Chesapeake Bay Program
Science. Restoration. Partnership.

Integrated Trends Analysis Team (ITAT)

Wednesday, October 23rd, 2024

10:00 AM – 12:00 PM

Meeting Materials: Link

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

Minutes

10:00 – 10:05 AM Welcome – Breck Sullivan (USGS) and Kaylyn Gootman (EPA)

Announcements:

- Scientific and Technical Advisory Committee (STAC) Synthesis Request for Proposal; ***Due December 2nd***.
- The newly published *Rappahannock Tributary Summary* is available on the ITAT webpage.

Upcoming Conferences, Meetings, Workshops and Webinars

- American Geophysical Union (AGU) 2024 Fall Meeting – December 9-13, 2024, Washington, D.C.
- 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 *Quantifying the Drivers of Hypoxia Onset Variability in the Chesapeake Bay*

Presenter(s): *Olivia Szot (Virginia Institute of Marine Science, VIMS)*

Description: Previous studies have shown that the timing of hypoxia initiation in the Chesapeake Bay can vary significantly from year to year, influenced by key factors such as wind patterns, air temperature, and terrestrial inputs. This presentation will examine and compare the relative impact of the individual factors on the timing of hypoxia onset.

In the past, there have been several studies that have looked at long term trends of hypoxia onset in the Bay. In 2004, James Hagey looked at the variability of hypoxia each year between 1950-2001 (*Hagy et al., 2004*). The earliest onset he found was May 2nd and the latest observed was July 3rd.

Similarly, Jeremy Testa and Michael Kemp looked at how onset differs spatially and across the Bay (*Testa & Kemp, 2014*). It was found that onset will vary by a longer duration (~50 days). Hypoxia was most prominent in the upper Chesapeake Bay with an onset difference of ~2 months.

More recent studies have looked at how climate change will impact onset timing. Hawes (2024) examined the effect of climate change compared to a 1990s baseline and found that hypoxia might start two weeks earlier in the future with current climate scenarios (*Hawes, 2024*). In 2018, Irby and others found that hypoxia might potentially start one week earlier in the future (*Irby et al., 2018*). Overall, there are expected differences in onset timing in the future due to climate change.

Why do we care about when hypoxia starts?

1. *Ecological impact:* earlier onset can extend the time that environment is under stress.
2. *Water quality management:* understanding the onset drivers can improve forecasts and allow for more targeted management approaches.
3. *Climate change indicator:* changes in onset timing can serve as an indicator of environmental changes.

What causes this year-to-year variability in hypoxia onset timing? Known drivers of hypoxia include wind patterns (wind speed, wind direction and waves), temperature (gas solubility, biological rates, stratification), and terrestrial inputs (nutrient availability, stratification, estuarine circulation). The factors influence hypoxia in varying ways, either through biological impact or through physical impacts, or different combinations.

Our objective is to quantify the relative influence wind patterns, air temperature, and terrestrial inputs have on hypoxia onset. To answer this question, we will be using Regional Ocean Modeling System – Estuarine Carbon Biogeochemistry (ROMS-ECB), which is a 3D fully coupled hydrodynamic biochemical model (*Feng et al, 2015*; *St-Laurent & Friedrichs, 2024*). This modeling system includes regional ocean modeling system (ROMS), the hydrodynamic component with a 600-meter grid resolution model with 20 terrain falling levels. This is fully coupled with the estuarine carbon biogeochemistry modeling (ECB) which uses full carbon and nitrogen cycles, sinks and sources of oxygen, air, sea exchanges, biochemical flux at the bed, and a sediment transport module.

This model is forced by a regulatory watershed model – the Chesapeake Bay Phase 6 watershed model. Additionally, atmospheric forcings come from the ERA5 Atmospheric Reanalysis and the North American Mesoscale (NAM) Forecast System. Realistic waves are forced using the SWAN model (Simulating WAves Nearshore).

Methods: Control Run

Our first simulation was to run just a single year simulation as our baseline for the following experiments. This is the daily hypoxic volume using the threshold of 3 milligrams per liter (mg/L) to define hypoxia. We observed the total hypoxic volume in Chesapeake Bay (Slide 6). To define the first day of hypoxic onset was the first day of when the hypoxic volume approached 1 km^3, and this was on June 1st in our control run. This will be used to compare how the onset date changes between the control and the different experiments performed.

