Chesapeake Bay Program
Science. Restoration. Partnership.

Integrated Trends Analysis Team (ITAT) and Nontidal Network (NTN) Workgroup Joint Meeting

Wednesday, December 17th, 2025
1:00 – 2:30 PM

Visit the meeting webpage for meeting materials and additional information.

Minutes

I. Welcome, Introductions & Announcements **(1:00-1:05 PM)**
*Lead: **Peter Tango** (U.S. Geological Survey, USGS) NTN Chair, **Breck Sullivan** (USGS) ITAT Co-coordinator, and **Kaylyn Gootman** (U.S. Environmental Protection Agency, EPA) ITAT Co-coordinator.*

- Chesapeake Community Research Symposium abstract submission now open! Deadline is February 13th, 2026, at 5 PM EST.
- Chessie BIBI (Chesapeake Basin-wide Index of Biotic Integrity) scoring will be updated on Friday, December 19th at the Stream Health Workgroup Meeting. This is an indicator the Chesapeake Bay Program (CBP) has used for nearly 20 years to tell the story of habitat and living resources in the watershed. ITAT and NTN may want to think about how living resources connect to our mapping and broader discussions moving forward.

II. 2024 Tidal Trends **(1:05 – 1:45 PM)**
Description: Rebecca Murphy (University of Maryland Center for Environmental Science, UMCES) will provide a presentation on bay-wide summaries of water quality trends in the tidal waters. Click here if you would like to see the full summary. Additional tools are available to explore the tidal trends results including baytrendsmap and the Watershed Data Dashboard.

Lead: Rebecca Murphy

Rebecca Murphy: This is a big collaborative effort across multiple jurisdictions, organizations, and universities including UMCES, USGS, Virginia Department of Environmental Quality (VA DEQ), Maryland Department of Natural Resources (MD DNR), District of Columbia Department of Energy and Environment (DOEE), Tetra Tech and the ITAT team at the CBP Office. For these trends, we look at both short- and long-term changes at about 150 monitoring stations across the Chesapeake Bay mainstem and tidal tributaries for multiple water quality parameters including nutrients, clarity, oxygen and temperature. We achieve this through the use of Generalized Additive Models (GAMs) which allow us to account for seasonal influences, variation in flow or salinity, and changes in sampling methods over time. This methodology was developed through extensive ITAT collaboration and is documented in a peer-reviewed publication. A key strength of this approach is that it allows us to generate consistent and comparable results across tidal jurisdictions, even across state lines, providing a coherent Bay-wide picture. To access the full trends release, please visit the ITAT webpage here.

The long-term (1980s-2024) and short-term (2015-2024) trends capture: Total Nitrogen (TN), Total Phosphorus (TP), Secchi depth, Chlorophyll*a* (Chla), water temperature, and dissolved oxygen (DO). We also account for trends between 1999-2024 and short-term Total Suspended Solids (TSS), Dissolved Inorganic Nitrogen (DIN), and Orthophosphate (PO4). We also capture different perspectives of these by considering the surface and bottom waters, variability across different seasons for Chla, Secchi and DO, and the observed conditions versus flow-adjustment and/or salinity conditions. This is analogous to flow normalization in Weighted Regressions on Time, Discharge, and Season (WRTDS) for nontidal waters and helps us assess the influence of management actions over time.

The team developed an interactive application, baytrendsmap, that allows users to explore recent conditions, long-term and short-term trends, and customize map views.

Results:

For orientation of the maps (slide 7), arrow direction indicate whether the trend is increasing (upward) and decreasing (downward); colors indicate whether the station is seeing improving (blue) or degrading (red) trends and solid arrows indicates whether the trend is statistically significant ($p < 0.05$) and a transparent arrow indicates a possible trend ($0.05 < p < 0.25$); the grey diamonds indicate an unlikely trend (not significant, $p > 0.25$).

For TN, most stations show decreasing nitrogen concentrations over the long-term. The short-term map tells a different story (slide 8), with more stations showing no change or increasing trends over the past decade. The bar chart summarizes this (slide 9): more than 80% of stations showed improving nitrogen trends over the long term, dropping to about 50% over the short term, with the remainder shifting to no-change or degrading categories.

