Chesapeake Bay Program Hypoxia Collaborative Meeting
Thursday, October 5th, 2023 · 10:00 AM – 12:00 PM
Meeting Materials: Link
This meeting was recorded for internal use only to assure the accuracy of meeting notes.

Attendance:
Aaron Bever (AQEA), August Goldfischer (CRC), Bailey Robertory (CRC), Breck Sullivan (USGS), Bruce Vogt (NOAA, Carl Friedrichs (VIMS), Cindy Johnson (VADEQ), Colin Hawes (VIMS), Elgin Perry (independent statistician), Jay Lazar (NOAA), Jeremy Testa (UMCES), Lew Linker (EPA), Marjy Friedrichs (VIMS), Mark Trice (MD DNR), Peter Tango (USGS), Rebecca Murphy (UMCES), Tom Parham (MD DNR)

Action Items:
- ✓ The Hypoxia Collaborative leadership will synthesize feedback given on next station locations and reach out to individuals if further information is needed as they start to make decisions on next locations.
- ✓ The Hypoxia Collaborative leadership will share the implementation plan document with Kevin Schabow (NOAA), Lee McDonnell (EPA), STAR leadership, and then publish it on the Hypoxia Collaborative webpage.

Minutes:
10:00 – Introductions and announcements *(Peter Tango, USGS & Bruce Vogt, NOAA)*

- Peter and Bruce updated the group on the Goal Implementation Team (GIT) funding program. The 2023 funding is on pause while the program is being assessed and re-designed to be more effective. The program will occur in 2024 and include the funding from both 2023 and 2024. Peter and Bruce suggested that a good proposal for this funding would be a project to support sampling design for hypoxia monitoring. An abstract with cost estimates would need to be developed, and since the Hypoxia Collaborative Team is under STAR this proposal would need to be run through STAR's leadership before going to the CBP leadership (but STAR would have no issue supporting it). Right now there has been no set date communicated that the proposals will need to be submitted by but GITs have been told to develop short abstract length proposals.
- Bruce also noted that the funding amount will increase (70-100k/project) as well as the scope of the projects so that proposals for multi-year projects could be submitted (as opposed to one year, fairly limited scope projects in the past).

10:10 – Update on current hypoxia monitoring stations (*Jay Lazar, NOAA*)

- Jay Lazar (NOAA) reminded the group that NCBO deployed instruments at the lower Choptank in mid-April, in the mid-Bay in mid-May, and at the lower Potomac in late May. Jay said that because of contract timing, NCBO is still without backup instruments for the hypoxia monitoring arrays. Their plan was to have backup spare sensors and buoys, and fully outfit the arrays with sensors every two meters of depth, and be able to swap those as sensor data becomes suspect. Unfortunately they haven't been able to do that this

year. This year has been a test of resilience of the system and nearly everything that can go wrong has. However, at least 3 stations have been operating in the water with at least two sensors collecting dissolved oxygen (DO) and temperature data. The conductivity probes have not been as resilient as hoped. However, they are still getting decent conductivity data which is a testament to the maintenance team which maintains them weekly. The Choptank has DO data at 1 and 5 meters; Potomac has 3- and 10-meter sensors that are looking good, and mid-Bay has 5-, 13-, and 17- meter sensors that are looking good. So, there is a good range if not a perfect match in depth across all stations. They are supposed to be getting more sensors next week. NCBO plans to continue to maintain these stations as long as they can. They'd like to have 1-3 stations out there throughout the winter as well, depending on the Hypoxia Collaborative's input. There is a lot from the quality control side that's been done. They have routines that give confidence in the data collected from collecting validation casts and employing different flagging routines.

- Peter summarized that the challenge now is that without backups, if a sensor goes down, that will lead to missing data and analysis of the data set with some gaps will then present a challenge. What that means for criteria assessment and how to work around those gaps will have to be decided.
- Rebecca Murphy (UMCES) thanked the NCBO team. Before this meeting Rebecca looked at this year's data with some of the functions she wrote before from last year's data. Despite the challenges, Rebecca shared that it is great information. These 3 locations are providing interesting and helpful information.

