Integrated Trends Analysis Team (ITAT)

Workgroup Meeting

Wednesday, January 28th, 2025
10:00 – 11:00 AM

Visit the meeting webpage for meeting materials and additional information.

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

Minutes

I. Welcome, Introductions & Announcements (10:00-10:05 AM)

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

Upcoming Conferences, Meetings, Workshops and Webinars

- Choose Clean Water Conference – May 18-20, 2026. Lancaster, Pennsylvania.
- Chesapeake Community Research Symposium – June 1-3, 2026. Annapolis, Maryland. ***Abstracts are due February 13, 2026.***

II. Flow, Biology, and Diel Oxygen Variability in a Shallow estuary: Insights from the Patuxent River Estuary (10:05 – 10:45 AM)

Lead: Amir Azarnivand (University of Maryland Center for Environmental Science, UMCES)

Amir presented a study examining long-term changes in diel (sub-daily) dissolved oxygen (DO) variability in the Patuxent River Estuary, using high-frequency monitoring data spanning multiple decades. He emphasized that while much of the classic hypoxia literature focuses on persistent, seasonal oxygen depletion in deep, stratified systems, many estuaries experience large daily oxygen swings that are often missed by low-frequency monitoring. These diel dynamics can strongly influence ecosystem metabolism and hypoxia risk yet remain understudied at long time scales.

The analysis leveraged 15-minute DO records from seven high-frequency monitoring stations across the Patuxent, spanning tidal freshwater to mesohaline regions. Power spectral density (PSD) analysis was used to separate diel and tidal signals, with diel-band PSD serving as a metric of oxygen variability. Hypoxia duration was calculated from the same dataset, and relationships with river flow, chlorophyll, and nutrient concentrations were examined to identify physical and biological drivers. Annual averages of these metrics were used to assess long-term trends.

The first major finding focused on the mid-estuary Benedict station, which has one of the longest continuous DO records in the Chesapeake region. Over the past six decades, this site has experienced increasing river flow and nutrient loads, consistent with climate-driven hydrologic change. These shifts correspond to higher chlorophyll concentrations, increased diel oxygen variability, and more frequent early-morning hypoxia events. The results indicate that physical forcing (flow) and biological production reinforce one another in the mid-estuary, amplifying diel oxygen swings over time.

In contrast, the shallow Mattaponi Creek station exhibited a very different response. This marsh-fringed, benthic-dominated tributary showed the highest diel oxygen variability in the system, particularly following the loss of submerged aquatic vegetation (SAV) around 2019. However, unlike downstream sites, increased river flow suppressed chlorophyll and diel variability by enhancing flushing and turbidity. This demonstrated that shallow upper-estuary habitats can respond oppositely to the same hydrologic forcing, highlighting strong habitat-specific controls on oxygen dynamics.

At Iron Pot Landing, located just downstream of a wastewater treatment plant, diel oxygen variability decreased over time following enhanced nutrient removal upgrades implemented in the mid-2000s. Declines in orthophosphate and chlorophyll were associated with a weakening biological signal and a greater relative influence of tidal physical processes. This site illustrated how nutrient management can directly reduce metabolic variability and lower the risk of nighttime hypoxia in light-limited freshwater systems.

Finally, there is supporting evidence that short-distance horizontal oxygen gradients near marsh creeks can influence tidal-scale DO variability. High-frequency spatial measurements showed that very large DO gradients can occur over hundreds of meters near marsh–estuary interfaces, suggesting processes may contribute to observed tidal signals. Overall, the study demonstrated that diel oxygen variability is shaped by interacting biological, physical, and spatial drivers that vary across habitats and time scales, underscoring the need for models and monitoring programs that explicitly capture this multiscale complexity.

<u>*Discussion:*</u>

Q from chat: *Elgin Perry:* Have you examined DataFlow data sets to confirm the spatial DO gradients that you infer from the ConMon Data (continuous monitoring)?

- ***A:*** *Amir Azarnivand:* Unfortunately, we didn't because the gradient part wasn't the core part of our study. Later on, Walter Boynton mentioned the DataFlow data but we couldn't find the time nor were we able to relate this to the whole part of the estuary we wanted to look at. Also, we had limited high-frequency timeseries. The most recent high-frequency measurements at Benedict were from roughly 2003-2006, depending on the station, and only about one year overlaps with the available DataFlow record. We focused on 2005 in our operator theory analysis, and while we could potentially extend that approach to 2003 or 2004 around Benedict, the overlap was limited. Maybe we will revisit this in the future.

- ***Response:*** *Elgin Perry:* I've looked at DataFlow data from a similar site in the Potomac near Piscataway Creek, and my sense is that it would likely confirm what you're inferring. In some areas, particularly along small tributaries, you can see very strong dissolved oxygen gradients over relatively short spatial scales. If you find the time to explore it, I think you would find it to be a productive line of research that supports the inferences you're making from these data.