Using baytrendsmap, we can examine specific stations. For example, some Virginia tributaries show increasing surface nitrogen. By clicking on a station in the York River, we can view a time-series plot showing a modest but statistically significant increase over both the long and short term. Concentrations remain relatively low, generally between 0.5 and 1 mg/L. In contrast, stations in areas like the Nanticoke River show higher concentrations, greater variability related to flow, and different trend behavior.

For TP, we see a similar long-term pattern (slide 16), with many stations showing decreasing concentrations. Over the short term, however, improvements have diminished, and more stations show no change or degrading trends. These short-term increases are more spatially mixed across the tidal waters. In many locations, phosphorus shows a long-term decline from the mid-1980s followed by a slight uptick over the past decade (slide 18). These recent increases are generally modest compared to the magnitude of the earlier declines. When viewed alongside nontidal trends (slide 19), many of these patterns correspond between watershed and tidal systems, which is not surprising. Previous studies have shown that changes in nontidal loads and point sources help explain tidal trends, reinforcing the importance of watershed management actions.

Beyond nutrients, we also evaluate Secchi depth as a measure of water clarity (slide 21). Over the long-term, many saltier regions of the Bay show degrading Secchi depth, while short-term trends suggest leveling or improvement in many areas. Patterns differ between deeper, saltier waters and shallower, tidal-fresh areas. Recent research, including a recent publication by Jessica Turner et al., provides insight into these long-term clarity trends and recent stabilization.

Chlorophyll-*a*, an indicator of phytoplankton biomass, shows a mixed pattern across the Bay (slide 23). Long-term trends vary regionally, while short-term trends are dominated by no-change results. This leveling aligns with patterns seen in Secchi depth and reflects the complex interactions among nutrients, temperature, and biological processes.

Water temperature trends are more uniform (slide 24). Nearly all stations show increasing temperatures over both the long- and short-term, consistent with broader global patterns. These increases affect oxygen solubility, phytoplankton growth, seasonal cycles, and habitat conditions, including submerged aquatic vegetation (SAV).

Summer bottom DO trends present a mixed picture (slide 25-26). In deeper mainstem waters, many stations show improving trends, while tributaries show a combination of improving and degrading conditions. These differences reflect varying degrees of stratification and mixing across the tidal system. Current condition maps highlight areas of persistent low bottom DO in the central Bay and some tributaries, underscoring continued concern in these regions.

Overall, nutrient trends show strong long-term improvement with some leveling in the short-term. Response parameters such as Secchi depth, Chla, and DO are more mixed, with recent reductions in degrading trends for Secchi and Chla, and spatially variable DO patterns. These findings are consistent with results from recent years, with no major departures in 2024 relative to 2023.

Discussion:

Comment from chat: *Elgin Perry:* Increasing Chla in the Tidal Fresh Oligohaline is not necessarily a bad story. It could be that it is caused by relaxing light limitation due to improving water clarity.

Q from chat: *Alex Soroka:* Are the temperature trends driven by changes in a particular season or month?

- ***A:*** *Breck Sullivan:* A previous Chesapeake Bay Program (CBP) staffer and Virginia Institute of Marine Science (VIMS) graduate with Marjy Friedrichs, Kyle Hinson, wrote a paper on the causes of temperature trends [link].
- ***A:*** *Rebecca Murphy:* Certainly, there are months that have strong influence on our trends but we are seeing increased temperature trends year-round.
- ***Comment:*** *Elgin Perry:* baytrends cluster analysis can look at that question of whether some months have stronger trends too.

III. 2024 River Input Monitoring (RIM) Trends (1:45 – 2:00 PM)
Description: James Webber (USGS) will provide a brief presentation of 2024 RIM station trends. See the full data release here.