We ran 40 experiments on the factors that we were interested in, including wind speed, wind direction, wind waves, air temperature, terrestrial inputs and freshwater discharge. All terrestrial inputs including freshwater, nutrients, organic matter, and sediment were modified. We ran several experiments where we modified the factors for one month through March, April, May (wind patterns and air temperature) and January, February, March, April, May (terrestrial inputs and freshwater discharge). Our first experiments included +1 standard deviation (SD), and the second experiment was -1 SD (calculated from 25 years climatology). Spring to early summer is the period that these are most likely to impact hypoxia onset. However, for the terrestrial inputs experiments, I had modified months January through May as it's more likely that earlier months from the year can impact hypoxia onset in the context of these factors.

Results:

The control baseline experiments are used to compare the different modified factors. The red line (slide 10) indicates an increase in wind speed that causes a later onset initiation (by 9 days) and the yellow line indicates a decrease in wind speed which led to an earlier onset by 12 days. When increasing the wind speed, this mixes the water column and brings the oxygen rich surface water down to the deeper hypoxic waters, allowing a later onset initiation.

Looking at the wind direction (slide 11), the red line indicates the wind direction was rotated to the right by +1 SD and the yellow line indicates rotation to the left by +1 SD. It was found that there was minimal impact on the onset timing with as little of as <2 day difference. Overall, wind direction had a relatively minor effect on onset timing.

Examined wind waves (slide 12), the red line indicates increased waves and the yellow indicates decreased waves. Increased waves led to a later onset by a relatively short time period (<2 days). Decreased waves led to an earlier onset by <2 days. By increasing the waves, there is an increased amount of resuspension and increased total suspended solids (TSS) concentrations in the water column. This leads to a reduction of primary productivity and less organic matter production. So, there was less organic matter earlier in the summer that led to less oxygen consumption and a later hypoxia onset time. Overall, there remains little impact on onset time.

Next, looking at temperature (slide 13), the red line indicates increased air temperature and the yellow indicates decreased temperature. Increased air temperature led to an earlier onset by 6 days and decreased temperature led to later onset by 2 days. This was primarily due to warmer air temperatures decreasing gas solubility – less oxygen can be held in the water. Also, warmer air temperature increases biological activity, leading to increased respiration and remineralization.

In the terrestrial inputs (slide 14), the red line indicates increased terrestrial inputs and the yellow line indicates decreased terrestrial inputs. Generally, both the increase and decrease in terrestrial inputs (which includes nutrients and freshwater command) had minimal impact on the onset time (<2 days). However, the changes in terrestrial inputs had a sizeable impact on the magnitude for the summer period. An increase in the terrestrial inputs led to an increase in summer hypoxia by 25% and the decrease led to a decrease in the hypoxic volume. From this, we asked how the nutrient loading and sediment loading impact hypoxia versus the amount of freshwater coming in. Thus, we ran an additional experiment modifying only freshwater discharge.

When just modifying the freshwater discharge (slide 15), the red line indicates increased freshwater discharge, and the yellow line indicates a decrease in freshwater discharge. There is a much smaller influence on the onset on the overall magnitude of hypoxia. However, there was a slightly larger time on onset time. This tells us that nutrient loading is the primary cause for the large difference in magnitude for the terrestrial inputs. However, there is an inverse relationship observed here in comparison to the total terrestrial inputs where an increase in freshwater led to a later onset and a decrease in the magnitude. Overall, these two different components of the terrestrial inputs do have slightly opposing effects but do not have too much impact on onset time.

Takeaways:

We found that the windspeed was the greatest determining factor of when hypoxia starts in the Bay (an onset range of ~3 weeks). The air temperature was also a key factor, leading to an onset range of ~1 week. The wind direction and waves both had a relatively small impact of ~<2-day onset date in comparison to the control. Lastly, we also found that the terrestrial input had a relatively small influence on the onset time but did have the most impact on the total magnitude of summer hypoxia.

How might this change in the future with climate change? With wind speed or wind patterns, there is high uncertainty in future hypoxia onset time with uncertain future changes to wind patterns. Research shows that future wind speed may decrease, potentially inducing earlier onset times in the future. But with more intense storms, that might increase the magnitude of wind speed and possibly mitigate hypoxia. For temperature and warming conditions, we can anticipate earlier onset in the future. Lastly, the terrestrial input experiments really reinforced the ongoing need that we have for nutrient reductions.

