tidal waters.

- ***Comment**: Sujay Kaushal:* I think there's a role for carbon management, especially in non-tidal areas and possibly tidal ones too. As you mentioned, carbon is also linked to metals since it can bind contaminants. When carbon contacts salt, it can flocculate and settle, leading to burial. Restoration and conservation can therefore influence carbon in ways that affect denitrification and contaminant binding. In the restoration community, we think about carbon, but not often in terms of broader ecosystem impacts like tidal freshwater systems. You wouldn't necessarily manipulate carbon directly but perhaps expand wetland extent or focus on plant composition in those wetlands.
- ***Response:** Lewis Linker:* We don't try to manipulate organic carbon directly. Instead, we work to understand it in its categories: G1, G2, and G3, representing different reactivity rates, such as BOD5, BOD30, and BOD ultimate. We carefully separate these fractions in our models. We also distinguish dissolved versus particulate carbon, and if particulate, whether it falls into G1, G2, or G3. Every particulate carbon fraction has associated nitrogen and phosphorus. While no BMPs are designed specifically to manage carbon, we strive to understand its fractions and effects.

- ***Comment from chat:** Tish Robertson:* Dissolved Organic Carbon (DOC) acts like the charcoal filter in your Brita pitcher. It binds up positively charged ions (like metals), making them so that they are not biologically available.

- ***Comment:** Carl Friedrichs:* I want to echo the point about wetlands suppressing dissolved oxygen in tidal tributaries. I learned more about this recently from Tish Robertson while serving on a regulatory panel with her. She noted that the tidal Mattaponi and Pamunkey rivers show depressed oxygen levels, so they use a 4 mg/L summer open-water standard instead of 5. Tish has also found similar results in the tidal Chickahominy, which has extensive upper tidal wetlands, and suggests it too should use a 4 mg/L standard. Another example is the oligohaline Pocomoke. This pattern is common: tidal wetlands add organic matter, depressing oxygen. This talk highlights that similar dynamics occur in streams, which is something I hadn't considered until recently. It's a reminder that simply reducing nitrogen doesn't solve the problem if high organic carbon drives oxygen depletion. If nitrogen is low but organic carbon is high in forms that consume oxygen, we may not have solved the issue, we've just shifted the problem. Success must be measured by dissolved oxygen, chlorophyll, and clarity. Nitrogen is only a tool for improving oxygen. If oxygen declines despite lower nitrogen, we haven't achieved our goal. Still, there are other benefits worth considering, as the CESR report emphasizes – looking across multiple ecosystem services.

- ***Response:** Lewis Linker:* Denitrification occurs in tidal wetlands, which helps improve oxygen conditions in deep channels. For systems like the Chickahominy and others with extensive tidal wetlands, variances in oxygen standards are appropriate. These wetlands clearly depress surface water DO and acknowledging that through variances helps guide management in the right direction by giving the correct signal.
- ***Comment from chat:** Joseph Delesantro:* Just a note that further CBP watershed carbon modeling was planned with collaboration with Xuesong Zhang at the USDA, but this collaboration was put on hold due to cuts at the USDA.

III. Developing Numeric Chlorophyll a Criteria Through Science, Enhanced Monitoring, and a Collaborative Stakeholder Partnership

Lead: Tish Robertson (Virgina Department of Environmental Quality, VA DEQ)

Presentation:

Tish Robertson: We use Chlorophyll-*a* criteria to manage nutrient pollution and minimize eutrophication in the Chesapeake Bay. But why chlorophyll rather than nutrients themselves, which are the actual pollutants? From a standards perspective, nutrients are complicated. They exhibit time lags where you can have high Total Nitrogen (TN) or Total Phosphorus (TP) with no bloom, and weeks later see a bloom with low measured nutrients. The relationships are nonlinear, making it difficult to define clear dose-response thresholds. Regulators prefer simpler, defensible criteria, and nonlinearity complicates that. Algal growth is also influenced by other factors such as light availability, canopy cover, turbidity, grazing pressure, pH, and turbulence. These interactions make nutrient criteria development far more challenging than chlorophyll.