10:20 – Using the new vertical profiler oxygen data to improve CBEFS (the Chesapeake Bay Environmental Forecast System) (*Marjy Friedrichs, VIMS, Aaron Bever, Anchor QEA, and Pierre St-Laurent, VIMS*)

Presentation summary:

- Marjy said to avoid confusion when talking about continuous monitoring data, the hypoxia monitoring data should be called vertical profile data because that's what sets them apart from other existing data in the bay. Other continuous monitoring data are in relatively shallow, well mixed water and with generally only one sensor.
- Vertical profile data are critical for Chesapeake Bay modeling. Last time Marjy talked about the use of in-situ data for model development, improvement, and confidence in forecasts. Chesapeake Bay Environmental Forecast System (CBEFS) is using the water quality monitoring data from monthly cruises, continuous monitoring station data, and now vertical profile station data as well. CBEFS uses atmospheric inputs, coastal inputs, and terrestrial inputs from Phase 6 model, and applies a neural network algorithm to get forecasted loading and USGS discharge from the land. That gets put into the model, evaluated, and every night a now-cast and two-day forecast is given and shown via VIMS

and via MARACOOS. Metrics are displayed including temperature, salinity, hypoxia, acidification, bacteria (vibrio), harmful algal blooms, water clarity, and waves.

- The vertical profiler data helps put the cruise data in context when comparing monitoring data with the model data. Marjy showed CBEFS vs vertical profiler data, noting that color scheme of the data visualization is reversed in that red is good or high oxygen and blue is bad or low oxygen. Overall, the data is comparable. The dissolved oxygen data from the cruises is variable depending on when in the tidal cycle the data is captured, so the continuous vertical profiler data helps give additional context. The cruise samples are taken and then interpolated up to get the hypoxic volume for the whole Bay based on a number of sites.
- Aaron Bever and Marjy Friedrichs work on an annual hypoxia report card. This year's hypoxic volume is low compared to recent years. Comparing the integrated hypoxic volumes from the model to the monitoring data, including an estimation of uncertainty, shows that they line up fairly well. They both agree that this is a low hypoxia year. Again, the monitoring data from cruises is lining up with the vertical profiler data. High frequency bottom variability is really important.
- Marjy wrapped up her presentation by saying in summary, these real-time vertical profiler data are an opportunity to enhance modeling and put the cruise data in context. They provide evidence of high frequency bottom oxygen variability and help quantify uncertainty in interpolations computed from biweekly/monthly sampling. These data are key only if stations are placed in optimal locations. New sensor placements should complement existing continuous monitoring data, as well as where vertical structure is significant and there is limited mixing.

<u>Discussion:</u>

- Jay: For the report card that shows the lower hypoxic volume this year, that's still being based on monthly and bimonthly samples, right?
- Marjy: Our report card is based on the continuous modeling. And there's another report card based only on the cruise data.
- Jay: The real time data corroborates the model data. Do you think that it would change this estimate significantly based on that one comparison or it's very accurate?
- Marjy: In the short time we've had it's qualitative; quantitative might take some more funding. They are corroborating each other. It gives us more confidence.
- Bruce: Are you able to forecast heatwaves? And is there a correlation between heatwaves and hypoxia?
- Marjy: Yes. As long as we get atmosphere temperature right, we get the estuarine temperatures right. Estuarine heat waves mimic the atmospheric heat waves to a large extent.
- Bruce: Any idea what is driving the lower hypoxia this year?

- Jeremy Testa: It will be interesting to see what everyone thinks. I think flow was consistently low, perhaps even especially low at times this summer (but have not looked at USGS data yet)
- Marjy: The forecast said it would be a low year, not sure if it said it would be as low as it actually was. I wonder about these huge high years in 2018 and 2019; did they have an extended influence on 2020 and 2021 that we are now finally overcoming the influence of these high years? It was a dry year, but we've had other dry years; it was even lower than we thought. Or we're seeing impact of nutrient management!
- Peter: I think of that 1999-2002 period was 3 out of 4 years with extreme drought; I'd be curious if those years had similar lows.
- Marjy: Yes. We'll be doing all this analysis. I think this year is even lower.
- Jeremy Testa (UMCES): One thing that jumped out to me is when I was looking at the two comparisons that Marjy showed, the lower Potomac and 4.1 c, both had those short-term dynamics that brought the oxygen up and then down. Potomac was really dramatic even over a tidal cycle. But at 4.1 c it came up but barely above 2 mg/l. That variability is there but maybe didn't push it into non hypoxia. I wonder about having paired monitors like on in a deep station and one in a place like lower Potomac that seems a bit more episodic tidally, might help us see how extensive these periodic ups and downs of oxygen might be.
- Bruce: I was thinking about re forecast question, connecting to living resources. Where we have established temp and oxygen thresholds for species such as striped bass, being able to predict how conditions would change in a way that would indicate habitat quality or an extreme event for living resources where they respond either mortality or they are moving to avoid it. Striped bass is one example, there could be others. That idea of being able to take that info and put it into habitat condition or quality context for some of the species with high mgmt. and economic interest in Bay.
- Marjy: For striped bass model we're happy to provide these forecasts. A lot of the living resources care about the bottom. Now we have the confidence that we're really getting these bottom waters. The next step is absolutely using these to force living resource models.
- Bruce: I think you and Mary are working on that, excited to see where that goes.