Discussion:

Q: *Lewis linker:* I wanted some confirmation of wind speed and temperature but the terrestrial inputs, really sets the thermostat. I would recommend *Ping Wang et al. (2016)* on wind velocity in terms of trumping wind direction, and especially there is a particular velocity and once that velocity is hit, it really assists in mixing and lowering hypoxia. One question, on slide 10, why did we have an increase in mid July – August if we have a higher wind speed and a higher hypoxia? And it looks like a similar story on slide 13? ***A:*** *Olivia:* We only modified the wind speed during May and the primary impacts were in early summer.

But we are seeing this prolonged impact from those May wind speeds because there are less nutrients that were being taken up here due to mixing and they are now available later in the summer, leading to increases in hypoxic volume.

- ***Q:*** *Lew:* In the event of high wind speed, high velocity in the spring, there will basically be a catching up/burning up of the organics that weren't able to be burned up in the spring and therefore high in the summer. But on slide 13, there is a decrease of hypoxia in July – maybe the wind even had some sort of downstream consequences?
- ***A:*** *Olivia:* Yes, it's a similar impact from what had happened in the wind speed experiment and with the air temperature (slide 13). It is a similar story where the temperature may have affected the summer's nutrient availability.

Q from chat: *Elgin Perry:* what is the control wind direction? And when you look through how each of these factors changes, it still will not describe the degree of onset variability seen in the observations. Are we missing something? Combined wind factors? Maybe the combined factors can explain what we are observing. ***A:*** *Olivia:* in April, the month modified, and the mean wind direction was towards the east. So, in experiment 1, that would be towards the south and experiment 2 is the opposite direction, towards the north.

- ***A:*** *Olivia:* This is a great point and one thing to point out in the literature is that they define hypoxia differently. Hagy defines it as the onset of anoxia, 0.2 mg/L, at a specific station and the first day would be when the waters reached this level. Testa defines hypoxia as 2 mg/L and onset would be the first day that waters reached this level. So, the way we calculate and define hypoxia onset may account for these differences we are observing. And, looking at the combination of different factors, we do have some results to share – looking at the combined factors of wind speed, waves and wind direction rotation, we see about a four-week difference (slide 20). This is about half of what was observed in the observational studies, and this is only looking at the combined wind factors. If we could run other combined factors, like wind speed and temperature, we might find earlier or later onset of four-weeks.
- ***Response:*** *Elgin:* This is great. I would also add that with a model like this, you're expecting that the model is cracking the mean of observations and when you add some maybe stochastic variability, you would expect that the window might get bigger just due to randomness and that might be another factor that plays in what is creating bigger differences in the observed data than what your model produces.
- ***Response:*** *Lew:* The classic spring fresh story for hypoxia is that a lot of nitrogen hits the Bay in the spring and the temperature warms and this unlocks the big diagenesis engine in the sediment. So, the largest sources of nutrients in the summertime are from the sediments in the Bay, from the ammonia and phosphate going to the center. I wonder if another forcing function could be the amount of bioavailable organics in sediments, which is something of a reflection of the previous year.

Q from chat: *Anthony Timpano:* Any thoughts on potential for long-term temporal lag effects not captured in the models? What if there is extreme tropical weather and intercedent fall which is predicted to increase in frequency and intensity as climate change progresses. You demonstrated such a difference in magnitude with the terrestrial inputs, I'm thinking, could there also be temporal lag with huge sediment inputs one fall that you wouldn't see until the summer? ***A:*** *Olivia:* This is possible if there is a large hurricane or something that happens later in the hypoxic season, the organic matter might settle down and be waiting in that area until it can be used again earlier in the summer when the conditions are right. There is potential for long-term lag and something that could be looked at by running 2-year experiments like mine but altering the conditions from the previous year.

10:35 – 11:30 AM ***2023 Tidal Trends Summary***

Presenter(s): *Rebecca Murphy (University of Maryland Center for Environmental Science, UMCES)*

Description: Rebecca will present the 2023 bay wide tidal water quality trends generated through a joint effort with ITAT, Maryland Department of Natural Resources (MD DNR), Virginia Department of Environmental Quality (VA DEQ), Old Dominion University (ODU), Department of Energy and Environment (DOEE) and Metropolitan Washington Council of Governments (COG). Rebecca will examine any new patterns for the trends and get feedback on presentation and dissemination of the results.

This is a combined effort across jurisdictions with Renee Karrh running the trends for Maryland, Mike Lane for Virginia, and Mukhtar Ibrahim for DC. We do this on an R package called baytrends and a mapping software that Eric Leppo and Jon Harcum at Tetra Tech maintain. Data comes from DOEE, MD DNR, and VA DEQ.