Chlorophyll-*a* offers several practical advantages. It maintains a direct, nearly one-to-one relationship with algal biomass without significant lag. It's also inexpensive and easy to measure with fluorescence probes, and its meaning is intuitive for the public, i.e. green water is a visible signal of pollution. For both technical and communication reasons, chlorophyll has become an effective regulatory surrogate for nutrients.

The James River, Virginia's largest and most iconic river, illustrates this well. Historically important since colonial times, it spans urbanized areas near Richmond and Hampton Roads as well as rural agricultural headwaters. Unfortunately, it is notorious for algal blooms, particularly in its tidal fresh reaches, a reputation that dates back to the 1990s. Yet, unlike other tributaries such as the York or Rappahannock, the James rarely experiences low dissolved oxygen because it is shallower, more tidally mixed, and frequently flushed by Atlantic waters. Consequently, Virginia manages eutrophication there using Chlorophyll-*a* rather than DO criteria.

In 1999, EPA's review of Virginia's Bay data identified tidal James segments as impaired for nutrients, while other Bay segments were impaired for DO. EPA asked DEQ to develop chlorophyll-based nutrient management criteria to delist those segments. DEQ, with help from the Bay Program's Rich Batiuk, created reference-based chlorophyll criteria focused on maintaining balanced phytoplankton communities to support healthy fish assemblages where, at that time, harmful algal blooms (HABs) were not yet a major concern. Using reference-based approaches common in the early 2000s, DEQ identified least-impaired waterbodies, analyzed their chlorophyll distributions, and adopted seasonal mean thresholds for five tidal James segments in 2005. These were groundbreaking and the first estuarine chlorophyll criteria in the nation.

After EPA's 2010 Chesapeake Bay Total Maximum Daily Load (TMDL), however, the James criteria became contentious. The TMDL linked the tidal James endpoints directly to chlorophyll criteria, and model results indicated that basin dischargers would need to implement costly, near-limit-of-technology phosphorus controls. This triggered opposition from dischargers and legislators, who questioned why James River permits were stricter than those for other tributaries with worse DO problems. In 2011, the Virginia General Assembly directed DEQ to review the chlorophyll criteria's scientific basis, providing $3 million to fund new studies and model improvements.

The resulting eight-year James River Chlorophyll study included extensive new data collection and two advisory panels: a Regulatory Advisory Panel (RAP) and a Scientific Advisory Panel (SAP). Partners included Virginia Commonwealth University (VCU), Viginia Institute of Marine Science (VIMS), Old Dominion University (ODU), and Hampton Roads Planning District Commission (HRPDC), which contributed weekly data-flow surveys and phytoplankton analyses.

The SAP, composed of leading experts in phytoplankton ecology, genetics, and water quality, met quarterly for two years and recommended shifting from a reference-based to an effects-based approach. They proposed developing empirical relationships between Chlorophyll-*a* and response variables such as microcystin concentrations, cell densities of toxic dinoflagellates (*Cochlodinium polykrikoides*), and measures of water clarity, pH, and DO.

The effects-based framework defines chlorophyll thresholds that minimize the probability of undesirable outcomes. For example, if HAB events become unacceptable above a 10 percent risk level, the chlorophyll concentration corresponding to that risk becomes the "effect threshold." The most protective (lowest) threshold across all responses is selected as the criterion. This approach provides clear, communicable management targets based on observable ecological effects rather than abstract community metrics.

During SAP deliberations, Claire Buchanan offered a strong defense of the reference-based approach, noting limitations of purely effects-based criteria, particularly when data do not capture the full range of responses, forcing extrapolation beyond observed conditions. Such extrapolations weaken defensibility and could allow degradation if criteria are set above historical concentrations. Recognizing these concerns, DEQ developed a hybrid method, combining both philosophies: criteria would (1) minimize harmful algal-related effects and (2) prevent degradation of current water quality.

The new framework began by characterizing baseline conditions (2005–2013), a period with exceptionally dense datasets from continuous, data-flow, and weekly sampling. Over a million data points were analyzed to describe spatial and temporal variability. DEQ then modeled stressor-response relationships for poor clarity, high pH, microcystin, and *Cochlodinium* abundance, using these models to derive protective chlorophyll thresholds. For instance, a logistic model predicted a 21 µg/L effect threshold for HAB risk in the lower James, leading to a protective summer criterion of 7 µg/L when accounting for spatial and temporal probabilities of exceedance.

