Bay Oxygen Research Group (BORG)

Monday, August 18, 2025
12:00 PM – 1:30 PM

Meeting Materials Link
This meeting was recorded for internal use to assure the accuracy of meeting notes.

ACTION ITEMS

✓ Curate a list of data sources and types that have been part of the compilation that will be made available to users of the interpolator.

✓ Include a key or table describing interpolation region acronyms to go with the map that Rebecca provided on slide 16 of her presentation. ***Response:*** A table is provided in the document posted with the meeting files including the list of segments within each group. An additional Excel file has now been added with a filterable list of the segments.

✓ The 4-d interpolator team should create a FAQ document that can concisely answer questions posed by members and point users to resources, such as meeting minutes, that can provide more in-depth information.

✓ As model and method documentation is completed, the development team will send it out to the BORG members to review. This will be in small increments, rather than waiting for the full documentation to be ready.

✓ States, and Bay Program staff should meet to discuss the topics posed by Matt Stover including "how the 2003 document influences state actions, how it works within the Clean Water Act (CWA), and what state regulatory agencies are required to do under the CWA."

MINUTES

12:00 PM: Introductions/announcements
Peter Tango (USGS), Chair

Summary: Breck Sullivan introduced the team to the meeting's agenda because Peter was having some computer issues. Within the agenda, she highlights the final agenda item of addressing stakeholder questions. The questions addressed in this meeting come from members at the Maryland Department of the Environment (MDE), but the group intends to answer any questions posed. If you have further questions, feel free to email them to Breck Sullivan (bsullivan@chesapeakebay.net). Breck opened the floor to announcements, but no one shared.

12:05 PM: 4-dimensional (4-D) Interpolator Development Overview: Recent Updates
Breck Sullivan (USGS)

Summary: Breck's presentation focused on the updates from the 4-d interpolator development team since the [last BORG meeting](#) (May 2025). These included data structure and compilation, segment interpolation regions, pycnocline assessment, complete interpolation structure that links all 4 parts of the 4-d interpolation, and output use in criteria assessment. On slide 9, Breck shared the timeline for the project. This presentation also covered next steps, which included further work on the pycnocline, case studies, parameter refinements, working with the Criteria Assessment Protocol (CAP) Workgroup to link with criteria assessment, and further documentation and users' guidance.

Comment from chat: *Amanda Shaver:* A list of the data sources and types that have been part of the compilation would be helpful to see.

- ***Response:*** *Breck Sullivan:* We can get that together for you.
- **Action Item:** Curate a list of data sources and types that have been part of the compilation that will be made available to users of the interpolator.

Q: *Matt Stover:* You mentioned a Scientific and Technical Advisory Committee (STAC) review, what would that be of? Documentation? Results?

- ***A:*** *Breck Sullivan:* It would be of the 4-d interpolator itself. It would be based off the documentation we have on methods and justifications of tool development. It would be looking at some testing results but not results you need to report on right now.
- ***Q:*** *Matt Stover:* The states would have access to that documentation before it goes to STAC, right?
- ***A:*** *Breck Sullivan:* Yes, and you can review them along with STAC, if you'd like. Part of the Bay Program process is that STAC does a review, but that doesn't mean that you can't do your own review.
- ***Q:*** *Matt Stover:* As I understand it, STAC is an independent body that checks on the work of the partnership to make sure what we are doing has some basis in science? It just gives a critical review, right?
- ***A:*** *Breck Sullivan:* Yes, and sometimes it's not STAC members themselves performing the review. Sometimes it means getting experts in that topic to do the review. STAC would just be coordinating it.
- ***Comment:*** *Matt Stover:* The states have a big role in the partnership. Should we review it before STAC? When we propose something, it goes out to public review, but before that we always review it internally and have other agencies review it. This way we are all on board and can defend it. Where in the process does it make sense for the states to comment? Whether that's before or after a STAC review. If the states

are not comfortable with the 4-d interpolator, when would the best time to express that be?