Lead: James Webber

James Webber: The goal of the RIM network is to compute the load and trend of nitrogen, phosphorus, and suspended sediment delivered from 9 of the largest watershed tributaries to the Chesapeake Bay. We use this monitoring to assess water-quality conditions and inform management decisions. Loads are defined as the total amount of nutrients or sediment that is delivered over a time period (annually). Flow-normalized (FN) loads remove most of the hydrologic variability associated with loads, synonymous to the flow-adjusted reported trends from the tidal portion.

USGS collects monthly and storm-targeted water quality samples from 9-station RIM network. The RIM stations represent about 78% of the Chesapeake Bay watershed area. The nine RIM stations span north to south. In Maryland, we have the Susquehanna, Choptank, Patuxent, and Potomac Rivers. In Virginia, we have the Rappahannock, Mattaponi, Pamunkey, James, and Appomattox Rivers.

Results:

Results are expressed in yields (load, pounds per acre) by dividing total load by the watershed area. For TN yield (slide 7), the darkest colors represent the highest per acre loads and lighter colors represent lower per acre loads. We see the highest nitrogen yields from the Choptank, followed by the Susquehanna. Moving into the Potomac and into Virginia tributaries, yields are generally lower. We have substantial research explaining some of these patterns, especially for the Choptank, where intensive agriculture and Eastern Shore groundwater dynamics contribute to elevated nitrogen delivery.

For TP yields, the spatial pattern is different (slide 7). The Choptank remains a hotspot, reflecting intensive agriculture and legacy phosphorus in soils. We also see elevated phosphorus yields in the Patuxent, and in the Rappahannock and James. Sediment yields show another helpful comparison. The Rappahannock and James mobilize relatively large amounts of sediment compared to other watersheds. Because sediment and phosphorus often move together, higher sediment delivery can help explain elevated phosphorus in the Rappahannock and James. In contrast, the Choptank has lower sediment yield due to its lower-gradient landscape, which may indicate the phosphorus delivery there is more dissolved in form rather than sediment-bound.

To discuss change over time (trends), it's useful to review the streamflow context (slide 9). This bar chart shows annual flow from 1985 through 2024. Taller bars indicate wetter years with higher streamflow; shorter bars indicate drier years. The long-term average is shown as a dashed line. 2019 was the wettest year on record. Water year 2024 was near average, just slightly above the long-term mean. To compare to the TN load delivered to the Bay from the RIM network (sum of all nine RIM stations), the pattern strongly reflects hydrology when looking at observed conditions. For instance, in wet years like 2019, nitrogen delivery is higher, same with drier years like 2023. In 2024, flow was slightly above average, but TN delivered was slightly below average. That illustrates the value of looking at both raw delivery and FN trends when interpreting watershed-to-estuary linkages.

Looking at FN loads across the entire RIM network (slide 10), TN has decreased over time. The black line shows the sum of FN-TN loads across all nine stations from 1985 to 2024. The overall trend is downward, which is a positive long-term signal: the RIM watersheds are delivering less FN nitrogen to the Bay over time. The Susquehanna is shown here because it is the largest watershed amongst the RIM stations and delivers the largest load. Much of the overall network signal is influenced by changes in the Susquehanna, with the Potomac as the next-largest contributor. Together, the Susquehanna and Potomac typically account for roughly 70–90% of the total RIM loads delivered to the Bay.

For TP (slide10), the long-term pattern is less linear than nitrogen. From the mid-1990s into the 2010s, we saw an upward trajectory that has since started to reverse and decline, perhaps flattening more recently. This "hump" appears to be driven largely by patterns in the Susquehanna, and there are several hypotheses about contributing factors, including major storm events around 2010–2011. SS shows a similar hump-shaped pattern. Sediment and phosphorus share delivery pathways in many cases, so it is not surprising to see similar long-term dynamics.

Looking at station level detail (slide 11), this table summarizes trends for each of the nine RIM stations. Green indicates improving (decreasing loads), orange indicates degrading (increasing loads), and the stations are listed from north to south, from the Susquehanna down to the Appomattox. The table also shows short-term trends for the last 10 years. Overall, since 1985 we see a mix of improving and degrading trends. Over the last 10 years, more stations show degrading trends than improving trends, and many of the degrading signals are concentrated in Virginia tributaries. Since 2015, nitrogen, phosphorus, and sediment have all improved in the Susquehanna. That is significant because it is the largest watershed and heavily influences Bay loading and conditions in the upper Bay.