Final criteria were selected as the lower of (a) the chlorophyll concentration protective of all documented effects, or (b) the observed baseline mean. The resulting 2020 criteria were generally lower than those from 2005, reflecting improved understanding and finer-scale data. Some segment-seasons were set by baseline protection, others by effects-based thresholds. DEQ also added short-duration (1-day or 1-month median) HAB-protection criteria alongside seasonal means, aligning implementation with the statistical methods used in analysis.

Lessons learned included the critical importance of partnerships and high-frequency, spatially intensive data. The collaboration with HRPDC, VIMS, and VCU produced an unprecedented dataset that made the criteria scientifically defensible and persuasive to stakeholders. Continuous sensors and data-flow mapping captured diurnal and spatial dynamics invisible to monthly grab samples. The study also prompted DEQ to replace cumulative frequency distributions (CFDs) with a new method that embedded spatial-temporal protection directly into the criterion magnitudes, avoiding problematic spatial interpolation.

Finally, tracking biological and toxicological effects alongside traditional water-quality metrics proved invaluable. HAB toxins and fish-killing dinoflagellates represent direct ecological threats beyond shifts in DO or pH. Integrating those endpoints strengthened the scientific foundation and management relevance of the criteria.

In conclusion, both nutrients and chlorophyll are complex to regulate, but chlorophyll remains a practical, effective management tool when grounded in robust science, rich data, and strong partnerships. The James River Chlorophyll study demonstrated how collaborative, effectsinformed approaches can modernize water-quality standards while maintaining credibility with scientists, regulators, and the public alike.

Discussion Notes:
Q: *Breck Sullivan:* You mentioned combining reference-based and effects-based approaches. In your hybrid method, which part represents the "baseline" or reference component?

- ***A:*** *Tish Robertson:* The baseline serves as a self-reference for the waterbody. Traditional reference-based criteria aim to prevent degradation and move conditions toward an idealized state. For the James River chlorophyll criteria, we similarly sought to prevent degradation, at a minimum keeping conditions stable when effects cannot be clearly tied to algae, so we avoid inviting unforeseeable outcomes (e.g., invasive species) that aren't captured by monitoring models. That baseline safeguard is the reference-based element within the hybrid framework.

Q: *Breck Sullivan:* You noted other Virginia tributaries focus on dissolved oxygen. Do you foresee applying this Chlorophyll-*a* approach to those systems? Has that already happened, or would it represent a change?

- ***A:*** *Tish Robertson:* What I've heard at DEQ is that developing comparable chlorophyll criteria elsewhere would require significant support and roughly $3 million in resources. The approach is transferable, and if there were political will and pressure, we could apply the framework to another system. The specific numeric values wouldn't carry over; we would need to start from scratch for that waterbody. We'd have to rebuild the dataset and analyses, but we now have a clear strategy to follow.

IV. Adjourn 12:00 PM

Next Meeting: October 22nd, 10 AM – 12PM

Attendees:
Kaylyn Gootman (EPA), Breck Sullivan (USGS), Gabriel Duran (CRC), Sujay Kaushal (UMD), Allison Welch (CRC), Tish Robertson (VADEQ), Renee Karrh (MDDNR), Blessing Edje (DOEE), Elgin Perry (Consultant), Mukhtar Ibrahim (MWCOG), Cynthia Johnson (VADEQ), Anthony Timpano (VADEQ), Rebecca Murphy (UMCES), Helen Smith (Devereux Consulting), Klaus Huebert (MDDNR), Joseph Morina (VADEQ), Claire Buchanan (ICPRB), Andrew Keppel (MDDNR), James Webber (USGS), Ashley Dann (UMD), Joseph Delesantro (ORISE), Carl Friedrichs (VIMS), Amanda Shaver (VADEQ), Olivia Devereux (Devereux Consulting), Carol Cain (MDDNR), Efeturi Oghenekaro (DOEE), Michael Lane (ODU), Lewis Linker (EPA), Jeremy Hanson (CRC), Rikke Jepsen (ICPRB), and Goerge Onyullo (DOEE).