<u>Chat comments:</u>

- Tom Parham (MD DNR): Marjy- great presentation. Quick question - Has the model that provides your weather data model changed/improved significantly since you have been running CBEFS?
- Peter Tango (USGS): Wind mixing can influence reaeration - was it a particularly windy year? I don't know (as an explanation), or partly, with the flow story.
- Aaron Bever (AQEA): Tom - Yes. When we started the weather model was lower resolution and less frequent (3 hourly vs. hourly now).

- Mark Trice (MD DNR): I briefly looked at 3-month precipitation June-August for MD, VA and PA. PA was above average and MD/VA about average. January-May definitely below average though.
- Elgin Perry: Does a two-day forecast give you an opportunity to ground truth predictions of extreme events?
- Aaron Bever: We haven't looked back quantitatively yet, but it may be a combination of low flow and relatively windy. A couple "good" factors.
- Tom Parham: Thanks Aaron!
- Mark Trice: Wind anomalies during summer were not too much either at least according to a NOAA product I was looking at.
- Aaron Bever: Elgin - Yes, to two days out. When we started, we did an analysis of how the model captures quick changes in DO. We quantified the lag/lead depending on how for out the forecast was. I don't remember exactly what the lag/lead times were for 36-48 hours forecast, but the wind product has improved as well since then.
- Mark Trice: In case folks didn't see our striped bass squeeze product: https://maryland.maps.arcgis.com/apps/dashboards/4d96f21cf7e64ef6a5009f3adc35cd6a. You might have to zoom into map for points to display.
- Marjy Friedrichs: Amazing striped bass product! I encourage everyone to check it out if they haven't already. I think combining these forecasts with the striped bass algorithm holds lots of promise!
- Peter Tango: @Mark - really cool. So many more data points for the bay than I would figure. Are watermen contributing data during their fishing efforts since you reference fishing hot spots?
- Mark Trice: Peter, I'm the graphics guy on this one, assembling/programming the ArcGIS dashboard. Andrew Keppel and Tom created the model. My understanding is they are using the Chesapeake Bay interpolator with the monitoring data. Fishing hot spots are results from interpolator points that correspond to popular fishing bars/locales. No outside data from fishermen.
- Peter Tango: Ah - cool, thanks Mark! Good to hear.
- Tom Parham: Since the website was just deployed this summer, not yet. But we have reached out to the angling community for comments.
- Jeremy Testa: Very cool product Tom and Mark. I will say that I have a little concern with it. If the tool was successful in garnering the attention of the recreational fishing community, and they started using it to target fish, and it worked, this would be negative for the populations. Fishing is their biggest problem, much bigger than low DO.

10:40 – Implementation plan finalization/next steps (*Bruce Vogt, NOAA*)

- The implementation plan documents the process of building up the hypoxia monitoring network, identifying the station locations, how decisions were made, roles and responsibilities, funding sources, data products and endpoints, and next steps.

- This document will be provided to Kevin Schabow (NOAA) and Lee McDonnell (EPA), and STAR leadership. The document will be posted on the hypoxia collaborative team website. Feedback was received from the collaborative and has been addressed/incorporated, so the document is ready to be shared with the leadership (Kevin and Lee), STAR leadership and then posted on the website.

11:00 – Potential locations for next hypoxia buoys/feedback (*Bruce Vogt & Jay Lazar, NOAA*)
What would we prioritize for next buoys? Top 4 new locations.
Considerations:
-4d interpolator
-Hot spots for living resources
-Development of ecosystem models
-More than one buoy in a segment
-Operation/maintenance of buoy

Results of Polling - PDF (Excel spreadsheet is posted on the calendar page)

Discussion:

- Elgin Perry: I think Upper Bay and CB4 are similar.
- Marjy Friedrichs: I wonder if voting for optimal characteristics rather than individual sites would be more helpful. It seems like tides are incredibly important and means that the fixed stations are missing a lot where we have strong bottom tidal influences. I know the York has big tides.
- Lew Linker: We have Multiple Tributary Models augmenting the Main Bay Model in the Choptank, in the Rappahannock, and in the Baltimore Harbor Patapsco River. It doesn't add any resolution but it adds another layer to decisions.
- Aaron Bever: I voted for the Rappahannock because we know from the water quality monitoring data and the VIMS trawl survey data that the Rappahannock has intermittent hypoxia issues. But we don't know how extensive or often it is because we only have snapshots of it. This could further our understanding of DO and how living resources can use the Rappahannock.
- Elgin Perry: The Rappahannock was my second choice.
- Aaron Bever: For the second question I voted for the Potomac because I'm interested in how far the hypoxia goes up the Potomac on a consistent basis and the linking of two profilers. Marjy showed the tides have a big influence on what the DO is at any hour during the day. Can we follow that, does the hypoxia move out of one location and into the next one and then back? How far is it moving? Or is it more compressing towards the surface and shallows and getting more vertical?
- Peter Tango: The spatial assessment is key to the picture we're painting across time of habitat structure. Might need more than one.
- Tom Parham: The southern shore of the Potomac is interesting. I get a lot of calls in the summer from crabbers. When you have winds coming across, there is low DO coming up

on the southern shore and they lose a lot of crabs in the pots. There's sloshing around of the low DO water when that occurs.

- Jay Lazar: I selected Eastern Bay for the reason that with a proposed large scale oyster restoration effort across multiple sectors that's looking at the upper portion of Eastern Bay, there's an opportunity to get some baseline data in ahead of a large scale effort. If there's hypoxic water moving up the deeper part of the channel, understanding how it pushes up through Eastern Bay would be interesting from a living resources perspective.
- Rebecca Murphy: I like Jay's suggestion for Eastern Bay. The bottom DO has a stronger vertical profile than the Choptank region as well.
- Tom Parham: For Mid-Bay, Aaron and Marjy just had that paper out that showed that two profilers in the Mid-Bay area could predict hypoxia well. It would be neat to see how well that worked.
- Jay Lazar: To add to that, the current Mid-Bay site is between the two sites using the long term monitoring stations were suggested. Recognizing that those deep channel long term stations are something that we cannot occupy permanently. We did get ourselves into as deep at that approximate location for that reason and the idea was that could be a sentinel. We're going to have a difficult time in any of the deep channel sites. I kind of built those recommendations into the original three thinking of living resources, model validation as well as the assessment piece.
- Peter Tango: Along that line, you have some bottom sensors at Goose's Reef. Is there any potential for linking in space as close as you can get to the ideal location and having a bottom sensor in the near vicinity to complement that?
- Jay Lazar: We haven't had a separate acoustically linked bottom sensor on Goose's Reef for some time. That was a proof of concept that there was a lot of variability not being captured. It's something that could be looked at from a lower frequency signal though. We had some challenges with working through that. We could tie that consideration into the existing CBIBs larger buoy platforms. We are considering ideas for how we can integrate CBIBs and the hypoxia profilers.
- Peter Tango: Putting another buoy in Mid-Bay could confirm what we saw this year. Having both the high frequency and the long term will help us tell the story.
- Jeremy Testa: The Patuxent is representative of the idea that there are all these places in the Bay we know there is some amount of hypoxia but we don't have a lot of information on it. I like the idea of looking into some of the tributaries where we know there's hypoxia like Eastern Bay and Choptank. Understanding the dynamics there more closely may help us understand change over time. I think there's value in those types of environments, whether it's Patuxent or another tributary.
- Peter Tango: That complements the CESR report findings if we're looking at moving into shallower water systems.
- Lew Linker: The Potomac is also a Multiple Tributary Model site. I find the arguments compelling to have multiple stations in the Potomac. The difficulty is that it is big, it has the pool of deep water, and the sill.
- Bruce Vogt: If we're going to do in any particular tributary would the Potomac be favored over the Choptank due to its size and dynamics?