Integrating nontidal and tidal trends (slide 12). On the left are the RIM trends for the last 10 years: nitrogen on the left panel and phosphorus on the right panel. Tidal trends are overlaid the RIM station maps. Green indicates improvement, orange indicates degradation, and yellow indicates lower statistical confidence. This integrated view has been a big ask from the community - linking watershed delivery trends to tidal response. For example, we see improving nitrogen loads from the Susquehanna and generally improving nitrogen conditions in the upper Bay. Similarly, improving watershed loads from the Patuxent and Potomac correspond with generally improving tidal patterns in those reaches. In the Virginia tributaries, we see increasing nitrogen loads in places like the Rappahannock, with corresponding indications of increasing tidal concentrations at some stations within that tributary. The York is more mixed. In the James and Appomattox, increasing watershed nitrogen loads are reflected in portions of the tidal tributaries as well.

Please visit our project webpage for recent data, summary of results and more information.

IV. 2024 RIM and Tidal Trends Discussion (2:00 – 2:30 PM)

Description: Workgroup members and interested parties will be able to discuss the side-by-side comparison of 2024 tidal and RIM trends. It is also an opportunity to raise priority questions to inform future research and help inform management decisions related to water quality.

Q: *Peter Tango:* Can you touch on a bit of the zone of influence from the RIM stations to the tidal fresh areas? I know residence time varies by tributary, and some of that is built into how we interpret chlorophyll as a function of residence time and loading. I know some work has been done that looked at relative influence as you move downstream through tidal waters.

- ***A:*** *Rebecca:* I think that influence is pretty far downstream. For instance, the Susquehanna load has been linked many times to oxygen conditions far down into the Bay. Of course, it changes form and gets reused and recycled, but it does have an impact far down. If we see a trend just here and there at the tidal stations and not consistently down the Bay, it could be that there are slight changes happening and this can definitely be impacted by seasonality, etc. Having these targeted questions are super important for summarizing and knowing specific parameters or locations for informing the community.

Comment: *Rebecca:* For the Pamunkey and York nitrogen pattern, point sources could be having a substantial impact or role in what we could be seeing at stations below the fall line (downstream of RIM stations). If there are slight increases, it would be worth checking whether point sources changed in a way that could affect downstream tidal conditions. There may also be estuarine processes influencing these signals, and the trends themselves are quite small.

- ***Comment:*** *James Webber:* Those patterns aren't fully congruent. Our RIM trends in those areas are pretty slight, and the overall amount of material delivered from those watersheds is generally lower, so that could be part of it. But I agree with your point: we should explore point sources, because even small changes in point source loads could meaningfully affect downstream tidal conditions.

- ***Response:*** *Peter Tango:* When I look at the Rappahannock and see one improving signal among other directions or no clear trends, it raises questions whether something local is influencing that station differently than surrounding areas, especially below the fall line. We have modeling for below fall line loads, but we don't see yields or trends from monitoring there the way we do upstream. I wonder whether bringing in modeled estimates for the below fall line area could help illustrate the story, since we don't have those smaller tributaries measured. Maybe this is already covered in the tributary summaries, but it feels like a potential addition for interpretation.

- ***Comment:*** *Breck Sullivan:* We do look at land use within each tributary to help understand water quality impacts, and tying in land use might help with the kind of habitat connections you mentioned earlier.

Q: *James Webber:* I'm wondering whether there are specific questions the group wants to address with these comparisons. We know, generally, they relate. We also know point sources matter. Would it be more useful to focus on a narrower set of questions or priority locations, rather than continuing to ask the broad question of whether the systems connect? I'm curious what people see as the next step for how we should use this integrated analysis.

- ***Response:*** *Amanda Shaver:* One thing I've missed hearing is the context piece we often emphasize with trends: an increase or decrease doesn't necessarily mean a huge gain or loss in overall water quality. We can see a small change that is statistically significant over time, but the concentrations might still be low overall. If we want to dig in and focus on areas, it might be most useful to prioritize places with the highest concentrations or the largest increases – places where land-use changes, discharges, or other drivers are more likely to be identifiable. I think this is better than focusing on a general, watershed-wide progression that's harder to pinpoint.