We look at a wide variety of water quality parameters both long-term (1980s-2023) and short-term (1999-2023). The long-term parameters include Total Nitrogen (TN), Total Phosphorus (TP), Secchi Depth, Chlorophyll-*a* (Chl-*a*), Water temperature, and Dissolved Oxygen (DO). The short-term parameters include Total Suspended Solids (TSS), Dissolved Inorganic Nitrogen (DIN), and Orthophosphate (PO_4). Multiple views of each parameter include both the surface and bottom concentrations trends. We look at the different seasons for Chlorophyll-*a*, Secchi disk depth and DO. Lastly, we also look at observed conditions, and flow- or salinity-adjusted conditions. These observed conditions give us a picture of what was truly happening in the water that living resources felt or saw. The flow- or salinity-adjusted trend gives us a picture of what the trends would be if the ability of flow year-to-year into Chesapeake Bay had been more average – a more management perspective.

Methods:

To compute the trends, we use an ITAT product (both published and an R package). We use generalized additive models (GAM) which is a statistical approach that fits smooth functions to the data. For example, this figure shows the data of TN for our period and the smooth curve on top of the data is our GAM, demonstrating the seasonal cycle with the bumping up and down of the mean over time (slide 3). With this output, we can do a few things like mean seasonal predictions along with 95% confidence intervals. For instance, the green line is April, and in general the spring is the highest nutrient concentration at the station (slide 5). One key thing about this approach is the variability of river flow for the year-to-year fluctuations. To address this, we consider either the salinity measured at the same place and time or an upstream discharge in our water quality observations put into the GAM (Slide 6). This expands our equation quite a bit and the results fit the data a lot better (indicated with the purple line, slide 7), capturing the extremes of the observations and capturing the smooth version of what's going on with surface TN at this station.

There are a lot of these models that run for all the parameters and for 150 stations. To simplify this and get a Bay wide picture, we take a percent change from the start to the end record and then also over the last 10 years to get the short-term (slide 8). In this example, we see that TN is clearly decreasing and the results show that we have a lot of statistical confidence in that. This is conducted across all the stations in Chesapeake Bay and at the Chesapeake Bay Program (CBP), we aggregate the results across VA, MD and DC and put them in various places where you can explore them depending on what you need. The ITAT webpage is a great repository of the results which is now updated with the 2023 results. The CAST team, Olivia Devereux and Helen Golimowski, are very helpful with providing a place on the CAST website with estuary trends and you can find a table that summarizes the trends and in which direction. Baytrendsmap is the place to go if you want to dig in and try to understand the different parameters across the Bay and their spatial trends. You can toggle to look at long- or short-term trends, flow- or salinity-adjusted, etc.

Results:

Looking specifically at the flow-adjusted maps for TN, TP, Secchi depth, Chlorophyll-*a*, water temperature, and DO, on slide 12, the surface TN is shown here where the left panel is the long-term changes, and the right panel is the short-term changes. The downward triangle indicates significant decreases in trends and upward triangles indicates significant increases in trends. Circles indicate possible trends, not significant. The blue depicts improving trends and the red depicts degrading trends. Diamond markers are places where the whole analysis was done, but the trend from the two points in the record is not or is very unlikely.

To summarize the trends portrayed here, long-term trends decrease at most stations (and the bottom is similar). Short-term trends are more mixed. To help visualize the distribution of improving, no change, and degrading trends across the Bay, we provide bar charts of the percent of stations with each type of trend (slide 14). The solid bars are the long-term and the hatched bars are the short-term. For TN, about 85% of the station's show improving long-term and this drops to about 45% for the short-term.

On slide 15, we present the surface TP with the same orientation as TN. In the long-term, we see decreasing patterns across the Bay, and more of a mixture for the short-term. To provide some examples (slide 16), the Patuxent and James have long-term decreases, but it looks like these trends turn around in the short-term. Overall, most stations have decreases over the long-term and then more of a mixture over the short-term with even counts of degrading and improving trends in the short-term (slide 17).

On slide 18, we present the Secchi depth with the same orientation; however, the colors are switched where red indicates decreasing trends and blue indicates increasing trends. Here, we were able to add more stations from the DC area. In summary, this is a bit different from the total nutrients. In the long-term, it is mostly degrading trends across the Bay, but in the short-term, this mainstream has not persisted. Looking at a specific example from DC (slide 19), the trend is increasing – the water is getting clearer. The bar chart (slide 20) shows in the long-term, it is mostly degrading, but there are more improving trends in the short-term.