- **Response:** *Peter Tango:* Matt, you are online today. You are representing your agency. These meetings are open to everyone. This is part of the process, and we hold these meetings as a feedback opportunity. Hopefully, you wouldn't wait until the end, but we are co-producing, presenting updates, and receiving feedback. Hopefully, when we get a year down the road, we will have worked together on this. I understand we want to make sure we have that moment to work together on a review. We will continue to work together as part of the BORG and CAP process.
- **Response:** *Matt Stover:* Although we do attend a lot of these meetings, there's not a lot of documentation to review. There are a lot of details moving forward that we're not clear on. I appreciate all of the time you've taken, coming to our office. We have gotten into some of the overarching issues, but we still haven't dug into the details. In reviewing the materials, we are still in a black box and that makes us uncomfortable. As we've talked about in CAP WG, Virginia and Maryland are interested in pursuing an alternate methodology. We feel that this is kind of a runaway train. We've been expressing some hesitation along the way, but it just keeps rolling. We are giving constant feedback, but we don't want it to get to such a stage of finalization that we have to adopt it.
- **Response:** *Peter Tango:* I hear you. Respectfully, this is 20 years in the making. As you've seen in the documentation, direction and evaluation of the work there. This is probably the most integrated process we've had in the last 20 years, and it has been moving along in the last couple of years.
- **Response:** *Matt Stover:* But it's moving along in the Bay Program. It hasn't moved along with major state involvement or support. I don't think that's fair to say.
- **Response:** *Peter Tango:* Its community based, and we've brought that through the Hypoxia Collaborative as a piece that is serving the entire community. I hear your concerns. Thank you for your questions and we hope to continue the interaction.
- **Response:** *Breck Sullivan:* For the documentation, we've started it, but there isn't much to review at the moment. In hearing those concerns, maybe we can send pieces to review, rather than waiting for the full draft document to go out. Maybe we can also make time in some of our meetings for addressing questions and comments after a section has been sent out for review.
- **Response:** *Matt Stover:* I think that would be great, Breck. One of our concerns is that we haven't established our assessment methodology for instantaneous minimum, one day, and seven day. Typically, we develop those definitions first and then develop the assessment methodology, statistics, or interpolation design. That's the reason we're uncomfortable with it. We feel like that should have been

work that was completed at the beginning. This is what we expressed last August in Colonial Beach.

- **Comment from chat:** Peter Tango: Matt - respectfully, USEPA 2003 lays out the CFD method for assessing dissolved oxygen (DO) and chlorophyll a criteria. It is not specific to 1 criterion, it is not unique to DO. It is the general guidance for any criterion assessment. USEPA 2003 is the guidance adopted by the bay jurisdictions to support standards assessments. MDE, Virginia Department of Environmental Quality (DEQ), DC and more were represented on the Water Quality Standards Coordination Team that produced and approved USEPA 2003. We therefore have a published method, developed-approved-published guidance, adopted by the States, to cover any criterion. It has been STAC reviewed and approved, and peer reviewed in multiple publications. USEPA 2003 and all subsequent monitoring program reviews recognized the data gap, not an assessment method gap, for applying the CFD. Respectfully then, we have worked together as a community ever since to fulfill the guidance put together by the partnership, for the partnership, through partnership activities. We are on a continued track of collaborative, coordinated community activity based on the best available science to meet collective needs. We greatly appreciate working with you all in this process. Thank you. And I apologize for the assessment gap comment, that was the parallel track since 2003, my apologies for misrepresenting the parallel process in my note. I have reviewed the 20-year history of that parallel track for and with the community.

- **Response in chat:** *Matt Stover:* I agree wholeheartedly with you Peter that we are committed to working with the entire partnership to accurately assess our waters. I didn't intend to suggest anything otherwise. I think it might be good for us to have this discussion offline (including VA) as I think it would be good for us to arrive at a common understanding. Topics could include how that 2003 document influences state actions, how it actually works within the Clean Water Act (CWA), and what State regulatory agencies are required to do under the CWA.

- **Response in chat:** *Peter Tango:* Sure Matt. We probably need a few other folks. We can work on that. Thank you.

- **Response in chat:** *Matt Stover:* Thanks Peter. I just want to say, we really appreciate having you all as partners.

- **Action Item:** As model and method documentation is completed, the development team will send it out to the BORG members to review. This will be in small increments, rather than waiting for the full documentation to be ready.

- **Action Item:** States, and Bay Program staff should meet to discuss the topics posed by Matt Stover including "how the 2003 document influences state actions, how it

works within the Clean Water Act (CWA), and what state regulatory agencies are required to do under the CWA."

Q from chat: *Guido Yactayo:* Are the segments in slide 4 the TMDL segments?