Q: *Rebecca Murphy:* For the Benedict, you mentioned having high frequency data in the mid-2000s but you also mentioned having measurements since the 1960s. Were those measurements also high frequency?

- ***A:*** *Amir Azarnivand:* Surprisingly, those measurements were on an hourly basis. One of Walter Boynton's students collected measurements between 1963-1967, including DO, temperature and conductivity (proxy for salinity). These data were originally recorded on strip charts and later digitized by Walter Boynton's lab several years ago. Then, in 1992, another of Walter's students, Brandon Sweeney, conducted similar high-frequency measurements to compare against the 1960s data. Additional measurements were later conducted between 1995 and 1998, although those were at 15-minute intervals. The 1992 and 1960s datasets were averaged to hourly resolution.

Q: *Breck Sullivan:* Would any of your findings change the way we do monitoring in any of these tributaries? What would you recommend?

- ***A:*** *Amir Azarnivand:* One key takeaway is that many of us want more high-frequency data, and we simply don't have enough recent high-frequency monitoring in many parts of the Patuxent or elsewhere in the Chesapeake Bay. While we analyzed data through 2021, and some stations continue to collect data, we don't have that fine temporal resolution across much of the system. For example, while Chesapeake Biological Laboratory is doing some high-frequency monitoring, it would be extremely valuable to have hourly or 15-minute resolution data in locations between the mouth near Solomons and Jug Bay. That mid- to lower-estuary region is particularly susceptible to hypoxia, is deeper, and is currently sampled biweekly. Without high-frequency measurements, we miss important dynamics.

Comment: *Peter Tango:* This is outstanding work. I think it aligns extremely well with Bay Program discussions around tiered implementation and the emphasis on shallow-water signals as primary responses, rather than focusing solely on deep-channel responses. Your work really sharpens our understanding of fine-scale shallow-water dynamics and the physical-biological relationships influencing them. This is exactly the kind of analysis that helps tell the nutrient story while also capturing temperature effects and habitat responses. It's a beautiful and very helpful contribution for understanding how the system responds beyond just the deep channel narrative.

III. Discussion on the scope and purpose of ITAT (10:45 – 11:00 AM)

Lead: ITAT Leaders

Discussion:

Comment: *Breck Sullivan:* The way the Bay Program sees ITAT is to bring together different analysts across different entities, like academia, nonprofits, federal and state agencies, to help understand the trends and patterns happening in water quality and to provide linkages among the different research that people are doing in order to really foster collaboration. We also provide an opportunity to develop standard sets of analysis tools including the baytrends app, cluster analysis, and even some members working on the 4D interpolator – allowing us the opportunity to explore our own development and research.

Comment: *Kaylyn Gootman:* ITAT is where we can bring together different parts of the watershed, including tidal and nontidal and have a cross pollination of the different research occurring across the Bay. I think this is a direction we have started exploring recently and something that has received a lot of attention across the Program.

Comment: *Rebecca Murphy:* One thing I particularly appreciate is having a clear home for tidal trends methods and coordinating annual analyses, managing methodological changes, and interpreting results. At the same time, today's presentation shows how ITAT is also an excellent venue for broader scientific discussions. Looking ahead, integrating tidal and non-tidal trends even more intentionally feels like a very promising direction.

Comment: *Elgin Perry:* I really like the direction where ITAT has been going in the last decade with tools like baytrends and cluster analysis. However, it focuses a bit too much on average conditions and although this is super helpful in identifying general trends, it really misses the source of emerging problems. What I would like to see in the future is more discussion on what kind of data is needed in identifying where those problematic signals originate, likely through smaller-scale monitoring in tributaries. Conversations like what we had today with Amir's presentation is something that we should welcome and encourage.

- ***Comment from chat:*** *Rebecca Murphy:* Elgin's idea is great. Also, maybe more link to living resources? We had some good work a few years ago linking water quality to SAV. More like that perhaps.
- ***Comment from chat:*** *Peter Tango:* Agree with Elgin in that, like Amir showed, duration of events is a sensitive measurement metric. Like the deep hypoxia, hypoxic-volume-days looks more sensitive than max or average hypoxia annually. It can help us see signals before the big metrics (e.g., average) respond.

IV. Adjourn (11:00 AM)

Next meeting: February 25th from 10 AM – 12 PM.

Attendees:

Kaylyn Gootman (EPA), Breck Sullivan (USGS), Rebecca Murphy (UMCES), Peter Tango (USGS), Gabriel Duran (CRC), Amir Azarnivand (UMCES), Qian Zhang (UMCES), Jon Harcum (Tetra Tech), Stephanie Nummer (ICPRB), Mukhtar Ibrahim (MWCOG), Renee Karrh (MDDNR), Andrew Keppel (MDDNR), Elgin Perry (Consultant – CBPO), Christopher Mason (USGS), Anthony Timpano (VADEQ), Coral Howe (USGS), Carl Friedrichs (VIMS), Cynthia Johnson (VADEQ), Blessing Edje (DOEE).