On slide 21, we look at surface spring Chl-*a* for our indicator of phytoplankton (this is also modeled for the summer). This map has the same orientation as TN and TP. This map is more variable, a big mixture of improving and degrading trends. Some examples from a MD station show a large range of concentrations and there is a gradual increase in the short-term that is causing the increasing trend. Another example is from a station at the mouth of Choptank River which demonstrates some variability across the long-term with a slight decrease in the short-term. In summary, both seasons have a large mixture of trends for Chl-*a*. They are slightly better bay-wide trends in Spring than in the Summer.

On slide 24, we look at water temperature with the same orientation as Chl-*a*, TN, TP. There is a clear story here where water temperature is increasing all throughout the Bay. For example (slide 25), looking at a station in the Virginia Main Stem, there is a general increase, and there is a noticeable increase in temperature in the winter seasons too. In summary, there is only degrading trends in water temperature all throughout.

On slide 27, we look at the bottom summer DO with the same orientation as Secchi disk depth. These values are quite different across the Bay. Focusing on the middle mainstem and nearby regions, there is an increasing trend. We have separate maps on baytrendsmap that show the recent average concentrations (slide 30), and this allows for comparing these results. Also, MDDNR already does status and trends on their website where they show two symbols to indicate status and trend. Maybe moving forward we can also start to show symbol size changes to represent the range of oxygen levels where larger symbols are low oxygen levels and vice versa. To visualize this, we have an example from the 2022 trends map on slide 31.

Summary:

Nutrient trends are mostly improving over the long-term with some leveling-out over the short-term. The number of stations with degrading trends have decreased over the short-term for Secchi and Chl-*a*, while DO has different patterns in deeper vs tributary waters. All in all, the trends here are very similar to what was presented last year (2022 Tidal Trends Summary).

Discussion:

Q: *Olivia Devereux:* We have a Total Maximum Daily Load (TMDL) for TN, TP and sediment. Your nutrients are going down overall but with slight increases in recent history, and I was wondering why this might be happening despite the TMDL? Another question, looking at the TMDL for Chl-*a* and Submerged Aquatic Vegetation (SAV), do you include the targets/goals? ***A:*** *Rebecca:* Here on slide 35, and Jimmy Webber presented this in June (link), we see the long-term trends in the nutrients are driven a lot by wastewater treatment upgrades and detergent bans, but this is not distributed across the watershed. We have demonstrated that the long-term decreases in the nutrient loads from the point sources and the water upstream are visible in these tidal water quality trends. Over the short-term, it must be the conflicting pressures on the watershed, including rising populations. But when considering the River Input Monitoring (RIM) stations, it is consistent with what is seen in the tidal waters. To answer your second question, the metrics of where we need to be for Clh-*a*, DO, etc. the water quality criteria come into play. Our goal for the tidal trends is to look at everything, everywhere that can give us an indication of where and when changes might be happening – why we see the big picture or not in the water quality criteria.

- ***Comment:*** *Elgin:* I think overall, we just don't have a clue as to why some of these trends are happening. Living on the Rappahannock, I observe what I call the Rappahannock Phosphorus conundrum which is at the fall line. We see improvements in Phosphorus, and at the Bay interface, you see improvements and yet, in the middle section where I live, we see degrading conditions. I am not sure why these things are happening, especially considering that there have been minor changes to land use. We just need to consider that these are just approximate.
- ***Response:*** *Qian:* I see there is strong correspondence between the RIM stations and the trend maps you provided. The RIM trends are very consistent with what we see in those tidal tributaries in terms of the increases. Looking at the short-term trends for TN you have loads increasing but for the long-term you have sediment loads increasing. It's more of a short-term phenomenon compared to the long-term and it's particularly interesting for TSS. We talk about the RIM vs below RIM relative contribution in different locations, but we don't have a table summarizing that. We do have that information in the individual tributary reports. Maybe we can have a table side by side with these results.