- **A from chat:** *Rebecca Murphy:* Guido – those are groupings of the TMDL segments.
- **Q from chat:** *Guido Yactayo:* Why are they grouped? I recall assessments are generally output by TMDL segment. I presume that would not change results.
- **A from chat:** *Rebecca Murphy:* Good question, I'll address that in my presentation.

Q from chat: *Marjy Friedrichs:* quick question - is the database structure available for other Bay researchers? Like me? It sounds incredibly helpful/useful!

- **A:** *Breck Sullivan:* From my understanding, not at the moment, but we will have it in a format that other analysts can utilize the tool and structure.
- **Response:** *Marjy Friedrichs:* Great! It sounds like this will be so useful to so many people. If you ever want us to take a look and give you some feedback on this, we'd be happy to do so.
- **Action Item:** Compile an example dataset with the common structure and share it with Marjy to test if the structure can be helpful and utilized in other projects. Jon has sent the data file, and we will hear back from Marjy and her team at a later date.

12:25 PM: [Segment Interpolation Regions](#)
Rebecca Murphy (UMCES)

Description: *For the 4D spatial-temporal interpolator being developed for use in Chesapeake Bay tidal waters, one part of the interpolation process involves fitting Generalized Additive Models (GAMs) to dissolved oxygen (DO) concentrations over time by region. The GAM process involves knowing the location, depth, time, and day of each DO observation. To conduct the GAM portion of the process as accurately to the data as possible, early testing showed that spatially limiting the data used to fit each GAM to water with similar conditions was beneficial. Therefore, our approach aimed to create segment interpolation regions that support robust DO interpolations with the right amount of data to effectively fit the GAM in target segment assessments.*

Evaluation of these regions will continue as we generate GAM daily estimates on the interpolation grid using all high frequency data and combine the hourly estimates. Feedback is welcome on these groups as well as what information would be helpful to understand them. For background information, reference [this document](#) which was shared with the group in July.

Summary: Rebecca Murphy presented on the segment interpolation regions, which focuses on how to split up the Bay in the mid-day-space-and-time interpolation GAM part of the tool. This is already done in the 3-d interpolator, where nearby segments are used for the interpolation of a single segment. However, in the 4-d interpolator, there needs to be sufficient data to build the relationships between space, time and DO and one segment usually doesn't provide enough. This means the team has to find a way to interpolate across the Bay with regions greater than the individual segments. Rebecca designed 31 regions for this and shows some of those example segment interpolation regions. Some of the bigger segments are alone, but the smaller ones are grouped together. While these regions should stay relatively consistent, they are easy to edit in case any changes need to be made. Rebecca discusses the alternative strategies they tested before landing on this way to segment the Bay. Rebecca and the team used the root mean squared error (RMSE) for each station to determine the best method. The findings were that the set of 31 segments are the best for accurately interpolating, especially in smaller segments.

Questions and Discussion

Comment: *Tish Robertson:* This is great, and I wanted to give you kudos. I went through the document, and it is more of a systematic process compared to the current data regions in the 3-d interpolator. You could tell that those boundaries were arbitrary and didn't work well for their intended purpose. They didn't always overlap with stations. I worked with Richard on refining the current 3-d interpolator data regions, so they don't leave any areas outside of the boundary. What you have here is great and I'm grateful that you took the time to do this in a transparent and defendable way. An issue I have with our current boundaries is that there is no documentation so if wanted, someone would not be able to replicate our process. This is vastly superior to what we have.

- **Response:** *Rebecca Murphy:* Thank you for those comments. If there is anything you saw that would we helpful to include, please send me a note.

Q: *Richard Tian:* I have two questions. One is spatial and one is temporal. For the spatial and the grouping of the segments, when I saw the number 79, I was glad because that is the designation number of the Bay Program, but unfortunately it doesn't work that way. There is a concern that the shallow water segments and mainstem Bay segments are different. When you group segments together, are the shallow water segments grouped with the mainstem or is there a boundary?

- **A:** *Rebecca Murphy:* You identified exactly what I thought about for a while. If there is a shallow water area that is grouped with a lot of deeper water, it is hard to get a good oxygen interpolation in the shallow water system. That was the example with the lower Eastern Shore. When it had a boundary with a lot of the mainstem, the

dissolved oxygen interpolation was not good. We've been trying to achieve that balance. When it's more of a tidal fresh region, it's boundaries would be the closest things, oligohaline and not deeper waters.