- ***Comment from chat:*** *Alex Soroka:* Great question from Amanda, Is the magnitude of change in nontidal similar to tidal?

- ***Response:*** *James Webber:* We've talked for years about linking monitoring results to water-quality goals and to what jurisdictions identified in their WIPs. Your example is exactly right: should we care about a small increase in the James if the absolute nitrogen delivery is relatively low? Or should we be more concerned about places like the Choptank where improvements are great, but concentrations and yields may still be far higher than desired? That perspective is really helpful.

- ***Comment:*** *Rebecca Murphy:* That has been a challenge for us over the years of showing trends while also answering the question, "How bad is it?" If water quality is already poor and is degrading, that's a major concern. The baytrendsmap tools were built, in part, to help provide that context by showing current conditions alongside trends. USGS has also done a great job with context through yields. Any feedback on how to present trends while keeping that context front and center is welcome.

Comment: *Qian Zhang:* Looking at these maps (slide 12), I'm wondering whether we have a way to host this integrated type of information somewhere. We have Story Maps, but they're not always flexible for exploring the underlying results. We've talked before about putting trends, loads, and concentrations together, both tidal and nontidal, so that users can filter by region or concentration level. For example, I might want to see only high-yield stations, or where concentrations are low but degrading, or where concentrations are high but improving. Having a platform that allows us to interact with the data behind these maps would give us more flexibility to dig deeper.

- ***Response:*** *James Webber:* One thing to note is that we're comparing load-based results with concentration-based results, so the methods and parameters are comparable but not identical. Still, if the group is comfortable with those limitations and we clearly communicate them, we could absolutely build a web-based tool or web map to host and explore this integrated view.
- ***Comment:*** *Rebecca Murphy:* One option might be to add the RIM trends into BayTrendsMap as a toggle layer, with clear notes about what the data represent. I could see this combined map fitting naturally into that platform.
- ***Comment:*** *Breck Sullivan:* I'll add that there does seem to be growing interest within CBP in moving beyond simple "yes/no" status indicators and toward tools that support targeting, interpretation, and understanding reasons behind change. I can see more appetite for this type of collaboration than in the past. I've also heard that folks are less concerned about differing methods, as long as we are transparent about limitations. If there are concerns, please reach out so we can incorporate them. Also, speaking of tools, Elgin raised a related point earlier about whether certain months or seasons drive stronger trends. The same team working on baytrendsmap and the tidal trends R package is also taking the baytrends clustering work and developing it into a tool. That should be available in the coming months in 2026, allowing users to identify stations with similar trend patterns within tributaries.

V. Adjourn (2:30 PM)

Attendance:

Gabriel Duran (CRC), Kaylyn Gootman (EPA), Rebecca Murphy (UMCES), James Webber (USGS), Peter Tango (USGS), Breck Sullivan (USGS), Klaus Huebert (MDDNR), Lori Brown (DNREC), Joseph Morina (VADEQ), Renee Karrh (MDDNR), Tish Robertson (VADEQ), Tyler Shenk (SRBC), James Colgin (USGS), George Onyullo (DOEE), Elgin Perry (Consultant), Matthew Kearns (USGS), Tyler Trostle (PADEP), Bhanu Paudel (DNREC), Mark Brickner (PADEP), Qian Zhang (UMCES), Murray (WVDEP), Andrew Keppel (MDDNR), Cynthia Johnson (VADEQ), Kristen Heyer (MDDNR), Ashley Hullinger (PADEP), Scott Heidel (PADEP), Allison Welch (CRC), Amanda Shaver (VADEQ), Jeremy Hanson (CRC), Alex Soroka (USGS), Efeturi Oghenekaro (DOEE), Jon Harcum (Tetra Tech), Mukhtar Ibrahim (MWCOG), Carl Friedrichs (VIMS), Douglas Moyer (USGS).