- ***Response:*** *Kaylyn:* How do we link nontidal-tidal, and I wonder if what you suggest Qian about having the summaries side-by-side will help people in drawing their conclusions. Like, here are the long and short-term trends, RIM and what is going on in the Bay. A good way to test this would be the Tributary Summary Story Map.
- ***Response:*** *Qian:* Maybe we can have a table like this (slide 35) with the tidal trends that Rebecca presented and with the salinity zones with a tributary specific summary.
    - Some links to App for the WQS attainment indicator (binary): https://wqs.chesapeakebay.net/wqs_attainment_indicator/
    - And App for the WQS attainment deficit (non-binary): https://wqs.chesapeakebay.net/wqs_attainment_deficit/
- ***Q: Tish:*** Interestingly, in the Rappahannock, we are doing well with the SAV, and it is interesting to see that we have another discordancy here. How do we communicate that with what we're seeing in the trends? It's not necessarily undermining what we're doing on one actual water quality standards. ***A:*** *Rebecca:* I did not do this here, but I tend to look at the SAV patterns too and the SAV growth in the Rappahannock was one of the reasons of the hypothesis we added to our paper where we linked the nontidal to the tidal nutrient trends. There were a couple of places we didn't fully explain the trends with the RIM and the Potomac tidal fresh and the Rappahannock, which are both places where there had been a lot of SAV growth, and this could really play a role. This is something that we should really keep in mind, especially since it could influence things.
- ***Comment from chat:*** *Peter Tango:* If initial conditions are good, degradation can happen but not exceed light thresholds for example. But degradation raises our awareness of focusing on such areas of importance (and improving trends for success stories).
- ***Comment: Carl:*** Another issue with the RIM tables is that it connotes that the trends are similar whereas the ones doing well over the long- and short-term tend to be the ones with big watersheds like Susquehanna, Potomac, and James. The way they are listed here looks like there is more watersheds potentially doing poorly but the ones doing poorly are small in comparison. It would be nice if the tables were made in terms of the total amount of stuff that is going into the Bay instead of dividing it up into the various places. For instance, like Elgin mentioned, the Rappahannock and York have big tidal waters there that are estranged and not dominated by their watershed. So, it is just complicated that even connecting it with the TMDL above the RIM is simply hard to do so.
    - ***Comment:*** *Kaylyn*: This makes me think the contribution of the relative watershed size influences the places where the trends are going in the wrong direction, but these are low yield places. I guess it would come down to the prioritization of where the top places are to put our efforts toward meanwhile considering watershed area size.
    - ***Comment from chat:*** *Qian:* I think we had this conversation before at ITAT and suggested adding average loads/yields as new columns or shaded colors.

- *Comment from chat:* *Peter:* Maybe a presentation of trends rank ordered by watershed size for reference?
- ***Comment from chat:*** *Roger:* Perhaps we should consider volume to scale outputs.

Q: *Rebecca:* On slide 31, looking at the symbology and color of the maps for the combination of concentration and trend maps - are there better ways to compare the trends?

- ***Comment from chat:*** *Peter:* Also - Rebecca - something to consider on the bar graphs of improving-no change-degrading. A slight addition to the presentation to represent what I heard you say is also reflecting the previous year results (something like arrows or lines representing the bar heights for short and long-term of each of the 3 to see the annual change? We can chat.)
- ***Comment from chat:*** Qian: perhaps using fewer categories to better see the color contrast?
- ***Comment from chat:*** Peter: Would you dare to interpolate the trend values for the bay?

Comment: *Olivia:* I love the connections being made here between the tidal trends, the watershed size, RIM stations, etc.

- ***Comment:*** *Kaylyn:* Maybe this is an idea for a future ITAT hybrid meeting that is built into working sessions on these connections and focus on select rivers.

11:37 AM Adjourn

Next Meeting: Wednesday November 20th, 2024, from 10 AM – 12 PM

Attendance:

Gabriel Duran (CRC), Olivia Szot (VIMS), Roger Stewart (VA DEQ), Qian Zhang (UMCES), Cynthia Johnson (VA DEQ), Rebecca Murphy (UMCES), Alexa Labossiere (VIMS), Elgin Perry (CBP – consultant), Jon Harcum (Tetra Tech), Helen Golimowski (Devereux Environmental Consulting), Michael Lane (ODU), George Onyullo (DOEE), August Goldfischer (CRC), Kaylyn Gootman (EPA), Joseph Morina (VA DEQ), Carl Friedrichs (VIMS), Kyle Hinson (VIMS), Anthony Timpano (VA DEQ), Mukhtar Ibrahim (MWCOG), Olivia Devereux (Devereux Environmental Consulting), Lewis Linker (EPA), Tish Robertson (VA DEQ), Peter Tango (USGS), Marjy Friedrichs (VIMS).