- ***Response:*** *Richard Tian:* In the current 3-d interpolation, a number of stations in the neighboring segments are included, but not the whole neighboring segment.

Q: Richard Tian: My other question is about the midday interpolation. Are you assuming that all of the data are collected at midday?

- ***A:*** *Rebecca Murphy:* We have a time variable in our equation. If it's the fixed station data, most of it is collected between 10am and 2pm. We did an analysis of this. It's almost always in the middle of the day. Sometimes it's not if there were extenuating circumstances and we would have an indication that it was collected at a different time. Of course, the high-frequency data is throughout the day and night, so that has a time associated with it. If there is enough data to get that daily cycle in this first part of the interpolator, it will be there. When we do our interpolation estimate for the mid-day, we're predicting at 11am. It might be somewhere between two data points that were collected earlier and later, but it is estimated for 11am. We picked a time that was centered on most of the fixed station data. Also, Richard said something important, that the current interpolator uses just a station or two outside it's boundary for a segment as that boundary information. We tried that also, but we didn't like that it was a little too flexible. Having a whole segment of a boundary future-proofs it, so that stations/data can be removed or added and it would still be used as the boundary.
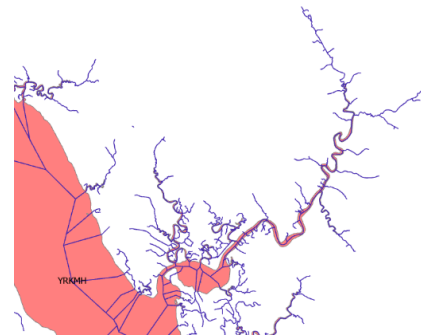
Q: Richard Tian: Are the 31 regions overlapped?

- ***A:*** *Rebecca Murphy:* No, there's no overlap in the primary segments where our estimates are being generated. There is overlap for the data that's used from each. CB5 in the middle would be using data from the mesohaline Patuxent as boundary information and vice versa for the Patuxent using CB5.

Comment in chat: Amanda Shaver: I would recommend a key or table describing the interpolation region acronyms to go along with this map in the documentation. Thanks for the clarifications, Rebecca!

- **Action Item:** Include a key or table describing interpolation region acronyms to go with the map that Rebecca provided on slide 16 of her presentation. ***Response:*** A table is provided in the document posted with the meeting files including the list of segments within each group. An additional Excel file has now been added with a filterable list of the segments.

Q: Tish Robertson: Currently, the data regions go across land a bit because we have small tidal creeks that we are monitoring. They are not mapped in the Bay segmentation scheme, but they are tidal waters. We visit those when we're going DEQ monitoring and send those data to Mike Mallonee at the Bay Program to include in the assessment. Will we still be able to use those data? They aren't part of the Bay segments, but we are still sampling them. Just because they are not part of the segments doesn't mean they can't be used for DO.

- *A: Rebecca Murphy:* We have a data inclusion net around the segment boundaries so that if there are data that are not in tidal creeks, but are close, they would be included.
- *Q from chat: Jon Harcum:* How far away are these additional stations from the actual segments, meters or kilometers?
- *A from chat: Tish Robertson:* Jon, it varies. Sometimes a station might be 1 km away from the actual segment.
- *Attachment from chat: Tish Robertson:* The tidal Poropotank River in YRKMH goes past the segment boundary for at least 1 mile. DEQ could potentially take a sample at the head of tide for that creek. Currently those data would be included in the assessment because it is enveloped in the data region for YRKMH.

- **Action Item:** Jon followed up with Tish to share that the tool uses a 92-segment boundary with a 500-meter buffer. Tish looked to see how many DEQ stations would fall through the cracks with a 500-meter buffer, which only excludes 13 stations. She agreed that 13 is a small enough number to continue using the 500-meter buffer.

Q from chat: Melinda Cutler: Thanks so much Rebecca, your explanation and documentation were really clear and helpful. I had one question as I was listening, was the segment grouping analysis only done with 2021 data?