- Lew Linker: The other tradeoff is that Choptank is so important for living resources. I guess I would be inclined towards Potomac although Choptank has compelling reasons as well.
- Peter Tango: While some sites may be long term, many will have the possibility to move from place to place.
- Bruce Vogt: Is there one site in particular that could get us closer to delisting if we put a station there? Being able to show near term wins.
- Peter Tango: For the Choptank some of the nutrient trends are still going up, as well as with the Potomac.
- Jay Lazar: I am interested in getting back to the lower Potomac. We have the station on the north side that gets down to 10 m. There's been suggestion of looking at the south side. I wonder how far upriver would folks want to go recognizing that the first segment is 80 km. Thinking of logistics, having a boat be able to hit 3 stations in a relatively shorter area is helpful logistically as well as helping us see how dynamic it is across that 2D space.
- Peter Tango: In conversations with VA DEQ and MD DNR last year, both states expressed interest in Potomac for understanding the near-shore, off-shore connectivity. For exactly where, I suggest looking at the extent of what we think is our normal hypoxic range and pick something that's 30-50% up there to understand the fluctuation of the distribution.
- Bruce Vogt: One of the challenges is that there is so much interest, almost anywhere we go there could be a reason for it. But we'll do our best to take the input here and tie it to a few objectives to balance across different interests.
- Marjy Friedrichs: Are any of these going to go in over winter at these new locations? Which locations to overwinter? Ice would play a role in the choice.
- Jay Lazar: From a criteria assessment standpoint the year-round data is pretty important. With that in mind we came into this thinking we would span the seasons – March-November. As climate change is warming the bottom waters there may be a compelling reason to keep a handful of these year-round. It can help us understand whether the conditions are changing in a way that the metabolic rates of oysters, etc, in those deeper waters are affected. There's scientific and regulatory compelling reasons to keep that in year round, and we have to balance that with maintenance considerations as well. We're open to figuring it out as we go.
- Marjy Friedrichs: I like the idea. We need winter data because we have a lot less of it and to make sure we get the summer data right for the right reasons. What's going in next April?
- Jay Lazar: Ideally, we'll have 6-7 of these out there by next April. It will depend on the contract delivery and the permits. As they come in stations will be prepared, but we can't prepare a station until we have the location and a depth to cut the wire to and outfit everything. Our goal is once we have this information and a prioritized list of next sites, we'd like to swap out what's out there with brand new equipment and refurbish what's out there. If we can do it this winter we'll consider that.

- Jeremy Testa: Anything we can do to make these easy to maintain should be considered because it's important to making sure we can get good data.

Chat Comments:

- Rebecca Murphy: This may be helpful. I look at each of these in light of water quality criteria and how are far they are from meeting the various criteria. https://public.tableau.com/app/profile/emily.trentacoste/viz/WaterQualityStandardsAttainment1985-2020_16661218611900/WaterQualityMonitoringSegment-PercentNonattainment#1
- Jay Lazar: Upper Bay & CB4 reflect the same idea.
- Tom Parham: Sorry - having issues with menti freezing. Voting for upper bay (top of deep trough), also Potomac since hypoxia goes up pretty far. I saw my name was on the upper bay/top of cb4. Not sure of why they weren't lumped together.
- Jeremy Testa: Full disclosure I voted for the Patuxent. I am biased here, but my overall thinking here is that these sensors give us an opportunity that like Aaron said, allow us to monitor short-term changes where the short-term really matters.
- Mark Trice: cb4 is below the upper extent of hypoxia
- Jeremy Testa: And where we know there is hypoxia, but perhaps more variable than deep channel.
- Mark Trice: My 'other' vote here was for that VA bay trough between the Potomac and York, to look at how hypoxia is self-generated there or spill over from MD on other side of that spill.
- Peter Tango: Per Aaron's highlights about spatial variability of Aaron and Potomac, I'm supportive of some areas receiving 2 or more in these early years as research/hypothesis testing that is complementary with informing assessments as we learn together with these tools and new vertical profile data.
- Tom Parham: Thanks Jay.
- Jeremy Testa: Jay, would having two systems in one tributary make maintenance any easier?
- Tom Parham: For the 4D estimator development, where would multiple stations be the most helpful - Potomac, Choptank or mainstem?
- Jay Lazar: Jeremy, it would. From a maintenance perspective, hitting multiple sights a day, which we are currently doing, is ideal. We can visit all three in about a 10-hour period with good on-water conditions.
- Tom Parham: Peter - Thanks for bringing the SWM angle up about the Potomac.
- Rebecca Murphy: Tom - Elgin may have an opinion too, but Potomac and mainstem would be above Choptank for me. I have to wonder if the Choptank doesn't justify the vertical array due to less DO stratification than other places.
- Marjy Friedrichs: I agree, Rebecca.
- Tom Parham: Thanks!

- Lew Linker: I'm unsure what would be best for 4D estimator development Tom. However, I would think the Potomac given it's a largish pool of hypoxia in the lower Potomac and it's relatively low density of monitoring stations.
- Tom Parham: Thanks Lew!
- Elgin Perry: I liked Marjy's idea that we should spend some time discussing what we hope to learn from these new stations. So far I am hearing better our understanding of vertical structure, better understanding of tidal excursion influence, better understanding of wind influence. Completing this list would be helpful.
- Jeremy Testa: I need to head out. I think anywhere we put these is going to give us information. I think weighing the practical maintenance concerns should be highlighted. If we can't maintain the sensors well, the data we get from them will be compromised

12:00 – Adjourn