- *A from chat: Rebecca Murphy:* Melinda, good question. I actually tested 2022 and 1993 as well. As it turned out, there were so many iterations that settling on one year to make graphs, etc was necessary. 2021 was selected simply because there was a good amount of ConMon and it was recent.
- *Q from chat: Melinda Cutler:* Gotcha, thank you! Did you see any initial differences in the accuracy with the 32 groupings with those different years, or was it pretty consistent?
- *A: Rebecca Murphy:* I did test combinations for different years (1993-2022). The reason for 1993 is that if there isn't much data collected, like in the 90s when we

didn't have ConMon, we needed to create bigger sections since there wasn't enough data to fit the GAM. That 1993 test was one of the reasons I grouped some individual segments together instead of running them by themselves. In case the monitoring programs need to drop ConMon in certain areas or have them rotate, we want to have a safety net so we can at least fit the models to just the fixed station network. That would be the major difference year to year.

- **Response:** *Elgin Perry:* The exercise Rebecca did assessed the fitting capabilities for only DO. If we start looking at other parameters, things might change. There's a lot of evaluation work that needs to be done with this tool.
- **Response:** *Breck Sullivan:* Yes, more can be done, but also knowing that with this tool we are going to be able to do better than what we currently are doing now.

1:00 PM: Beginning of Addressing Stakeholder Questions about the 4-d Interpolator

Summary: Breck Sullivan introduced this conversation and facilitated the questions and discussion. This question came from a meeting with the Maryland Department of the Environment (MDE) about the 4-d interpolator. They posed a lot of great questions, some of which the team were unable to get to. This agenda item featured one of the questions that still hadn't been answered. Breck also shared that she'd like to know how the group wants questions answered. Feel free to send feedback on this to Breck (bsullivan@chesapeakebay.net).

*Question***:** What are the shortest time values that will be used in the 4-d Interpolator? Is it one hour? We're curious why this was chosen.

- **A:** *Elgin Perry:* The time dimension in the 4-d interpolator is calculated as an independent variable. You could do interpolations on any time scale from a theoretical point of view. There are trade-offs about having a fine time scale for the interpolations. If you make it too fine, it chews up a lot of computer time and disk space to get and store them. If you make it too coarse, then we'll miss good estimates on the instantaneous minimum. We chose an hour because we could crunch the numbers in a reasonable amount of time and still give us something that was a reasonably close approximation to what the instantaneous minimum would be. This isn't fixed in stone. If someone had justification for finer or coarser scale, we could adjust this. We don't have any data on a finer scale than 10-15 minutes. Those are the constraints we're working with. It seemed like hourly data was a good compromise.
- **A:** *Jon Harcum:* Our continuous monitoring (ConMon) data being at 10-15 minutes has set the benchmark for me. In terms of being able to populate the parameters

that go into the smoothing curves and hourly components of the interpolator, it seemed that an hour timescale matched well with the data we had to support it.

- ***Comment from chat:*** *Marjy Friedrichs:* Given the time scales of the relevant physical and biogeochemical processes in the Bay, I fully support the one-hour decision!

Q: *Matt Stover:* If you have ConMon data that is collected every 15 minutes, how do you put that into the 4-d interpolator?

- ***A:*** *Jon Harcum:* For the ConMon data, we did down select the data to an hourly basis because we needed a common framework for the purposes of evaluating temporal correlations. The opportunity to revisit that is probably coming up this fall, where we may be able to look at that again. Now that we have confidence that we know how to use the information, it opens up the opportunity to refine that evaluation.
- ***A:*** *Elgin Perry:* A lot of the procedures we are using to create our smoothing curves are statistically based. In using these procedures, there are always assumptions you need to make. In this case, we assume they are correlated and identically distributed. I know it may sound like we're throwing away data when we say that we're only using one per hour and we don't use the ones that are collected in between. We are caught in a bind because we want them to be identically distributed. If you averaged all of the data in one hour, that would have a much smaller variance than any one datum. From a statistical point of view, there is a justification for preferring rarefication of the data as opposed to averaging.

Comment: *Marjy Friedrichs:* I think the computational argument for using an hour compared to 10-15 minutes is strong. I also want to add that if you look at the time scales of the dominant processes, the tides, the growth of phytoplankton, it would lead you to decide on an hour rather than 10-15 minutes. I think that's another argument for using one hour.

Q: *Melinda Cutler:* I think the hourly timescale makes sense. If we're just picking one datum, things like the instantaneous minimum could get lost in the criteria assessment. If we have a moment in time of that 10-15 minute data that dips below our criteria values that we might be missing. I don't know if that would work within this tool or if the instantaneous data needs a separate assessment.

- ***A:*** *Elgin Perry:* That's a very good point. I think we have a tool built into our procedure that does deal with that. When we do our interpolations, we've allowed there to be a random component. By doing analysis of ConMon data, we've been able to estimate the autocorrelation behavior of data through time. When we do our interpolations, we add in randomly generated components that reflects the time series nature of

the data. We can do 100 repeated simulations, which would give us an envelope of predictions for a single point in time and space. It's our thinking that by reproducing this random variability that we've observed in the data that we'll be capturing that noise that happens at the fine scale.

- **Q:** *Melinda Cutler:* That's helpful, especially for areas where we don't have data. I was thinking it would be helpful to look at those areas where we have actual concrete data that's showing what is happening there. It's also helpful to consider Tish's comment (below) that the instantaneous minimum typically represents one hour.

- **A:** *Elgin Perry:* Yes. When we're doing our model fitting, we rarify to one hour data. When we do our simulations, we do our interpolations at a one-hour schedule. When we're doing our validations and comparing what we're getting from our interpolator to observed data, then we use all of the observed data to try to see if the noise we're imputing to our interpolator reflects to the noise we see in the 10-15 minute observed data.

Q from chat: *Jim Hagy:* Do you interpolate the data to get them "on the hour" or does the model use data that is hourly but not necessarily "on the hour?"

- **A from chat:** *Tish Robertson:* The instantaneous minimum criteria represents a one-hour duration (typically).

- **A from chat:** *Jon Harcum:* For purposes of the cyclic component, no we did not interpolate values. (We did interpolate values for other exploratory analyses, e.g., wavelet analysis.)

- **Response from chat:** *Jim Hagy:* Thanks. I was wondering if for statistical purposes you needed the data to fit in a regularized matrix of some sort, or if you could have data at 1:05 PM, 2:05 PM, etc. at one station and 1:10, 2:10, etc. at other stations.

Additional Questions Posed

Amanda Shaver (from chat): One of our questions revolves around the type and how much data the 4D interpolator will need (going forward) to get the best results. Feel free to get back to us, no need to try to address it now. What are the data that are needed to get the best results from the 4-D Interpolator?

- What kind? Discrete vs high-frequency
- How much?
- Where?
- What happens when we don't have the optimal data, but still have some data?

Comment: *Breck Sullivan:* Thank you, Amanda, for submitting some of your questions. We'd love feedback into whether you liked this format of question and answering or if there is something else you'd like to see in how we address your questions.

- ***Comment:*** *Melinda Cutler:* I don't want to speak for everyone, but I found this discussion really helpful. I like that we could ask our follow-up questions. Maybe we could write down the answered questions in a reference document, so we aren't asking the same questions.
- ***Response:*** *Breck Sullivan:* If we use the same format of posing a question and having open discussion during the meetings, Allison takes minutes which serve as documentation. We could also copy and paste it into a frequently asked questions document too.
- ***Comment:*** *Amanda Shaver:* I agree with Melinda that a format like this is a good idea. I think an FAQ document to go along with communication and to use as a resource during communication with the team or with the public. Maybe this would have some concise answers in the FAQs and then we could point the public towards other documentation, like the meeting minutes, if they want to dive further.
- ***Comment from chat:*** *Matt Stover:* A set of FAQs based on these might be helpful!
- ***Response:*** *Breck Sullivan:* Yeah, I think that would be helpful. That is something we can work on in terms of documentation. I think you all submitting these types of questions would be helpful in starting FAQs based on your questions.

The next meeting will be [Monday, November 17, 2025 from 12pm-1:30pm](#).

1:30 PM: Adjourn

Attendance: Allison Welch (CRC), Gabriel Duran (CRC), Rebecca Murphy (UMCES), Breck Sullivan (USGS), Peter Tango (USGS), Jon Harcum (TetraTech), Erik Leppo (TetraTech), Amanda Shaver (VA DEQ), Tish Robertson (VA DEQ), Matt Stover (MDE), Marjy Friedrichs (VIMS), Carl Friedrichs (VIMS), Melinda Cutler (MDE), Elgin Perry, Molly Westbrook (DNR), Jim Hagy (EPA), Guido Yactayo (MDE), Angie Wei (UMCES), Mark Trice (MD DNR), Joseph Morina (VA DEQ), Richard Tian (MD DNR), Andrew Keppel (MD DNR), and Jay Lazar (NOAA).